









THE ORIGIN OF SPECIES.

anstanh Worisce

263066-2001

" But with regard to the material world, we can at least go so far as this—we can perceive that events are brought about not by insulated interpositions of Divine power, exerted in each particular case, but by the establishment of general large."

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Ist prich of be row. Ist prich of be row. In improved texts. Out wirre Charge Hurreflew (vo 1176)

WHEWELL: Bridgewater Treatise.

"The only distinct meaning of the word 'natural' is stated, fixed, or settled; since what is natural as much requires and presupposes an intelligent agent to render it so, i.e., to effect it continually or at stated times, as what is supernatural or miraculous does to effect, it for ence."

BUTLEN; Analogy of Revealed Religion.

"To conclude, therefore, let no man out of a weak conceit of subsity; or an ill-applied moderation, think or maintain, that a man can search too for or be too well studied in the book of God's word, or in the book of God's works; divinity or philosophy; but rather let men endeavour an endless progress or proficience in both."

BACON : Advancement of Learning.

Down, Bechenham, Kent, First Edition, November 24th, 1859. Sixth Edition, Jan. 1872.

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

By CHARLES DARWIN, M.A., F.R.S., &c.

SIXTH EDITION, WITH ADDITIONS AND CORRECTIONS.

(ELEVENTH THOUSAND.)

LONDON:

JOHN MURRAY, ALBEMARLE STREET.

1872.

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BY THE SAME AUTHOR.

THE DESCENT OF MAN AND SELECTION IN RELA-TION TO SEX. Biolds Thousand. 2 vols. Sto. 246. MURBAR, 1871.

- THE VARIATION OF ANIMALS AND PLANTS UNDER DOMESTICATION. With Illustrations. Third Theorem 4, 2 vol. Sve. 294, Murmar, 1868.
- A NATURALIST'S VOYAGE ROUND THE WORLD; or, a Jonesal or Researchers for othe NATERAL HERORY AND GOLOGY of the Convertence visited during the voyage of H.M.S. 'Bengle,' under the command of Captain FraDor, R.N. Referent Phononsol, Post Syn. 91. MURLAR, J. 1998,
- ON THE VARIOUS CONTRIVANCES BY WHICH BRITISH AND FOREIGN ORCHIDS ARE FERTILISED BY INSECTS; and on the Good Experses or Consume. With Woodcuts. Pust Svo. 5v. Mcmaar.
- ON THE STRUCTURE AND DISTRIBUTION OF CORAL REEFS. SHITH, ELDIN, & CO.

GEOLOGICAL OBSERVATIONS ON VOLCANIC ISLANDS. SHITH, ELDER, & CO.

GEOLOGICAL OBSERVATIONS ON SOUTH AMERICA. Serrer, Eaden, & Co.

- A MONOGRAPH OF THE CIRRIPEDIA. With numerous linstrations. 2 vols. Svo. Ray Society. Hardwicks.
- ON THE MOVEMENTS AND HABITS OF CLIMBING PLANTS. With Woodcuts. WILLIAMS & NORDATE.
- FACTS AND ARGUMENTS FOR DARWIN. By FRITZ MÜLLIR. From the German, with Additions by the Author. Translated by W. S. DALLAR, F.L.S. With Hilustrations. Post Syc. 6s. MULLIAR.

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ADDITIONS AND CORRECTIONS

TO THE SIXTH EDITION.

NUMEROUS small corrections have been made in the last and present editions on various subjects, according as the evidence has become somewhat stronger or weaker. The more important corrections and some additions in the present volume are tabulated on the following page, for the convenience of those interested in the subject, and who possess the fifth edition. The second edition was little more than a reprint of the first. The third edition was largely corrected and added to, and the fourth and fifth still more largely. As copies of the present work will be sent abroad, it may be of use if I specify the state of the foreign editions. The third French and second German editions were from the third English, with some few of the additions given in the fourth edition. A new fourth French edition has been translated by Colonel Moulinié; of which the first half is from the fifth English, and the latter half from the present edition. A third German edition, under the superintendence of Professor Victor Carus, was from the fourth English edition ; a fifth is now preparing by the same author from the present volume. The second American edition was from the English second. with a few of the additions given in the third; and a third American edition has been printed from the fifth English edition. The Italian is from the third, the Dutch and three Russian editions from the second English edition. and the Swedish from the fifth English edition.

Additions and Corrections.

Fifth Edition.	Sixth Edition.	Chief Additions and Corrections.
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100	68	Influence of fortuitous destruction on natural selection.
158	101	On the convergence of specific forms.
220	142	Account of the Ground-Woodpecker of La Plata modified,
225	145	On the modification of the eve.
230	149	Transitions through the acceleration or retardation of the period of reproduction.
231	150	The account of the electric organ of fishes added to.
233	151	Analogical resemblance between the eyes of Cephalopod and Vertebrates.
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255	168	The first part of this new chapter consists of portions, in much modified state, taken from chap, iv, of the forme editions. The latter and larger part is new, and relate chiefly to the supposed incompetency of natural selection to account for the incipient stages of useful structure. There is also a discussion on the cause which proves
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080		foster-brothers confirmed.
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568	421	Natural selection not the exclusive agency in the mod fication of species, as always maintained in this work.
572	424	The belief in the separate creation of species generally hel by naturalists, until a recent period.

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AN HISTORICAL SKETCH

OF THE PROGRESS OF OPINION ON THE ORIGIN OF SPECIES.

PREVIOUSLY TO THE FUBLICATION OF THE FIRST EDITION OF THIS WORK.

I wan, here a give a held absch of the progress of optimion on the torigin of Species. Totali iterative the gravitational transmittabelieved that species were immutable productions, and had been abscheden the species of the species of the species of the abscheden transmittation of the species of t

Lamack was the first man whose conclusions on the subject excited much attention. This justly-celebrated naturalist first published his views in 1801; he much enlarged them in 1809 in his 'Philosophie Zoologique,' and subsequently, in 1815, in the Introduction to his 'Hist, Nat, des Animaux sums Vertébres'. In these

• Aristeita, in his 'Physica accordinations' (bb. 2, org. 8, e. 2, thermal section of the sec

Historical Sketch.

works he upholds the doctrine that all species, including man, are descended from other species. He first did the eminent service of arousing attention to the probability of all change in the organic as well as in the inorganic world, being the result of law, and not of miraculous interposition. Lamarck seems to have been chiefly led of distinguishing species and varietics, by the almost perfect gradation of forms in certain groups, and by the analogy of domestic productions. With respect to the means of modification he attributed something to the direct action of the physical conditions of life and disuse that is, to the effects of habit. To this latter avency he the long neck of the giraffe for browsing on the branches of trees But he likewise believed in a law of progressive development ; and as all the forms of life thus tend to progress, in order to account for the existence at the present day of simple productions, he maintains that such forms are now spontaneously generated.*

Geoffroy Saint Hilairo, as is stated in his 'Life, 'written by his may, mapeted, as active at 1780, that what we call species are various degenerations of the same type. It was not tutil 1926 that he published his down/teit on hist the same forms have not been perpetuated since the origin of all things. Configure sents to have relied histly on the conditions of 10 key, the "mode and maintim" as the cases of damps. He was excitous in during combinations and the range of damps. He was excitous in during combinations and the range on damps of cost down models where the range of the same transformer and the range of the rang

• I have taken the date of the fore publication of Lanuer's from 104 forefore yokin Hinney V (Hun NA, Ganera's (Yum L), P. (408), 18890 erelised for history of equation as this adjust, In this work, a full consult is given gravitative. It is the neural neural probability of the state of

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In 1813, Dr. W. C. Wells read before the Royal Society 'An Account of a White Female, part of whose skin resembles that of Essays upon Dew and Single Vision' appeared in 1818. In this it only to the races of man, and to certain characters alone. After remarking that negroes and mulattoes enjoy an immunity from certain tronical diseases, he observes, firstly, that all animals tend to vary in some degree, and, secondly, that agriculturists improve their done in this latter case " by art, seems to be done with equal efficacy, though more slowly, by nature, in the formation of varieties of mankind, fitted for the country which they inhabit. Of the accidental varieties of man, which would occur among the first few and scattered inhabitants of the middle regions of Africa, some one would be better fitted than the others to bear the diseases of the country. This race would consequently multiply, while the others would decrease ; not only from their inability to sustain the attacks vigorous neighbours. The colour of this vigorous race I take for granted, from what has been already said, would be dark. But the same disposition to form varieties still existing, a darker and a darker race would in the course of time occur ; and as the darkest would be the best fitted for the climate, this would at length become the most prevalent, if not the only race, in the particular country in which it had originated." He then extends these same views to the white inhabitants of colder climates. I am indebted to Mr. Rowley, of the United States, for having called my attention, through Mr. Brace, to the above passage in Dr. Well's work,

The line, and lice: W. Herber, afterwards Flow of Machalener, In the fourth volume of the Herbergium Transactions, HE22, and in his seven on the "Annurylikouses" (AST, p. 10, 200), declares that in his seven of the Annurylikouses" (AST, p. 10, 200), declares that of the Annurylikouses of the Annurylikouses of the Annurylikouse manner takes of variations. The extends the same view to animals the Dana holieves that single species of each physics used content of the Annurylikouse of the Annurylikouse and the Annulia and the Annurylikouse and the Annurylikouse and the Annutary and the Annurylikouse and the Annurylikouse and the Annuer existing appears.

In 1826 Professor Grant, in the concluding paragraph in his well known paper ('Edinburgh Philosophical Journal,' vol. xiv. p. 283) on the Spongilla, clearly declares his belief that species are descended from other species, and that they become improved in the course of modification. This same view was given in his 55th Locture, published in the 'Lancet' in 1834.

In 1831 Mr. Patrick Matthew published his work on 'Naval Timber and Arboriculture,' in which he gives precisely the same view on the origin of species as that (presently to be alluded to) propounded by Mr. Wallace and myself in the 'Linnean Journal' and as that enlarged in the present volume. Unfortunately the view was given by Mr. Matthew very briefly in scattered passages unnoticed until Mr. Matthew himself drew attention to it in the ' Gardeners' Chronicle,' on April 7th, 1860. The differences of Mr. Matthew's view from mine are not of much importance : he seems to consider that the world was nearly depopulated at successive periods, and then re-stocked ; and he gives as an alternative, that new forms may be generated " without the presence of any mould or germ of former aggregates." I am not sure that I understand some passages : but it seems that he attributes much influence to the direct action of the conditions of life. He clearly saw, however, the full force of the principle of natural selection.

The celebrated geologist and naturalist, Von Buch, in his excellent 'Description Physique des Isles Canaries' (1836, p. 147), clearly expresses his belief that varieties slowly become changed into permanent species, which are no longer capable of intercrossing.

Ratinesque, in his 'New Flors of North America', published in 1826, wrote (p, 6) as follows:—"All species might have been varieties once, and many varieties are gradually becoming species by assuming constant and peculiar characters," but farther on (p, 18) he adds, "except the original types or ancestors of the genus."

In 1843–44 Professor Haldeman ('Boston Journal of Nat. Hist. U. States,' vol. iv. p. 408) has ably given the arguments for and against the hypothesis of the development and modification of species: he seems to lean towards the side of change.

The 'Vestiges of Creation' appared in 1844. In the test and much improved clitica (1855) the anonymous author any (p. 185).—The proposition determined on after much consideraand oldest up to the highest and most recent, are, under the providence of God, the results, *first*, of an impute which has been imparted to the forms of life, advancing them, in definite times, by generation, through erades of generation terminating in the

Historical Sketch.

highest dicotyledons and vertebrata, these grades being few in number, and generally marked by intervals of organic character, which we find to be a practical difficulty in ascertaining affinities ; second, of another impulse connected with the vital forces, tending, in the course of generations, to modify organic structures in accordance with external circumstances, as food, the nature of the habitat, and the meteoric agencies, these being the 'adaptations' organisation progresses by sudden leaps, but that the effects produced by the conditions of life are gradual. He argues with much force on general grounds that species are not immutable productions. But I cannot see how the two supposed "impulses" account in a scientific sense for the numerous and beautiful coadaptations which we see throughout nature ; I cannot see that we thus gain any insight how, for instance, a woodpecker has become adapted to its peculiar habits of life. The work, from its powerful and brilliant style, though displaying in the earlier editions little accurate knowledge and a great want of scientific caution, immediately had a very wide circulation. In my opinion it has done excellent service in this country in calling attention to the subject, in removing prejudice, and in thus preparing the ground for the reception of analogous views.

In 1846 the veteran geologist M. J. d'Ornalius d'Halley published in an excellent hough short paper (P halleins de l'Acad, Roy. Bruxelles, tom. xili, p. 581), his epinion that it is more probable that new species have been produced by descent with modification than that they have been separately created : the author first promulgated this opinion in 1831.

"Professor Owen," in 1840 C Matture of Limble," poly, works as follows......" Whe actively allel laws an annihistori in the field under diverse such modifications, yron this planet, long prior to the existence of these similar placet inter studies compility is. To what natural laws or excendary causes the orderiv mecosion and programsion of and the equin plenomena may have been committed, programsion of end with order of the studies of the studies operation of erativity power, or of the end-mational discontinue, in 1858, he speake (p. 1k) of "the axism of the absorbiant builting, he addle, "These phenomena shake our confidence in the conclusion, that the Apteryx of New Zealand and the Red Grouss of Edgatad were discust environment of the stress in middle theory and "tend". Hencing the red for the stress in the laws of the well restantist the nodogist means 't precess he known and

Historical Sketch.

what " He amplifies this law by adding, that when useds causes as that of the Biol Grosse are * emeranced by the acologiet as writeness of distinct creation of the bird in and for such histophy theory and the Known with the two He Biol Grossen same to a standard or the state of the bird of the bird and the expressing much ignorance, his belief that both the bird and distands over their origin to a grant fair Creative Cause." If we interpret these sentences given in the same Address, one by the other, it apparent that this sentimet pithologier field in 1508 his confiftence shatem that the Aytery rand the Biol Grosse first appaued the heave not state at the Aytery rand the Biol Grosse present we have not state at the avera of the bird of the state of the state of the heave not state at the avera of the state of the state of the state of the state at the avera of the state of the state of the state of the heave not state at the state of the

This Address was delivered after the papers, by Mr. Wallace and invself on the Origin of Species, presently to be referred to, had been read before the Linnean Society. When the first edition of this work was published, I was so completely deceived, as were many others, by such expressions as "the continuous operation of creative power," that I included Professor Owen with other palacontologists as being firmly convinced of the immutability of species; but it appears ('Anat, of Vertebrates,' vol. iii. p. 796) that this was on my part a preposterous error. In the last edition of this work I inferred, and the inference still seems to me perfectly just, from a passage beginning with the words " no doubt the type-form," &c. (Ibid. vol. i. p. xxxv.), that Professor Owen admitted that natural selection may have done something in the formation of new between Professor Owen and the Editor of the 'London Review,' natural selection before I had done so; and I expressed my surprise and satisfaction at this announcement : but as far as it is possible to understand certain recently published passages (Ibid. vol. iii, p. 798), I have either partially or wholly again fallen into error. sial writings as difficult to understand and to reconcile with each other, as I do. As far as the mere enunciation of the principle of

M. Isidore Geoffroy Saint Hilaire, in his Lectures delivered in 1850 (of which a Résumé appeared in the 'Revue et Mag. de

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Zoolog," Jan. 1951), briefly gives his reason for beliering that specific characters 'nost ficks', por endouse enjoys, hard qu'elle se perprêten au millet des mêmes erromstances : la se modifica, i de circostances ambinates viennest à chongre." He résund, l'observation des animax auxysges démontes della la variabilité libilité due supèce. La capériense net les animax auxysges derenna domostiques, et sur la saintaxax domostiques reborenes derenna domostiques derenna deren derenna d

Proma actendar lately issued it appears that Dr. Preke, in 1861. (Dablin Meiclan Prese', D. 322), promodel the doctions that all organic beings have descended from one primerial form. His grounds of being and treatment of the anilytest are whichly different from mine, but as Dr. Prack has now (1861) published his Basay on 'the Origin of Speciels by means of Organic Affinity', the diffientia atompt to give any idea of his views would be superfluous on my port.

Mc Hersett Spenory, in an Zewy (originally published in the Uander, March 1962, and republished in his 'Essays' in 1858), has contrasted the theories of the Creation and the Derelopment of equalo bingly with remarkable abilit and force. He argues from the analogy of domestic productions, from the difficulty of distinguishing, this types have been molitorily on the difficulty of distinguishing greets and varieties, and from the principle of general specification of the type of the specific distribution of the theory of the specific distribution of the specific distribution of the specification of the type of the specific distribution of the theory has also result. Psychology on the principle of the necessary laytiment of educ mental power and organity by gradiation.

In 1852 M. Satalia, a distinguished botainis, expressly attach, in a malamika paper on the Origin of Speece (N Farre II Meritolo, P. 102; inter party republished in the "Networke Archives and Madom", toon. I., 2113, his bield that apoelsa are brend in an analogoue manner as varieties are under entityation; and the down of shore here abelican act under a strateging of the brend of the strateging of the strateging of the strateging present. He lays weight on what he emitta that and the principle of finality, " prismane mysteleness, indereminée; fatalité pour las mas pour strates, valoue la volume, et la durée de channel que, e maion drende, la forme, le volume, et la durée de channel que, e maion durée, la forme y volume, et la durée de channel que, e maion.

de sa destinée dans l'ordre de choses dont il fait partie. C'est cette puissance qui harmonise chaque membre à l'ensemble en l'appropriant à la fonction qu'il doit remplir dans l'organisme général de la nature, fonction qui est pour lui sa raison d'être."*

a matrix joint of up to plant, the second state of the second sta

In this same yar, 1863, Dr. Scharflausen published an crclenits puppher (Verhand, eds Nathathi, Vereina der Prenz, Rheinhand, "deo, in wicht her maintains the progravity developlanet of erganic forms on the archt. In thirds that many specialace kept true for long periodic, whereas a few have become molifield. The distinction of species he explains by the distinguishment of segments from the excit. In the same mean special constant of the second state of the second state of the prenative state of the second state of the second state of the true and segmental from the excit." Do now estimate, but are used to reach the state of the second state there outlines in the state of the second state of the second state there outlines in the state of the second state of the second state there outlines in the state of the second state of the second state there outlines in the state of the second state of the second state there outlines in the state of the second state of the second state there outlines in the state of the second state of the second state there outlines in the state of the second state of the second state there outlines in the state of the second state of

⁶⁰ Polyavitka ukowa Prench botanist, M. Lecoq, writes in 1854 (* Endes aur Géograph. 10c., * tom. 1, p. 260), ** On voit que nes recherches aur la fixitó on la variation de l'arapée, nous conditions directement aux idées énsies, par deux hommes justement edibres, Geoffroy Sain-Hähre et Genther. ** Somo other passages scattered through M. Lecoq's large work, make it a little doubful how far he extends hai views on the modification of species.

The 'Philosophy of Creation' has been treated in a masterly manner by the Rev. Baden Powell, in his' Essays on the Unity of Worlds,' 1855. Nothing can be more striking than the manner in which he shows that the introduction of new species is "a regular."

 Form references in Breach's Unterschwapen there die Entstelchungen Genergi, 'n appears that the celebraria and palaestochysic Unger published, in 1852, ihs ballet flut appears undergo development and molitiseries. Allon, Breisen, in Flutar and Dilten's werk on somali Stelch, supressed, in 1821, a similar ballet. Similar views have, as is well known, ben ministated by (low is his in appriate). Nature Philosophic, 'Tomo obter discontinues of the second stellar stellar spectra and the ball ballet. The second stellar stellar spectra are continue all yieling produces are continue and pile ball produces are continued.

I may add, that of the thirty-four authors named in this Historical Sketch, who believe in the modification of species, or at least disbelieve in separate acts of creation, twenty-seven have written on special branches of natural history or geology.

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not a casual phenomenon," or, as Sir John Herschel expresses it, "a natural in contradistinction to a minaculous process."

The third volume of the 'Journal of the Linnean Society' contains papers, read July 1st, 1858, by Mr. Wallace and myself, in which, as stated in the introductory remarks to this volume, the theory of Natural Selection is promulgated by Mr. Wallace with adminable force and clearness.

Von Baer, towards whom all zoologists fed so profound a respect expressed about the year 1850 (see Yrof. Rudohh Wagner, "Zoologush-Anthropologische Untersnehmagen," 1861, s. 61) his conviction, chieldy grounded on the laws of geographical distribution, that forms now perfectly distinct have descended from a single parent-form.

In June, 1859, Professor Huxley gave a lecture before the Royal Institution on the ' Persistent Types of Animal life.' Referring to such cases, he remarks, "It is difficult to comprehend the meaning of such facts as these, if we suppose that each species of animal and plant, or each great type of organisation, was formed and act of creative power; and it is well to recollect that such an assumption is as unsupported by tradition or revelation as it is opposed to the general analogy of nature. If, on the other hand, we view ' Persistent Types' in relation to that hypothesis which supposes the species living at any time to be the result of the gradual modification of pre-existing species-a hypothesis which, though unproven, and sadly damaged by some of its supporters, is yet the only one to which physiology lends any countenance; their existence would seem to show that the amount of modification very small in relation to the whole series of changes which they have suffered."

In December, 1859, Dr. Hooker published his 'Introduction to the Australian Flora'. In the first part of this great work he admits the truth of the descent and modification of species, and supports this doctrine by many original observations.

The first edition of this work was published on November 24th, 1859, and the second edition on January 7th, 1860,



ORIGIN OF SPECIES.

INTRODUCTION.

Wrats on board H.J.K., "Bangle" as naturalist, T was much strengt with cartian facts in the distribution of the equatio beings inhabiing South America, and in the geological relations of the present to the strength of the strength of the strength of the strength in the strength of the strength of the strength of the strength on the origin of species—that mystary of mysterion, as it has been distributed by one of our greatest philosophics. On my return hence, it second by our strength of the strength of mysterion great on the origin of species—that mystary of mysterion, as it has been distributed by the strength of the strength of the strength one constraints of the strength for year's work I allowed mysterior in the onlyder, and of the conclusion, which then seemed to me probable : from that of the transform that I have not here have by incoming to a decision.

My work is now (2650) northy finished, but as it will take as may more years to complete it, and an up-hashih is far from strang. I have been urged to publish this Ahstract. I have more expecially been induced to do this, as Mr. Wallace, who is now studying the natural history of the Malay antipicage, has arrive equiping expected. In 1858 he next me an emmoir on the online, with a request that I would forward it to Sr Charles Lynd, who wit is to the Homme Society, and it is published in the third volume of the Journal of that Society. Silv Cl 1yell and Dr. Hookey, we have the to be the source of the source of the source of the source of the bus there of the york-the latter faring read my sketch of Wallacek curved, seems brief curstaf from my minnscepta.

This Abstract, which I now publish, must necessarily be imperfect. I cannot here give references and authorities for my

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several statements ; and I must trust to the reader repuisity considered in my accurate, No doubt error will have erryt in, through I here I have always here cardious in trusting to good authorities alone. I can here give only the general conclusions at which I have arrived, with a fore facts in illustration, but which, have a structure of the structure of the structure of the last L of or the needing of the structure of the structure in the structure of the structure of the structure of the facts, with references, on which may conclusion have been grounded and I hope in a full card any aperatry biading to conclusion directly organise to those at which I have turkes, the facts and any organism of both directs of each queriest on a structure of the months of the structure of each queriest on the structure of each queriest on the structure of the structure of the structure of each queriest on the structure of the structure of the structure of each queriest on the structure of the structure of the structure of each queriest on the structure of the structure of the structure of each queriest on the structure of the structure of the structure of each queriest on the structure in provide structure of the structure o

I much regret that want of space prevents my having the satisfaction of acknowledging the generous assistance which I have received from very many naturalists, some of them peronally known to me. I cannet, however, let this opportunity pass without expressing my deep obligations to Dr. Hocker, who, for the last fifteen years, has aided me in every possible way by his large stores of theoretical stores of theoreti

In considering the Origin of Species, it is quite conceivable that a naturalist, reflecting on the mutual affinities of organic beings, on their embryological relations, their geographical distribution, clusion that species had not been independently created, but had descended, like varieties, from other species. Nevertheless, such a conclusion, even if well founded, would be unsatisfactory, until it could be shown how the innumerable species inhabiting this world and coadaptation which justly excites our admiration. Naturalists continually refer to external conditions, such as climate, food, &c., as the only possible cause of variation. In one limited sense, as we shall hereafter see, this may be true; but it is preposterous to attribute to mere external conditions, the structure, for instance, of the woodpecker, with its feet, tail, beak, and tongue, so admirably adapted to catch insects under the bark of trees. In the case of the mistletoe, which draws its nourishment from certain trees, which has seeds that must be transported by certain birds, and which has certain insects to bring pollen from one flower to the other, it is with its relations to several distinct organic beings, by the effects

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of external conditions, or of habit, or of the volition of the plant itself.

It is, hencieve, of the highest importance to gain a clear insight into the means of modification and cadopitation. At the commencement of my observations it is sensed to me probable that a careful and yeld constrained anniash and of calibrated plants would offer the best damos of making out this observe problem. Nor have new new new plant plants and that our innovelapping imported hings in the sofvariation mader domestication, afforded the best and andset clear. If we returned and many afforded the best and andset clear, statisming the set of the set of the set of the set of the statism statisming the set of the set of the set of the set of the set statisming the set of statisming the set of the set of the set of the set of the set statements.

a large amount of hereditary modification is at least possible ; and, what is equally or more important, we shall see how great is the variations. I will then pass on to the variability of species in a state of nature; but I shall, unfortunately, be compelled to treat this subject far too briefly, as it can be treated properly only by giving long catalogues of facts. We shall, however, be enabled to discuss what circumstances are most favourable to variation. In the next chapter the Struggle for Existence amongst all organic beings throughout the world, which inevitably follows from the high geometrical ratio of their increase, will be considered. This is the doctrine of Malthus, applied to the whole animal and vegetable kingdoms. As many more individuals of each species are born than recurring struggle for existence, it follows that any being, if it vary however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be naturally selected. From the strong principle of inheritance, any selected variety will tend to

This fundamental subject of Natural Selection will be treated at some length in the fourth chapter and we shall then see how Natural Selection almost invertiably causes much Extinction of the loss improved formed I/b, and leads to what I have called Divergence of Character. In the next chapter I shall discuss the complex will like known in the five successful discuss the complex will be given: manely, fasis, the distinction of the five successful will be given: manely, fasis, the distinction of the time of the second will be given: manely, fasis, the distinction of the time of the second will be given: manely, fasis, the distinction of the time of the second will be given: manely, fasis, the distinction of the time of the second se

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simple bigg or a simple organ can be changed and perfected (into a highly develop) leng or into an elaboratizy constructed ergangaccounty, the analysis of function, or the mental powers of animaly secondly, the analysis of metricular second second second second tables, by the simple of the second sec

No one ought to feel energies at much remaining as yet more explained in regard to the origin of operas and varieties, if the make due allowance for our problem Hyponneon in regard to the mutant due allowance for our problem Hyponneon in regard to the mutant due allowance for our problem Hyponneon in the section of the protein values are observing as which we have the mutaneous, and why autober allow a prediction of the highest inperiors, for they determine the preserving and the section of the highest inperiors, for they determine the preserving parts possigniar spectra of the section of the mutant relations of the immersche in history. Although much due mutant is discuss and will loop remain observation of the section of which is no explosing that each mutantian of the section of which is no equivale, that the view which most assumption nature that each species has been independently created—section-musing that each species has been independently created—sections mutantian of the species. For the energy excitation of the species is an excitation of the species. For theremore, I am corrison the descendants of the species. Purcharence, I am corrison with the species has been independently created as precises are the descendants of the species. Purcharence, I am corrison the descendants of the species. Purcharence, I am corrison the descendants of the species. Purcharence, I am corrison the descendants of the species. Purcharence, I am corrison the descendants of the species. Purcharence, I am corrison the descendants of the species. Purcharence, I am corrison the descendants of the species. Purcharence, I am corrison the descendants of the species. Purcharence, I am corrison the descendants of the species. Purcharence, I am corrison the descendants of the species are the species of the species are the species are the species of the species are the species

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CHAPTER I.

VARIATION UNDER DOMESTICATION.

Canna of Variability — Effects of Habit and the use or discuss of Parts — Gerradust Variability — Effects of Habit and the use or discuss of Parts — Overdated Variation — inheritones — Character of Dimensity Variaties — Difficulty of distinguishing between Variaties and Species — Origin of Dimensity Variation from anse or more Species — Domastle Figures, their Differences and Origin — Principles of Solection, anticetty followed, their Difference Machine and Uscanceines Selection — Uhawown Origin of our Domastic Preductions — Circumstances favourable to Marky Specer & Solection,

Causes of Variability.

As far as I am able to judge, after long attending to the subject, the conditions of life appear to act in two ways,—directly on the whole organisation or on certain parts alones, and indirectly by affecting the reproductive system. With respect to the direct

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action, we must bear in mind that in every case, as Professor Weismann has lately insisted, and as I have incidentally shown in my work on 'Variation under Domestication,' there are two forces ramety, the nature of the organism, and the nature of the

my work on 'Variation under Domestication,' there are twofactors ; namely, the nature of the organism, and the nature of the conditions. The former seems to be much the more important ; for nearly similar variations sometimes arise under, as far as we can judge, dissimilar conditions; and, on the other hand, dissimilar variations arise under conditions which appear to be nearly uniform. The effects on the offspring are either definite or indefinite. They may be considered as definite when all or nearly all the offspring of individuals exposed to certain conditions during several generations are modified in the same manner. It is extremely difficult to come to any conclusion in regard to the extent of the changes which have been thus definitely induced. There can, however, be little doubt about many slight changes,-such as size from the amount of food, colour from the nature of the food, thickness of the skin and hair from climate, &c. Each of the endless variations which we see in the plumace of our fowls must have had some efficient cause ; and if the same cause were to act uniformly during a long series of generations on many individuals, all probably would be modified in the same manner. Such facts as the complex and extraordinary out-growths which invariably follow from the insertion of a minute drop of poison by a gall-producing insect, show us what singular modifications might result in the case of plants from a chemical change in the nature of the sap.

Indefinite variability is a much more common result of changed conditions than definite variability, and has probably played a more important part in the formation of our domestic races. We see indefinite variability in the endless slight peculiarities which distinguish the individuals of the same species, and which cannot be accounted for by inheritance from either parent or from some more remote ancestor. Even strongly-marked differences occasionally appear in the young of the same litter, and in seedlings from the same seed-capsule. At long intervals of time, out of millions of individuals reared in the same country and fed on nearly the same food, deviations of structure so strongly pronounced as to deserve to be called monstrosities arise ; but monstrosities cannot be separated by any distinct line from slighter variations. All such which appear amongst many individuals living together, may be considered as the indefinite effects of the conditions of life on each different men in an indefinite manner, according to their state-

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of body or constitution, causing coughs or colds, rheumatism, or inflammations of various organs.

With respect to what I have called the indirect action of changed ditions, and partly from the similarity, as Köireuter and others crossing of distinct species, and that which may be observed with plants and animals when reared under new or unnatural conditions, Many facts clearly show how eminently susceptible the reproducthe male and female unite. How many animals there are which instincts. Many cultivated plants display the utmost vigour, and vet rarely or never seed ! In some few cases it has been discovered that a very triffing change, such as a little more or less water at some particular period of growth, will determine whether or not a plant will produce seeds. I cannot here give the details which but to show how singular the laws are which determine the reproduction of animals under confinement, I may mention that carnivorous animals, even from the tropics, breed in this country pretty freely under confinement, with the exception of the plantigrades or bear family, which seldom produce young : whereas carnivorous birds, with the rarest exceptions, hardly ever lay fertile eggs. Many exotic plants have pollen utterly worthless, in the same condition as in the most sterile hybrids. When, on the one and sickly, breeding freely under confinement; and when, on the other hand, we see individuals, though taken young from a state of nature perfectly tamed, long-lived and healthy (of which I could give numerous instances), yet having their reproductive system so seriously affected by unperceived causes as to fail to act, we need not he surprised at this system, when it does act under confinement. acting irregularly, and producing offspring somewhat unlike their parents. I may add, that as some organisms breed freely under in hutches), showing that their reproductive organs are not easily affected; so will some animals and plants withstand domestication

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or cultivation, and vary very slightly-perhaps hardly more than in a state of nature.

Some naturalists have maintained that all variations are connected with the act of sexual reproduction; but this is certainly an error; for I have given in another work a long list of "sporting plants," as they are called by gardeners ;---that is, of plants which have suddenly produced a single bud with a new and sometimes widely different character from that of the other buds on the same plant. These bud variations, as they may be named, can be propagated by grafts, offsets, &c., and sometimes by seed. They occur rarely under nature, but are far from rare under culture. As a the same tree under uniform conditions, has been known suddenly to assume a new character ; and as buds on distinct trees, growing under different conditions, have sometimes vielded nearly the same variety-for instance, buds on peach-trees producing nectarines, and buds on common roses producing moss-roses-we clearly see that the nature of the conditions is of subordinate importance in comparison with the nature of the organism in determining each particular form of variation ;---perhaps of not more importance than the nature of the spark, by which a mass of combustible matter is ignited, has in determining the nature of the flames,

Effects of Habit and of the Use or Disuse of Parts; Correlated Variation; Inheritance,

Changed habits produce an inherited effect, as in the period of the forwing of plastic when transported from one elimate to another. With animals the increased use or disuse of parts has had a more bareled influence: Has 1.6 in it rise descentish dusk; that the house of size wige weigh has and the houses of the log more, in proportion and his charges may be asidy attributed in the domains dusk flying model how, and walking more, than its will appreciate the grant and inherited evolvement of the delters in cover and gasts in creative where they are labitually milked, in comparison with these equars in only convertised animals en he mandel and how a suggestion of the delter in the straines of the effects of use. Not one of our domastic animals en he mandel has been suggested the thirty drosoing easy; and the view which has been suggested the stray of moring easy; and the view which measles of the our, from the maintals being seldom much alarmedy, some possible.

Many laws regulate variation, some few of which can be dimly

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seen, and will hereafter be briefly discussed. I will here only allude to what may be called correlated variation. Important changes in the embryo or larva will probably entail changes in the mature animal. In monstrosities, the correlations between quite distinct parts are very curious; and many instances are given in Isidore Geoffroy St. Hilaire's great work on this subject. Breeders believe that long limbs are almost always accompanied by an elongated head. Some instances of correlation are quite whimsical ; thus cats which are entirely white and have blue eves are generally deaf; but it has been lately stated by Mr. Tait that this is confined to the males. Colour and constitutional peculiarities go together. and plants. From facts collected by Heusinger, it appears that white sheep and pigs are injured by certain plants, whilst darkcoloured individuals escape : Professor Wyman has recently communicated to me a good illustration of this fact; on asking some farmers in Virginia how it was that all their pigs were black, they informed him that the pigs ate the paint-root (Lachnanthes), which coloured their bones pink, and which caused the hoofs of all but the black varieties to drop off; and one of the "crackers" litter for raising, as they alone have a good chance of living." Hairless dogs have imperfect teeth : long-haired and coarse-haired animals are apt to have, as is asserted, long or many horns ; pigeons with short beaks have small feet, and those with long beaks large feet. Hence if man goes on selecting, and thus augmenting, any parts of the structure, owing to the mysterious laws of correlation.

The results of the various, unknown, or bott imity understood laws of variation are infinitely compares and diversified. It is well worth while carefully to study the several treaties on some of the infinite several parts, as on the lepsicistic potentiac, even the shalls, for , and it is really surprising to note the enables points of diversified several several several several several several diversified several several several several several several laws become plassic, and departs in a slight degree from that of the parental type.

Any variation which is not inherited is unimportant for us, But the number and diversity of inheritable deviations of structure, both thouse of slight and those of considerable physiological importance, are endless. Dr. Prosper Lucas's treatise, in two largo volumes, is the fullest and the best on this subject. No here/ber

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doubts how strong is the tendency to inheritance; that like produces like is his fundamental belief; doubts have been thrown on this principle only by theoretical writers. When any deviation of structure often appears, and we see it in the father and child, we cannot tell whether it may not be due to the same cause having acted on both ; but when amongst individuals, apparently exposed to the same conditions, any very rare deviation, due to some extraordinary combination of circumstances, appears in the parent -say, once amongst several million individuals-and it reappears in the child, the mere doctrine of chances almost compels us to attribute its reappearance to inheritance. Every one must have heard of cases of albinism, prickly skin, hairy bodies, &c., appearing in several members of the same family. If strange and rare deviations of structure are really inherited, less strange and commoner deviations may be freely admitted to be inheritable. Perhaps the correct way of viewing the whole subject would be, tolook at the inheritance of every character whatever as the rule, and

The laws governing inheritance are for the most part unknown. No one can say why the same peculiarity in different individuals. of the same species, or in different species, is sometimes inherited and sometimes not so; why the child often reverts in certain tor; why a peculiarity is often transmitted from one sex to both sexes, or to one sex alone, more commonly but not exclusively to the like sex. It is a fact of some importance to us, that peculiarities either exclusively or in a much greater degree, to the males alone, A much more important rule, which I think may be trusted, is that, at whatever period of life a peculiarity first appears, it tends times earlier. In many cases this could not be otherwise; thus in the offspring when nearly mature ; peculiarities in the silkworm are known to appear at the corresponding caterpillar or cocoon stage. But hereditary diseases and some other facts make me believe that the rule has a wider extension, and that, when at the same period at which it first appeared in the parent. I believe this rule to be of the highest importance in explaining the laws of embryology. These remarks are of course confined to the first appearance of the peculiarity, and not to the primary cause-

which may have acted on the ovules or on the male element; in nearly the same manner as the increased length of the horns in the offspring from a short-horned cow by a long-horned bull, though amengring late in life, is clearly 4 us to the male element.

statement often made by naturalists-namely, that our domestic There would be great difficulty in proving its truth : we may safely or not nearly perfect reversion had ensued. It would be necessary in order to prevent the effects of intercrossing, that only a single variety should have been turned loose in its new home. Nevertheleas, as our varieties certainly do occasionally revert in some of their characters to ancestral forms, it seems to me not improbable that if we could succeed in naturalising, or were to cultivate, during many generations, the several races, for instance, of the cabbage, in very poor soil (in which case, however, some effect would have to be attributed to the definite action of the poor soil). that they would, to a large extent, or even wholly, revert to the wild aboriginal stock. Whether or not the experiment would succeed, is not of great importance for our line of anyument ; for by be shown that our domestic varieties manifested a strong tendency to reversion,-that is, to lose their acquired characters, whilst kept under the same conditions, and whilst kept in a considerable body, so that free intercrossing might check, by blending together, any slight deviations in their structure, in such case, I grant that we But there is not a shadow of evidence in favour of this view : to assert that we could not breed our cart and race-horses, long and short-horned cattle, and poultry of various breeds, and esculent vezetables, for an unlimited number of generations, would be opposed to all experience.

Character of Domestic Varieties: difficulty of distinguishing between Varieties and Species; origin of Domestic Varieties from one or more Species.

When we look to the hereditary varieties or races of our domestic . animals and plants, and compare them with closely allied species we generally perceive in each domestic race, as already remarked. less uniformity of character than in true species. Domestic more that, although differing from each other, and from other species of extreme degree in some one part, both when compared one with another, and more especially when compared with the species under nature to which they are nearest allied. With these exceptions (and with that of the perfect fertility of varieties when crossed -a species of the same genus in a state of nature, but the differences in most cases are less in degree. This must be admitted as true, for the domestic races of many animals and plants have been ranked by some competent judges as the descendants of aborigivarieties. If any well marked distinction existed between a domestic race and a species, this source of doubt would not so perpetually recur. It has often been stated that domestic races -do not differ from each other in characters of generic value. It can be shown that this statement is not correct ; but naturalists differ much in determining what characters are of generic value; all such valuations being at present empirical. When it is explained how genera originate under nature, it will be seen that we have no right to expect often to find a generic amount of difference in our domesticated races.

In attempting to estimate the associet of structural differences between allied denoise icrose, we are soon involved in double, from not knowing whether they are descended from one or several proteins. This point, if it could be cleared up, would be interesting: if, for instance, it could be absorn that the greybound, proparation, buries, paradial, and bulk-doe, which we call know proparation, buries, paradial, and bulk-doe, which we call know proparation, buries, and and and bulk-doe, which we call all out the inmutability of the many closely solid outmust all able to finances of the many forme--inhabiling different quarters of the solution, as we call increasing solution that the which

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amount of difference between the several hereds of the dog has been produced under domestication; 1 believe that a stand part of the difference is due to their being descended from distinct species. In the case of strongly marked mess of some other domesticated species, there is presumptive or even strong evidence, that all are descended from a single wild stock.

It has deen is ensamed that must have chosen for dometric-to animus and pulsate having an extra-consilurary inherent tendency to vary, and likewise to withstand diverse climates. It do not disput that these capacities have added largely to be value of most of our dometric diverse disput to be valued or primately have when its first transmiss whether the word is vary primately. These dometric diverse disput to the start of the start of the dometric diverse disput to the start of the start of the dometric diverse diverse disputs of the start of the start her little variability of the ans and goose, or the small gover of dometric diverse diverse disputs of the start of the dometric diverse disputs of their animals and paints, equal in number to our domethication, here would predict a start of nature, and end have made to hered for an an arrange werg as inspirations under domethication, they would among the start of the start of antest and could be made to hered for an an arrange werg as inspirations under domethication, they would associated as interprint of the start of the start of the domethication of the start of the

In the case of most of our meneratly domesticated animals enlishes, it is not possible to course to any distintion conclusion, whether mainly relief on the theory of the state of the state of the domestic animals k is the work of in the non-ancient times, an the moments of Egypt, and in the halo-habitations of Switzerland, bench, and the state of the state of the state of the state interaction of the state of the state of the state of the moments of the state of the state of the state of the state bench charger memory and most state of the state interaction of the state minute. They also carried on commerces with other mations, altiing momenta of the state of the state of the state of the state minute. They also carried on commerces with other mations, altimatic carried state of the different districts, marked and given rise to function theory.

existed at an enormously remote period; and we know that at the present day there is hardly a tribe so barbarous, as not to have domesticated at least the dog.

The origin of most of our domestic animals will probably for ever remain vague But I may here state, that, looking to the domestic dors of the whole world, I have, after a laborious collection of all known facts, come to the conclusion that several wild species of Canida have been tamed and that their blood in some cases mingled together, flows in the veins of our domestic breeds. In regard to sheep and goats I can form no decided opinion. From facts communicated to me by Mr. Blyth, on the habits, voice, constitution, and structure of the humped Indian cattle, it is almost certain that they are descended from a different aboriginal stock from our European cattle : and some competent judges believe that these latter have had two or three wild progenitors --- whether or not these deserve to be called species. This conclusion, as well as that may, indeed, he looked upon as established by the admirable researches of Professor Rütimever. With respect to horses, from species. Having kept nearly all the English breeds of the fowl wild Indian fowl, Gallus bankiva ; and this is the conclusion of Mr. Blyth, and of others who have studied this bird in India. In regard to ducks and rabbits, some breeds of which differ much from each other, the evidence is clear that they are all descended

The dottine of the origin of our several domains races frame several aboriginal tools, has how careful to an advance learning by some autoers. They heliver that every more which breaks trave, bit distinctive characters he ever so alight, has had it will be goodtype. At this rate there must have existed at least a sever of down, and several new within Grant Hurtin. One autoe heliver that there formely existed learner with grant halos. Due has heliver that there formely existed learner with grant halos. The source heliver down and several new velocar in multical. One such a heliver that there formely existed learners with grant helius heliver and the several down and the several several model. The several of several down and the several several model of the several must admit that many domaint, here here are series of the several that the many domaint. Becards and the several several that many domaint. Becards and the several several several here are several and the several several several several several several several several several models and the several here are several several several several several several here are several several several several several several several here are several several several several several several several here are several several several several several several several several here are several several several several several several several several here are several sev

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in India. Even in the case of the breeds of the domestic dog throughout the world, which I admit are descended from several wild species, it cannot be doubted that there has been an immense amount of inherited variation; for who will believe that animals closely resembling the Italian greyhound, the bloodhound, the bull-dog, pug-dog, or Blenheim spaniel, &c .- so unlike all wild Canidaever existed in a state of nature? It has often been loosely said that all our races of dogs have been produced by the crossing of a few aboriginal species; but by crossing we can only get forms in for our several domestic races by this process, we must admit the former existence of the most extreme forms, as the Italian greyhound, bloodhound, bull-dog, &c., in the wild state. Moreover, exaggerated. Many cases are on record, showing that a race may be modified by occasional crosses, if aided by the careful selection of the individuals which present the desired character; but to be very difficult. Sir J. Sebright expressly experimented with this object, and failed. The offspring from the first cross between two pure breeds is tolerably and sometimes (as I have found with enough ; but when these mongrels are crossed one with another for several generations, hardly two of them are alike, and then the difficulty of the task becomes manifest.

Breeds of the Domestic Pigeon, their Differences and Origin.

Beliering that it is always best to study some special group, 1 have, after dilutions, taken up domestic jepsons. I have kept always, after dilutions, taken up domestic jepsons. I have kept superstand the study of the study of the study of the speciality by the Li and provide the study of the study of the study for some study of the study of the study of the study of considerable antiputy. I have associated with wersa instants function, and have been premitted to joint two of the London Pigeon Chub., The diversity of the breaks is something atomisting the wooderful difference in their backs, stating accompany of the wooderful difference in their backs, stating accompany of the wooderful difference in their backs, stating accompany of the system of the statistic from the wooderful divergement of the communities skin shorts the back and this is accompanied by

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and a wide cape of month. The short-faced tumbler has a beak in flock and tumbling in the air head over heels. The runt is a bird of great size, with long massive beak and large feet ; some of the sub-breeds of runts have very long necks, others very long wings carrier, but, instead of a long beak, has a very short and broad one. The pouter has a much elongated body, wings, and legs; and its enormously developed grop, which it glories in inflating, may well excite astonishment and even laughter. The turbit has a short and conical beak, with a line of reversed feathers down the breast ; and the esophagus. The Jacobin has the feathers so much reversed along the back of the neck that they form a hood : and it has nonportionally to its size, elongated wing and tail feathers. The trumpeter and lausher, as their names express, utter a very different coo from the other breeds. The fantail has thirty or even forty tail touch : the oil-gland is quite aborted. Several other less distinct breeds might be specified.

In the achieves of the servel hereda, the deredopment of the scheme of the face is length and iteration decreating differences moving. The shape, as we it as the breacht and length of the runnes moving. The shape, as we it as the breacht and length of the runnes calculated and end the presence of the strength of the runnes of the rulns, log-ther with their relative breacht and the presence of the rulns, log-ther with their relative breacht and the presence of the rulns, log-ther with their relative breacht and the strength rulns of the strength of the strength of the rulns of the moving of the strength of the strength of the ruln of the moving strength of the strength of the strength of the strength of the notified of the size of the core and of the upper part of the weighting of the development and abording of the strength of the strength of the strength of the log and foot; the number of accusion with the size is discussed and the strength of the strength of the strength of the log and hold to each strength of the strength of strength of the strength of the log and foot; the number of accusion of attreatment within are variable. The preside at while, the particle the nontifies there are obtained with mathematic. The answers and asset is not strength of the strength of the log and hold. The above of attreatment within are variable.

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of the eggs vary. The manner of flight, and in some breeds the voice and disposition, differ remarkably. Lastly, in certain breeds, the males and females have come to differ in a slight degree from each other.

Altogether at least a score of pigeous might be closen, which, if shown, to an enrichedoptist, and be vere total that they were wild least and certainly be manded by him as well-defined aperics. Now spit at the bleview that any crimithogits would in this approxer, if an one bleview that any crimithogits would in this approxer to the bleview that any crimithogits would in this approxer that the bleview that any crimithogits would in this approxer to the bleview that any crimithogits would in this approxer to the bleview that any crimithogits would in this approxer to the bleview that any crimithogits would be approxed and the bleview that any crimithogits would be approxed by a finde would call them could be above this.

Great as are the differences between the breeds of the pigeon, I am fully convinced that the common opinion of naturalists is correct, namely, that all are descended from the rock-pigeon (Columba livia), including under this term several geographical races or sub-species, which differ from each other in the most triffing respects. As several of the reasons which have led me to this belief are in some degree applicable in other cases, I will here briefly give them. If the several breeds are not varieties, and have not proceeded from the rock-pizeon, they must have descended from at least seven or eight aboriginal stocks; for it is impossible to make the present domestic breeds by the crossing of any lesser number : how, for instance, could a pouter be produced by crossing two breeds unless one of the parent-stocks possessed the characteristic enormous crop? The supposed aboriginal stocks must all have two or three other species of rock-pigeons are known; and these have not any of the characters of the domestic breeds. Hence the supposed aboriginal stocks must either still exist in the countries where they were originally domesticated, and yet be unknown to ornithologists; and this, considering their size, habits, and remarkable characters, seems improbable; or they must have become good fliers, are unlikely to be exterminated; and the common rockpigeon, which has the same habits with the domestic breeds, has or on the shores of the Mediterranean. Hence the supposed extermination of so many species having similar habits with the rockpigeon seems a very rash assumption. Morever, the several above-

again into their native constry; but not one has become wild or fead, though the devect-pigons, which is the role-pigons in a very alightly altered state, has become feral in several places. Again, all recent experience shows that it is difficult to get with a simular to breed. Iresely under domestication; yet, on the hypothesis of the autiple origin over pigons, it must be assumed that at least access to exploy the size of the properties of the size of times by hale/entiled man, as to be quitie politic under continues by hale/entiled man, as to be quitie politic under con-

An argument of great weight, and applicable in several other aces, in, that the above-specified breach through agreeding generally with the wild reck-spigoon in constitution, habits, voles, coloring, and in most parts of their arcenture, year overhistly highly absermal in other parts i we may look in walk through the whole guest in the second second second second second second second that of the short-color of the second second second second factors in the second second second second second second only that half-vitiled mass mesceled in theorempty domestation only that half-vitiled mass mesceled in theorempty domestation prevent species, how that has in future only or by chance picked second species have since all become extinct or unknown. So many strange continguingence are implicible in the higher degree.

Some facts in regard to the colouring of nigeons well deserve consideration. The rock-pigeon is of a slaty-blue, with white loins; but the Indian sub-species, C, intermedia of Strickland, has this part bluish. The tail has a terminal dark bar, with the outer feathers externally edged at the base with white. The wings have two black bars. Some semi-domestic breeds, and some truly wild breeds, have, besides the two black bars, the wings chequered with black. These several marks do not occur together in any other species of the whole family. Now, in every one of the domestic breeds, taking thoroughly well-bred birds, all the above marks, even to the white edging of the outer tail-feathers, sometimes concur perfectly developed. Moreover, when birds belonging to two or more distinct breeds are crossed, none of which are blue or have any of the above-specified marks, the mongrel offspring are very several which I have observed :-- I crossed some white fantails, which breed very true, with some black barbs-and it so happens that blue varieties of barbs are so rare that I never heard of an instance

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tail and red spot on the forehead, and which notoriously breeds very the mongrel barb-fantails with a mongrel barb-spot, and they prodouble black wing-bar, and barred and white-edged tail-feathers, as any wild rock-pigeon ! We can understand these facts, on the well-known principle of reversion to ancestral characters, if all the domestic breeds are descended from the rock-pigeon. But if we deny this, we must make one of the two following highly improbable suppositions. Either, first, that all the several imagined aboriginal stocks were coloured and marked like the rock-pigeon. although no other existing species is thus coloured and marked, so that in each separate breed there might be a tendency to revert to the very same colours and markings. Or, secondly, that each breed, even the purest, has within a dozen, or at most within a score, of generations, been crossed by the rock-pigeon : I say within a dozen or twenty generations, for no instance is known of crossed such a cross will naturally become less and less, as in each succeeding generation there will be less of the foreign blood ; but when there has been no cross, and there is a tendency in the breed to this tendency, for all that we can see to the contrary, may be by those who have written on inheritance.

Lastly, the hybrids or mongrule from Jervene all the breede of the pigoven represely furtius, all can state from any own observations, purposely made, on the most distinct breads. New, handly argues have been accertained with orientially of hybrids from two quite distinct species of animals being perfectly fertile. Some makes balieve that long-continued dominication is in prohably quite correct, if applied to species closely adjusted and or some carries, that may constrained a special of the strain of the strain of the species of the strain the special special special special special special special and the special special special special special special and the special spe

From these several reasons, namely,---the improbability of man having formerly made seven or eight supposed species of pigeons to

hered freqly unler domestication; ... these supposed species being agine nuixoon: in with stark, and there for karving besome anywhere fan-1,-these species presenting certain very absormal clasneders, as compared with all derb Columbia, through so like the problem frequency of the stark of the special spectra indication of the special spectra of the special spectra special spectra of the spectra of the spectra of the special spectra of the spectra of the spectra of the special spectra of the spectra of the spectra of the spectra special spectra of the spectra of the spectra of the spectra special spectra of the spectra of the spectra of the spectra spectra of the spec

In favour of this view, I may add, firstly, that the wild C. livia has been found capable of domestication in Europe and in India: and that it agrees in habits and in a great number of points of structure with all the domestic breeds. Secondly, that, although an characters from the rock-pigeon, yet that, by comparing the several sub-breeds of these two races, more especially those brought from distant countries, we can make, between them and the rock-niceon. an almost perfect series; so we can in some other cases, but not with all the breeds. Thirdly, those characters which are mainly distinctive of each breed are in each eminently variable, for instance the wattle and length of beak of the carrier, the shortness of that of the tumbler, and the number of tail-feathers in the fantail ; and tion. Fourthly, pigeons have been watched and tended with the utmost care, and loved by many people. They have been domesticated for thousands of years in several quarters of the world; the earliest known record of pigeons is in the fifth Ægyptian dynasty, about 3000 B.C., as was pointed out to me by Professor Lepsius; but Mr. Birch informs me that pigeons are given in a bill of fare in the previous dynasty. In the time of the Romans, as we hear from Pliny, immense prices were given for pigeons ; "nay, they are come to this pass, that they can reckon up their pedigree and race." Pigeons were much valued by Akher Khan in India, about the year 1600; never less than 20,000 pigeons were taken with the court. "The monarchs of Iran and Turan sent him some very rare birds;" breeds, which method was never practised before, has improved them astonishingly." About this same period the Dutch were as eager of these considerations in explaining the immense amount of variation which pigeons have undergone, will likewise be obvious when

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we treat of Selection. We shall then, also, see how it is that the several breads so often have a somewhat monstrous character. It is also a most favourable circumstance for the production of distinct breads, that male and female pigeons can be easily mated for life; and thus different breads can be kept together in the same aviar.

many species of finches, or other groups of birds, in nature. One are firmly convinced that the several breeds to which each has attended, are descended from so many aboriginally distinct species. a common parent-stock, and he will laugh you to scorn. I have never met a pizeon, or poultry, or duck, or rabbit fancier, who was tinct species. Van Mons, in his treatise on pears and apples, shows how utterly he disbelieves that the several sorts, for instance a races; and though they well know that each race varies slightly, they ignore all general arguments, and refuse to sum up in their minds slight differences accumulated during many successive games rations. May not those naturalists who, knowing far less of the deride the idea of species in a state of nature being lineal descendants

Principles of Selection anciently followed, and their Effects.

Let us now briefly consider the steps by which domestic races have been produced, either from one or from several allied species, Some effect may be attributed to the direct and definite action of the external conditions of life, and some to habit; but he would be a bold man who would account by such agencies for the differences between a dray and race horse, a greyhound and bloodhound, a carrier and tumbler pigeon. One of the most remarkable features in our domesticated races is that we see in them adaptation, not indeed to the animal's or plant's own good, but to man's use or fancy, Some variations useful to him have probably arisen suddenly, or by one step ; many botanists, for instance, believe that the fuller's tensel. with its hooks, which cannot be rivalled by any mechanical contrivance, is only a variety of the wild Dipsacus; and this amount of change may have suddenly arisen in a seedling. So it has probably been with the turnspit dog; and this is known to have been the case with the ancon sheep. But when we compare the drayhorse and race-horse, the dromedary and camel, the various breeds of sheep fitted either for cultivated land or mountain pasture, with the wool of one breed good for one purpose, and that of another breed for another purpose; when we compare the many breeds of dogs, each good for man in different ways; when we compare the game-cock, so pertinacious in battle, with other breeds so little quarrelsome, with "everlasting layers" which never desire to sit, and with the bantam so small and elegant; when we compare the host of agricultural, culinary, orchard, and flower-garden races of plants, beautiful in his eyes, we must, I think, look further than to mere variability. We cannot suppose that all the breeds were suddenly produced as perfect and as useful as we now see them ; indeed, in many cases, we know that this has not been their history. The sive variations; man adds them up in certain directions useful to him. In this sense he may be said to have made for himself useful

The great power of this principle of selection is not hypothetical. It is certain that several of our eminent breaders have, even within a single lifetime, modified to a large extent their breads of statle and sheep. In order fully to realise what they have done, it is almost necessary to read several of the many treatises devoid to this subject, and to inspect the animals. Breaders habitually speak of an animal's organisation as something plastic, which they can model

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Selection by Man.

almost an there plasme. If I has space I could quote numerous parages to this effect from highly competent authorities. Notati, who was probably better acquinities with the works of agrentitruities that almost any other birdrichal, and with works a insuffic a wave good could be the approximation of the strength of the strength of the could be the approximation of the strength of the strength of the head of the strength of the strength of the strength of the plasme. Lot of the strength o

What English breeders have actually effected is proved by the enormous prices given for animals with a good pedigree ; and these have been exported to almost every quarter of the world. The improvement is by no means generally due to crossing different breeds; all the best breeders are strongly opposed to this practice, except sometimes amongst closely allied sub-breeds. And when a cross has been made, the closest selection is far more indispensable even than in ordinary cases. If selection consisted merely in separating some very distinct variety, and breeding from it, the principle would be so obvious as hardly to be worth notice; but its importance consists in the great effect produced by the accumulation in inappreciable by an uneducated eye-differences which I for one have vainly attempted to appreciate. Not one man in a thousand has accuracy of eye and judgment sufficient to become an eminent broeder. If gifted with these qualities, and he studies his subject for years, and devotes his lifetime to it with indomitable perseverance, he will succeed, and may make great improvements; if he wants any of these qualities, he will assuredly fail. Few would readily believe in the natural capacity and years of practice requisite to become even a skilful pigeon-fancier.

The same principles are followed by horticulturists; but the variations are here often more abrupt. No one supposes that our choicest productions have been produced by a single variation from the abortginal stock. We have proofs that this has not been so in served cases in which exact records have been kept; thus, to give a

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very trilling instance, the steadily-increasing aim of the common gradienty may be quoted. We see an attachising improvement in many forkits flowers, when the forces of the present day are compared of share increasing the steady of the main proper standard. With animals this kind of related for the of force in the steady of the steady of a steady of the steady

In regard to plant, here is another means of closering, thus assummiated effects of obscious—manyle, by comparing the diverssity of theorem in the different variation of the same species in this product the same state of the same species in the same product of the same state of variations, in comparison with the forware of the same state of variations. See how different the laware at the species in the order-add, in comparison with the laware as the species in the order-add, in comparison with the laware and the species in the order-add, in comparison with the laware and the species in the order-add of geoseberries different the laware at the frait of the different kinds of geoseberries differe in size, colour, show, and hardware any stal how are present very slight diffeteres. It is not that the variation which differe largely in moteo and of correlated variation, the impertance of which should haver to order-law reso and difference which differe largely in moteo and of correlated variation, the impertance of which should haver to even law the three sees differences that as a general relative same to burbed that the continued abselfs of adjust variations.

Is may be objected that the principle of solution has been related to methodic practice for account panet has characterized of a centry ; it has certainly been more attended to of histy may. and may treatists have been published on the miljeter; and the result has been, in a corresponding degree, rapid and important list is very far form true that the principle is a modern discovery. It can be also been in the solution of the solution of the solution between the solution of the solution of the solution of the balances periods of the solution balance is also been discover, botch, and have seres passed to preven them were done interaction of the solution of the solution of the solution of the period, and have seres passed to preven the induced of the solution becomes of the solution of the solution of the solution of the distribution of the solution of the solution of the solution of the becompared to the "requiring" of plants by unresponse. The principle of solution if the distribution is not an an elevent Chinese energy-

Unconscious Selection

degradia. Explicit rules are hid down by some of the Bronn disord writers. Provide the same stars are denoised, it is clear that the colour of domestic minula was at that early period attended to. Strongers now outcomestication and the same stars and the same domestic stars and the same stars and the same stars and the parameters in Filty. The arrayses in South Africa moth their tesms of dogs. Livingitones states that good domestic breaks are highly and with European and source of the Rayminnuk their tesms of dogs. Livingitones states that good domestic breaks are highly and with European. Some of these fores do not down works are administration of the same stars and the stronger domestic minula was activity attended to in ancient times, and is now attended to by the lowest arrays. It would, indeed, have been a strange fact, had qualities in so ordering.

Unconscious Selection.

At the present time, eminent breeders try by methodical selection, with a distinct object in view, to make a new strain or sub-breed, superior to anything of the kind in the country. But, for our purpose, a form of Selection, which may be called Unconscious, and which results from every one trying to possess and breed from the best individual animals, is more important. Thus, a man who intends keeping pointers naturally tries to get as good dogs as he can, and afterwards breeds from his own best dogs, but he has no wish or expectation of permanently altering the breed. Nevertheless we may infer that this process, continued during centuries, would improve and modify any breed, in the same way as Bakewell, Collins, &c., by this very same process, only carried on more methodically, did greatly modify, even during their lifetimes, the forms and qualities of their cattle. Slow and insensible changes of this kind can never be recognised unless actual measurements or careful drawings of the breeds in question have been made long ago, which may serve for comparison. In some cases, however, unchanged, or but little changed individuals of the same breed exist in less civilised districts, where the breed has been less improved. consciously modified to a large extent since the time of that monarch. Some highly competent authorities are convinced that the setter is directly derived from the spaniel, and has probably been slowly altered from it. It is known that the English pointer has been greatly changed within the last century, and in this case the change has, it is believed, been chiefly effected by crosses with the foxhound ::

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but what concerns us is, that the change has been effected unconsciously and gradually, and yet so effectually, that, though the old Spanish pointer certainly came from Spain, Mr. Borrow has not seen, as I am informed by him, any rative dog in Spain like our pointer.

By a similar process of solution, and by decrea training, Lagran mechanisms have conto a surgase in factors and a similar the purent Arais, so that the later, by the explaintion for the fourievoil flaves, and a control in the weight which the Taylor. A new reconciluation are shown how they assume that the solution of the stars are shown how the similar theory of the solution of the similar of the former and present which the second old training of the former and present state of carrier and training papers in historica, the solution of the second section in various old training of the second section in various which they have, insamely passed, and come to differ so grandly from the rock-piccox.

Totati gives an accellent illustration of the effects of a corres of selection, which may be considered an unconcisor, in no for that the breakers could never have expected, or even withed, to problem terms in the two fields of Leionter sheep large by Mr. Bockly and Mr. Burgas, and Mr. Yoantr remarks, "have been purely level from the original stock of Mr. Bakewell for upwork of firty years. There is not a majorine activity in the tunit of any one at all deviated in any one instance from the pure blood of Hr. Eakewell deviated in any one instance from the pure blood of Hr. Eakewell guite different retrees. It is always and the sheep possessed by these two guited minimum is or rent that they have the appearance of being quite different views.

If there exist averages to be there of the oblighting of their discontinuous answer to think of the inhibition minimal particularly satch to them, for any apocal parrons, would average a new binding and each choice animals, would thing over all parts are set of the same set of the same set of the same large set on binding and such choice and setting and the larges more offset and a remansions modeling agoing on. We see the would be a bind or momentum setting and the same binding of the same setting and the same setting and by the same setting and the same setting and the same binding of the same setting that the same setting and a soft here same binding along.

In plants the same gradual process of improvement, through the occasional preservation of the best individuals, whether or not sufficiently distinct to be ranked at their first appearance as distinct varieties, and whether or not two or more species or more have become blended together by crossing, may plainly be recognised in

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the increased size and beauty which we now see in the varieties of the heartsease, rose, pelargonium, dahlia, and other plants, when compared with the older varieties or with their parent-stocks. No one would ever expect to get a first-rate hearsease or dahlia from the seed of a wild plant. No one would expect to raise a first-rate melting pear from the seed of the wild pear, though he might succeed from a poor seedling growing wild, if it had come from a garden-stock. The pear, though cultivated in classical times, appears, from Pliny's description, to have been a fruit of very inferior quality. I have seen great surprise expressed in horticultural works at the wonderful skill of gardeners, in having produced such splendid results from such poor materials; but the art has been simple, and, as far as the final result is concerned, has been followed almost unconsciously. It has consisted in always cultivating the best known variety, sowing its seeds, and, when a slightly better variety chanced to appear, selecting it, and so onwards. But the gardeners of the classical period, who cultivated the best pears which they could procure, never thought what

A large amount of change, thus slowly and monoscionly are emutated, explaint, as I billever, the will-hown fact, that in a number of once we cannot recognize, and derected to determine the will parent-toleks of the plants with have been longest edittication of the state of the state state of the state of the entropy of the state of the plant sector. It is not that these constraints, or it is in that enter the plant sector during the state of the state of the state of the plant sector during the state of the state of the state of the plant sector during the state of the state of the state of the plant sector during the state of the state of the state of the plant sector during the state of the state of the state of the continues alsociation up to a standard of perfectives.

In regard to the denosatic animals keep by uncervised many, its abound not be overloaded that they amont always have to strangels for their own food, at least during certain suscense. And in two constricts way differently circumstanced, individuals of the same species, having alightly different constitutions or structure, would ofton succeed better in the one courty than in the other i and thus by a process of "natural selection," as will hereafter be more fully explained, two mixbreeds might be formed. This, perturber, party

explains why the varieties kept by savages, as has been remarked by some authors, have more of the character of true species than the varieties kent in civilised countries.

On the view here given of the important part which selection by man has played, it becomes at once obvious, how it is that our domestic races show adaptation in their structure or in their habits to man's wants or fancies. We can, I think, further understand the frequently abnormal character of our domestic races, and likewise so slight in internal parts or organs. Man can hardly select, or internal. He can never act by selection, excepting on variations man would ever try to make a fantail till he saw a pigeon with and the more abnormal or unusual any character was when it first appeared, the more likely it would be to catch his attention. But to use such an expression as trying to make a fantall, is, I have no doubt, in most cases, utterly incorrect. The man who first selected a pigeon with a slightly larger tail, never dreamed what the descendants of that pigeon would become through long-continued, partly unconscious and partly methodical, selection. Perhaps the parentbroods, in which as many as seventeen tail-feathers have been counted. Perhaps the first pouter-pigeon did not inflate its crop much more than the turbit now does the upper part of its œso-

Now let it be thought that areas great deviation of structure would be messawing to catch the functions' syst. Is provives extravolve mail differences, and it is in human nature to value any value of the system in the individuals of the same species, he joing of by the value established. It is known that with pipcons many slight variations established. It is known that with pipcons many slight variations therefore the system of the system of the system of the system established. It is known that with pipcons many slight variations from from the system but bound are system of the system of the system from the system of the system of the system of the system from the system of t

CHAR. I. Circumstances favourable to Selection.

fleeting of characters, have lately been exhibited as distinct at our zoultry-shows.

-namely, that we know hardly anything about the origin or history of a language, can hardly be said to have a distinct origin. A man preserves and breeds from an individual with some slight deviation of structure, or takes more care than usual in matching his best spread in the immediate neighbourhood. But they will as yet hardly have a distinct name, and from being only slightly valued, their history will have been disregarded. When further improved by the same slow and gradual process, they will spread more widely, then probably first receive a provincial name. In semi-civilised countries, with little free communication, the spreading of a new sub-breed would be a slow process. As soon as the points of value are once acknowledged, the principle, as I have called it, of unconscious selection will always tend,-perhaps more at one period than at another, as the breed rises or falls in fashion .- perhans more of the inhabitants,-slowly to add to the characteristic features of the breed, whatever they may be. But the chance will be infinitely small of any record having been preserved of such slow, varying,

Circumstances favourable to Man's Power of Selection.

I will now any a few works on the circumstance, favorable, or the reverse, to main power of selection. A high degree of variability is obviously favorable, as feely giving the materials for electron to werk on the science ones to allow of the neuranitation of a high angle of the science ones to allow of the neuranitation of high angle number of individual differences are not difference of the science of their appearance will be much heat as viriations are muched on the science of the science only coexistential werk of the science of the science of the science of the highest insportance for ancesses. On this principle without linearity remarked, with respect to the alseep of parts of Monial formet presenting larger stocks of the same plane, are mand, ally for most possible the science of the science of the science of ally for most possible that the science of the science of the science ally for most possible that the science of the science of the science ally for most possible that the science of the science o

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In small only where the conditions for its propagation are favoreals. When the individual are a samply, will be ablowed to level, whatever their quality may be, and this will effectually prevent selection. Bit probably the norm improved terms in that the mannator is paid to even the slightst division in this qualition exstructure. Unless norm that the slightst division is the qualition exstructure. The same is normalized with the same of the slightst division of the slightst division of the slightst division of the distance of the slightst division of the slightst division of the distance of the slightst division of the slightst division of the slight transmission of the slightst division of the slightst is use calibrated, but the slight variation had been neglected. As a slight page, cattler, or before fruit, and raised scaling from them, and squal hysical out the base slightst division between the spaced during the label solution of provided these apposed during the had had ensures.

With animals, facility in preventing crosses is an important element in the formation of new races,-at least, in a country which is already stocked with other races. In this respect enclosure of the land plays a part. Wandering savages or the inhabitants of open plains rarely possess more than one breed of the same species. Pigeons can be mated for life, and this is a great and kept true, though mingled in the same aviary ; and this circumstance must have largely favoured the formation of new breeds. Pigeons, I may add, can be propagated in great numbers and at a very quick rate, and inferior birds may be freely rejected, as when killed they serve for food. On the other hand, cats, from their nocturnal rambling habits, cannot be easily matched, and, although breed long kept up; such breeds as we do sometimes see are almost doubt that some domestic animals vary less than others, yet the rarity or absence of distinct breeds of the cat, the donkey, peacock, goose, &c., may be attributed in main part to selection not having been brought into play : in cats, from the difficulty in pairing them ; in donkeys, from only a few being kept by poor people, and little attention paid to their breeding; for recently in certain parts of Spain and of the United States this animal has been surprisingly modified and improved by careful selection : in peacocks, from not being very easily reared and a large stock not kept : in geese, from being valuable only for two purposes, food and feathers, and more

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especially from no pleasure having been felt in the display of distinct breeds; but the goose, under the coaditions to which it is exposed, when dometicated, seems to have a singularly infestible organisation, though it has varied to a slight extent, as I have elsewhere described.

has been attained in any one case ; for almost all our animals and period ; and this implies variation. It would be equally rash to assert that characters now increased to their utmost limit, could not, after remaining fixed for many centuries, again vary under new conditions of life. No doubt, as Mr. Wallace has remarked with much truth, a limit will be at last reached. For instance, this will be determined by the friction to be overcome, the weight of body to be carried, and the power of contraction in the muscular same species differ from each other in almost every character, which of the same genera. Isidore Geoffroy St. Hilaire has proved this in characters, Eclipse was far fleeter, and a dray-horse is incomparably stronger than any two natural species belonging to the same genus. So with plants, the seeds of the different varieties of the bean or maize probably differ more in size, than do the seeds of the distinct species in any one genus in the same two families. The same remark holds good in regard to the fruit of the several varieties of the plum, and still more strongly with the melon, as well as in many other analogous cases.

To run up on the origin of our densetic near of animals and phase. Changed couldings of like are of the highest through particules in causing variability, both by arting directly on the organisation, and infinitely by affecting the reproductive system. It is not prohabe that variability is an inferent and necessary contingent, under all variantsmass. The partiest or loss fact is not the star of the problement of the system of the star of the star of the star production of the star of the star of the star of the star probably the most important. Semichting, but have a fue conditions of like. Same, plengta a great, of effect may be attributed to the

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interested use or diners of parts. The final result is thus reduced infinitely complete. In some cases the interesting of adverginally distinct properties, then sover ableved an important part in the origin of our levels. When several breach laws conce beam formed in any constrainty, the source of the particular source of the source of the source of the source of the source and the source of the source of the source of the source of the source and the source of the source

CHAPTER II.

VARIATION UNDER NATURE.

Variability — Individual differences — Doubtful species — Wile ranging, much diffused, and common species, vary most — Species of the larger genera in each contry vary more frequently than the species of the smaller genera — Maay of the species of the larger genera resemble varieties in being very closely, but unequally, related to each other, and in having restricted ranges.

Breves applying the principles mrived at in the last chapter to coming length as the store of matrix, we much heigh discuss whether prome hey any started ratios, we much heigh discuss whether the startes of the variant distingtion of the startes of the startes of the variant distingtion of the startes of the distingtion of the startes of the startes of the startes of creation. The unreality is proved. We have also what the distingtion of the startes of the startes of the startes to difficient bars are merely be proved. We have also what a mantro the startes of the startes of the startes of the startes, generally higherings, or not used to the the prediction. Startes, attacked in the startes were approached to the startes of the startes, generally higherings, or not used to the startes of the startes of the startes are started product to the prediction. Startes where no may that the divertificic condition of abolis in the bracking where of the failable of variable plants are started at the startes of the shares of the startes of variable plants are started at the startes of the starte

It may be doubted whether sudden and considerable deviations of structure such as we occasionally see in our domestic productions, more especially with plants, are ever permanently propagated in a state of nature. Almost every part of every organic being is so beautifully related to its complex conditions of life that it seems as

D

Individual Differences.

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implicitles that any part should have been modeling projocal deces, so that complex makine should have been invented by mass in a perfect state. Under domotification monstructures non-modeling and the state of the state of the state maintain. Thus pips have occusionally been been appeal that this langproposing and if any wild appeals of the same genus had maintainly possible a probating, it might have been appeal that this langappeards as a monotony is built have been appeal that this is a short part of the state of the state of the state in sample allies forms, and these alone bear on the question. If an explaid of reproducting dwelling appear in stated of nature and are capital of reproducting constitutions. They would, also, during the fast and succeeding generations creates with the ordinary form, and that all have to store in a future shape to the preservation and carrentation in the state of a state of the preservation and correstion of single expositions.

Individual Differences.

The maps alight differences which appear in the offspring from the many partor, now which is may be presented have blue arises, from heng closerval is the individual of the num repeties differences. No can express that all the individual of the same species are cast in the same settal model. These individual differences are of the highest importance for us, for they are often materials for natural selection to set on and accumulate, in the materials for natural selection to set on and accumulate, in the differences are of the same species in the set of the same materials for natural selection to set on and accumulate in the differences in his domesticated productions. These individual differences in his domesticated productions, these individual differences in his domesticated productions, these individual differences is a set of the set of the set of the set of the individual of the same species. I are convinced that the most word or satisfilty even in important parts of arrows, which he could or close the remembered has presentative and for the set of the remembered has presentative and for the set of species of variability, were in the instead parts of arrows, which he could observe the remembered has presentative and for the set of the remembered has presentative and for the set of the there are not many mark which is important characters, which we important organs, and compare them is many agreements of

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Individual Differences.

also mass predict. It would never have been expected that the manning of the main nerves do not be great central graphon of an inset would have been variable in the same species $\chi^{(1)}_{1}$ induces the theorem of the same species of the same species $\chi^{(1)}_{1}$ is a single species of the same large species of the same species of the same species $\chi^{(1)}_{1}$ is a single species of the same species $\chi^{(1)}_{1}$ is a single species of the same species $\chi^{(1)}_{1}$ is a single species $\chi^{(2)}_{1}$ and $\chi^{(2)}_{2}$ is a single species $\chi^$

There is one point connected with individual differences, which is crimely expendence. If refer to those genes methods have been called " potents" or " physicaphics" in which the special proteint in inte-" potents" or " physicaphics" in which the special protein a more than the special product of the special product of the special special special product of the special special special special special special product of the special have fixed and definite homometry is an experiment of the special special special and definite special product of the special have fixed and definite hinds of the special have fixed and definite the special special special special special special special special tions for an experiment of the conditions of His. I among product the special spec

Individuals of the same proceeds often present, as is known to very one, grast differences of structures, independently of variation, as in the two sense of various animals, in the two or three castses of the same structures of many of the lower assimals. There area, also, case its structure of the same structures and in the immatry and low structures of many of the lower assimals. There area, also, case the same structure of the same structures area, and the same structure of the same structure of the same structures of hands above, which is holy called a tractings in the same hands many distribution of the same structure of the same structures of hands and the formals of certain reports of the same structures of the same structure of the same structure of the same structures of the same structure of

Doubtful Species.

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with the males of certain Brazilian Crustaceans : thus, the male of a Tanais regularly occurs under two distinct forms; one of these has strong and differently shaped pincers, and the other has antennæ much more abundantly furnished with smelling-hairs. Although in most of these cases, the two or three forms, both with animals and plants, are not now connected by intermediate gradations, it is probable that they were once thus connected. Mr. Wallace, for instance, describes a certain butterfly which presents in the same island a great range of varieties connected by intermediate links, and the extreme links of the chain closely resemble the two forms of an allied dimorphic species inhabiting another part of the Malay archipelago. Thus also with ants, the several worker-castes are generally quite distinct ; but in some cases. ducing at the same time three distinct female forms and a male; and that an hermanhrodite plant should produce from the same different kinds of females and three or even six different kinds of males. Nevertheless these cases are only exaggerations of the common fact that the female produces offenring of two sexes which sometimes differ from each other in a wonderful manner.

Doubtful Species.

The forms which posess in some considerable degree the elistate of periods, but which are so closely similar to other forms, or are so closely linked to them by intermediate gradations, that includes do not like to rank them a solicitaty species, are in several respects the most important for as. We have every formal have permeating vertical their definition of σ is long from law permeating vertical their definition of σ is long intermediate links up two forms, but routs the one as a verify the other frauding the most common, but sometimes the over find describel, as the species, and the other as the variety but cases of grant difficulty, which is will not have examined to variety of another, every when they graved to rank can four variety of another, every when they graved to rank the interm of a dimeter with the comparison of the other is and variety of another, every when they graved to rank the other is a solution.

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the intermediate forms always remove the difficulty. In very many cases, however, one form is ranked as a variety of another, not because the intermediate links have actually been found, but because analogy leads the observer to suppose either that they do now somewhere exist, or may formerly have existed; and here a wise door for the entry of doubt and conjecture is opened.

Doubtful Species.

Hence, in determining whether a form should be ranked as a species or a variety, the opinion of nataralists having sound judgment and wide experience sense the only guide to follow. We must, however, in many cases, decide by a majority of nataralists, for for well-maxied and well-known varieties can be named which have not been ranked as species by at least some competent judges.

That varieties of this doubtful nature are far from uncommon cannot be disputed. Compare the several floras of Great Britain, of and see what a surprising number of forms have been ranked by Mr. H. C. Watson, to whom I lie under deep obligation for assistance of all kinds, has marked for me 182 British plants, which are generally considered as varieties, but which have all been ranked by botanists as species; and in making this list he has omitted by some botanists as species, and he has entirely omitted several highly polymorphic genera. Under genera, including the most polymorphic forms, Mr. Babington gives 251 species, whereas Mr. Bentham gives only 112,-a difference of 139 doubtful forms ! Amongst animals which unite for each birth, and which are highly locomotive, doubtful forms, ranked by one zoologist as a species and by another as a variety, can rarely be found within the same country, but are common in separated areas. How many of the birds and insects in North America and Europe, which differ very slightly from each other, have been ranked by one eminent they are often called, geographical races! Mr. Wallace, in several valuable papers on the various animals, especially on the Lepidoptera, inhabiting the islands of the great Malavan archipelago. when all from the several islands are compared together, the dif-

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frames are seen to be so alight and graduated, that it is impossible to define of desorb them, shough at the narrow time the extreme forms are sufficiently distinct. The geographical more are ab-point and the strength of the strength without in an possible test but individual optication to determinis. Largely, representative appeals of the same place in the natural target of the strength and they are distinguished from each other by a gravitar amount of difference but not be been as possible to streng species. Nevertheless, no certain criterion can possibly the given by which wrafals the compution of the strength of the strengt

Many years ago, when comparing, and seeing others compare, the land, I was much struck how entirely vague and arbitrary is the distinction between species and varieties. On the islets of the little Madeira group there are many insects which are characterized as varieties in Mr. Wollaston's admirable work, but which would certainly be ranked as distinct species by many entomologists. Even Ireland has a few animals, now generally regarded as varieties, but which have been ranked as species by some zoologists. Several experienced ornithologists consider our British red grouse as only a strongly-marked race of a Norwegian species, whereas the greater number rank it as an undoubted species peculiar to Great Britain. A wide distance between the homes of two doubtful forms leads many naturalists to rank them as distinct species; but what distance, it has been well asked, will suffice; if that between America and Europe is ample, will that between Europe and the Azores, or Madeira, or the Canaries, or between the several islets of these small archipelagos,

Mr. B. D. With, a distinguished enternologist of the United States, has described what he calls the Hypothalder varieties and Fibytophatp process. Most repeatable-feeding implementation of the many kinds, but do not in consequence vary. In surveal cases, however, insets found hiving cal different plants, have been observed by Mr. Walah to present in their larval or matters state, or in both states, slight, though constant differences in coloury size, or in the

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Doubtful Species.

nature of their secretions. In some instances the males alone, in other instances both males and females, have been observed thus to differ in a slight degree. When the differences are rather more strongly marked, and when both sexes and all ages are affected, the forms are ranked by all entomologists as good species. But no which of these Phytophagic forms ought to be called species and which varieties. Mr. Walsh ranks the forms which it may be supposed would freely intercross, as varieties; and those which appear to have lost this power, as species. As the differences depend on the insects having long fed on distinct plants, it cannot be expected that intermediate links connecting the several forms should now be found. The naturalist thus loses his best guide in determining whether to rank doubtful forms as varieties or species. This likewise necessarily occurs with closely allied organisms, which inhabit distinct continents or islands. When, on the other hand, an animal or plant ranges over the same continent, or inhabits many islands in the same archipelago, and presents different forms in the different areas, there is always a good chance that intermediate forms will be discovered which will link together the extreme states; and these are then degraded to the rank of varieties.

Some for naturalized maintin that animals avere present variatics (not the the same naturalists rank the slightest difference as of specific value; and when the same identical form is most with it we distat constrainties, see in two specifical formations, they find the strainties of the same strainties of the strainties of the "hyperbarg and summing a specification of the strainties", the "hyperbarg and summing a specification of the strainties of the mainly of some strainties of the strainties of the strainties of the mainly of their highly-somptent judges. But to discuss whether mainly of their highly-somethy is a strainties of the strainties of th

Many of the cases of strongly-marked varieties of adultid species and laserse conductants is for several interesting lines of arguments, and there is a strong the strong structure of the strong structure of the structure of the structure of the structure of the structure parts, have been branch as bear into a strong structure of the strucption, in many cases, will so don't bring naturalities to agree how works doubtil fragments. Yet it must be accolsed that it is in the structure of the structure structure of the structu 40

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attracts has attantion, variation of it will, almost universally be non-moved. These variaties, moreover, will often be ranked by scara attinkors as precise. Look at the common only, how closely it, has how a toiled by each of the start of the highest bonards and nucleuis and percised a mean to quenci to share the bonards and nucleuis and percised a mean to percise of the highest bonards and nucleuis and percised a mean to percise of the highest bonards and nucleuis and percised a mean to percise of the highest comment with the start of the star

I may here allude to a remarkable memoir lately published by have worked on them with more zeal and sagacity. He first gives in detail all the many points of structure which vary in the several variations. He specifies above a dozen characters which may be found varying even on the same branch, sometimes according to generally enter into specific definitions. De Candolle then goes on nected by intermediate states. After this discussion, the result of so much labour, he emphatically remarks : "They are mistaken, who repeat that the greater part of our species are clearly limited, to be true, so long as a genus was imperfectly known, and its species were founded upon a few specimens, that is to say, were provisional. and doubts as to specific limits augment." He also adds that it is the best known species which present the greatest number of spontaneous varieties and sub-varieties. Thus Quercus robur has twentyeight varieties, all of which, excepting six, are clustered round three sub-species, namely, Q. pedunculata, sessiliflora, and pubescens. rare ; and, as Asa Gray again remarks, if these connecting forms, that out of the 300 species, which will be enumerated in his Prodromus as belonging to the oak family, at least two-thirds are

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provisional species, that is, are not known strictly to fulfil the definition above given of a true species. It should be added that De Candello no longer believes that species are immutable creations, bat most according the derivative theory is the most natural one, "and the most accordant with the known facts in palaeoutology, gegraphical botany and zoology, of anatomical structure and classifiaction."

"When a young naturalist commences the introl of a group of granina spite through the one consider as specific, and with a determining what differences to consider as specific, and with a constraint the group is radject, and the introl of the specific of the group is a specific of the specific of the specific of the specific of the distribution of the specific of the lower to radius the specific of the specific of the lower to radius the specific of the specific of the lower to radius the specific of the specific of the lower to radius of the distribution of the specific of the lower to radius of the distribution of the specific distribution of the specific of the specific of the specific distribution of the specific distribution of the specific distribution of the specific of the specific of the specific of the specific distribution of the specific of the specific

Certainly no clear line of demarkation has an yet been drawn between species and unb-species—bat is, the forms which in the optimic of some naturalistic come very near to, but do not quite arrive at, the rank of species 1: or, again, between unbergeles and well-markot varieties, or between lower varieties and individual differences. Thuse differences helm into each other by an innearable setter; and a series impresses the mind with the idea of an actual pamage.

Hence I look at individual differences, though of small interest to the systematic, as of the highest importance for us, as being the first steps towards such alight varieties as are barely thought worth recording in works on natural history. And I look at varieties which are in any decree more distinct and bernament, as stors

Dominant Species vary most.

towards more strongly-matched and permanents varieties (and lattice the parages from one shapeder, and then to specific. All then to specific the parages from one shape of difference to another mays in many case, by the parages of the parages of

To note not be supposed that all validities or indipinits species tains therm had projects. They may become existinc, or they may confluent as variables for very long periods, as had been above to be shallow in Madeins, and with plants by Gostano de Superior. If a validity area of the start of the start of the start of the species, is would have mark as the species, and the species as a waterly over to find the const to suppliest and externizable the plants relatively of the start of the start of the start of the start species. But would have not be start of the start of the start species. But would have not be start of the start of the start species. But would have not species of the start of the start of the start species. But would have not start on the subject.

From these remarks it will be seen that I look at the term species as one arbitrarily given, for the sake of convenience, to a set of individuals clockly resembling each other, and that it does not essentially differ from the term variety, which is given to iess distinct ad more fluctuating forms. The term variety, again, in comparison with mere individual differences, is also applied arbitrarily, for convenience's ake.

Wide-ranging, much-diffused, and common Species vary most.

Ordel by theoretical considerations, I though that sease live trending roule might be obtained in regard to the nature and relations of the species which vary most, by takaking all the varieties in several wall-worked force. At first this second a simple tack, but M. H. G. Watson, to whem I are much induced by a straight of the several material fidentities, as did material the alteries of the several material fidentities, as did material the direct of the several second second second second second method the direction of the second second second second mumbers of the varying species. Dr. Hocker permits us to takk at after having correlative and that after having correlative material and second second

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Dominant Species vary most.

takies, he thinks that the following statements are fairly well establahed. The whole subject, however, treated as it necessarily here is with much browing, is rather perplexing, and allusions cannot be avoided to the "struggle for existence," "divergence of character," and there neutrons, hereafter to be discussed.

Alphonse de Candolle and others have shown that plants which have been expected, as they are exposed to diverse physical conditions, and as they come into competition (which, as we shall hereafter see, is an equally or more important circumstance) with different sets of organic beings. But my tables further show that, that is abound most in individuals, and the species which are most widely diffused within their own country (and this is a different consideration from wide range, and to a certain extent from commonness), oftenest give rise to varieties sufficiently well-marked to have been recorded in botanical works. Hence it is the most are the most numerous in individuals .- which oftenest produce well-marked varieties, or, as I consider them, incipient species. And this, perhaps, might have been anticipated ; for, as varieties, in order to become in any degree permanent, nocessarily have to struggle with the other inhabitants of the country, the species which are already dominant will be the most likely to yield offspring, which, though in some slight degree modified, still inherit those their compatriots. In these remarks on predominance, it should be into competition with each other, and more especially to the members of the same genus or class having nearly similar habits of life. With respect to the number of individuals or commonness of species, the comparison of course relates only to the members of the same group. One of the higher plants may be said to be dominant if it be more numerous in individuals and more widely nearly the same conditions. A plant of this kind is not the less allies in the above respects, it will then be dominant within its own

Species of the Larger Genera in each Country vary more frequently than the Species of the Smaller Genera.

If the plants inhabiting a country, as described in any Flora, be divided into two equal masses, all those in the larger genera (i.e., those including many species) being placed on one side, and all those in the smaller genera on the other side, the former will be much diffused or dominant species. This might have been anticipated; for the mere fact of many species of the same genus inhabitinorganic conditions of that country favourable to the genus : and consequently, we might have expected to have found in the larger genera, or those including many species, a larger proportional number of dominant species. But so many causes tend to obsenze this result, that I am surprised that my tables show even a small majority on the side of the larger genera. I will here allude to only two causes of obscurity. Fresh-water and salt-loving plants generally has little or no relation to the size of the genera to which the species belong. Again, plants low in the scale of organisation are and here again there is no close relation to the size of the genera.

From holding at species as only strongly-smarked and well-defined evolution, it was hold a obtaction that that maps of the allogrammers in each country would obtact present variations, that has a point of a species of the same ground have many cloudly related agenesis (Le species of the same ground have many cloudly related agenesis indipient species origin, and a special rink, to be now forming. Where many appears of a ground have many cloudly variation, driemantances have been formed through variation, drie extensions have been formed through variation, drie sensatones have been formed through variation, drie sensatones have been formed through variation, drie sensatone have been formed through variation, drie sensatone have been formed through variation, drie variation. On the order hand, if we look at each species as a varieties should occur in a group having many species, than in each aring fore.

To test the truth of this anticipation I have arranged the plants of twelve countries, and the coleopterous insects of two districts, into two nearly equal masses, the species of the larger generation of the

CHAP. II. Species of Larger Genera variable.

side, and those of the smaller genera on the other side, and it has invariably proved to be the case that a larger proportion of the species on the side of the larger genera presented varieties, than on the side of the smaller genera. Moreover, the species of the large genera which present any varieties, invariably present a larger average number of varieties than do the species of the small genera. Both these results follow when another division is made, and when all the least genera, with from only one to four species, are altogether excluded from the tables. These facts are of plain signification on the view that species are only strongly-marked and permanent varieties ; for wherever many species of the same genus have been still in action, more especially as we have every reason to believe the process of manufacturing new species to be a slow one. And this certainly holds true, if varieties be looked at as incipient species ; for my tables clearly show as a general rule that, wherever many species of a genus have been formed, the species of that genus the average. It is not that all large genera are now varying much, and are thus increasing in the number of their species, or that noso, it would have been fatal to my theory ; inasmuch as geology plainly tells us that small genera have in the lapse of time often increased greatly in size ; and that large genera have often come to their maxima, declined, and disappeared. All that we want to show is, that, where many species of a genus have been formed, on an average many are still forming ; and this certainly holds good.

Many of the Species included within the Larger Genera resemble Varieties in being very closely, but unequally, related to each other, and in having restricted ranges.

There are other relations between the species of large genera and, their records variates which descree nodes: We have seen that there is no inhibitible criterion by which to distriguish appelois and, which are the second set of differentiate in the large nodes from between doubtful forms, mateminists are compared to come to distribution the bis mounds of difference between them, judging to the much dependence between them, judging to the much of species. Hence the annount of difference is one avery proportant criterion in setting which are been formed by much as species or varieties. Now First has remarked in paragrad to plants, at Wetwood in regard to innextly, that in large genera the annount.
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of difference between the species is often ecceedingly small. I have collarowered to test this namerically by averages, and, as for a say imperfect results go, they confirm the view. I have also consider a signature and the structure of the structure of the structure of the larger genera results wavelets, more than do the species of the smaller genera. On the case may be put in another wave, and it may be said, that in the larger genera, in which a number of vanisies of number of the structure excitate results variation, for they differ from each other by law than the number of differences.

Moreover, the speeds of the larger genera are related to each other. It is many mean we are barriedies of any one speeds are called to each other. No naturality protonds that all the speeds of the distribution of the speed of the speeds of the speed o

There is one other point which is worth, notes. Variaties present and have much correlated a ranges this statement is indeed search prove than a trains, for if a variety were found to have a vider range that hale of its sproged surveises/species, their denominition would be reversed. But there is reason to believe that the conduction of the state of the sproged state of the state states are state. We can show that a random state of the conduction of plants of the state of the state of the states of the state of the states of the state of the divided dynamics are considered and these states of the state of the divided dynamics are considered and these states of the state of the divided dynamics are considered and these states of the state of the s

resemble Varieties

whereas, the species to which these varieties belong range over 14-3 provinces. So that the acknowledged varieties have nearly the same restricted average range, as have the closely sailed forms, marked for me by Mr. Watson as doubful species, but which are almost universally ranked by British bonainsts as good and true species.

Summary.

Finally, varieties cannot be distinguished from species,—coxpt, find, by the discovery of intermediate hinding frames in al., secondly, by a certain indefinite amount of differences between them i, for two manifolds in the special constraints of the special spectra of the withinkanding that they cannot be clearly connected by the the amount of difference considered necessary to give to any two forms the rank number of species in any constry, the species of these guerns have more than the average number of varieties. In large guerns the species are apt to be clearly but tone gually, allied to guerns of the species apparently have reatively. The species vary douby allied to clear species apparently have reatively analyzed with varieties. Add we can clearly monother the species of the species of the specses at the rest of the species of the species of the species of the species are an entry intermediated. The species of the species at the rest of the species of the s

We have, also, seen that is the most flowrihing or dominanejecies of the large preservibile and the as which can average yield the greatest number of varieties; and varieties, as we shall hereafter set, tend to become enverted into new and distinct species. Thus the larger geness that lo become larger and thoughto instants the forms of like which we not obminaia tend to be come allow the observation of the set of the set of the second like the low larger geness. And it has the forms all the threaky pills multiple geness. And it has the form a flic threaghout the universe become divided into groups withorhim to groups.

CHAP. UI.

CHAPTER III.

STRUGGLE FOR EXISTENCE.

In leaving an antural solection — The term used in a wide some—Genntrical ratio discrease — Rayd increase of naturalized animals and phanta — Nature of the checks to increase — Competition universal, "Effects of distants — Protection from the number of individual: Complex relations of all animals and phants throughout nature... Strength for its most severe between individuals and varieties of the same species: often severe between species of the same genue... Tealting of experiment to ensume the next important of all relations.

Brown metering on the subject of this dapter, I must make a fee periminary remarks to show N ow the struggle for existence bars on Natural Selection. It has been seen in the last chapter that subscriptions are subscription of the struggle of existence bars of the structure of the structure of the structure of the structure structure of the structure of the structure of the variability induced in an ot source that this are ever been dispited. It is immaterial for an whether a multitude of doubtful forms to both of the existence of any well-analyced variations be admitted. Well-analyced structure of the structure of the structure of the well-analyced variations, the structure of the structure of the structure well-analyced variations, the structure of the structure of the structure of the organization to nonder part, and to the conditions of the structure which elitizes to the structure of the structure of the structure of the structure in the plends which is worked by the gradient or a structure in the plends which is worked by the gradient of the structure of

Again, it may be asked, how is it that varieties, which I have called incipient species, become ultimately converted into good and distinct species, which in most cases obviously differ from each other far more than do the varieties of the same species? How do those groups of species, which constitute what are called distinct

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Struggle for Existence.

genera, and which differ iron states doubt more times to the speceoic is the set of th

We will now discuss in a little more detail the strangle for existence. In my future work this subject will be tracked, as it was been as the straight of the straight of the straight of the value integration integration. The shear back calculate and specitize the straight of the back of the straight of the straigh

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The Term, Struggle for Existence, used in a large sense.

I should premise that I use this term in a large and metaphotonic sense including dependence of each being on another, and intending (which is more important) and only the life of the individual, increases in leaving dependence of the sense in leaving property. Two each materials, in a time of dearth, may be truly said basic on the edge of a desert is said to encode the sense of the sense of the sense of the sense of the sense in leaving sense in the sense of the sense of the sense to material the density through none properly it should be and to be dependent on the moisture. A plant which smmally predices a thousand seed, of which only one on an average comes to material the sense truly and to average the argument. The mathematics is dependent on the angle and a leve other trees, but an only in a far-fetched sense be and to struggle with these trees, for one. As the mathematics is discussioning the birth so the dependence of dependence the structure of by birth is mating which these dependence there and the sense the sense the set is maximized with other first-basicing plants, in temportal by birth is, in existence dependence there and the sense the set and the set of the event at the discussion of the set of the set of the set of the set of the discussion of the set of the set of the set of the set of the discussion of the set of the set of the set of the set of the discussion is discussioned by birth is, in existence dependence there are the set of the discussion is discussioned by birth is in the set of the set of the discussion of the set of the set of the set of the set of the discussion is discussioned by birth is in the set of the set of the discussion of the set of t

Geometrical Ratio of Increase.

A straight for existence incrinityly follows from the high ratis which all organic lengs tunto in caracasa. Every being, which during its natural lifetime probators several eggs or easely, must suffic diverticed ariting uson period of all high, and during games assume or constant yrang, therewine, so the principle of geometrical interests, or more setting the straight of existence of the mean particle of the lifetime probation of the straight of existence, eather one individual with the physical existence, either one individual with the aphysical existence, either one individual with the aphysical existence of the non-individual with the aphysical existence for the non-individual with the aphysical existence there each exact the non-individual and vegatible applied with mainful forces to the whole animal and vegatible applied with mainful forces to the whole animal and vegatible applied with mainful forces to the straight of exactle set there can be conticles in the conset of 600, may be now increasing, more or these rapidly. In numbers, all casned do so, for the work would not hold them.

There is no exception to the rule that every organic being

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cometrical Ratio of Increase.

summity immunous at so high a ratio, that, if not dostryyd, the earth weald acons bowers by the program of a single pair. Even also-keening man has doubled in twenty-twe would literally not be standing-cosing fract harmonic pairs and the second pairs of the manifering of the second pairs of the second base of the pairs of manifering the pairs of the second pairs of the second pairs of and a cos, then in twenty years there would literally not be and as one, then in twenty years there would literal models unintern the objects in the second has a second base of multino plants, and I have takens score pairs to estimate its probable minimum rate of nutral increases ji will be addeed of all known a minula, baseding when thirty years old, and goes on breeding till history wave old, beinging that six yong in the history and neuricol trave to heat a structure of the neuron of the second of the two models objection of the history theorem million depiants with a second the plants theorem million depiants and they desting the object and the plants of the second second travers of the second plant of the history and plant and they desting the object and the second million based of the tor types of plants of the history and plants of the history and they desting the object and the second million desting the second plants of the history and plants of the history and the object of the history and plants of the history and the second history and plants of the history and plants of the history and plants of the history and the history and history and

But we have better evidence on this subject than mere theoretical calculations, namely, the numerous recorded cases of the astonishingly rapid increase of various animals in a state or nature, when following seasons. Still more striking is the evidence from our domestic animals of many kinds which have run wild in several parts of the world; if the statements of the rate of increase of slow-breeding cattle and horses in South America, and latterly in Australia, had not been well authenticated, they would have been incredible. So it is with plants; cases could be given of introduced plants which have become common throughout whole islands in a period of less than ten years. Several of the plants, such as the cardoon and a tall thistle, which are now the commonest over the wide plains of La Plata, clothing square leagues of surface almost to the exclusion of every other plant, have been introduced from Europe; and there are plants which now range in India, as I hear from Dr. Falconer, from Cape Comprin to the Himalaya, which have been imported from America since its discovery. In such cases, and endless others could be given, no one supposes, that the fertility of the animals or plants has been suddenly and temporarily increased in any sensible degree. The obvious explanation is that the conditions of life have been highly favourable, and that there has consequently been less destruction of the old and young, and that nearly all the young have been enabled to breed, Their geometrical ratio of increase, the result of which never fails to be surprising, simply explains their extraordinarily rapid increase and wide diffusion in their new homes.

Geometrical Ratio of Increase.

In a scatt of nations almost every full-grown plant annually produces acid, and among at minimal there are very few which do not annually plant. Hence we may confidently amort, that all plants and minima are tooling to increase at a geometrical mationthat all would rapidly nobel every status in which they could any behavior exit,—and has impossible includery to increase must be elsewed by dustruction at some period of life. Our instanticity with the larger domestic minimation that they are do not keep in minitor at an annually administration of the domestic in the state on many and are annually administration of the domestic in the domestic matter and even number would have accommoder to be disputed of.

The only afference between expansions which mutually reduces group easely by the thorsand, and three which in probes extremely people, under favorable conditions, a whole district, let it he ever a singer. The condition has a could or eigen and the outful a score of the singer of the same of the singer of the singer of the singer of the same country the sender may be the more numerous to be the same numerous hird in the world. One fly depoint handrade of eggs, and another, like the hippolonea, a single energy to the singer of the same singer of the singer of the singer sender of the singer of the singer of the singer of the singer singer of the singer of the singer of the singer of the singer singer of the singer of the singer of the singer of the singer singer of the singer of the singer of the singer of the singer singer of the singer of the singer of the singer of the singer singer of the singer of the singer of the singer of the singer singer of the singer of the singer of the singer of the singer singer of the singer singer of the singer of the

In looking at Nature, it is most necessary to keep the foregoing considerations always in mind—never to forget that every single organic being may be said to be striving to the utmost to increase in numbers; it that each lives by a struggle at some period of its life; that heavy destruction inevitably falls either on the young or old, during each generation or at recurrent intervals. Lichten any

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Nature of the Checks to Increase.

check, mitigate the destruction ever so little, and the number of the species will almost instantaneously increase to any amount,

Nature of the Checks to Increase.

as much as it swarms in numbers, by so much will it tend to the reader's mind some of the chief points. Eggs or very young case. With plants there is a vast destruction of seeds, but, from some observations which I have made it appears that the seedlings suffer most from germinating in ground already thickly stocked choking from other plants, I marked all the seedlings of our native mown, and the case would be the same with turf closely browsed

The amount of food for each predict of course gives the actement input to which each can increase, but vary frequently it is not the obtaining food, but the serving as prey to other animals, which downing the average numbers of a specific. Thus, there seems to be sub-outly that the stelek of partridges, prome, and have entropy of the second structure of the stele of the stele second structure of the stele of the stele of the stele second structure of the stele of the stele of the stele second structure of the stele of the stele of the stele second structure of the stele of the stele of the stele stele of the stele stele of the stele of the stele stele of the stele stele stele stele of the stele stele of

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destroyed by beasts of prey; for even the tiger in India most rarely dares to attack a young elephant protected by its dam.

drought seem to be the most effective of all checks. I estimated (chiefly from the greatly reduced numbers of nests in the spring) that the winter of 1854-5 destroyed four-fifths of the birds in my own grounds; and this is a tremendous destruction, when we remember that ten per cent, is an extraordinarily severe mortality from epidemics with man. The action of climate seems at first severe struggle between the individuals, whether of the same or of distinct species, which subsist on the same kind of food. Even when climate, for instance extreme cold, acts directly, it will be the least vigorous individuals, or those which have not least food through the advancing winter, which will suffer most. When we travel from south to north, or from a damp region to a dry, we invariably see some species gradually getting rarer and rarer, and finally disappearing ; and the change of climate being conspicuons, we are tempted to attribute the whole effect to its direct action. But this is a false view ; we forget that each species, even where it most abounds, is constantly suffering enormous destruction at some period of its life, from enemies or from competitors for the same place and food ; and if these enemies or competitors be in the least in numbers ; and as each area is already fully stocked with inhabitants, the other species must decrease. When we travel southward and see a species decreasing in numbers, we may feel sure that the cause lies quite as much in other species being favoured, as in this one being hurt. So it is when we travel northward, but in a somewhat lesser degree, for the number of species of all kinds, and therefore of competitors, decreases northwards ; hence in going northwards, or in ascending a mountain, we far oftener meet with stunted forms, due to the directly injurious action of climate, than we do in proceeding southwards or in descending a mountain. When we reach the Arctic regions, or snow-capped summits, or absolute

That climate acts in main part indirectly by favouring other species, we clearly see in the proligious number of plants which in our gardens can perfectly well endure our climate, but which never become naturalised, for they cannot compete with our native plants nor resist destruction by our native animals.

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When a species, owing to highly favourable circumstances, increases isomilarity in number in a small track, rejedomics-atlant, this scena generally to occur with our game animals—ofeners and here we have a limiting each independent of the strength of the file. But even some of these no-called splications appare to be due pravails worraw, which haves from some cases, somethy, have disperpendently favoured: and here course in a sort of strategic before the ranks and the track.

On the other hand, in many cases, a large stock of individuals of the same species, relatively to the numbers of its enemies, is absolutely necessary for its preservation. Thus we can easily raise plenty of corn and rape-seed, &c., in our fields, because the seeds are in great excess compared with the number of birds which feed food at this one season, increase in number proportionally to the any one who has tried, knows how troublesome it is to get seed case lost every single seed. This view of the necessity of a large some singular facts in nature such as that of very rare plants being sometimes extremely abundant, in the few spots where they do exist ; and that of some social plants being social, that is abounding in individuals, even on the extreme verse of their range. For in conditions of its life were so favourable that many could exist together, and thus save the species from utter destruction. I of close interbreeding, no doubt come into play in many of these cases ; but I will not here enlarge on this subject.

Complex Relations of all Animals and Plants to each other in the Struggle for Rwistence,

Many cases as on or record showing how complex and many-peorls with checka and relations between oracine beings, which have to straight expether in the same country. I will give only a single instance, which theory and a single constant of the straight of the single straight of the sense is a single straight of the single means of the straight of the sense is a single straight of the single single single straight of the single singl

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native vegetation of the planted part of the heath was most remarkable, more than is generally seen in passing from one quitecounting grasses and carices) flourished in the plantations, which could not be found on the heath. The effect on the insects must have been still greater, for six insectivorous birds were very common in the plantations, which were not to be seen on the heath ; and the heath was frequented by two or three distinct. insectivorous birds. Here we see how potent has been the effect of the introduction of a single tree, nothing whatever else having been done, with the exception of the land having been enclosed, so that cattle could not enter. But how important an element enclosure is, I plainly saw near Farnham, in Surrey. Here there are extensive heaths, with a few clumps of old Scotch firs on the distant hilltops: within the last ten years large spaces have been enclosed. and self-sown firs are now springing up in multitudes, so close together that all cannot live. When I ascertained that these young trees had not been sown or planted. I was so much surprised at their numbers that I went to several points of view. and literally I could not see a single Scotch fir, except the old planted clumps. But on looking closely between the stems of the been perpetually browsed down by the cattle. In one square yard, I counted thirty-two little trees; and one of them, with twentysix rings of growth, had, during many years tried to raise its head above the stems of the heath, and had failed. No wonder that, as soon as the land was enclosed, it became thickly clothed with vigorously growing young firs. Yet the heath was so extremely barren and so extensive that no one would ever have imagined that cattle would have so closely and effectually searched it for food.

Here we see that exite absolutely determine the existences of the footbh frip but is served part of the word in most of determine the violations of statis. Purpays offers the most enrices are server movidly, down the server most one of the server for a state is and Azara and Renger have above that this is ensued by the greater number in Paraguys of a certain fry, which hay is so of these fine, numerous as they are state services of these fine, numerous as the service of the services are start of the service of the service most provide by down the result.

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ingenitivenue hists were to documents in Pangany. the parallel ingenitivenue hists birrenest and hist world lessen the number of the avaid-lexploring fills—then cattle and hence world become linguight and hist world because the observations of the largely affect the innext, and thing as we have just seen in Staffarding, the innext/resona hists, and to ownership in even-increasing erises of complexity. Not that under nature the real-ions will be a simple as this. Staffar works in the staffar were the ions and the staffar works in the staffar world because into the ownership with works and the staffar work in the staffar work with works and the staffar works in the test ions have been been as the staffar works and the staffar would give the victory to one cognize being over number. Neverthing, so probond is our ginemasca, and high our presemption, that we nared when we hear of the extinction of an organic being works of the formation of the form of the form of the for-

I an tempted to give one more instance aboving how plants and minals, remote in the same for starters, are bound tegether by a web of complex relations. I shall hereafter have excators to show that and comequately, from its predict arcmiter, gaspine how based, and comequately, from its predict arcmiter and the same starding of the same starter and the same starter and the field from experiments that humble-been are shown indipensable to instart to enrow their pole-masses and thus to fortillate them. I field from experiments that humble-been are shown indipensable to necessary for the fortillation of same hands of dever r. for instance, bload of Dutted drever (Tricklum repear) yielded 2,200 seeks, but 20 other hands protected from bear problem in the other start on the same same starts of civer, gas other bear same and the other start on the same start of the same start of the same start of the same starts of civer, gas other bear same starts and the other with the first ord civer, gas other bear same starts and the other starts and the same start of the same start of the same show starts of civer, gas other bear same starts and the other with the same starts are starts and the same start and the starts that civer same starts and the other starts are bard with the same starts are very reas in Kagland, the hartmans and the starts the same starts are start are starts are starts are starts are starts are starts are very reas in Kagland, the hartmans and the starts and starts are starts are very reas in the bards are starts are starts are starts are starts are very reas in the bards are starts are starts are starts are starts are very reas in the bards are starts and the starts are starts are starts are starts and the starts and starts are starts and the starts and starts are starts are starts are

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Is also with that "more than two-thinks of them are thus destroyed at over Raighand". Now the number of most is largely dependent, as overy one knows, on the number of easts; and Col. Nerman rays. "As writings and small towar 1 have found the nested of humblebess more numerous than destruct, which is a tribute to the numtor of sust that destruct hem are in squite cavillab that the presence of a filtee minimal in larger 1 of minima and theory the source of the number of the number of a minimal state of the source of a state of the state of the number of the number of the framework of the district of the number of the number of the framework of the district of the number of the number of the number of the number of eartim flowers in that district 1.

In the case of every species, many different checks, acting at different periods of life, and during different seasons or years, probably come into play ; some one check or some few being generally the most potent; but all will concur in determining the average number or even the existence of the species. In some cases it can be shown that widely-different checks act on the same species in different districts. When we look at the plants and bushes clothing an entangled bank, we are tempted to attribute their proportional numbers and kinds to what we call chance. But how false a view is this! Every one has heard that when an American forest is cut down, a very different vegetation springs up ; but it has been observed that ancient Indian ruins in the Southern United States, which must formerly have been cleared of trees, now display the same beautiful diversity and proportion of kinds as in the surrounding virgin forest. What a struggle must have gone on during long centuries between the several kinds of trees, each annually scattering its seeds by the thousand ; what war between insect and insectbetween insects, snails, and other animals with birds and beasts of prey-all striving to increase, all feeding on each other, or on the trees, their seeds and seedlings, or on the other plants which first clothed the ground and thus checked the growth of the trees! Throw up a handful of feathers, and all fall to the ground according to compared to that of the action and reaction of the innumerable plants and animals which have determined, in the course of centuries, the proportional numbers and kinds of trees now growing on the old Indian ruins !

The dependency of one cognic being on another, as of a paralle on its prey, line generally between beings remote in the scale of nature. This is likewise nomelines the case with those which may be strictly raid to strengle with each other for existence, as in the case of locatis and grass-focking quarkings. But the strengtle will almost invariably be most serves between the individuals of the same opticels, for they frequent the same districts, require the same

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loop and zero exposed to the same dampine. In the case of variaties of the mass speech the strangle will meanly be almost equally server, and we sometimes such be centest nove desided's for intrance, it seech variation of wheat he power together, and the surfaces or remaining the most fertila, will best the tolters and a by yield new almost the most fertila, will best the tolters and a by yield new almost the most fertila, will statistic and the power of the statistic sector of the statistic sector of the statistic at the variation-bosonic sector power, they must be such year otherwise the wards of the statistic sector of the power of the statistic sector of the statistic sector of the statistic at the variation with the wardies of theory is its assess and and the statistic sector of the statistic sector of the power otherwise the wards or main the variation of the power of the statistic sector of the statistic sector of the statistic flat certain mountain-wardsets will startly decrease in templer and the densetile pairs of the statistic sector of the power of the statistic sector of the prevention of the height power of the statistic sector of the statistic secsor statistic sector of the statistic sector of the statistic secsor statistic sector of the statistic sector of the statistic sector of the statistic secsor statistic sector of the statistic sector of the statistic secsor statistic sector of the statistic sector of the statistic secsor statistic sector of the statistic sector of the statistic sector of the statistic secsor statistic sector of the statistic sector of the statistic sector of the statisti

Struggle for Life most severe between Individuals and Varieties of the same Species.

As the species of the same genus usually have, though by no means invariably, much similarity in habits and constitution, and always in structure, the struggle will generally be more severe between them, if they come into competition with each other, than between the species of distinct genera. We see this in the recent extension over parts of the United States of one species of swallow having caused the decrease of another species. The recent increase of the missel-thrush in parts of Scotland has caused the decrease of the song-thrush. How frequently we hear of one species of rat taking the place of another species under the most different climates In Russia the small Asiatic cockroach has everywhere driven before it its great congener. In Australia the imported hive-bee is rapidly exterminating the small, stingless native bee. One species of charlock has been known to supplant another species; and so in other cases. We can dimly see why the competition should be most severe one species has been victorious over another in the great battle of life.

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A couldary of the highest importance may be obtained from the forgoing semanta, manny, that the structures of every equalic being is related, in the most essential yet often hidden matner, to fail, of the obtainer equation being which hit has to except or on which is proys. This is obvious in the structure of the total and have of the typer, and in that of the log and obtain of the high go of the sole of the domination, and in the fastimut and finguid high of the sole of the domination, and in the fastimut and finguid high go of the sole of the domination, and in the fastimut and finguid high go of the sole of the domination, and in the fastimut and finguid high go of the sole of the domination, and in the fastimut and finguid high go the distance of the domination of the sole of the sole of the domination in the domes relation to the low being heavy thickly delated with other plants so that the seeds may be widely distributed and finguid in particular sole of the domination of the sole of the sole of the domination. The sole of the domination of the sole of the domination of the domination of the sole of the domination of the sole of the domination of the domination of the sole of the domination of the

¹ The store of nutrimont laid up within the seeds of many plants seems at first sight to have no sort of relation to other planta. But from the storeg growth of young plants produced from such needs, as pass and beans, when sown in the midst of long grass, it may be suspeted that the chief us of the nutriment in the seed is to favore the growth of the seedlings, whils struggling with other plants growth of the seedlings, and the set of the seedlings of the set of the sections.

Lock as a plack in the midia of its range, why does it not double or quadruph its multimeters? We know that it can preferred y well withstand a little more heat or cold, dampnoss or dynamic, for lowwhere it mages in a little prove of the disk, damper or direr dissident its start of the second start of the second start of the to give the plant the power of the disk of the disk minimization to give the plant the power of the disk of the disk of the disk which prove it. On the continuous of its geographical range a change to our plant, but we have ranson to believe that and y a few plants to our plant, but we have ranson to believe that and y a few plants in the disk of the disk life, in the Arctic regions or on the brokeh the atterned confidence of disk, y there will be competition between some few species, or between his individual of the same perison, for the warments or damperison problem.

Hence we can see that when a plant or animal is placed in a new country amongst new competitors, the conditions of its life will generally be changed in an essential manner, although the climate

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may be exactly the same as in its former home. It is average numbes are to increase in its new home, we should have to modify it in a different way to what we should have had to do in its native country; for we should have to give it some advantage over a different set of competitors or enemies.

It is good thus to try in imagination to give to any other spectra and abstrategover an output: . To boldy in row us of our ignorance on the matrial relations of all expanse beings a convertice on a new spectra in a single relation of all expanse beings a convertice on a new spectra in mixed that each expanse being is aritivize to increase in a generatiba year, during couple, all that are our do, is to keep steadily in mixed that each expanse being is aritivize to increase in a generatiba year, during compared being in a strength for the hyper during the tile and the spectra of the spectra of the spectra of the spectra is not increased, that no four is full, that is ward of nature is not increased, that no four is full, that is during a matrix is not increased, the half year out the largey survive and multiply.

Natural Selection

CHAP, IV.

CHAPTER IV.

NATURAL SELECTION; OR THE SURVIVAL OF THE FITTEST.

Stand Solution — in power compared with main solution — in power on character of triding importance — in power at all ages and an lask area — formal Solution — On the paramility of intervenous letters were a found to be a standard or the solution of the solution of the second solution — Solution — Solution and the intervenous letters instand , number of initiation — -Slow attica — Existencia mouth by Attand Solution — Derregans of Characteric, radio the discussivy inhibition of the solution of the solution of the solution of the Belteins, integral Derregans of Characteric, and Existencia, on the behters, the solution of the solution of the solution of the solution beings — Artens in expansion — — are formed provided of largest beings — Artens in expansion — — are formed provided of the solution of character — Indication annihistance despised — Summary.

How will the struggle for existence, briefly discussed in the last chapter, act in regard to variation ? Can the principle of selection. which we have seen is so potent in the hands of man, apply under nature ? I think we shall see that it can act most efficiently. Let the endless number of slight variations and individual differences occurring in our domestic productions, and, in a lesser degree, in those under nature, be borne in mind ; as well as the strength of the hereditary tendency. Under domestication, it may be truly said that the whole organisation becomes in some degree plastic. But the variability, which we almost universally meet with in our domestic productions, is not directly produced, as Hooker and Asa Gray have well remarked, by man ; he can neither originate accumulate such as do occur. Unintentionally he exposes organic beings to new and changing conditions of life, and variability ensues ; but similar changes of conditions might and do occur under nature. Let it also be borne in mind how infinitely complex and close-fitting are the mutual relations of all organic beings to each other and to their physical conditions of life; and consequently what infinitely varied diversities of structure might be of use to each being under changing conditions of life. Can it, then, be thought improbable, seeing that variations useful to man have

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substitution country, that softwarming the descent processing of the softwarm of the softwarm

Several writers have misapprehended or objected to the term Natural Selection. Some have even imagined that natural selection. variations as arise and are beneficial to the being under its conditions of life. No one objects to agriculturists speaking of the potent effects of man's selection ; and in this case the individual differences given by nature, which man for some object selects, must of necessity first occur. Others have objected that the term modified; and it has even been urged that, as plants have no volition, natural selection is not applicable to them! In the literal sense of the word, no doubt, natural selection is a false term ; but who ever objected to chemists speaking of the elective affinities of the various elements ?---and yet an acid cannot strictly be said to elect the base with which it in preference combines. It has been snid that I speak of natural selection as an active power or Deity ; is meant and is implied by such metaphorical expressions; and they are almost necessary for brevity. So again it is difficult to avoid personifying the word Nature ; but I mean by Nature, only

We shall best understand the probable course of natural selection by taking the case of a country undergoing some slight physical change, for instance, of climate. The proportional numbers of its

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inhibitons will almost immediately undergo a draws, and assogrees will possible feature attack. We note a conserve in which the inhibiton of each contry are bound together, that my change in the numerical projections of the inhibitons, independently of the damage of dimate itself, would writenely affect the others. If the inhibiton of the start is a start of the start of the start of some of the former inhibitont. Let it be remembered how powerful the influence of a single introduced two or manual has powerful and the influence of a single introduced two powers in the influence of the former inhibitont. Let it is the remembered how of the original inhibitont we use in more manage multilet powerful and influence of a single introduced two or manual has powerful and influence of a single introduced two or manual has powerful and influence of a single introduced two or manual has powerful and influence of a single introduced two or manual has powerful and influence of a single introduced two or manual has powerful and influence of a single introduced two or manual models are been so of the original inhibitonts were in nove manuage multilitation and the original inhibitonts were in nove manuage multilitation and any species, by better adapting them to their altered couldings, would lead to be dimensional and leaders in works that we do scope for the work. Interview of the single single single single power in the single single single power in the single single single power in the single single single power in the single sin

We have good reason to believe, as shown in the find chapter that changes in the conditions of like give a touchney to increased variability; and in this foregoing cases the conditions have changed applied by the tensor of the contractions of profilable variations. These meth occur, natural selection can do nothing. Under the ten of * variations i' must never be foregraten that more indiridual differences are included. As man can produce a great readidirection invivation difference, to could natural node on a proference of the selection of the contraction of the selection of the selection in the selection of the selection of the selection more scaling, from having incompanity larger time for a done. Not contract the selection of the selection of the selection of the selection of the selection in the selection of the selection of the selection of as all the inhabitants of each country are stranging to cocher with two first here the selection of the selection of the selection of the sense conditions of this and provide would done inflation of the same conditions of this and profile by shalles means of whistenes and dorkers. Now contrary needs the selection of the sense of the first period selection of the same barrier of the sense of the same conditions of this and profile by shalles means of the sense of the sense conditions of this and profile by shalles means of the sense of the sense conditions of the and profile by shalles means of the sense of the sense conditions of the and profile by shalles means of the sense of the sense conditions of the and profile by shalles means of the sense of the sense conditions of the and profile by shalles means of the sense of the sense conditions of the and profile by shalles means of the sense of the sense conditions of the sense c

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the native inhabitants are now so perfectly adapted to each other and to the physical conditions under which the yivs, that none of them could be still better adapted or improved y for in all countries, that they have allowed some foreigners to in every country bus, of some of the natives, we use addro-consider with the matterin shave been some of the natives, we may addro-consider that the matterin have been modified with advantage, so as to have better resisted the intruders.

As man can produce, and certainly has produced, a great result. natural selection effect? Man can act only on external and visible characters : Nature, if I may be allowed to personify the natural preservation or survival of the fittest, cares nothing for appearances except in so far as they are useful to any being. She can act on every internal organ, on every shade of constitutional difference. on the whole machinery of life. Man selects only for his own good : Nature only for that of the being which she tends. Every selected character is fully exercised by her, as is implied by the fact. of their selection. Man keeps the natives of many climates in the pigeon on the same food; he does not exercise a long-backed or with long and short wool to the same climate. He does not allow the most vigorous males to struggle for the females. He does not season, as far as lies in his power, all his productions. He often some modification prominent enough to catch the eye or to be the struggle for life, and so be preserved. How fleeting are the wishes and efforts of man ! how short his time ! and consequently. how poor will be his results, compared with those accumulated by Nature's productions should be far " truer " in character than man's most complex conditions of life, and should plainly bear the stamp

It may metaphorically be said that natural selection is daily and hourly scrutinising, throughout the world, the slightest variations; sejecting those that are bad, preserving and adding up all that are

good; silently and insensibly working, whenever and universe opportunity offers, at the improvement of each organic being in relation to its expanic and incompanic conditions of life. We see nothing of these slow changes in progress, until the hand of time has marked the lapse of age, and then so imperfect is our view into long-past geological ages, that we see only that the forms of life are now different form what here y charactly were the most of the are post different form what here y charactly were the set of the set

In each that any great amount of modification should be deficied in a species, a variety when cone formed must spain, pricing a sher a long interval of time, vary or greenst individual differences of the mean feventiles and time as before; such them must be again preserved, and so envents step by step. Means, that individual difference of the same kind perpetually treng, this can hanly be come, we can judge analy be seeing; how for the Typetholes accurtion and the period period period of the same of the same hand, the endimy telief that the amount of possible variation is a stretchy initial quantity is likewise a simple summition.

Although natural selection can act only through and for the good of each being, yet characters and structures, which we are ant to consider as of very trifling importance, may thus be acted on. When we see leaf-cating insects green, and bark-feeders mottled-grey ; the alpine ptarmigan white in winter, the red-grouse the colour of birds and insects in preserving them from danger. Grouse, if not destroyed at some period of their lives, would increase in countless numbers; they are known to suffer largely from birds of prey; and hawks are guided by eyesight to their prev-so much so, that on parts of the Continent persons are warned not to keep white pigeons, as being the most liable to destruction. Hence natural selection might be effective in giving the proper colour to each kind of grouse, and in keeping that colour, when once acquired, true and constant. Nor ought we to think that the occasional destruction of an animal of any particular colour would produce little effect : we should remember how essential it is in a flock of white sheep to destroy a lamb with the faintest trace of black. We have seen how the colour of the hogs, which feed on the "paint-root " in Virginia, determines whether they shall live or die. In plants, the down on the fruit and the colour of the flesh are con-

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more form a certain disease than yellow pluma; whereas another disease attacks yellow-fielded posteds for more than those with other cohored fields. If, with all the able of art, these slight differcases make a grave difference in cultivitating the several varieties, assurably, in a state of nature, where the trees would have to transfer with other trees and with a host of exemines, usch differences would effectually settle which variety, whether a smooth or down, a yellow or purple fields difficult, sheeld succeed.

In looking at many small points of difference between species, which, as far as our ignorance permits us to joing, scenn quilto uninportant, we must not forget that elimate, food, &ee, have no doubt produced nome direct effect. It is also necessary to bear in mind that, owing to the law of correlation, when one part varies, and the variations are accumulated through natural selection, other molifications, often of the most uncopeted nature, will ensue.

As we see that those variations which, under domestication appear at any particular period of life, tend to reappear in the offspring at the seeds of the many varieties of our culinary and agricultural plants; in the caterpillar and cocoon stages of the varieties of the silkworm ; in the eggs of poultry, and in the colour of the down of their chickens; in the horns of our sheep and cattle when nearly adult ;---so in a state of nature, natural selection will be enabled to act on and modify organic beings at any age, by the accumulation of variations profitable at that age, and by their inheritance at a corresponding age. If it profit a plant to have its seeds more and more widely disseminated by the wind, I can see no greater difficulty in this being effected through natural selection, than in the cotton-planter increasing and improving by selection the down in adapt the larva of an insect to a score of contingencies, wholly different from those which concern fhe mature insect; and these modifications may affect, through correlation, the structure of the adult. So, conversely, modifications in the adult may affect the structure of the larva ; but in all cases natural selection will ensure that they shall not be injurious : for if they were so, the

Natural selection will modify the structure of the young in relation to the parent, and of the parent in relation to the young. In nocial animals it will adapt the structure of each individual for the benefit of the whole community; if the community profits by the selected change. What natural selection cannot do, is to notify the structure of one species, without giving it any advantage, for the good of σ

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acadae repeirs; and though attacments to this effect may be form, in order of attaints' history. I cannot find one case which will have investigation. A structure need only core in an animal's life (if or high importance to it, night he molified to any extent by natural soliciton; for instance, the grant jawn passmeet by extinin lasses; and exclusively for optimality in corescing the structure of the structure and exclusively for optimality in corescing the structure of the structure of the structure of the structure has to make manned path in the org than are able to go dott of (it) to that fracters masks in the act of hashing. Now if rature hash to make the back of a full-group rigonouv ry should be very above, and they very howed be simulationally the orger size selection of all the years between the structure of the hiddle models in the structure.

It may be well here to remark that with all beings there must be on the course of natural selection. For instance a vast number of eggs or seeds are annually devoured, and these could be modified through natural selection only if they varied in some manner which protected them from their enemies. Yet many of these eggs or better adapted to their conditions of life than any of these which happened to survive. So again a vast number of mature animals would not be in the least degree mitigated by certain changes of structure or constitution which would in other ways be beneficial to the species. But let the destruction of the adults be ever so heavy, if the number which can exist in any district be not wholly kept down by such causes,---or again let the destruction of eggs or seeds be so great that only a hundredth or a thousandth part are developed, -yet of those which do survive, the best adapted individuals, supposing that there is any variability in a favourable direction, will tend to propagate their kind in larger numbers than the less well adapted. If the numbers be wholly kept down by the causes just indicated, as will often have been the case, natural selection will be powerless in certain beneficial directions; but this is no valid objection to its efficiency at other times and in other ways; for we are far from having any reason to suppose that many species ever

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undergo modification and improvement at the same time in the same area,

Sexual Selection.

Inasmuch as peculiarities often appear under domestication in one be under nature. Thus it is rendered possible for the two sexes to be modified through natural selection in relation to different habits of life, as is sometimes the case; or for one sex to be modified in relation to the other sex, as commonly occurs. This leads me to say a few words on what I have called Sexual Selection. This form of the individuals of one sex, generally the males, for the possession of the other sex. The result is not death to the unsuccessful cornpetitor, but few or no offspring. Sexual selection is, therefore, less progeny. But in many cases, victory depends not so much on sex. A hornless stag or spurless cock would have a poor chance of leaving numerous offspring. Sexual selection, by always allowing nearly the same manner as does the brutal cockfighter by the careful selection of his best cocks. How low in the scale of nature the law of battle descends, I know not ; male alligators have been described as fighting, bellowing, and whirling round, like Indians in a war-dance, for the possession of the females; male salmons have been observed fighting all day long; male stag-beetles sometimes bear wounds from the huge mandibles of other males; the males of certain hymenopterous insects have been frequently seen by that inimitable observer M. Fabre, fighting for a particular female who sits by, an apparently unconcerned beholder of the struggle, and then retires with the conqueror. The war is, perhaps, severest between the males of polygamous animals, and these seem oftenest provided with special weapons. The males of carnivorous animals are already well armed; though to them and to others, special means of defence may be given through means of sexual selection, as the mane to the lion, and the hooked jaw to the male salmon ; for the shield may be as important for victory, as the sword or spear.

Amongst birds, the contest is often of a more peaceful character.

All these who have attended to the subject, believe that there is the severest rivalry between the males of many species to attract, by some others, congregate ; and successive males display with the most elaborate care, and show off in the best manner their gorgeous pinmage; they likewise perform strange antics before the females, which, that they often take individual preferences and dislikes : thus Sir R. Heron has described how a pied peacock was eminently attractive to all his hen birds. I cannot here enter on the necessary details; but if man can in a short time give beauty and an elegant carriage to his bantams, according to his standard of beauty, I can see no good reason to doubt that female birds, by selecting, during thousands of standard of beauty, might produce a marked effect. Some wellknown laws, with respect to the plumage of male and female birds, in comparison with the plumage of the young, can partly be explained through the action of sexual selection on variations occurring at different ages, and transmitted to the males alone or to both sexes at corresponding ages ; but I have not space here to enter on this

Thus it is, as I believe, that when the males and fermiles of up minih have the same percell halvis of hilo, but differ in structure, robot, or cranament, such differences have been minity ensuelly exact also lection: that is, by I builvident, and having hal, in anexact also believes in the lay built halvident and having have an interpret of the same structure of the same structure of the here and optimizing dance. Yet, I would not with to a training any answer of the interpret of the same structure of the same structure of the same structure of the same structure of a same structure of the same structure of the same structure of a same structure of the same structure of the same structure and the same structure of the same structure of the same structure of the fermal kind y-in-index, had the number of the same structure of the fermal kind y-index and the same structure of the same strucler in work have been and an amountarie.

Illustrations of the Action of Natural Selection, or the Survival of the Fittest.

In order to make it clear how, as I believe, natural selection acts, I must beg permission to give one or two imaginary illustrations. Let us take the case of a wolf, which preys on various animals, securing some by craft, some by strength, and some by fleetness; CHAP, IV.

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and let us surpose that the flowtest prey, a four fer instance, has from any change in the coentry increased in numbers, or that other prey had decreased in numbers, during that season of the year when explicit and alignment where would have the best chance of surviving and no its preserved or suleton—provided always that they suitable attempts to meast their prey at this or same other period of the year, when they were compatible to provide the ways. The they suitable attempts the to improve the first theory to the the constant sectors of the top of the the scale of the period constant sectors of the top of the the scale of the period constant sectors when the top of the the scale of the constant sectors when the top of the the scale of the scale of the period of the period of the the scale of according to Mr. Pitros, there are never variation of the orthogonal the Cudail Monstants in the Truide States, one with a light greyhomaticities of the terms, which periods deep and the other more latify bracks.

It should be observed that, in the above Illinguing, I space is the aliment individual worker, and not of any single stronglymarked variation having been preserved. In former elisions of this second structure individual structure is and frequench powerds. Law the part importance of all the more or law withink individuals, and on the destruction of all the more or law withink individuals, and on the destruction of all the more or law visualite individuals, and on the destruction of all the more or law and that for a first preserved, it would parenally be loss by subcuration of articures, such as a memorytary, would be a more event, and that f at first preserved, it would parenally be loss by subspit traitencoming which, from warden cause of destructions, and the structure of the structure of the individual structure is destructure estimates for most of the individuals. Nevertheless, until differ or strongly-model, could be perpendiated. The number takes the onset of a pair of saminals, providing during their lifetime to coulded afforting of the individual structure is a structure of the individual strucment estimates for most of the individual structure is a structure in activence estimates for most of the individual syst the during structure of the structure is a structure in the individual syst the emission as the break, and that fir promy main trains the measure at the articular is also the reak and the promy filting the filting at maximum and the side the regions in to show the promy

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would have only a nightly better chance of surviving and becomes and halo chance would go on descenating in the streeological generament of the streeological streeological streeological streeological LG for instances, a hind of some kind could prevent its food mass based by having the back curvel, and for some wrote how with the back strengy curvel, and which consequently foortical, nevertheau how the streeological streeological streeological streeological heaving the streeological streeological streeological streeological handly be a double, judging by what we see thating place neurodomstitution, that he result would follow from the preservation diming many generations of a large number of individuals with neulogical neurons of a streeological streeological streeological strengt number with the strengistical backs.

It should not, however, he everlooked that certain maker stange function variations, which no one worked rack as more individual ministry acted on,—off which fast numerous instances could similarly acted on,—off which fast numerous instances could for a standard standard standard standard standard standards individual dots of standard transmit to its offspring in novly-sequence individual dots of standard transmit to its offspring in standards are standards. It would be a standard to the standard standards are vary in the same names. The standard standards are standards and all the individuals of the same spaces have been stimularly molified fast strength of the same names. The standards of the standards of which the aid of any form of selection. Or only a third, fifth, or varies the standards of the same spaces have been stimularly molified fast strength standards and the standards are streng that all the individuals of the same spaces. The same than a direction of the fast strength standards and the standards and the strength standards are varied to same that the same strength standards are standards and standards or standards of the strength standards are standards and standards of the strength standards are strength and show to sequentiate the standards and the standards are strength and show the standards and the standards are strength and some to supplanticely the molified form, through the survival of the fitter.

To the effects of interconsing in administing variations of all kinks, I shall have to resure, but it may be here mean-field that most animals and plants keep to their order the start of the kinks, I which almost always returns to the same space. Using which almost always returns to the same space, the simulation of newly-formed writery would prescribe the almost space of newly-formed individual would be almost field, assemin to be the common rule with varieties in a state of nations; so that similarly modified the field field simulation of the simulation of the same space second in the simulation of the field simulation of the same space.

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district, competing with and conquering the unchanged individuals on the margins of an ever-increasing circle.

sweet juice, apparently for the sake of eliminating something inhase of the stipules in some Leguminose, and at the backs of the leaves of the common laurel. This juice, though small in quantity, is greedily sought by insects ; but their visits do not in any way of any species. Insects in seeking the nectar would get dusted with pollen, and would often transport it from one flower to another. The flowers of two distinct individuals of the same species would thus get crossed; and the act of crossing, as can be fully proved, gives rise to vigorous seedlings, which consequently would have the flowers with the largest glands or nectaries, excreting most nectar, would oftenest be visited by insects, and would oftenest he crossed : variety. The flowers, also, which had their stamens and pistilsplaced, in relation to the size and habits of the varticular insect which visited them, so as to favour in any degree the transportal of the pollen, would likewise be favoured. We might have taken the fertilisation, its destruction appears to be a simple loss to the plant ; yet if a little pollen were carried, at first occasionally and then and a cross thus effected, although nine-tenths of the pollen were destroyed, it might still be a great gain to the plant to be thus-

When our plant, by the shows process long continued, had been usedued highly attentive to insect, they would, unitatentically on moderal kingly attentive to insect, they would, and instructionally on the plant interaction of the state of the state of the state bars of the interaction of the state of the state of the state of the states of plants. States had by the states of the states of plants, states had by the states of the states of the states of plants, states and plants of the states of plants at the states of the states o

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Having Sund a female tree exactly sixty yards from a male tree,] not the stigmas of twenty flowers, taken from different branches. under the microscope, and on all, without exception, there were a few pollen-grains, and on some a profusion. As the wind had set for several days from the female to the male tree, the pollen could not thus have been carried. The weather had been cold and boisterous, and therefore not favourable to bees, nevertheless even female flower which I examined had been effectually fertilised by the bees, which had flown from tree to tree in search of nectar. But to return to our imaginary case: as soon as the plant had been rendered so highly attractive to insects that pollen was regularly carried from flower to flower, another process might commence. No naturalist doubts the advantage of what has been called the "physicon one whole plant, and pistils alone in another flower or on another plant. In plants under culture and placed under new conditions of life, sometimes the male organs and sometimes the female organs become more or less impotent ; now if we suppose this to occur in ever so slight a degree under nature, then, as pollen is already carried regularly from flower to flower, and as a more complete senaciple of the division of labour, individuals with this tendency more and more increased, would be continually favoured or selected, until at last a complete separation of the sexes might be effected. It would take up too much space to show the various steps, the sexes in plants of various kinds is apparently now in progress; are, according to Asa Gray, in an exactly intermediate condition, or,

Let us now term to the meta-fording inserts, we may approprited the plant, of which we have been about jurnerssing the mediar by continued selection, to be a common plant; and that certain uses descussed in much part on its sensation for food. To could give instance, their habit of certaing holes as an to avec times for instance, their habit of certaing holes are are presented in the bases of certain hovers, which which are very little more tensible, they can note by the mostly. Bearing such facts in minds, it muy is the curvature energies of certain the course of the secarity of the second second second second second second appreciated by us, might peofic a bear or other inserts, in this approximation that for the second second

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than others; and thus the communities to which they belonged would flourish and throw off many swarms inheriting the same incarnate clovers (Trifolium pratense and incarnatum) do not on a hasty glance appear to differ in length ; yet the hive-bee can easily suck the nectar out of the incarnate clover, but not out of the common red clover, which is visited by humble-bees alone ; so that whole fields of the red clover offer in vain an abundant supply of precious nectar to the hive-bee. That this nectar is much liked by the hive-bee is certain ; for I have repeatedly seen, but only in the autumn, many hive-bees sucking the flowers through holes bitten in the base of the tube by humble-bees. The difference in the length of the corolla in the two kinds of clover, which determines the visits of the hive-bee, must be very trifling; for I have been assured that when red clover has been mown, the flowers of the second crop are somewhat smaller, and that these are visited by many hive-bees. I do not know whether this statement is accurate : nor whether another published statement can be trusted. namely, that the Ligurian bee, which is generally considered a mere variety of the common hive-bee, and which freely crosses with it, is able to reach and suck the nectar of the red clover. Thus, in a country where this kind of clover abounded, it might be a great advantage to the hive-bee to have a slightly longer or differently constructed proboscis. On the other hand, as the fertility of this clover absolutely depends on bees visiting the flowers, if humblebees were to become rare in any country, it might be a great advantage to the plant to have a shorter or more deeply divided corolla, so that the hive-bees should be enabled to suck its flowers. Thus I can understand how a flower and a bee might slowly become, either simultaneously or one after the other, modified and adapted to each other in the most perfect manner, by the continued preservation of all the individuals which presented slight

I am well awaw that this detrine of sustant selection, example field in the above minipary instances, it capes to the mans debettions which were first urged against Site Charlos Lyolit mode views or "the motion charges of the earth, as illustrative of geology," but we now solvem have the agencies which we see still at work, splete of a triffinger simplication, when used in cryshaining the excernation of star despet vallays or the formation of long lines of hindiding. Natural sciencing actions of the preservation and accemunities of sum and the start of the start of the start of the start served being and as moder molecular base and the start of the start served being and as moder molecular base almost basinable steh

views as the excavation of a great valley by a single diluvial wave, so will natural selection banish the belief of the continued creation of new organic beings or of any great and sudden modification in their structure.

On the Intercrossing of Individuals.

I must here introduce a short digression. In the case of animals and plants with separated sexes, it is of course obvious that two individuals must always (with the exception of the curious and not well-understood cases of parthenogenesis) unite for each birth ; but in the case of hermaphrodites this is far from obvious Nevertheless there is reason to believe that with all hermaphrodites two individuals, either occasionally or habitually, concur for the reproduction of their kind. This view was long ago doubtfelly suggested by Sprengel, Knight and Kölreuter. We shall presently see its importance ; but I must here treat the subject with extrema brevity, though I have the materials prepared for an ample discussion. All vertebrate animals, all insects, and some other large groups of animals, pair for each birth. Modern research has much diminished the number of supposed hermaphrodites, and of real hermaphrodites a large number pair; that is, two individuals not habitually pair, and a vast majority of plants are hermaphrodites. What reason, it may be asked, is there for supposing in these cases that two individuals ever concur in reproduction? As

In the first place, I have collected as large a keylo of fastig and make so may expressions, showing, in accordance with the almost universal heliof of freeders, that with animals and plants a cross between different varieties, or between individuals of the same variety but of another strain, gives vigour and fertility to the degranging and on the other hand, that coles interbreeding diminishes view in settility i that these fasts alone incline net believes individual is examined of matter that no cognito being fieldliss individual is examined by possible and the same with another individual is examined by possible and the same strain individual is examined by possible and the same strain of the individual is examined by possible and the same strain of the individual is examined by possible and the same strain strain of the same strain of the same strain of the same strain strain of the same strain of the same strain of the same strain strain of the same strain of the same strain of the same strain strain of the same strain of the same strain of the same strain strain of the same strain of the same strain of the same strain strain of the same strain of the same strain of the same strain strain of the same strain of the same strain of the same strain strain of the same strain of the same strain of the same strain of the same strain strain of the same strain

On the belief that this is a law of nature, we can, I think, understand several large classes of facts, such as the following, which on any other view are inexplicable. Every hybridizer knows how unfavourable exposure to wet is to the fertilisation of a flower, yet

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what a smittenke of flower have their anthere and trigma fully copied to the watter [1 for accessingle cross be indispensible, notivitationing that the jam's even anthere and pittel study to me and, other as almost to ensure soft-fortilization, the fullist frashom for the untranse experime of the expans. Many flowers, on the other inamical experime of the expans, Many flowers, almost investible posent benefitted and writton adaptations in radiation the visits of moster. But there for this is gravity almost in the prast particulation of the expans, almost investible to be visits of moster. But there for this is gravity dimined if they writte be prevent. Next, this assuredy possible for inmests to fly from flower to flowers, and not to courry polent from one to the older, to be pract accord the plant. Tracter as tills a candidating practif, and it is sufficient, to ensure fortilization, but to stigma of another put it must not be supposed that these would thus produce is multitude of hybrids hetreon distinct poles is for if the stars, the former is no proposet: that is invariably and the matching the former is no proposet. that is invariably and the former is no proposet. This is invariably and the matching the former is no proposet. The functional pole is the final stars of the former is no proposet. The infinitence of the foreign pole former. The pole of the function of the foreign pole of the foreign pole.

a) When the summer of a flower and/arily apping towards the pickly of solviny more one after the other towards it, the contrivance scena adapted adely to ensure addi-for this acid. It is the agency of more its is often required to addite the the addite of the solution of the solutio

feady in any garden. In very many other case, though them is no special modulation contrinuous to prevent the atigma rewriting polar from the same flower, you, as Fjernenja, and more resently likeliheant, and others, have above, and possible for fertilitations, or othe initian second control of the same second second second tensor is mody below the polar of that flower is ready, so that more a second second second. So it is with the redpressible more that the same second second second second second more than the second se

If several varieties of the cabbage, radish, onion, and of some other plants, he allowed to seed near each other, a large majority of the seedlings thus raised turn out, as I have found, mongrels: for instance, I raised 233 seedling cabbages from some plants of different varieties growing near each other, and of these only 78 were true to their kind, and some even of these were not perfectly true. Yet six stamens, but by those of the many other flowers on the same without insect-agency; for I have found that plants carefully protected from insects produce the full number of pods. How, then, comes it that such a vast number of the seedlings are mongrelized? It must arise from the pollen of a distinct variety having a prepotent effect over the flower's own pollen ; and that this is part of the general law of good being derived from the intercrossing of distinct individuals of the same species. When distinct species are crossed the case is reversed, for a plant's own pollen is almost always prepotent over foreign pollen ; but to this subject we shall return in a future chapter.

In the case of a large tree overed with immunella forces, \mathbf{F} may be object that pollon could adopt more than the carried from tree to tree, and at most coly from flower to flower on the same tree; and flowers on the same tree can be considered as distinct individual flowers on the same tree can be considered as distinct individual that at most coly the same tree in the privace flowers through the same tree pollon much same tree pollon to sates are separated, although the make and formate flowers may the generation of much same tree, pollon much be regularly carried from generation of the same tree, pollon much be regularly carried from

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donors to forwer; and this will give a better chance or pollon being constantily carried from tree to tree. That trees belonging to all othern have their across more often separated than other plants; I that but he tass in this country; rank at any request De. Howker tablied to the trees of New Zashani, and Dr. Aas forry those of the other standards of the sensitiva as at 1 substitution. On the other hand, Dr. Howker informs much at the rule does not hold pool in attracting, but informs that the rule does not hold pool in attracting the standard the standards of the standards of the standards attracting to the model that the resents on trees simply to call attention to the block.

Turning for a larie space number is various terretricit pepties and neurophysically can be at the factomethous and early-avorants but these all pair. As yet I have not found a single torrestation outcome a constant with terrestatial plants, it intelligible on the view outcome a constant with terrestatial plants, it intelligible on the view of the constant of the terretrial plants, it intelligible on the view of the constant with terrestatial plants, it intelligible on the view of large constant with terrestatian plants, which we have the of insects and of the wind with plants, by which an occusional coses of two individuals. Of spatial canimals, there are many self-fertiling neural plants and there the current without the concustometers means for a constant areas. As in the case of theory, I have a mean for an economical error. As in the case of theory, I have a mean for an economical error A with the term of the sector of a single brown to be physically impossible. Christopher long apparent with the expanse of reproduction no perfectly enclosed that access the as is protent, marking the origin of the sector of the sector individual, theory hole, by a formation chance, to prove that two the sector of the sector of the sector of the sector of the sector individual, theory hole, have a formation chance, to prove that two sectors.

It must have struck most naturalists as a strange anomaly that, both with animals and plants, some species of the same family and even of the same genus, though agreeing closely with each other in their whole organisation, are hermapirotices, and some unisexual. But if, in fact, all hermaphrotices do occasionally intercoss, the difference between them and unisexual species is, as far as function is concorred, very small.

From these several considerations and from the many special facts which I have collected, but which I am unable here to give, it appear that with an aimals and plants an coccasional intercross between distinct individuals is a very general, if not universal, law of nature.

Circumstances favourable for the production of new forms through Natural Selection.

This is an externely intricte nebject. A great amount of varibility, under which term individual directors are always include, will evidently be favorable. A large number of individual, y pring a letter danswer within any great prior of the apparance organized prior and the individual, and is, I believe, a highly imperiacenter of a nears. Tough Nature greates long periods of time for the work of nutural solection, also does not great an individual period for an end period being one advisor box great an individual in the observed of number of the sole period of time for the work of nutural solection, also does not great an individual period for a sole of the sole of the sole of the sole of the in the observed of the sole sole of the sol

In the case of methodical melection, a breader selects for momendefine object, and the individuals ballwood freely to interess, his work will completely fail. But when many men, without individual to alter the bread, have a marky common standard of interest, and the bread start of the set at a start interest of the bread start of the set at a start, and improvement sample to process and bread frame the loss at an individual. Thus it will be under nature, for within a set of individual. Thus it will be under nature, for within a spectra of the set of the set of the set of the set of the complete all the individuals varying in the right direction, house many is set of the set of the set of the set of the set of hears. Be sense, will be the large set of the set of the complete all the individuals varying in the right direction, house many is set of the set of the set of the set of the set of hears. Be sense, which is the set of the set of the set of the large many set of the set of the set of the set of the large many set of the set of the set of the set of the large manual be arguing and the set of the set of the set of the large manual be arguing and the set of the set of the set of the large manual by a set of the set of the set of the set of the large manual by a set of the large set of the set of the set of the set of the large manual by a set of the set of the set of the set of the large many set of the large set of the large set of the set of the large set of the large set of the large set of the set of the set of the set of the large set of the set o

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tirth, but which wander little and can increase at a rapid rate, a new and improved variety might be quickly formed on any one speed, and might there maintain itself in a lody and afterwards agreed, so that the individuals of the new variety would chiefly cons topether. On this principle nurrerymen always prefer avoing seed from a large body of plants, as the chance of intercrossing is then learned.

Even with minuals which units for each hirth, and which do not propage an apply we must not assume that fore intervisioning would prove the start of the start of matrix sheeting in the start forward a considerable body of facts showing that within the same area, two varieties of the same animal may long remain distinct, from haunting different stations, from baceling and hybrid different searcas, or from the individuals of each variety preferring to pair toother.

Isolation, also, is an important element in the modification of project through narral selection. In a confined or isolated area, if not very large, the equation and inorganic conditions of like will tend to gravity be inhumed uniformed in the inhabitant of the auronation galaxies massure. Interesting with the inhabitant of the auronation galaxies their scaling of the inhabitant of the auronation galaxies their scaling of the automation of the inhabitant of the auronation galaxies labels on interesting easy on this subject, and has shown that by labels on interesting easy on this subject, and has shown that by the arrive randered by blacking in prevention.
Circumstances favourable to the

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from treating is peakally grater even that 3 urgeoux). But from reasons already angied I can by no mana agree with this naturalist, that migration and isolation are necessary elements for the formation of new speeds. The importance of isolation is likewise grats in preventing, after any physical change in the conditions and as of climatic questions of the shared shares of the starbulk of the start of the share of the start of the startic start of the start for a new variety to be improved at a slow rate s and this may consiting have the start of the start of the production after form having energy will be madig and this will related the production of raw pages will be madig and this will related the production of raw pages.

The new layse of time by tasked Jone modeling, efficient for a spatial metric also before. It is a best of the second second second same that the element of time has been assumed by run to play we are secondly metric play of the second second second second of time is only so far important, and its importance in this respect of time is only so far important, and its importance in this second second

If we turn to nature to test the truth of these remarks, and lead at any small lookad area, such an an cosmic lashed, although the number of species inhabiting it is small, as we shall see in cerdaptice on Grogophical Distribution; yol of these species a very device on Grogophical Distribution; yol of these species a main howbere else in the wealth. Hence are, the species of the species of

Although isolation is of great importance in the production of new species, on the whole I am inclined to believe that largemess of area is still more important, especially for the production of species which shall prove capable of enduring for a long period, and of specading widely. Throughout a great and open area, not only will have be

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better chance of favourable variations, arising from the large number of life are much more complex from the large number of already existing species ; and if some of these many species become modified degree, or they will be exterminated. Each new form, also, as soon as it has been much improved, will be able to spread over the open and continuous area, and will thus come into competition with many other forms. Moreover, great areas, though now continuous, will often, owing to former oscillations of level, have existed in a broken condition : so that the good effects of isolation will generally. to a certain extent, have concurred. Finally, I conclude that, although small isolated areas have been in some respects highly favourable for the production of new species, yet that the course of modification will generally have been more rapid on large areas; and what is more important, that the new forms produced on large areas, which already have been victorious over many competitors. will be those that will spread most widely, and will give rise to the greatest number of new varieties and species. They will thus play a more important part in the changing history of the organic

In accordance with this view, we can, perhaps, understand some facts which will be again alluded to in our chapter on Geographical Distribution ; for instance, the fact of the productions of the smaller continent of Australia now yielding before those of the larger Europeo-Asiatic area. Thus, also, it is that continental productions small island, the race for life will have been less severe, and there will have been less modification and less extermination. Hence, we can understand how it is that the flora of Madeira, according to Oswald Heer, resembles to a certain extent the extinct tertiary flora of Europe. All fresh-water basins, taken together, make a small area compared with that of the sea or of the land. Consequently, the competition between fresh-water productions will have been less produced, and old forms more slowly exterminated. And it is in fresh-water basins that we find seven genera of Ganoid fishes, remnants of a once preponderant order : and in fresh water we find have endured to the present day, from having inhabited a confined

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area, and from having been exposed to less varied, and therefore less severe, competition.

To sum up, as far as the extreme intricacy of the subject permits, new species through natural selection. I conclude that for terrestrial productions a large continental area, which has undergone many will have been subjected to severe competition. When converted many individuals of the same species on each island : intercrossing on the confines of the range of each new species will have been checked : after physical changes of any kind, immigration will have been prevented, so that new places in the polity of each island will have had to be filled up by the modification of the old inhabitants; and time will have been allowed for the varieties in each to become well modified and perfected. When, by renewed elevation, the islands were reconverted into a continental area, there will again have been very severe competition : the most favoured or improved varieties will have been enabled to spread ; there will have been much extinction of the less improved forms, and the relative proportional numbers of the various inhabitants of the reunited continent will again have been changed ; and again there will have been a fair

That natural selection generally acts with extreme slowness I fully admit. It can act only when there are places in the natural polity of a district which can be better occupied by the modification of some of its existing inhabitants. The occurrence of such places will often depend on physical changes, which generally take place very slowly, and on the immigration of better adapted forms being prevented. As some few of the old inhabitants become modified, the mutual relations of others will often be disturbed; and this will create new places, ready to be filled up by better adapted forms; but all this will take place very slowly. Although all the individuals of the same species differ in some slight degree from each other, it would often be long before differences of the right nature in various parts of the organisation might occur. The result would often be greatly retarded by free intercrossing. Many will exclaim that these several causes are amply sufficient to neutralise the power of natural selection. I do not believe so, But I do believe that

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natural selection will generally act very slowly, only at long intervals of time, and only on a few of the inhabitants of the same region. I further believe that these slow, intermittent results accord well with what geology tells us of the rate and manner at which the inhabitants of the world have changed.

Slow though the process of selection may be, if feeble man can do much by artificial selection, I can see no limit to the amount of charge, to the basity and complexity of the coadoptations between all organic beings, one with another and with their physical conditions of life, which may have been effected in the long course of time through nature's power of selection, that is by the survival of the fittest.

Extinction caused by Natural Selection.

This endpice will be now fully discussed in our chapter on cleostry in hit mutues here haldshad from being infinitately connected with natural selection. Matural selection acts solely through the preservation of variations in non-way advantageous, which of all expands beings, each area is already fully stoched with inhibiany; and its follower from this, that as the forcered form isomessis number, no generally, will the less favoured derivates and beeased on the second state of the second of its remains. But we may for further than this is for a second state of its remains. But we many of drams must become extinct. That the number of equilible forms and become string the present function of the second string of the second has not become immession provide. The second has not become immession provide present.

We have seen that the repeets which are nost numerous in individuals have the bost chance of producing favorables variations within any given period. We have evidence of this, in the facts stated in the second calcepte, alweing that it is the common and diffused or dominant species which offer the greatest number of vectorist and the factors, are negless with the loss quickly modified between the more for life by the modified and improved incoming between the reserve.

From these several considerations I think it inevitably follows,

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that as new species in the corns of time are formed htrough uning decision, otherw will become near an inter, and finally cutient. The form which stand in closest competition with those undergoint outlination and improvement, will astronally radie must. Add will have seen in the shapers on biceletist of the same species, and pogies of the same genus or or risted generary—which, from harving merity the same structure, constitution, and habits, generally come into the servest competition with each shaper transmission of the same genus of the same genus corress of risted generary—which, from harving nearly the same structure, constitution, and habits, genuently come into serverst competition with each shaper transmission the weak structure of the same structure, constrained and weak the same server of the structure another of the same space and the same structure, and the same structure of the same structure, constrained and the shaper structure of the same strucder of the same structure of the same strucder of the same structure of the s

Divergence of Character.

The principle, which I have designated by this term, is of high importance, and explains, as I believe, several important facts. In the first place, varieties, even strongly-marked ones, though having somewhat of the character of species-as is shown by the hopeless doubts in many cases how to rank them-yet certainly differ far less from each other than do good and distinct species. Nevertheless, according to my view, varietics are species in the process of then, does the lesser difference between varieties become augmented into the greater difference between species ? That this does habitually happen, we must infer from most of the innumerable species throughout nature presenting well-marked differences; whereas varieties, the supposed prototypes and parents of future well-marked species, present slight and ill-defined differences. Mere chance, as we may call it, might cause one variety to differ in some character from its parents, and the offspring of this variety again to differ but this alone would never account for so habitual and large a degree of difference as that between the species of the same

As has always been my practice, I have sought light on this

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head from our domestic productions. We shall here find something different as short-horn and Hereford cattle, race and cart horses, the several breeds of pigeons, &c., could never have been effected by the mere chance accumulation of similar variations during many successive generations. In practice, a fancier is, for instance, struck by a pigeon having a slightly shorter beak; another fancier is struck by a pigeon having a rather longer beak; and on the acknowledged principle that " fanciers do not and will not admire a medium standard, but like extremes," they both go on (as has actually occurred with the sub-breeds of the tumbler-pigeon) choosing and breeding from birds with longer and longer beaks, or with shorter and shorter beaks. Again, we may suppose that at an early period of history, the men of one nation or district required swifter horses, whilst those of another required stronger and bulkier horses. The early differences would be very slight; but, in the course of time, from the continued selection of swifter horses in the one case, and of stronger ones in the other, the differences would become greater, and would be noted as forming two sub-breeds. Ultimately, after the lapse of centuries, these sub-breeds would become converted into two well-established and distinct breeds. As the differences became greater, the inferior animals with intermediate characters, being neither very swift nor very strong, would not have been used for breeding, and will thus have tended to disappear. Here, then, we see in man's productions the action of what may be called the principle of divergence, causing differences, at first barely appreciable, steadily to increase, and the breeds to diverge in character, both from each other and from their common

But how, it may be aked, can any analogous principle apply in ature ? I believe it can and does apply mot efficiently (hough it was a long time before 1 aw low), from the simple circumstance that the more diversified the descendants from any one rpcies bosonic astructure, constitution, and habia, by so much will they be better anabled to series on many and widely diversified places in the policy of nature, and so be enabled to increase in numbers.

We can clearly discert this in the case of animals with simple habits. Take the case of a carniverous quadruped, of which the number that can be supported in any country has long ago arrived at its full average. If its natural power of increase be allowed to act, it can unceed in increasing (the country not undergoing any change in conditions) only by its varying descendants setting on places at present occeptied by other animals: some of them, for Divergence of Character.

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instance, being enabled to feed on new kinds of prey, either dead or alive; some inhabiting new stations, climbing trees, frequenting water, and some perhaps becoming less carnivorous. The more diversified in habits and structure the descendants of our carnivorous animals become, the more places they will be enabled to occupy, What applies to one animal will apply throughout all time to all animals-that is, if they vary-for otherwise natural selection can effect nothing. So it will be with plants. It has been experimentally proved, that if a plot of ground be sown with one species of grass, and a similar plot be sown with several distinct genera of herbage can be raised in the latter than in the former case. The Hence, if any one species of grass were to go on varying, and the in the same manner, though in a very slight degree, as do the distinct species and genera of grasses, a greater number of individual plants of this species, including its modified descendants, would succeed in living on the same piece of ground. And we know that each species and each variety of grass is annually sowing almost countless seeds; and is thus striving, as it may be said, to the utmost to increase in number. Consequently, in the course of many thousand generations, the most distinct varieties of any one species of grass would have the best chance of succeeding and of increasing

The truth of the principle that the greatest amount of this can be supported by great diversitations of a structure, is seen under may natural downsatances. In an extremely small arcs, especially of the structure diversity in its inhabitants. For instance, I found that a piece of the structure of the structure of the structure of the structure pieces and these biological diversity of the structure pieces and these biological diversity of the structure of the order of the structure of the order of the structure of the structure

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piece of ground, could live on it (anypoing its nature not to be in any way peculiary, and may be said to be pairwing to the utmost to live there; but, it is seen, that where they come into the closest compatiton, the salvantages of directification of structures, with the accompanying differences of habit and constitution, determine that the inhibitations, which thus pictole each other most closely, shall, as a general rule, belong to what we call different genera and colors.

The same principle is seen in the naturalisation of plants through fand would generally have been closely allied to the indigenes; for these are commonly looked at as specially created and adapted for their own country. It might also, perhaps, have been expected that naturalised plants would have belonged to a few groups more especially adapted to certain stations in their new homes. But the case is very different; and Alph. de Candolle has well remarked, in his great and admirable work, that floras gain by naturalisation, proportionally with the number of the native genera and species, far more in new genera than in new species. To give a single instance: in the last edition of Dr. Asa Gray's 'Manual of the Flora of the Northern United States,' 260 naturalised plants are enumerated, and these belong to 162 genera. We thus see that these naturalised plants are of a highly diversified nature. They differ, moreover, to a large extent, from the indigenes, for out of the 162 naturalised genera, no less than 100 genera are not there indigenous, and thus a large proportional addition is made to the genera now living in the United States.

By considering the nature of the plants or animals which have in any country struggled successfully with the indigenes, and have three become naturalised, we may gain some crude idea in what manner some of the natives would have to be modified, in order to gain an advantage over their comparitoirs ; and we may at least infer that diversification of structure, amounting to new generic differences, would be prefutable to them,

The advantage of diversification of structure in the inhabitants of the same region is, in fact, the same as that of the physiological division of labour in the crysms of the same individual body—a molecular diversified by the Diversity. No physiological absults that a stemach adapted to digast vegetable matter along, or field absord, arrows on turitizent from these substances. So in this general eccompt of any hand, the more widely and perfectly the animals and plants and intermediation different halots of lifes, so will

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a greater annuber of individuals be capable of three supporting themasives. A set of animals, with their erganisation bus little discriftiols, cold hardly singularity and their erganisation bus little discriftions and a set of the other have membral, our carativeron, runniant, and rolent manlo, cold mesoscilly competer with these well-developed orders. In the Astrahian mammal, we see the process of diversification, in a next yaa dincomplete stage of development.

The Probable Effects of the Action of Natural Selection through Divergence of Character and Extinction, on the Descendants of a Common Ancestor.

After the foregoing discussion, which has been much compressed, we may assume that the modified descendants of any one species, will necceed so much the better as they become more diversible in structure, and are thus enabled to encreach on places occupied by other beings. Now let us as show this principle of benefit being derived from divergence of character, combined with the principles of natural selection and of excitation, tends to act.

The accompanying diagram will aid us in understanding this rather perplexing subject. Let A to L represent the species of a genus large in its own country; these species are supposed to resemble each other in unequal degrees, as is so generally the case in nature, and as is represented in the diagram by the letters standing at unequal distances. I have said a large genus, because as we saw in the second chapter, on an average more species vary in large genera than in small genera ; and the varying species of the large genera present a greater number of varieties. We have, also, seen that the species, which are the commonest and the most widely diffused, vary more than do the rare and restricted species. Let (A) be a common, widely-diffused, and varying species, belonging to a genus large in its own country. The branching and diverging dotted lines of unequal lengths proceeding from (A), may represent its varying offspring. The variations are supposed to be extremely slight, but of the most diversified nature ; they are not supposed all to appear simultaneously, but often after long intervals of time; nor are they all supposed to endure for equal periods. Only these variations which are in some way profitable will be preserved or naturally selected. And here the importance of the principle of benefit derived from divergence of character comes in ; for this will generally lead to the most different or divergent variations (repre-



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sented by the outer dotted lines) being preserved and accumulated by matural selection. When a dotted line reaches one of the horizontal lines, and is there marked by a small numbered letter, a sufficient around of variation is supposed to have been accumulated to form it into a fairly well-marked variety, such as would be thought worthy of record in a systematic work.

If, then, these two varieties be variable, the most divergent of their variations will possibly to preserved during the next thousand generations. And after this interval, variety of a surgood in the effect of the strength of the strength of the strength of the effect of divergence of their more from (A) that all it variety of a strength of the variety of the strength of the variety of the strength and more molfied coulding, among producing two or three varieties, and more molfied coulding, among producing the strength of the diagram the present of the quench and plaqued in diameter. In the diagram the present of the strength on the two-thousand in generation, and the present of the strength on the two-thousand in generation.

But I must here remark that I do not suppose that the process ever goes on so regularly as is represented in the diagram, though in itself made somewhat irregular, nor that it goes on continuously; it is far more probable that each form remains for long periods unaltered, and then again undergoes modification. Nor do I suppose

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that the most divergent variation are invariably preserved: a molecular more may clock non-relative, and may or may nor probate more than one molified disconstant; for narrow labelets, will adverge at a contribution by the start of the start of the depend on infinitely complex relations. But as a general rais, but one existential in infraring the storage by which be built on a disconstant of the storage built of the start of the start depend on infinitely complex relations. But as a general rais, but here a diversified in infraring the suscessive forms which have become brand latters marking the suscessive forms which have become infinitely distinct to be recorded as varieties. But these iteraks are imaginary, and halpfiel have been inserted a stypheng after infradivergent primities.

As all the modified descendants from a common and widdydiffused proto-bioching to a large grave, will tend to paratale of the same advantages which made their paratent messedial in lis, they will generately go on multiplying in numbers as will as soveral, divergants branches proceeding from (A). The modified ordering, from the laren and near highly improved hemches in the lines of descent, will, it is probable, often takes the pipters of same sodering, the same and low improved branches; this is represented in the diagram by some of the lower branches; the increasing and multitation will be confined to a single line of descent, will be number of modified descentation will not be increased; although the anomet of divergent modification multiply that from at orde⁻¹. In couling from (A) were nursely, excepting that from at orde⁻¹. This case would be represented in the diagram, if all the lines proceeding from (A) were nursely, excepting that from at orde⁻¹. In early both gave on abovery diverging in character from their original to a structure of the same of the

After tox thousand generations, species (A) is approach to have provided three forms, a^{m}/r^{m} and a^{m}/r^{m} , which, from having diverged in character during the successive generations, will have come to differ largely, but perhaps unregality, from each during the success much horizontal line in our line matrix is the sum of charge bits these three forms may still be only well-marked variables, but yet have only to suppose the steps in the process of molification to be

into donabid or at last into well-defined spectra. Thus the diagram limitate the keys by which the small difference distinguishing variations are increased into the larger difference distinguishing e.o., By continuing the same process for a greater mumber of generations (as shown in the diagram in a condensed and simplified and m^{2} , all descended from (A). Thus, as I believe, species are multible and genera are formed.

In a large genus it is probable that more than one species would vary. In the diagram I have assumed that a second species (I) has produced, by analogous steps, after ten thousand generations, either two well-marked varieties (1010 and 233) or two species, according to the amount of change supposed to be represented between the horizontal lines. After fourteen thousand generations, six new species, marked by the letters n¹⁴ to z¹⁴, are supposed to have been produced. In any genus, the species which are already very different in character from each other, will generally tend to produce the greatest number of modified descendants; for these will have the best chance of seizing on new and widely different places in the polity of nature : hence in the diagram I have chosen the extreme species nine species (marked by capital letters) of our original genus, may for long but unequal periods continue to transmit unaltered descendants; and this is shown in the diagram by the dotted linesunequally prolonged upwards.

But during the process of modification, represented in the diagram, another of our principles, mangle that of exitnetion, will have played an important part. As in each fully stocked country natural solution necessarily with by the selection framing income advaning the selection of the selection of the selection of the selection of the improved decountainty of the selections and their original progenitor. For it should be remembered that the competition will generally be not serve between those froms and structures. Hence all the intermediate from between subtermediates and the selection of the same species, as well as the original parent-species itself, will whole solutional line of descent, which will be compared by this map whole solutions in the solution of the selection of the same species, as well as the original parent-species itself, will whole solutions line of descent, which will be compared by blaye whole solutions are solved as the solution of the same species in the selection of the same of the selection which will be compared by blaye whole solutions in the solution of the same and the selection of the same species, as well as the original parent-species itself, will be solution on the single solution of the same solution balance to some solutions with the same distingtion of some solutions in the same single solution of the same solution of the same solution is also the solution of the same single solution of the same solution is also the solution of the same single solution of the same solution is also the solution of the same single solution of the same solution is also the solution of the same solution is also the

quite new station, in which offspring and progenitor do not come into competition, both may continue to exist.

If, then, our diagram be assumed to represent a considerable amount of modification, species (A) and all the earlier varieties will have become extinct, being replaced by eight new species (a^{u_1} to m^{u_1}); and species (1) will be replaced by six (n^{u_1} to a^{u_1}) new species.

But we may go further than this. The original species of our grants were argoest to resemble seek of their in unequiladigenes, as is so generally the case in nature 1 species (A) being more more, is so generally the case in nature 1 species (A) being more insets (A) and (B) are also mapped by the species (A) and (D) were a bit, R, T, thin to the others. These two species (A) and (D) were also mapped by be very common and windry diffusion functions in markers at the fortex-browned harmonic distances of more than the species of the genus. Their molified describances, there are also mapped by the species of the species of the species and of the enter harmonic species of the species and the species of the space of the species of the species adjust to many related to their parents. Uncer very fave of the original species with have ranse ones of the original perices which were used (T) and (D), buil likes the structure from the original appeals with have ranse mapped that only or (D), of the two species (T) and D). We have least colledy related to this last angle of descent, but were least colledy related to this last angle of descent.

The new species in our diagram descended from the original oliver species, will nove be fifteen in number. Overing to the divergent tendency of natural solvedies, the extreme amount of difference in the number of tensors produce of an alpha will be much generate flux there species, moreover, will be allow for each other in a weishy different from "more". A species of the species of the species of the species of α^{0} , α^{0} ,

The six descendants from (1) will form two sub-genera or genera. But as the original species (1) differed largely from (A), standing

nearly at the extreme end of the original parms, the site Ameendance from ()) will, owing to inheritone above, diffee considently from the sight denomination from (A), the two groups, noncover, any intermediate strength (A), the two groups, noncover, and (A) is the strength of the site of the

Thus it is, as I believe, that two or more genera are produced by denore with molfinden, from two or more speeds of the same genus. And the two or more present-speeds are supposed to budesconded from some one speeds of an archire genus. In our diatities, converging in sub-brankse downwards towards a single point; this point presents a speeds, the supposed progmiter of our several new mb-perma and genera.

It is well while to reflect for a moment on the character of the new probes P_{i}^{A} which is reproport over to have diverged much in character, but to have retainod the form of (P), either unaltered effect only in a sliph degree. In this case, it is affinities to the other formers new species will be of a curies and ermitains to the other formers new species will be of a curies and ermitains to the momenta of the simulation of the strength of the simulation of the simulation of the strength of the strength of the momenta of the simulation in that strength of the simulation gamma diverging in character P_{i} and the simulation of the simulation of the simulation of the simulation of the simulation gamma diverging in character P_{i} and the simulation of the simulation is simulated with the bard energy intermodulate horizon them, but mather between types of the two groups is not every naturalise will be able to call and maken before the mind.

In the diagram, such horizontal line has hitherto been apposed to represent a thousand generation, but each may represent a million cores generations; it may also regresses a section of the shorts weak of the our thirk series including entities transition. We address weak of the our thirk series including entities transition. We address the start of the start is series in the start of address to this subject, and I thicks we shall the same the start of the start is series and the start of the start is start of the start of the start of the start of the same living the start is start of the start weak of the start of the start of the start of the start of the scatter appearing groups is address of the start of the start lines of dissums that diverged has.

I see no reason to limit the process of incuffication, the low gradiance in the financian of garcy-generated by each successive group of diverging dotted limas to be great, the forms mutted with to $p_{\rm e}^{-1}$ theorem marked b² and $p_{\rm e}^{-1}$ and these mutted with $m_{\rm e}^{-1}$ with lies in three very distinct geness. We shall also have two very distinct families, or collect, according to the mount of divergent modification supposed be are represented in the distant. And the two instefamilies, or collect, according to the amount of divergent modification supposed be are represented in the distant. And the two more families, or collect, ac obscinged from some will more mainting or collect, ac discondered from some will more accessing and subsciences from some will more accessing more accessing and subsciences for the second limit.

species. This, indeed, might have been expected; for, as natural already have some advantage; and the largeness of any groun new and modified descendants will mainly lie between the larger thus lessen its chance of further variation and improvement. Within the same large group, the later and more highly perfected the earlier and less improved sub-groups. Small and broken groups increase. But which groups will ultimately prevail, no man can and consequently that, of the species living at any one period,

more indent species have unmanified descendants to the present day, and, at all the observations of the assens species form a class, we show a division of the list hat there exists so few dances in each and division of the minual and versable kingdome. Although few of the most andent species have left molified descendants, yet, a remote prological periods, the earth may have been almost as well popela with species of many genera, families, orders, and classe, as at the present time.

On the Degree to which Organisation tends to advance.

Natural Selection acts exclusively by the preservation and accumulation of variations, which are beneficial under the organic and inorganic conditions to which each creature is exposed at all periods of life. The ultimate result is that each creature tends to become more and more improved in relation to its conditions. This improvement inevitably leads to the gradual advancement of the organisation of the greater number of living beings throughout the world. But here we enter on a very intricate subject, for naturalists have not defined to each other's satisfaction what is meant by an advance in organisation. Amongst the vertebrata the degree of intellect and an approach in structure to man clearly come into play. It might be thought that the amount of change which the various parts and organs pass through in their development from the embryo to maturity would suffice as a standard of comparison ; but there are cases, as with certain parasitic crustaceans, in which animal cannot be called higher than its larva. Von Baer's standard seems the most widely applicable and the best, namely, the amount of differentiation of the parts of the same organic being, in the adult state as I should be inclined to add, and their specialisation for different functions ; or, as Milne Edwards would express it, the completeness of the division of physiological labour. But we shall see how obscure this subject is if we look, for instance, to fishes, amongst which some naturalists rank those as highest which, like the sharks, approach nearest to amphibians ; whilst other naturalists rank the common bony or teleostean fishes as the highest, inasmuch as they are most strictly fish-like, and differ most from the other subject by turning to plants, amongst which the standard of inteland pistils, fully developed in each flower; whereas other botanists,

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probably with more truth, look at the plants which have their several organs much modified and reduced in number as the highest.

If we take as the standard of high organisation, the amount of informations and specialization of the averal organs it such being when adult (and this will helded the advancement of the lensitivitic standard in the state of the predictivities of the state interaction of the state of the predictivities of the state interaction of the state of the predictivities of the state interaction of the state of the predictivities of the state interaction of the state of the predictivities of the state interaction of the state of the state of the state of the state interaction of the state of the state of the state of the state interaction of the state of the state of the state of the state or errory uncompiled or lens well compiled place in the scenary of or nucleus in such cases there would be refrequencies in the scale of or nucleus in and nears there would be predictive the present day will be non-conventively deviced predictive of the present of the scenario of the scenario of the present day will be non-conventively deviced predictive of the present day of the scenario of the scenario of the scenario of the scenarios of the scenar

But it may be objected that if all organic beings thus tand to irs in the scale, how it if that throughout the world a multimized of irs in the scale, how it if that throughout the world a multimized is more forms are far more highly developed than others? Why have not here the scale of the scale of the scale of the scale actermization that the difficulty so strengly, that he was held to appear to have fait this difficulty so strengly, that he was held to appear to have fait this difficulty so strengly, that he was held to appear to have fait this difficulty so strengly, that he was held to appear how any strength of the scale of the scale of the scale to have fait this difficulty is strengly. As the scale here the difficulty is a strength of the scale of the scale of the matural solector, or the murvial of the fitted, does not necessarily place relations of life. A scale of the scale of the scale of the scale scale of the scale scale of the scale isofial to scale of the scale

have remained for an enormous period in nearly their present state. But to suppose that most of the many now existing low forms have not in the least advanced since the first dawn of life would be extremely reak for every naturalist who has dissected some of the beings now ranked as very low in the scale, must have been struck with their really woodrogs and basultful organization.

Nearly the same remarks are applicable if we look to the different grades of organisation within the same great group ; for instance, in the vertebrata, to the co-existence of mammals and fish-amongst mammalia, to the co-existence of man and the ornithorhynchusamongst fishes, to the co-existence of the shark and the lancelet structure approaches the invertebrate classes. But mammals and fish hardly come into competition with each other; the advanceclass, to the highest grade would not lead to their taking the place of fishes. Physiologists believe that the brain must be bathed by so that warm-blooded mammals when inhabiting the water lie under a disadvantage in having to come continually to the surface to breathe. With fishes, members of the shark family would not tend to supplant the lancelet; for the lancelet, as I hear from Fritz Müller, has as sole companion and competitor on the barren sandy shore of South Brazil, an anomalous annelid. The three lowest orders of mammals, namely, marsupials, edentata, and rodents, co-exist in South America in the same region with numerous monkeys, and probably interfere little with each other, Although organisation, on the whole, may have advanced and be still advancing throughout the world, yet the scale will always present many degrees of perfection; for the high advancement of certain whole classes, or of certain members of each class, does not at all necessarily lead to the extinction of those groups with which they do not enter into close competition. In some cases, as we shall hereafter see, lowly organised forms appear to have been preserved to the present day, from inhabiting confined or peculiar stations, where they have been subjected to less severe competition. and where their scanty numbers have retarded the chance of favour-. able variations arising.

Finally, I believe that many lowly organised forms now exist throughout the world, from various causes. In some cases variations or individual differences of a favourable nature may never have arises for natural selection to act on and accumulate. In no case, probably, has time sufficient for the utmost possible amount of

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development. In some few cases there has been what we must call retrogression of organisation. But the main cause lies in the fact that under very simple conditions of life a high organisation would be of no zervice,-possibly would be of a stated disservice, as being of a more delicate nature, and more liable to be put out of order and injured.

Looking to the first down of life, when all equation beings, are way below, presented the integrist attracture, have, it has been parts have axism? An interest Spenner would prohably assees that, as not an aimput united that any spenner attracted to distinct to be compounded of sevenal cells, or beams attracted on a properting access, his is w⁻¹ that homologous units of any dens (news, his is w⁻¹ that homologous units of any dens (news, his is w⁻¹ that homologous units of any dens (news, his is w⁻¹ that homologous units of any dens (news, his is w⁻¹ that homologous units of any dens (news, his is w⁻¹ that homologous units of any dens (news, his is w⁻¹ that homologous units of any dens (news, his is w⁻¹ that homologous units of any dens (news), his is w⁻¹ that homologous units of any dens (news), his is w⁻¹ that we have been at the observation of a cilcano, and, to compute that here would be no straight for cilcano, and, the homologous during dense mainly at mission tatation night be homolish, or two during form anglets at his homologies to be submitted to be a straight at homologies at which to be straight to homology acy we may have a straight at his main the straight homologies at his homologies at the probabil hybrid and hight homologies at his homologies at homologies at his homologies at his mission of any probability how preset this, and all more or during past ages.

Convergence of Character.

Mr. H. C. Wotson thinks that I have evertated the impettees of divergence of abarater (in which, however, he sequently ballway), and that convergence, as it may be called, has illevies pixel a pixel. If two precises, balonging is two distinct though allel geners, but bell produced a large number of more and diverent structures and the set of the second pixel and the second genus pixel model. The voltation of the second pixel and the second pixel and the set of the distinct pixel and the set of colorly that they would have all to be extremely pixel has dust blue to convergence a close and general administry of structures in the molified descendance of vold-y distinct forms. The shape of acception is detormined using by the molecular forces, and it is not surging is detormined using by the molecular forces, and it is not surging in which extends theory would have all to be into the form of the with the extends theory are been as the set of the force of the set of the force of the set o

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Convergence of Character.

each depends on an infinitude of complex relations, namely on the variations with have arises, these built depends on the surroundintrinsit to be followed out,—on the nature of the variations which may be not preserved or solected, and hid depends on the surrounding physical conditions, and in a still higher depends on the surroundmention of the start with which are being final comous lite compatinomian dependence with which are being final comous lite compatiions and the start of the start of the start of the start of the dependence of the start of the start of the start of the start of the leader of the start indication. If this had ever after which have with the start form indication. If this and ever after which were the with the start for indication of the start indication of the start indication of the start of the start

Mr. Watson has also objected that the continued action of natural selection, together with divergence of character, would tend to make an indefinite number of specific forms. As far as mere inorganic conspecies would soon become adapted to all considerable diversities of heat, moisture, &c. ; but I fully admit that the mutual relations might be produced. We do not know that even the most prolific area is fully stocked with specific forms : at the Cape of Good Hope and in Australia, which support such an astonishing number of species, many European plants have become naturalised. But geology shows us, that from an early part of the tertiary period the same period the number of mammals, has not greatly or at all increased. What then checks an indefinite increase in the number of species? The amount of life (I do not mean the number of specific forms) supported on an area must have a limit, depending inhabited by very many species, each or nearly each species will be represented by few individuals; and such species will be liable to extermination from accidental fluctuations in the nature of the seasons or in the number of their enemies. The process of extermination in such cases would be rapid, whereas the production of new

Natural Selection.

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species must always be slow. Imagine the extreme case of as many species. Rare species, and each species will become rare if the will, on the principle often explained, present within a given period becomes very rare, close interbreeding will help to exterminate it ; the deterioration of the Aurochs in Lithuania, of Red Deer in Scotland, and of Bears in Norway, &c. Lastly, and this I am inclined has already beaten many competitors in its own home, will tend to spread and supplant many others. Alph. de Candolle has shown that those species which spread widely, tend generally to spread very widely ; consequently, they will tend to supplant and exterminate several species in several areas, and thus check the inordinate increase of specific forms throughout the world. Dr. Hooker has recently shown that in the S.E. corner of Australia, where, apparently, there are many invaders from different quarters of the globe, the endemic Australian species have been greatly reduced in number. How much weight to attribute to these several considerations I will not pretend to say; but conjointly they must limit in each country the tendency to an indefinite augmentation of specific

Summary of Chapter.

If under changing conditions of like organic beings present infirstout all differences in almost every part of their structures, and this cannot be dispitable ; if there here, overage to their genometrical area of the control of the structures of the structures of the structures complexity of the relations of all ergenic beings to such other and to the control or such the observation of theory in structures, onesitiation, and habits to be advanted, beings to such other and to being over beings, in the mann manner or constructured in the sucocourder useful to man. But if variations these almost the structures occurred useful to find the variant of the structure of the single over beings, numerical individuals thus changing for like insign even bloces, mannership individuals thus changing for like mannership in the structures. The structure of the structures of the structure of the structures. The structure of the structures of the structure of the structure of the structure of the structures of the structure of the structure of the structure of the structures of the structure of the structure of the structures. The structure of the structures of the structure of the structure of the structures of the structure of the struc

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Summary

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servation, or the survival of the fittest, I have called Natural Selection. It leads to the improvement of each creature in relation to its arguine and inorganic conditions of life; and consequently, in most cases, to what must be regarded as an advance in organisation. Nevertheless, low and simple forms will long endure if well fitted for their simple conditions of life.

Natural identities, on the priority of qualities burgin theretood as corresponding acyas, can modify the carg, each, or young, an easily as the shift. Amongst many minula, sexual selection will have given its faid to configure selection, by assuming the the nuclei vigcowas and best adopted makes the greatest number of affreging. Sexual objection will along the datasets method to be makes about, in their strengths or relativy with other makes joint. As we are seen to interinate with prevents.

Whether natural selection has really thus acted in adapting the various forms of life to their several conditions and stations, must be judged by the general tenor and balance of evidence given in the following chapters. But we have already seen how it entails extinction; and how largely extinction has acted in the world's history, geology plainly declares. Natural selection, also, leads to divergence of character; for the more organic beings diverge in number be supported on the same area, -of which we see proof by naturalised in foreign lands. Therefore, during the modification of the descendants of any one species, and during the incessant struggle of all species to increase in numbers, the more diversified the descendants become, the better will be their chance of success in the battle for life. Thus the small differences distinguishing varieties of the same species, steadily tend to increase, till they equal the greater differences between species of the same genus, or even of distinct genera.

We have seen that 1 is the common, the wide/addinued, and wide/amaging weights, belowing to the Marger genners within andchan which array most ; and these tend to transmits to their modified depends that arguments. A start is a start with the start of the local tendence of the start of the start of the start of the start of the affinities, and the generally well-defined distinctions become like affinities, and the generally well-defined distinctions determined and meta-decayable below.

the weid, may be explained. It is a feedy wooderful fact-use wooder of which we are pt to overload from familiarity-metat all animals and all plants threepolat all time and spaces should be related to each other improve nitorithemic to groups, its the manner mate cloudy related, process of the same group use cloudy and any other states of the same group use cloudy and any other states of the same group use cloudy and inferred degrees (chording actions and sub-greeners, needsindered degrees (chording actions and sub-greeners, needsindered degrees (chording actions and sub-greeners), sub-clauses, ranked in a single file, but seem clautered round priority, and the same distribution of clausification in it is explicited three hald been independently created in our latter all selection, smaller inheritance and the complex clausifier any we have seen illustrated in the diagram.

The affinities of all the beings of the same class have sometimes been represented by a great tree. I believe this simile largely speaks the truth. The green and budding twigs may represent existing species; and those produced during former years may represent the long succession of extinct species. At each period of growth all the growing twigs have tried to branch out on all sides. same manner as species and groups of species have at all times overmastered other species in the great battle for life. The limbs divided into great branches, and these into lesser and lesser branches. were themselves once, when the tree was young, budding twigs; and this connection of the former and present buds by ramifying branches may well represent the classification of all extinct and living species in groups subordinate to groups. Of the many twigs which flourished when the tree was a mere bush, only two or three, gical periods, very few have left living and modified descendants. decayed and dropped off; and these fallen branches of various sizes a fossil state. As we here and there see a thin strangling branch

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consistently see an animal like the Ornitorrypoints of Lepidotirev, which in some small degree connected by its affinities two large branches of life, and which has apparently been awed from fatal competition by having inhabited a protection state. As body give orise by growth to feah help, and then, if vigcours, branches and outworts in all should be the state of the deal and becken branches the ernst of the earth, and covers the order of the state of the state of the state.

CHAPTER V.

LAWS OF VARIATION.

Effects of charged conditions — Use and disress, combined with natural selection programs of flight and of vinien — Accimatiation — Correlation variation — Compensation and economy of growth — Poise correlations — Multiple, ruinionestry, and lowly organised structures variables — Parts developed in an unumal manner are highly variables specific characters more variable than generics secondary secund characters, variables — Species of the same genus vary in an analogous manner — Berevenies to long-lot characters — Summary.

I nark hilder to excettions speaken as if the variations—are exceense and matilicent with expanse beings under domestization, and in a large of equily a with the increase expression, but due to charms. Thus, the set of the set of the increase expression, but due to charms. Thus, the set of structure, as to make the dubli like its parents. This the first of during ways the produce individual differences, or alight deviations of attracture, as to make the dubli like its parents. This the first during wide ranges than of those with restricted range, likel is barring wide ranges than of those with restricted ranges, likel is barring wide ranges than of those with restricted ranges (b) who due tions of life which each species has been exposed during seven barring wide ranges than of those with restricted ranges, likel is consistent of the which each species has been exposed during seven threads the set of the section of the structure of the expansion, which is much the most important of the transitions constrained the set of the section of danaged conditions loads to dudinize tradications. The direct scient of the angular loads to dudinize tradication of the section of danaged conditions what it is tradicative is near the section of danaged conditions loads to dudinize tradications are been explored as the restruction of the result, when results have much fluctuation way that its tradicative is near the section of danaged conditions what its the result, when results are been sections of the section of the near set the condition that the section of the section of the section that its result is bound results and the section of the section of the near set the condition that the section of the section of the section of the near set the condition that the section of the se

It is very difficult to decide how far changed conditions, such as of climate, food, &c., have acted in a definite manner. There is

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Laws of Variation.

remark to halves that in the cosms of time the effects have been graver than one by proved by peter relations. But we may subly conclude that the immunerable complex co-adaptations of structures, which we are throughout to term hardware. In the following cases the conditions seem to have produced some alight of durits effort: A peter sarrer that shale is their content. In the following cases the conditions seem to have produced some alight of durits effort: A peter sarrer that share that we have a structure of the strucson bardware of the structure of the structure

When a variation is of the alightent use to any being, we cannot tell to be much to attribute to the assemulative section of ratural sheeling, and here much to attribute to the sourcemulative vaccino fractant and the field of the assemulation of the conditions of disk. Thus, we have the first provide the provided the source of the sour

Instance enable be given of similar varieties heim produced from the mass pepties more rectannel conditions of life as ulferrant as can well be conserved; and, on the other hand, of distinitar varieties and the state of the similar variant of the similar varieties appears keeping turns, or not varying at al., although living mades the most opposite distants. Such conductions as these liceline not equive layout weight on the direct action of the surrounding ordinary to the same of the same variant of the same variant sites productions of the same variant of the same variant of the same same variant of the same variant same variant of the same variant of the same variant of the same variant of the same variant same variant of the same variant of the same variant of the same variant same variant of the same variant of the same variant of the same variant same variant of the same variant of the same variant of the same variant same variant of the same var

In one sense the conditions of life may be said, not only to cause variability, either directly or indirectly, but likewise to include natural selection; for the conditions determine whether this or that variety shall survive. But when man is the selecting agent, we clearly nee that there of elements of change are editinic; variability

is in some manner excited, but it is the will of man which accumulates the variations in certain directions; and it is this latter agency which answers to the survival of the fittest under nature.

Effects of the increased Use and Disuse of Parts, as controlled by Natural Selection.

From the facts alluded to in the first chapter, I think there can be no doubt that use in our domestic animals has strengthened and enlarged certain parts, and disuse diminished them ; and that standard of comparison, by which to judge of the effects of longcontinued use or disuse, for we know not the parent-forms ; but many animals possess structures which can be best explained by the effects of disuse. As Professor Owen has remarked, there is no several in this state. The logger-headed duck of South America can only flap along the surface of the water, and has its wings in nearly the same condition as the domestic Aylesbury duck : it is a remarkable fact that the young birds, according to Mr. Cunningham, can fly, while the adults have lost this power. As the larger ground-feeding birds seldom take flight except to escape danger, it is probable that the nearly wingless condition of several birds, now by no beast of prey, has been caused by disuse. The ostrich indeed inhabits continents, and is exposed to danger from which it cannot efficiently as many quadrupeds. We may believe that the progenitor of the ostrich genus had habits like those of the bustard, and cessive generations, its legs were used more, and its wings less,

Kirdy has remarked (and Liwe observed the same fact) has the merice train, of red, of many made dample-desing boulds are often locken off, be examined sevences appeirment in his own collection, and not one had even a relie left. In the Online appelles the train are so habitually lost, that the insect has been described as so having them. In some other genera they are present, but in a reliminative constraints of the order of the section of the constraints of the section of the section of the section remains the section of the section of the section of the remarkable cases observed by Boern-Soquel in granting in a device indication of the section of the section of the section of the sec-

Effects of Use and Disuse.

this tendency. Hence it will perhaps be ander to look at the entire absence of the anterior trark in Ateuchus, and their rodimentary condition is more other genera, not as cases of inherited mutilations, but as due to the effects of long-continued disuse; for as many dung-feeding beetles are generally found with their trark lost, this must happen early in life; therefore the trark cannot be of much investment when much with with was insets.

In some cases we might easily put down to disuse modifications of structure which are wholly, or mainly, due to natural selection. Mr. Wollaston has discovered the remarkable fact that 200 beetles, out of the 550 species (but more are now known) inhabiting Madeira, are so far deficient in wings that they cannot fly; and that, of the twenty-nine endemic genera, no less than twenty-three and perish; that the beetles in Madeira, as observed by Mr. Wollaston, lie much concealed, until the wind lulls and the sun shines; that the proportion of wingless beetles is larger on the exposed Desertas than in Madeira itself; and especially the extraordinary fact, so strongly insisted on by Mr. Wollaston, that certain large groups of beetles, elsewhere excessively numerous, which absolutely require the use of their wings, are here almost entirely absent ;- these several considerations make me believe that the wingless condition of so many Madeira beetles is mainly due to during many successive generations each individual beetle which flew least, either from its wings having been ever so little less perfectly. developed or from indolent habit, will have had the best chance of surviving from not being blown out to sea; and, on the other hand, those beetles which most readily took to flight would oftenest have been blown to sea, and thus destroyed.

The interact in Mattin which are not ground-fooding and which are trainf forest-fooding colopters and philopters, much shaltnakly are their wings to gain their subhistenes, have, an $M_{\rm c}$. While only one compatible with a all relaxed, the term enlarged. This is quiet compatible with a star of the size of the size of the same insect first arrived on the island, the tendency of natural science of the size number of individuals were saved by successfully lutting exploring the much were first and the size of the size of the lutting exploring the size of the size

swimmers if they had not been able to swim at all and had stuck to the wreck.

The eye of moles and of some herrowing robotics are rulininustry in fast, and in some save equile oversel by skin and fire. This states of the eyes is probably due to granular velocitient from discuting the eyes is probably due to granular velocitient from discuting probability and the moles and it was setted by a sprainal, who had does anoth them, that they were frequently hind. One which I heps alive was certainly in this constitut, and including molecular the state of the state of the state of the sprainal, who had been couple them, that they were frequently hind. One which I heps alive was certainly in this constitut, and including molecular. As frequent information of the eyes may be injections to any animal, and a eyes are certainly not include any with the ablastion of the synthic and growth of the order than, which all shell effects of discuss.

It is well known that several animals, belonging to the most different datase, which indukt the cave of Carolia and of Kantusky, are blind. In some of the crash this foot-datk for the topy that the several several several state of the theorem is animation, though the year is going -1 defined that the several state of the several several several several several several difficult to imagine that eyes, through uselans, could be in any way difficult to which were apprecised by Professor Silliann at above half a mile distance from the mosth of the acces, and there is not in the groundmatch depth the eyes were historias and of man, after having box exposed for above a seven of the bind high asymptotic procession. In this processor Silliann at high, separative a simple processor of the seven is a significant light, separative a simple processor of the silling the seven is the significant seven in the seven in processor of the silling the seven is the seven in the seven is a single seven in the significant seven is the seven in the seven is the seven in the seven is the seven is the seven in the seven in the seven is the seven in the seven is the seven in the seven is the seven is the seven is the seven in the seven is the

It is difficult to imagine conditions of this more similar thus obspin linestone events under a neuty limital cointast; so that, in secondance with the old view of the bind azimals having here one and the second second

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generally between the fauna of Europe and of North America." On my view we must suppose that American animals, having in generations from the outer world into the deeper and deeper rehabit for as Schijdte remarks. "We accordingly look upon the into the earth from the geographically limited faunas of the adjacent tracts, and which, as they extended themselves into darkness, have been accommodated to surrounding circumstances. Animals not far remote from ordinary forms, prepare the transition from light to darkness. Next follow those that are constructed for twilight ; and, last of all, those destined for total darkness, and whose formation is quite peculiar." These remarks of Schiödte's, it should be understood, apply not to the same, but to distinct species. By perfectly obliterated its eyes, and natural selection will often have effected other changes, such as an increase in the length of the antenne or palpi, as a compensation for blindness. Notwithstanding such modifications, we might expect still to see in the caveanimals of America, affinities to the other inhabitants of that continent, and in those of Europe to the inhabitants of the European continent. And this is the case with some of the American caveanimals, as I hear from Professor Dana ; and some of the European cave-insects are very closely allied to those of the surrounding country. It would be difficult to give any rational explanation of the affinities of the blind cave-animals to the other inhabitants of the two continents on the ordinary view of their independent creation. That several of the inhabitants of the caves of the Old and New Worlds should be closely related, we might expect from a blind species of Bathyscia is found in abundance on shady rocks become adapted to dark caverns. Another blind genus (Anophthalmus) offers this remarkable peculiarity, that the species, as Mr. Murray observes, have not as yet been found anywhere except America are distinct ; but it is possible that the progenitors of these several species, whilst they were furnished with eyes, may formerly

Acclimatisation.

CHAP, V.

have ranged over both continents, and then have become exiting, accepting in their present socialod stoles. Far from feeling susprise that some of the care-animals should be very anomalous, as Agassin has remarked in regard to the billoid flat, the Amblyquis, and as in the case with the billoid Trotess with reference to the replies of Enropy. I an only surprised balan successential states are also be as a strain the state of the state of the strain which the casety inhabitants of these dark alcoles will have been exceeded.

Acclimatisation.

Habit is hereditary with plants, as in the period of flowering, in nate, &c., and this leads me to say a few words on acclimatisation. genus to inhabit hot and cold countries, if it be true that all the species of the same genus are descended from a single parent-form. acclimatisation must be readily effected during a long course of descent. It is notorious that each species is adapted to the climate region cannot endure a tropical climate, or conversely. So again, many succulent plants cannot endure a damp climate. But the live is often overrated. We may infer this from our frequent inclimate, and from the number of plants and animals brought from different countries which are here perfectly healthy. We have reason to believe that species in a state of nature are closely limited in their ranges by the competition of other organic beings quite as much as, or more than, by adaptation to particular climates. But whether or not this adaptation is in most cases very close, we have evidence with some few plants, of their becoming, to a certain extent, naturally habituated to different temperatures ; that is, they become acclimatised : thus the pines and rhododendrons, raised from seed collected by Dr. Hooker from the same species growing at different heights on the Himalaya, were found to possess in this country different constitutional powers of resisting cold. Mr. Thwaites informs me that he has observed similar facts in Ceylon; analogous observations have been made by Mr. H. C. Watson on European species of plants brought from the Azores to England; and I could give other cases. In regard to animals, several authentic instances could be adduced of species having largely extended, within historical times, their range from warmer to cooler latitudes,

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and conversely; but we do not positively know that these animals were strictly adapted to their native elimitet, though in all ordinary cases we assume such to be the case; nor do we know that they have subsequently become specially acclimatised to their new homes; on s to be better fitted for them than they were at first.

As we may infer that our domestic animals were originally chosen traordinary caracity in our domestic animals of not only withstanding the most different climates, but of being perfectly fertile (a far severer test) under them, may be used as an argument that a large proportion of other animals now in a state of nature could easily be brought to bear widely different climates. We must not, however, push the foregoing argument too far, on account of the prohable origin of some of our domestic animals from several wild stocks; the blood, for instance, of a tropical and arctic wolf may perhaps be mingled in our domestic breeds. The rat and mouse ported by man to many parts of the world, and now have a far wider range than any other rodent; for they live under the cold climate of Farce in the north and of the Falklands in the south, and on many an island in the torrid zones. Hence adaptation to any special climate may be looked at as a quality readily grafted on an innate wide flexibility of constitution, common to most animals, On this view, the capacity of enduring the most different climates by man himself and by his domestic animals, and the fact of the extinct elephant and rhinoceros having formerly endured a glacial tropical in their habits, ought not to be looked at as anomalies, but as examples of a very common flexibility of constitution, brought,

How much of the scellinguisation of species to may possible dimensional states of the scellinguisation of the scelence of of varieties having different instate constitutions, and how much on human combined is an obscure question. That halfs of centers in the scelence of the scelence of the scelence of the instant scelence of the scelence much focus scelence of the much focus scelence of the sce

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Correlated Variation.

CHAP, V.

tion would inevitably tend to preserve those individuals which were this is strikingly shown in works on fruit-trees published in the most of these varieties are of recent origin, they cannot owe their constitutional differences to habit. The case of the Jerusalem which consequently new varieties have not been produced, has even been advanced, as proving that acclimatisation cannot be effected. for it is now as tender as ever it was! The case, also, of the kidneybean has been often cited for a similar purpose, and with much greater weight; but until some one will sow, during a score of generations, his kidney-beans so early that a very large proportion with care to prevent accidental crosses, and then again get seed from these seedlings, with the same precautions, the experiment cannot be said to have been tried. Nor let it be supposed that differences in the constitution of seedling kidney-beans never appear, for an account has been published how much more hardy some seedlings are than others; and of this fact I have myself observed striking instances.

On the whole, we may conclude that habit, or use and disuse, have, in some cases, played a considerable part in the modification of the consistintion and structure; but that the effects have often been largely combined with, and sometimes overmastered by the natural selection of innate variations,

Correlated Variation.

I mean by this expression that the whole expension is no tide together during its growth and development, that when slight variations in any case parts cover, models are accumulated through the statistic state of the state different classes of facts may be here easily confunded together when shall presently use that simple informations often grave maturally parts of the body which are bioensignees, and which, at an accept embyonic profile, substitution is the state of the state of the the state of the body which are bioensignees, and which, at an accepensity of the state of the theory and the state of the the state of the body which are bioensignees, and which, at an accep-

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Correlated Variation.

andly acposed to similar condition, seen eminantly liable to varble allow manuers: we can bin in the right and bit sides of the body varying in fills same manner; in the front and hind bags, and emin in tha jawa and limits, varying text content with the limits. The second second second second second second second the limit of the second second second second second second with an applic only on one adds; and if this had been of any grant sets to the blesch, it might penchda places mereduced permanants are to the blesch, it might penchda places mereduced permanants are to the blesch, it might penchda places have reduced permanants.

Toollingues parts as has here remarked by some authors, test to colver, this is drawns in monotouv plants: and nothing is more emmon than the union of the plants into a table. That pure structures, as in the union of the plants into a table. That pure some authors that with blink the diversity in the shape of the plants marked by the structure of the balance of the balance Others below that the shape of the plant killenges. Others below that the shape of the plant is due to the dimense by pressure the shape of the bala of the heider of the shape of the plant is due to the balance of the balance of evaluating is during a shape of the plants and the manue of evaluating iteramine the shape of the balance of the balance of the shape of the plants and the shape of the balance of the shape of the shape of the plants and the manue of the shape of the shape of the shape of the balance of the balance of evaluating iteramine the shape of the balance of the balance of the shape of the shape of the balance of the balance of the shape of the shape of the balance of the balance of the balance of the shape of the shape of the balance of the balance of the balance of the shape of the shape of the balance of the balance of the balance of the shape of the balance of the balance

The nature of the bond is frequently quite obscure, M. Is. Geoffroy St. Hilaire has forcibly remarked, that certain malconbeing able to assign any reason. What can be more singular than the relation in cats between complete whiteness and blue eyes with deafness, or between the tortoise-shell colour and the female sex ; or in pigeons between their feathered feet and skin betwixt the outer toes, or between the presence of more or less down on the young pigeon when first hatched, with the future colour of its plumage; or, again, the relation between the hair and teeth in the naked Turkish dog, though here no doubt homology comes into play? With respect to this latter case of correlation, I think it can hardly be accidental, that the two orders of mammals which are most abnormal in their dermal covering, viz., Cetacea (whales) and Edentata (armadilloes, scaly ant-caters, &c.), are likewise on the whole the most abnormal in their teeth ; but there are so many exceptions to this rule, as Mr. Mivart has remarked, that it has

I know of no case better adapted to show the importance of the laws of correlation and variation, independently of utility and therefore of natural selection, than that of the difference between

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the outer and inner flowers in some Compositous and Umbelliferous and central florets of, for instance, the daisy, and this difference in reproductive organs. But in some of these plants, the seeds also differ in shape and sculpture. These differences have sometimes to their mutual pressure, and the shape of the seeds in the rayspecies with the densest heads which most frequently differ in their inner and outer flowers. It might have been thought that reproductive organs causes their abortion ; but this can hardly be inner florets differ, without any difference in the corolla. Possibly of nutriment towards the central and external flowers: we know. at least, that with irregular flowers, those nearest to the axis are I may add, as an instance of this fact, and as a striking case of correlation, that in many pelargoniums, the two upper petals in the central flower of the truss often lose their patches of darker colour : and when this occurs, the adherent nectary is quite aborted : the central flower thus becoming peloric or regular. When the colour is absent from only one of the two upper petals, the nectary

With respect to the development of the corella, Sprengibl ikus that the ray-block serve to attract income, whose againsy in highly advantageous or necessary for the fertilization of these plants; in highly prohabils and if an attrat is leader in may have come into play. These in indexes to the needs, it resums impossible that that it dist indexes and the second is a strateging of the second is and the decored and the needs in the second second second feed on the second second second second second second feed on the decored and the second seco

We may often falsely attribute to correlated variation structures which are common to whole groups of species, and which in truth

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are simply due to independence for an ancient programitor may have some interpret particular electrics come one modification, in structure, and, after themsands of generations, some wheth and indeposite modification; and these two modifications, having been transmitted to a whole group of descendants with diverse halo's, related to a whole group of descendants with diverse halo's, related. Some detected that winged seems are never found in fruits which do not equare 1 should explain this rule by the impossibility of soding sharing becoming winged theory harmal selection, makes were a little better adapted to be walfout by the wind, frame advantage over endences are signified to be walfout by the wind, given advantage over endences as signified to be walfout by the wind, given as advantage over endences as signified to be walfout by the significant destruction.

Compensation and Economy of Growth.

The elder Geoffroy and Goethe propounded, at about the same time expressed it, " in order to spend on one side, nature is forced to economise on the other side." I think this holds true to a cortain extent with our domestic productions : if nourishment flows to one part or organ in excess, it rarely flows, at least in excess, to another nart ; thus it is difficult to get a cow to give much milk and to fatten readily. The same varieties of the cabbage do not yield abundant and nutritious foliage and a copious supply of oil-bearing seeds. When the seeds in our fruits become atrophied, the fruit itself gains largely in size and quality. In our poultry, a large tuft of feathers on the head is generally accompanied by a diminished comb, and a large beard by diminished wattles. With species in a state of nature it can hardly be maintained that the law is of universal application; but many good observers, more especially botanists, believe in its truth. I will not, however, here give any instances, for I see hardly any way of distinguishing between the effects, on the one hand, of a part being largely developed through natural selection and another and adjoining part being reduced by this same process or by disuse, and, on the other hand, the actual growth in another and adjoining part.

I unspect, also, that zone of the cases of compensation which have been advanced, and likewise some other facts, may be merged under a more present principle, namely, that natural selection is continually trye comomises every part of the organisation. If ander changed comititions of like a structure, blorow useful, becomes

Multiple and Rudimentary

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Ince useful, its diministica will be forwards, for it will profit the individual net to have its matrimum variation in building up an unclease attraction. To case this only understand a fast with which mapping instances of the given ramaving, that when a will mapping instances of the given ramaving. This is the case with the most Hink and its a to choose of the second second time in the second second second second second second terms of the given ramaving. This is the case with the most Hink and its a to choose of the second second terms of the second second second second second second terms of the second second second second second second terms of the second second second second second second leads of the second second second second second second leads of the second second second second second second leads at the second s

Thus, as I believe, natural selection will tend in the long run to reduce any part of the organisation, as soon as it becomes, through changed habits, superfluous, without by any means causing some other part to be langely developed in a corresponding degree. And, conversely, that natural selection may perfectly well succeed in largely developing an organ without requiring as a necessary compensation the reduction of some adjoining part.

Multiple, Rudimentary, and Lowly-organised Structures are Variable.

It seems to be a rule, as remarked by fa. Gendry Et. Hinny, the with virieties and speech, that when any part or engan is repeated many times in the same individual (and the vertikers in repeated many times in the same individual (and the vertikers in stable, vibress the many partice individual (and the vertikers) is constant. The same anther as well as each behaviour have further vertical that multiple parts are extremely liable to vary in intrastrue. As a vegatiation repetition," to use Paol. Genesity is a second that multiple parts are extremely liable to vary in intrastrue. As a vegatiation repetition, in the same Paol second with the common optition of materiality, individual stated stated for in the scale of nature are more variable that misses which stated for in the scale of mature are more variable that interval parts of the egation have been but little specialized for particular parts of the egation is a set of the scale of regular parts of ward, we can prefere use we with it shaded remain variable. That is no work, we can prefere the scale of the scale of the scale of the scale parts of the scale parts of the scale of th

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why natural selection should not have preserved or rejected each little derivation of form as carefully as when the part has to serve for some one special purpose. In the same way that a knife which has to cat all sorts of things may be of almost any shape; whilst a tool for some particular purpose must be of some particular shape. Natural selection, it should never be forgotten, can ast order to room and for the advantage of each being.

Radimentary parts, as it is generally admitted, are hot to be highly variable. We shall have to recur to this subject; and I will here only add that their variability seems to result from their uselessness, and consequently from natural selection having had no tower to check deviations in their structure.

A Part developed in any Species in an extraordinary degree or manner, in comparison with the same Part in allied Species, tends to be highly variable.

Several years ago I was much struck by a remark, to the above effect, made by Mr. Waterhouse. Professor Owen, also, seems to have come to a nearly similar conclusion. It is hopeless to attempt to convince any one of the truth of the above proposition without giving the long array of facts which I have collected, and which cannot possibly be here introduced. I can only state my conviction that it is a rule of high generality. I am aware of several causes of error, but I hope that I have made due allowance for them. It should be understood that the rule by no means applies to any in one species or in a few species in comparison with the same part in many closely allied species. Thus, the wing of a bat is a most abnormal structure in the class of mammals; but the rule would not apply here, because the whole group of bats possesses wings; it would apply only if some one species had wings developed in a remarkable manner in comparison with the other species of the same genus. The rule applies very strongly in the case of secondary sexual characters, when displayed in any unusual manner. The term, recondary sexual characters, used by Hunter, relates to characters which are attached to one sex, but are not directly connected with the act of reproduction. The rule applies to males and females ; but more rarely to the females, as they seldom offer remarkable secondary sexual sexual characters, may be due to the great variability of these characthink there can be little doubt. But that our rule is not confined to secondary sexual characters is clearly shown in the case of

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herms/herms

As with birds the individuals of the same species, inhabiting the same contry, vary extremely little, I have particularly attended to them; and the rule certainly seems to hold good in this class. I cannot make out that it applies to plants, and this would have seriously abaken my belief in its truth, had no the great variability in plants made it particularly difficult to compare their relative degrees of variability.

When we see any part or ergran developed in a remarkable degree or manner in a species, the fair presentation is that it is of high importance to that process, the second second second second table to variation. Way should this be α^{-1} On the view that we now see them, I can see to explanation. But α the view that second second second frame some other process, and have been modified through natural selection, I think we can obtain see light. First the masks some preliminary remarks. If, in our domestic animals, any year or the vielo a animal is ungletedly in an obtain the septicit, that part (for instance, the could in the shear the properties of the second process of the second in the second second second second second second second second in a setuctive bary split, that part (for instance, the could be in themsetry rand the based may be unit coups of have a multime denseter part of the process ratio of the process that the second tion distribution is a further than the second built (like specialization to the a further than coups of the second second multimetary organs, and in those which have been built (like specialization to like a further than coups of the second second multimetary organs, and is made which have been built (like specialization to like a further than coups of the second second multimetary organs, and is multimetary organization to like the present time the second second multimetary which at the present time to second se

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the instructions of the same level of the piceon, and see what a perighora moutor difference there is in the basic of turblers, in the basis and wattle of carriers, in the carriers and tail of finating e.e., thus bing the points now multiply instructed (10 ky English and the points and the point is point multiply instructed (10 ky English multiply is a noteriously affinish to breed nearly perfect hirds, multiply is a noteriously affinish to breed nearly perfect hirds, indicating the processing of the problem of the point of the tailong to for exercise to a law perfect hirds. Here, may truly be solid to be a constant strength apping on between, on the one hand, into the sing and we do not except to this of here. The the power of steady assigns the observations of a law perfect hirds, a low observation the obstand and we do not except to this of low completely as to breed hirds around the single multiply regions from a 'good' alor-fided bird as common multiply regions from a 'good' alor-fided on the multiply multiply multiply and prove the exceeded of the truth multiply multiply mixed by a verse of the single single single multiply mixed by the verse of the multiply multiply multiply mixed by a verse of the single single single multiply mixed by the verse of the multiply multiply model and multiply mixed by the verse of the multiply multiply multiply mixed by a verse of the verse of the single single multiply mixed by the verse of the single single multiply mixed by a verse of the verse of the single single multiply mixed by the verse of the single single multiply mixed by the verse of the single single single multiply mixed by the verse of the single single multiply mixed by the verse of the single single multiply mixed by the verse of the single single multiply mixed by the verse of the single single multiply mixed by the verse of the single single multiply mixed by the verse of the single single multiply mixed by the verse of the single single multiply mixed by the verse of the single single multiply mixed

Now let us turn to nature. When a part has been developed in an extraordinary manner in any one species, compared with the other species of the same genus, we may conclude that this part has when the several species branched off' from the common progenitor degree, as species mrely endure for more than one geological period, An extraordinary amount of modification implies an unusually large and long-continued amount of variability, which has continually been accumulated by natural selection for the benefit of the species. But as the variability of the extraordinarily developed part or organ has been so great and long-continued within a period find more variability in such parts than in other parts of the organisation which have remained for a much longer period nearly constant. And this, I am convinced, is the case. That the struggle between natural selection on the one hand, and the tendency to reversion and variability on the other hand, will in the course of come not to be more variable than any other structure. It is only suriability, as it may be called, still present in a high degree. For

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in this case the variability will seldom as yet have been fixed by the continued selection of the individuals varying in the required manner and degree, and by the continued rejection of those tending to revert to a former and less-modified condition.

Specific Characters more Variable than Generic Characters,

The principle discussed under the last heading may be applied to our present subject. It is notorious that specific characters are more variable than generic. To explain by a simple example what flowers and some had red, the colour would be only a specific varying into red, or conversely; but if all the species had blue example because the explanation which most naturalists would advance is not here applicable, namely, that specific characters are physiological importance than those commonly used for classing genera. I believe this explanation is partly, yet only indirectly, true; I shall, however, have to return to this point in the chapter on Classification. It would be almost superfluous to adduce evidence in support of the statement, that ordinary specific characters are more variable than generic ; but with respect to important characters, I have repeatedly noticed in works on natural history, that when an author remarks with surprise that some important organ or part, which is generally very constant throughout a large group variable in the individuals of the same species. And this fact shows that a character, which is generally of generic value, when it sinks in value and becomes only of specific value, often becomes variable, though its physiological importance may remain the same. Something of the same kind applies to monstrosities : at least Is. Geoffroy St. Hilaire apparently entertains no doubt, that the more an organ

On the ordinary view of each species having been independently created, why should that part of the structure, which differs from the same part in other independently-created species of the same genus, be more variable than those parts which are closely alite in the several species? I do not see that any explanation can be given. But on the view that species are only strongly marked and fixed varieties, we might expect close to full them still continuing

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more Variable than Generic.

to vary in those parts of their structure which have varied within a moderately recent period, and which have thus come to differ. Or to state the case in another manner :- the points in which all the species of a genus resemble each other, and in which they differ from allied genera, are called generic characters; and these characters may be attributed to inheritance from a common progenitor, for it can rarely have happened that natural selection will have modified several distinct species, fitted to more or less widely-different habits. in exactly the same manner : and as these so-called generic characspecies first branched off from their common progenitor, and subsequently have not varied or come to differ in any degree, or only in a day. On the other hand, the points in which species differ from other species of the same genus are called specific characters; and as these specific characters have varied and come to differ since the period when the species branched off from a common progenitor, it is probable that they should still often be in some degree variable .-at least more variable than those parts of the organisation which have for a very long period remained constant.

Secondary Sexual Characters Variable .--- I think it will be admitted by naturalists, without my entering on details, that secondary sexual characters are highly variable. It will also be admitted that species of the same group differ from each other more widely in their secondary sexual characters, than in other parts of their organisation : compare, for instance, the amount of difference between the males of gallinaceous birds, in which secondary sexual characters are strongly displayed, with the amount of difference between the females. The cause of the original variability of these characters is not manifest; but we can see why they should not have been rendered as constant and uniform as others, for they are accumulated by sexual selection, which is less rigid in its action than ordinary selection, as it does not entail death, but only gives fewer offspring to the less favoured males. Whatever the cause may be of the variability of secondary sexual characters, as they are highly variable, sexual selection will have had a wide scope for action, and may thus have succeeded in giving to the species of the same group a greater amount of difference in these than in other

It is a remarkable fact, that the secondary differences between the two sexes of the same species are generally dipplayed in the very same parts of the organisation in which the species of the same genus differ from each other. Of this fact I will give in illus-

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tration the two first instances which happen to stand on my list : relation can hardly be accidental. The same number of joints in the tarsi is a character common to very large groups of beetles, har in the Engidge, as Westwood has remarked, the number varies greatly; and the number likewise differs in the two sexes of the same species. Amin in the fossorial hymenoptera, the neuration of the wings is a character of the highest importance, because common to large groups; but in certain genera the neuration differs in the different species, and likewise in the two sexes of the same species. Sir J. Lubbock has recently remarked, that several minute crustaceans offer excellent illustrations of this law. "In Pontella, for instance, the sexual characters are afforded mainly by the anterior antenna and by the fifth pair of legs ; the specific differences also are principally given by these organs." This relation has a clear meaning on my view : I look at all the species of the same genus as the several species to their several places in the economy of nature, and likewise to fit the two sexes of the same species to each other,

Finalty, then, I couloids that the greater variability of specific character, or those which distinguish originations from specific than of generic duraters, or those which are possessed and the specificcharacter of the stream variability of any part which is deritical the frequenci attern variability of any part which is determined by the stream of the stream of the stream of the the same part in its comparent and the slight dygree of variability constants on whole group of specific parts differences in deally constant sequencing the stream of the stream of the stream or stream of the stream of the stream of the stream of the second second constraints of the stream parts of researching matter and principles (node) variables the stream parts of researching matheful due to the species of the stream group being the descendant of common-poly that which have recently and largely variable large instriction and have to variable-to constant election much in commontor the variable of the stream recently and largely variable large instriction and have to variable-to constant election have more one of the stream of the stream of the variable of the stream of th

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Characters Variable.

less completely, according to the lapse of time, overmastered the tundency to reversion and to further variability,—to sexual selection being less rigid than ordinary selection,—and to variations in the same parts having been accumulated by natural and sexual selection, and having been thus adapted for secondary sexual, and for ordinary neuroses.

Distinct Species present analogous Variations, so that a Variety of one Species often assumes a Character proper to an allied Species, or reverts to some of the Characters of an early Progenitor, -These propositions will be most readily understood by looking to our domestic races. The most distinct breeds of the pigeon, in countries widely apart, present sub-varieties with reversed feathers on the head, and with feathers on the feet,-characters not possessed by the aboriginal rock-pigeon; these then are analogous variations in two or more distinct races. The frequent presence of fourteen or even sixteen tail-feathers in the pouter may be considered as a variation representing the normal structure of another race, the fantail. I presume that no one will doubt that all such analogous variations are due to the several races of the pigeon having inherited from a common parent the same constitution and tendency to vegetable kingdom we have a case of analogous variation, in the and Ruta baga, plants which several botanists rank as varieties distinct species ; and to these a third may be added, namely, the common turnip. According to the ordinary view of each species having been independently created, we should have to attribute this similarity in the enlarged stems of these three plants, not to the very cause of community of descent, and a consequent tendency to vary in a like manner, but to three separate yet closely related acts of creation. Many similar cases of analogous variation have been observed by Naudin in the great gourd-family, and by various authors in our cereals. Similar cases occurring with insects under natural conditions have lately been discussed with much ability by Mr. Walsh, who has grouped them under his law of Equable

With pigeons, however, we have another case, namely, the occasional appearance in all the breeds, of slaty-blue birds with two black bars on the wings, white losing, a bar at the end of the tail, with the outer features externally edged near their bases with white. As all these marks are characteristic of the parent rock-

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pipes, I promue that no one will doubt that this is a case of version, and no of a new yet analogous variation appending in the seventh reads. We may, I think, confidently come to this conclusion, because, as we have soon, these cohornel marks are emissivily liable to appear in the crossel efforting of two disignal differently cohornel breachy and its discover presents mothing addy-shap, with the sevent marks, beyond the influence of hermory and of crossing on the laws of inheritories.

appear after having been lost for many, probably for hundreds of generations. But when a breed has been crossed only once by some other breed, the offspring occasionally show for many generations a tendency to revert in character to the foreign breed-some say, for a dozen or even a score of generations. After twelve generations, the proportion of blood, to use a common expression, from one ancestor, is only 1 in 2048; and yet, as we see, it is generally foreign blood. In a breed which has not been crossed, but in which both parents have lost some character which their progenitor possessed, the tendency, whether strong or weak, to reproduce the lost character might, as was formerly remarked, for all that we can see to the contrary, be transmitted for almost any number of generations. When a character which has been lost in a breed, reappears after a great number of generations, the most probable hypothesis is, not that one individual suddenly takes after an ancestor generation the character in question has been lying latent, and at last, under unknown favourable conditions, is developed. With the barb-pigeon, for instance, which very rarely produces a blue bird, it is probable that there is a latent tendency in each generation to produce blue plumage. The abstract improbability of such a tendency being transmitted through a vast number of generations, is not greater than that of quite useless or rudimentary organs being similarly transmitted. A more tendency to produce a rudiment is indeed sometimes thus inherited.

As all the species of the same genus are supposed to be descended from a common progenitor, it might be expected that they would occasionally way in an analogour manner; so that the varieties of two or more species would resemble each other, or that a variety of one species would resemble or estim characters andher and distinct species,—this other species being according to our view; only a well-marked and permanent virity. But characters excile-

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Analogous Variations.

sively due to analogous variation would probably be of an unimcharacters will have been determined through natural selection, in accordance with the different habits of the species. It might further be expected that the species of the same genus would occasionally exhibit reversions to long lost characters. As, however, we do not know the common ancestor of any natural group, we If, for instance, we did not know that the parent rock-pigeon was not feather-footed or turn-crowned, we could not have told, whether such characters in our domestic breeds were reversions or only analogous variations; but we might have inferred that the blue which are correlated with this tint, and which would not probably have all appeared together from simple variation. More especially we might have inferred this, from the blue colour and the several marks so often appearing when differently coloured breeds are crossed. Hence, although under nature it must generally be left doubtful, what cases are reversions to formerly existing characters. and what are new but analogous variations, yet we ought, on our theory, sometimes to find the varying offspring of a species assuming characters which are already present in other members of the same group. And this undoubtedly is the case,

The difficulty in distinguishing variable species is largely due to the varietism modifies as it is were, show proceeds of the same genus. A considerable caladogen, also, could be given of forms intermediate variety on so the form, which it dimension cases on only doubtinly be breast to varie and the source of the same genus. The forms be considered as independently created species, that they are in varying assumed source of the characters of the others. But the loss of variety assumed source of the characters of the others. But the loss of variety assumed source of the characters of the others. But the loss of variety assumed source of the characters of the others. But the loss of variety as as to presently in some dargere, he same part or organ y vary us in to presently in some dargere, he same part of variety the same shows. The other dargere at historic state of such assays, but here, as the form, a lower at the same same case using the three, as the others. It is most the grant thinks such cases carticity occur, and some to never yremarkable.

I will, however, give one curious and complex case, not indeed as affecting any important character, but from occurring in several species of the same genus, rarty under domesteriation and party under nature. It is a case almost certainly of reversion. The ass sometimes has very distinct transverse bars on its legs, like those on the legs of the zebra; it has been asserted that these are plaines

Distinct Species present

in the from . The array is which T have much T believe this to be true, T are attripted with the other is scontening only hand in the second and these attripts are scontinuous very observer, or actually quite large and these attripts are scontinuous very observer, or actually quite large second de the hereincows with a distinut abulation section, and the property has noney and I. have been informed. by the bary here, and fully even dated this species are specific second sec

With respect to the horse, I have collected cases in England to the spinal article in horses of the most distinct breach, and of all colours, transverse have on a characteristic distinct breach, and of any second legist carcinoses with a double striptic on each shoulder and with legist carcinoses with a double striptic on each shoulder and with legist carcinoses with a double striptic on each shoulder and with legist carcinoses with a double striptic on each shoulder and with legist carcinoses with a double striptic on each shoulder and with legist carcinoses with a double striptic on each shoulder and with legist carcinoses with a double striptic on the should be all with free yacaella striptions on each shoulder.

In the north-sense part of rolas the Katyyara Feed of beess openenity strips, that, as 1 has fracta Colonda Polo, who ensulates and the particular of the strips of the strips of the large are parently haven in the strips are abreed with a sometimes dendes and non-times trebs, is common jub side of the monocover, is nonemines strips. In the strips are often philosity from the strips of the strips are often philosity of the strips of the strips of the strips are often philosity in facility. If not a strips are often philosity of the strips of the strips of the strips are often philosity and strips in more than the strips are often philosity and strips in more than the strips are often philosity of the strips of the strips of the strips are often philosity and strips in more than the strips are often philosity and and the strips of the strips are observed by the strips and interplant dense in the strips are strips are strips are interplanted exception of the strips are strips and the strips are interplanted exception of the strips are strips and the interplanted exception because in the strips are strips are interplanted exception because in the strips and the strips are interplanted exception because in the strips and the strips are interplanted exception because in the strips and the strips are interplanted exception because in the strips and the strips are interplanted exception because in the strips and the strips are strips and the strips are strips and the strips are strips and the strips and the strips are strips at the strips are strips at the stri

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Eastern China; and from Norway in the north to the Malay Archipelago in the south. In all parts of the world these stripes occurs fare drunest in duma and monas-duma job the terms duma large range of colour is included, from one between brown and black to a close source to exemp-robust

¹¹ Les sourse that Gonnel Hamilton Smith, who has written on the ability, bibleren that the several brows of the horse are described from several abergingtal species—one of which, the data was striped; and the absorbed-series del approximates are all don to macini crosses with the dum teck. But this view may be addy opticated, for it is highly impublish the havery Balgim carihores, Wash protos, Kerwagim ords, do an world, advahl at have been croude with one muscod shoridinal totek.

ass and horse is narticularly ant to have bars on its legs; accordout of ten mules have striped legs. I once saw a mule with its legs so much striped that any one might have thought that it was a hybrid-zebra; and Mr. W. C. Martin, in his excellent treatise on the horse, has given a figure of a similar mule. In four coloured the legs were much more plainly barred than the rest of the body ; Morton's famous hybrid from a chestnut mare and male quagga, the hybrid, and even the pure offspring subsequently produced plainly barred across the legs than is even the pure quagga. ass only occasionally has stripes on his legs and the hemionus has

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What now are we to say to these several facts? We see several characters, is-that there is a tendency in the young of each successive generation to produce the long-lost character, and that this tendency, from unknown causes, sometimes prevails. And we have just seen that in several species of the horse-genus the stripes are old. Call the breeds of pigeons, some of which have bred true for centuries, species; and how exactly parallel is the case with that of animal striped like a zebra, but perhaps otherwise very differently constructed, the common parent of our domestic horse (whether or not it be descended from one or more wild stocks) of the ass, the hemionus, quagga, and zebra.

He who's believes that each equine precise was independently result, will, Presents, assert that each projects has been created with a tendency to vary, both moder nature and under domesficiation. In this perturbative numerics, on a other to become stripted like the interpret of the work, when created with precise house methods when the stripted of the stripted stripted and the stripter attraction of their own presents, but other species robust for an unsulment their own presents, but other species of the genus. The stripter, and the work, or for the stripter are not form an unsulment tendency and theorytics or . It makes the works of food is more moders and theorytics or . It makes the works of the stripter to of and ingramed components, that is stript in the other stripter.

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but had been created in stone so as to mock the shells living on the

Summary .- Our ignorance of the laws of variation is profound. Not in one case out of a hundred can we pretend to assign any reason why this or that part has varied. But whenever we have the means of instituting a comparision, the same laws appear to variability, but sometimes they cause direct and definite effects : though we have not sufficient evidence on this head. Habit in producing constitutional peculiarities and use in strengthening and disuse in weakening and diminishing organs, appear in many cases to have been potent in their effects. Homologous parts tend to vary in the same manner, and homologous parts tend to cohere. Modifications in hard parts and in external parts sometimes affect softer and internal parts. When one part is largely developed, perhans it tends to draw nourishment from the adjoining parts ; and every part of the structure which can be saved without detriment will be saved. Changes of structure at an early age may affect parts subsequently developed; and many cases of correlated variation, the nature of which we are unable to understand, undoubtedly occur. Multiple parts are variable in number and in structure, perhaps arising from such parts not having been closely specialised for any particular function, so that their modifications have not been closely checked by natural selection. It follows probably from this same cause, that organic beings low in the scale are more variable than those standing higher in the scale, and which have their whole organisation more specialised. Rudimentary organs, from being useless, are not regulated by natural selection, and hence are variable. Specific characters-that is, the characters which have come to differ since the several species of the same genus branched off from a common parent-are more variable than generic characters, or those which have long been inherited, and have not differed within this same period. In these remarks we have referred to special parts or organs being still variable, because they have recently varied and thus come to differ ; but we have also seen in the second chapter that the same principle applies to the whole individual; for in a district where many species of a genus are

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we now find, on an average, most varieties. Secondary sexual developed organ has become the parent of many modified descenmanner it may have been developed. Species inheriting nearly the same constitution from a common parent, and exposed to similar

Whatever the cause may be of each slight difference between the offspring and their parents—and a cause for each must exist—we have reason to believe that it is the steady accumulation of beneficial differences which has given rise to all the more important modifications of structure in relation to the habits of each acceles.

Difficulties of the Theory.

CHAPTER VI.

of transitional varieties - Transitions in habits of life - Diversified habits in the same species - Species with habits widely different transition - Cases of difficulty - Natura non facit saltum - Organs of small importance - Organs not in all cases absolutely perfect -

Loxo before the reader has arrived at this part of my work, a crowd of difficulties will have occurred to him. Some of them are so serious that to this day I can hardly reflect on them without being in some degree staggered ; but, to the best of my judgment, the number are only apparent, and those that are real are greater not, I think, fatal to the theory.

These difficulties and objections may be classed under the following heads :- First, why, if species have descended from other species by fine gradations, do we not everywhere see innumerable transitional forms? Why is not all nature in confusion, instead of the species being, as we see them, well defined ?

Secondly, is it possible that an animal having, for instance, the structure and habits of a bat, could have been formed by the modification of some other animal with widely-different habits and structure? Can we believe that natural selection could produce, on the one hand, an organ of trifling importance, such as the tail of

Thirdly, can instincts be acquired and modified through natural

Fourthly, how can we account for species, when crossed, being sterile and producing sterile offspring, whereas, when varieties are The two first heads will here be discussed; some miscellaneous

objections in the following chapter; Instinct and Hybridism in the two succeeding chapters.

On the densers or During of Transitional Territotica—An startinscheit nuck solvly the properturbation of profitable modifications, such nucleon term will lead in a fully-stoched control to take the place of and finally to extreminist with within the concess into competition. This extraction and natural selection go hand in final. Hence, if we look at each species as descended here some unknown form, both the generat and all the transitional variations will presently have been of the other form.

But, as by thist theory insumeable transitional forms much large circled, why do we so that them embodied in counties numbers in the crust of the earth? I will be more convenient to discuss the other of the earth? I will be more convenient to discuss Recent; and I will here only state that I believe the answer maily in the screece of the state of the state of the state of the isometry of the state mainted of time.

But it may be urged that when several closely-allied species inhabit the same territory, we surely ought to find at the present time many transitional forms. Let us take a simple case : in evidently filling nearly the same place in the natural economy of the land. These representative species often meet and interlock ; and as the one becomes rarer and rarer, the other becomes more and more frequent, till the one replaces the other. But if we compare these species where they intermingle, they are generally as absolutely distinct from each other in every detail of structure as are specimens taken from the metropolis inhabited by each. By my theory these allied species are descended from a common parent; and during the process of modification, each has become adapted to the conditions of life of its own region, and has supplanted and exterminated its original parent-form and all the transitional varieties between its past and present states. Hence we ought not to expect at the present time to meet with numerous transitional varieties in each region, though they must have existed there, and may be embedded there in a fossil condition. But in the intermediate region, having

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quite confounded me. But I think it can be in large part ex-

The fact phase we should be externely cartinous in inferring, beams on a rest incore continuous, that is has been continuous during in long period. Geology would limit us to bifere that must continue have been been up into bialance were, diving the base of the strength of the strength of the strength of the base of the strength of the strength of the strength of the form of the hand and of diratic matrix matrix nears. By changes in the form of the hand and of diratic matrix matrix nears the strength of the strength of

In looking at species as they are now distributed over a wide confines, and finally disappearing. Hence the neutral territory between two representative species is generally narrow in comparison with the territory proper to each. We see the same fact in asounding mountains, and sometimes it is quite remarkable how abruptly, as Alph. de Candolle has observed, a common alpine species disappears. The same fact has been noticed by E. Forbes in sounding the depths of the sea with the dredge. To those who important elements of distribution, these facts ought to cause surprise, as climate and height or depth graduate away insensibly, But when we bear in mind that almost every species, even in its metropolis, would increase immensely in numbers, were it not for other competing species; that nearly all either prey on or serve as any one species, depending as it does on the range of others, will tend to be sharply defined. Moreover, each species on the confines

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of its mage, where it exists in lessened numbers, will, during fluctuations in the number of its enemies or of its prey, or in the nature of the seasons, be extremely liable to utter extermination; and thus its geographical range will come to be still more sharply defined.

As all der veryessentative species, wihm inholitäting a continuous ang, ase generging) disticutied in main an manner that welch has a main ase generging) disticutied in main and a manner that welch has them, in which they become maker and henry meres and marge than probably apply to both, and if we take a varying profess inhabiting and and the second state of the species inhabiting the state of the second state of the second state of the probably apply to both, and if we take a varying profess inhabiting the state of the second state of the second state of the form inhabiting an arrow and lesser area and predicably, as for an I can make out, this rule holds good with varieties in a state of a varieties intermotical between well-mached varieties in the genus Balanca. And it world appear from information given me by Kinvarieties intermotical between well-mached varieties in the species built were and the second state of the second state of the varieties intermotical between well-mached varieties in the species built wells and the second state of the second state of the second varieties intermotical between well-mached varieties in the varieties linking two other varieties inducing and conclude the varieties linking two other varieties inducing and conclude the varieties linking two other varieties inducing and the varieties linking two other varieties inducing the varieties linking two sources then the form which they estimate (have we can understated were intermediate varieties inducing the varieties inducing the varieties induced the varieties intermotical between well-matter (have we loss proserved the the form which they estimate (have we loss proserved the the form which they estimate (have between the sector).

For any form existing in lower numbers would, as already remarked, rem as guester chance of being externinated than one existing in large numbers; and in this particular case the interdentiated of the second second second second second likelity of the second second second second second important consideration, that during the present of the the model of the second second second second second second second particular to variation are supported to be converted and particular burned second presenting further structures would be a second second presenting further structures would be the second second theore, the more common forms, in the more for like, will tend to be at an explaint the large common forms, for these subbest the second best the second second

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garging multiple and improved. It is the same principle which, as thoses, accounts for the common species in each country, as shown in the second chapter pomenting on an average a practic multiple of well-awards watering that do the more species. It may illustrate what I muon by approxing these transmission of a comparison provide the start of the second species of a comparison provide start of the start of the second species phase at the base; and that the inhabitants are all trying with equal instanties and will be introved that tacks by selection; the chances in this case will be strongly in favour of the provide base of the start polythy that the multiple strong the start of the start of the two loweds, which expirate a strong the start of the start of the start well bases, which expirately in favour of the start of the start product and the start of the start of the start of the start of the start product and the start of the start of the start of the start of the start product at the start of the s

¹⁵ sum ip, 1 believe that species come to be tokensby verification objects, nod bo ot at any one period persent an interticable chao of verying and hatmendiate links: first, lossues new variation instant, selection can do an othing with a distribution of the start of the selection of the

Secondly, here now continuous must often have existed within existent second second second second second second second water much, may have segmatize the second second second water much, may have segmatize presentative species and boltant corract as representative species. In this case, interboliar instains between the several prepresentative species and the second second second second second second second solution second second second second second second anterna selection with have been builts during the process of the desyst with solvage be found in a plury and second frequency with solvage be found in a plury and second se

in different

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preficies of a strictly continuous may, intermolities varieties with, its probable, at find such been formout in the intermolities boson, but they will geomethy have had a short duration. For these intermentary barriers of the first strictly and the strictly of the intermediate strictly of the short duration of checky alloid or representative protons, and likewise of adcordedged varieties, which they tend to connect. From this status along the intermolities varieties with the oxiecletate steremission in add ensity for process of incher molification through natural selection, they will baroot certainly be known and emphasisment by the form switch they connect, for these from exciting in add then be further in the baroot in a status of the status and the status of the status and connection and and information and and the status is also through matural selection and main further advantages.

Laady, looking not to any one time, but to all time, if my theory be true, numbered intermediate varieties, linking doodly together all the species of the same group, must assured by have excited; i hav the very process of natural netection constantly tends, a has been mediate in link. Consequently evidence of their former existence we shall attempt to alwo in a future chapter, in an extremely imperfect and intermitten record.

On the Dright and Transitions of Drawits Bridges well possible Diables and Structures—11 has been taked by the opponents of staff views at Joid, how, for instance, could a inde enriversa animal time the staff of the start and a scale statistic start and the start and the start and a scale statistic start and the start and the start and a scale statistic start and the start and the start and a scale statistic start and the start and the start and a scale statistic start and the start and the start of the start and the start and the start and the start with a start and the start and the start and the start start and the start and the start and the start and the start start and the start and the start and the start and the start start and the start and the start and the start and the start start and the start and the start and the start and the start start and the start and the start and the start and the start start and the start and the start and the start and the start start and the start and the start and the start and the start start and the start start and the start start and the start and the

Here, as on other occasions, I lie under a heavy disadvantage, for, out of the many striking cases which I have collected, I can give only one or two instances of transitional habits and structures in

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allied species; and of diversified habits, either constant or occasional, in the same species. And it seems to me that nothing less than a long list of such cases is sufficient to lessen the difficulty in any particular case like that of the tat.

Look at the family of souirrels; here we have the finest gradation from animals with their tails only slightly flattened, and from others, as Sir J. Richardson has remarked, with the posterior have their limbs and even the base of the tail united by a broad glide through the air to an astonishing distance from tree to tree. We cannot doubt that each structure is of use to each kind of squirrel in its own country, by enabling it to escape birds or beasts of prev, to collect food more quickly, or, as there is reason to believe, to lessen the danger from occasional falls. But it does not follow from this fact that the structure of each squirrel is the best that it is possible to conceive under all possible conditions. Let the climate and vegetation change, let other competing rodents or analogy would lead us to believe that some at least of the squirrels manner. Therefore, I can see no difficulty, more especially under viduals with fuller and fuller flank-membranes, each modification being useful, each being propagated, until, by the accumulated effects of this process of natural selection, a perfect so-called flying

Now look at the Galacpithema se as-called (ripped lemm, which somely use maked amough tasks, that is now believed to belong to the innertrans. An extremely wide finale membrane stretches with the advanced field by to to the time, and includes the limits with the advanced membrane membrane in the stretches with an excessor muscle. Although no sense have advanced in the source neural methods are associated and the stretches with the source of the stretches of the stretches of the stretches in the source of the stretches of the stretches of the of stretches having been useful why filling equivalence with the source having been useful why filling equivalence of the of stretches having been useful why filling equivalence of the stretches and forward for the Galacpitheme and the been granty building the stretches below. And the stretches are been granty building the stretches below on and the stretches and the been granty building the stretches below on a stretches are been granty building the stretches below on and the stretches and the stretches are been granty building the stretches below on a stretches are below on the stretches are been granty building the stretches below on a stretches are below on the stretches are

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organs of flight are concerned, would have converted the animal into a bat. In certain bats in which the wing-membrane extends from the top of the shoulder to the tail and includes the hind-legs, we perhaps see traces of an apparatus originally fitted for gliding through the air rather than for flight.

If about a down genera of biels were to become extint, when vould have ventured to samulate that their night have existed which and their wings solely as flappers, like the loggerband direct [Man] energy of $\gamma(m)$, as an single like the orticity and functionally for no purpose, like the Apteryx Y. Net the structures of a draw bries is good for it, under the conditions of life to which it is exposel, for each the Apteryx Y. Net the structures candof draw bries in good for it, under the conditions. It must not be inferred from these remarks that any of the grades of wingsrestances for analbodies dy which perhaps may all be the result of parkets never of flipler, but they save to show what diversified mass of framions are it and structures.

Seeing that a for members of such water-breaking classes as the Crastass and Mollens are adapted to live on the hady and seeing that we have frying briefs and mammals, frying insects of the most deventied types, and formerly plut diffying reptiles; it is concrivable that frying-fail, which now glidle for through the align lightly rising and truting by the aid of the flattering fast, might have been moduled into percently winged animals. If this had have been moduled into percently weight and the second transitional attack they had been the bindmann of the open comp, and had used their inepient cograss of flight enclosurely, as for as we know, to ensemp bind devenue ho open fails?

When we see any structure highly perfected for any particular shafts at so wings of a birls of fighly, we should have in mind that minual displaying early transitional grades of the attracture will solub new surprised to the present day, for they will have been supplicated by their necessary, which were gradually rendeed more indication of the structure of the structure of the structure will have been derived by their necessary which were gradeed by the transitional structure of the structure of the structure will have been derived by the structure of the structure of the grade numbers and used may are structured form. The prevent to our imaginary illustration of the flying-fish, it does not seen to our many subcolinatie forms, for taking peep of many kinks in many ways, on the hand and in the water, mult licht organs of flight

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had come to a high stage of perfection, so as to have given them a decidiad advantage over other minush in the battle for life. Hence the chance of discovering species with transitional grades of structure in a fossil condition will always be less, from their having existed in lesser numbers, than in the case of species with fully developed structures.

I will now give now or three instances both of diventifiel and of handle lakity in the individual of the same preion. In either almost halfs, in the individual of the same preion, a first effect of the animal to its changed halfs, or exclusively to one of its second batts. It is, however, difficult to dedds, and immatchal for any subscher halts generally change first and structure afterease of changed halfs, its will million field arteriator halfs to changed any Dirith indexes which now field one excells plants, or excluaively or artificial ambiances. Of diversified halfs immureable means of changed halfs, its will million free on exclude lays, or excluaively on artificial ambiances. Of diversified halfs immureable means standing stationary on the margin of varies, and then dashing into it line a kingthest at a his. In our own contrary the larger except of a stationary on the margin (his a kingthe by hlows on the bade) and I have many times seen and lays all humines multilations. It would be a static by hlows and the market multilation in the solution with the static diverged in multilation in the varies.

As we senselinos see individuals following habits different from then proper to their precises and to be other aposites of the annogenes, we might expect that such individuals would consistently transmission of the second second second second second transmission. The second second second second second second their type. And such instances occur in nature. Can a more frequencies of the second for dimensional second se

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atiff as in the typical weokpower, and a straight strong back. The back, however, in such a straight or strong as in the typical state (ask), which is not a straight or a strong as in the back (ask), but is a consult part of its structure is a wookpower. Such as the straight part of its structure is a wookraidencible, to common weokpower is plainly dedicated ; yer, as I can asser, not only from ray over observation is these matchings in the straight or a straight of the structure is a strong straight of the straight of the structure is a straight of the straight of the structure is a straight of districts, however, this same woolpecker, as M. Hudon states, I may mention as another liberation of the varied halfs of this grammation is an another liberation of the varied halfs of this grammation is straight by the straight of the straight of this grammation is straight by the straight of the varied halfs of this grammation is straight by the straight of the varied halfs of this grammation is straight by the straight by th

Detribute are the most aierial and eccendic of biols, but in the optics mounds of Terres of Denge, the Unitaria barradi, his agreemit ming and of dying the Purillanian barradi, his is agreemit and a source of the second second second second second second particular barradian and a second second second second second in relation to the neural barradian of the organization professionally modified in relation to the neural barradian of the process the workshop of the second second second second second second second second workshop of the second second second second second second workshop of the second second second second second second which is allicle to the thresh family achieting by diverge-anding its which is allicle to the thresh family achieting by diverge-anding its workshop of the second diverse above the second second second second second second diverse do be agained in its babbits in food matching, and remains diverse do be agained in the babbits in the short of the second diverse do be agained in the babbits in the short of the second diverse do be agained in the babbits in the short of the second diverse babbits and the babbits of the transpaced by the second diverse babbits and the babbits and the short of the second second diverse babbits and the babbits and the short of the second second diverse babbits and the babbits and the short of the second second diverse babbits and the babbits and the short of the second second diverse babbits and the second second the second second second second second diverse babbits and the second second the second seco

Be who believes that each being has been created, as we appear it, must ecalcadour) have fails arrive when ho has not which an animal having habits and structure not fin agreement. What can be plainer than that the webbeld set of hadron and genus are formed for swimmlay? You there are uphand genes with webbel dust which may go near the waver; and no case except Annihoo has seen the fights-link, which has all its four toos webbel, aligned no the strucof the cosen. On the other hand, green and costa are eminomity spatial, although their teos are only bordered by membrane. What some although that the long toos, not finanished with membrane

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of the Gralatores are formed for validing over symmps and floating plantics—the wavelens and aluading are members of this order, yet the first is nearly as aquatic as the cost, and the second nearly as trenstrial at the equal or particles. In such cases, and many others could be given, halts have changed with equations of the second begiven, halts have changed with the second method. The second second second second second second and to have become almost redimentary in function, hencels not in structure. In the fright-brind, the deeply excepted membrane beforem the too shows that structures has begin to change.

He who believes in separate and immunovable acts of cratific many sty, that in these eases it has phenoid the Crattor to cause a being of one type to take the photo of one belonging to another the start of the start of the start of the start of the start principle of rankets belong the start of the start of the principle of rankets absolute, will adknowledge that every expandling is constantly anolymaps. The start of the different that may be from its over place. Hence it will cause this feed, leften the should be goes on the first believer where latedly feed, its tree should be longed on the start of the

Organs of extreme Perfection and Complication.

To suppose that the age with all its initialized contrivances for adjusting the focus to different distances, for solutioni, different aberration, could have been formed by attended to the solution aberration, could have been formed by attended to the solution and that the sum atood still and the world turned round, here said that the sum atood still and the world turned round, here and fast the sum atood still and the world turned round, here the solution of the solution of the solution of the solution by transit of periodic solutions and the solution of the form a simple and imprivate syst to accomplex and perfect can be shown to exist, each grade being unrile to its possessor, as in the solution be solution of the solution that and the media to separative the solution of the solution of the the solution of the solution of the solution of the solution the solution of the solution of the solution of the solution of the solution the solution of the solution the solution of th

could be formed by natural selection, though insuperable by our minguintoi, should not be considered as subvertive of the theory. How a nerve comes to be sensitive to light, hardly concerns us more than how if for itself originated is but range remark that, an accessful of the howest erganisms, in which nerves cannot be detected, are capable of previously light, it does not seem impossible than certain smuttive elements in their arcode should become aggregated ad developed in the nerves, endroved with this special smullidity.

In searching for the graduations through which an ergan in any species has been perfected, we oughly to look exclusively to its lineal progenitors, but this is surveyly ever possible, and we are forced to indicate the search of the same group. Much it is to the collision disconductor from the network of the same group. Much having here, transmitted in an unalised of the same of a same graduation having here transmitted in an unalised we disconduction. But the state of the same cogain in distinct classes may incidentially there is a state of the same cogain in distinct classes may incidentially there is a step by which it has been perfected.

The simplet ergs which can be called an eye consists of an optic arrey, nurround (b) ypigantic-tailed and overall by transformation of the arrey nurround (b) ypigantic-tailed (b) ypigantic-tailed (b) and (b) ypigantic-tailed (b) ypigantic-

In the great class of the Articulata, we may start from an optic nerve simply coated with jegment, the latter sometimes forming a soci of pupi) had destitute of a lens or other optical contrivance. With insects it is now known that the numerous facets on the cornea of their great compound eyes form true lenses, and that lace come include curvisity modified nervous filaments. The these

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organs in the Articulata are so much diversified that Müller formerly made three main classes with seven subdivisions, besides a fourth main class of aggregated simple eyes.

When we reflect on these facts, here given much too briedly, with respect to the wirks (diversified, and graduated range of attracture in the cycs of the lower animals; and when we base in mind here small the number of all wirks (from much be). The second theory with the second invasion by transparent membrane, into an optical instrument 2 and invasion by transparent second invasion by transparent second second

the variation of domestic animals, it is not necessary to suppose serve for the same general purpose : as Mr. Wallace has remarked, which might have been added and perfected at any stage of the

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from embryonic sub-cataneous tissue. To arrive, however, at a piet conclusion exparing the formation of the exp, with all its marvalues yet not absolutely perfect characters, it is indispensable that the reason should conquer the imagination; but I have felt the difficulty far too keenly to be surprised at others hesitating to extend the principle of natural solection too so startling a length.

It is scarcely possible to avoid comparing the eye with a telescope. infer that the eye has been formed by a somewhat analogous process. But may not this inference be presumptuous? Have we instrument, we ought in imagination to take a thick layer of transparent tissue, with spaces filled with fluid, and with a nerve layers of different densities and thicknesses, placed at different distances from each other, and with the surfaces of each laver slowly changing in form. Further we must suppose that there is a power, represented by natural selection or the survival of the fittest, always intently watching each slight alteration in the transparent layers ; and carefully preserving each which, under varied circumimage. We must suppose each new state of the instrument to be multiplied by the million; each to be preserved until a better one is produced, and then the old ones to be all destroyed. In living bodies, variation will cause the slight alterations, generation will millions of years; and during each year on millions of individuals of many kinds; and may we not believe that a living optical works of the Creator are to those of man ?

Modes of Transition,

If it could be demonstrated that any complex organ existel, which could not possibly have been formed by numerous, successive, alight modifications, my theory would also lettly break down. But I can find out no such case. No doubt many crgans exist of which we do not know the transitional grades, more sepcially if we look to much-isolated species, round which, according to the theory, there has been runch extinction. Or granin, if we take

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an organ common to all the members of a class, for in this latter case the organ must have been originally formed at a remote period, since which all the many members of the class have been developed; and in order to discover the early transitional grades through which the organ has passed, we should have to look to very ancient anceatral forms, loor since become extinct.

We should be extremely sentises in consisting that an ergan could not have been benearly by transitional gradients with high answer ergan performing at the mass time wholly district functions, then in the larger of the singular data in the full Collets the alignment grannel neighbor, and excerts. In the Hydra, the alignment grannel basics on the single data in the full Collets the alignment grannel basics on the single data in the full collets of the single data in the single data in the single data in the single speciality, if any advantage were thus galaxed, the whole or our function along and thus by immufile steps grantly datage its preference in the single constraints for every in a data in the single data in the same time difference constraints for every in all reads plants were by problem ones. In the single set of the species. It is, howeevery problem in the single set of the species is a line howevery problem in the constraint of forwards being a single share and the basis of the stress set of forward basis. In this spectrum problem is a single set of the species is a line howevery problem ones for along and the species is a line howevery problem ones for a single set of the species. In this howevery problem ones for a single set of the species is a line hole.

The illustration of the swimbladder in fishes is a good one,

because it adverse us clearly the highly important fact that an engine equipally constrained for one purpose, markly, floatings, may be converted into one for a witchly different purpose, namely, respective The semishader has also, here. and the physiclogitat advection that are semislated as a single barry and the physiclogitat advection the semislated is homologous, σ^{**} ideally similar "in position and the semislated is homologous, σ^{**} ideally similar" in position and these constrained into pany, or an around and interval for here is no reason to dott that the aveinablatic has scaling these is no reason to dott that the aveinablatic has been used to an interval of the physical sector of the sector of the sector of the sector of the physical sector of the sector of

Accounting to this view it may be inferred that all vertebents mains with the using are descended by coeflary generation from an ancient and unknown prototype, which was introlled with a finating apprator on weinholder. We can thus, at 1 their from Own's interverying being fixed and drink which we available has to be a set of the the image, neuvirolationality drive beautiful contrivators by which the district is closed. In the higher Vertheat and benachias have which distributions are also also be a set of the set of financial set of the set of financial set of the set of financial set of the set of financial set of the set of the

In considering transitions of organs, it is to important to bare in mind the probability of conversion from one function to another, that I will give another instance. Polumeinted eirripedea have to minime folds of sinc, called by more the origonous freema, which serve, through the manne of a study scenerio, for principal study of the study of the study of the study of the monolash, the whole without of the study of the study of submitting the study of the study of the study of the submitting of the study of the study of the study of the submitting the study of the study single study of the study single study of the study

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any gradient into each other. Therefore it need not be doubled in the two little fields of a dist, which originally served a origonus fram, but which, likewise, very alightly aided in the and or exprained, have been gradiently converted by natural abelian into humching, simply through an increase in their aiss and he oblitzmiss of their solverse quarks. If all potenciated erripides had become extinct, and they have sufficient fails contaction that there used in this that the fails of the originally magned to the the solver source in the inter fails of originally magned use the fails of preventing the ora from being washed out of the ask?

would sooner or later be lost ; and in this case, especially if the during nearly their whole lives. With mammals, for instance, the form of the skull is often much altered with age, of which Dr. Murie has given some striking instances with seals ; every one cases .--- and many could be given .--- if the age for reproduction were would be modified; nor is it improbable that the previous and the differences between the young and the mature, and between

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Special Difficulties of the Theory of Natural Selection.

Although we must be extremely cautious in concluding that any organ could not have been produced by successive, small, transitional gradations, yet undoubtedly serious cases of difficulty occur.

this case will be treated of in the next chapter. The electric organs of fishes offer another case of special difficulty; for it is been produced. But this is not surprising, for we do not even know of what use they are. In the Gymnotus and Tornedo they no doubt serve as powerful means of defence, and perhaps for securing prev; yet in the Ray, as observed by Mattencei, an analogous organ in the tail manifests but little electricity, even when the animal is greatly irritated; so little, that it can hardly be of any use for the above purposes. Moreover, in the Ray, besides the organ just referred to, there is, as Dr. R. M'Donnell has shown, another organ near the head, not known to be electrical. but which appears to be the real homologue of the electric battery these organs and ordinary muscle a close analogy, in intimate structure, in the distribution of the nerves, and in the manner in which they are acted on by various reagents. It should, also, be especially observed that muscular contraction is accompanied by an electrical discharge ; and, as Dr. Radcliffe insists, " in the electrical apparatus of the torpedo during rest, there would seem to be a charge in every respect like that which is met with in muscle and nerve during rest, and the discharge of the torpedo, instead of being peculiar, may be only another form of the discharge which attends not at present go in the way of explanation ; but as we know so little about the uses of these organs, and as we know nothing about the habits and structure of the progenitors of the existing electric fishes, it would be extremely bold to maintain that no serviceable transitions are possible by which these organs might have been

These organs appear at first to offer another and far more serious difficulty; for they occur in about a doen, kinds of fash, of which serveral are widely remote in their affinities. When the same organ is found in several members of the same class, especially if in members having very different habits of life, we may generally attribute its presence to inheritance from a common ancestor; and

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of Natural Selection.

In a shown in some of the members in loss through dismoss emissions for the So that if the discretise expanse had been inherited from some one andest pregention, we might have spectral data with the field from the source of the second seco

The luminose ergsms which event in a few innexts, belonging to which different families, and which are situated in different parts of the body, effer, miler our present state of ignorance, a body of the body, effer, miler our present state of ignorance, and the body of the state of the state of the body of the state which as a dislover dism as an open state of the state of beings, for removed from each other in the scale of exempations, which are franked by state of the state of beings for removed from each other in the scale of exempation of the state of transparent induces on a number of the state of the st

Difficulties of the Theory

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throwing an image at the back of a darkened chamber. Beyond between the eyes of cuttle-fish and vertebrates, as may be seen by sible to conceive, and so in other points. Hence it is not a little course, open to any one to deny that the eye in either case could invention, so in the several foregoing cases it appears that natural far as function is concerned, in distinct organic beings, which

Frist Miller, in order to test the conclusions arrend as in this volume, has followed or with much care as a early similar lines of argument. Several families of crutakenas include a few gendes, where the several several several fields of the several several velocity of the several several several several several examined by Miller, and which are nearly related to each other the protein agree most cloudy in all important abancelers; mamby in the dimensional several microsofteness of the several several several several several microsofteness of the several microsofteness of the several severa

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whilst all the other important organs were closely similar or rather identical.

Fritz Muller argues that this does similarity in to many points the assessment of the pinetianse free as common rependitor. But as the vart majority of the projects in the slove two finnilies, as well as most offset presentances, are sequential in their habits, it is impossible in the highest degree, that their common progenitor entropy of the project of the slove two finnilies and original to differ in each in several important points, and the position of the origins, in the manaxis in which they are opered and highest degrees of the slove the point of the origins, and have an entropy to the significant of the manaxis of the point of the point of the degrees of the slove the point of the origins of the point of the degrees from beinging to distinct families, would principle that the matter of each variation degreed on the forgement. Concernantly model allowed are the slove the slove the function of the regions and the root of the sarrounding conditions, their variability assumptly would not have been catefy the some. Concernently model allowed and the slove that the functional result, and the structures thus acquired would harves the functional result and the structures thus acquired would harve and the whole case remains uninchiligible. This these of variant flow whole case presents uninchiligible. This these of the structure of the structures the structure of the structure of the structure of the structure of the structure. This has the structure of the structure

Another distinguished models, the late Prodesor Glagacida, has appeed in the same manner, and has arrived at the same result. He shows that there are paralitic mites (Azerilas) belonging to diminist sub-families and families, which are fermiosited with hatistrained and the same strained and the same strained by the same same strained and the same strained by the same strained as they can be same strained by the same strained by the same strained and the same strained by the same strained by and in the averant largenge they are forced by the same strained by the same strained by the same strained by the same strained by the same same strained by the same strained by the same strained by the same same strained by the same strained by the same strained by the same same strained by the same strained by the same strained by the same same strained by the same strained by the same strained by the same same strained by the same strained by the same strained by the same same strained by the same strained by the same strained by the same same strained by the same same strained by the same strain

In the lorgeling cases, we see the same end gained and the same function performand, in beings not at all or only remotely allied, by egans in appearance, though not in development, closely similar. On the other hand, it is a common rule throughout nature that the same end should be gained, even sometimes in the case of closelyrelated beings, by the most diversified means. How differently

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constructed is the feathered wing of a bird and the membranefly, the two wings of a fly, and the two wings with the elytra of a beetle. Bivalve shells are made to open and shut, but on what a Mussel ! Seeds are disseminated by their minuteness,-by their capsule being converted into a light balloon-like envelope,-by being embedded in pulp or flesh, formed of the most diverse parts. quadrupeds,-and by being furnished with wings and plumes as by every breeze. I will give one other instance ; for this subject of the same end being gained by the most diversified means well have been formed in many ways for the sake of mere variety, almost like toys in a shop, but such a view of nature is incredible. though hermaphrodites, the pollen does not spontaneously fall on the stigma, some aid is necessary for their fertilisation. With several kinds this is effected by the pollen-grains, which are light and incoherent, being blown by the wind through mere chance on to the stigma; and this is the simplest plan which can well be conceived. An almost equally simple, though very different, plan occurs in many plants in which a symmetrical flower secretes a few drops of ngctar, and is consequently visited by insects; and these

From this simple stage we may pass through an incentantified number of contrivuous, all for the annu purpose and defeted in constally the same manore, but establing charges in every pixel to the same start of the same start of the same start of the index with the same man of pixfils models in many ways, some times forming trap-like contributions, and annutines equal to the same start of the same start of the same start ways are started as the same start of the same start holdword out into a great taubet, into which drops of almost pure video contained pixel from two scenetics phare which and above $1_{1,1}$ and when the bucket is half till, the water contributed $1_{1,2}$ and when the bucket is half till, the water contributed backet, and is intellifications of the same of the distance of the same start start of the same start of the same with two

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of Natural Selection.

lateral entrances; within this chamber there are curious fleshy ridges. The most ingenious man, if he had not witnessed what serve. But Dr. Crüger saw crowds of large humble-bees visiting to gnaw off the ridges within the chamber above the bucket; in doing this they frequently pushed each other into the bucket, and viscid glands of the pollen-masses. The pollen-masses are thus glued to the back of the bee which first happens to crawl out a bee which he had killed before it had quite crawled out with a pollen-mass still fastened to its back. When the bee, thus provided, pussage, the pollen-mass necessarily comes first into contact with the viscid stigma, and adheres to it, and the flower is fertilised. Now at last we see the full use of every part of the flower, of the water-secreting horns, of the bucket half full of water, which

The conturnion of the flower in mother closely allel certisk, mody the Gatastenia, wieddy different, choogh serving the same exist in all is quality versions. How visit these flowers, like those of the same service of the same service service of the same incrimity toots he same gate regulation, or as I have auditor of vibration to a certain membrase which is instantly reprintly this sate from a pring by which the poller-mass is about the bulk in the same service in the right distribution, and allowers by in vibration of the same service in the right distribution of the same service to the flower of the same service in the right distribution of the same time of the same service in the right distribution of the same the flower of the same service in the right of the same service is the flower of the same service in the right distribution of the same service in the right distribution is effected.

How, it may be asked, in the foregoing and in innumerable other

Organs of little Importance

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instances, can we understand the graduated scale of complexity and the multifations mances for pairing the same end. The starver no theorem is an already remarked, that is then we do the starver by well not be of the same exact nature, and the degrad the results obtained through natural selection for the same gravent parces well obtained through natural selection for the same gravent parces well are been been denoted by the source of the same graves of the same starver being the source of the same graves of the same model of the same set of the same graves of the same factors will not readily be quick load, but of our dot and packan factors will not readily the quick load, but of our dot appeads factors will not readily be quick load, but of our dot appeads change, through which the queeries has passed furting its mesonesive advantations to change in halts and couldings of like.

This them, at local is many cases it is most silficative even objective by what ransitions organ have varied at their present state $\gamma \phi_{c}$ considering how multi-the proportion of thring mail knows that $\gamma \phi_{c}$ considering how multi-the proportion of thring mail knows in the state $\gamma \phi_{c}$ are even as a simulation of the state of the s

Organs of little apparent Importance, as affected by Natural Selection,

As natural selection acts by life and death,—by the survival of the fittest, and by the destruction of the less well-fitted individuals,—I have sometimes felt great difficulty in understanding the origin or formation of parts of little importance; almost as

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great, though of a very different kind, as in the case of the most perfect and complex organs.

In the first phase, we use much too ignoratio in repeat to the back seconcer of any grain engine like into two which will be transitioned and the second second second second second repeated by the second second second second second second quarkrought, which, from being correlated with constitutional differences or from distribution of interior, might difference on from distribution of interior, might distribution and the second second second second pripose by accessive high tradifications, each latter and better and the distribution and existence of cattle and other anish in Section difference in that individuals which could by any means defect of inserts: no that individuals which could by any means defect of inserts: no that individuals which could by any means defect on present second they are more analysts. It is our that the larger quadrupols are astimized, but increases and the strength readow of the they are more analysts to illuscose; on do a well based is from the distribution of the distribution of the strength readow of the strength second second second second second second or strength and they are more analysts to illuscose; on do a well based of the strength of the distribution of the distribution of the distribution of the strength of the distribution of the strength readow of the strength of the distribution of the distrest of the distrest of the distribution of the distrest

Organization of trilling impertance have probably in some cases been of high impertance to an early possitor, and, after having been don't high impertance to a surface possitor, and, after having children early statistical probability of the state of the statistic species in mary that any attribution of every slight uses, let any attribution probability of the state of the term been been therefore the states of the states of the states of the states of the state of the states of the states of the states of the state of the state of the states being which early and the state of the state of the states which devices that having been framed in an aquatic animal, it might subsystemic origin may perhaps be than accounted for. A state of the states of the state of the state of the states of the states of the state of the state of the states of the states of the states of the state of the state of the states which is the states of the state of the state of the states of the state of the states of the states of the states which is the states which have the state of the states of the s

In the second place, we may easily err in attributing importance to characters, and in believing that they have been developed Organs of little Importance

through natural solection. We must by no means overholds the effects of the definite action of chample conditions of $10 \, {\rm He}_{-}{\rm eff}$ are called spatismeous variations, which seem to depend in a quite absolution to degrees on the nature of the toro-filtions,—of the toro-filtion of the second second second second second gravity, such as of corolation, corresponding, of the presence of ones or part on another, &ee,—and finally of second selection, by which more or how perfectly to the other second second second second solutions are second second second second second second advantage to a predictly to the other second second second advantage to a prediction, may subsequation play be been taken advance tags of ty in modified documents, under new conditions of this and newly acquired habits.

If green woodpeckers alone had existed, and we did not know that there were many black and pied kinds, I dare say that we should have thought that the green colour was a beautiful adaptaconsequently that it was a character of importance, and had been acquired through natural selection; as it is, the colour is probably in chief part due to sexual selection. A trailing palm in the Malay Archipelago climbs the loftiest trees by the aid of exquisitely constructed hooks clustered around the ends of the branches, and this which, as there is reason to believe from the distribution of the thornfirst have been developed for this object, and subsequently have been further modification and became a climber. The naked skin on the head of a vulture is generally considered as a direct adaptation for wallowing in putridity ; and so it may be, or it may possibly be due to the direct action of putrid matter ; but we should be very on the head of the clean-feeding male Turkey is likewise naked. a beautiful adaptation for aiding parturition, and no doubt they facilitate, or may be indispensable for this act; but as sutures escape from a broken egg, we may infer that this structure has

We are profoundly ignorant of the cause of each slight variation

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or individual difference; and we are immediately made conscious of this by reflecting on the differences between the breeds of our domesticated animals in different countries,-more especially in the selection. Animals kept by savages in different countries often certain extent to natural selection, and individuals with slightly different constitutions would succeed best under different climates. selection. Some observers are convinced that a damp climate correlated. Mountain breeds always differ from lowland breeds ; and a mountainous country would probably affect the hind limbs from exercising them more, and possibly even the form of the pelvis; and then by the law of homologous variation the front the size of the chest ; and again correlation would come into play. whole organisation is probably still more important; and this, as H. von Nathusius has lately shown in his excellent Treatise, is apparently one chief cause of the great modification which the breeds of swine have undergone. But we are far too ignorant to speculate on the relative importance of the several known and unknown causes of variation ; and I have made these remarks only to show that, if we are unable to account for the characteristic differences of our several domestic breeds, which nevertheless are generally few parent-stocks, we ought not to lay too much stress on our ignorance of the precise cause of the slight analogous differences

Utilitarian Doctrine, how far true : Beauty, how acquired.

The foregoing remarks lead me to say a few words on the protest lately made by some naturalities, against the utilitarian doctrine that every detail of structure has been produced for the good of its possessor. They believe that many structures have been created for the sake of beauty, to delight man or the Creator (but this latter point is beyond the scope of scientific discussion), or for the

Utilitarian Doctrine how far true : CHAP. VI.

sake of more variety, a view already discussed. Such doctrines it gained. But a still more important consideration is that the chief ance; and consequently, though each being assuredly is well fitted believe that the webbed feet of the upland goose or of the frightehorse, in the wing of the bat, and in the flipper of the seal, are of special use to these animals. We may safely attribute these structures to inheritance. But webbed feet no doubt were as useful to the progenitor of the upland goose and of the frighte-bird. believe that the progenitor of the scal did not possess a flipper, but principle of utility, probably through the reduction of more numerous bones in the fin of some ancient fish-like progenitor of the whole class. It is scarcely possible to decide how much allowance ought to be made for such causes of change, as the creature either now is, or was formerly, of some direct or indirect use to its possessor.

With respect to the belief that organic beings have been created benutified for the delight of man,— a belief which it has been preroomed is autorensive of my whole theory——I may first remark that the sense of benuty obviously depends on the number of ble that the ident of which is a start of the start of the that the ident of which is a start of the start of the that the ident of which is a start of different near solution entropy different standard of heavity in their worsen. If bounding objects had been created solely for man's gratification, it cought to be start of the start o

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Beauty how acquired.

be shown that before man appeared, there was less beauty on the face of the earth than since he came on the stage. Were the beautiful volute and cone shells of the Eccene epoch, and the gracefully sculptured ammonites of the Secondary period, created that man might ages afterwards admire them in his cabinet? Few objects are more beautiful than the minute siliceous cases of the diatomacose: were these created that they might be examined and admired under the higher powers of the microscope ? The beauty to symmetry of growth. Flowers rank amongst the most beautiful productions of nature ; but they have been rendered conspicuous time beautiful, so that they may be easily observed by insects. I have come to this conclusion from finding it an invariable rule that when a flower is fertilised by the wind it never has a gaily-coloured corolla. Several plants habitually produce two kinds of flowers : one kind open and coloured so as to attract insects: the other closed, not coloured, destitute of nectar, and never visited by insects. Hence we may conclude that, if insects had not been developed on the face of the earth, our plants would not have been decked with beautiful flowers, but would have produced only such poor flowers as we see on our fir, cak, nut and ash trees, on grasses, spinach, docks, and nettles, which are all fertilised through the agency of the wind. A similar line of argument holds good with fruits; that a ripe strawberry or cherry is as pleasing to the eye as to the ralate .- that the gaily-coloured fruit of the spindle-wood tree and the scarlet berries of the holly are beautiful objects,-will be admitted by every one, But this beauty serves merely as a guide to birds and beasts, in order that the fruit may be devoured and the manured seeds disseminated : I infer that this is the case from having as yet found no exception to the rule that seeds are always thus disseminated or pulpy envelope), if it be coloured of any brilliant tint, or rendered conspicuous by being white or black.

On the other hand, I willingly admit that a great number of massimals, and our most pergoes thick, scene fishes, repulse, and mammals, and a host of magnificently colored hatterfields have been residential for learning wake, but this has been made having be small selection, that is, by the more learning in the delight of mass. So it is with the tothe families and not finde from all that a neutry similar tasks for beautiful observations from some small common results. The selection of the animal frame family set of the selection of the select

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Utilitarian Doctrine how far true. CHAP. VI.

kingdom. When the form it as a bourifully colourd a the made, which is no rarely the nears with birds and betterfiles, the cause appearing lies in the colour acquired through secural selection having bear transmitted to both secure, instead of to the males alone. How the sense of hearty in its simplest form—that is, the reception of a possible risk of of plasmer from certain colours, forma, and sounds—was first developed in the mind of main and of the lower simulation is a security of the same set of difficulty is presented, if we explicit how in its that of the lower having reports to have control on a certain certain time. In these mains beyone in their control on the constitution of the nervous system in each profes.

Natural selection cannot possibly produce any modification in a species exclusively for the good of another species ; though throughout nature one species incessantly takes advantage of, and profits by, the structures of others. But natural selection can and does often produce structures for the direct injury of other animals, as we see in the fang of the adder, and in the ovinositor of the ichneumon, by which its eggs are deposited in the living bodies of other insects. If it could be proved that any part of the structure of any one species had been formed for the exclusive good of another species, it would annihilate my theory, for such could not have been produced through natural selection. Although many statements may be found in works on natural history to this effect, I cannot find even one which seems to me of any weight. It is admitted that the rattlesnake has a poison-fang for its own defence, and for the destruction of its prey; but some authors injury, namely, to warn its prev. I would almost as soon believe that the cat curls the end of its tail when preparing to spring, in order to warn the doomed mouse. It is a much more probable view that the rattlesnake uses its rattle, the cobra expands its frill, and the puff-adder swells whilst hissing so loudly and harshly, in order to alarm the many birds and beasts which are known to principle which makes the hen ruffle her feathers and expand her frighten away their enemies.

Natural selection will never produce in a being any structure more injurious than beneficial to that being, for natural selection

acts solely by and for the good of each. No expan will be formed, as Platy has remarked, for the purpose of causing pain or for deing an injury to its particular M is fair halance be struck. Lettween the good mercors, After the lapse of time, under changing conditions of line, flam practice nomes to be injuries, it will be modified; or if it be note on, the being will become extinct as myriads have become extinct.

Natural selection tends only to make each organic being as perfect as, or slightly more perfect than, the other inhabitants of the same country with which it comes into competition. And we see endemic productions of New Zealand, for instance, are perfect one commared with another; but they are now rapidly yielding before the advancing legions of plants and animals introduced from Europe. Natural selection will not produce absolute perfection, nor do we always meet, as far as we can judge, with this high standard under nature. The correction for the aberration of light is said by Müller not to be perfect even in that most perfect organ, the human eye. Helmholtz, whose judgment no one will dispute, after describing in the strongest terms the wonderful powers of the human eve. adds these remarkable words : " That which we have discovered in the way of inexactness and imperfection in the optical machine and in the image on the retina, is as nothing in comparison with the incongruities which we have just come across in the domain of the sensations. One might say that nature has taken delight in accumulating contradictions in order to remove all foundation from the theory of a pre-existing harmony between the external and internal worlds." If our reason leads us to admire with enthusiasm a tells us, though we may easily err on both sides, that some other contrivances are less perfect. Can we consider the sting of the bee as perfect, which, when used against many kinds of enemies, cannot be withdrawn, owing to the backward serratures, and thus inevitably causes the death of the insect by tearing out its viscera ?

If we look at the sting of the box, as having existed in a remote regression can about generating and serated interment, like that in so many members of the same great order, and that it has a since been modified but not perfected for large-scatter propose, with the point orderanally adapted for some other odject, such as to produce galls, since interacting, we can be as to produce galls, since the state should so due to the state the use of the state should so due can be used to be used to be should be outed using should so due can be insected on a due to the state should be powered singing be useful to the social community, the state of the should be power of singing be useful to the social community.

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is will fail all the requirements of natural selection, theorh it may accur the dash of some for moments. If we admits the trajky wouldn'th power of seems by which the mains of many incess flack to the second selection of the second selection of the second of the industrions and archie sinters". It may be difficult, but we ought to admits a darked in stars, but would be admitted industrions and archie sinters". It may be difficult, but we ought to admits the average young queues, ber dasphere, a some and they are been one parents here of the two bar difficult, but we can always a star of the second second second second second and the second second second second second second second and the second se

Summary: the Law of Unity of Type and of the Conditions of Existence embraced by the Theory of Natural Selection.

We have in this chapter discussed some of the difficulties and objections which may be urged against the theory. Many of them are serious; but I think that in the discussion light has been thrown on several facts, which on the belief of independent acts of creation are utterly obscure. We have seen that species at any one period are not indefinitely variable, and are not linked together by a multitude of intermediate gradations, partly because the process of natural selection is always very slow, and at any one time acts only on a few forms; and partly because the very process of natural selection implies the continual supplanting and extinction of preceding and intermediate gradations. Closely allied species, now living on a continuous area, must often have been formed when the area was not continuous, and when the conditions of life did not insensibly graduate away from one part to another. When two varieties are formed in two districts of a continuous area, an intermediate variety will often be formed, fitted for an intermediate zone; but from reasons assigned, the intermediate variety will usually exist in lesser numbers than the two forms which it connects ; consequently the two latter, during the course of further modification, from existing in greater numbers, will have a great advantage over the less numerous intermediate variety, and will thus generally succeed in supplanting and exterminating it.

Summary.

We have seen in this chapter how cautions we should be in concluding that the most different habits of life could not graduate into each other; it hat a tak for instance, could not have been formed by natural selection from an animal which at first only wilded through the air.

We have seen that a species under new conditions of life may change its labits; or it may have diversified habits, with some very unlike these of its nearest compenses. Hence we can undersand, bearing in mind that each organic being is trying to live wherever it can inve, how it has arise that there are upland greess with webbed fest ground woodpeckers, diving thrashes, and petrols with the habits of subs.

Although the balls that an ergma so perfect as the up o could have been, frome by matural selection, is ecough to stager any one γ with the same of any organ, if we know of a balag metrics of the charge conditions of link, there is no begind impossibility in the sequences of the same in which we know of no intermediate or transitional states, we school be extremely caution in ecoel-ling income on have existed, for the metamethous of many ergons have no end we existed for the metamethous of many ergons have no end we existed for the metamethous of many ergons have no end we existed for the metamethous of many ergons have no end we existed for the metamethous of many ergons have no end we existed for the metamethous of many ergons have no end we existed for the metamethous of many ergons have no end we are also been performed simultaneously very different functions, and them having been in parts or in whole performed within adding the coloring must of the larger function length in the state of the larger formed simultaneously performed within adding the coloring must of the larger function length functions and the state function, the cone having been performed within adding the coloring must of the larger functional transitions.

We have seen this in two bings widdy remost from ands others in the natural scale, organs avering for the same perpose and in external spearance closely atimizer may have been separately and independently format, it is with we nice obrass are closely examined, so and all differences in their structure can almost always be detected, but is the structure of the structure in minimum also internet of the other hands. The structure is minimum also internet diversity of structures for gaining the subsection of this again alwayship of structures for gaining the subsection.

In many cases we are far too ignorant to be enabled to assert that a part or organ is so unimportant for the welfare of a species, that modifications in its structure could not have been slowly accumulated by means of natural selection. In many other cases, modifi-

Summary.

cations are probably the direct result of the laws of variations or of growth, independently of any good gene then grained. The resu mask intrustices have of any and trigger bene than grained, been allowparedly taken abraw consulting and the truther modified, for the grain of the structure based of the structure of the structure of the structure structure of the structure of the structure of the structure structure of the structure of the structure of the structure structure of the structure of the structure of the structure structure of the structure of the structure of the structure structure of the structure of the structure of the structure structure of the structure of the

Natural selection can produce nothing in one species for the exclusive good or injury of another; though it may well produce parts, organs, and excretions highly useful or even indispensable, or again highly injurious to another species, but in all cases at the same time useful to the possessor. In each well-stocked country natural selection acts through the competition of the inhabitants, and consequently leads to success in the battle for life, only in accordance with the standard of that particular country. Hence the inhabitants of one country, generally the smaller one, often yield to the inhabitants of another and generally the larger country. For in the larger country there will have existed more individuals and more diversified forms, and the competition will have been severer, and thus the standard of perfection will have been rendered higher. Natural selection will not necessarily lead to absolute perfection ; nor, as far as we can judge by our limited faculties, can absolute perfection be everywhere predicated.

On the theory of natural selection we can clearly understand the full meaning of that old canon in natural history, "Natura non facit saluum." This canon, if we look to the present inhabitants alone of the world, is not attrictly correct ; but if we include theory to strictly true.

It is provedly acknowledged that all organic heigh have been formed on two gravits how-livity of Type and the Conditions of Existence. By unity of type in means that fundamental agreement which is neglit independent of their havins of this. On any theory, unity of type is explained by unity of doesent. The expression of collision of existences, so othen institution of the thin integration Cavier, is fully embranded by the principle of natural selection. For each being the transmission of the transmission of this of the transmission Cavier, is fully embranded by the principle of natural selection. For each being to its cognition and integration collisions of fills of the fills of the transmission of the transmission

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inving soluted them during past periods of time: the solutions being added in many cases by the increased use or disms of parts, being affected by the direct action of the external conditions of life, and ambjected in all cases to the several laws of growth and variation. Hence, in fact, the laws of the Conditions of Kintence is the higher law; as it includes, through the inheritance of former variations and applications, that of Ultry of Type.

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CHAPTER VII.

MISCELLANEOUS OBJECTIONS TO THE THEORY OF NATURAL, SELECTION.

Lengvirp — Multifattines not accessibly simultaneous — Multifattines apparently of no direct service—Progravity development, of mult fractional importance, the most constant—Suppord incompersons of natural solveints in a scenario for the implying stategy of useful structures—Canner shich interfere with the acquisition through antrust associated or world structure—constantions of structures with a structure of the structure of the structure with class, developed from one and the same source—Insame for disbelowing in prestant adverpt mollifattion.

I will devote this chapter to the consideration of various miscellaneous objections which have been advanced against my views. as some of the previous discussions may thus be made clearer ; but it would be useless to discuss all of them, as many have been made by writers who have not taken the trouble to understand the subject. Thus a distinguished German naturalist has asserted that the weakest part of my theory is, that I consider all organic beings as imperfect : what I have really said is, that all are not as perfect as they might have been in relation to their conditions ; and this is shown to be the case by so many native forms in many quarters of the world having yielded their places to intruding foreigners. Nor can organic beings, even if they were at any one time perfectly adapted to their conditions of life, have remained so, when their conditions changed, unless they themselves likewise changed ; and no one will dispute that the physical conditions of each country, as well as the numbers and kinds of its inhabitants, have undergone

A critic has lately insisted, with some parale of mathematical nonnexy, that longerity is a great advantage to all species, so that he who believes in natural selection. Wrants arrange his generalogical future.¹¹ in use's a manner that all the descendants have longer lives than their progenitors! Cannot our critic oncavies that a biennial plant or one of the lower animals might maps into a cold climate and perioh three very winter; and yet, owing to advantages

pained through natural selection, survive from year to year by manne of its needs or every *M*. R. F. Bay Lankester has recently discussed this unbject, and he concludes, as far as its extreme comparity allows thin to form a injuryent, that longwirty is generally related to the standard of each species in the scale of expansions, as well as to the amount of expensitive in proposition and in general activity. And these conditions have, it is probable, been larged extermined through natural selection.

It has been argued that, as none of the animals and plants of Egypt, of which we know anything, have changed during the last three or four thousand years, so probably have none in any part of the world. But, as Mr. G. H. Lewes has remarked, this line of argument proves too much, for the ancient domestic races figured on the Egyptian monuments, or embalmed, are closely similar or even identical with those now living : yet all naturalists admit that such races have been produced through the modification of their original types. The many animals which have remained unchanged since the commencement of the glacial period, would have been an incomparably stronger case, for these have been exposed to great changes of climate and have migrated over great distances: whereas in Egypt, during the last several thousand years, the conditions of life, as far as we know, have remained absolutely uniform. The fact of little or no modification having been effected since the glacial period would have been of some avail against those who believe in an innate and necessary law of development, but is of the fittest, which implies that when variations or individual differences of a beneficial nature happen to arise, these will be circumstances.

The eicherator placenoiclogict, Prenn, at the close of his German transition of this work, asks, how, our the principle of natural selection, neur a variaty live side by side with the parent-species? Work has been second reliable of the side of the second polymerphic species, in which the variability with on cost of polymerphic species, in which the variability of the side of the polymerphic species, in which the variability of the side of the specimic nature, and have tempory variations, each as size, attaining a significant state of the side of the

Bronn also insists that distinct species never differ from each other

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in single characters, but in many parts ; and he asks, how it always comes that many parts of the organisation should have been modi-But there is no necessity for supposing that all the parts of any being have been simultaneously modified. The most striking modifications, excellently adapted for some purpose, might, as was formerly remarked, be acquired by successive variations, if slight, mitted all together, they would appear to us as if they had been objection is afforded by those domestic races which have been modified, chiefly through man's power of selection, for some special purpose. Look at the race and dray horse, or at the greyhound and mastiff. Their whole frames and even their mental characteristics have been modified ; but if we could trace each step in the history of their transformation,-and the latter steps can be traced,-we should not see great and simultaneous changes, but first one part and then another slightly modified and improved. Even when selection has been applied by man to some one character alone, -of which our cultivated plants offer the best instances.-it will invariably be found that although this one part, whether it be the flower, fruit, or leaves, has been greatly changed, almost all the other parts have been slightly modified. This may be attributed partly to the principle of correlated growth, and partly to so-called spontaneous variation.

A much more serious objection has been urged by Bronn, and recently by Broca, namely, that many characters appear to be of no service whatever to their possessors, and therefore cannot have been influenced through natural selection. Bronn adduces the length of the ears and tails in the different species of hares and mice,-the complex folds of enamel in the teeth of many animals, and a multitude of analogous cases. With respect to plants, this subject has been discussed by Nägeli in an admirable essay. He admits that natural selection has effected much, but he insists that the families of plants differ chiefly from each other in morphological characters, which appear to be quite unimportant for the welfare of the species. He consequently believes in an innate tendency towards progressive cells in the tissues, and of the leaves on the axis, as cases in which natural selection could not have acted. To these may be added the numerical divisions in the parts of the flower, the position of the ovules, the shape of the seed, when not of any use for dissemination, &c.

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There is much force in the above objection. Nevertheless, we ought, in the first place, to be extremely cautious in pretending to decide what structures now are, or have formerly been, of use to each species. In the second place, it should always be borne in mind that when one part is modified, so will be other parts, through of nutriment to a part, mutual pressure, an early developed part affecting one subsequently developed, and so forth,-as well as through other causes which lead to the many mysterious cases of correlation, which we do not in the least understand. These agencies may be all grouped together, for the sake of brevity, under the expression of the laws of growth. In the third place, we have life, and for so-called spontaneous variations, in which the nature of the conditions apparently plays a quite subordinate part. Budmee, or of a nectarine on a peach-tree, offer good instances of spontaneous variations ; but even in these cases, if we bear in mind the power of a minute drop of poison in producing complex calls, we ought not to feel too sure that the above variations are not the effect of some local change in the nature of the sap, due to some change in the conditions. There must be some efficient cause for each slight individual difference, as well as for more strongly marked variations which occasionally arise ; and if the unknown cause were to act persistently, it is almost certain that all the individuals of the species would be similarly modified.

It may be worth while to Illustrate some of the foregoing remarks. With respect to the assumed intuility of various parts and organs, it is larsly necessary to observe that even in the higher and botiknown animals many structures exist, which are so highly developed that no ones doubt that they are of importance, yet their tues has no been, or has our presently been, accretaind. As foron gives the length of the ears and tail in the several apecies of mices as intracess, theophy trilling costs, of difference in structure which can

he of no special use, I may mention that, according to Dr. Schöhl, the external cars of the common mouse are supplied in an extraordinary manner with nerves, so that they no doubt serve as tacking organs; hence the length of the cars can hardly be quite mimiportant. We shall, also, presently see that the tail is a highly useful prehensile organ to some of the species; and its use would be much influenced by its length.

With respect to piant, to which on account of X-Sqiffe angut fall contain marks if in the following marks, it will be admitted that the flowers of cerkids present a multitude of curious structures, buch a few years are would have been considered as mere morphological differences without any special function; but they are norknown to be of the highest importance for the fertilization of the species through the aid of interest, and have probably bein gained that in discorphic activity of the structure of the species through and entirespike plantes the different lengths of the stansen and justilis, and their arrangement, could have been of any series, but now we know this to be the case.

In certain whole groups of plants the ovules stand erect, and in others they are suspended; and within the same ovarium of some few plants, one ovule holds the former and a second ovule the latter position. These positions seem at first purely morphological, or of no physiological signification ; but Dr. Hooker informs me that within the same ovarium, the upper ovules alone in some cases, and in other cases the lower ones alone are fertilised; and he suggests that this probably depends on the direction in which the pollen-tubes enter the ovarium. If so, the position of the ovules, even when one is creet and the other suspended within the same ovarium, would follow from the selection of any slight deviations in position which favoured their fertilisation, and the production of seed. Several plants belonging to distinct orders habitually produce flowers of two kinds,-the one open of the ordinary structure, the other closed and imperfect. These two kinds of flowers sometimes differ wonderfully in structure, yet may be seen to graduate into each other on the same plant. The ordinary and open flowers can be intercrossed; and the benefits which certainly are derived from this process are thus secured. The closed and imperfect flowers are, however, manifestly of high importance, as they yield with the utmost safety a large stock of seed, with the expenditure of wonderfully little pollen. The two kinds of flowers often differ much, as just stated, in structure. The petals in the imperfect flowers almost always consist of mere rudiments, and the pollen-grains are reduced in diameter. In Ononis columnæ five of the alternate stamens are

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relationsity i and in some species of Viola three statumes are in this state, two relating their paper denotion, has being of very small size. In site out at (three of the closed flower) is an influention of the state of the state of the state of the state of the two threes. In one section of the Multiphinese the closed flowers, according to Δ_{0} denotes, are still further modified, for the first statement which are oblight as a value state of the state of the two threes. In one section of the Multiphinese the closed flowers, according the state of the state and this statement is not present in the ordinary discrete of the owner of the state of the state of the state of the downer of the state of the state of the state of the state of the downer state of the state of the state of the state of the downer have been than determined, but must have followed from the laws of laws the state of the polyment and the downer of the downer state of the downer of the polyment and the downer of the downer.

It is so necessary to appreciate the important effects of the laws of growth, that I will give some additional cases of another kind, namely of differences in the same part or organ, due to differences in relative position on the same plant. In the Spanish chestnut, and in certain fir-trees, the angles of divergence of the leaves differ. according to Schacht, in the nearly horizontal and in the upright branches. In the common rue and some other plants, one flower, usually the central or terminal one, opens first, and has five sepals and petals, and five divisions to the ovarium ; whilst all the other flowers on the plant are tetramerous. In the British Adoxa the uppermost flower generally has two calvx-lobes with the other organs tetramerous, whilst the surrounding flowers generally have three calyx-lobes with the other organs pentamerous. In many Composite and Umbellifere (and in some other plants) the circumferential flowers have their corollas much more developed than those reproductive organs. It is a more curious fact, previously referred to, that the achenes or seeds of the circumference and centre sometimes differ greatly in form, colour, and other characters. In Carthamus and some other Composita the central achenes alone are furnished with a pappus; and in Hyoseris the same head yields achenes of three different forms. In certain Umbelliferse the exterior seeds, according to Tausch, are orthospermous, and the central one coelospermous, and this is a character which was considered by De Candolle to be in other species of the highest systematic im-

perturns. Prof. Bream mentions a Fumarianceous growt, in which deforeven in the lower part of the spike hour oval, ribbed, onecooled nucleus; and in the apper part of the spike, knowlat, twoveloved, and travesould alliques. In these served cases, with the acception of that of the well developed ray-flowets, which are of arrive in making the flowers complexity in the served or early in a quite include the flower of the spike served on the pikely position and hater-action of the party part in the pikely position and hater-action of the party part is may flow the develop and hater-action of the party part is may flow the develop and hater-action of the party part is and its spike that been used to spike the spikely of the spikely of the spikely of the spikely and haven in certain positions, all would have been modified in the same manner.

In numerous other cases we find modifications of structure, which are considered by botanists to be generally of a highly important nature, affecting only some of the flowers on the same plant, or occurring on distinct plants, which grow close together under the same conditions. As these variations seem of no special use to the plants, they cannot have been influenced by natural selection. Of their cause we are quite ignorant; we cannot even attribute them, as in the last class of cases, to any proximate agency, such as relative position. I will give only a few instances. It is so common to observe on the same plant, flowers indifferently tetramerous, pentamerous, &c., that I need not give examples; but as numerical variations are comparatively rare when the parts are few. I may mention that, according to De Candolle, the flowers of Papaver bracteatum offer either two sepals with four petals (which is the common type with poppies), or three senals with six petals, The manner in which the petals are folded in the had is in most groups a very constant morphological character; but Professor Asa Gray states that with some species of Mimulus, the astivation is almost as frequently that of the Rhinanthideze as of the Antirrhinides, to which latter tribe the genus belongs. Aug. St. Hilairo gives the following cases : the genus Zanthoxylon belongs to a division of the Rutacese with a single ovary, but in some species flowers may be found on the same plant, and even in the same panicle, with either one or two ovaries. In Helianthemum the capsule has been described as unilocular or 3-locular; and in H. mutabile, "Une lame, plus ou moins large, s'étend entre le pericarne et le placenta." In the flowers of Saponaria officinalis, placentation. Lastly, St. Hilaire found towards the southern extreme of the range of Gomphia olescformis two forms which he did

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not at first doubt were distinct species, but he subsequently saw them growing on the same bush; and he then adds, " Volià done dans un même individu des loges et un style qui se rattachent taofd à un ase verticale et tanfet à un grandbase."

We thus see that with plants many morphological changes may independently of natural selection. But with respect to Nägeli's development, can it be said in the case of these strongly proprogressing towards a higher state of development? On the contrary, I should infer from the mere fact of the parts in question differing or varying greatly on the same plant, that such modifications were of extremely small importance to the plants themselves, of whatever importance they may generally be to us for our classifications. The acquisition of a useless part can hardly be said to raise an organism in the natural scale ; and in the care of the imperfect, closed flowers above described, if any new principle has to be invoked, it must be one of retrogression rather than animals. We are ignorant of the exciting cause of the above specified modifications; but if the unknown cause were to act almost uniformly for a length of time, we may infer that the result species would be modified in the same manner.

Trout the fast of the above characters being unimportent for the walf or of the speein as we julky variations which occurred in them would not have been accumulated and augmented through hangestimate and and the speet of the speet of the speet of the spectra of the speet of the speets, they may be, and apparently often have walfant of the speets, they may be, and apparently often have one clusters with the frammanile, holding or reptiles, whether they were cluster with the frammanile, holding or reptiles, whether they were cluster with the frammanile, holding or reptiles, whether they were cluster with the appeared of the speet of t

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impertance to the species. Thus, as I am include to being employing all differences, which we conclude as impertunit—much as the arrangement of the laway, the divisions of the flower or ditarget of the strength of the strength of the strength of the strength the nature of the equation and of the surrounding collisions, away and a thrength the intervention of the strength the nature of the equation and of the surrounding collision is then only how the strength of the strength then in the strength the intervention of distribution in the strength the matter of the strength on the strength of the strength of the strength on the strength of the strength this latter agency. It is a strengt result which we thus arrive any anody that character of slight virial importance to the species, are the most important to the systematizit, but, are subition is but no other specific the strength of the species, are the most important to the systematizit, but, are subition is but no other specific the strength of the species.

Although we have no good evidence of the existence in cagain bling of an instant tendency towards programsive development, yet this necessarily follows, as 1 have attempted to above in the fourth capter, through two continuous calles on attempt selections. For the level definition which has ever been given of a high standard or equination, is the degree to which the grant have been pecklahed much as the parts are thus enabled to perform their functions more efficiently.

A distinguished zoologist, Mr. St. George Mivart, has recently collected all the objections which have ever been advanced by myself and others against the theory of natural selection, as propounded by Mr. Wallace and myself, and has illustrated them with admirable art and force, When thus marshalled, they make a formidable array ; and as it forms no part of Mr. Mivart's plan to give the various facts and considerations opposed to his conclusions, no slight effort of reason and memory is left to the reader, who may wish to weigh the evidence on both sides. When discussing special cases, Mr. Mivart passes over the effects of the increased use and disuse of parts, which I have always maintained to be highly important, and have treated in my 'Variation under Domestication' at greater length than, as I believe, any other writer. He likewise often assumes that I attribute nothing to variation, independently of natural selection, whereas in the work just referred to I have collected a greater number of well-established cases than can be found in any other work known to me. My judgment may not be trustworthy, but after reading with care Mr. Mivart's book, and

comparing each section with what I have said on the same head, I never before felt so strongly convinced of the general truth of the conclusions here arrived at, subject, of course, in so intricate a subject to much trattial error.

All MA Mearly abjections will be or have been, considered in the present views. The one new you're which appears to have atrack may readers is, " that natural selection is intompretent to a source for the incipient stages of useful structures." This analyset is infimately connected with that of the graduator of charactery of the last degrader of the last degrader of the structure. The structure is the last degrader of the structure of the last degrader of the last degrader. Nevership was defined by the structure is the structure of the last degrader of the last degrader. Nevership was defined by the structure is the structure of the last degrader of the structure is the structure of the last degrader of the structure is the form of the structure of the structu

The gimffe, by its lofty stature, much elongated neck, fore-legs, head and tongue, has its whole frame beautifully adapted for browsing on the higher branches of trees. It can thus obtain food beyond the reach of the other Ungulata or hoofed animals inhabiting dearths. The Niata cattle in S. America show us how small a ence in preserving an animal's life. These cattle can browse as well as others on grass, but from the projection of the lower jaw they cannot, during the often recurrent droughts, browse on the twigs of trees, reeds, &c., to which food the common cattle and horses by their owners. Before coming to Mr. Mivart's objections, it may be well to explain once again how natural selection will act in all ordinary cases. Man has modified some of his animals, without preserving and breeding from the flectest individuals, as with the the individuals which were the highest browsers and were able during dearths to reach even an inch or two above the others, will often have been preserved; for they will have roamed over the species cften differ slightly in the relative lengths of all their parts importance to most species. But it will have been otherwise with

the nascent ginaffe, considering its probable habits of life; for thosyindividuals which had some one part or several parts of their bodies rather more cloughted than usual, would generally have survived. These will have intercrossed and left offspring, either inhering the same bodily peculiarities, or which a tendency to vary again in the same manner; whilst the individuals, less favoured in the same respects, will have been the meet liable to perish.

We here see that there is no need to separate single pairs, as man does, when he methodically improves a breed ratural selection will preserve and thus separate all the superior individuals, allowing them fresh to intervens, and will derive all the individuals, allowing data. By this preserve long-continued, which we may correspond orbits in a use in important manner with the individual effects of the increased use of parts, its seems to me almost certain that an ordinary heoled quadruped might be converted into a girthfic.

To this conclusion Mr. Miyart brings forward two objections One is that the increased size of the body would obviously requirean increased supply of food, and he considers it as "very problematical whether the disadvantages thence arising would not, in times of scarcity, more than counterbalance the advantages." But as the giraffe does actually exist in large numbers in S. Africa, and as some of the largest antelopes in the world, taller than an ox, abound mediate gradations could formerly have existed there, subjected as now to severe dearths. Assuredly the being able to reach, at each stage of increased size, to a supply of food, left untouched by the other hoofed quadrupeds of the country, would have been of some advantage to the nascent giraffe. Nor must we overlook the fact. that increased bulk would act as a protection against almost all neck .- and the taller the better, -- would, as Mr. Chauncey Wright has remarked, serve as a watch-tower. It is from this cause, as Sir S. Baker remarks, that no animal is more difficult to stalk than the giraffe. This animal also uses its long neck as a means of offence or defence, by violently swinging its head armed with stump-like horns. The preservation of each species can rarely be determined. by any one advantage, but by the union of all, great and small.

Mr. Mivart they asks (and this is his second objection), if natural selection he so potent and if high browsing be so great an advantage, why has not any other hooded quadruped acquired a long neck and lofty stature, besides the giraffs, and, in a lesser degree, the eanel, guanaco, and macrauchenia? Or a gain, why has not any

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number of the group acquired a long probasit: With wayeet to know which way memory inhibits by numerous here is of the pirafis, the answer is not difficult, and can best be given by an illustration. In every machow in Eighthy and in which trees grow, in the second second second second second second second the beauting of the hereas ere can be able to a second second the beauting of the hereas ere can be able to a second second by for instance, to hereas the observation of the second seco

Why, in other quarters of the world, various animals belonging to this same order have not acquired either an elongated neck or a proboscis, cannot be distinctly answered ; but it is as unreasonable to expect a distinct answer to such a question, as why some event in the history of mankind did not occur in one country, whilst it did in another. We are ignorant with respect to the conditions which determine the numbers and range of each species: and we cannot even conjecture what changes of structure would be favourable to its increase in some new country. We can, however, see in a general manner that various causes might have interfered with the development of a long neck or proboscia. To reach the foliage at a considerable height (without climbing, for which hoofed animals are singularly ill-constructed) implies greatly increased bulk of body; and we know that some areas support singularly few large quadrupeds, for instance S. America, though it is so luxuriant ; whilst S. Africa abounds with them to an unparalleled degree. Why this should be so, we do not know; nor why the later tertiary periods should have been much more favourable for their existence than the present time. Whatever the causes may have been, we can see that certain districts and times would have been much more favourable than others for the development of so large a quadruped as the giraffe.

In order that an animal should acquire some structure specially and harpy developed, it is almost indigenable that several other parts should be modified and with the increasing parts about a barys arguing the structure of the structure of the about a barys arguing the structure of the structure of the about a barys arguing the structure of the structure of the about a barys arguing the structure of the structu

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access special gar much more variable than others. Term if the infinitry variation di aries, it does not follow than straturel solection would be able to ade on them, and profices a structure which gap specially would be foundiate to the spectra of the spectra through descruction by beauts of proy.—by acternal or internal will be able to do ittics, or well be greatly restand or internal will be able to do ittics, or well be greatly restanded, in modifying the in a subset program, and the same fraverable conditions must long enzyme in order that any marked effect should thus be proceed. Except by sogning und gargent and verges reasons, we cannot explain why in many question of the work), holdid galapoint of the should be branched for the work. Modifying the branched for the weaks of the spectra of the strate of the source of the spectra of the spe

Objections of the same nature as the foregoing have been advanced by many writers. In each case various causes, besides the general ones just indicated, have probably interfered with the acquisition through natural selection of structures, which it is thought would be beneficial to certain species. One writer asks, why has not the ostrich acquired the power of flight? But a moment's reflection will show what an enormous supply of food would be necessary to the air. Oceanic islands are inhabited by bats and seals, but by no terrestrial mammals ; yet as some of these bats are peculiar species, they must have long inhabited their present homes. Therefore Sir C. Lyell asks, and assigns certain reasons in answer, why have not scals and bats given birth on such islands to forms fitted to into terrestrial carnivorous animals of considerable size, and bats into terrestrial insectivorous animals; for the former there would be no prey; for the bats ground-insects would serve as food, but these would already be largely preyed on by the reptiles or birds, which first colonise and abound on most oceanic islands. Gradations of structure, with each stage beneficial to a changing species, will be favoured only under certain peculiar conditions. A strictly terrestrial animal, by occasionally hunting for food in shallow water, then in streams or lakes, might at last be converted into an animal so thoroughly aquatic as to brave the open ocean. But seals would not find on oceanic islands the conditions favourable to their gradual reconversion into a terrestrial form. Bats, as formerly shown, probably acquired their wings by at first gliding through the air from tree to tree, like the so-called flying-squirrels,

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for the mixe of ensaming from their ensembles, or for avoiding fully in the whote the power of trans infight allow ones here acquired, it would invert be reconverted back, at least for the above prepresen, into their the maxel would be accounted by the start of the start completely lost, through finance, but in this case it would be completely lost, through finance, but in this case it would be completely lost, through finance, but in this case it would be accounted by the start of the start of the start of the complete with hirds or shire ground animals; and for who a charge at a terms in significant of the start of start of the start of the boxer maked memory to above that a transition of starter would easily charge in a transition path loss of the start of the start of the start starters in a transition path loss of the start of the start of the start starters in a transition path loss of the start of the start of the start starters in a transition path loss of the start of the start of the start starters in a transition path loss of the start of the s

Lastly, more than one write this asked, why have some animals that that mer mersion proceedings of the second second second development would be advantages to all? Why have not appendencing on the second second second second second second animals of the second seco

We will return to Mr. Mivart's other objections. Insects often resemble for the sake of protection various objects, such as green or decayed leaves, dead twigs, bits of lichen, flowers, spines, excrement of birds, and living insects ; but to this latter point I shall hereafter recur. The resemblance is often wonderfully close, and is not confined to colour, but extends to form, and even to the manner in which the insects hold themselves. The caterpillars which project motionless like dead twice from the bushes on which they feed, offer an excellent instance of a resemblance of this kind. The cases of the imitation of such objects as the excrement of birds, are rare and exceptional. On this head, Mr. Mivart remarks, "As, according to Mr. Darwin's theory, there is a constant tendency to indefinite variation, and as the minute incipient variations will be in all directions, they must tend to neutralize each other, and at first to form such unstable modifications that it is difficult, if not beginnings can ever build up a sufficiently appreciable resemblance to a leaf, hamboo, or other object, for Natural Selection to seize

But in all the foregoing cases the insects in their original state no doubt presented some rude and accidental resemblance to an object commonly found in the stations frequented by them. Nor is this at all improbable, considering the almost infinite number of surrounding objects and the diversity in form and colour of the hosts of insects which exist. As some rude resemblance is necessarv for the first start, we can understand how it is that the larger and higher animals do not (with the exception, as far as I know, of one fish) resemble for the sake of protection special objects, but only the surface which commonly surrounds them, and this chiefly in colour. Assuming that an insect originally happened to resemble in some degree a dead twig or a decayed leaf, and that it varied slightly in many ways, then all the variations which rendered the insect at all more like any such object, and thus favoured its escare, would be preserved, whilst other variations would be neglected and ultimately lost; or, if they rendered the insect at all less like the imitated object, they would be eliminated. There would indeed be force in Mr. Mivart's objection, if we were to attempt to account for the above resemblances, independently of natural selection. through mere fluctuating variability ; but as the case stands there

Nor can I see any force in Mr. Mivart's difficulty with respect to "the last touches of perfection in the mimicry;" as in the case given by Mr. Wallace, of a walking-stick insect (Ceroxylus laceratus), which resembles "a stick grown over by a creeping moss or jungermannia." So close was this resemblance, that a native Dyak maintained that the foliaceous excrescences were really moss. Insects are preyed on by birds and other enemies, whose sight is probably sharper than ours, and every grade in resemblance which aided an insect to escape notice or detection, would tend towards its preservation; and the more perfect the resemblance so much the better for the insect. Considering the nature of the differences between the species in the group which includes the above Ceroxylus, there is nothing improbable in this insect having varied in the irregularities on its surface, and in these having become more or less green-coloured ; for in every group the characters which differ in the several species are the most apt to vary, whilst the generic characters, or those common to all the species, are the most

The Greenland whale is one of the most wonderful animals in the world, and the baleen, or whale-bone, one of its greatest peculiarities. The baleen consists of a row, on each side, of the upper

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jace, of Jonet 300 plates or maxima, which stand close together transversity to be longer axis of the north. Within the main row there are some subsidiary rows. The atternuties and macer margins of all the plates are frequed in attiff translates, which elds the the whole gignatic plates, and serve to strain or stift the water, and thus o scence the mining rey on which theory pertainming a build. The middle and longest lamma in the Greenshard whole is tra, twelve, or even finem test in length, but in the different species of Glucasan these are graduations in length, the in the different species of Glucasan theore are graduations, and in the Bluenpeter rootstan only about miss in length. The quality of the whole-box also different in the different species.

With respect to the balacon, Mr. Mivast remarks that if the "halo core statistical stars has and deredposent as to be at all useful, then its preservation and augmentation within services. In this the beginning of a star hand of the stars of the stars of the beginning of a star hand of the stars of the stars of the baseline have possessed a month constructed something like the lancellined back of a disk? Though, the whales, which they diffuse handlined back of a disk? Though the whales, which the disk distribution of the stars stars of the stars of the stars of the stars of the stars in the stars of the stars of the stars of the stars in the stars of the stars of the stars of the stars of the stars in the stars of the stars of the stars of the sponses months

The back of a shore-list-chird (Spatial elypsata) is a more beam field and complex structures than the mouth of a whate. The upper manifolds is intrinsibled an askin also (in the specime scanning by the structure) of the structure of the biology breading as as to be printed, and plands transversely to the longer atts of the mouth. They arise from the palats, and are stability fourist the molding are the longert, being short concludion (e)g. At their base there is a short modeling to see of obliquely transverse humilies. In these several respects they resemble the state of the back they filter much, as they resemble the state of the back they filter much, as they resemble the state of the back they filter much, as they reject inversely, back much the state of the back they differ much, as they reject inversely through momentumly line table; is also en enco-schedensch of the

length of the head of a molecularly large Balancopter rotation, in which species the theorem is only mice index locary is of that if we were for make the head of the downline us long as that of the system to make the head of the downline rule in the species of which. The lower mandula of the absorbed results of the system of the lower module of the absorbed result of the species of which. The lower module of the absorbed result of the system of the system of the species of the species of the species of the lower large the species of the species of the species of the system of the species of the species of the species of the system of the species of the spec

Proon the highly developed structure of the showedlark' back we may proceed (at 1) share learnt from information and appendiants and fifthing is recovered. It thereaft the black of the Merganeta target and fifthing is recovered. It thereaft the black of the Merganeta target common close. In this latter species, the hauseline are much concetion in the showedler, and are firmly attached to the sides of the manifolds: they isre easily about 50 in multicer on easily index of the manifolds (it is the size of the size of the size of the size of the manifolds) is the size of the size of the size of the size of the manifolds (it is the size of the size of the size of the size of the manifolds) is the size of the lower manifolds are call for crashing fool. The object of the lower manifolds are call for the size of the lower manifolds are size of the developed than its the common is in the life are considerably by late developed than its the common size is the size of the

Turning to another group of the same family. In the Leggstangoes (Chambogy), the back doaly resumbles that of the cammon deak i but he handles are not so numerous, nor so disticuts frame and others not on they prejects so much investing is the high good, as 1 am infermed by Mr. E. Rattett, " muss its hill like a doalk by grows which it except the investment" is chick for doal, however, is grows which its expert that is shown in this into thick, the handles of the upper machine on poos. In this into thick, as one of the investment of the investment of the investsion control with that remaind handles. The object of the lower also covered with that remaind handles. The object of the lower

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mankible are serated with tenth much more prominent, coarser, and sharper than in the duck. The ecanomo good cose not sift the water, but uses its beak exclusively for tearing or cutting berbage, for which purpose it is so well fitted, that it can crop grass closer than almost any other animal. There are other species of greese, as I hear from Mr. Bartlett, in which the lamella are less developed than in the common goose.

We thus see that a member of the duck family, with a beir constructed like has of the common goon and shapted solvely for grading, or even a number with a back having less well-developed hashing, high the sourcested by multi-backgas has a species like hashing hashing the convertised by multi-backgas hashing and hashing hashing the like historic provided with a back almost calculated by the back, except the hooled thy, for stering or terring well fields. The backgas have backgas have backgas have well as the stering of the stering or terring to well be backgas have backgas have backgas have backgas have well as the stering of the stering or terring to well backgas difficult with gradient stering or terring stering for the which different proposed overlap live fish.

Returning to the whales. The Hyperoodon bidens is destitute of true teeth in an efficient condition, but its palate is roughened, according to Lacepède, with small, unequal, hard points of horn. There is, therefore, nothing improbable in supposing that some early Cetacean form was provided with similar points of horn on the palate, but rather more regularly placed, and which, like the knobs on the beak of the goose, aided it in seizing or tearing its food. If so, it will hardly be denied that the points might have been converted through variation and natural selection into lamellæ as welldeveloped as those of the Egyptian goose, in which case they would have been used both for seizing objects and for sifting the water : until they became as well constructed as those of the shoveller, in which case they would have served exclusively as a sifting apparatus. From this stage, in which the lamella would be two-thirds of the length of the plates of baleen in the Balænoptera rostrata, gradations, which may be observed in still-existing Cetaceans, lead us onwards to the enormous plates of baleen in the Greenland whale. Nor is there the least reason to doubt that each step in this scale might have been as serviceable to certain ancient Cetaceans, with the functions of the parts slowly changing during the progress of development, as are the gradations in the beaks of the different existing members of the duck-family. We should bear in mind that each species of duck is subjected to a severe

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struggle for existence, and that the structure of every part of its frame must be well adapted to its conditions of life.

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The Pleuronectidae, or Flat-fish, are remarkable for their asymmetrical bodies. They rest on one side,-in the greater number of species on the left, but in some on the right side ; and occasionally reversed adult specimens occur. The lower, or resting-surface, resembles at first sight the ventral surface of an ordinary fish : it is of a white colour, less developed in many ways than the upper side, with the lateral fins often of smaller size. But the eyes offer the most remarkable peculiarity; for they are both placed on the upper side of the head. During early youth, however, they stand opposite to each other, and the whole body is then symmetrical with both sides equally coloured. Soon the eye proper to the lower side begins to glide slowly round the head to the upper side ; but does not pass right through the skull, as was formerly thought to be the case. It is obvious that unless the lower eye did thus travel round, it could not be used by the fish whilst lying in its habitual position on one side. The lower eve would, also, have been liable to be abraded by the sandy bottom. That the Pleuronectidae are admirably adapted by their flattened and asymmetrical structure for their habits of life, is manifest from several species, such as soles, flounders, &c., being extremely common. The chief advantages thus gained seem to be protection from their enemies, and facility for feeding on the ground. The different members, however, of the family present, as Schiödte remarks, "a long series of forms exhibiting a gradual transition from Hippoglossus pinguis, which does not in any considerable degree alter the shape in which it leaves the ovum, to the soles, which are entirely thrown to one side."

Mr. Miver has taken up this care, and remarks that a sudder spontanous randomization in the position of the ages is hardly conceivable, in which I quite agree with him. He there adds : "if the transit was grandal, then how much transit of one eyes a minute fraction of the journey towards the other side of the head could benefit the induced in induced, for more elses. It seems, even, them the induced is induced, for more elses it is seem, even, there are an end of the induced section of the set of the objection in the excellent documentation much rather have been injuferencedtab, whild very young and still symmetry and the present θ statistics of possible sides of the head, cannot frame frame a vertical possible after a frame duce the basis graduations of and in size of their learnal frame, and to their basis, galaxing the

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wrimbladder. Hence scon growing tired, hery fall to the bottom one neide. While thus at rate they often twick, as Malm observed, the lower eye upwards, to see above them; and they append to this so vigraculty that the eye is presede laced against the upper part of the orbit. The forbands between the eyes comequently become, as could be playing one were presently contrasted depress the lower eye through an angular distance of alout seventy degrees.

We should remember that the skull at this early age is cartilaginous and flexible, so that it readily yields to muscular action. It is also known with the higher animals, even after early youth. that the skull yields and is altered in shape, if the skin or muscles be permanently contracted through disease or some accident. With long-cared rabbits, if one car lons forwards and downwards, its weight drags forward all the bones of the skull on the same side, of which I have given a figure. Malm states that the newly-hatched young of perches, salmon, and several other symmetrical fishes. have the habit of occasionally resting on one side at the bottom ; and he has observed that they often then strain their lower eves so as to look upwards; and their skulls are thus rendered rather crooked. These fishes, however, are soon able to hold themselves in a vertical position, and no permanent effect is thus produced. With the Pleuronectidae, on the other hand, the older they grow the more habitually they rest on one side, owing to the increasing flatness of their bodies, and a permanent effect is thus produced on the form of the head, and on the position of the eyes. Judging from analogy, the tendency to distortion would no doubt be increased through the principle of inheritance. Schiödte believes, in opposition to some other naturalists, that the Pleuronectidæ are not quite symmetrical even in the embryo: and if this be so, we could understand how it is that certain species, whilst young, habitually fall over and rest on the left side, and other species on the right side. Malm adds, in confirmation of the above view, that the adult Trachypterus arcticus, which is not a member of the Pleuronectidae, rests on its left side at the bottom, and swims diagonally through the water ; and in this fish, the two sides of the head are said to be somewhat dissimilar. Our great authority on Fishes, Dr. Günther, concludes his abstract of Malm's paper, by remarking that "the author gives a very simple explanation of the

We thus see that the first stages of the transit of the eye from one side of the head to the other, which Mr. Mivart considers would

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be injurious, may be attributed to the habit, no doubt beneficial to the individual and to the species, of endeavouring to look unwards with both eyes, whilst resting on one side at the bottom. We may also attribute to the inherited effects of use the fact of the mouth in several kinds of flat-fish being heat towards the lower surface, with the jaw bones stronger and more effective on this, the eveless side of the head, than on the other. for the sake, as Dr. Traquair supposes, of feeding with ease on the loned condition of the whole inferior half of the body, including the lateral fins : though Yarrell thinks that the reduced size of these fins is advantageous to the fish, as " there is so much less room for their action, than with the larger fins above." Perhaps the lesser number of teeth in the proportion of four to seven in the upper halves of the two jaws of the plaice, to twenty-five to thirty in the lower halves, may likewise be accounted for by disuse. From the colourless state of the ventral surface of most fishes and of many other animals, we may reasonably suppose that the absence of colour in flat-fish on the side, whether it be the right or left, which is undermost, is due to the exclusion of light. But it cannot be supposed that the peculiar speckled appearance of the upper some species, as recently shown by Pouchet, of changing their of bony tubercles on the upper side of the turbot, are due to the action of the light. Here natural selection has probably come into fishes, and many other peculiarities, to their habits of life. We effects of the increased use of parts, and perhaps of their disuse, will be strengthened by natural selection. For all spontaneous variations in the right direction will thus be preserved ; as will those individuals which inherit in the highest degree the effects of the increased and beneficial use of any part. How much to attribute in each particular case to the effects of use, and how much to natural

I may give another instance of a structure which apparently over its ergin exclusively to use or habit. The extremity of the tail in non-American molecys has been coverted in the avoiderfully perfect perhendle organ, and zerves as a fifth hand. A reviewer who agrees with K. Mivart in every detail, remarke on this structure: "I is impossible to helive that in any number of ages the first alght inclusive thendexy to gramp could perserve the hires of

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the individuals possessing it, or favour their chance of having and of maying offspring." But there is no necessity for any such helief. Habit, and this almost implies that some benefit great or small is thus derived, would in all probability suffice for the work. Brehm saw the young of an African monkey (Cercopithecus) clinging to the under surface of their mother by their hands, and at the same time they booked their little tails round that of their mother. Professor Henslow kent in confinement some harvest mice (Mus messorius) which do not possess a structurally prehensile tail . but he frequently observed that they curled their tails round the branches of a bush placed in the care, and thus aided themselves in climbing. I have received an analogous account from Dr. Günther, who has seen a mouse thus suspend itself. If the harvest mouse had been more strictly arboreal, it would perhaps have had its tail rendered structurally prehensile, as is the case with some members of the same order. Why Cerconitheous, considering its habits whilst young, has not become thus provided it would be difficult to say. It is, however, possible that the long tail of this monkey may be of more service to it as a balancing organ in making its prodigious leaps, than as a prehensile organ,

The mammary glands are common to the whole class of mammals and are indispensible for their existence; they must therefore, have been developed at an extremely remote period, and we can know nothing positively about their manner of development. Mr. Miyurt, asks : " Is it conceivable that the young of any animal was ever saved from destruction by accidentally sucking a drop of scarcely nutritious fluid from an accidentally hypertrophied cutaneons gland of its mother? And even if one was so what chance was there of the perpetuation of such a variation ?" But the case is not here put fairly. It is admitted by most evolutionists that mammals are descended from a marsunial form : and if so the mammary glands will have been at first developed within the marsupial sack. In the case of the fish (Hippocampus) the eggs are hatched, and the young are reared for a time, within a sack of this nature ; and an American naturalist, Mr. Lockwood, believes from what he has seen of the development of the young, that they are nourished by a secretion from the cutaneous glands of the sack. Now with the early progenitors of mammals, almost before they deserved to be thus designated, is it not at least possible that the young might have been similarly nonrished ? And in this case, the individuals which secreted a fluid, in some degree or manner the most nutritious, so as to partake of the nature of milk, would

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in the long run have reared a larger number of well-soutished of spring, than would be individuals which secreted a power fluid, and hus the extancous gland, which are the homologues of the memnary glands, would have been improved or rendered more effective. It accords with the widely extended principle of spreaditation, that the glands over a certain space of the sack thoush have become more highly developed than the remainder and tingy would be developed than the transmission and the space of the Grant Index of the mammalian spectra of the space though the Grant Index of the mammalian spectra of the space of the space of the spectra of the space of the space of the space theory is a spectra of the space of the space of the space of the Grant Index of the space of the spa

The development of the mammary glands would have been of no service, and could not have been effected through natural selection, unless the young at the same time were able to partake of the secretion. There is no greater difficulty in understanding how young mammals have instinctively learnt to suck the breast, than in understanding how unliatched chickens have learnt to break the egg-shell by tapping against it with their specially adapted beaks ; or how a few hours after leaving the shell they have learnt to pick up grains of food. In such cases the most probable solution seems to be, that the habit was at first acquired by practice at a more advanced age, and afterwards transmitted to the offspring at an earlier age. But the young kangaroo is said not to suck, only to cling to the nipple of its mother, who has the power of injecting milk into the mouth of her helpless, half-formed offspring. On this head Mr. Mivart remarks : "Did no special provision exist, the young one must infallibly be choked by the intrusion of the milk into the windpipe. But there is a special provision. The larynx is so clongated that it rises up into the posterior end of the nasal passage, and is thus enabled to give free entrance to the air for the lungs, while the milk passes harmlessly on each side of this elongated larynx, and so safely attains the gullet behind it." Mr. Mivart then asks how did natural selection remove in the adult kangaroo (and in most other mammals, on the assumption that they are descended from a marsupial form), " this at least perfectly innocent and harmless structure?" It may be suggested in answer that the voice, which is certainly of high importance to many animals, could hardly have been used with full force as long as the larynx entered the nasal passage ; and Professor Flower has suggested to me that this structure would have greatly interfered with an animal swallowing solid food.

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We will now turn for a short space to the lower divisions of the maintal kingdom. The Echicologenate (division of the section, s.e.), are furnished with remarkable ergsus, sulled poleitaris, which could be a section of the section of the section of the furnishing of the section of the secti

With respect to these organs, Mr. Mivart, as on so many previous occasions, asks : "What would be the utility of the first rudimentary beginnings of such structures, and how could such incipient buddings have ever preserved the life of a single Echinus ?" He adds, " not even the sudden development of the snapping action could have been beneficial without the freely moveable stalk, nor could the latter have been efficient without the snapping jaws, yet no minute merely indefinite variations could simultaneously evolve these complex co-ordinations of structure ; to deny this seems to do no less than to affirm a startling paradox." Paradoxical as this may appear to Mr. Mivart, tridactyle forcepses, immovably fixed at the base, but capable of a snapping action, certainly exist on some star-fishes; and this is intelligible if they serve, at least in part, as a means of defence. Mr. Agassiz, to whose great kindness I am indebted for much information on the subject, informs me that there are other star-fishes, in which one of the three arms of the forceps is reduced to a support for the other two; and again, other genera in which the third arm is completely lost. In Echinoneus, the shell is described by M. Perrier as bearing two kinds of pedicellariae, one resembling those of Echinus, and the other those of Spatangus; and such cases are always interesting as affording the means of apparently sudden transitions, through the abortion of one of the two states of an organ,

With respect to the steps by which these curious organs have been evolved, Mr. Agassiz infers from his even researches and those of Mulley, that both in star-shear and searching the polocilaries must unolutebly be looked at as molfied spinse. This may be inferred from their manner of development in the individual, as well as from a long and perfect series of gravitations in different species and genera, from simple gravules to ordinary spinse, to gravitational events when the policilation of the second second species and genera, from simple gravules to ordinary spinse, to

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the manner in which ordinary spines and the pedicellarise with their supporting calcareous rods are articulated to the shell. In certain genera of star-fishes. "the very combinations needed to show that the pedicellarize are only modified branching spines" may be found. Thus we have fixed spines, with three equi-distant. servated moveable branches articulated to near their bases ; and higher up, on the same spine, three other moveable branches Now when the latter arise from the summit of a spine they form in fact a rude tridactyle pedicellaria, and such may be seen on the same spine together with the three lower branches. In this case the identity in nature between the arms of the pedicellarize and the admitted that the ordinary spines serve as a protection ; and if so there can be no reason to doubt that those furnished with serrated and moveable branches likewise serve for the same purpose ; and they would thus serve still more effectively as soon as by meeting together they acted as a prehensile or snapping apparatus. Thus overy gradation, from an ordinary fixed spine to a fixed pedicellaria. would be of service.

In certain general of star-foldes these expans, instead of being fixed or berns on an immovable approxy, are placed on the mummi of a facilities and muscular, though short, stem ; and in this case they probably moves some additional function bealesis defense. In the security of the start of the start of the start of the beams articular to the shell, and it thus rendered moveshic. If with 1 and space here to give a fuller abstract of Mr. Agassifit furthering observations on the delevations of the polsicilation intervalue generations on the delevation of the delevation of the start of the start of the shell of the shell of the start the polsicilation of the delevation of the delevation of the collision of near-archias and the analysis of the Modulatine, also belonging to the aman great class.

Outsin compound minimally or prophytes as they have been trends, namely the Polytons, any provided with enrices argues called avientiaris. These different productions in the different speech. In their most prefet condition, second only resembling band and beak of a vulture in miniature, asseed could be able of or movement, as il likewise the lower pare maniferent. Here, and or movement, and with the lower species observed by me all the avientaria on the name iround draw moved simultaneously backwards and forwards, with the lower jaw widely cope, through an angle of about 50% in the course of two scondays and their movement caused the whole polynamy to two scondays and their movement caused the whole polynamy to

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tremble. When the jaws are touched with a needle they seize it so firmly that the branch can thus be shaken.

Mr. Mivart adduces this case, chiefly on account of the supposed difficulty of organs, namely the avicularia of the Polyzoa and the pedicellarize of the Echinodermata, which he considers as "essentially similar," having been developed through natural selection in widely distinct divisions of the animal kingdom. But, as far as structure is concerned. I can see no similarity between tridactyle pedicellarize and avicularia. The latter resemble somewhat more closely the chelæ or pincers of Crustaceans ; and Mr. Mivart might have adduced with equal appropriateness this resemblance as a special difficulty : or even their resemblance to the head and heak of a bird. The avicularia are believed by Mr. Busk, Dr. Smitt, and Dr. Nitsche-naturalists who have carefully studied this group-to be homologous with the zooids and their cells which compose the zoophyte : the moveable lip or lid of the cell corresponding with the lower and moveable mandible of the avicularium. Mr. Busk, however, does not know of any gradations now existing between a zooid and an avicularium. It is therefore impossible to conjecture by what serviceable gradations the one could have been converted into the other: but it by no means follows from this that such gradations have not existed.

As the chelles of Crustaceasus resemble in some degree the avientators of Dayas, both serving as phonese, it may be worth while to show that with the former a long merica of service-balle graditions of a limb third beam of the service of the service of the long resulting on the service of the service of the long of the service of the service of the service of the long of the service of the service of the service of the long of the service of the service of the service of the long of the service of the service of the service of the long of the service of the service of the service of the long of the service of the service of the service of the long of the service of the long of the service of the service of the service of the long of the long of the service of the service of the service of the long of the service we remindent hores and more perfect, until we have a late an intervwer remindent hores. As the service of t

Besides the avicularia, the Polyzon possess entions organs called vibreamia. These generally consists of fong privations, caraphile of movement and easily excited. In one species examined by me the vibracita were alightly curved and semated along the otter margin; and all of them on the same polyzoary often moved simultaneously; so that, acting like long oras, they avery at branch margilly

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areas the adjace-gias of ray microscope. When a branch was pixed on in face, the thremhol scheme enhangle, and they make violate differs to free themselver. They are supposed to sever as defence, and may be now, as Mr. Buck remarks, "to sweep shearly and ensembly over the adjacent bulkitants of the selfwide several scheme enhanced to the set of the selfwide remarks are periods." The availabilitation of the selfwide several of the textuality of the currents within reach of the textuality of the currents within reach of the textuality of the current severit by the currents within reach of the textuality of the module. Shows epides are also for with viscous halons.

It is not easy to imagine two objects more widely different in the head of a bird ; yet they are almost certainly homolozons and with its cell. Hence we can understand how it is that these organs graduate in some cases, as I am informed by Mr. Busk. into each other. Thus with the avicularia of several species of Lepralia, the moveable mandible is so much produced and is so like a bristle, that the presence of the upper or fixed beak alone serves to determine its avicularian nature. The vibracula may have been directly developed from the lins of the cells, without having passed through the avicularian stage ; but it seems more probable that they have passed through this stage, as during the early stages of the transformation, the other parts of the cell with the included zooid could hardly have disappeared at once. In many cases the vibracula have a grooved support at the base, which seems to represent the fixed beak ; though this support in some species is quite absent. This view of the development of the vibracula, if trustworthy, is interesting : for supposing that all the species provided with avicularia had become extinct, no one with the most vivid imagination would ever have thought that the vibracula had originally existed as part of an organ, resembling a bird's head or an irregular hay or hood. It is interesting to see two such widely different organs developed from a common origin ; and as the moveable lip of the cell serves as a protection to the zooid, there is no difficulty in believing that all the gradations, by which the lip became converted first into the lower mandible of an avicularium and then

In the vegetable kingdom Mr. Mivart only alludes to two cases,

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namely the structure of the flowers of orchids, and the movements of climbing plants. With respect to the former, he says, "the explanation of their origin is deemed thoroughly unsatisfactoryutterly insufficient to explain the incipient, infinitesimal beginnings of structures which are of utility only when they are considerably developed," As I have fully treated this subject in another work, I will here give only a few details on one alone of the most striking of extremely viscid matter. The pollinia are by this means transported by insects from one flower to the stigma of another. In some orchids there is no caudicle to the pollen-masses, and the grains are merely tied together by fine threads; but as these are not confined to orchids, they need not here be considered ; yet I may mention that at the base of the orchidaceous series, in Cypripedium, we can see how the threads were probably first developed. In other orchids the threads cohere at one end of the pollen-masses ; and this forms the first or nascent trace of a caudicle. That this is the origin of the caudicle, even when of considerable length and highly developed, we have good evidence in the aborted pollengrains which can sometimes be detected embedded within the central and solid parts.

With respect to the second chief peculiarity, namely the little mass of viscid matter attached to the end of the caudicle, a long series of gradations can be specified, each of plain service to the plant. In most flowers belonging to other orders the stigma secretes a little viscid matter. Now in certain orchids similar viscid matter is secreted, but in much larger quantities by one alone of the three stigmas; and this stigma, perhaps in consequence of the copious secretion, is rendered sterile. When an insect visits a flower of this kind, it rubs off some of the viscid matter and thus at the same time drags away some of the pollen-grains. From this simple condition, which differs but little from that of a multitude of common flowers, there are endless gradations,-to species in which the pollen-mass terminates in a very short, free caudicle,-to others in which the caudicle becomes firmly attached to the viscid matter, with the sterile stigma itself much modified. In this latter case we have a pollinium in its most highly developed and perfect condition. He who will carefully examine the flowers of orchids for himself will not deny the existence of the above series of gradations -from a mass of pollen-grains merely tied together by threads, with the stigma differing but little from that of an ordinary flower,

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to a highly complex pullition, admirably adapted for transport by innext, nor with the deep that all the graduators in the several species are admirably adapted in relation to the greenal structure of each flower for its relationation by different insects. In this, and in almost every other case, the enquiry may be pushed further backwords; and it may be asked low diff the stigmat of an outlingy flower lessons visid, but as we do not know the full initity of any flower lessons visid, but as we do not know the full initity of any flower lessons visid, but as we do not know the full initity of any species.

We will now turn to climbing plants. These can be arranged in a long series, from those which simply twine round a support, to those which I have called leaf-climbers, and to those provided with tendrils. In these two latter classes the stems have generally, but not always, lost the power of twining, though they retain the power from leaf-climbers to tendril-bearers are wonderfully close, and certain plants may be indifferently placed in either class. But in ascending the series from simple twiners to leaf-climbers, an important quality is added, namely sensitiveness to a touch, by which means the foot-stalks of the leaves or flowers, or these modified and converted into tendrils, are excited to bend round and clasp the touching object. He who will read my memoir on these plants will, I think, admit that all the many gradations in function and structure between simple twiners and tendril-bearers are in each case beneficial in a high degree to the species. For instance, it is clearly a great advantage to a twining plant to become a leafclimber; and it is probable that every twiner which possessed climber, if the foot-stalks had possessed in any slight degree the requisite sensitiveness to a touch.

As twining in the simplest means of ascending a support, and from such basis of our series, it may anturally be aiked how did plants acquire this power in an incipient degree, afterwark to be improved and increased through natural selection. The power of twining depends, firstly, on their scattarial selection. The solice actual table (but this is a character common to many plants which are not elimberty) and, secondly on their continuity bending to all dense. By this measurement is the to their increasion, in the same core. By this measurement is the solice in succession, in the same series of nonver round and rund. As soon as the longer part still goes on bending and revelving, and thus necessarily tripse still goes on bending and revelving neural theory measurement of the solice part of a dark at the support. The revelving measurement courses after CHAP. VII.

heory of Natural Selection.

the early growth of each shoot. As in many widely separated independently acquired it, and cannot have inherited it from a common progenitor. Hence I was led to predict that some slight tendency to a movement of this kind would be found to be far from uncommon with plants which did not climb; and that this had afforded the basis for natural selection to work on and improve. When I made this prediction, I knew of only one imperfect case, namely of the young flower-peduncles of a Maurandia which revolved slightly and irregularly, like the stems of twining plants, but without making any use of this habit. Soon afterwards Fritz Müller discovered that the young stems of an Alisma and of a Linum .- plants which do not climb and are widely separated in the natural system,-revolved plainly, though irregularly; and he states that he has reason to suspect that this occurs with some other plants. These slight movements appear to be of no service to the plants in question ; anyhow, they are not of the least use in the way of climbing, which is the point that concerns us. Nevertheless we can see that if the stems of these plants had been flexible, and if under the conditions to which they are exposed it had profited them to ascend to a height, then the habit of slightly and irregularly revolving might have been increased and utilised through natural selection, until they had become converted into well-developed twining species.

With respect to the sensitiveness of the foot-stalks of the leaves as in the case of the revolving movements of twining plants. As a vast number of species, belonging to widely distinct groups, are endowed with this kind of sensitiveness, it ought to be found in a nascent condition in many plants which have not become climbers. This is the case : I observed that the young flower-peduncles of the above Maurandia curved themselves a little towards the side which was touched. Morren found in several species of Oxalis that the leaves and their foot-stalks moved, especially after exposure to a hot sun, when they were gently and repeatedly touched, or when the plant was shaken. I repeated these observations on some other species of Oxalis with the same result ; in some of them the movement was distinct, but was best seen in the young leaves; in others it was extremely slight. It is a more important fact that according to the high authority of Hofmeister, the young shoots and leaves of all plants move after being shaken ; and with climbing plants it is, as we know, only during the early stages of growth that the foot-stalks and tendrils are sensitive.

It is scarcely possible that the above slight movements, due to obedience to various stimuli, powers of movement, which are of manifest importance to them ; for instance, towards and more rarely from the light,-in opposition to, and more rarely in the direction of, the attraction of gravity. When the nerves and muscles of an animal are excited by galvanism or by the absorption of strychnine. the consequent movements may be called an incidental result, for the nerves and muscles have not been rendered specially sensitive to these stimuli. So with plants it appears that, from having the power of movement in obedience to certain stimuli, they are excited in an incidental manner by a touch, or by being shaken. Hence there is no great difficulty in admitting that in the case of leafclimbers and tendril-bearers, it is this tendency which has been taken advantage of and increased through natural selection. It is, however, probable, from reasons which I have assigned in my already acquired the power of revolving, and had thus become

I have already endowneeds to explain how plants because trianges, mandy, by the increase of a stendary or adigit and irregular revelving movements, which were all first of no use to them; just details revel of the lower of moving, gained for other and hearfield represe. Wiester, during the gradual development of enhance plants and the lower of moving, gained for other and hearfield represe. Wiester, during the gradual development of enhance plants, and were also be associated by the line field of the start of the line of the line start of the

I have now considered enough, perhaps more than enough of the score, weleted with one by a skill materiality, to prove bata statum selection is freemyeten to account for the incipient stages of useful statuters and 1 wave shown, as 1 hower, but there is no grast the material status of the status of the status of the first status of the status with shared functions—an improve elitics with week. I will now briefly receptibate the foregoing case.

With the giraffe, the continued preservation of the individuals of some extinct high-reaching ruminant, which had the longest necks, legs, &c., and could browse a little above the average height, and

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the continued destruction of those which could not browse so high, would have sufficed for the production of this remarkable quadruped ; but the prolonged use of all the parts together with inherit-With the many insects which imitate various objects, there is no common object was in each case the foundation for the work of of slight variations which made the resemblance at all closer ; and this will have been carried on as long as the insect continued to vary, and as long as a more and more perfect resemblance led to its on the palate ; and it seems to be quite within the scope of natural selection to preserve all favourable variations, until the points were converted first into lamellated knobs or teeth, like those on the beak of a goose,-then into short lamellæ, like those of the domestic ducks,-and then into lamellæ, as perfect as those of the shovellerduck,-and finally into the gigantic plates of baleen, as in the mouth of the Greenland whale. In the family of the ducks, the lamellar are first used as teeth, then partly as teeth and partly as a sifting apparatus, and at last almost exclusively for this latter purpose,

With much structures as the above handlas of here, see which should be used as the structure of the origin of the set can judge, towards their devolution. On this can be made throughout of the lower good a fast-fash to the upper aids of immediate the structure of the structure of the structure of almost wholly the continued use, log-structure with inherinane. With sufficient of a marginal structure of the structure of the competence of the marginal structure of the structure of structure of the structure of the structure of the structure of structure of the structure of the structure of the structure of fastions in the utilization of the structure of the structure of fastions in the structure of structure of the structure of fastions in the utilization of structure of the structure and structure of the structure of structure of the structure structure of the structure of structure and structure of structure of structure of structure of structure and structure of structure of structure of structure of structure and the structure of struc r farerics. With the pollinia of exhibit, the threads which originally needs to its together the pollen-grains, can be traced obtaining time mainlest, and the steps can likewise be followed by which wisch instants, such as that accreted by the steps and contains flowers, and still subscring nearly but not quite the same purpose, becaus anaload to the free ends of the couldiest—all these gradificas being of manifest benefit to the plants in question. With respect togenings plants. I need not repeat what has been to lately as all.

It has often been asked, if natural selection be so potent, why has of the rast history of each species, and of the conditions which at the present day determine its numbers and range. In most cases only general reasons, but in some few cases special reasons, can be assigned. Thus to adapt a species to new habits of life, many cohave happened that the requisite parts did not vary in the right manner or to the right degree. Many species must have been which stood in no relation to certain structures, which we imagine to us advantageous to the species. In this case, as the struggle and long-enduring conditions, often of a peculiar nature, are necesbeneficial to a species, would have been gained under all circumstances through natural selection, is opposed to what we can understand of its manner of action. Mr. Mivart does not deny that "demonstrably insufficient" to account for the phenomena which I exnalin by its agency. His chief arguments have now been considered, and the others will hereafter be considered. They seem to me to partake little of the character of demonstration, and to have little weight in comparison with those in favour of the power of bound to add, that some of the facts and arguments here used by me, have been advanced for the same purpose in an able article lately published in the 'Medico-Chirurgical Review.'

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neory of Natural Selection.

At the present day almost all naturalists admit evolution under

some form. Mr. Mirart beisres that species change through 'one internal force or tennerge's about which it is not pretended that anything its known. That species have a capacity for change will be abstituted by all evolutionizity is threft one is no read, as it seems to mo, to invoke any internal force beyond the tandmeny to outinary variability, which should also donestic nose, and which through and species the simulation of the simulation will be simulated as a simulation of the simulation will be simulated as a simulation of the simulation

Mr. Miver is further instinct to believe, and some naturalises are with him, that new precise manipus themselves "with anddemness and by mollifactions appearing at ones." For instance, is supposed that the differences between the existic three-tood Hipparion and the hores areas endolmly. He thinks it difficult to their batt the wigg of a kind" was developed in any other way than by a comparatively molecular distribution in the same wise propertual kind", is a paparently by world action by home we implies grant benks or discontinuity in the action, appears to me invehals in the hindice degree.

Berry one who helieves in slow and grabul evolution, will obcorne admit that predict danges may have been as helped and as great as any single variation which we meet with under nation, when downstriken or cultivated that much their natural conditions, it is not probable that much great and herpet variations have often occurring and the dangest value of the mergesar dense of the second or the second second second second have the second second second second second second second striking the second second second second second second managest second second second second second second second managest second second second second second second second sector second sector second second second second second second second sector second second second second second second second sector second s

My reasons for doubting whether natural species have changed as abruptly as have occasionally domestic races, and for entirely disbelieving that they have changed in the wonderful manner

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indicated by Mr. Mivert, we a follow. According to our engations, haven and a transpir model variations occurs in our domaincated productions, singly and at rather long intervals of time. If who occurred under attace, they would be liable, as formely explained, to be lost by accidental excuss of destruction and by molecular dimension, and not it howers to be under demaining the second structure of the second structure of the second structure of the second structure of the second and separated by the care of man. Hence in order that a way species should anotherly adapted individual appared simultaneously within the same district. This difficulty as in the case of taneously within the same district. This difficulty as in the second taneously within the same district. This difficulty as in the second detection of a large number which varies that an explore the second which varies of new rates in any favourable dimension, and of the detection of a large number which varies that an explore manner.

That many species have been evolved in an extremely gradied manner, duce can havely be a doubt. The species and even the peters of many large natural families area to closely silicit together, the it is difficult to distinguish ost far or them. On very ensuthat it is difficult to distinguish the silicit of the second states of the second states of the second states of the second states are silicities of a contrain difficult contradicts we have reason to believe were formally connected. But it making these and the distinguist permits, 1 an computed to a distingt a continuum, and new many of their inhalting and the second states of the theory of the doubting states of the second states of the a continuum, and new many of their inhalting are being the second state of the doubting states in the second state of the second states of the species which have just passed away with the inheet manifest that minimize or if we compare the four doors many to other species that thill exits, of have lately existed r and it will havely be maintained that rank species have the spectra, when a negative scalar states are also being the of to distingt appears, that numerous and washed by high gives in the state of the species that reactive scalar structures.

Many large groups of facts are intelligible only on the principle that species have been revolved by very small steps. For instance, the fact that the species included in the larger genera are more cleasly related to each other, and present a greater number of varieties than do the species in this smaller genera. The former are also

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grouped in little clusters, like varieties round species; and they present other analogie with varieties, saw as shown in our second chapter. On this same principle we can understand how it is that specific characters are more variable than generic characters; and how the parts which are developed in an extraordinary degree or manner are more variable than other parts of the same species, Many analogous facts, all pointing in the same direction, could be aded.

Although very many species have almost certainly been produced by steps not greater than those separating fine varieties ; yet it may be maintained that some have been developed in a different and abrupt manner. Such an admission, however, ought not to be made without strong evidence being assigned. The vague and in some respects false analogies, as they have been shown to be by Mr. Chauncey Wright, which have been advanced in favour of this view, such as the sudden crystallisation of inorganic substances, or the falling of a facetted spheroid from one facet to another, hardly deserve consideration. One class of facts, however, namely, the sudden appearance of new and distinct forms of life in our geological formations supports at first sight the belief in abrupt development. But the value of this evidence depends entirely on the perfection of the geological record, in relation to periods remote in the history of the world. If the record is as fragmentary as many geologists strenuously assert, there is nothing strange in new forms appearing as if suddenly developed.

Unless we admit transformations as prodigious as those advocated by Mr. Mivart, such as the sudden development of the wings of birds or bats, or the sudden conversion of a Hipparion into a horse, hardly any light is thrown by the belief in abrupt modifications on the deficiency of connecting links in our geological formations. But against the belief in such abrupt changes, embryology enters a strong protest. It is notorious that the wings of birds and bats, and the legs of horses or other quadrupeds, are undistinguishable at an early embryonic period, and that they become differentiated by insensibly fine steps. Embryological resemblances of all kinds can be accounted for, as we shall hereafter see, by the progenitors of our existing species having varied after early youth, and having transmitted their newly acquired characters to their offspring, at a corresponding age. The embryo is thus left almost unaffected, and serves as a record of the past condition of the species. Hence it is that existing species during the early stages of their development so often resemble ancient and extinct forms belonging to the

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blances, and indeed on any view, it is incredible that an animal should have undergone such momentous and abrupt transformtions, as these above indicated; and yet should not bear trace in its embryonic condition of any suddem modification; every detail in its structure being developed by insensibly fine steps.

The wine balances that areas ansient form was transformed actideny through an internal force or transformed parts formalised with wings, will be almost compelled to assume, in oppotion to all analogy, that many ionic algorithm of the second transformed parts and the second parts of the second parts that are associated with the second parts of the second transformed parts and the second parts of the second parts and the second parts and the second parts of t

Instinct.

CHAPTER VIII.

INSTINCT.

Initiates comparable with habits, but different in their origin - Instincts graduated - Aphide and ants - Instincts variable - Domostic instincts, ther origin - Skuturi Instincts of the cerkoo, moledame, entry of the set of the set of the set of the set of the making instinct - Change of limitst and structure on to essentiarly simultaneous-Difficulties of the theory of the Natural Solucion of initiates - Neutron of States - Soumary.

Maxy institucts are so wenderful that their development will probably appear to the reader a difficulty sufficient to overthrow my whole theory. I may here premise, that I have nothing to do with the origin of the mential powers, any more than I have with that of life itself. We are encomend only with the diversities of instinct and of the other mential factories in azimals of the same class.

I will not stempt any definition of matrice. It would be eary to show that several dimits metal actions are commonly one-head by this term ; but every one minimum and the several several and has intuintic implicit the events to margine and to hype the eggs dimens to enable as to perform, when performed by an animal, more equivally by a very symmetry experiment of the several formation of the several several several several sever

Prederick Cavier and several of the older hostaphysicians have compared institute with habit. This comparison gives (1 think are accurate notion of the frame of mind under which an institutive action is performed, but not necessarily of its origin. How moonactionary many labitual actions are performed, indeed not rarely fur additionary of the second second second second second of the pit he wire not compared and path the second second other habits, with certain periods of time, and states of the body Mess core acquired, hey often remain constant throughts that its prosent second second

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Several code points of resemblance between institutes and lattice scales be pointed on A is in repeating in weil-bown samp, so in indication of the samp, or in repeating a weil-bown samp, so in points of the samp or in repeating anything by mole, here generally focus 0 points to recover the individual facility is A. There from it is war with a notrepilar, which makes a very onor plated harmonic, if or 16 he toots a scalar point of the sample in a harmonic complexity may be a start stage of construction, and parts in a harmonic complexity may be a start stage of construction, and parts in a harmonic complexity may be a start stage of construction, and parts in a harmonic complexity may be a start and any one complexity of the forwards, a sate-rpillar were taken out of a harmonic market may for for indexes, to be possible from this is ware nucles embrandly done for it, for forwards, and the possible from this is ware nucles embrandly and and firs often to complete the harmonic, seemed forced to start from and first the complete the harmonic start of the totic to complete the almoder finited work.

If we suppose any habitual action to become inherited—and is and a barbow that this does nontimes happen—them the resumbiance between what originally was a habit and an innitical boxone so clean and to be dimingnished. If Moarxi, instead of playing the planofers at there years old with wooderfully little pretices of the player at two results and the might truly be said to have done so inductively. But it would be a series error to be determined on the series and the series of the series

It will be universally admitted that instincts are as important a composal structures for the wolfare of each probes, mole its grean conditions of life. Under changed conditions of life, it is at lass possible that alights modifications of intrinst might be peoffshile to a species and if it can be aboven that instincts do vary ever so and sufficient of the second structure of instinct or any exterior complex and wonders in the second structure of the second or complex and wonders in the second structure of the second or complex and wonders of the second structure of the second or complex and wonders of the second structure of the second of complex and wonders of the second structure arise from, and are ginitated. As modifications of a second structure arise from, and are ginitated as the model structure of the bar second structure are in the second structure are second with instincts. Bet I believe that the effects of the last are in many second each of second structure of the second second second structure and second structure are second structures of the second second second second structure are second second second second second second second structure are second second

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Instanct.

of what may be called spontaneous variations of instincts ;--that is of variations produced by the same unknown causes which produce slight deviations of bodily structure.

No complex instinct can possibly be produced through natural slight, yet profitable, variations. Hence, as in the case of corporeal structures, we ought to find in nature, not the actual transitional gradations by which each complex instinct has been acquired-for these could be found only in the lineal ancestors of each speciesbut we ought to find in the collateral lines of descent some evidence of such gradations; or we ought at least to be able to show that I have been surprised to find, making allowance for the instincts of animals having been but little observed except in Europe and North America, and for no instinct being known amongst extinct species, how very generally gradations, leading to the most complex instincts. can be discovered. Changes of instinct may sometimes be facilitated by the same species having different instincts at different periods of life, or at different seasons of the year, or when placed under different circumstances, &c.; in which case either the one or the other instinct might be preserved by natural selection. And such instances of diversity of instinct in the same species can be shown to occur in nature.

Again, as in the case of corporeal structure, and conformably to my theory, the instinct of each species is good for itself, but has never, as far as we can judge, been produced for the exclusive good of others. One of the strongest instances of an animal apparently acquainted, is that of aphides voluntarily yielding, as was first observed by Huber, their sweet excretion to ants : that they do so voluntarily, the following facts show. I removed all the ants from a group of about a dozen aphides on a dock-plant, and prevented their attendance during several hours. After this interval, I felt sure that the aphides would want to excrete. I watched them for some time through a lens, but not one excreted ; I then tickled and stroked them with a hair in the same manner, as well as I could, as the ants do with their antenna; but not one excreted. Afterwards I allowed an ant to visit them, and it immediately seemed, by its eager way of running about, to be well aware what a rich flock it had discovered ; it then began to play with its antennae on the abdomen first of one aphis and then of another; and each, as soon as it felt the antennæ, immediately lifted up its abdomen and excreted a limpid drop of sweet juice, which was eagerly devoured

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by the same. From the quite young aphilos bahaved in this manner, howing that the action was institutives, and not the result of experiments. It is certain, from the observations of Huber, that the philos show no disk to be note it. If the latter be note a presenthey are at last compatible to phet their exceeded. But as the exceeded in a structure work is philosophic travelation of exampsing atomic prevents in philosophic travelation for exampsing atomic prevents of the same structure of the context and the present structure of the same structure of the context and the prevent structure of the same structure of the prevents of the same scent has a structure of the same structure of the prevent system at trains to the shelly structure of states optimized at the same structure of the same structure of the species. So again certain institute scenar we composite has an our colloresonic the trave its here magnet over.

As some degree of variation in instincts under a state of nature. and the inheritance of such variations, are indispensable for the action of natural selection, as many instances as possible ought to he given : but want of space prevents me. I can only assert that instincts certainly do vary-for instance, the migratory instinct, both in extent and direction, and in its total loss. So it is with the mests of birds, which vary partly in dependence on the situations chosen, and on the nature and temperature of the country inhabited. but often from causes wholly unknown to us: Auduban has given species in the northern and southern United States. Why, it has been asked, if instinct he variable, has it not granted to the her "the ability to use some other material when wax was deficient "? But what other natural material could bees use? They will work. as I have seen, with wax hardened with vermilion or softened with lard. Andrew Knight observed that his bees, instead of laboriously collecting propolis, used a cement of wax and turpentine, with which he had covered decorticated trees. It has lately been very different substance, namely catmeal. Fear of any narticular enemy is certainly an instinctive quality, as may be seen in nestling fear of the same enemy in other animals. The fear of man is slowly inhabit desert islands; and we see an instance of this even in by man. We may safely attribute the greater wildness of our farge birds to this cause ; for in uninhabited islands large birds are

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hanges of Habit or Instinct.

not more fearful than small ; and the magpie, so wary in England, is tame in Norway, as is the hooded crow in Egypt.

That the mental qualities of animals of the same kind, horn in a state of nature, yary much, could be shown by many facts. Several cases could also be addressed of consistant and strange holts in wild animals, which, if advantageous to the species, might have given rise, through natural selection, to new instinct, Bet I mu will ware that these guaranties direct on the reacher's mind. I can only repeat my assenses, that I do not speak without good evidence.

Inherited Changes of Habit or Instinct in Domesticated Animals.

The possibility, or even probability, of inherited variations of ing a few cases under domestication. We shall thus be enabled to see the part which habit and the selection of so-called spontaneous variations have played in modifying the mental qualities of our domestic animals. It is notorious how much domestic animals vary in their mental qualities. With cats, for instance, one naturally takes to catching rats, and another mice, and these tendencies are known to be inherited. One cat, according to Mr. St. John, always brought home game-birds, another hares or rabbits, and another hunted on marshy ground and almost nightly caught woodcocks or snipes. A number of curious and authentic instances could be the oddest tricks, associated with certain frames of mind or periods of time, being inherited. But let us look to the familiar case of the breeds of the dog : it cannot be doubted that young pointers (I back other dogs the very first time that they are taken out; tendency to run round, instead of at, a flock of sheep, by shepherddogs. I cannot see that these actions, performed without experience by the young, and in nearly the same manner by each individual, performed with eager delight by each breed, and without the end being known-for the young pointer can no more know that he points to aid his master, than the white butterfly knows why she lays her eggs on the leaf of the cabbage-I cannot see that these actions differ essentially from true instincts. If we were to behold one kind of wolf, when young and without any training, as soon as it scented its prey, stand motionless like a statue, and then slowly

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Changes of Habit or Instinct

crawl forward with a psculiar gait; and another kind of weld runhing round, instead of at, a herd of doer, and driving them to a distant point, we should assuredly call these actions institucite. Domestic institucies, as they may be called, are certainly far less fixed than natural institucies, but they have been acted on by far less rigorous selection, and have been transmitted for an incomparably aborter preide conditions of life.

Here strongly these domestic institutes, holds, and dispositions are indirected, and low certorically the beams minipal, it will be a simulation of the strength of the strength of the strength of that a cross with a build-og has affected for many generations that may generate the strength of the strength of the strength of the strength on a whole family of almpheted-lengs at strength or a strength of the strength of the strength of the strength of the strength on a strength of the strength binneal together, and for a long period exhibit strenge of the institugend strength of the strength of the strength of the strength of the granulation was a well, and this dog showed a streng of the strength matter, when called.

have become inherited solely from long-continued and compulsory habit ; but this is not true. No one would ever have thought of teaching, or probably could have taught, the tumbler-pigeon to tumble,-an action which, as I have witnessed, is performed by young birds, that have never seen a pigeon tumble. We may believe that some one pigeon showed a slight tendency to this strange habit, and that the long-continued selection of the best individuals in successive generations made tumblers what they now are; and near Glasgow there are house-tumblers, as I hear from Mr. Brent, which cannot fly eighteen inches high without going head over heels. It may be doubted whether any one would have shown a tendency in this line; and this is known occasionally to happen, as I once saw, in a pure terrier : the act of pointing is probably, as many have thought, only the exaggerated pause of an animal preparing to spring on its prey. When the first tendency effects of compulsory training in each successive generation would soon complete the work ; and unconscious selection is still in progress, as each man tries to procure, without intending to improve the breed, dogs which stand and hunt best. On the other hand, habit alone in some cases has sufficed ; hardly any animal is more

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difficult to tame than the young of the wild mbbit; scarcely any animal is tamer than the young of the tame rabbit; but I can hardly suppose that domstir nabits have often been selected for immenses alone; so that we must attribute at least the greater part of the inherited change from extreme wildness to extreme tameness, to hakit and long-continued close confinement.

Natural instincts are lost under domestication : a remarkable Familiarity alone prevents our seeing how largely and how permanently the minds of our domestic animals have been modified. It is scarcely possible to doubt that the love of man has become instinctive in the dog. All wolves, foxes, jackals, and species of the cat genus, when kept tame, are most eager to attack poultry. sheep, and pigs; and this tendency has been found incurable in as Tierra del Fuego and Australia, where the savages do not keen these domestic animals. How rarely, on the other hand, do our civilised dogs, even when quite young, require to be taught not to attack poultry, sheep, and pigs! No doubt they occasionally do make an attack, and are then beaten ; and if not cured, they are destroyed; so that habit and some degree of selection have probably concurred in civilising by inheritance our dogs. On the other hand, young chickens have lost, wholly by habit, that fear of for I am informed by Captain Hutton that the young chickens of the parent-stock, the Gallus bankiva, when reared in India under a hen, are at first excessively wild. So it is with young pheasants reared in England under a hen. It is not that chickens have lost all fear, but fear only of dogs and cats, for if the hen gives the danger-chuckle, they will run (more especially young turkeys) from under her, and conceal themselves in the surrounding grass or thickets; and this is evidently done for the instinctive purpose of But this instinct retained by our chickens has become useless under domestication, for the mother-hen has almost lost by disuse the power of flight.

Hence, we may conclude, that under domestication instincts have been acquired, and natural instincts have been lost, partly by habit, and 'partly by man selecting and accumulating, during successive generations, peculiar mental habits and actions, which at first appared from what we must in our ignorance call an accident. In some cases compalsory habit alone has sufficed to produce inhe-

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rited mental changes; in other cases compulsory habit has done nothing, and all has been the result of selection, pursued both methodically and unconsciously: but in most cases habit and selection have probably concurred.

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We shall, periogs, but understand how institutes in a state of anions have bacener molifield by election, by considering a few cases. I will select only three,—annely, the institute which leads the enclose to be precised to other third nests, its devocusion institute of certain anis; and the cell-making power of the inversion. These two latter institutes have generally and justy been ranked by naturalists as the most worderful of all known institutes.

Instincts of the Cuckoo .- It is supposed by some naturalists that the more immediate cause of the instinct of the cuckoo is, that she lays her eggs, not daily, but at intervals of two or three days; so that, if she were to make her own nest and sit on her own erzs. there would be eggs and young birds of different ages in the same nest. If this were the case, the process of laving and hatching might be inconveniently long, more especially as she migrates at a very early period; and the first hatched young would probably have to be fed by the male alone. But the American cuckoo is in this predicament ; for she makes her own nest, and has eggs and young successively hatched, all at the same time. It has been both with a young jay in the nest of a Blue jay (Garrulus cristatus); and as both were nearly fully feathered, there could be no mistake birds' nests. Now let us suppose that the ancient progenitor of our she occasionally laid an egg in another bird's nest. If the old bird carlier or through any other cause ; or if the young were made more vigorous by advantage being taken of the mistaken instinct of another species than when reared by their own mother, encumbered as she could hardly fail to be by having eggs and young of different ages at the same time; then the old birds or the fostered young would gain an advantage. And analogy would lead us to

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Instincts of the Cuckoo.

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balance, that the young thus raread would be net to follow by inheriance the consolution and aleverant halo det their models, and in their turns would be apt to ing their eggs in other bind' nests, and the series of the case of the series of the series of the series of the series of millistic evidence, by Adolf Milley that the enclose cosmionally hyp he regues on the bars ground, sits on them, and fossile by some describant handles of the series of the series of the series of the describant heat of the series of the series of the size of the series of the series of the series of the series of the size of the series of the series of the series of the series of the size of the series of the series of the series of the series of the size of the series of the series of the series of the series of the size of the series of the series of the series of the series of the size of the series of the series of the series of the size of the series of the size of the series of the series of the series of the size of the series of the series of the size of the series of th

and adaptations of structure in the cuckoo, which are spoken of as had no facts to guide us. Until recently the instincts of the European and of the non-parasitic American cuckoo alone were known : now, owing to Mr. Ramsay's observations, we have learnt something about three Australian species, which lay their eggs in other birds" pests. The chief points to be referred to are three : first, that the common cuckoo, with rare exceptions, lays only one egg in a nest, so that the large and voracious young bird receives ample food. Secondly, that the ergs are remarkably small, not exceeding those of the skylark .-- a bird about one-fourth as large as the cuckoo, That the small size of the ezg is a real case of adaptation we may infer from the fact of the non-parasitic American cuckoo laving full-sized eggs. Thirdly, that the young cuckoo, soon after birth, has the instinct, the strength, and a properly shaped back for ejecting its foster-brothers, which then perish from cold and hunger. This has been boldly called a beneficent arrangement, in order that may perish before they had acquired much feeling !

Turning now to the Australian species; though these birth generlary by early one gain a neight, its our most for full row ond even three apps in the same near. In, the Borne enclose the ega vary below of main straints in the species of the species of the than there now lake, no as to have decived certain faster-period (see it is suscered in this projects of have had engue even smaller than there now lake, no as to have decived certain faster-period (see it is suscered in that there is a relation between the size of eggs or particular the species of the species of the species of the between given of the intenshato), hence has a indicately in between the size of eggs and the species of the species of would have had annalier and smaller eggs (for these would have some merging hashed) and reased). Mc Ramay remarks that

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two of the Australian excisos when they by the engr in a copunet, mainfeat a dealed preference for mission containing eggs similar in colour to their own. The European species apprently mainfeat modes are only a similar barriant, but not work deputs induces and the Halps-mathew with height premission bars are only have been added to those which if it is summed number deputs on exciso investigating displayed the absorbed matter of the second second second second second second second vary, according to ML Earnays to an extraormation dissection might have second and finding any advantageous variation, in the second se

In the case of the European cuckoo, the offspring of the fosterparents are commonly ejected from the nest within three days after the cuckoo is hatched ; and as the latter at this age is in a most helpless condition, Mr. Gould was formerly inclined to believe that the act of ejection was performed by the foster-parents themselves. But he has now received a trustworthy account of a young cuckoo which was actually seen, whilst still blind and not able even to hold up its own head, in the act of ejecting its foster-brothers. One of these was replaced in the nest by the observer, and was again thrown out. With respect to the means by which this strange and odious instinct was acquired, if it were of great importance for the young cuckoo, as is probably the case, to receive as much food as possible soon after birth, I can see no special difficulty in its having the strength, and structure necessary for the work of ejection ; for those young cuckoos which had such habits and structure best developed would be the most securely reared. The first step towards the acquisition of the proper instinct might have been mere uninadvanced in age and strength ; the habit having been afterwards improved, and transmitted to an earlier age. I can see no more difficulty in this, than in the unhatched young of other birds acyoung snakes acquiring in their upper jaws, as Owen has remarked, a transitory sharp tooth for cutting through the tough egg-shell. For if each part is liable to individual variations at all ages, and the variations tend to be inherited at a corresponding or earlier age,propositions which cannot be disputed,-then the instincts and

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Instincts of the Molothrus.

Some species of Molothrus, a widely distinct genus of American birds, allied to our starlings, have parasitic habits like those of the fection of their instincts. The sexes of Molothrus badius are stated by an excellent observer. Mr. Hudson, sometimes to live promisbird, occasionally throwing out the nestlings of the stranger. They either lay their eggs in the nest thus appropriated, or oddly enough their own eggs and rear their own young; but Mr. Hudson says the young of this species following old birds of a distinct kind and clamouring to be fed by them. The parasitic habits of another species of Molothrus, the M. bonariensis, are much more highly developed than those of the last, but are still far from perfect, This bird, as far as it is known, invariably lays its eggs in the nests of strangers; but it is remarkable that several together sometimes commence to build an irregular untidy nest of their own, placed in singularly ill-adapted situations, as on the leaves of a large thistle. They never, however, as far as Mr. Hudson has ascertained, complete a nest for themselves. They often lay so many eggs-from fifteen to twenty-in the same foster-nest. that few or none can possibly be hatched. They have, moreover, the extraordinary habit of pecking holes in the eggs, whether of their own species or of their foster-parents, which they find in the appropriated nests. They drop also many eggs on the bare ground, which are thus wasted. A third species, the M, pecoris of North America, has acquired instincts as perfect as those of the cuckoo, for it never lays more than one egg in a foster-nest, so that the young bird is securely reared. Mr. Hudson is a strong disbeliever in evolution, but he appears to have been so much struck by the imperfect instincts of the Molothrus bonariensis that he quotes my words, and asks, " Must we consider these habits, not as especially endowed or created instincts, but as small consequences of one general law, namely, transition ?"

Various binks, as has already been remarked, occasionally by their eggs in the nexts of other binds. This labit is not very uncommon with the Galiimacee, and throws some light on the singular instant of the ostrich. In this family several hen-binds units and by first a few eggs in one nest and then in another; and these are hatched by the males. This instinct may probably be accounted for by the fact of the bens laying a large number of eggs.

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but, as with the cuckoo, at intervals of two or three days. The instituct, however, of the American estrich, as in the case of the Molothrus boariemis, has not as yotb been perfected; if or a surprising number of eggs lie strewed over the plains, so that in one days hunning 1 picked up no less than twenty low tand wasted eggs.

Mary been are parentle, and regularly hey their equit in the near of coher hind of the set. This case is now remarkable than that of the euckosy for these been have not only had their institute loss for they do not possion of they had attered up food for their sequences are associated with their parallel halang parallel parallel and they had attered up food for their easy parameters and M. Faber had attered by food for their easy and stores it with paralysis and they had attered up food for their easy and stores it with paralysis parallel makes it soon there and stores it with paralysis parallel makes it soon there and stores it with paralysis parallel makes it soon there and stores it with paralysis parallel makes it soon there are so end different and the the speeds, and if the inner where an see no different parallel parallel parallel parallel permanent, if of arranges to the precise, and if the inner where matatol.

Some-making isolated.—This remarkable initiate was first discovered in the Formis (Polyrege) without Poly in the Source and the Polyre Hours of the Source and Source and Source and Source and Source Hours and Source and Source and Source and Source and Source formation to no work of any kind, and the worksner or interlife finalistic hough most energiest and couragence in a capturing also shows do other work. They are incepable of making their own mest, cell formalise in the source of the source and the source and the physical source and the source of the source and the source of the physical source of the source of the source of the source of the physical source of the source of the source of the source of the physical source of the source of the source of the source of the physical source of the dia nothing they could not even field have (Li faces), and her instantly wet to work, field and avoid the survivers in all not have one theoled the here and pay to the source of the source of the source of any other starses unitaries on the source of the

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Another species, Formica sanguinea, was likewise first discovered by P. Huber to be a slave-making ant. This species is found in to by Mr. F. Smith, of the British Museum, to whom I am much indebted for information on this and other subjects. Although tions which I made, in some little detail. I opened fourteen nests of F, sanguinea, and found a few slaves in all. Males and fertile females of the slave species (F. fusca) are found only in their own proper communities, and have never been observed in the nests of F, sanguines. The slaves are black and not above half the size of their red masters, so that the contrast in their appearance is great. When the nest is slightly disturbed, the slaves occasionally nest ; when the nest is much disturbed, and the larvæ and pune are exposed, the slaves work energetically together with their masters in carrying them away to a place of safety. Hence, it is clear, that the slaves feel quite at home. During the months of several nests in Surrey and Sussex, and never saw a slave either leave or enter a nest. As, during these months, the slaves are very few in number, I thought that they might behave differently when more numerous; but Mr. Smith informs me that he has watched the nests at various hours during May, June, and August, both in Surrey and Hampshire, and has never seen the slaves, though present in large numbers in August, either leave or enter the nest. Hence he considers them as strictly household slaves. The masters, the nest, and food of all kinds. During the year 1860, however, large stock of slaves, and I observed a few slaves mingled with their masters leaving the nest, and marching along the same road masters and slaves in the two countries, probably depends merely

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on the slaves being captured in greater numbers in Switzerland than in England.

One adj. I formally witnessel a migration of P, samplines from on not to nother, and it was a most interesting protectie to build the masters carefully carying that always in, that journ at the master carefully carying that always in the protection of build end of the same of P remines and another buy my risks ame upor, and evidently not in search of local Levy approach and were vigroundy repulsed by an independent community of the sitz-organized (F, fixed), ionwriters as many as three of beam and the same of the same of the same P_{12} remains the same option of the same of the same of distant, but they were repercised from guilding any pupe to rear at always. It found and put then down on a lawer spin ten fixed pikes of commands, they were requiry units at any may of the same of pikes of commands. The same proves the same of the pupe of P_1 fixed pikes of commany the same provide same pikes of commands of the pikes of commands. The same provide same pikes of the same of the pikes of commands, they were requiry units and they have been frequencies of pikes of commands. The same pikes of commands of the same of the pikes of commands of the same pikes of commands of the same barry of the fike the commands.

At the same time I hold on the same place a small parel of the pape of another papers, R, frace, will be for of these little puller ants attill eliging to the fragments of their next. This registes is the same start of the same start of the same start of the paper start of the same start of the same start of the same paper start of the same start of the same start of R from miler a some branch is next of the size smaller R same starts of the same start of the size start of R same starts of the same start of the size start of R same starts of the same start of the size start of R starts and it was a start of the size start of R starts and starts of R starts which for platinuity make into also steep, from part of R starts, which for platinuity make into also steep, from and it was evident that they did as which they can across R. Finally, whereas they were much terrified when they can along R. finally, whereas they were much terrified when they can along the paper, or even is early from the mask R. How, and quildly little yellow rate host careful as were the start and the start of the starts of the paper, R. The same start from the mask R for hear and quildly little yellow rate host careful as were they real start of the paper, R. The same start from the mask R for hear and emitted of the paper.

One evening I visited another community of F, sanguinea, and found a number of these anis returning home and entering their nests, carrying the dead bodies of F. fusca (showing that it was not a migration) and numerous pupe. I traced a long file of anis

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heathnood with body, for about forty yands lack, to a very thickdemong of analysis. The second se

Such are the facts, though they did not need confirmation by me. in regard to the wonderful instinct of making slaves. Let it be observed what a contrast the instinctive habits of F, sanguinea present with those of the continental F. rufescens. The latter does not build its own nest, does not determine its own migrations, does not collect food for itself or its young, and cannot even feed itself ; it is absolutely dependent on its numerous slaves. Formica sanguinea, on the other hand, possesses much fewer slaves, and in the early part of the summer extremely few; the masters determine when and where a new nest shall be formed, and when they migrate, the masters carry the slaves. Both in Switzerland and England the slaves seem to have the exclusive care of the larve. and the masters alone go on slave-making expeditions. In Switzerland the slaves and masters work together, making and bringing materials for the nest; both, but chiefly the slaves, tend, and milk, as it may be called, their aphides; and thus both collect food for the community. In England the masters alone usually leave the nest to collect building materials and food for themselves, their slaves and larvae. So that the masters in this country receive much less service from their slaves than they do in Switzerland.

By what steps the institute of Z, sanguines originated will not primit to conjecture. But as nati, which are not alwey-makers will, as I have seen, array of the papes of other speeds. If scattered both the start is the start of the start is the start of the formation of the start of the speeds with the start of the start of the start of the speeds with the start of the start o

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the instinct-always supposing each modification to be of use to the species-until an ant was formed as abjectly dependent on its elarge as is the Fermica rufescens.

Child-making instands of the Hine-Rote-al' will not have enter on minuth details on this milleck, but will meerly give an outline of the conclusions at which I have arrived. He must be a dull may adapted to the enquirist structure of a cowh, so beautifully adapted to the enquirist structure of a work, so beautifully adapted to the enquiriest structure of the structure of the conclusion of the structure would find it very difficult to make call of ward of the true form, though this is added by a crowel of bear working in a dark hive inconcervise when the gave correctly made. But the boundity work can be shown, I think, to follow from a few simple indicator.

I was lot to investigate this subject by Mir Waterlongs, who has have hat the form of the cell stands in close relation to the presence of adjusting easily and the following view may pellaps, the stands of the stands of the stands of the stands of the the stands of the stands of the stands of the stands of the not reveal to a her method of work. At one and a short select wave have humble-been, which use their docesson its hold heavy, sometimes adding to them short tubes of wax, and likewise making of the starts wave have the cell of the starts of the start of the starts wave have the cell of the humble-base of a single start present of the start wave the cell of the humble have easily at larger and the start wave humble the start of the starts wave adjusting cells on the expection size. In the starts here we have adjusting cells on the expection size. In the starts here we have adjusting cells on the expection size in the starts here we have adjusting cells on the expection size. In the starts here we have an humble-bey has more as in structure between the hives and humble-bey has more an early in structure cells, in which the would cells on the structure in the structure of the larger hyperse Histor, and humble-bey has more an early in structure cells in the structure of the structure of the structure of the cells of the starts of the structure of the structu

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are hatched, and, in addition, some large cells of wax for holding honey. These latter cells are nearly spherical and of nearly equal sizes, and are aggregated into an irregular mass. But the important point to notice is, that these cells are always made at that degree of nearness to each other that they would have intersected or broken into each other if the spheres had been completed; but this is never permitted, the bees building perfectly flat walls of wax between the spheres which thus tend to intersect. Hence, each cell consists of an outer spherical portion, and of two, three, or more flat surfaces, according as the cell adjoins two, three, or more other cells. When one cell rests on three other cells, which, from the spheres being nearly of the same size, is very frequently and necessarily the case, the three flat surfaces are united into a pyramid : tation of the three-sided pyramidal base of the cell of the hive-bee. As in the cells of the hive-bee, so here, the three plane surfaces in any one cell necessarily enter into the construction of three adjoining cells. It is obvious that the Melipona saves wax, and what is more important, labour, by this manner of building ; for the flat walls between the adjoining cells are not double, but are of the same thickness as the outer spherical portions, and yet each flat portion forms a part of two cells.

Reflecting on this case, it occurred to me that if the Melipuon had make its spheres at some given distance from each other, and had make them of orpal sizes and had arranged them symmetrically in a double layer, the resulting structure would have been as perfect as the comb of the hive-bee. Accordingly I wrote to Professor Miller, of Cambridge, and this geometer has kindly read over the following statement, drawn up from his information, and tells me that is it strictly correct \rightarrow

If a number of equal phases be described with their centers placed in two parallel layers, with the center of each phase at the distance of the second layers, which have been of each optical center distance of the second layers of the second layers of the distance of the second layers of the second layers of the distance of the second layers in the second layers in the second layers in the second layers in the short layers be formed, measurements there are also second layers of the second layer grant layers in the second layers of the second layer layers of the second layers of the second layer of the second layers of the layer layer layer layer layers of the second layer layers of the layer layer layer layers and layers of the second layer layers of the second layers of the second layer layers of the layer layer layers of the second layers of the second layers of the layers of the second layers of the second layers of the layer layers of the second layers of the second layers of the layers of the layers of the layers of the second layers of the layers of the layers of the layer layers of the layers of t

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workmanship of the bee has been greatly exaggerated; so much so, that whatever the typical form of the cell may be, it is rarely, if ever, realised.

Hence we may safely conclude that, if we could slightly modify the instincts already possessed by the Melipona, and in themselves not very wonderful, this bee would make a structure as wonderfully perfect as that of the hive-bee. We must suppose the Melipona to have the power of forming her cells truly spherical, and of equal does so to a certain extent, and seeing what perfectly cylindrical burrows many insects make in wood, apparently by turning round on a fixed point. We must suppose the Melipona to arrange her cells in level layers, as she already does her cylindrical cells; and we must further suppose, and this is the greatest difficulty, that she can somehow judge accurately at what distance to stand from her fellow-labourers when several are making their spheres; but she is already so far enabled to judge of distance, that she always describes her spheres so as to intersect to a certain extent; and then she unites the points of intersection by perfectly flat surfaces. By wonderful,-hardly more wonderful than those which guide a bird to make its nest,-I believe that the hive-bee has acquired, through natural selection, her inimitable architectural powers,

But this theory can be tested by experiment. Following the example of Mr. Tegetmeier, I separated two combs, and put between them a long, thick, rectangular strip of wax : the bees instantly began to excavate minute circular pits in it; and as they deepened these little pits, they made them wider and wider until they were converted into shallow basins, appearing to the eye perfectly true or narts of a sphere, and of about the diameter of a cell. It was most interesting to observe that, wherever several bees had begun to excavate these basins near together, they had begun their work at such a distance from each other, that by the time the basins had cell), and were in depth about one sixth of the diameter of the sphere of which they formed a part, the rims of the basins intersected or broke into each other. As soon as this occurred, the bees ceased to excavate, and began to build up flat walls of wax on the lines of intersection between the basins, so that each hexagonal prism was built upon the scalloped edge of a smooth basin, instead of on the straight edges of a three-sided pyramid as in the case of ordinary cells.

I then put into the hive, instead of a thick, rectangular piece of

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The bres instantly began on both sides to excavate little basins near to each other, in the same way as before ; but the ridge of wax vated to the same depth as in the former experiment, would have broken into each other from the opposite sides. The bees, however, did not suffer this to happen, and they stopped their excavations in due time; so that the basins, as soon as they had been a little deepened, came to have flat bases ; and these flat bases, formed by thin little plates of the vermilion wax left ungnawed, were situated. as far as the eye could judge, exactly along the planes of imaginary intersection between the basins on the opposite sides of the ridge of wax. In some parts, only small portions, in other parts, large portions of a rhombic plate were thus left between the opposed basins, but the work, from the unnatural state of things, had not been neatly performed. The bees must have worked at very nearly the same rate in circularly gnawing away and deepening the basins on both sides of the ridge of vermilion wax, in order to have thus succeeded in leaving flat plates between the basins, by stopping work at the planes of intersection.

Considering how flexible thin wax is, I do not see that there is any difficulty in the bees, whilst at work on the two sides of a strip of wax, perceiving when they have gnawed the wax away to the proper thinness, and then stopping their work. In ordinary combs it has appeared to me that the bees do not always succeed in working at exactly the same rate from the opposite sides; for I have noticed half-completed rhombs at the base of a just-commenced cell. which were slightly concave on one side, where I suppose that the bees had excavated too quickly, and convex on the opposed side where the bees had worked less quickly. In one well marked instance, I put the comb back into the hive, and allowed the bees to go on working for a short time, and again examined the cell, and I found that the rhombic plate had been completed, and had become perfectly flat : it was absolutely impossible, from the extreme thinness of the little plate, that they could have effected this by gnawing away the convex side; and I suspect that the bees in such cases stand on opposite sides and push and bend the ductile and warm wax (which as I have tried is easily done) into its proper inter-

From the experiment of the ridge of vermillon wax we can see that if the bees were to build for themselves a thin wall of wax, they could make their cells of the proper shape, by standing at the proper distance from each other, by excervating at the same rate,

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and by underwaring to make equal spherical holicow, but area; aboving the sphere to beack into each other. Now bees, as may be clearly seen by examining the edge of a growing could, do make a regul, eicentification will be related to a growing encoded partup drawp on a start of the sphere encoded growing a start of the sphere encoded and the sphere encoded growing and the sphere encoded and the sphere encoded the sphere commonds. How one could as the same time, but only this commonds. How one could as the same time, but only this one should go at the sphere encoded and they never complete her upper edges of the rizonike plates, whill the brangenal walks are commonds. How one of these startments of the first sphere encoded the plate plate of the sphere. Lower of the sphere encoded the plate plate of the sphere encoded of the sphere encoded with any theory.

Huber's statement, that the very first cell is excavated out of a little parallel-sided wall of wax, is not, as far as I have seen, strictly of wax ; but I will not here enter on details. We see how important a part excavation plays in the construction of the cells; but it would be a great error to suppose that the bees cannot build up a of intersection between two adjoining spheres. I have several specimens showing clearly that they can do this. Even in the rude wax has in every case to be finished off, by being largely gnawed away on both sides. The manner in which the bees build is which will ultimately be left. We shall understand how they and then to begin cutting it away equally on both sides near the cement on the summit of the ridge. We shall thus have a thin wall steadily growing upward but always crowned by a gigantic coping. From all the cells, both those just commenced and those completed, being thus crowned by a strong coping of wax, the bees can cluster and crawl over the comb without injuring the delicate hexagonal walls. These walls, as Professor Miller has kindly ascertained for me, vary greatly in thickness; being, on an average of twelve measurements made near the border of the comb, also of an
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inch in thickness; whereas the basal rhomboldal plates are thicker, nearly in the proportion of three to two, having a mean thickness, from twenty-one measurements of $\frac{1}{24}$ of an inch. By the above singular manner of building, strength is continually given to the comb, with the utmost utilized economy of wax.

It seems at first to add to the difficulty of understanding how bee after working a short time at one cell going to another, so that, as Huber has stated, a score of individuals work even at the commencement of the first cell. I was able practically to show this fact, by covering the edges of the hexagonal walls of a single cell, or the extreme margin of the circumferential rim of a growing comb, with an extremely thin layer of melted vermilion wax : and I invariably found that the colour was most delicately diffused by the bees-as delicately as a painter could have done it with his brush -by atoms of the coloured wax having been taken from the spot on which it had been placed, and worked into the growing edges of the cells all round. The work of construction seems to be a sort of balance struck between many bees, all instinctively standing at the same relative distance from each other, all trying to sweep equal spheres, and then building up, or leaving ungnawed, the planes of intersection between these spheres. It was really curious to note in cases of difficulty, as when two pieces of comb met at an angle, how often the bees would pull down and rebuild in different ways the same cell, sometimes recurring to a shape which they had at

When bees have a place on which they can stand in their proper positions for working,-for instance, on a slip of wood, placed directly under the middle of a comb growing downwards, so that the comb has to be built over one face of the slip-in this case the bees can lay the foundations of one wall of a new hexagon, in its strictly proper place, projecting beyond the other completed cells. It suffices that the bees should be enabled to stand at their proper relative distances from each other and from the walls of the last completed cells, and then, by striking imaginary spheres, they can build up a wall intermediate between two adjoining spheres ; but, as far as I have seen, they never gnaw away and finish off the angles of a cell till a large part both of that cell and of the adjoining cells has been built. This capacity in bees of laying down under certain circumstances a rough wall in its proper place between two just-commenced cells, is important, as it bears on a fact, which scems at first subversive of the foregoing theory ; namely, that the cells on the extreme margin of wasp-combs are sometimes strictly

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hexagonal; but I have not space here to enter on this subject. Nor does there seem to me any great difficulty in a single inacet (as in the case of a queen-wasp) making hexagonal cells, if she were to work alternately on the inside and outside of two or three cells commenced at the same time, always standing at the proper relative distance from the parts of the cells just begun, sweeping spheres or eviladers, and building up intermediate planes.

modifications of structure or instinct, each profitable to the individual under its conditions of life, it may reasonably be asked, how all tending towards the present perfect plan of construction, could is not difficult ; cells constructed like those of the bee or the warn gain in strength, and save much in labour and space, and in the materials of which they are constructed. With respect to the formation of wax, it is known that bees are often hard pressed to get sufficient nectar, and I am informed by Mr. Tegetmeier that it has been experimentally proved that from twelve to fifteen pounds of dry sugar are consumed by a hive of bees for the secretion of a pound of wax ; so that a prodigious quantity of fluid nectar must be collected and consumed by the bees in a hive for the secretion of the wax necessary for the construction of their combs. Moreover, many bees have to remain idle for many days during the process of secretion. A large store of honey is indispensable to support a large stock of bees during the winter ; and the security being supported. Hence the saving of wax by largely saving honey ant element of success to any family of bees. Of course the success of the species may be dependent on the number of its enemies, or parasites, or on quite distinct causes, and so be altogether independent of the quantity of honey which the bees can collect. But let us suppose that this latter circumstance determined, as it probably often has determined, whether a bee allied to our humblebees could exist in large numbers in any country ; and let us further suppose that the community lived through the winter, and consequently required a store of honey : there can in this case be no doubt that it would be an advantage to our imaginary humblehes if a slight modification in her instincts led her to make her waxen cells near together, so as to intersect a little; for a wall in common even to two adjoining cells would save some little labour and wax. Hence it would continually be more and more advan-

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Cell-making Instinct.

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Ingroot nor humble-bess, if they were to make their cells more an inner regular, marrer together, and acceptrated into a mass, like the cells of the Mulpona, i for in this case a large part of the more margin much inform and ware would be aveed. Again, from the sense casus, it would be advantageous the Mulpona, if she were to make her cells: closer together, and more regular the very way than a typesset, if chem, as we have seen, the spherical antifests would wholly disappear, and be replaced by these senders, and the proper disard sector of the sphere set of the sector of the largend like starse of prefetcion in marking the sector and sector and scheduler in ecconsisting block and a we can see, in a shedright prefet in ecconsisting block and and war as the sec-

Thus, as I believe, the most wonderful of all known instincts. that of the hive-bee, can be explained by natural selection having taken advantage of numerous, successive, slight modifications of simpler instincts : natural selection having, by slow degrees, more and more perfectly led the bees to sweep equal spheres at a given distance from each other in a double layer, and to build up and excavate the wax along the planes of intersection : the bees, of course, no more knowing that they swent their spheres at one particular distance from each other, than they know what are the several angles of the hexagonal prisms and of the basal rhombic plates ; the motive power of the process of natural selection having been the construction of cells of due strength and of the proper size and shape for the larve, this being effected with the greatest possible economy of labour and wax ; that individual swarm which thus made the best cells with least labour, and least waste of honey in the secretion of wax, having succeeded best, and having transmitted their newly-acquired economical instincts to new swarms, which in their turn will have had the best chance of succeeding in

Objections to the Theory of Natural Selection as applied to Instincts : Neuter and Sterile Insects.

It has been objected to the foregoing view of the origin of institutes that "the variations of structures and of institutes turned have been simultaneous and accurately adjusted to each other, as a modification in the case without an immediate corresponding change in the other would have been fatal." The force of this objection rests entirely on the samption that the changes in the institute and structure are a lærgel. To take as an illustration the case of the larger timoses (trans major) adjusted to in a previous chapter τ

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Objections to the Theory

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this bird often holds the seeds of the yew between its feet on a were better and better adapted to break open the seeds, until a beak was formed, as well constructed for this purpose as that of the nuthatch, at the same time that habit, or compulsion, or spontaneous variations of taste, led the bird to become more and more of a seed-eater ? In this case the beak is supposed to be slowly modified by natural selection, subsequently to, but in accordance with, slowly changing habits or taste; but let the feet of the titmouse vary and grow larger from correlation with the beak, or from any other unknown cause, and it is not improbable that such larger feet would lead the bird to climb more and more until it acquired the remarkable climbing instinct and power of the nuthatch. In this case a gradual change of structure is supposed to lead to changed instinctive habits. To take one more case: few instincts are more remarkable than that which leads the swift of the Eastern Islands to make its nest wholly of inspissated saliva. saliva ; and one of the swifts of North America makes its nest (as I have seen) of sticks agglutinated with saliva, and even with flakes other materials, and to make its nest exclusively of inspissated saliva? And so in other cases. It must, however, be admitted that in many instances we cannot conjecture whether it was instinct

No doubt many instinct of very difficult explanation could propose to the theory of matual selection—cases, in which we can one see how an instinct could have originately cases, in which we instantiat gradients are known to exist; cases of instinct of instinut the selection is cased in a second hardly have been acted by matual selection; cases of instinct, that we cannot account for their similarity by inheritance from a common progenitor, and a non-account of the selection of the selection of the second second second second second second second for their similarity by inheritance from a common progenitor, and eases, but will confine and. I will not here enter on these second eases, but will confine and. I will not here enter on these second appared to no incompany, and accounts in innect communities. I allow to the generator section form in innitot and in a structure

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from both the males and fertile females, and yet, from being sterile, they cannot propagate their kind.

The subject well deserves to be discussed at great length, but I will here take only a single case, that of working or sterile ants. How the workers have been rendered sterile is a difficulty ; but not much greater than that of any other striking modification of strucanimals in a state of nature occasionally become sterile; and if such insects had been social, and it had been profitable to the community that a number should have been annually born capable of work, but incapable of procreation, I can see no especial difficulty in this having been effected through natural selection. But I must pass over this preliminary difficulty. The great difficulty lies in the working ants differing widely from both the males and the fertile females in structure, as in the shape of the thorax, and in being destitute of wings and sometimes of eyes, and in instinct. As far as instinct alone is concerned, the wonderful difference in this respect between the workers and the perfect females, would have been better exemplified by the hive-bee. If a working ant or other neuter insect had been an ordinary animal, I should have unhesitatingly assumed that all its characters had been slowly acquired through natural selection ; namely, by individuals having been born with slight profitable modifications, which were inherited by the offspring ; and that these again varied and again were selected, and so onwards. But with the working ant we have an insect differing greatly from its parents, yet absolutely sterile; so that it could never have transmitted successively acquired modifications of structure or instinct to its progeny. It may well be asked how is it possible to reconcile this case with the theory of natural

First, let l is remembered that we have immumely instances, of all order domains productions and in these is a state of nature, of all order diffusions of inheritation of the secondard of the state of diffusions of the state of the secondard halo of the state of the state of the state of the state representation of the state of the state of the state of the representation of the state of the state of the state of the representation of the state of the state of the state of the representation of the state state of the shared becomes periadic with the state of the state of the state of the shared becomes periadic with the state of the state of the state of the state of the shared becomes periadic of the state of

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members of insect-communities : the difficulty lies in understanding, how such correlated modifications of structure could have been slowly accumulated by natural selection.

This difficulty, though appearing insuperable, is lessened, or, as I believe, disappears, when it is remembered that selection may be applied to the family, as well as to the individual, and may thus be well marbled together : an animal thus characterised has been slaughtered, but the breeder has gone with confidence to the same stock and has succeeded. Such faith may be placed in the power of selection, that a breed of cattle, always yielding oxen with extraordinarily long horns, could, it is probable, be formed by carefully oxen with the longest horns; and yet no one ox would ever have propagated its kind. Here is a better and real illustration : according to M. Verlot, some varieties of the double annual Stock from having been long and carefully selected to the right degree, always produce a large proportion of seedlings bearing double and quite sterile flowers; but they likewise yield some single and fertile plants. These latter, by which alone the variety can be propagated, may be compared with the fertile male and female ants, and the double sterile plants with the neuters of the same community. As with the varieties of the stock, so with social insects, selection has been applied to the family, and not to the individual, for the sake of gaining a serviceable end. Hence we may conclude that slight modifications of structure or of instinct, correlated with the sterile condition of certain members of the community, have proved advantageous : consequently the fertile males and females have flourished, and transmitted to their fertile offspring a tendency to produce sterile members with the same modifications. This process must have been repeated many times, until that prodigious amount of difference between the fertile and sterile females of the same species has been produced, which we see in many social insects.

But we have not a yet tombed on the elimax of the difficurt production of the start of the start of the start of the from the fertile females and ranks, but from each other, sometimes to an almost incredible degree, and as start model with our or even to a start of the start of the start of the start of the start into each other, but are preference of the start barry and alistic from each other as now yive species of the start barry and start of the each other as one yive species of an intraction start outling and solid metric, which are an intraction start waveling and solid metric, which are an intraction start contending the start of the start

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different: in Cryptocems, the workers of one casts alone carry a wonderful set of abids on their backs, the use of which is quite unknewn: in the Mexican Myrmecceystax, the workers of one casts, and they have an ecoromously developed abdomes which exceeds as set of hours, supplying the place of that eccerted by the aphidis, or the domestic cuttle as they may be called, which our European and supprised and alignments.

It will indeed be thought that I have an overweening confidence in the principle of natural selection, when I do not admit that such wonderful and well-established facts at once annihilate the theory. In the simpler case of neuter insects all of one caste, which, as I believe, have been rendered different from the fertile males and females through natural selection, we may conclude from the analogy of ordinary variations, that the successive, slight, profitable modifications did not first arise in all the neuters in the same nest, but in some few alone; and that by the survival of the communities with females which produced most neuters having the advantageous modification, all the neuters ultimately came to be thus characterised. According to this view we ought occasionally to find in the same nest neuter insects, presenting gradations of structure ; and this we do find, even not rarely, considering how few neuter insects out of Europe have been carefully examined. Mr. F. Smith has shown that the neuters of several British ants differ surprisingly from each other in size and sometimes in colour ; and that the extreme forms can be linked together by individuals taken out of the same nest; I have myself compared perfect gradations of this kind. It sometimes happens that the larger or the smaller sized workers are the most numerous; or that both large and small are numerous, whilst those of an intermediate size are scanty in numbers. Formica flava has larger and smaller workers, with some few of intermediate size ; and, in this species, as Mr. F. Smith has observed, the larger workers have simple eyes (ocelli), which though small can be plainly distinguished, whereas the smaller workers have their ocelli rudimentary. Having carefully dissected several specimens of these workers. I can affirm that the eyes are far more rudimentary in the smaller workers than can be accounted for merely by their proportionally lesser size ; and I fully believe, though I dare not assert so positively, that the workers of intermediate size have their ocelli in an exactly intermediate condition. So that here we have two bodies of sterile workers in the same nest, differing not only in size, but in their organs of vision, yet connected by some few members in an inter-

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mediate condition. I may digress by adding that if the smaller workers had been the most useful to the community, and these makes and females had been continually selected, which produced to the smaller state of the smaller workers, until all the workers ware in this condition; we should then have had a species of any whineutres in nearly the same condition as those of Myrnias. For the workers of Myrniac have not even ruliments of coeffi, though the male and female ants of this genus have well-developed coeffi.

I may give one other case : so confidently did I expect occasionally to find gradations of important structures between the different castes of neuters in the same species, that I gladly availed myself of Mr. F. Smith's offer of numerous specimens from the same nest of the driver ant (Anomma) of West Africa. The reader will perhaps best appreciate the amount of difference in these workers by my giving not the actual measurements, but a strictly accurate illustration : the difference was the same as if we were to see a set of workmen building a house, of whom many were five feet four inches high, and many sixteen feet high ; but we must in addition suppose that the larger workmen had heads four instead of three times as big as those of the smaller men, and jaws nearly five times as big. The jaws, moreover, of the working ants of the number of the teeth. But the important fact for us is, that, though the workers can be grouped into castes of different sizes, yet they graduate insensibly into each other, as does the widelydifferent structure of their jaws. I speak confidently on this latter point, as Sir J. Lubbock made drawings for me, with the the several sizes. Mr. Bates, in his interesting 'Naturalist on the Amazons,' has described analogous cases.

With these fields before mo, I believe that material addetion, by atting on the first matter or parents, could herm a species which about regularly produce metters, all of large size with one form of pays, or all of mail size with which different jays, or halfy, and this is the climax of different jays, or halfy, and this is the climax of different jays, which is a differentian, and initializationally another sit of workses of a difference, as in the extent i -m graduated series having first beam formals, and the parents which generated them, util more with an intermediate statem were produced.

An analogous explanation has been given by Mr. Wallace, of the equally complex case, of certain Malavan Butterflies regularly

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appearing under two or even three distinct female forms; and by Fritz Müller, of certain Brazilian crustaceans likewise appearing under two widely distinct male forms. But this subject need not here be discussed.

I have now explained how, as I believe, the wonderful fact of two distinctly defined castes of sterile workers existing in the same nest, both widely different from each other and from their parents, has originated. We can see how useful their production may have been to a social community of ants, on the same principle that the division of labour is useful to civilised man. Ants, however, work by inherited instincts and by inherited organs or tools, whilst man works by acquired knowledge and manufactured instruments. But I must confess, that, with all my faith in natural selection, I should never have anticipated that this principle could have been efficient in so high a degree, had not the case of these neuter insects led me to this conclusion. I have, therefore, discussed this case, at some little but wholly insufficient length, in order to show the power of natural selection, and likewise because this is by far the most serious special difficulty which my theory has encountered. The case, also, is very interesting, as it proves that with animals, as with plants, any amount of monification may be effected by the accumulation of numerous, slight, spontaneous variations, which are in any way profitable, without exercise or habit having been brought into play. For peculiar habits confined to the workers or sterile females, however long they might be followed, could not possibly affect the males and fertile females, which alone leave descendants. I am surprised that no one has hitherto advanced this demonstrative case of neuter insects, against the well-known doctrine of inherited habit, as advanced by Lamarck.

Summary.

I have endeavoured in this chapter briefly to show that the methal qualities of or densitic animality very, and that the variations are inherited. Still more hiefly I have attempted to show the instants very singlicity in a state of natures. No ease will disinitiate the strength of the state of the state of the state of institution with a second state of the state of the state of institution which are in any way useful. In many cases halts or naturel selections probably coses into play. I do not preted are not found as the probably coses into play. I do not preted any theory is the state is the state of the state of the state way theory is the state it. On the order made, the fact that institution the state is the state is the state of the state of the state of the state of the state is the state of the state

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are not aveys absolutely prefect and are liable to minicates — but no instituct can be aboven to have been produced for the good of other animals, though animals take advantage of the institucts of others — that the cason in natural history, of "Mattin zone facination," is applicable to functions as well as to corporal structure, and is plainly explicable on the forceoing views, but is otherwise inexplicable—all tend to corroberate the theory of natural selection.

This theory is also strengthened by some few other facts in regard to instincts; as by that common case of closely allied, but distinct, species, when inhabiting distant parts of the world and living under considerably different conditions of life, yet often retaining nearly the same instincts. For instance, we can understand, on the principle of inheritance, how it is that the thrush of tropical South America lines its nest with mud, in the same neceliar manner as does our British thrush ; how it is that the Hornbills of Africa and India have the same extraordinary instinct of plastering up and imprisoning the females in a hole in a tree, with only a small hole left in the plaster through which the males feed them and their young when hatched ; how it is that the male wrens like the males of our Kitty-wrens,-a habit wholly unlike that of any other known bird. Finally, it may not be a logical deduction, instincts as the young cuckoo ejecting its foster-brothers,-ants making slaves,-the larvæ of ichneumonidæ feeding within the live bodies of caterpillars,-not as specially endowed or created instincts, but as small consequences of one general law leading to the advancement of all organic beings,-namely, multiply, vary, let the strongest live and the weakest die

Hybridism.

CHAPTER IX.

HYBRIDISM.

Diduktion between the sterility of first eroses and of hybrids—Statistic particles in degrees, on universal, allocity of loss interbending, semerci by domenication—Loss generating the sterility of lysics and the sterility of lysics and the sterility of lysics and scattering between the sterility of lysics and sterility of lysics and scattering between the sterility of first eroses and of hybrids—Furthline between the sterility of first eroses and of hybrids—Furthline between the sterility of first eroses and of hybrids—Furthline between the sterility of first first hybrid eroses and of their subgreat displays and Furthling of version waves, eroses and of the sterility of the first hybrid eroses and the sterility of the sterility of the first hybrid eroses and the sterility of hybrid eroses and the sterility of hybrids eroses and the sterility of the sterility of hybrid eroses and the sterility of hybrid eroses

The view commonly entertained by naturalities in that species, when intervensed, have been peckally condersed with tertuility, in order to prevent their conflution. This view certainly seems at first highly distinct had they been employed for entry of the starting of the distinct had they been employed for entry persons. The unily expect when first encodes, and that of their hybrid offerpring, cannot have been equipied, as 1 shall show by the preservation of enployed with microscopic starts of the top terms of the personlation of the start of the person of the person of the person of the difference in the preparation between the persons of the person-persons.

In treating this subject, two classes of facts, to a large extent fundamentally different, have generally been confounded; namely, the storility of species when first crossed, and the sterility of the hybrids produced from them.

Thus pipels have of course their ergnan of reproduction in a perfect condition, you when interverse of the produce either for or nooffspring. Byleids, on the solar hand, have their reproductive the male eitherm in the hold pairs and minimal; though the demansitive organs themselves are perfect in structure, as for as the microscope reproduction of the solar pairs and minimal; though the demansitive organs themselves are perfect in structure, as for as the microscope of the solar solar structure, as for as the microscope of the solar developed, or are intel; in the scenario and they are different at all developed, or are intel; in the scenario and they are indire to a stal developed, or are intel; in the scenario and the developed of the scenario and developed of the scenario and the scenario and the scenario and developed of the scenario and developed and the scenario and developed and the scenario and developed and the scenario and the

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two cases, has to be considered. The distinction probably has been siurred over, owing to the sterility in both cases being looked on as a special endowment, beyond the province of our reasoning powers.

The fertility of varieties, that is of the forms known or believed to be descended from common parents, when crossed, and likewise the fertility of their mongrel offspring, is, with reference to my theory, of equal importance with the sterility of species; for it scens to make a broad and clear distinction between varieties and species.

Degrees of Sterility .- First, for the sterility of species when crossed and of their hybrid offspring. It is impossible to study the several memoirs and works of those two conscientious and admirable observers, Kölrenter and Gärtner, who almost devoted their lives to this subject, without being deeply impressed with the high menerality of some degree of sterility. Kölreuter makes the mla universal ; but then he cuts the knot, for in ten cases in which he found two forms, considered by most authors as distinct species. quite fertile together, he unhesitatingly ranks them as varieties Gärtner, also, makes the rule equally universal; and he disputes the entire fertility of Kölreuter's ten cases. But in these and in many other cases, Gärtner is obliged carefully to count the seeds, in order to show that there is any degree of sterility. He always when first crossed, and the maximum produced by their hybrid offspring, with the average number produced by both pure parentspecies in a state of nature. But causes of serious error here intervene : a plant, to be hybridised, must be castrated, and, what is often more important, must be secluded in order to prevent pollen being brought to it by insects from other plants. Nearly all the plants experimented on by Gärtner were potted, and were kept in a chamber in his house. That these processes are often injurious to the fertility of a plant cannot be doubted ; for Gärtner gives in his table about a score of cases of plants which he castrated, and artificially fertilised with their own pollen, and (excluding all cases such as the Leguminosæ, in which there is an acknowledged diffifertility in some degree impaired. Moreover, as Gärtner repeatedly crossed some forms, such as the common red and blue pimpernels many species are really so sterile, when intercrossed, as he believed.

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Degrees of Sterility.

sensibly, and, on the scher hand, that the furthity of pure species is no scalar Jafford by various circumstances, that for all practical purposes it is most difficult to any where perfect furthy ends and scalarity begins. This is no heter effective of this can be required humanly. Köhnether and Grienes, arrived at dimetrically coposite containsion in regression control of the scalar barries of the most function of the scalar scalar scalar scalar scalar scalar oblight of the scalar scalar scalar scalar scalar scalar scalar values of the scalar scalar scalar scalar scalar scalar scalar hybridisms, et plus and oblight is made and scalar scalar scalar different spaces. It can be above function and varieties, the scalar function function of the scalar value scalar scalar different spaces. It can this scalar spaces are value and varieties, the scalar function function of the scalar value scalar scalar different spaces. The scalar scalar scalar value scalar scalar different spaces from this scalar spaces from other scalar value scalar scalar

In regard to the sterility of hybrids in successive generations ; though Gärtner was enabled to rear some hybrids, carefully guarding them from a cross with either pure parent, for six or seven, and in one case for ten generations, yet he asserts positively that their fertility never increases, but generally decreases greatly and suddenly. With respect to this decrease, it may first be noticed that when any deviation in structure or constitution is common to both parents, this is often transmitted in an augmented degree to the offspring ; and both sexual elements in hybrid plants are already affected in some degree. But I believe that their fertility has been diminished in nearly all these cases by an independent cause, namely, by too close interbreeding. I have made so many experiments and collected so many facts, showing on the one hand that an occasional cross with a distinct individual or variety increases the vicour and fertility of the offspring, and on the other hand that very close interbreeding lessens their vigour and fertility, that I cannot doubt the correctness of this conclusion. Hybrids are seldom raised by experimentalists in great numbers; and as the parentspecies, or other allied hybrids, generally grow in the same garden, season ; hence hybrids, if left to themselves, will generally be fertilised during each generation by pollen from the same flower ; and this would probably be injurious to their fertility, already lessened by their hybrid origin. I am strengthened in this conviction by a remarkable statement repeatedly made by Gärtner, namely, that if even the less fertile hybrids be artificially fertilised

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with hybrid poline of the same kind, their fertility, proteinhisting, the frequent ill effects from manipulation, nonethern dedidely increases, and goes on increasing. Now, in the process of antificiation expected on the subtract of mother flower, as from the subtract flower of the same set in a state of the same plane, would be thus effected. Moreover, whenever complicated expertion accessively one correlated modeware and the same plane, would be thus effected. Moreover, whenever and the same plane, would be thus effected. Moreover, whenever and the same plane, would be thus effected. Moreover, whenever and the same plane is a cross with poline from a difficult for the same plane plane to from mother plane if the same hybrid nature. And thus a strange flow of an increase of fertility in the accessive generaspontaneously self-fertilised, may, at Theleve, ba accounted for by to close interbrevious plane in the same volded.

Now let us turn to the results arrived at by a third most regardcool hybridies, many, the Ho, and Hor.W. Herbert. He is a semplation in this conclusion that some hybridit are perfectly perfectly that some degrees of scattering between distributions and egrees of scattering between distribution performs of the two same degrees of a scattering between distributions performs of the interval and observe that the same degrees of the difference in their results may differ all high labels and difference in the two same area of the state of the state of the scattering between distributions and the scattering between t

This case of the Crimu hash me to refer to a singular field much data induced and provided in the second state of the harmonic data induced and the same plant, from the plant energy and the second state of the same plant, from the second state of the second state of the second state of the energy of the second state of the second state of the energy of the second state of the second state of the Protose Hilderica in the inducidation are in this possible and in obler that with using second state of the second state of th

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dimed for flowers; these verse furtilised by Herbert with their compollers, and the fourth was makesquark tertilised by the pollen of a compound hybrid descended from three distinct species : the nucli vast hat the variant of the three first flowers on concast to "grown, and after a few days periodic entirely, whereas the poital and after the pollen of the hybrid mode vigreerated rangely mogeness to maturity, and here good each, which regetions from β^{-1} . In Herbert tries similar experiments during on any start hight and mysterious causes the leaser or greater fertility of a mericy expendence determine.

The practical experiments of horticulturists, though not made with scientific precision, deserve some notice. It is notorious in how complicated a manner the species of Pelargonium, Fuchsia, Calceolaria, Petunia, Rhododendron, &c., have been crossed, yet many of these hybrids seed freely. For instance, Herbert asserts that a hybrid from Calceolaria integrifolia and plantaginea, species most widely dissimilar in general habit, "reproduces itself as perfectly as if it had been a natural species from the mountains of Chili," I have taken some pains to ascertain the degree of fertility of some of the complex crosses of Rhododendrons, and I am assured that many of them are perfectly fertile. Mr. C. Noble, for instance. informs me that he raises stocks for grafting from a hybrid between Rhod, ponticum and catawbiense, and that this hybrid " seeds as freely as it is possible to imagine." Had hybrids, when fairly treated, always gone on decreasing in fertility in each successive generation, as Gärtner believed to be the case, the fact would have been notorious to nursery-men. Horticulturists raise large beds of the same hybrid, and such alone are fairly treated, for by insect agency the several individuals are allowed to cross freely with each other, and the injurious influence of close interbreeding is thus prevented. Any one may readily convince himself of the efficiency find on their stigmas plenty of pollen brought from other flowers.

In regard to animals, much ferer experiments have been carefully tried than with phalox. If our systematic arrangements can be trusted, that is, if the grears of animals are as distinct from each other as are the genera of phants, then we may infer that animals more widely distinct in the scale of nature can be crossed more saily than in the scale of phants; but the hybrids themselves are, I think, more sterile. It should, however, be borne in mind that, wing to the waimals breeding friedy under confinement, for wains to be the scale of phants in the sterily under confinement, for wains to be a similar bereding threely under confinement, for

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experiment have been fairly tried: for instance, the canacy-lack has been crosses with mine singlets preselve of findenky takes as one of these laveds freely in configuration, we have no right or experit hat its first crosses between them sold the canacy, or that their hybrids, should be perfectly freinds. A dense for the set of the same hybrid have been raised at the same three densities of the same hybrid have been raised at the same three from difference. On the contrary, breakers and siters have usually been removed in cadmonitor, in equations, in equations to the constantly reparat absorbing of the set of the absorbing of the set of t

Although I know of hardly any thoroughly well-authenticated cases of perfectly fertile hybrid animals, I have reason to believe that the hybrids from Cervulus vaginalis and Reevesii, and from Phasianus colchicus with P. torquatus, are perfectly fertile. M. Quatrefaces states that the hybrids from two moths (Bombyx cynthia and arrindia) were proved in Paris to be fertile inter se for eight cenerations. It has lately been asserted that two such distinct species as the hare and rabbit, when they can be got to breed together, produce offspring, which are highly fertile when crossed with one of the parent-species. The hybrids from the common and Chinese geese (A. cygnoides), species which are so different that they are generally ranked in distinct genera, have often bred in this country with either pure parent, and in one single instance they have bred inter se. This was effected by Mr. Evton, who raised two hybrids from the same parents, but from different hatches; and from these two birds he raised no less than eight hybrids (grandchildren of the pure geese) from one nest. In India, however, these cross-bred geese must be far more fertile; for I am assured by two eminently capable judges, namely Mr. Blyth and Capt, Hutton, that whole flocks of these crossed geeso are kept in various parts of the country ; and as they are kept for profit, where neither pure parent-species exists, they must certainly

With our demostrated animals, the various races when crossed together are quite fortile; yet in many cases they are descended from two or more wild species. From this fact we must conclude either that the aboriginal parent-species at first produced perfectly fertile hybrids, or that the hybrids subsequently reared mole: domestication became quite fortile. This latter alternative, which

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was first propounded by Pallas, seems by far the most probable, and can, indeed, hardly be doubted. It is, for instance, almost certain perhaps the exception of certain indigenous domestic dogs of South America, all are quite fertile together; but analogy makes me have freely bred together and have produced quite fertile hybrids. So again I have lately acquired decisive evidence that the crossed offspring from the Indian humped and common cattle are inter se perfectly fertile ; and from the observations by Rütimever on their important osteological differences, as well as from those by Mr. Blyth on their differences in habits, voice, constitution, &c .. these two forms must be regarded as good and distinct species, The same remarks may be extended to the two chief races of the pig. We must, therefore, either give up the belief of the universal sterility of species when crossed; or we must look at this sterility in animals, not as an indelible characteristic, but as one canable of being removed by domestication.

Finally, considering all the ascertained facts on the intercrossing of plants and animals, it may be concluded that some degree of sterility, both in first crosses and in hybrids, is an extremely general result; but that it cannot, under our present state of knowledge, be considered as absolutely universal.

Laws governing the Sterility of first Crosses and of Hybrids.

We will now consider a little more in detail the laws governing the strilly of first crosses and of hybrids. Our chief object will be to see whether or not these laws indicate that species have been specially condered with this aquality, in order to preven their cosmission as down up chiefly from Gärtare's abministivents on the hybridization of plants. I have taken much pairs analyze on the hybridization of plants. I have taken much pairs awary our knowledge is in regard to hybrid animala, I have been surgivent to final how generally the same rules apply to both knowledge.

It has been already remarked, that the degree of fertility, both of first crosses and of hybrids, graduates from zero to perfect fertility. It is surprising in how many curious ways this gradution cun be abover; but only the barst outline of the facts can here be given. When pollen from a plant of one family is placed can the signum of a plant of a distinct family, it exerts no more inducence than comich increase id cats. From this absolute zero for

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facility, cale polisis of different species applied to the stigma of same one species of the same grave, yields a prefect gravitation in the number of asols preduced, up to marky complete or even quicks one of the same species of the same spectra policy produces. So in hybrids themselves, there are some while here also are ensued in of certain spectra spectra spectra spectra spectra spectra spectra spectra spectra the police of the purpose parents, a single forther seed 1. but its mass of spectra spectra spectra spectra spectra spectra spectra wither a celler than it otherwise would have doney in all the applied wither a celler than it otherwise would have doney in all the applied for this spectra spectra spectra spectra spectra spectra for the spectra for the spectra spe

The hybrids raised from two species which are very difficulto trees, and which rarely profoca are governed by very sterile jot the parallelism between the difficulty or making a fraces, and the sterily of the hydroid the produced – were diams of core, and the sterily of the hydroid the produced – were diams of the sterile sterile and the sterile sterile sterile sterile steriles. There are many cases, in which two pure species, as in the sterile sterile sterile sterile sterile sterile sterile sterile sterile steriles. There are many cases, in which two pure species, as in the sterile sterile sterile sterile sterile sterile sterile sterile sterile many cases the sterile sterile sterile sterile sterile sterile sterile many or which extreme the style, but the hybrid- are recound very many, for instance in Darkhub, these two opposite cases eccut.

The fertility, both of first crosses and of hybrids, in more single affected by unfercosine conditions, thus in that of pure species. Due the fertility of first crosses in likewise instactly variable jet constrained to the second second second second second second crosses of the second second second second second second firstilly is often found to differ greatly in the second height the second truth of the second second second second second firstilly is often found to differ greatly in the second height of the second second second second second second second firstilly is often found to differ greatly in the second height of the second second second second second second second second second truth second sec

By the term systematic affinity is meant, the general resemblance between species in structure and constitution. Now the fertility of finit crosses, and of the hybrid produced from them, is largely governed by their systematic affinity. This is clearly shown by hybrids never having been raised between species ranked by systematistic in distinct families ; and on the other hand, by very

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closely allied species generally uniting with facility. But the correspondence between systematic affinity and the facility of crossing is by no means strict. A multitude of cases could be given of very closely allied species which will not unite, or only with extreme difficulty : and on the other hand of very distinct species which unite with the utmost facility. In the same family there may be a genus, as Dianthus, in which very many species can most readily be crossed ; and another genus, as Silene, in which the most persevering efforts have failed to produce between extremely close species a single hybrid. Even within the limits of the same genus. we meet with this same difference ; for instance, the many species of Nicotiana have been more largely crossed than the species of almost any other genus; but Gärtner found that N. acuminata, which is not a particularly distinct species, obstinately failed to fertilise, or to be fertilised by no less than eight other species of Nicotiana. Many analogous facts could be given.

No can have been able to point out which link or what among of difference, in any receptualsed character, is indicate to prevent steo species crossing. It can be shown that johnts most which' different indication and general appearance, and having strengly matched differences in every part of the flower, even in the polen, in the fruit of the to originate, make second, standard appennial jakans, and fitted for extremely different channes, can often be crossed with case.

By a reciprocal cross between two species, I mean the case, for instance, of a female-ass being first crossed by a stallion, and then a mare by a male-ass : these two species may then be said to have been reciprocally crossed. There is often the widest possible difference in the facility of making reciprocal crosses, Such cases are highly important, for they prove that the capacity systematic affinity, that is of any difference in their structure or constitution, excepting in their reproductive systems. The diversity of the result in reciprocal crosses between the same two species was long ago observed by Kölreuter. To give an instance : Mirabilis jalapa can easily be fertilised by the pollen of M. longiflora, and the hybrids thus produced are sufficiently fertile; but Kölreuter tried more than two hundred times, during eight fol-M. jalapa, and utterly failed. Several other equally striking cases could be given. Thurst has observed the same fact with certain sea-weeds or Fuci. Gartner, moreover, found that this difference of

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facility in making redpread arcsass is extremely common in a lareer deprox. In the absolver of it even between closely related forms (ag Matthiola annea and glated) which many botanists rank of an avrieties. It is also a verarchicable fort, has hybriden inside from neiprocal crosses, though of comes compounded of the very maximum towards and the one species barriery mark within the accuratation of the second second second second second second and the second second

Several other singular rules could be given from Gattare: for limitance, none approximation have a remarkable power of crossing with other species; other species of the same genus haves a runarkable power of impossing their likenous on their hybrid affording; bet corrain hyperial within, instead of having, as is usual, an intermediate corrain hyperial within, instead of having, as is usual, an intermediate instance between which there acceptions extremely stelling. Seaguing strandards are also by brids, though externally so like one of their pays provide the provide strandard strategies and the second between their paysets, coorplicant and Amerenta liarity indicas are born, which colorly remember one of their pays parents; and these hybrids are almost always utterfy sterily, even when the other hybrids rate of moust of the second completely the solution of their pays.

Considering 'the several rules now given, which govern the furtilise of intri coses and of hybrids we see that when forms, which must be considered as good and distinct species, are mited, further that the considered as good and distinct species, are mited, forming and the several special special special special based on the several special special special special based on this coses, that their fertility hybrids is not should be a special sp

in the facility of effecting an union. The hybrids, moreover, produced from reciprocal crosses often differ in fertility.

Now do these complex and singular rules indicates that predetation of the second starting starting the prevent the besoning conformation in natures? I thing not. For why should the starting to so extrating different in degree, when various species are crossed, all of which we many approach would be qually important to keep instantion of the second starting of the second starting and instantion of the second starting starting and the second prediction of the second starting starting and the prediction of the second starting starting starting starting produce future for the second starting starting starting starting starting starting starting starting starts a difference in the result of a second starting startin

The foregoing rules and facts, on the other hand, appear to me clearly to indicate that the sterility both of first crosses and of hybrids is simply incidental or dependent on unknown differences in their reproductive systems ; the differences being of so peculiar and limited a nature, that, in reciprocal crosses between the same two species, the male sexual element of the one will often freely act on the female sexual element of the other, but not in a reversed direction. It will be advisable to explain a little more fully by an example what I mean by sterility being incidental on other differences, and not a specially endowed quality. As the capacity of one plant to be grafted or budded on another is unimportant for their welfare in a state of nature, I presume that no one will suppose that this capacity is a specially endowed quality, but will admit that it is incidental on differences in the laws of growth of the two plants. We can sometimes see the reason why one tree will not take on another, from differences in their rate of growth, in the hardness of their wood, in the period of the flow or nature of their sap, &c. ; but in a multitude of cases we can assign no reason whatever. Great diversity in the size of two plants, one being woody and the other herbaccous, one being everyreen and the other deciduous, and adaptation to widely different climates, do not always prevent the two grafting together. As in hybridisation, so with grafting, the capacity is limited by systematic affinity, for no one has been able to graft together trees belonging to quite distinct families ; and, on the other hand, closely allied species, and varieties

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of the same species, can usually, but not invariably, bu grafiel write, now. But this experisely, as in hybricalistic, is by no means alsolately generated by systematic affinity. Although many distingtion of the systematic affinity. Although many distingnear special back many generativity of the systematic and the system of the systematic and the system of the system part can be grafield for more readily on the quinter, which is rando as a disting generation, alto one shop special which is an angle and a statistic generation, alto each system of the prior takes with different activity and the system of the prior takes with different to activity and the system of the prior takes with the system activity and prior different varieties of the prior takes with different activity and the system of the prior takes with the system of the system o

As Gatter found that there was sometimes an innale difference in different inferiodants of the same two species in coming; as Sagaret believes this to be the case with different individuals of the same two species in being grafted together. As in respicaal crosses, the facility of effecting an union is often very far from equal, oo its sometimes is in grafting; the common goosterry, for instance, annot be grafted on the currant, whereas the currant will take, hough with difficulty, on the goosberry.

We have seen that the sterility of hybrids, which have their productive organs in an imperfect coulding, is a different case from the difficulty of uniting two pure species, which have their reproductive organs perfect; y without two distinct classes of comparing the Theorem Fundament and the stering of the stering which would freque the stering of the stering stering of grafted with no grast difficulty on a fourth appear, when thus grafted with no grast difficulty on a fourth appear, when thus sufficient theory of the stering stering stering of Serbas, when grafted on other pacies are stering stering of the stering stering stering stering stering of Serbas, when grafted on other species yielded twice as much fruit as when on their own rote. We are neuralised by this latter fast of the extraordinary cases of Birgenstrum. Funding, dee, while see the stering stering stering stering stering stering stering stering stering.

We have see, that, although there is a clear and press difference between the more addission of grafted stocks, and the union of the male and formale elements in the act of reproduction, yet that there is a rand degree of panellalum in the routins of grafted star creating distinct species. And as we must look at the creates and complex laws provering the facility with which there see an legraded on each other as incidental on unknown differences in hele provides on each other as incidental on unknown. Alternative provides the start of the start of the start of the start provides of the start of the start of the start of the start difference in their reproductive systems. These differences is hold uses, follow to a certain extent, a must have been exceeded.

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systematic affinity, by which term every kind of resemblance and dissimilarity between expanic beings is attempted to be expressed. The facts by no means seem to indicate that the greater or lesser difficulty of either grafting or ensuing various species has been a special endowment; although in the case of crossing, the difficulty is as important for the endemance and stability of specific forms, as in the case of grafting its is numportant for their welfare.

Origin and Causes of the Sterility of first Crosses and of Hybrids.

At one time it appeared to me probable, as it has to others, that acquired through the natural selection of slightly lessened degrees of fertility, which, like any other variation, spontaneously appeared in certain individuals of one variety when crossed with those of another variety. For it would clearly be advantageous to two varieties or incipient species, if they could be kept from blending, on the same principle that, when man is selecting at the same time two varieties, it is necessary that he should keep them separate. In the first place, it may be remarked that species inhabiting distinct regions are often sterile when crossed ; now it could clearly have been of no advantage to such separated species to have been rendered mutually sterile, and consequently this could not have been effected through natural selection ; but it may perhaps be argued, that, if a species was rendered sterile with some one compatriot, sterility with other species would follow as a necessary contingency. In the second place, it is almost as much opposed to the theory of natural selection as to that of special creation, that in reciprocal crosses the male element of one form should have been rendered utterly impotent on a second form, whilst at the same time the male element of this second form is enabled freely to fertilise the first form ; for this peculiar state of the reproductive system could hardly have been advantageous to either species.

In considering the probability of mainal selection having comting attraction, in readering species maturally sterils, the greatest integration is the selection of the selecti

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sterility could be increased through natural selection to that high degree which is common with so many species, and which is or family rank, will find the subject extraordinarily complex. After mature reflection it seems to me that this could not have been effected through natural selection. Take the case of any two species which, when crossed, produce few and sterile offspring ; now, what is there which could favour the survival of those individuals which happened to be endowed in a slightly higher degree with mutual infertility, and which thus approached by one small step towards absolute sterility? Yet an advance of this kind, if the occurred with many species, for a multitude are mutually quite parren. With sterile neuter insects we have reason to believe that modifications in their structure and fertility have been slowly accumulated by natural selection, from an advantage having been thus indirectly given to the community to which they belonged over other communities of the same species; but an individual animal not belonging to a social community, if rendered slightly sterile when crossed with some other variety, would not thus itself gain any advantage or indirectly give any advantage to the other individuals of the same variety, thus leading to their preservation.

But its would be superfluose to discuss this quarks in its durity or ensued presents must be due to some principle, quite independent of the strength of the strength of the strength of the general independent of the strength of the strength of species which were recover, for the present scale, to prese which never produce a single and plus type at an affected by the polen which were recover, for the present scale, to prese which never produce a single and plus type at an affected by the polen of certain other present, for the present scale, to prese then actively cosed to yield never a number of anisity, when the generous along is and plus varians grades of sterility, when the generous house is affected, cannot have been gained through we may infer that the access the statistical and variantle highespace, we may infer that the access the statistic is may be a has some or must when the same version is may be a state same or anythy the anoth and a case.

We will now look a little closer at the prohable nature of the differences between species which induce sterility in first crosses and in hybrids. In the case of first crosses, the greater or less difficulty in effecting an union and in obtaining offspring apparently depends on asveral distinct causes. There must sometimes be a

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physical impossibility in the male element reaching the ovule, as would be the case with a plant having a pistil too long for the pollentubes to reach the ovarium. It has also been observed that when the pollen of one species is placed on the stigma of a distantly allied stigmatic surface. Again, the male element may reach the female seems to have been the case with some of Thuret's experiments on Fuci. No explanation can be given of these facts, any more than why certain trees cannot be grafted on others. Lastly, an embryo may be developed, and then perish at an early period. This latter alternative has not been sufficiently attended to; but I believe, from observations communicated to me by Mr. Hewitt, who has early death of the embryo is a very frequent cause of sterility in first crosses. Mr. Salter has recently given the results of an examination of about 500 eggs produced from various crosses these eggs had been fertilised ; and in the majority of the fertilised eggs, the embryos had either been partially developed and had then perished, or had become nearly mature, but the young chickens had been unable to break through the shell. Of the chickens which were born, more than four-fifths died within the first few days, or at latest weeks, "without any obvious cause, apparently from mere inability to live ;" so that from the 500 eggs only twelve chickens were reared. With plants, hybridised embryos probably often perish in a like manner ; at least it is known that hybrids raised from very distinct species are sometimes weak and dwarfed, and perish at an early age ; of which fact Max Wichura has recently given some striking cases with hybrid willows. It may be here worth noticing that in some cases of parthenogenesis, the embryos within the eggs of silk moths which had not been fertilised, pass embryos produced by a cross between distinct species. Until the frequent early death of hybrid embryos ; for hybrids, when once born, are generally healthy and long-lived, as we see in the case of the common mule. Hybrids, however, are differently circumstanced before and after birth : when born and living in a the nature and constitution of its mother; it may therefore before birth, as long as it is nourished within its mother's womb, or within

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the egg or seel produced by the mother, be exposed to conditions in some degree unstallable, and conceptently be liable to prink at an early period; mere septenlay as all very young beings are emineatly sensitive to injurious or unnaturel conditions of life, Bot after all, the cause more probably lies in some imperfection in the original at of improgramion, causing the embryo to be imperfectly developed, rather than in the conditions to which it is albeoutently crossed.

In regard to the sterility of hybrids, in which the sexual elements are imperfectly developed, the case is somewhat different. I have more than once alluded to a large body of facts showing that, when animals and plants are removed from their natural conditions, they are extremely liable to have their reproductive systems seriously affected. This, in fact, is the great bar to the domestication of animals. Between the sterility thus superinduced and that of hybrids, there are many points of similarity. In both cases the sterility is independent of general health, and is often accompanied by excess of size or great luxuriance. In both cases the sterility occurs in various degrees ; in both, the male element is the most liable to be affected; but sometimes the female more than the male. In both, the tendency goes to a certain extent with systematic affinity, for whole groups of animals and plants are rendered impotent by the same unnatural conditions; and whole groups of species tend to produce sterile hybrids. On the other hand, one species in a group will sometimes resist great changes of conditions with unimpaired fertility; and certain species in a group will produce unusually fertile hybrids. No one can tell, till he tries, whether any particular animal will breed under confinement, or tries, whether any two species of a genus will produce more or less sterile hybrids. Lastly, when organic beings are placed during several generations under conditions not natural to them, they are extremely liable to vary, which seems to be partly due to their lesser degree than when sterility ensues. So it is with hybrids, for as every experimentalist has observed.

Thus we see that when organic beings are placed under new and unnatural conditions, and when hybrids are produced by the unnatural cosing of two species, the reproductive system, independently of the general state of health, is affected in a very similar manner. In the one case, the conditions of life have been disturbed, though often in a solight a degree as to be inappreciable

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by usy in the other case, or that of hybrids, the external conditions have remaind the man, but the organization has been disturbed by two distinct attractures and constitutions, including of course but reproductive systems, having been bilised into one. For it is asseedy possible that two organisations should be compounded into any without some distarchance covering in the device system, so organs one to another set to the conditions of life. When hybrids as able to breach diver set, they transmit to their offspring from generation to generation the same compounded organisation, and have been even also the tarried, at bottless relative, if the observable, in some degree variable, does not diminish; it is even spit to increase, this long generally have real, as bottless explained, of too chose interleng generally neural, as bottless explained, of too chose interleng generally neural, as bottless explained, of too chose interleng generally neural, as bottless explained, of too chose interlets when the Neural is a bottless explained, of too chose interlets when the Neural is a bottless explained, of too chose interlets when the Neural is a bottless explained, of too chose interlets when the Neural is a bottless explained, of too chose interlets when the Neural is a bottless explained, of too chose interlets when constitutions being compared into one has been strongly maintable b Max Neural.

It must however, be orned that we cannot understand, on the above any other were, averal fact with rangest to the aterility of hybridy; for instance, the unequal fertility of hybridy produced from respirocal coreses; or the increased sterility in those hybrids which occasionally and exceptionally resemble cloudy either parepares. Nor do 1 pretenti data the foregoing remarks go to the root of the matter; no explanation is offered why an expanism, when placed under mustantic cantilons, is rendered steriks. All that laws attempted to show is, that in two cases, in near expects conditions of life having been disturbed, in the other case from the expansion having been disturbed, by two expansions being compounded into one.

A similar parallelium holds good with an alliel yet very different sions of facts. It is not do and androm viewnal holds from do and considerable holy of evidence, which I have showing given, that build in the second start of the second start of the second holds. The second start of the second start of second start frequent exchanges of second, tubers, does, from one soil or elimites to showing will be day damin. During the second scale start frequent exchanges of second, tubers, does, from one soil or elimites to anythen, will be day damin. During the second scale scale scale and the second scale scale and the second scale scale scale that a creation scale and given signature in the clarest evidence that as easily start will be set of the second scale scale scale the next relations, if them is being tuber of the scale scale scale in $\beta_{\rm c}$ and scale scale is the second scale scale scale scale the next relations, if them is being tuber of the scale scale scale scale in $\beta_{\rm c}$ and the scale sca

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Hence it seems that, on the one hand, slight changes in the conditions of life benefit all organic beings, and on the other hand, that slight crosses, that is crosses between the males and females of the same species, which have been subjected to slightly different conditions, or which have slightly varied, give vigour and fertility to the offspring. But, as we have seen, organic beings long habituated to certain uniform conditions under a state of nature, when subjected, as under confinement, to a considerable change in their we know that a cross between two forms, that have become widely or specifically different, produce hybrids which are almost always in some degree storile. I am fully persuaded that this double parallelism is by no means an accident or an illusion. He who is able to explain why the elephant and a multitude of other animals are incapable of breeding when kept under only partial confinement in their native country, will be able to explain the primary cause of hybrids being so generally sterile. He will at the same time be able to explain how it is that the races of some of our domesticated animals, which have often been subjected to new and not uniform conditions, are quite fertile together, although they are descended from distinct species, which would probably have been sterile if aboriginally crossed. The above two parallel series of facts seem to be connected together by some common but unknown bond, which is essentially related to the principle of life; this principle, according to Mr. Herbert Spencer, being that life depends on, or consists in, the incessant action and reaction of various forces, which, as throughout nature, are always tending towards an equilibrium; and when this tendency is slightly disturbed by any change, the vital forces gain in power,

Reciprocal Dimorphism and Trimorphism.

This emblect may be here briefly discussed, and will be found to the own come light on hybridism. Several phants belonging to distinct events present iteo forms, which crast in about equal compares on the mathematical several several several several a short pitted with long atomests in the two having differently side of the pitted several several several several several several with different several forms present along setting several severa

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that half the stammers in two of the forms stand on a level with the signm of the horiform. Now I have shown, and the results has been confirmed by other observers, that, in other to obtain for forms show the certained by the standard states of the standard forms show the fore thinds by polar takets from the stammer of corresponding height in another form. So that with dimyhile species two unlows, which may be called legituring, are fully circle ₁ and trave, which may be called legituring, are fully circle ₁ and trave, which may be called legituring are fully circle ₁ and trave, which may be called legituring and the priority of and two are fully firstland or more or bus infertile.

The infertility which may be observed in various dimorphic and pollen taken from stamens not corresponding in height with the pistil, differs much in degree, up to absolute and utter sterility ; just in the same manner as occurs in crossing distinct species. As the degree of sterility in the latter case depends in an eminent degree on the conditions of life being more or less favourable, so I have found it with illegitimate unions. It is well known that if pollen of a distinct species be placed on the stigma of a flower, and its own pollen be afterwards, even after a considerable interval of time, placed on the same stigma, its action is so strongly prepotent that the pollen of the several forms of the same species, for legitimate pollen is strongly prepotent over illegitimate pollen, when both are placed on the same stigma. I ascertained this by fertilising several flowers, first illegitimately, and twenty-four hours afterwards legitimately, with pollen taken from a peculiarly coloured variety, and all the seedlings were similarly coloured ; this shows that the legitimate pollen, though applied twenty-four hours subsequently, had wholly destroyed or prevented the action of the previously applied illegitimate pollen. Again, as in making reciprocal crosses between the same two species, there is occasionally a great difference in the result, so the same thing occurs with trimorphic plants ; for instance, the mid-styled form of Lythrum salicaria was illegitimately fertilised with the greatest ease by pollen from the longer stamens of the short-styled form, and yielded many seeds ; but the latter form did not yield a single seed when fertilised by the longer

In all these respects, and in others which might be added, the forms of the same undoubted species when illegitimately united behave in exactly the same manner as do two distinct species when crossed. This led me carefully to observe during four years many scalings, raised from several liketimate tunons. The chief result is

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that these illegitimate plants, as they may be called, are not fully ferand short-styled illegitimate plants, and from trimorphic plants all three illegitimate forms. These can then be properly united in a legitimate manner. When this is done, there is no apparent reason legitimately fertilised. But such is not the case. They are all infertile, in various degrees; some being so utterly and incurably even seed-capsule. The sterility of these illegitimate plants, when united with each other in a legitimate manner, may be strictly compared with that of hybrids when crossed inter se. If, on the other hand, a hybrid is crossed with either pure parent-species, the sterility is usually much lessened ; and so it is when an illegitimate plant is fertilised by a legitimate plant. In the same manner as the sterility of hybrids does not always run parallel with the difficulty of making the first cross between the two parent-species. so the sterility of certain illegitimate plants was unusually great, whilst the sterility of the union from which they were derived was by no means great. With hybrids raised from the same seedcapsule the degree of sterility is innately variable, so it is in a marked manner with illezitimate plants. Lastly, many hybrids are profuse and persistent flowerers, whilst other and more sterile hybrids produce few flowers, and are weak, miserable dwarfs; exactly similar cases occur with the illegitimate offspring of various dimorphic and trimorphic plants.

A biggether there is the closest identity in character and behavior between lightman plants and hybrids. It is hardly an exaggeration to maintain that illightmate plants are hybrids periods within the limits of the annu speech with the plants are hybrids. Periods and the second second second second second second reperturbations between as-said distingt species. We have also leaved second there is the closest similarity in all respects between first: illightmate unions and first crasses between first; illightmate unions and first crasses between distingt between first: illightmate unions and first crasses between distingt therepist. This will perhap be made more fully appeared by an macked varieties (and such occur) of the long-tripled form of the transplit leptrmess alianets), and that the yespital areas of a single second second second second second second second they halo been two distinct species. But to make a second second respects and the second second

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and Trimorphism.

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find that the seedlings were miscrably dwarfed and utterly sterile, and that they behaved in all other respects like ordinary hybrids. He might them maintain that he had actually proved, in accordance with the common view, that his two varieties were as good and as distincspecies as any in the world; but he would be completely mistaken.

The facts now given on dimorphic and trimorphic plants are important, because they show us, first, that the physiological test of lessened fertility, both in first crosses and in hybrids, is no safe criterion of specific distinction ; secondly, because we may conclude that there is some unknown bond which connects the infertility of illegitimate unions with that of their illegitimate offspring, and we are led to extend the same view to first crosses and hybrids; thirdly, because we find, and this seems to me of especial importance. that two or three forms of the same species may exist and may differ in no respect whatever, either in structure or in constitution, relatively to external conditions, and yet be sterile when united in certain ways. For we must remember that it is the union of the sexual elements of individuals of the same form, for instance, of two long-styled forms, which results in sterility ; whilst it is the union of the sexual elements proper to two distinct forms which is fertile. Hence the case appears at first sight exactly the reverse of what occurs, in the ordinary unions of the individuals of the same species and with crosses between distinct species. It is, however, doubtful whether this is really so; but I will not enlarge on this obscure

We may, however, infer an evoluble from the consideration of immepha and triumophic pains, that the sterility of distinct species when crossed and of their hybrid program, dopenda actiativity on the nature of their search demonstra, and not on any differense in their attractures or general constitution. We are also lot to this same constants by considering energy and the starder of the star of the star of the star of the star of the distingtion of the star of the star of the star of the star beam of the star of the star of the star of the star dense star of the star of the star of the star of the star observer, Graven on the offsets with predict faility. That combine observer, Graven on the offsets with predict faility. That combine observer, Graven on the offsets with predict faility of the star of the observer star of the interverse or offsets of the predict faility. The star with offset star of the star of t

Fertility of Varieties when Crossed, and of their Mongrel Offspring, not universal.

It may be urged, as an overwhelming argument, that there must be some essential distinction between species and varieties, inasmuch as the latter, however much they may differ from each other in external appearance, cross with perfect Kolity, and yield perfectly

ferrile origing. With some exceptions presently to is given, if figure and that this is the rule. But the molect is a surround, by figure and the source of the start of the source of the forms induces regarded to be variative by found in any degree neighcognition, they are a none nanded by mount naturalists as specias. You instance, the blue and red pinnermed, which are considered by most bolanias as a variety, are well by Guinar to be quiet, starting when a survival, and he conservation by Guinar to be quiet, starting when a survival, and he conservation of the starting of all walked when a survival with asserved by here to be granted.

If we turn to varieties, produced, or supposed to have been produced, under domestication, we are still involved in some doubt, For when it is stated, for instance, that certain South American indigenous domestic dogs do not readily unite with European dogs, the explanation which will occur to every one, and probably the true one, is that they are descended from aboriginally distinct species. Nevertheless the perfect fertility of so many domestic races, differing widely from each other in appearance, for instance those of the pigeon, or of the cabbage, is a remarkable fact; more especially when we reflect how many species there are, which, though resembling each other most closely, are utterly sterile when intercrossed. Several considerations, however, render the fertility of domestic varieties less remarkable. In the first place, it may be observed that the amount of external difference between two species is no sure guide to their degree of mutual sterility, so that similar differences in the case of varieties would be no sure guide. It is certain that with species the cause lies exclusively in differences in their sexual constitution. Now the varying conditions to which domesticated animals and cultivated plants have been subjected, have had so little tendency towards modifying the reproductive system in a manner leading to mutual sterility, that tendency ; so that the domesticated descendants of species, which in their natural state probably would have been in some degree sterile when crossed, become perfectly fertile together. With plants, so far is cultivation from giving a tendency towards sterility between capacity of fertilising, and being fertilised by, other species. If

CHAP. IX. Fertility of Varieties when Crossed.

it becomes in the highest degrée improbable that similar conditions long-continue Ahoudi likowies induce this tendency; though in certain cases, with species having a peculiar constitution, sterility might occasionally be thus caused. Thus, as I believe, we can understand why with domenicated animals varieties have not been produced which are mutually sterile; and why with plants only a few such cases, immediately to be given, have been observed.

The real difficulty in our present subject is not, as it appears to me, why domestic varieties have not become mutually infertile when crossed, but why this has so generally occurred with natural varieties, as soon as they have been permanently modified in a sufficient degree to take rank as species. We are far from precisely knowing the cause: nor is this surprising, seeing how profoundly ignorant we are in regard to the normal and abnormal action of the reproductive system. But we can see that species, owing to their struggle for existence with numerous competitors, will have been exposed during long periods of time to more uniform conditions, than have domestic varieties; and this may well make a wide difference in the result. For we know how commonly wild animals and plants, when taken from their natural conditions and subjected to captivity, are rendered sterile; and the reproductive functions of organic beings which have always lived under natural conditions would probably in like manner be eminently sensitive to the influence of an unnatural cross. Domesticated productions, on the other hand, which, as shown by the mere fact of their domestication, were not originally highly sensitive to changes in their conditions of life, and which can now generally resist with undiminished fertility repeated changes of conditions, might be expected to produce varieties, which would be little liable to have their reproductive powers injuriously affected by the act of crossing with other varieties which had originated in a like manner.

I have as yet spoken as if the variation of the same species are viscalidy furth when interevosed. But it is impossible to resist the orthogon of the existence of a certain amount of density in the density of the start and the start and the start and the start multitude of species. The evidence is also, derived from houfly as a density of the start and the start and the start with a start full of the mass work updates each and unrively update start full of mains with yubbe work, and and unrively update start full on the start start and the start and the start entering of the start and the start and the start and the start entering of the start and the start these plates have separated encough the proceeds and a start pole of the the furthetist during the start and the start and the start start and the start and the start and the start and the start start and the start and the start and the start and the start start and the start and the start and the start and the start start and the start and the start and the start and the start start and the star

Fertility of Varieties when Crossed. CHAP. IX.

other; but only a single hash produced may seed, and this case hash produced only fiver grains. Manipulation in this case could not have here injurions, such a plants have separated sexes. No on, I. Leiver, M. as supported that these varieties of mains are distinct species; and it is important to notice that the hybrid plants thus minde were themevers perfedily fortilize to that even Garner did not venture to consider the two varieties as specifically distingt.

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Given de Buzareingues crossed three varieties of gourd, which like the maize has separated sexes, and he assorts that their mutual fertilisation is by so much the lass cays at heir differences are greater. How far these experiments may be trusted, I know not; but the forms experimented on an eraked by Sgener, who mainly founds his classification by the test of infertility, as varieties, and Nauch has come to the same conclusion.

The following case is far more remarkable, and seems at first incredible ; but it is the result of an astonishing number of experiso good an observer and so hostile a witness as Gärtner: namely that the yellow and white varieties when crossed produce less seed than the similarly coloured varieties of the same species. Moreover, he asserts that, when yellow and white varieties of one species are crossed with vellow and white varieties of a distinct species, more seed is produced by the crosses between the similarly coloured flowers, than between those which are differently coloured. Mr. Scott also has experimented on the species and varieties of Verbascum ; and although unable to confirm Gärtner's results on the crossing of the distinct species, he finds that the dissimilarly coloured varieties of the same species yield fewer seeds, in the proportion of 86 to 100, than the similarly coloured varieties. Yet these varieties differ in no respect except in the colour of their flowers; and one variety can sometimes be raised from the seed of another.

Netwerkey whose sectracy has been confirmed by every subsequent observer, has proved the remarkable fact, that one particular watery of the common toknose was more fertile than the other arcticles, when crossed with a widely duration spectra method in five forms which are examined by reprinted and which he toknose by the serverse trial, namely by recipiend methods, and he toknot heir snooped of gringing periodicy fertile. For an encoder with the Nordmain diffusions, analysy yields hydride two so steriles as those which were produced from the four either arcticle system.

of this one variety must have been in some manner and in some degree modified.

Prox these facts it can, no lenger be maintained that writelies when crossed as invariable quite ferring. From the grant difficulty of ascernizing the infectivity of variation in a state of matree, by another the state of the state of the state of the state of the above invariant processing of the state of the state of the above invariant processing of the state of the state of the above invariant processing of the state of the state of the above invariant processing of the state of the state of the above invariant processing of the state of the state of the above invariant processing of the state of the stat

Hybrids and Mongrels compared, independently of their fertility.

Independently of the question of fartility, the offspring of species and of varieties when crosed may be compared in several other respects. Glatter, whose strong wish it was to draw a distinct line between species and varieties, could find never five, and as it seems to ma, quiet unimportant differences between the so-called, hybrid offyring of species, and the so-called morgel of spring of varieties. And, on the other hand, they agree most closely in many important respects.

I shall here discuss this subject with extrems hereity. The near important distinctions is that in the first generation mongels are more variable than hydridy. I tot Gärner admits that hydrid from the strength and the strength of the strength of the first distinct further admits that hydrid, here we distinct present and this shows that the difference in the adgree of variablet and this shows that the difference in the adgree of variabresent and this shows that the difference in the disperse of the hydrid present are near variable than those from very distinct present and this shows that the difference in the adgree of variabtion of the disperse in how one at the more first help hydrid. Why the disperse is how one of the strength of the strength of the disperse of the variability, however, in the nonceser generations of compute is persister, generet than in hydrid. at This genere variability in mongring that in hydrids does not of an hourly domenics variable that is in hydrids.

Hybrids and Mongrels compared.

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tried on matrixed variations), and the implies that there has been resent variability, which would often continue and would suggest that artifug from the act of cressing. The slight variability of hybris in the first parameters of the strength bases on the view which I have taken of one of the causes of collinary variability ramsly, that the respondencie variations for bases on the view which I have taken of one of the causes of design strength in the strength of the strength of the strength opping clowely strengths is all artopoles to the parent-form. Now laytofis in the first generation are descended from precises (excluding variables) which have no had their regredinging systems in any way affected, and they are not variable; but attects, and their downchants are highly variable.

But to return to our comparison of mongrels and hybrids-Gärtner states that mongrels are more liable than hybrids to revert to either parent-form ; but this, if it be true, is certainly only a difference in degree. Moreover, Gärtner expressly states that hybrids from long cultivated plants are more subject to reversion than hybrids from species in their natural state; and this probably explains the singular difference in the results arrived at by different observers : thus, Max Wichura doubts whether hybrids ever revert to their parent-forms, and he experimented on uncultivated species of willows; whilst Naudin, on the other hand, insists in the strongest terms on the almost universal tendency to reversion in hybrids, and he experimented chiefly on cultivated plants. Gärtner further states that when any two species, although most closely allied to each other, are crossed with a third species, the hybrids are widely different from each other ; whereas, if two very distinct varieties of one species are crossed with another species, the hybrids do not differ much. But this conclusion, as far as I can make out, is founded on a single experiment ; and seems directly opposed to the results of several experiments made by Kölreuter.

Such alone are the unimportant differences which Grätner is able to point out between hybrid and monograp hants. On the other hand, the degrees and kinds of resemblance in monograbs and in hybrid to their reserved variants, more sopeialty in hybrid a preduced from many related species, follow according to Grätner fall and the species of the species are considered, as has constitute a proposal power of the species are considered, and has constitute to be a species of the species of the species of the species of hybrid to the with varieties of plants; and with animals can waity certainly den has thin proposal power power and other to be with varieties of plants; and with animals can be also be
variety. Hybrid plants produed from a reciprocal cross, generally resemble each other closely; and so it is with mongrel plants from a reciprocal cross. Both hybrids and mongrels can be reduced to either pure parent-form, by repeated crosses in successive generations with either arent.

These several remarks are apparently applicable to animals, it is the subject is here much complicately areity owing to be existence of asconkary sexual characters) but more especially owing to particle the order, both when one species is crossed with another, and when one variety is crossed with another variety. For instance, I shink those authors are right, who maintain that hese as hear a projectal power over the heres, as that hout the truth end the hain promise more density day is the much than its the female area of the three stars and the much that is the female when one variety of the three much that is the female when the three stars, which is the offspring of the female-as and stallon.

Much stress has been hick by seems anthow on the surgeout flag; the ii is only with high blocks of their perents; but this does not with the block of the stress of the second stress is a stress of the stress of energy stress of the stress of the stress of the stress of stress of the stress which are under the stress of th

Independently of the question of fertility and sterility, in all other respects there seems to be a general and close similarity in the offspring of crossed species, and of crossed varieties. If we look at species as having been specially created, and at varieties as

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Summary.

having been produced by secondary laws, this similarity would be an astonishing fact. But it harmonises perfectly with the view that there is no essential distinction between species and varieties.

Summary of Chapter.

First crosses between forms, unfiliently distinct to be maked, as species, and their hypothis, are very ground'ly, but not universally, neurine. The sterility is of all degrees, and is often so dight that the not careful a groundmittal have arrived at dimensionally opposing variable in individuals of the same species, and is miting approximation of the same species, and is miting and approximation of the same species, and is miting and the individual of the same species and is miting and the individual of the same species and is miting and the individual of the same species of the same species and in the hypothesis of the same species in the species of the same species of the s

In the same manner as in grafting trees, the capacity of case species or variety to take on another, is incidental on difference, generally of an unknown nature, in their vegetative systems, soir ensing, the praces or less facility of one species to unitie with another is incidental on unknown differences in their reproductive systems. These is no more reason to thick that a species have been repeating and between its variant degrees of interlity to prevent their packing and the static variant degrees of interlity to prevent their landing in our forense.

The sterility of flux travess and of their hybrid program has use been nequired through natural selection. In the case of flux traves it seems to depend on several eironantances; in none instances in a semi to depend on several eironantances; in some instances in a superstruct program on their widers. In the case of hybrids is superstruct program on their widers in a superstruct program on the original disturbed by being ecuryonaded from two distances forms; the disturbed by being ecuryonaded from two distances forms; the flux widers will explain the two rew of unmatimal conditions of this flux widers will explain the two rew and unmatimal conditions of the flux widers of the state in the views and two properties hyperaparable widers of the state in the view star and startility of all original heiners; widers of the state in the views are used to be the star and the star of such wider kind is markly, that is the star structure of a star being starting of hybrids (11) or the view starting of all original heiners; widers of the state in the views are as the starting of all original heiners; widers widers are conditions of the original the starting of all original heiners; widers widers and the starting of the original the starting of all original heiners; widers widers are as the starting of the starting of all original heiners; widers are as the starting of the starting of the starting widers are not be starting widers are as the starting of the starting widers are as the starting of the starting widers are as the starting of the starting widers are as the star

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CHAP. IX. Summary.

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sterility of the illegitimate unions of dimorphic and trimorphic clearly leads to the conclusion that the primary cause of the sterility of crossed species is confined to differences in their sexual elements. so generally have become more or less modified, leading to their close relation to species having been exposed for long periods of

It is not surprising that the difficulty in crossing any two species, respond, even if due to distinct causes; for both depend on the amount of difference between the species which are crossed. Nor is it surprising that the facility of effecting a first cross and the fertility of the hybrids thus produced, and the capacity of being widely different circumstances-should all run, to a certain extent, parallel with the systematic affinity of the forms subjected to experiment; for systematic affinity includes resemblances of all kinds,

First crosses between forms known to be varieties, or sufficiently alike to be considered as varieties, and their mongrel offspring, are very generally, but not, as is so often stated, invariably fertile. it is remembered how liable we are to argue in a circle with respect to varieties in a state of nature ; and when we remember that the greater number of varieties have been produced under domestication by the selection of mere external differences, and that they have not been long exposed to uniform conditions of life. It should also to eliminate sterility, and is therefore little likely to induce this same quality. Independently of the question of fertility, in all other respects there is the closest general resemblance between hybrids and mongrels,-in their variability, in their power of absorbing each other by repeated crosses, and in their inheritance of characters from both parent-forms. Finally, then, although we are as ignorant of the precise cause of the sterility of first crosses and of hybrids as we are why animals and plants removed from their natural conditions become sterile, yet the facts given in this chapter do not seem to me opposed to the belief that species aboriginally existed as varieties,

CHAPTER X.

ON THE IMPERFECTION OF THE GEOLOGICAL RECORD.

On the absence of intermulate variation at the present day—0 on the nature of entire distormalist variaties as their number—0.00 the large of times, an inferred from the rate of densation and of departies—0.00 the large of time as estimated by years—0.00 the porneos of an planetodigical subletions—0.00 the intermittence of geological formation variation in any see formatio—0.00 the surface appearance of groups of spaces—0.00 their existen appearance in the lowest known fissillareau strata—Antiputy of the haldtade arch.

In the sixth chapter I enumerated the chief objections which might be justly urged against the views maintained in this volume. Most of them have now been discussed. One, namely the distinctness of specific forms, and their not being blended together by innumerable transitional links, is a very obvious difficulty, I assigned reasons why such links do not commonly occur at the their presence, namely on an extensive and continuous area with graduated physical conditions. I endeavoured to show, that the presence of other already defined organic forms, than on climate; and, therefore, that the really governing conditions of life do not graduate away quite insensibly like heat or moisture. I endeavoured, also, to show that intermediate varieties, from existing in lesser numbers than the forms which they connect, will generally be beaten out and exterminated during the course of further modification and improvement. The main cause, however, of innumerable intermediate links not now occurring everywhere throughout nature, depends on the very process of natural selection, through which new varieties continually take the places of and supplant their parentforms. But just in proportion as this process of extermination has varieties, which have formerly existed, be truly enormous. Why then is not every geological formation and every stratum full of

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CHAP. X. Imperfection of the Geological Record.

such intermediate links? Geology assuredly does not roveal any such finely-graduated organic chain; and this, perhaps, is the most obvious and actious objection which can be urged against the theory The explanation lies, as I believe, in the extreme imperfection of the geological record.

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In the first place, it should always be borne in mind what sort I have found it difficult, when looking at any two species, to avoid picturing to myself forms directly intermediate between them. But this is a wholly false view ; we should always look for forms intermediate between each species and a common but unknown progenitor ; and the progenitor will generally have differed in some respects from all its modified descendants. To give a simple illustration : the fantail and pouter pigeons are both descended from the rock-pigeon ; if we possessed all the intermediate varieties between both and the rock-pigeon ; but we should have no varieties directly intermediate between the fantail and pouter; none, for instance, combining a tail somewhat expanded with a crop somewhat enlarged, the characteristic features of these two breeds, These two breeds, moreover, have become so much modified, that, if we had no historical or indirect evidence regarding their origin, it would not have been possible to have determined, from a mere comparison of their structure with that of the rock-nizeon. C. livia, whether they had descended from this species or from some other allied form, such as C. oenas,

Bo with natural species, if we look to forms very disiticat, for instance to the here and tagity we have no reason to suppose that links directly intermediate between them ever existed, but between sheat at at unbound on the strength strength strength strength tagit and to the hores i, but in some points of attracture may have differed considerably from both, even perlaps more than they differ to strength by from both, even any two or more species, were if we delay compared the interacture of the parent with that of the intermediate the strengtherm of the parent with that of the intermediate the interactions of the parent with that of the intermediate the intermediate of the parent with that of the intermediate the intermediate binds. Here the intermediate the perfect that in of the intermediate binds.

It is just possible by the theory, that one of two living forms might have descended from the other; for instance, a horse from a tapir; and in this case direct intermediate links will have existed between them. But such a case would imply that one form had remained for a very long period unaltered, whilst is descendants had undergone a vast amount of change; and the principle of competition between organism and organism, between child and prent, will render this a very rare event; for in all cases the new and improved forms of life tend to supplant the old and unimproved forms.

By the theory of matrix latestion all living spaces have been connoted with the parametery-sector of each gravely. Set differences not greater than we are between the natural and downste varies of the sector of the sector of the sector of the sector of the connector with more another forms ; and a on the starkwards, streys connected with more another forms ; and as on the starkwards, streys connected with more another forms ; and as on the starkwards, streys are common another of the sector of the sector of the sector in the sector of intermediate and transitional links, between all anordry, if this theory is turn, such have lived upon the earth,

On the Lapse of Time, as inferred from the rate of Deposition and extent of Denudation.

Independently of our not finding fossil remains of such infinitely numerous connecting links, it may be objected that time cannot have sufficed for so great an amount of organic change, all changes having been effected slowly. It is hardly possible for me to recall to the reader who is not a practical geologist, the facts leading the mind feebly to comprehend the lapse of time. He who can read Sir Charles Lyell's grand work on the Principles of Geology, which the future historian will recognise as having provast have been the past periods of time, may at once close this volume. Not that it suffices to study the Principles of Geology, or to read special treatises by different observers on separate formations, and to mark how each author attempts to give an inadequate idea of the duration of each formation, or even of each stratum. We can best gain some idea of past time by knowing the agencies at work, and learning how deeply the surface of the land has been denuded, and how much sediment has been deposited. As Lyell has well remarked, the extent and thickness of our sedimentary formations are the result and the measure of the denudation which the earth's crust has elsewhere undergone. Therefore a man should examine for himself the great piles of superimposed strata, and watch the rivulets bringing down mud, and the waves wearing away the sea-cliffs, in order to comprehend something about the duration of past time, the monuments of which we see all around us.

The Lapse of Time.

It is good to wander along the coast, when formed of molerately hand neeks, and mark the process of dynamics. The tides in most cases reach, the cliffs only for a short time tories a day, and phase in the cliffs of the short time tories a day, and phase is the time is good evidence that pure water effects moting in warring away rock. At last the base of the cliff is undermined, pinge fragments that (down, and these, running fixed, have to be eagn be rolled alone) by the waves, and then they are more particle that have the start of the start of the cliffs of the start prand into phylotics, shorting how lifts they are starded and for mines ary line of redwy diff, which is underging degradation, for mines ary line of redwy diff, which is underging degradation, redsh the start of the start of the start of the start of the start reads ary line of redwy diff, which is underging degradation, which that it is only here and there, along a short line affer a round in the phylotic start into a differ provide the start of the start for moles ary line of redwy diff, which is underging degradation, when y and the start is the start into a differing very varia have closed in low the y washed here.

We have, however, recently learnt from the observations of Ramsay, in the van of many excellent observers-of Jukes, Geikie, Croll, and others, that subaerial degradation is a much more important agency than coast-action, or the power of the waves. The whole surface of the land is exposed to the chemical action of the air and of the rain-water with its dissolved carbonic acid, and in colder countries to frost ; the disintegrated matter is carried down even gentle slopes during heavy rain, and to a greater extent than might be supposed, especially in arid districts, by the wind; it is then transported by the streams and rivers, which when rapid deepen their channels, and triturate the fragments. On a rainy day, even in a gently undulating country, we see the effects of subaerial degradation in the muddy rills which flow down every slope. Messrs, Ramsav and Whitaker have shown, and the observation is a most striking one, that the great lines of escarpment in the Wealden district and those ranging across England, which formerly were looked at as ancient sea-coasts, cannot have been thus formed, for each line is composed of one and the same formation, whilst our sea-cliffs are everywhere formed by the intersection of various formations. This being the case, we are compelled to admit that the escarpments owe their origin in chief part to the rocks of which they are composed having resisted subaerial denuquently has been gradually lowered, with the lines of harder rock

left projecting. Nothing impresses the mind with the wast duration of time, according to our ideas of time, more forcibly than the conviction thus gained that subcarial agencies which apparently have so little power, and which seem to work so slowly, have produced creat results.

When thus impressed with the slow rate at which the land is worn away through subaerial and littoral action, it is good, in order to appreciate the past duration of time, to consider, on the one hand, the masses of rock which have been removed over many extensive areas, and on the other hand the thickness of our sedimentary formations. I remember having been much struck when viewing volcanic islands, which have been worn by the waves and rand all round into perpendicular cliffs of one or two thousand feet in height ; for the gentle slope of the lava-streams, due to their formerly liquid state, showed at a glance how far the hard, rocky beds had once extended into the open ocean. The same story is told still more plainly by faults,-those great cracks along which the strata have been upheaved on one side, or thrown down on the other, to the height or depth of thousands of feet ; for since the crust cracked, and it makes no great difference whether the upheaval was sudden, or, as most geologists now believe, was slow and effected by many starts, the surface of the land has been an completely planed down that no trace of these vast dislocations is externally visible. The Craven fault, for instance, extends for upwards of 30 miles, and along this line the vertical displacement of the strata varies from 600 to 3000 feet. Professor Ramsay has published an account of a downthrow in Anglesea of 2300 feet; and he informs me that he fully believes that there is one in Merionethshire of 12,000 feet; yet in these cases there is nothing on the surface of the land to show such prodigious movements; the pile of rocks on either side of the crack having been smoothly swept

On the other band, in all parts of the world the pipe of endmetry stata as or wonderful thebaus. In the Coeffine I estimated end must of conglomerate at ten flowmal of as a quite strain theorem and the strain strain strain strain strain strain performance of the strain strain strain strain strain performance of the strain strain strain strain strain strain matrix strains and the strain performance from strain stor of Orara Berting and this in the prediction of the strain strain of Orara Berting and this in the prediction strain strain strain strain strain strain strain strain strain strains and strain stra

Palsozoic strata (n	ot in	cludi	og ig	-	s bed	8)		Feet. 57,154
Secondary strata								13,190
Tertiary strata								2,240

-making allogather 72,686 for; that is, very novely thirteen and inter-quirters Brithmindic. Some of the formation, which are represented in England by thin bold, are thousands of feet in thickness on the Continent. Moreover, benefacity, but periods of continuous length. So that the lefty pile of nonlineary reacht for the formation of the formation of the set of the during their accumulation. The consideration of these values affects are also been as the set of the set of the set of the andwarent targraphy with the bile of centrally.

Nevertheless this impression is partly false. Mr. Croll, in an interesting paper, remarks that we do not err "in forming too great a conception of the length of geological periods," but in estimating them by years. When geologists look at large and complicated nhenomena, and then at the figures representing several million years, the two produce a totally different effect on the mind, and the figures are at once pronounced too small. In regard to subserial denudation. Mr. Croll shows, by calculating the known amount of areas of drainage, that 1000 feet of solid rock, as it became gradually disintegrated, would thus be removed from the mean level of the whole area in the course of six million years. This seems an astonishing result, and some considerations lead to the suspicion that it may be too large, but even if halved or quartered it is still very surprising. Few of us, however, know what a million really means ; Mr. Croll gives the following illustration ; take a narrow strip of paper, 83 feet 4 inches in length, and stretch it along the wall of a large hall : then mark off at one end the tenth of an inch. This tenth of an inch will represent one hundred years, and the entire strip a million years. But let it be borne in mind, in relation to the subject of this work, what a hundred years implies, represented as it is by a measure atterly insimificant in a hall of the above dimensions. Several eminent breeders, during a single lifetime, have so largely modified some of the higher animals, which propagate their kind much more slowly than most of the lower animals, that they have formed what well deserves to be called a new sub-breed. Few men have attended with due care to any one strain for more than half a century, so that a hundred years represents the work of two breeders in succession. It is not to be sup-

pand that species in a state of mature were change so quickly as domatic animals much the galances of methodical selection. The comparison would be in every way fairer with the effects which, follow from unconscions selection, that is the preservation of the most model or beautiful animals, with no intention of modifying length shows been sensibly changed in the course of two or three caturies.

Specia, however, probably charge much more however, and with the same contraver pairs of a weak spectra the same time. This sizemes follows from all the inhalitants of the same time. This sizemes follows from all the inhalitants of the same times in the poly of nature do not occur until after long intervals, due to the scenatress of physical charges of same kind, or though the setter of new forms. Moreover variations or individual differences of the fitted to their new pheses much the altered circumstances, readdermining, accounting to the standard of years, how lang a period it takes to modify a species; but to the subject of time we must return.

On the Poorness of our Palaeontological Collections,

Now let us turn to our richest geological museums, and what a paltry display we behold ! That our collections are imperfect is admitted by every one. The remark of that admirable palæontobroken specimens, or from a few specimens collected on some one spot. Only a small portion of the surface of the earth has been geologically explored, and no part with sufficient care, as the important discoveries made every year in Europe prove. No organism wholly soft can be preserved. Shells and bones decay and disappear lating. We probably take a quite erroneous view, when we assume that sediment is being deposited over nearly the whole bed of the sea, at a rate sufficiently quick to embed and preserve fossil remains. Throughout an enormously large proportion of the ocean, the bright blue tint of the water bespeaks its purity. The many cases on record of a formation conformably covered, after an immense interval of time, by another and later formation, without the underlying bed having suffered in the interval any wear and tear, seem explicable only on the view of the bottom of the sea not rarely lying

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Palaontological Collections.

for ages in an unaltered condition. The remains which do become embedded, if in sand or gravel, will, when the beds are upraised, generally be dissolved by the percolation of rain-water charged with carbonic acid. Some of the many kinds of animals which live on the beach between high and low water mark seem to be rarely preserved. For instance, the several species of the Chthamalinge (a sub-family of sessile cirrinedes) coat the rocks all over the world in of a single Mediterranean species, which inhabits deep water, and this has been found fossil in Sicily, whereas not one other species has hitherto been found in any tertiary formation : yet it is known that the genus Chthamalus existed during the Chalk period. Lastly, many great deposits requiring a vast length of time for their accumulation, are entirely destitute of organic remains, without our being able to assign any reason ; one of the most striking instances is several thousand, occasionally even six thousand feet, in thickness, and extending for at least 300 miles from Vienna to Switzerland : and although this great mass has been most carefully searched, no fossils, except a few vegetable remains, have been found.

With respect to the terrotical productions which lived during the Secondary and Pallboomic periods, it is superfronto to state that our evidence is fingumentary in an extreme degree. For instance, the second second second second second second second second bases was periods, with the acception of one special discovered by Site G. 19941 and De. Dawon in the actional from the lines. In regard, the meaning-based has been found in the line. In regard, the meaning-based has been found in the line. In regard, the meaning-based has been found in the line. In regard, the meaning-based has been found in the line. In regard, the meaning-based has been found in the line. In regard, the meaning-based has been been been been been been defined in rarity surgrising, when we remember how larges a propertion of the been of territy meansming have been discovered either in ensuing the location deposite, and that oat avec or time phonone formations.

But the imperfection in the geological receed largely results from another and more important eases than any of the foregoing; namely, from the several formations being separated from each other by wide intervals of time. This dectrime has been emphatically admitted by many geologists and palseconlogists, who, like E. Forkey, entirely diabelieses in the change of species. When we see the formations tabulated in written works, or when we follow them in nature, it is difficult to avoid believing that they are closely

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Sources the superimposed formation; to 0.1 is in Nerth America, and in many other parts of the world. The most a killing species, if his attantion had been confined exclusively to these large terforing, would never have mayceld that, driving the periods which were blank and harms in his own country, grant pilles of softmat, damps with and harms in his own country, grant pilles of softmat, larged with the period of the softmation of the softmation of the construction of the length of time which has slapsed between the saccertaion. The frequent and great changes in the minimal goal composition of consocitive formations, generally implying past confinem was derived, accord with the belief of was internals of time having along between each formation.

We can, I think, see why the geological formations of each region are almost invariably intermittent; that is, have not followed each other in close sequence. Scarcely any fact struck me more when examining many hundred miles of the South American coasts, which have been upraised several hundred feet within the recent period. than the absence of any recent deposits sufficiently extensive to last for even a short geological period. Along the whole west coast, which is inhabited by a peculiar marine fauna, tertiary beds are so poorly developed, that no record of several successive and peculiar marine faunas will probably be preserved to a distant age. A little reflection will explain why, along the rising coast of the western side of South America, no extensive formations with recent or tertiary remains can anywhere be found, though the supply of sediment must for ages have been great, from the enormous degradation of the coast-rocks and from muddy streams entering the sea. The explanation, no doubt, is, that the littoral and sub-littoral deposits are continually worn away, as soon as they are brought up by the slow and gradual rising of the land within the grinding action of the coast-waves.

We may, I think, conclude that seliment must be accumulated in extremely thick, solid, or extensive masses, in order to withstand the inessant action of the waves, when first upraised and during accessive oscillations of level, as well as the anbisquine subscript degradation. Such thick and extensive accumulations of sediment may be formed in two ways ; either in profound depids of the sets, in which case the bottom will not be inhaltical by so many and such varied forms of life, as the more analhout sensa; and the mass

when upshed will give an imported record of the commission when constant in the neighborhood during the period of its accumulation. Or, solimout may be deposited to any thickness and extent over a sallow bottom, if it commons dony to subside. In this itster case, as long at the rate of exhibitons and the angle of accliment neutry bottoms such obset, then saw will remain halow and forwards for bottom operations, bottom is the same that the same state of the theory of the same of the same of the same state of the same state with the same of the same state of the same state of the same state with the same state of the same state of the same state of the same state with the same state of the same state state of the same state state of the same state state of the same state of th

I an coverised that starty all our modent formations, which are throughout the gravitate parts of their thickness relation, for density, have thus here formed, during subsidences. Since publishing may view on this analysis in 1.54 (). Laws watchink the programs of Genkey, ing of this or that grant formation, has come to the conclusion that it was accumulated during subsidence. Tany add, that the only moment territary formation on the west coast of Secth America, as yet suffered, but which will handly hast to a distant people of the production of the strength of the strength of the strength genetic during the bickness.

All geological facts tell us plainly that each area has undergone numerous alow couldinos of level, and paperwish these colliations have afficied wide spaces. Consequently, formations of the final and afficiently thick and returnive to react nulseopent degradation, and and the start of the start of the start of the start base of the start of the start of the start of the start with the start of the start of the start of the start matrix start outer, the start of the start of the start in the start of the start in the start of the st

These remarks apply chiefly to litteral and sublitteral depolits in the case of an extensive and shallow see, much as that within a large part of the Maky Archipelage, where the depth varies from $30 \sim 40$ to 60 Athons, as widely extended formation might be formed during a period of elevation, and yet not suffer excessively from demotiation during its alow updaval, but the thickness of the formation could not be great, for owing to the elevatory movement it would be less than the depth in which it was formed in or would

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Denudation of granitic Areas.

the deposit he much consolidated, nor be exped by overlying formations, so that it wereal run a good chance of being worn wave by a tamoghetic deposition and by the action of the was during unbtance of the second second second second second second second Mr. Hopkins, that if one part of the area, after rising rand being being demuch, ambida, the deposit formed thrug the tring morement, though not thick, might afterwards become protected by fread.

Mr. Hopkins also expresses his belief that sedimentary bels of considerable horizontal extent have rarely been completely destroyed. But all geologists, excepting the few who believe that our present metamorphic schists and plutonic rocks once formed the primordial nucleus of the globe, will admit that these latter rocks have been stript of their covering to an enormous extent. For it is scarcely possible that such rocks could have been solidified and crystallized whilst uncovered ; but if the metamorphic action occurred at profound depths of the ocean, the former protecting mantle of rock may not have been very thick. Admitting then that gneiss, micaschist, granite, diorite, &c., were once necessarily covered up, how can we account for the naked and extensive areas of such rocks in many parts of the world, except on the belief that they have subsequently been completely denuded of all overlying strata? That such extensive areas do exist cannot be doubted ; the granitic region of Parime is described by Humboldt as being at least nineteen times as large as Switzerland. South of the Amazon, Boué colours an area composed of rocks of this nature as equal to that of Srain. France, Italy, part of Germany, and the British Islands, all conthus. Von Eschwege gives a detailed section of these rocks, a straight line; and I travelled for 150 miles in another direction. and saw nothing but granitic rocks. Numerous specimens, colme, and they all belonged to this class. Inland, along the whole northern bank of the Plata I saw, besides modern tertiary beds, only have formed a part of the original capping of the granitic series. estimated the areas by cutting out and weighing the paper, and I find that the metamorphic (excluding "the semi-metamorphic")

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and granitic rocks exceed, in the propertion of 19 to 125, the whole of the never Paleotoic formations. In many regions the metamorphic and granitic rocks would be found much more widely extended that they appear to be full the addimentary bedware recovered which rest unconformably on them, and which could not have formed part of the original match under which they were crystalliced. Hence it is probable that in some parts of the word whole formationa have been completely demodel, with not a work left behind,

One remark is how worth a pausing notice. During period, on elevation the area of the hand and of the adjusting shadp part of the sex will be increased, and new stations will often be formaliand the state of the state of the state of the state of the generality less hink in the geolegical record. On the other hand, and the state of the state will decreme (state state of the state will be state of the st

On the Absence of Numerous Intermediate Varieties in any Single Formation,

From these several considerations, it cannot be doubled that the geological record, viewel as a whole, is extremely imperfect; but if we confine our attention to may one formation; his becomes much more difficult to understand why we do not therein find closely gradinated varieties between the aliad species which level at its more effective term of the second state of the same protein species of the second state of the second state of the same protein species of the second state of the same protein species of the second state of the second state of the same protein species from a first mixed state of the same of the gradinated forms of Filtencies multiferming in the successive of second state in indiperiably required a wait number of instances of the gradinated forms of Filtencies multiferming in the successive herein the second state of the species of the second state of the succession has indiperiably required a wait number of years for its more the second state of the species of the second state of the succession has indiperiably required a wait number of years for its responsion weight to the following considerations, and the proportional weight to the following considerations.

Although each formation may mark a very long lapse of years, each probably is short compared with the period requisite to change one species into another. I am aware that two palecontologists, whose opinions are worthy of much deference, namely Bronn and

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We may safely infer that with marine animals of all kinds there has been a large amount of migration due to climatal and other changes; and when we see a species first appearing in any formation, the probability is that it only then first immigrated into that area. It is well known, for instance, that several species appeared somewhat earlier in the ralgeozoic beds of North America than in those of Europe : time having apparently been required for their migration from the American to the European seas. In examining the latest deposits in various quarters of the world, it has everywhere been noted, that some few still existing species are common in the denosit, but have become extinct in the immediately surrounding sea; or, conversely, that some are now abundant in the nzighbouring sea, but are rare or absent in this particular denosit. It is an excellent lesson to reflect on the ascertained amount of migration of the inhabitants of Europe during the glacial epoch. which forms only a part of one whole geological period ; and likewise to reflect on the changes of level, on the extreme change of climate, and on the great lapse of time, all included within this same glacial period. Yet it may be doubted whether, in any of this period. It is not, for instance, probable that sediment was can best flourish : for we know that great geographical changes Mississippi during some part of the glacial period shall have been at different levels, owing to the migrations of species and to geographical changes. And in the distant future, a geologist, examining

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in any Single Formation.

these beds, would be tempted to conclude that the average duration of life of the embedded fossils had been less than that of the glacial period, instead of having been really far greater, that is, extending from before the clacial eroch to the present day.

and lower parts of the same formation, the deposit must have gone on continuously accumulating during a long period, sufficient for the slow process of modification ; hence the deposit must be a very thick one; and the species undergoing change must have lived in the same district throughout the whole time. But we have seen can accumulate only during a period of subsidence; and to keep the depth approximately the same, which is necessary that the same marine species may live on the same space, the supply of sediment must nearly counterbalance the amount of subsidence. But this same movement of subsidence will tend to submerge the area whence the sediment is derived, and thus diminish the supply, whilst the downward movement continues. In fact, this nearly exact balancing between the supply of sediment and the amount of subsidence is probably a rare contingency ; for it has been observed by more than one palgeontologist, that very thick deposits are usually barren of organic remains, except near their upper or lower

It would seem that each separate formation, like the whole pile of formations in any country, has generally been intermittent in its accumulation. When we see, as is so often the case, a formation composed of beds of widely different mineralogical composition, we may reasonably suspect that the process of deposition has been more or less interrupted. Nor will the closest inspection of a formation give us any idea of the length of time which its deposition may have consumed. Many instances could be given of beds only a few feet in thickness, representing formations, which are elsewhere thousands of feet in thickness, and which must have required an enormous period for their accumulation ; yet no one ignorant of this fact would have even suspected the vast lanse of time represented by the thinner formation. Many cases could be given of the lower beds of a formation having been upraised, denuded, submerged, and then re-covered by the upper beds of the same formation,-facts, showing what wide, yet easily overlooked, intervals have occurred in its accumulation. In other cases we have the plainest evidence in great fossilised trees, still standing upright as they grew, of many long intervals of time and changes of level during the process of deposition, which would not have been sus-

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period, bal, not, the trees been preserved: thus file C. Lyout and Dr. Davono from al archindrano below 10400 fest thick in Nova Scotia, with ancient root-bearing attack, one above the older at no sensity of the bolt and the sensitivity of the sensitivity of the period of degradients, both and the sensitivity of the sensitivity period of degradients, both and sensitivity of molecular distribunary times, during the same geological period. Consequently if at degradient of any come geological period. Consequently if at degradient of any come geological period. Consequently if at degradient of any come geological period. Consequently if at the sensitivity of the sensitivity of the sensitivity of the degradient of any come geological period. Consequently if at the sensitivity of the degradient of any come geological period. Consequently if at the sensitivity of the sensitivity

It is all-important to remember that naturalists have no golden rule by which to distinguish species and varieties; they grant some little variability to each species, but when they meet with a somewhat greater amount of difference between any two forms, they rank both as species, unless they are enabled to connect them together by the closest intermediate gradations; and this, from the reasons just assigned, we can seldom hope to effect in any one geological section. Supposing B and C to be two species, and a third, A, to be found in an older and underlying bed; even if A were strictly intermediate between B and C, it would simply be ranked as a third and distinct species, unless at the same time it could be closely connected by intermediate varieties with either one or both forms. Nor should it be forgotten, as before explained, that A might be the actual progenitor of B and C, and yet would not necessarily be strictly intermediate between them in all respects. So that we might obtain the parent-species and its several modified descendants from the lower and upper beds of the same formation, and unless we obtained numerous transitional gradations, we should not recognise their blood-relationship, and should consequently rank them as distinct species.

It is notorious on what accessively alight differences many pulse vologists have founded their species and they do this the neureadily the specimena come from different ant-stages of the same result of the specimena constraints and the specific specific of the very fins species of DV/righty and others into the match written at and on this view we so for that haird of evaluates of a straint specific specific specific specific specific specific later tertury dreposite, which include many of the bayered by the monitory of naturations to be identical with existing regression planes were excellent naturalists, as Ansatz and Picet, moniton that all these tertury species are as periodically distinct, though the distinction

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is admitted to be very slight; as that here, unless we believe that these minimum standing have been minible by their imagination, and that there is the territary species reality present no oblight (sing presentativers), the standing of the standing of the standing of the standing standing of the standing of the standing of the standing standing of the standing of the standing of the we look to maker wider interval of time, mannly to during the standing of the standing of the standing of the standing standing of the standing of the standing of the standing standing of the standing of the standing of the standing standing of the st

With animals and plants that propagate rapidly and do not wander much, there is reason to suspect, as we have formerly seen. that their varieties are generally at first local ; and that such local they have been modified and perfected in some considerable degree, According to this view, the chance of discovering in a formation in any one country all the early stages of transition between any two forms, is small, for the successive changes are supposed to have been local or confined to some one spot. Most marine animals have a wide range; and we have seen that with plants it is those which have the widest range, that oftenest present varieties ; so that, with shells and other marine animals, it is probable that those which had the widest range, far exceeding the limits of the known geological formations of Europe, have oftenest given rise, first to local varieties and ultimately to new species; and this again would creatly lessen the chance of our being able to trace the stages of transition in any one geological formation.

It is a more important consideration, leading to the same roult, as lately insisted on by Dr. Falconer, namely, that the period during which each species underwent modification, though long as measured by years, was probably short in comparison with that during which is remained without undergoing any change.

It should not be forgotien, that at the present day, with perfect specimens for examination, two forms can seldom be connected by intermediate varieties, and thus proved to be the same species, until many specimens are collected from many places; and with fossil species this can rarely be done. We shall, perhaps, hest perceive the improbability of our being enabled to connect species

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by numeras, fina, intermediate, foull links, by suffing ourseiver whenker, for instance, molecular at the first period will be able to prove that our different besolds of cattle, sheep, hores, and dogs and descended from a single atcket for mosered a borginal stockar, or, again, whether certain seashills inhabiting the shores of Neth America, which are randoed by some concluding its and the stockar and the stockar and the stockar at the dot varieties, are randoed by some concluding that and the stockar at the stockar at the stockar at the had incorrecting in a found at the numerous intermediate graduates at each scoces at introducible the stockar at each scoces at its introducible the dipleted degrace.

It has been asserted aver and over anit, by written who believe in the immutability of opticals, that producy yields no linking forms, This assertion, as we shall use in the next charper, is certaily rearrows. As first J. Lablock has meratedly, "I keyr species as link between other alited forms". If we take a generative product a constraint of the strenge of the strenge of the strenge of each other, If the extreme forms in the genus happen to have one that degrees. What geological research has not revealed, by the former extreme of limiting presences products as fing as species. But this cupits not to be expected as you this has have product has not net works on before an and net revealed by repeatedly alwareas a not net serious objection against previous.

It may be worth while to arm up the foregoing remarks on the asses of the imprecision of the goodscale record under an imagnary literation. The Maky Archiptage is about the size of Rhome from the North Cape to the Making and the size of the Size Rhome to the Size and the Maky Archiptage and the size of the North Size and Size and Size and Size and Size and Archiptage with the Gravita and the Size and Size and the Size Size and Size and Size and Size and Size and the Size Size and the Size Size and the Size and Size and Size and Size and Size and Size and the Size and Siz

But we have every reason to believe that the terrestrial productions of the archipelago would be preserved in an extremely imperfect manner in the formations which we suppose to be there accumulating. Not many of the strictly littoral animals, or of

in any Single Formation.

those which lived on naked submarine rocks, would be embedded ; and those embedded in gravel or sand would not endure to a distant epoch. Wherever sediment did not accumulate on the bod of the say, or where it did not accumulate at a sufficient rate to protect organic bodies from decay, no remains could be preserved.

sufficient to last to an age as distant in futurity as the secondary formations lie in the past, would generally be formed in the archipelago only during periods of subsidence. These periods of subsidence would be separated from each other by immense intervals of time, during which the area would be either stationary or rising ; whilst rising, the fossiliferous formations on the steeper shores would be destroyed, almost as soon as accumulated, by the incessant coast-action, as we now see on the shores of South America. Even throughout the extensive and shallow seas within the archipelago, sedimentary beds could hardly be accumulated of great thickness during the periods of elevation, or become capped and protected by subsequent deposits, so as to have a good chance of enduring to a very distant future. During the periods of subsidence, there would probably be much extinction of life : during the periods of elevation, there would be much variation, but the geological record would then be less perfect.

It may be doubted whether the duration of any one great predict of unbalances over this whole or part of the archipelase, together with a contemporaneous accumulation of rationari, would exceed the end of the second second second second second second second gradation between any two or more species. If weak prediction were soit all fully parential, transitional nuclei were soit all fully parential, transitional nuclei probable that each great period of subbidrase would interves during each length periods rated in the inhabitance verse during each length period rate in the second in the second probable that each great period of subbidrase would intervese during each length periods rated in these cases the inhabitance of their modelications could be tweered.

Very many of the marine inhabitants of the archipelage now mage thousands of miles beyond its confines; and analogy plainly leads to the build that it would be chiefly those far-ranging specker, though only smoot of them, which would discness the position new variaties; and the varieties would at first be local or confined to one place, but if possessed of any decided advantance, or when further modified and improved, they would slowly spread and applient their parent-forms. When such varieties returned to Sudden Appearance of

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their ancient homes, as they would differ from their former state in a nearly uniform, though perhaps extremely slight degree, and as they would be found embedded in slightly different substages of the same formation, they would, according to the principles followed by many palesontologists, be ranked as new and distinct species.

If them there be some degree of truth in these remarks, we have no right to expect to find, in our groupdial formations, an infinite number of those finst transitional forms which, on our theory, have consolid all they near and present specifies of the same group into one long and branching chains of this, We could only to look for some more (colory, related to some otherwise), and the base of the same specific strength of the same formation, because one more (colory, related to some otherwise), and have the same strength of the same formation. The base or essential that is based access have supported how prowould, by many passent/optical, here have supported how prowould have any support optical strength and not the was hare recent in the lost prosvering expecting all some first and likely on any theory.

On the sudden Appearance of whole Groups of allied Species.

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Groups of Allied Species.

longer perhaps in many cases than the time required for the accumulation of each formation. These intervals will have given time for the multiplication of species from some one parent-form; and in the succeeding formation, such groups or species will appear as if suddenly created.

I may here recall a remark formerly made, namely, that it micht and peculiar line of life, for instance, to fly through the air : and confined to some one region ; but that, when this adaptation had once been effected, and a few species had thus acquired a great rapidly and widely throughout the world. Professor Pictet, in his excellent Review of this work, in commenting on early transitional forms, and taking birds as an illustration, cannot see how the successive modifications of the anterior limbs of a supposed prototype could possibly have been of any advantage. But look at the penguins of the Southern Ocean; have not these birds their front limbs in this precise intermediate state of " neither true arms nor true wings"? Yet these birds hold their place victoriously in the battle for life ; for they exist in infinite numbers and of many kinds. which the wings of birds have passed ; but what special difficulty is there in believing that it might profit the modified descendants of the penguin, first to become enabled to flap along the surface of the sea like the logger-headed duck, and ultimately to rise from its surface and glide through the air?

I will now give a few examples to illustrate the foregoing remarks, and to also how buy liable was not lower in supporting that whole gramps of specific laws molicity heat probability. The second statistical gramps of specific laws the statistical statistical statistical specific laws and the specific laws and statistical statistical engines of animals have been considerably modified ; and a third elifont would require stall further changes. I may recall the weller statistical work and the statistical statistical statistical statistical statistical middle of the scenario gravity and trace mammalias have been dimidial statistical s 284

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and writely wintum, one how eating species are observables of the stage. Built not how for the rare scalar distribution of the preservation of footstrps in the new red annihilation of the preservation of the star we structure loss more for granute and the star that with write like and the star of the star of the star star is the structure distribbit-like animals, some of granute size, exited during that presidkes a fragment of bone has been discovered in these boles. Note long minimals, with the star of the star of the star of the star of the theory of the star like star is a star of the star of the star of the star of the star like star is particle with the star of the star of the star of the star for the star of the star star of the star star of the star of

I may give another instance, which, from having passed under my own eyes, has much struck me. In a memoir on Fossil Sessile Cirripedes, I stated that, from the large number of existing and extinct tertiary species; from the extraordinary abundance of the individuals of many species all over the world, from the Arctic upper tidal limits to 50 fathoms ; from the perfect manner in which specimens are preserved in the oldest tertiary beds ; from the case with which even a fragment of a valve can be recognised ; from all these circumstances. I inferred that, had sessile cirripedes existed during the secondary periods, they would certainly have been proserved and discovered; and as not one species had then been discovered in beds of this age, I concluded that this great group had This was a sore trouble to me, adding as I then thought one more instance of the abrupt appearance of a great group of species. But my work had hardly been published, when a skilful palgeontologist, takeable sessile cirripede, which he had himself extracted from the chalk of Belgium. And, as if to make the case as striking as possible, this cirripede was a Chthamalus, a very common, large, and ubiquitous genus, of which not one species has as yet been found even in any tertiary stratum. Still more recently, a Pyrgoma, a member of a distinct sub-family of sessile cirrinedes, has been discovered by Mr. Woodward in the upper chalk; so that we now

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have abundant evidence of the existence of this group of animals during the secondary period.

The case most frequently insisted on by palaeontologists of the apparently sudden appearance of a whole group of species, is that of the teleostean fishes, low down, according to Agassiz, in the Chalk classed by one high authority. If the teleosteans had really appeared suddenly in the northern hemisphere at the commencement but it would not have formed an insuperable difficulty, unless it could likewise have been shown that at the same period the species the world. It is almost superfluous to remark that hardly any fossil-fish are known from south of the equator ; and by running through Pictet's Palseontology it will be seen that very few species are known from several formations in Europe. Some few families of fish now have a confined range ; the teleostean fishes might formerly have had a similarly confined range, and after having been largely developed in some one sea, have spread widely. Nor have we any right to suppose that the seas of the world have always been so freely open from south to north as they are at present. Even at this day, if the Malay Archipelago were converted into land, the tropical parts of the Indian Ocean would form a large and perfectly enclosed basin, in which any great group of marine animals might be multiplied ; and here they would remain confined, until some of the species became adapted to a cooler climate, and were enabled to double the Southern capes of Africa or Australia, and thus reach other and distant seas.

From these considerations, from our ignorance of the geology of other countries beyond the confines of Runoy and the United States, and from the revolution in our palsemological knowledge effected by the discoveries of the last doorn yarse, it seems to ne to be about as make to degrantize on the succession of organic forms where the other of the second state of the second state of the intervence of the second state of the second state of the minimum on a barren point in Australia, and then to discuss the number and mange of its productions.

On the sudden Appearance of Groups of allied Species in the lowest known Fossiliferous Strata,

There is another and allied difficulty, which is much more serious. I allude to the manner in which species belonging to several of the

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lowest known fossiliferous rocks. Most of the arguments which have convinced me that all the existing species of the same groun are descended from a single progenitor, apply with equal fores to the earliest known species. For instance, it cannot be doubted that all the Cambrian and Silurian trilobites are descended from some one crustacean, which must have lived long before the Cambrian age, and which probably differed greatly from any known animal, Some of the most ancient animals, as the Nautilus, Lingula, &c., do not differ much from living species; and it cannot on our theory be supposed, that these old species were the progenitors of all the species belonging to the same groups which have subsequently appeared, for they are not in any degree intermediate in character. Consequently, if the theory be true, it is indisputable that before the lowest Cambrian stratum was deposited, long periods elarsed, as long as, or probably far longer than, the whole interval from the Cambrian age to the present day ; and that during these vast periods the world swarmed with living creatures. Here we say counter a formidable objection ; for it seems doubtful whether the earth, in a fit state for the habitation of living creatures, has lasted long enough. Sir W. Thompson concludes that the consolidation of the crust can hardly have occurred less than 20 or more than 400 million years ago, but probably not less than 98 or more than 200 million years. These very wide limits show how doubtful the data are; and other elements may have hereafter to be introduced into the problem. Mr. Croll estimates that about 60 million years have claused since the Cambrian period, but this, judging from the small amount of organic change since the commencement of the Glacial epoch, appears a very short time for the many and great mutations of life, which have certainly occurred since the Cambrian formation ; and the previous 140 million years can hardly be considered as sufficient for the development of the varied forms of life which already existed during the Cambrian period. It is, however, probable, as Sir William Thompson insists, that the world at a very early period was subjected to more rapid and violent changes in its physical conditions than those now occurring ; and such changes would have tended to induce changes at a corresponding rate in the organisms which then existed.

To the question why we do not find rich fossiliferous degotits belonging to these assumed earliest periods prior to the Cambrian system, I can give no satisfactory answer. Several eminant geo logists, with Sir R, Murchison at their head, were until recently coverinced that we beheld in the organic remains of the lowest

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Silurian stratum the first dawn of life. Other highly competent judges, as Lycll and E. Forbes, have disputed this conclusion. We should not forget that only a small portion of the world is known with accuracy. Not very long ago M. Barrande added down in the Lower Cambrian formation, Mr. Hicks has found in South Wales beds rich in trilobites, and containing various molluses and annelids. The presence of phosphatic nodules and bituminous matter, even in some of the lowest azoic rocks, probably indicates life at these periods; and the existence of the Eozoon in the Laurentian formation of Canada is generally admitted. There are three great series of strata beneath the Silurian system in Canada, in the lowest of which the Eozoon is found. Sir W. " that of all the succeeding rocks, from the base of the palseozoic " series to the present time. We are thus carried back to a period "so remote, that the appearance of the so-called Primordial fauna "(of Barrande) may by some be considered as a comparatively "modern event." The Eozoon belongs to the most lowly organised of all classes of animals, but is highly organised for its class; it existed in countless numbers, and, as Dr. Dawson has remarked, certainly preved on other minute organic beings, which must have lived in great numbers. Thus the words, which I wrote in 1859, about the existence of living beings long before the Cambrian period, and which are almost the same with those since used by Sir W. Logan, have proved true. Nevertheless, the difficulty of assigning any good reason for the absence of yast piles of strata rich in fossils beneath the Cambrian system is very great. It does not seem probable that the most ancient beds have been quite worn away by denudation, or that their fossils have been wholly obliterated by metamorphic action, for if this had been the case we should have found only small remnants of the formations next succeeding them in age, and these would always have existed in a partially metamorphosed condition. But the descriptions which we possess of the Silurian deposits over immense territories in Russia and in North America, do not support the view, that the older a formation is, the more invariably it has suffered extreme denudation and metamorphism.

The case at present must remain inexplicable; and may be truly unged as a valid argument against the views here entertained. To show that it may hereafter receive some explanation, I will give the following hypothesis. From the nature of the organic remains

which do not appear to have inhabited profound depths, in the second formations of formers and of the United States, and from the amount of submerst, miller it takets, or which the formation of the second states of the second states of the second states of material family, where the scattering takets are stated as a first of takets, where the scattering takets are derived, occursely in the melphotenhoot of the more existing continuum of Kerney and Area's Amorica. This many true has takets drawing these materials of this product the second states of the scattering of the scattering of the interval is between the scenario formations of whether Europe and the United States during these intervals existed and principles, are sub-based of an open and unitakenable non.

Looking to the existing oceans, which are thrice as extensive as the land, we see them studded with many islands; but hardly one truly oceanic island (with the exception of New Zealand, if this can be called a truly oceanic island) is as yet known to afford even a remnant of any palseozoic or secondary formation. Hence we may norhans infer, that during the nalmozoic and secondary periods neither continents nor continental islands existed where our oceans now extend ; for had they existed, palaeozoic and secondary formaderived from their wear and tear; and these would have been at least vartially unheaved by the oscillations of level, which must have intervened during these enormously long periods. If then we may infer anything from these facts, we may infer that, where our oceans now extend, oceans have extended from the remotest period of which we have any record ; and on the other hand, that where continents now exist, large tracts of land have existed, subjected no doubt to great oscillations of level, since the Cambrian period. The coloured map appended to my volume on Coral Reefs, led me to conclude that the great oceans are still mainly areas of subsidence, the great archipelagoes still areas of oscillations of level, and the continents areas of elevation. But we have no reason to assume that things have thus remained from the beginning of the world. the areas of preponderant movement have changed in the lapse of ages? At a period long antecedent to the Cambrian epoch, conclear and open oceans may have existed where our continents now

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we should have fiel asilinentary formations in a recognizable collision older than the Gunkrinn strates, megnolag much to have been femery' deposited; for it might well happen that strata, and which had head some miles marer to the centre of the earth, and which had been pressed on by an concrease weight of a sprinand which had been pressed on by an energon of the seriflex. The immense areas in some parts of the world, for instance in batch during on the duck materia prior back, which muth alwar been hashed and great pressure, have always seemed to me to requese the factors are always assembly the inter the two areas in these larger areas, the many formations during the strate of the factors are always assembly and the strate of the factors are always assembly and the strate of the factors are always assembly and the strate of the scaling of the

The several difficulties here discussed, namely-that, though we find in our geological formations many links between the species which now exist and which formerly existed, we do not find infinitely numerous fine transitional forms closely joining them all as at present known, of formations rich in fossils beneath the Cambrian strata,-are all undoubtedly of the most serious nature. We see this in the fact that the most eminent palcontologists, namely, Cuvier, Agassiz, Barrande, Pictet, Falconer, E. Forbes, &c., and all our greatest geologists, as Lyell, Murchison, Sedgwick, &c., have unanimonaly, often vehemently, maintained the immuhis high authority to the opposite side ; and most geologists and relacentelogists are much shaken in their former belief. These who believe that the geological record is in any degree perfect, will undoubtedly at once reject the theory. For my part, following out world imperfectly kept, and written in a changing dialect ; of this history we possess the last volume alone, relating only to two or three countries. Of this volume, only here and there a short chapter has been preserved ; and of each page, only here and there a few lines. Each word of the slowly-changing language, more or falsely appear to us to have been abruptly introduced. On this

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CHAPTER XI.

ON THE GEOLOGICAL SUCCESSION OF ORGANIC BRINGS,

On the alow and mecosive appearance of new species —On their different rates of charge —Species case to the ots are rappear. —Orange of species follow the same general rules in their appearance and dispiparance as do single représe —On extinction —On simultaneous changes in the forms of life throughout the world —On the affinities of exiting species to each other and to living appeare.—On the attaints of exiting the space —On the succession of the same types within the same areas —Summary of presenting and present chapter.

LET us now see whether the several facts and laws relating to the geological succession of organic beings accord best with the common view of the immutability of species, or with that of their slow and gradual medification, through variation and natural selection.

New species have appeared very dowly, one after modelre, bolt on the hand and in the watters. Lyth the aboven that it is in a high the stars, and the watters. Lyth the aboven that it is in a bulk to the stars, and near the very truth to fill up the binks between the stars, and to make the properior between the botts and estiting forms more gradual. In some of the next recent bolt, fidge inducibely of high antiquity if maximum by yours, only one of appeared there for the first time, either leading or, as first a wave, on the fine of the antit, the secondary formations are more broken; but, as Dean has remarked, nother the appendix on bulk presented of the angle species candidal in each formation as the secondary formations of the first the secondary formations are more broken; but, as Dean has remarked, nother the sequences

Species belonging to different genera and classes have not damged at the same rais, or in the same deprese. In the older tetriky beds a few iving shalls may still be found in the midde of a midtical of existing froms. Falcower has given a sained with may be an anomaly and regulate in the sub-Himalayan deposits. The Subrian Linguia differs but Hitt from the living neposies of this grouts y horeas most of the other Siltriran Mollows and all the Cantesona have changed gravity. The productions of the links

of Organic Beings.

areas to have changed at a quicker rate than these of the sec, of which a strilling training have the quantum string of the second rate of the second string string of the second string rate of the second string string string string string string to the same in a soft second variable of the second string with the found to have undergoing second string string string with the string str

process of modification must be slow, and will generally affect only is independent of that of all others. Whether such variations or natural selection in a greater or less degree, thus causing a greater or less amount of permanent modification, will depend on many complex contingencies-on the variations being of a beneficial nature, on the freedom of intercrossing, on the slowly changing physical conditions of the country, on the immigration of new the varying species come into competition. Hence it is by no means surprising that one species should retain the same identical bitants of distinct countries; for instance, the land-shells and coleopterous insects of Madeira have come to differ considerably marine shells and birds have remained unaltered. We can perhaps understand the apparently quicker rate of change in terrestrial in a former chapter. When many of the inhabitants of any area principle of competition, and from the all-important relations of

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organism to organism in the struggle for life, that any form which did not become in some degree modified and improved, would be likely to externization. Hence we see why all the species in the same region do at last, if we look to long enough intervals of time, become modified, for otherwise they would become extinct.

In members of the same class the average amount of charge, during long and qual periods of time, away, perhaps, be many har amore, but as the accumulation of enduring formation, neth in finalit, depends on great masses of solumnt being deputied on minimized as welds alregalaxy interminited mitary and consequently the amount of erganics change exhibition by the fault consequence of the solution of the consequence of the solution but only an occasional zeros, taken almost at hannel, in an ever solution of the solution of t

We can charly understand why a species when ones host holds have re-rappen, excit the very name conditions of like, segments and might be adapted (can' no denbt this has coverred in immunels hancon) to fill the phere of another presents in the scoomary of matters, and thus anyphant ity yes the two forms——be diand the mes—round not be identically the same gives in the scoomary of matters, and thus anyphant ity yes the two forms——be diand the distribution of the star of the star of the star present benefician or the star of the star of the star of explosions atomized with the star of the star of the present beneficiant of the star of the star of the star distribution of the star of the star of the star of the star distribution of the star of the star of the star of the star distribution of the star of the star of the star of the star distribution of the star of the star of the star of the star distribution of the star of the star of the star of the star for the another with the star of the star of the star of the star for the another with the star of the star of the star of the star for the another with the star of the star of the star of the star for the another with the star of the star of the star of the star distribution of the star distribution of the star of the sta

Groups of species, that is genera and families, follow the same general rules in their appearance and disappearance as do single species, changing more or less quickly, and in a greater or lesser degree. A group, when it has one disappeard, never respects; that is, its cristence, as long as it lasts, is continuous. I am aware that there are some apparent exceptions to this rule, but the exceptions are argument exceptions to this rule, but the exceptions are argument exceptions to this rule, but the

of Organic Beings.

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Woolweed (though all strongly exposed to each views as I maintain) admin in terthic, and the real-articly accession with the heavy. For all the species of the same group, however loog it may have lasted, as the modified describation, one from the other, and all from a common progenitor. In the grann Linguis, for instance, the species which have successively a graneral at all ages must have been connected by an unbesken artis of generations, from the lowest Silveins actaint mo that researd day.

We have seen in the hat chapter that while groups of pecies mominum failary paper to have been abreryly developed; and I have attempted to give an explanation of this fact, which if tree works be failad to gives an explanation of this fact, which if tree developed the second second second second second second trees are also been provided that and the second second

On Extinction.

We have as yet speken only incidentify of the disreparators of species and of groups of projects. On the theory of natural selection, the extinction of old forms and the production of now and improved in a concentry product is very generally grown, up, even by cluster product is a concentry product in very generally grown, up, even by these general very would minimally land them to this continuity. On the contrary, we have every means to bisiers, from the study of the

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tertiary formations, that species and groups of species gradually disappear, one after another, first from one spot, then from another. breaking of an isthmus and the consequent irruption of a multitude of an island, the process of extinction may have been rapid. Both single species and whole groups of species last for very unequal periods; some groups, as we have seen, have endured from the earliest known dawn of life to the present day ; some have disappeared before the close of the paleozoic period. No fixed law species or any single genus endures. There is reason to believe that cess than their production ; if their appearance and disappearance be represented, as before, by a vertical line of varying thickness. the line is found to taper more gradually at its upper end, which marks the progress of extermination, than at its lower end which marks the first appearance and the early increase in number of the species. In some cases, however, the extermination of whole groups, as of ammonites, towards the close of the secondary period,

The extention of species has been involved in the most granitous projecty. Some values have cern arrows that, at the individual some can have marvelled more than 1 have does at the extinction of the second states of the second states of the second states with the remains of Matsdow, Megatherium, Toxolon, and other extinct monetax, which all osciential with said length and were bate projection of the second state of the second state states are stated as the second state of the second state states are states at an unparalleled rate, 1 and and model as increased in numbers at an unparalleled rate, 1 and and model as increased in numbers of the second state of the second state different of the space states are stated as the state of the state increased in the state state of the state of the state of the state different of the space states are stated as the state of the state would have setter the length state in a state of the state states are stated as a state of the state of the state of the state states are stated as the state of the state of the state of the state states are stated as the state of the state of the state of the state states are stated as the state of the state of the state of the state states are stated as the state of the state of the state of the state states are stated as the state of the s

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certain, from this analogy of all chier mammals, even of the above baseling dephane, and from the history of the maturalization of the domestic hower in South America, that under mere Movemble coatilities it would in a very few years have atocked the whole continues. Inst we goals not have table, where the source even outgrades of the source of the source of the source of the outgrades of the source of the source of the source of the outgrades of the source of the source of the source of the outgrades of the source of the source of the source of the outgrades of the source of the source of the source of the outgrades of the source of the source of the source of the outgrades of the source of the source of the source of the outgrades of the source outgrades of the source of the source of the outgrades of the source outgrades of the source of the source of the outgrades of the source outgrades of the source outgrades of the outgrades of the source outgrades outgrades of the source outgrades outgrades of the outgrades of the source outgrades outgrade

It is most difficult always to remember that the increase of every creature is constantly being checked by unperceived hostile agencies ; and that these same unperceived agencies are amply sufficient to cause rarity, and finally extinction. So little is this subject undermonsters as the Mastodon and the more ancient Dinosaurians having become extinct; as if mere bodily strength gave victory in the battle of life. Mere size, on the contrary, would in some cases determine, as has been remarked by Owen, quicker extermination from the greater amount of requisite food. Before man inhabited India or Africa, some cause must have checked the continued increase of the existing elephant. A highly capable judge, Dr. Falconer, believes that it is chiefly insects which, from incessantly harassing and weakening the elephant in India, check its increase; and this was Bruce's conclusion with respect to the African elephant in Abyssinia. It is certain that insects and blood-sucking bats determine the existence of the larger naturalised quadrupeds in

We see in many cases in the more recent tertiary formation, that nrity preceds extinction; an any whore what this has been their programs of events with those animals which have been exterinated, either because of the second second second second premety because more backers due because the second second prime at the nrity of a species, and yet to marvel gravity when the prime at the nrity of a species, and yet to marvel gravity when the interlevent is from the second second second second the interlevent is back the second second second second at second second second second second second second at second second second second second second second at second second second second second second second second at second second

The theory of natural selection is grounded on the belief that each new variety, and ultimately each new species, is produced and

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maintained by having zone advantage over these with which in comes into competential rank of the compared extinction of the lass favored berns almost inevitably follows. It is the same write and innevita productions when a new advantage of the same write and the same neighborrhood is when much improved it is it range of and new, like or other-here an tight and that the phase of other breach in other constraints. Thus the appearance of new forms and the damperature of other damperatures of the same write in the same of the other constraints. Thus the appearance of damperatures of the maps and the same periodic production of the same straint production of the same periodic production on individually been regreter than the number of new specific forms which have been next extrained and prove time has at some periodic product be constrained and the viscouries of the same periodic products are individually been regreter than the number of the old specific forms which have been next extrained to be sknow that precisis have not appear on individually thermasing the viscouries of the same periodic products are been externised to be sknow that proton is an appearance of old forms.

The competition will generally be most severe, as formerly explained and illustrated by examples, between the forms which are most like each other in all respects. Hence the improved and nation of the parent-species; and if many new forms have been nation. Thus, as I believe, a number of new species descended genus, belonging to the same family. But it must often have developed from the successful intruder, many will have to yield suffer from some inherited inferiority in common. But whether it yielded their places to other modified and improved species, a few of the sufferers may often be preserved for a long time, from being

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With respect to the apparently solidon attermination of which families or cellers, and Triholties at the close of the paleoscio period and of Ammoniton at the close of the secondary period, we are approximately and the close of the secondary period, we are approximately and the secondary period of the intervals there may have been much above externization. Morement, many probes of a new grasp have taken procession of an energy may have been much above externization. Morement, many probes of a new grasp have taken procession of an energy may have been much above externization. Morement, many probes of a new grasp have been externation in the secondary problem of a new grasp. The secondary period development, many problem of a new grasp have been been externation of the secondary period of the secondary period of the same inferiodity in common.

Thus, as it seems to me, the varanner in which single species and while groups of process become extinct accords well with the theory of natural selection. We need not marvel at extinction, if we use that we understand permany provide the selection of the mean set of the mean set of the set of t

On the Forms of Life changing almost simultaneously throughout the World.

Eases) any phasentological discovery is more striking than the date, that the forms of life charge absorb simultaneously threngdout the work). Thus our European Galak formation can be recognized in many distant englosus, moder the assort different climates, where not a fragment of the mineral chail itself can be, in Yerra and Harges at the Coge of Good Hape, and in the postment of Irelia. For at these distant points, the organic remains in a critical bala transfer and the same species are mark with ; for in some cases not can expect as unmittaneously the assorb, that the polycon (the larges in the organic larges) and the same same simple bolong of the same family admittened in such setting points as more superfail are pixel and the same, which are not formal in the Charge

Forms of Life changing

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but which court in the formations stillar above or balow, covering the heaven order at the socializato pitto for the words. In the sevenal associative palaeontic formations of Russia, Western Europe, and the social state of the social state of the social state of the social system and the seven is a socieding to farget the Russian and North American tortiary deposits. From if the key logit wheely out of view, the general paulibilium in the successive logit wheely out of view (and general paulibilium in the successive logit wheely out of view (and general paulibilium in the successive state) are solved in the social for solved parallel.

These observations, however, relate to the matrice inhibiting of the world : we have not sufficient data to judge whether the psydections of the land and of freedw whet at distant points change in the same parallel manner. We may double whether they have him changed i: if the Magatherium, Mylolon, Macromotenia, and Toxodon hal been broaded to Enzops from La Flata, while the most formation in regard to their product position, no one would have the at how a non-most more exception of the star of the star of the star at the same matrix of the star of the star of the star of the star Hore, it is unjet at least have been inferred that they had lived during one of the late treations gas.

When the matrix forms of life are spoken of a having dauged similaneously threaghout the work), it must not be supposed that this expression relation to the same year, act to the name century, matrix animals not wirking in Energy, and all those that lived in Europe during the pleistocens period (a very remote period as measured by years, including the whole glucial equilibrium of the measured by years, including the whole glucial equilibrium theory of the pleistocens including the spike of the present century of the spike spike of the spike of the present clongic theors of the non-theor hearing productions of the Tailod States are more clongy robust to the present formed barries or the southern benefative to the present formed barries or the spike spike spike spike spike spike formed barries or the spike spike spike spike spike spike formed barries or the barries of the spike spike spike barries. Nevertheless, looking to a remotely future epsk, there are belist for during the interplacement and attrictly modern barries the upper placeons, the plationeon and attrictly modern barries and the spike spike spike spike spike spike spike spike spike the upper placeons, the plationeon and attrictly modern barries and the spike spi

throughout the World.

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forms which are found only in the older underlying deposits, would be correctly ranked as simultaneous in a geological sense.

The fact of the forms of life changing simultaneously, in the above large sense, at distant parts of the world, has greatly struck those admirable observers, MM. de Verneuil and d'Archiac. After referring to the parallelism of the palaeozoic forms of life in various parts of Europe, they add, "If, struck by this strange sequence, we " turn our attention to North America, and there discover a series " fications of species, their extinction, and the introduction of new " ones, cannot be owing to mere changes in marine currents or other " causes more or less local and temporary, but depend on general " laws which govern the whole animal kingdom." M. Barrande has made foreible remarks to precisely the same effect. It is, indeed, quite futile to look to changes of currents, climate, or other physical conditions, as the cause of these great mutations in the forms of life throughout the world, under the most different climates. We must, as Barrande has remarked, look to some special law. We shall see this more clearly when we treat of the present distribution of organic beings, and find how slight is the relation between the physical conditions of various countries and the nature of their inhabitants.

This great fact of the parallel succession of the forms of life throughout the world, is explicable on the theory of natural selection. New species are formed by having some advantage over some advantage over the other forms in their own country, give birth to the greatest number of new varieties or incipient species. We have distinct evidence on this head, in the plants which are dominant, that is, which are commonest and most widely diffused, producing the greatest number of new varieties. It is also natural that the dominant, varying, and far-spreading species, which have already invaded to a certain extent the territories of other species, should be those which would have the best chance of spreading still further, and of giving rise in new countries to other new varieties and species. The process of diffusion would often be very slow, depending on climatal and geographical changes, on strange accivarious climates through which they might have to pass, but in the course of time the dominant forms would generally succeed in We might therefore expect to find, as we do find, a less strict degree

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of parallelism in the succession of the productions of the land than with those of the sea.

Thus, as it seems to me, the parallel, and, taken in a large sense, iminihanous, accession of the same forme of life throughout the world, accords well with the principle of new species having been found by dominant precises apscaling which and warrying; the new found is a series of the series of the series of the series having had some advantage, over their already dominant, but havducing new forms. The old forms which are basten and which which therefore, an even all interesting reasoning many pladicing new forms. The old forms which are basten and which allow its new root of the large of the series of the series allow in process, and again regress from gene throughout the world, where the series of all discrete series and the series of the series of the series and discrete series where the series of the series of the series of the series and all discrete series.

There is one other remark connected with this subject worth making. I have given my reasons for believing that most of our great formations, rich in fossils, were deposited during periods of subsidence; and that blank intervals of vast duration, as far as the sea was either stationary or rising, and likewise when sediment was not thrown down quickly enough to embed and preserve organic remains. During these long and blank intervals I suppose that the inhabitants of each region underwent a considerable amount of modification and extinction, and that there was much migration from other parts of the world. As we have reason to believe that large areas are affected by the same movement, it is probable that strictly contemporaneous formations have often been accumulated over very wide spaces in the same quarter of the world : but we are very far from having any right to conclude that this has invariably been the case, and that large areas have invariably been affected by in two regions during nearly, but not exactly, the same period, we paragraphs, the same general succession in the forms of life; but the species would not exactly correspond ; for there will have been a little more time in the one region than in the other for modifica-

I suspect that cases of this nature occur in Europe. Mr. Prestwich, in his admirable Memoirs on the eccene deposits of England and France, is able to draw a close general parallelism between the successive stages in the two countries; but when bo

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compares certain stages in England with those in France, although belonging to the same genera, yet the species themselves differ in a manner very difficult to account for considering the proximity of the two areas,-unless, indeed, it be assumed that an isthmus separated two seas inhabited by distinct, but contemporaneous. faunas. Lyell has made similar observations on some of the later tertiary formations. Barrande, also, shows that there is a striking general parellelism in the successive Silurian deposits of Bohemia difference in the species. If the several formations in these regions have not been deposited during the same exact periods .--- a formaother .- and if in both regions the species have gone on slowly changing during the accumulation of the several formations and during the long intervals of time between them ; in this case the several formations in the two regions could be arranged in the same order, in accordance with the general succession of the forms of life, and the order would falsely appear to be strictly parallel; nevertheless the species would not be all the same in the apparently corresponding stages in the two regions.

On the Affinities of Extinct Species to each other, and to Living Forms.

Let us now look to the mutual affinities of extinct and living species. All fall into a few grand classes ; and this fact is at once explained on the principle of descent. The more ancient any form is, the more, as a general rule, it differs from living forms. But, as Buckland long ago remarked, extinct species can all be classed forms of life help to fill up the intervals between existing genera, families, and orders, is certainly true; but as this statement has often been ignored or even denied, it may be well to make some remarks on this subject, and to give some instances. If we confine our attention either to the living or to the extinct species of the same class, the series is far less perfect than if we combine both into one general system. In the writings of Professor Owen we continually animals; and in the writings of Agassiz, of prophetic or synthetic types; and these terms imply that such forms are in fact inter-M. Gaudry, has shown in the most striking manner that many of the fossil mammals discovered by him in Attica serve to break

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down the intervals between existing genera. Cuvier ranked the Owen has had to alter the whole classification, and has placed but the Macrauchenia of S. America connects to a certain extent Professor Gervais expresses, and which cannot be placed in any existing order. The Sirenia form a very distinct group of mammals and lamentin is the entire absence of hind limbs, without even a rudiment being left; but the extinct Halitherium had, according to Professor Flower, an ossified thigh-bone "articulated to a welldefined acetabulum in the pelvis," and it thus makes some approach all other mammals, but the tertiary Zenglodon and Squalodon. which have been placed by some naturalists in an order by themselves, are considered by Professor Huxley to be undoubtedly cetaceans, " and to constitute connecting links with the aquatic car-

Even the wide interval between birds and reptiles has been hown by the anstatutisti jost quoids to he yardally bidged ever in the most meacpeteid manner, on the one hand, by the outfiles attick Arkologetyrs, and ca file outer hand, by the Compognation, one of the Dimensitant—that group which includes the not generate of all treneristict applied. Turning to the Inverteleration, harmode seets, and a higher authority could not be inset the he is every day tunght that, shores, yet what at this monitor period the groups were not so distingtly separated from each other as there no are:

Some writers have objected to any extinct species, or group of species, being considered as intermediate between any two living species, or groups of species. If by this term it is meant that an extinct form is directly intermediate in all its characters between two living forms or groups, the objection is probably ralid.

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But in a natural classification many fossil species certainly stand between living species, and some critical genera between living genera, even between genera belonging to distinct families. The most censmo case, specially with inspect to very distinct groups, such as fais and repeiles, seems to be, that, supposing them to be distinguished at the promet day by a score of characters, the hancient of the two groups formerly made a somewhat mater approach to each other than they now do.

¹ It is a common belief that the more ancient a form is by pomuch the more its that is common ity power of its character groups new videly separated from each other. This remark no doubt and be reducted to these groups which have undergoes much strain the reduction of the separate separate separate separate to prove the truth of the proposition, for every now and then even invites mannal and the Lepidonten, is discovered having affinities directed towards very distinct groups. Yet if we compare the doce Regults and the colour Mannaha, with the more vera manhane strain the second mannaha and the three is write in the the remark.

Let us see how far these several facts and inferences accord with the theory of descent with modification. As the subject is somewhat complex, I must request the reader to turn to the diagram in the fourth chanter. . We may suppose that the numbered letters in italics represent genera, and the dotted lines diverging from them the species in each genus. The diagram is much too simple, too few genera and too few species being given, but this is unimportant for us. The horizontal lines may represent successive geological formations, and all the forms beneath the uppermost line may be considered as extinct. The three existing genera a¹⁴, a¹⁴, p¹⁴, will form a small family ; b¹⁴ and f²⁴ a closely allied family or sub-family ; and o's, e's, m's, a third family. These three families, together with the many extinct genera on the several lines of descent diverzing from the parent-form (A) will form an order; for all will have inherited something in common from their ancient progenitor. On the principle of the continued tendency to divergence of character, which was formerly illustrated by this diagram, the more recent any form is, the more it will generally differ from its ancient progenitor. Hence we can understand the rule that the most ancient fossils differ most from existing forms. We must not, however, assume that diversence of character is a necessary contingency ; it depends solely

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on the decondants from a species being thus enabled to seize an many and different places in the concentry of nature. Therefore it is guite possible, as we have seen in the case of some Silurian forms, that a species might go on being slightly modified in relation to its alightly altered conditions of like, and yet retain throughout a vast period the same general characteristics. This is represented in the diarrow but held ster ²⁴.

All the many forms, extinct and recent, descended from (A), make, as block or temarked, one order; and this order, from the continued effects of extinction and divergence of character, has become divided into several sub-familles and families, some of which are supposed to have periabed at different periods, and nome to have endured to the present day.

By looking at the diagram we can see that if many of the extinct discovered at several points low down in the series, the three existing families on the uppermost line would be rendered less distinct from each other. If, for instance, the genera a1, a5, a19, closely linked together that they probably would have to be united into one great family, in nearly the same manner as has occurred with ruminants and certain pachyderms. Yet he who objected to the living genera of three families, would be partly justified, for they are intermediate, not directly, but only by a long and circuitous course through many widely different forms. If many extinct forms were to be discovered above one of the middle horizontal lines or geological formations-for instance, above No. VI.-but none from beneath this line, then only two of the families (those on the left hand, a14, &c., and b14, &c.) would have to be united into one : and there would remain two families, which would be less distinct from each other than they were before the discovery of the fossils. So again if the three families formed of eight genera (all to mil) on the unrermost line, be supposed to differ from each other by half-a-dozen important characters, then the families which existed at the period marked of characters: for they would at this early stage of descent have diverged in a less degree from their common progenitor. Thus it or between their collateral relations.

Under nature the process will be far more complicated than is

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regressited in the diagram; for the groups will have been more memory it by will have obtained for externedy unoqual lengths of time, and will have been modified in various degrees. As we present only the activations of the geological revert, and that in a very includence constitution, we have no right to expect score and then its sum its distinct families or orders. All that we have a right to expect is, that these groups which have which we a right to expect is, that these groups which have which all the its sum its sum early a start of the start of the older formations make some slight approach to each other in some of their characters than do the existing numbers of the information of the information of the scientific or the automation of the information of the scientific or or the automation of the information of the scientific or the science of the science o

Thus, on the theory of descent with modification, the main facts with respect to the mutual affinities of the extinct forms of life to each other and to living forms, are explained in a satisfactory manner. And they are wholly inexplicable on any other view.

On this same theory, it is evident that the fauna during any one great period in the earth's history will be intermediate in general character between that which preceded and that which succeeded it. Thus the species which lived at the sixth great stage of descent in the diagram are the modified offspring of those which lived at the fifth stage, and are the parents of those which became still more modified at the seventh stage ; hence they could hardly fail to be nearly intermediate in character between the forms of life above and below. We must, however, allow for the entire extinction of some preceding forms, and in any one region for the immigration of new forms from other regions, and for a large amount of modification during the long and blank intervals between the successive formations. Subject to these allowances, the fauna of each geological period undoubtedly is intermediate in character, between the preceding and succeeding faunas. I need give only one instance, namely, the manner in which the fossils of the Devonian system, when this system was first discovered, were at once recognised by palæontologists as intermediate in character between those of the overlying carboniferous, and underlying Silurian systems. But each fauna is not necessarily exactly intermediate, as unequal intervals of time have elapsed between consecutive formations.

It is no real objection to the truth of the statement that the fauna of each period as a whole is nearly intermediate in character between the preceding and succeeding faunas, that certain genera

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offer exceptions to the rule. For instance, the species of mastodons place according to their periods of existence,-do not accord in or the most recent; nor are those which are intermediate in character, intermediate in age. But supposing for an instant, in this and other such cases, that the record of the first appearance and disappearance of the species was complete, which is far from the case, we have no reason to believe that forms successively produced necessarily endure for corresponding lengths of time. A very ancient form may occasionally have lasted much longer than a form trial productions inhabiting separated districts. To compare small things with great; if the principal living and extinct races of the would not closely accord with the order in time of their production, and even less with the order of their disappearance ; for the rarent and the carrier have become extinct; and carriers which are extreme in the important character of length of beak originated earlier than short-beaked tumblers, which are at the opposite end

Closely connected with the attainant, that the organic results from an intermediate formation are in some degree intermediate in character, is the fact, instaled on by all paleoutlogicity, thus the order of the second second second second second to each other, thus are the Gausie formation of the organic results for gravity results from the averal stages of the Gall formalies, though the species are duling that days of the Gall formalies, though the species are duling the species of the species of the stage of the species of the species of the species of the species results from the averal stages of the Gall formation, though the species are duling the species. Here she is a special with the duitrbuffun of existing species over the globy, will and though concentrity formations, by the physical constituent of the species of the species in the species in the species in desity concentrity formations, by the physical constituent of the results and different dimension and conditions. Closeling for under the most different dimension and conditions. Considtent under the most different dimension and conditions. Considtent is the form of line, is just the subscription of the species from of the species form of the inhight that of the sone have been faction.

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State of Development.

On the theory of dascert, the full meaning of the fossil remains from decay concentries formations being cloadyr related, though match as duffinited species, is obvious. As the accumulation of each formation has order hear interrupted, and as long blanks intervals have information has order been interrupted, and as long blanks intervals accepte to find, as a tratempted to observe in the last chapter, in any one or in my two formations, all the intermediate varieties between the species which appeared at the commencement and close of these

periods: but we ought to find after intervals, very long as measured by years, but only moderately long as measured geologically, closely allied forms, or, as they have been called by some authors, representative species; and these assuredly we do find. We find, in short, such evidence of the slow and searedly sensible mutations of specific ferms, are when her the right to expect.

On the State of Development of Ancient compared with Living Forms.

We have seen in the fourth chapter that the degree of differentiation and specialisation of the parts in organic beings, when arrived at maturity, is the best standard, as yet suggested, of their degree of perfection or highness. We have also seen that, as the specialisation of parts is an advantage to each being, so natural selection will tend to render the organisation of each being more specialised and perfect, and in this sense higher; not but that it may leave many creatures with simple and unimproved structures fitted for simple conditions of life, and in some cases will even deerade or simplify the organisation, yet leaving such degraded beings better fitted for their new walks of life. In another and more general manner, new species become superior to their predecessors : for they have to beat in the struggle for life all the older forms, with which they come into close competition. We may therefore conclude world could be put into competition with the existing inhabitants the former would be beaten and exterminated by the latter, as would the secondary by the eocene, and the ralgeozoic by the secondary forms. So that by this fundamental test of victory in the battle for life, as well as by the standard of the specialisation of organs, modern forms ought, on the theory of natural selection, to stand higher than ancient forms. Is this the case? A large majority of palæontologists would answer in the affirmative : and it seems that this answer must be admitted as true, though difficult of

It is no valid objection to this conclusion, that certain Brachiopods

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have been but slightly modified from an extremely remote geological epoch ; and that certain land and fresh-water shells have remained nearly the same, from the time when, as far as is known, they first appeared. It is not an insuperable difficulty that Foraminifera have even the Laurentian epoch; for some organisms would have to remain fitted for simple conditions of life, and what could be better fitted for this end than these lowly organised Protozon? Such objections as the above would be fatal to my view, if it included advance in organisation as a necessary contingent. They would likewise be fatal, if the above Foraminifera, for instance, could be proved to have first come into existence during the Laurentian epoch, or the above Brachiopods during the Cambrian formation; for in this case, there would not have been time sufficient for the development of these organisms up to the standard which they had then reached. When advanced up to any given point, there is no necessity, on the theory of natural selection, for their further continued progress; though they will, during each successive age, have to be slightly modified, so as to hold their places in relation to slight changes in their conditions. The foregoing objections hinge on the question whether we really know how old the world is, and at what period the various forms of life first appeared; and this

The problem 'whether erganization on the whole has advanced is in many ways exceensively intricts. In geodegical recent, at all times imperfet, does not extend for enough had, by below on the problem of the same class, naturalists are not maximum while for members of the same class, naturalists are not maximum while for the same class, naturalists are not maximum while of atoms on the box from as in approximation. The problem of the same class, naturalists are not maximum while of atoms on the box from the same class. The same class and the same class is a same class and the same class of atoms on the box from the same class. The same class and the same class is a same class of the same class of highman classes in a number, but four the same class of highman classes are will be add that falses have advanced of highman classes are will be add that falses have advanced of highman the same of highman seems have advanced in the same class is a same between the same class of highman have advanced by the same the same the same interval the same classes are same of distinct types in the same of highman seems have advanced than a the data have advanced by the same the same that the have advanced by the same the same the same that the have advanced by the same the same the same that the have advanced by the same the same that the same the same time state of the same of the same the same the same that the have the same transmission. The same the same the same the same time state of the same the same the same the same same the same time state of the same the same the same the same the same the same time state of the same the same the same the same the same the same time state of the same the same the same the same the same the same time state of the same the same the same the same the same time state of the same the same the same the same the same time state of the same the same the same the same the same the same time state of the same the same the same the same the same the same time state of the same the same the same

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Ancient and Living Forms.

own class, might beat cephalopods, the highest molluscs ; and such crustaceans, though not highly developed, would stand very high in not solely to compare the highest members of a class at any two periods-though undoubtedly this is one and perhaps the most all the members, high and low, at the two periods. At an ancient have largely increased; consequently some naturalists maintain that molluses were formerly more highly developed than at present : but a stronger case can be made out on the opposite side, by considering the vast reduction of brachiopods, and the fact that our existing cephalopods, though few in number, are more highly organised than their ancient representatives. We ought also to compare the relative proportional numbers at any two periods of the high and low classes throughout the world : if, for instance, at the present day fifty thousand kinds of vertebrate animals exist, and if we knew ought to look at this increase in number in the highest class, which in the organisation of the world. We thus see how hopelessly difficult it is to compare with perfect fairness, under such extremely complex relations, the standard of organisation of the imperfectly-

We shall appreciate this difficulty more clearly, by looking to creating exacting financian and forms. From the extraordinary manager in which Librophan predomination membry prepared over New Compiled by the librophane predomination of the extraordinary for an extra straight of the extraordinary of the extra straight and plants of Great Firstian were set free in New Zauland, a multition of Great Firstian were set free in New Zauland, are subtract the straight of the extra straight of the extra straight of the extra straight of the extra straight of the starting the straight of the extra straight of the extra straight the other hand, freen the fact that having a satisfy industriant of the starthern hermisphere has become with the model on extra black which will be straight of the extra straight of the extra straight of the 10 Great Finding ange concilentiate number would be emailed to the the Ortex Hingin age concilentiate number would be emailed to the the the straight of the straight of the extra straight of the Under this point of view, the preductions of Great Hinin at and much higher in the straight of the stra

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most skilful naturalist, from an examination of the species of the two countries, could not have foreseen this result.

Agassiz and several other highly competent judges insist that ancient animals resemble to a certain extent the embryos of recent animals belonging to the same classes ; and that the geological succession of extinct forms is nearly parallel with the embryological development of existing forms. This view accords admirably well with our theory. In a future chapter I shall attempt to show that the adult differs from its embryo, owing to variations having supervened at a not early age, and having been inherited at a corresponding age. This process, whilst it leaves the embryo almost unaltered, continually adds, in the course of successive generations, more and more difference to the adult. Thus the the former and less modified condition of the species. This view may be true, and yet may never be capable of proof. Seeing for instance, that the oldest known mammals, reptiles, and fishes strictly belong to their proper classes, though some of these old forms are in a slight degree less distinct from each other than are the typical members of the same groups at the present day, it would be vain to look for animals having the common embryological character of the Vertebrata, until beds rich in fossils are discovered far beneath the lowest Cambrian strata-a discovery of which the

On the Succession of the same Types within the same Areas, during the later Tertiary periods.

Mr. Gith many years ago showed that the fosdi mammale framthe Anattalian over verse closely allel to the living mampilas of thit continent. In South America, a similar relationship is amount, like these of the arrantitik, frand in several parts of La matrix and the start of the start the start of the start that most of the sould mammally, labeled there in such markers, we related to South American types. This relationship is even new related to South American types. This relationship is even new related to South American types. This relationship is even new with these facts that 1 strongly imission (in 1989) and 1845, or this "law of the ancessation of types"—out "this woulderful relationship "law of the ancessation of types"—out "this woulderful relationship "law of the ancessation of types"—out "this woulderful relationship "strong of the Odd World. We see the same targe granulation to the mammals of the Odd World. We see the same this of New Zanaka. We

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see it also in the birks of the caves of Brazil. Mr. Woodward has abovn that the same hav holds good with seasi-ellsh, but, from the wide distribution of most mollause, it is not well displayed by them. Other cases could be added, as the relation between the extinct and living land-shells of Mateira; and between the extinct and living brackish water-shells of the Arab-Caspian Sea.

Now what does this remarkable law of the succession of the South America, under the same latitude, would attempt to account, on the one hand through dissimilar physical conditions, for the dissimilarity of the inhabitants of these two continents; and, on the other hand through similarity of conditions, for the uniformity of the same types in each continent during the later tertiary periods. Nor can it be pretended that it is an immutable law that marsupials in South America. For we know that Europe in ancient times was peopled by numerous marsupials; and I have shown in the publications above alluded to, that in America the law of distribution of North America formerly partook strongly of the present character of the southern half of the continent; and the southern half was formerly more closely allied, than it is at present, to the northern half. In a similar manner we know, from Falconer and Cautley's its mammals to Africa than it is at the present time. Analogous facts could be given in relation to the distribution of marine animals.

On the theory of descent, with modification, the great have of the long enduring, but not immutualing, enceeding of the same types within the same array, is at once explained; for the inhibitrate of each quarter of the world will obviously tend to have in that quarter, during the next successful geroid of times, clearly all theory in some degree modified descents. If the inhibitrate of one continue formerly differed greatly from these of a soften continue, is will their modified descents, still, differ in nearly times, and here greatly program. But after very long intervals of times, and here greatly programs. But after very long intervals of times, and here greatly programs. But after very long intervals of the soft will be ability will yield to the town dominant forms, and there will be nothing immutable in the distribution of organic beings.

It may be asked in ridicule, whether I suppose that the megatherium and other allied huge monsters, which formerly lived in

Summary of the

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South America, have left behind them the sloth, armadillo, and anteater, as their degenerate descendants. This cannot for an instant be admitted. These huge animals have become wholly extinct, and have left no progeny. But in the caves of Brazil there are many extinct species which are closely allied in size and in all other characters to the species still living in South America : and some of these fossils may have been the actual progenitors of the living species. It must not be forgotten that, on our theory, all the species of the same genus are the descendants of some one one geological formation, and in a succeeding formation there he six other allied or representative genera each with the same number of the new genera containing the several species; the other seven species of each old genus having died out and left no progeny. Or. and this will be a far commoner case, two or three species in two or three alone of the six older genera will be the parents of the new genera : the other species and the other whole genera having become utterly extinct. In failing orders, with the genera and species decreasing in numbers as is the case with the Edentata of South America, still fewer genera and species will leave modified blood-

Summary of the preceding and present Chapters.

Three attempted to show that the geological record is externed inperfect i, that only a small periton of the globe has been grologically explored with care i that only certain classes of enguine being have been ingoly persevered in a found state; that this number both of specimums and of species, preserved in corrunnesses, is a closithy at an orbital geoing or many which, and thick enough to ording to rubakinen being almost necessary for the accumulation of deposits rich in coll species of many which, and thick enough to outlast future degradation, great intervals of time much have algoing between most of our successive formations, in at during the laber the record with have been least perfectly kept; that each night formtion have notice on the period of detaution; and during the laber the record with have been least perfectly kept; that each night formtion of negative formas; that futuring the laber the intervaltion of negative formas; that mignition has played an important give the of negative formas; that mignition has played an important of the formas; player imprint on the period of detaution; the of negative formas; that imprints has played an important give

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that addpt maging species are those which have varied most figourity, and have closenst given fite to one species; it has that varieties have as if the been local; and lastly, although each species must have passed through memory at multiload stages, it is probable that the periods, during which each underweat modification, brough many and long as measured by years, have been shock in comparison with the period entry which a species must extent explain "exploring which complexity, will to a large enterminable warrieties, connecting together all extinct and stating from by the frank any linking variety between two found the perfectly motored, as a new and durind species chains could be perfectly motored, as a new and durind species chains and be perfectly motored, as a new and durind species which and the perfect perfect on the durind species on the species and worked casts and be used as a species of the species of the species of the species of the species and the species and the species and the species of the species of

He who rejects this view of the imperfection of the geological record, will rightly reject the whole theory. For he may ask in vain where are the numberless transitional links which must formerly have connected the closely allied or representative species, found in the successive stages of the same great formation ? He may disbelieve in the immense intervals of time which must have elapsed between our consecutive formations ; he may overlook how one great region, as those of Europe, are considered ; he may urge the apparent, but often falsely apparent, sudden coming in of whole groups of species. He may ask where are the remains of those the Cambrian system was deposited ? We now know that at least one animal did then exist; but I can answer this last question only by supposing that where our oceans now extend they have extended for an enormous period, and where our oscillating consented a widely different aspect ; and that the older continents, the ocean,

Passing from these difficulties, the other great leading facts in palaeontology agree admirably with the theory of descent with modification through variation and natural selection. We can thus understand how it is that new species come in alowly and success sively; how species of different classes do not necessarily change

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togather, or at the same rarge (in the same drager, yet in the larger mit that all unlergy modification to some extent. The scrtinetical of all forms is the almost inertiable compares of this has necessary of the same structure of the same structure of the same structure of the same structure. Compared a special interasts in numbers slowly, and enders for unsequal periods of time ; for the species of modification is necessarily boy, and depends on many and dominant groups tend to have many modified descendary, which form new shore programs and more all the same structure of a species of the lass vignous groups, from their inferiorly inhering from a common perspective, that the booms extinct together, and there extends the survival of a web sequence of the lass dependence of the solution of a whole group of precises has normaling in protected and isolated attantions. When a group has one whole programs, for an together and the link of generation has the properties of the link of generation has a similar period of the link of generation of the link of generation has a similar period on the link of generation has the link of the link of generation similar protection of the link of generation has a similar period on the link of generation has a similar period base to the link of generation has the link of generation of the link of generation has a similar period base to the link of generation has a similar period base to the link of generation has a similar period base to the link of generation has a similar period base to the link of generation has a similar period base to the similar of a similar period base to the link of generation has a similar period base to the link of generation has a similar period base to the similar of a similar period base to the link of generation has a similar period base to the similar similar base to the link of generation has a similar base to the link of generation has a similar base to the similar similar base to the similar similar base to the similar similar base to the link

We can understand how it is that dominant forms which spread widely and yield the greatest number of varieties tend to people the world with allied, but mollified, descendants ; and these will generally succeed in displacing the groups which are their inferiors in the struggle for existence. Hence, after long intervals of time, the productions of the world appear to have changed simultaneously.

We can understand how its that all the forms of life, ancient and recent, make together a for granule classes. We can understaal, from the continued tendency to divergence of character, why have the strength of the strength of the strength of the page between existing forms, sometimes blending two groups, previously classes and as in some degrees that more commonly hirting them only a little closer together. The more materials form is, the wore often it statistics, this one give intermediate between groups mere distinct, for the more material form is, the more material parts of groups, and the statistical term of the statistical form are soldown directly intermediate between existing forms; but are are soldown directly intermediate between existing forms; but are existent and different forms. We can clearly use why the organic transition of only in long and circumsitions are closerly alided; for they are closely limited together by generation, we can clearly use character, where the intermediate formation are not constrained and they are closely limited together by generation. The can clearly use character, discussion of the strength of the strength of the strength of an endown of the strength of the strength of the strength of the strength of character, discussion of the strength of CHAP. XL

preceding and present Chapters.

The inhalitants of the world at each necessive period in its history have beach their predicences in the mee for H6, and are, in so fa, higher in the scale, and their structure has genetrally become more specialised; and thist may become the order the whole has progressed. Extinct and macient minimal results to a certain extent the onlyway of the necession of the same explanation according to our views. The necession of the same type of the same theory of the networks of the same type of the same theory of the networks of the same type of the same theory of the networks of the same type of the same theory of the same type of the same type of the same theory of the same type o

If them the geological record is as imperfect as many believe, and it may at least be asserted that the neered cannot be proved to be much more perfect, the main objections to the theory of natural adjustment of the start of the start of the start of the start all the chief laws of paleoutology plainly proclaim, as it seems to much ast species may been produced by collaray generations : old forms haring been supplanted by ender agreementors: old forms haring been supplanted by more and improved forms of life, the products of Variation and the Startvirial of the Pittets.

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CHAPTER XII.

GEOGRAPHICAL DISTRIBUTION.

Present distribution cannot be accounted for by differences in physical conditions—Importance of barriers—Affaitig of the productions of the same continent — Cantres of creation—Means of disparal by changes of climate and of the level of the land, and by occasional means— Desperal during the Glacial paried—Alternate Glacial periods in the North and South.

It considering the distribution of organic beings over the fiber of the globa, the fits greats fast which strikes us is, this multiple the similarity nort the dissimilarity of the inhibitation of various regions in by . Of y assumets, only y direction is in string the analyset is the control of the similarity of the inhibitation of various regions in the control of the proves in truths. If of two exclusions is the nord function activity of the similarity of the similarity and most strike the proves in truths. If of two exclusions is the truth of the similarity of the similarity of the similarity ward American continues, from the spring proves of the Kindle distates to its externs southern point, we must write the functions, graves places from the similarity of the similar attance and the point of the similarity of the similar limits a constraint, from the similarity of a similar or confiltention and the similarity of the similarity of the similar limits a constraint, foreits, market places in the similar must achieve the pointed out in the Oti Workh horizon and different from that of the surrounding districts, for its raws to find a grave parallelism in the conditions or N CM and X New Workh, here widely different are their living productional.

In the southern hemisphere, if we compare large tracts of land in Australia, South Africa, and western South America, between latitudes 25° and 35°, we shall find parts extremely similar in all their

conditions, yet it would not be possible to point out three forms and forms more study dissimiliar. Or, signif, we may compute the preductions of South America south of Bat, 35° with those northof 35°, which consequently are separated by a space of the dogress of latitude and are exposed to considerably different conditions, yet have an isocomparation more basely or Antice mathematic the same dimensional states of the state of the state of the state end of the state of the state of the state of the state end of the state end of the state end of the state end of the state of the st

A second great fact which strikes us in our general review is. that barriers of any kind, or obstacles to free migration, are related in a close and important manner to the differences between the productions of various regions. We see this in the great difference in nearly all the terrestrial productions of the New and Old Worlds, excepting in the northern parts, where the land almost joins, and where, under a slightly different climate, there might have been free migration for the northern temperate forms, as there now is for the strictly arctic productions. We see the same fact in the great difference between the inhabitants of Australia, Africa, and South America under the same latitude ; for these countries are almost as much isolated from each other as is possible. On each continent, also, we see the same fact ; for on the opposite sides of lofty and continuous mountain-ranges, of great deserts, and even of large rivers, we find different productions; though as mountain-chains, deserts, &c., are not as impassable, or likely to have endured so long, as the oceans separating continents, the differences are very inferior in degree to those characteristic of distinct continents.

Turning in the say, we find the same law. The narries halfsituation of the eastern and wortern shows of South America are very distinct, with extremely few shells, crustance or exhibitodemain neuronov; in D.F. Guither has recently shown that shout thirty yet cents of the finite saw the same on the opposite sides billier that the histoma was formerly open. Weiswale of the shows of America, a wide space of open occan extend, with not insidial of a shuftlengia-face for enigramic, itere we have a barrier of another kind, and as soon at this is passed we much the astern issued of the Pointer with another and totally distinct from S. Is that there matrix frames range far cortivarial and southward in paired linguistic strength of the same and the strength quinted, to their halo, recovering, still farther wavevand from the astern bar has been hand or even as a three are shared with a same and their halo, stowed sing at large matrix strength quinting. On the learning the same transmitter and the same shall quinting the same there has have precovering still farther wavevand from the astern than the same transmitter that the same strength quinter, On the

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jainabi of the tropical parts of the Pacific, we recounter to impandle larries, and we have immunelly histoder as haltingplaces, or continuous coasts, until, after travelling over a hemitipar-, we come to the shows of Africa ; and over this vast spaces we need with no well-defined and distinct matrix formas. Although so give medica animals are common to the above-named three approximate frames of Eastern and Western America and the eastern Pacific Cours, and many balls are common to the neistern islands of the Pacific and the antern shows of Africa on almost exactly opposing meritains of location.

A third great fact, partly included in the foregoing statement, is sea, though the species themselves are distinct at different points and stations. It is a law of the widest generality, and every contravelling, for instance, from north to south, never fails to be strick by the manner in which successive groups of beings, specifically distinct, though nearly related, replace each other. He hears from sees their nests similarly constructed, but not quite alike, with errs coloured in nearly the same manner. The plains near the Straits of Magellan are inhabited by one species of Rhea (American ostrich), and northward the plains of La Plata by another species of the same genus; and not by a true ostrich or emu, like those inhabiting Africa and Australia under the same latitude. On these same plains of La Plata, we see the acouti and bizcacha, animals having nearly the same habits as our hares and rabbits and belonging to the same order of Rodents, but they plainly display an American type of structure. We ascend the lofty peaks of the Cordillera, and we find find the beaver or musk-rat, but the coypu and capybara, rodents given. If we look to the islands off the American shore, however much they may differ in geological structure, the inhabitants are essentially American, though they may be all peculiar species. We may look back to past ages, as shown in the last chapter, and we in the American seas. We see in these facts some deep organic water, independently of physical conditions. The naturalist must

The bond is simply inheritance, that cause which alone, as far as

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we positively know, produces organisms quite like each other, or, as we see in the case of varieties, nearly alike. The dissimilarity of the inhabitants of different regions may be attributed to modification through variation and natural selection, and probably in a subordinate degree to the definite influence of different physical conditions. The degrees of dissimilarity will depend on the migration of the more dominant forms of life from one region into another having been more or less effectually prevented, at periods more or less remote ;---on the nature and number of the former immigrants ; -and on the action of the inhabitants on each other in leading to the preservation of different modifications; the relation of organism to organism in the struggle for life being, as I have already often remarked, the most important of all relations. Thus the high importance of barriers comes into play by checking migration : as does time for the slow process of modification through natural selection. triumphed over many competitors in their own widely-extended homes, will have the best chance of seizing on new places, when they spread into new countries. In their new homes they will be exposed to new conditions, and will frequently undergo further modification and improvement; and thus they will become still further victorious, and will produce groups of modified descendants. On this principle of inheritance with modification, we can understand how it is that sections of genera, whole genera, and even families, are confined to the same areas, as is so commonly and notoriously the case.

These is no orbitron, as was remarked in the hat chapter, of the existence of any law of neasury devolution. As the variability of each propers is an independent property, and will be taken advaninge of by antam believes, only no fast as it profits each individual in the complex stranges for life, so the amount of multication in the having law encoupted with an advance of the strand law enter having law encoupted with an advance of the strand law enter having law encoupted with an advance of the strand law enter migration in a body into a new and afterwards isolated contripwer would be lite habits to moliformic on frame law entring on the place of the lab to be another strand law encoupted and the law encoupted law encoupted and the law encoupted and the law encoupted law encoupted and law encoupted period, recenting regions improved over any spaces, and have not become group to e at all maindia.

According to these views, it is obvious that the several species of the same genus, though inhabiting the most distant quarters of the

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world, must exiginally have proceeded from the same sorray, as tags are described from the same program for the energy of the same species, which have undergone during which geological periods like the same species of the same structure of the same species of a species which we have reason to the same species of a game and elimitat changes which have aspectreed since antennis times, and same species of migration is possible. But in many other game, time particular to the same species of a game particular species of the same species of a game area dimensioned and the same species of the species of the same species, though now inholding distant and isolation of the same species, though now inholding distant and isolation of the same species, though now inholding the species of the parent were first pochecies 1 for a star have negatively of the the species of a game species of the species of the species of the species of a game species of the species of the species of the species of a game species of the species of the species of the species of a species of the species of the species of the species of the species of a species of the species of the species of the species of the species of a species of the species of the species of the species of the species of a species of the species of the species of the species of the species of a species of the spec

Single Centres of supposed Creation .- We are thus brought to the question which has been largely discussed by naturalists, namely, whether species have been created at one or more points of the earth's surface. Undoubtedly there are many cases of extreme difficulty in understanding how the same species could possibly have migrated from some one point to the several distant and isolated points, where now found. Nevertheless the simplicity of the view that each species was first produced within a single region captivates the mind. He who rejects it, rejects the vera causa of ordinary generation with subsequent migration, and calls in the agency of a miracle. It is universally admitted, that in most cases the area inhabited by a species is continuous; and that when a plant or animal inhabits two points so distant from each other, or with an interval of such a nature, that the space could not have been easily passed over by migration, the fact is given as something remarkable and exceptional. The incapacity of migrating across a wide sea is more clear in the case of terrestrial mammals than perhaps with any other organic beings; and, accordingly, we find no inexplicable instances of the same mammals inhabiting distant points of the world. No geologist feels any difficulty in Great Britain possessing the same quadrupeds with the rest of Europe, for they were no doubt once united. But if the same species can be produced at two separate points, why do we not find a single mammal common to Europe and Australia or South America? The conditions of life are nearly the same, so that a multitude of European animals and of the aboriginal plants are identically the same at these distant points of the northern and southern hemispheres? The answer, as

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I believe, is, that minimal have not been able to mixing, whereas more plants, from their varies masses of dispersal, have simplicity across the wide and broken interspotse. The great and striking infinitesso of largers of all kinds, is minilaphilo only on the view that the great majority of projects have been produced on one aids, and have not been adds to majority to be upposts aids. Using for simple, the strike of a strike of the strike of the strike number of astrikes of genera, are endined to a single region; and it has been observed by averal naturations, that the more natural genera, on these genera in which the species are most closely related to each other, are greenedly confined to be same constary, or if they have a wide range that their range is continuous. What is strange using a down one step have in the strate, having the more posttion, confined to same one excited.

Hence it seems to me, as it has to many other naturalists, that the view of each species having been produced in one area alone, and having subsequently migrated from that area as far as its powers of migration and subsistence under past and present conditions permitted, is the most probable. Undoubtedly many cases occur, in which we cannot explain how the same species could have rassed from one point to the other. But the geographical and climatal changes, which have certainly occurred within recent geological times, must have rendered discontinuous the formerly continuous range of many species. So that we are reduced to consider whether the exceptions to continuity of range are so numerous and of so grave a nature, that we ought to give up the belief, rendered probable by general considerations, that each species has could. It would be hopelessly tedious to discuss all the exceptional cases of the same species, now living at distant and separated points, nor do I for a moment pretend that any explanation could be offered of many instances. But, after some preliminary remarks, I will discuss a few of the most striking classes of facts ; namely, the existence of the same species on the summits of distant mountainsecondly (in the following chapter), the wide distribution of freshwater productions; and thirdly, the occurrence of the same terrestrial species on islands and on the nearest mainland, though separated by hundreds of miles of open sea. If the existence of the same species at distant and isolated points of the earth's surface, can in many

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from a single birthplace; then, considering our ignorance with respect to former elimatal and geographical changes and to the various occasional means of transport, the belief that a single birthplace is the law, seems to me incomparably the safest.

In discussing this subject, we shall be enabled at the same time to consider a point equally important for us, namely, whether the several species of a genus, which must on our theory all be descended from a common progenitor, can have migrated, undergoing modification during their migration, from some one area. If, when most of the species inhabiting one region are different from those of another region, though closely allied to them, it can be shown that migration from the one region to the other has probably occurred at some former period, our general view will be much strengthened : for the explanation is obvious on the principle of descent with modification. A volcanic island, for instance, upheaved and formed at the distance of a few hundreds of miles from a continent, would probably receive from it in the course of time a few colonists. and their descendants, though modified, would still be related by inheritance to the inhabitants of that continent. Cases of this nature are common, and are, as we shall hereafter see, inexplicable on the theory of independent creation. This view of the relation of the species of one region to those of another, does not differ much from that advanced by Mr. Wallace, who concludes that "every species has come into existence coincident both in space and time with a pre-existing closely allied species," And it is now well known that he attributes this coincidence to descent with modification.

The question of single or multiple centres of creation differ from another theory halfed question—mustry, whether all the individual of the same species are descended from a single play or single hermaphyticit, or whether, as soon aathors suppose, from many individuals simultaneously created. With organic being second from a mean species is not hoter heritication planted each other, but have sorrer blended with other heritication of modification, all the individuals of the same species of modification, all the individuals of the same posterior smoothly with all organisms which habitanly mine for each bring or which consideration futures on the same species or which consideration interesting the individuals of the same species crowing: so that many individuals of the same species crowing: so that many individuals will go so simulinatority crowing: so that many latividuals will go an simulinatority.

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not be due to descent from a single parent. To illustrate what I mean: our English race-horses differ from the horses of every other breed; but they do not ove their difference and superiority to descent from any single pair, but to continued care in the selecting and training of many individuals during each generation.

Before discussing the three classes of facts, which I have selected as presenting the greatest amount of difficulty on the theory of "single centres of creation," I must say a few words on the means of discersal.

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Sir C. Lyell and other authors have ably treated this subject. I can give here only the briefest abstract of the more important facts. Change of climate must have had a powerful influence on migration, A region now impassable to certain organisms from the nature of its climate, might have been a high road for migration, when the climate was different. I shall, however, presently have to discuss this branch of the subject in some detail. Changes of level in the land must also have been highly influential ; a narrow isthmus now separates two marine faunas; submerge it, or let it formerly have been submerged, and the two faunas will now blend together, or may formerly have blended. Where the sea now extends, land may at a former period have connected islands or possibly even continents together, and thus have allowed terrestrial productions to pass from one to the other. No geologist disputes that great mutations of level have occurred within the period of existing organisms. Edward Forbes insisted that all the islands in the Atlantic must have been recently connected with Europe or Africa, and Europe likewise with America. Other authors have thus hypothetically bridged over every ocean, and united almost every island to some mainland. If indeed the arguments used by Forbes are to be trusted, it must be admitted that scarcely a single island exists which has not recently been united to some continent. This view cuts the Gordian knot of the dispersal of the same species to the most distant points, and removes many a difficulty ; but to the best of my judgment we are not authorized in admitting such It seems to me that we have abundant evidence of great oscillations in the level of the land or sea; but not of such vast changes in the position and extension of our continents, as to have united them oceanic islands. I freely admit the former existence of many islands, now buried beneath the sea, which may have served as halting-

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places for plants and for many animals during their migration. In rings of coral or atolls standing over them. Whenever it is fully something definite about the means of distribution, we shall be enabled to speculate with security on the former extension of the land. But I do not believe that it will ever be proved that within the recent period most of our continents which now stand quite separate, have been continuously, or almost continuously united with each other, and with the many existing oceanic islands. Several facts in distribution,-such as the great difference in the marine faunas on the opposite sides of almost every continent .--the close relation of the tertiary inhabitants of several lands and even seas to their present inhabitants,-the degree of affinity between the mammals inhabiting islands with those of the nearest continent, being in part determined (as we shall hereafter see) by the depth of the intervening ocean,-these and other such facts are within the recent period, as are necessary on the view advanced by Forbes and admitted by his followers. The nature and relative proportions of the inhabitants of oceanic islands are likewise opposed to the belief of their former continuity with continents. Nor does the admission that they are the wrecks of sunken continents ;--if least of the islands would have been formed, like other mountainrocks, instead of consisting of mere piles of volcanic matter.

. Instant now say a few works on what are called academial means the which more properly should be called constant and means of distribution. I shall have confine myself to pattern. In bonnies works, this or that place is effert static to be 111 adapted few wild work, this or that place is effert static to be 111 adapted few wild work, this or that place is a state of the state of the state of the state may be such to gravity and the state of the state with M. Brichty and A. few experiment, it wan not even knewn how far needs could resist the injurices action of state of the immersion of St days, and a few survived an immersion of St and the state of the state of the state of the state of the state interaction of St days, and a few survived an immersion of St and the state of the state of the state of the state of the state interaction of St days, and a few survived an immersion of St and the state of the interaction of St days, and a few survived in the state of the state interaction of St days, and a few state of the state of the state interaction of St days, and a few state of the state of the state interaction of St days, and a few state of the state of the state interaction of St days, and a few state of the state of the state interaction of St days, and the state of the state of the state of the state interaction of St days, and the state of the state o

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immersion. For convenience' sake I chiefly tried small seeds, without the capsule or fruit ; and as all of these sank in a few days. they could not have been floated across wide spaces of the sea, whether or not they were injured by the salt-water. Afterwards I tried some larger fruits, capsules, &c., and some of these floated for a long time. It is well known what a difference there is in the buoyancy of green and seasoned timber ; and it occurred to me that floods would often wash into the sea dried plants or branches with stems and branches of 94 plants with ripe fruit, and to place them on sea-water. The majority sank quickly, but some which, whilst green, floated for a very short time, when dried floated much longer ; for instance, ripe hazel-nuts sank immediately, but when dried they floated for 90 days, and afterwards when planted germinated ; an asparagus-plant with ripe berries floated for 23 days, when dried it floated for 85 days, and the seeds afterwards germinated ; the ripe seeds of Helosciadium sank in two days, when dried they floated for above 90 days, and afterwards germinated. Altogether, out of the 94 dried plants, 18 floated for above 28 days; and some of the 18 floated for a very much longer period. So that as §\$ kinds of seeds germinated after an immersion of 28 days; and as 18 distinct species with ripe fruit (but not all the same species these scanty facts, that the seeds of 100 kinds of plants of any the average rate of the several Atlantic currents is 33 miles per this average, the seeds of 14 plants belonging to one country might be floated across 924 miles of sea to another country, and when stranded, if blown by an inland gale to a favourable spot.

Subsequently to my experiments, M. Martenz tried similar cores, but is a much term namer, for burlacio the seeks in a box in the scenin was, such at they were alternatively wet and expende to the form mixtry that before many larger for the and theoretic core from phants which lives more these say and this would have be average itegrily of their flexitons and their resistance to the previously dry the phants or item. On the other family, hold not previously dry the phants or item. The start has the bare for the previously dry the phants or item or item of them to have flexible where were, wround have cousted some of them to have family

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much longer. The result was that $\frac{1}{2}$ of his seeds of different hinds fastical for $\frac{1}{2}$ days, and were them capable of germination. Thus I do not dealth that plants exposed to the wave would find for a less time that holes optexted for workers were set as the first the result of about $\frac{1}{2}$ plants of a fors, shere having hear diried, could be fasted as the same of the larger fraints of the first, and the fasted as the same of the larger fraint of the larger than the same of a local bar having hear and the larger than the same larger that the larger fraint of the larger frait which, as Alph, de Catollo has shown, generally have prstricted ranges, could have by temported by any other means.

timber is thrown up on most islands, even on those in the midst of the widest oceans ; and the natives of the coral-islands in the Pacific procure stones for their tools, solely from the roots of drifted trees, these stones being a valuable royal tax. I find that when irregularly shaped stones are embedded in the roots of trees, small rarcels of earth are frequently enclosed in their interstices and behind them,-so perfectly that not a particle could be washed away during the longest transport ; out of one small portion of earth thus completely enclosed by the roots of an oak about 50 years old. three dicotyledonous plants germinated ; I am certain of the accuracy of this observation. Again, I can show that the carcases of birds, when floating on the sea, sometimes escape being immediately devoured : and many kinds of seeds in the crops of floating birds long retain their vitality : peas and vetches, for instance, are killed by even a few days' immersion in sea-water ; but some taken out of the crop of a pigeon, which had floated on artificial sea-water for

Living their can handly full to be highly effective agents in the transportation of scales. I could give many facts aboving how frequently ticks of many kinds are blown by gales to varial distance structures the occasa. We many skill structures that under such distanses the box on the structures of the structure of the same authoria have given a far higher estimate. These near tenus an instance of nutritices assels passing through the interactive of a birl, but hand needs of furth pass uninjured through two marks disputive engages of tarkey. In the occurse of two months, I pfolded up in my genden 12 kinds of seeds, out of the excernment of anall body, and those some pareties phases of the one of them, which we except a fulled do not secreting particip hinos, and do not go at a 1 knowly with phase to the task the correlation of seeds, and at all such as the secretion of this phase.

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has found and devoured a large supply of food, it is positively asserted that all the grains do not pass into the gizzard for twelve or even eighteen hours. A bird in this interval might easily be blown to the distance of 500 miles, and hawks are known to look out for tired birds, and the contents of their torn crops might thus readily get scattered. Some hawks and owls bolt their prey whole, and, after an interval of from twelve to twenty hours, disgorge pellets, which, as I know from experiments made in the Zoological Gardens, include seeds capable of germination. Some seeds of the oat, wheat, millet, canary, hemp, clover, and beet germinated after having been from twelve to twenty-one hours in the stomachs of different birds of prey; and two seeds of beet grew after having been thus retained for two days and fourteen hours. Fresh-water fish, I find, eat seeds of many land and water plants: fish are frequently devoured by birds, and thus the seeds might be transported from place to place. I forced many kinds of seeds into the stomachs of dead fish, and then gave their bodies to fishing-eagles, storks, and pelicans : these birds, after an interval of many hours, either rejected the seeds in pellets or passed them in their excrement; and several of these seeds retained the power of germination. Certain seeds, however, were always killed by this process,

Locusts are sometimes blown to great distances from the land ; I myself caught one 370 miles from the coast of Africa, and have heard of others caught at greater distances. The Rev. R. T. Lowe informed Sir C. Lycll that in November 1844 swarms of locusts visited the island of Madeira. They were in countless numbers, as thick as the flakes of snow in the heaviest snowstorm, and extended upwards as far as could be seen with a telescope. During two or three days they slowly careered round and round in an immense ellipse, at least five or six miles in diameter, and at night alighted on the taller trees, which were completely coated with them. They then disappeared over the sea, as suddenly as they had appeared, and have not since visited the island. Now, in parts of Natal it is believed by some farmers, though on insufficient evidence, that injurious seeds are introduced into their grass-land in the dung left by the great flights of locusts which often visit that country. In consequence of this belief Mr. Weale sent me in a letter a small packet of the dried pellets, out of which I extracted under the microscope several seeds, and raised from them seven grass plants, belonging to two species, of two genera. Hence a swarm of locusts, such as that which visited Madeira, might readily be the means of introducing several kinds of plants into an island lying far from the

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Although the heaks and feet of birds are generally clean, cortisometimes adheres to them ; in one case I removed sixty-one grains, and in another case twenty-two grains of dry argillaceous earth from the foot of a partridge, and in the earth there was a pebble as large as the seed of a vetch. Here is a better case : the leg of a woodcock was sent to me by a friend, with a little cake of dry earth attached to the shank, weighing only nine grains; and this contained a seed of the toad-rush (Juncus bufonius) which germinated and flowered Mr. Swaysland, of Brighton, who during the last forty years has naid close attention to our migratory birds, informa me that he has often shot wagtails (Motacillae), wheatears, and whinchats (Saxicolse), on their first arrival on our shores, before they had alighted : and he has several times noticed little cakes of corth attached to their feet. Many facts could be given showing how generally soil is charged with seeds. For instance, Prof. Newton sent me the leg of a red-legged partridge (Caccabis rufa) which had been wounded and could not fly, with a ball of hard earth adhering to it, and weighing six and a half ounces. The earth had been kent for three years, but when broken, watered and placed under a bell glass, no less than 82 plants sprung from it ; these consisted of the young leaves, of at least three distinct species. With such facts before us, can we doubt that the many birds which are annually blown by gales across great spaces of ocean, and which annually migrate-for instance, the millions of quails across the Mediterranean-must occasionally transport a few seeds embedded in dirt adhering to their feet or beaks ? But I shall have to recur to this subject.

As isolway are known to be sometimes loaded with earth and known, while we can married braknowsky, hence, and the nest of a land-itely it can hardly be doubted that they runt cosmissing we approxed by Joydh are transported scales from one part to another of more appendix the scale regimes 1 and during the Gainking pixel Access, from the large number of plants common to Ensoys, in comparison with the species on the other islands of the Atlantic, while and sensers to the superscient another more and the matter with the a trateful superscient at methods the single that the species with the intraction. In generic that the scale has a been utily with the intraction generic that the shaded had been utily Sir G. Legell wrote to M. Harrang, to faquine whether is had been effective of the structure of the species of the the observed earthe boundes on these islands and is parameted that he

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had found large fragments of granite and other rooks, which do not occur in the archipelago. Hence we may safely infer that icebergs formerly landed their rocky burthens on the shores of these midocean islands, and it is at least possible that they may have broughs thilter some few seeds of northern relats.

action year after year for tens of thousands of years, it would, I think, be a marvellous fact if many plants had not thus become accidental, but this is not strictly correct: the currents of the sea are not accidental, nor is the direction of prevalent gales of wind. It should be observed that scarcely any means of transport would carry seeds for very great distances ; for seeds do not retain their vitality when exposed for a great length of time to the action of sea-water : nor could they be long carried in the crops or intestines of birds. These means, however, would suffice for occasional transport across tracts of sea some hundred miles in breadth, or from island to island, or from a continent to a neighbouring island, but not from one distant continent to another. The floras of distant continents would not by such means become mingled; but would remain as distinct as they now are. The currents, from their course, would never bring seeds from North America to Britain, though they might and do bring seeds from the West Indies to our western shores, where, if not killed by their very long immersion in salt water, they could not endure our climate. Almost every year, one or two land-birds are blown across the whole Atlantic Ocean, from North America to the western shores of Ireland and England ; one means, namely, by dirt adhering to their feet or beaks, which is in itself a rare accident. Even in this case, how small would be the chance of a seed falling on favourable soil, and coming to maturity ! But it would be a great error to argue that because a well-stocked island, like Great Britain, has not, as far as is known (and it would be very difficult to prove this), received within the last few centuported to an island, even if far less well-stocked than Britain, perto become naturalised. But this is no valid argument against what would be effected by occasional means of transport, during the long

lapse of geological time, whilst the island was being uphcaved, and before it had become fully stocked with inhabitants. On almost hare land, with few or no destructive insects or birds living there, nearly every seed which chanced to arrive, if fitted for the elimate, would cerminate and survive.

Dispersal during the Glacial Period.

The identity of many plants and animals, on mountain-summits, separated from each other by hundreds of miles of lowlands, where Alpine species could not possibly exist, is one of the most striking cases known of the same species living at distant points, without the apparent possibility of their having migrated from one point to the other. It is indeed a remarkable fact to see so many plants of the same species living on the snowy regions of the Alps or Pyrences, and in the extreme northern parts of Europe ; but it is far more remarkable, that the plants on the White Mountains, in the United States of America, are all the same with those of Labrador, and nearly all the same, as we hear from Asa Gray, with those on the loftiest mountains of Europe. Even as long ago as 1747, such facts led Gmelin to conclude that the same species must have been independently created at many distinct points; and we might have remained in this same belief, had not Agassiz and others called vivid attention to the Glacial period, which, as we shall immediately see, affords a simple explanation of these facts. We have evidence of almost every conceivable kind, organic and inorganic, that, within a very recent geological period, central Europe and North America suffered under an arctic climate. The ruins of a house burnt by fire do not tell their tale more plainly than do the mountains of Scotland and Wales, with their scored flanks, polished surfaces, and perched boulders, of the icy streams with which their valleys were lately filled. So greatly has the climate of Europe changed, that in Northern Italy, gigantic moraines, left by old glaciers, are now clothed by the vine and maize. Throughout a large part of the United States, erratic boulders and scored rocks plainly reveal a former cold period.

The former influence of the glacial climate on the distribution of the inhabitants of Europs, as explained by Edward Pores, is substantially as follows. But we shall follow the changes mere reality, by supposing a new glacial period solwy to come one, and the pass away, as formerly occurred. As the cold came on, and as each more southern zone become fulled for the inhabitants of the north, these would take the places of the former inhabitants of the tomperator engoins. The latter, at the same time, would ravel further and further conthusnal, makes they were stopped by burring, in which case they would period. The montaints would become covered with move and ics, and their ference Alpiten induktions would descend the pains. By the limit has thet would had method in maximum, we should have an arealic forms and form, covering the contral parts of Rourga as a." That the stop of may be also used as the stop of the stop of the stop of the mask and these would he nearly the same with these of Rourge i, for the present chromoplar imhibitant, which we suppose to have every where travelido scotured, are creatarbally uniform round the world.

As the warmsh returned, the arctic forms would netrate sorthward, closely following in their reterest by the protocitiess of the more temperate regions. And as the nove melled from the bases of the monutains, the arctic forms would network the source the nove still further disappears, the provided states on the densed the more still further disappears, higher and higher, which their burgers are stated with the state of the state of the source would again by formal their northering turney. Hence, when the would again by formal furth states regulates of the full and New would again by formal full metale regions of the full and New each others.

This we can understand the identity of many plants at points on immunoity remote as the normalized of the Darith States and these of Borrys. We can thus also understand the fact that the other of the states of t

As the arctic forms moved first southward and afterwards backnot have been exposed during their long migrations to any great diversity of temperature; and as they all migrated in a hole together, their mutual relations will not have been much disturbed Hence, in accordance with the principles inculcated in this volume. these forms will not have been liable to much modification. But with the Alpine productions, left isolated from the moment of the returning warmth, first at the bases and ultimately on the summits of the mountains, the case will have been somewhat different; for it is not likely that all the same arctic species will have been left on mountain-ranges far distant from each other, and have survival there ever since : they will also in all probability, have become mingled with ancient Alpine species, which must have existed on the mountains before the commencement of the Glacial epoch, and which during the coldest period will have been temporarily driven down to the plains ; they will, also, have been subsequently exposed to somewhat different climatal influences. Their mutual relations will thus have been in some degree disturbed - consequently they will have been liable to modification ; and they have been modified ; for if we compare the present Alpine plants and animals of the several great European mountain-ranges one with another, though many of the species remain identically the same, some exist as varieties, some as doubtful forms or sub-species, and some as distinct yet closely allied species representing each other on the several ranges.

In the foregoing illustration I have assumed that at the commencement of our imaginary Glacial period, the arctic productions were as uniform round the polar regions as they are at the present day. But it is also necessary to assume that many sub-arctic and some few temperate forms were the same round the world, for some of the species which now exist on the lower mountain-slopes and on the plains of North America and Europe are the same; and it may be asked how I account for this degree of uniformity in the sub-arctic and temperate forms round the world, at the commencement of the real Glacial period. At the present day, the sub-arctic and northern temperate productions of the Old and New Worlds are separated from each other by the whole Atlantic Ocean and by the northern part of the Pacific. During the Glacial period, when the inhabitants of the Old and New Worlds lived farther southwards than they do at present, they must have been still more completely separated from each other by wider spaces of ocean; so that it may well be asked how the
CHAP. XII. Dispersal during the Glacial Period. 333

mana speaks exhi then or previously have extend the two contimuts. The explansion, I believ, he in the nature of the climate blows the common ensum of the Guical preiol. Af this, hence Piloscan period, the majority of the inhibitizat of the world wave predically plus mass as now, maintoin the mover Piloscan period. The spectra days Haron wave may express that the cognitions which now live under latitude 60°, iteed thering the Hickens period farther north under the Defa Circle, in inhibition 60°-67° and all that the present days of the days of the spectra days of the spectra days Defa Circle, in inhibition 60°-67° and the difference of the preductions then lived on the booken intel ull more to the prior ductions that there is almost estimations of the difference of the Bibliotic to cancern America. And this continuity of the elemenplasi and, with the consequent freedom under a more favourable climate far interminication, will account for the approxed uniformly Worlds at a particle nutrice to the fluctuated and Neu-

Believing, from reasons before alluded to, that our continents have long remained in nearly the same relative position, though subjected to great oscillations of level, I am strongly inclined to extend the above view, and to infer that during some still earlier and still warmer period, such as the older Pliocene period, a large number of the same plants and animals inhabited the almost continuous cinumpolar land ; and that these plants and animals. wards as the climate became less warm, long before the commencement of the Glacial period. We now see, as I believe, their descendants, mostly in a modified condition, in the central rarts of Europe and the United States. On this view we can understand the relationship with very little identity, between the productions of North America and Europe,-a relationship which is highly remarkable, considering the distance of the two areas, and their severation by the whole Atlantic Ocean. We can further understand the singular fact remarked on by several observers that the productions of Europe and America during the later tertiary stages were more closely related to each other than they are at the present time ; for during these warmer periods the northern parts of the Old and New Worlds will have been almost continuously united by land, serving as a bridge, since rendered

During the slowly decreasing warmth of the Pliceene period, as soon as the species in common, which inhabited the New and Old Worlds, migrated south of the Polar Circle, they will have been completely cut off from each other. This separation, as far as the more temperate productions are concerned, must have taken place long ages ago. As the plants and animals migrated southward, native American productions, and would have had to compete with them; and in the other great region, with those of the Old World. Consequently we have here everything favourable for much modification, - for far more modification than with the Alpine productions, left isolated, within a much more recent period, on the several mountain-ranges and on the arctic lands of Europe and N. America. Hence it has come, that when we compare the now living productions of the temperate regions of the New and Old Worlds, we find very few identical species (though Asa Gray has lately shown that more plants are identical than was formerly supposed), but we find in every great class many forms which some naturalists rank as geographical races, and others as distinct species; and a host of closely allied or representative forms

As on the hand, "so in the waters of the sea, a slow scatteres imparison of a matrix frame, which, during the Toicsens or even a somewhat earlier period, was nearly uniform along the continous above of the Poler Crele, will accent, on the theory of molifiction, for many closely allel forms now living in matrix areas completely and/erect. Thus, it think, we can understand the presence of some closely allel, shift cistating and exittee iterality forms, on the mattern and we were more than the strengt of the site hearitful in Durit's dimitrable work), some fifth and other matters and we can be been provided by the provided of $d_{\rm POM-}$ these two areas being now completely separated by the hearith of a whole continent and p wide spaces of cons.

These cases of close relationship in precise sittler more of fourly inhibiting the same on the neartran wavestra shores of Nuclibability of the same of the same strange of the same strange of Netth America and Europe are incepticable on the theory of evaluation. We compare, for intermet, estimal particle doubties allow, in correspondence with the nearly similar physical conditions of the areas in for the compare, on instance, estimal part of Souri doubties of the same in the two compares, or instange and the decay similar in all their physical conditions, with their inhabtanata utterip discussion.

Alternate Glacial Periods in the North and South.

But we must return to our more immediate subject. I am convinced that Forbes's view may be largely extended. In Europe we meet with the plainest evidence of the Glacial period, from the Pyrenees. We may infer from the frozen mammals and nature the Lebanon, according to Dr. Hooker, perpetual snow formerly covered the central axis, and fed glaciers which rolled 4000 feet down the valleys. The same observer has recently found great moraines at a low level on the Atlas range in N. Africa. Along the Himalaya, at points 900 miles apart, glaciers have left the marks of their former low descent; and in Sikkim, Dr. Hooker saw maize growing on ancient and gigantic moraines. Southward of the Asiatic continent, on the opposite side of the equator, we know, from the excellent researches of Dr. J. Haast and Dr. Hector. that in New Zealand immense glaciers formerly descended to a low level; and the same plants found by Dr. Hooker on widely separated mountains in this island tell the same story of a former cold period. From facts communicated to me by the Rev. W. B. Clarke, it appears also that there are traces of former glacial action

Looking to America; in the northern half, ice-borne fragments of rock have been observed on the eastern side of the continent, as far south as lat, 36°-37°, and on the shores of the Pacific, where the climate is now so different, as far south as lat, 46°. Erratic boulders have, also, been noticed on the Rocky Mountains. In the Cordillera of South America, nearly under the equator, glaciers once extended far below their present level. In Central Chile I examined a vast mound of detritus with great boulders, crossing the Portillo valley, which there can hardly be a doubt once formed a huge moraine; and Mr. D. Forbes informs me that he found in various parts of the Cordillera, from lat, 13° to 30° S., at about the height of 12,000 feet, deeply-furrowed rocks, resembling those with detritus, including grooved pebbles. Along this whole space of the Cordillera true glaciers do not now exist even at much more considerable heights. Farther south on both sides of the continent, from lat. 41° to the southernmost extremity, we have the clearest evidence of former glacial action, in numerous immense boulders transported far from their parent source.

From these several facts, namely from the glacial action having

Alternate Glacial Periods

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extended all round the northern and southern hemispheres-from the period having been in a geological sense recent in both hemispheres-from its having lasted in both during a great length of time as may be inferred from the amount of work effected-and the whole line of the Cordillera, it at one time appeared to me that whole world had been simultaneously lowered during the Glacial period. But now Mr. Croll, in a series of admirable memoirs, has of various physical causes, brought into operation by an increase in the eccentricity of the earth's orbit. All these causes tend towards the same end; but the most powerful appears to be the indirect According to Mr. Croll, cold periods regularly recur every ten or fifteen thousand years; and these at long intervals are extremely as Sir C. Lyell has shown, is the relative position of the land and water. Mr. Croll believes that the last great Glacial period occurred about 240,000 years ago, and endured with slight alterations of climate for about 160,000 years. With respect to more ancient Glacial periods, several geologists are convinced from direct evidence that such occurred during the Miocene and Eccene formations, not to mention still more ancient formations. But the most important result for us, arrived at by Mr. Croll, is that whenever the northern hemisphere passes through a cold period, the temperature of the much milder, chiefly through changes in the direction of the oceancurrents. So conversely it will be with the northern hemisphere, whilst the southern passes though a glacial period. This conclusion throws so much light on geographical distribution that I am demand an explanation.

In Senth America, Dr. Hocker has above that besiden more loady alloid apock hereas for your fifty of the flowering platts of Thera del Energy, forming no inconsiderable part of its senty france are common to North America and Entrop, economoly remote a these areas in opposite hemispheres are from each other approximations of equitability. America a host of peellar, species belonging to European genera occur. On the Organ memtian of Bandl rome few temperete European, some Antartelis and Some Andean genera were found by Gardner, which do not etails in the low intervenition bott outlines. On the Sills of Cananya

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the illustrious Humboldt long ago found species belonging to genera characteristic of the Cordillera.

In Africa, several forms characteristic of Disroys and some for presentatives of the fine of the Cay of Good Hope cover on the mominian of Alyssinia. At the Cays of Good Hope avery few the European ageeds, buildend not be hown introduced by man, found, which have not been discovered in the interrupted period frike. Dr. Bolocci has also inderly shown that several of the plants living on the upper parts of the idry island of Fernando Fo and on the sngiboling". Governorm monitoria, in the 'Guid' of Chemica, are cleady related to those rate is a several and approximation of the line of the sngiboling". Governorm monitoria, the 'Guid' of Chemica, are cleady related to those rate the analysis of the size been discovered by the Rev. R. T. Lowe on the mountains of the Cays of the's islands. This creation of the same temperate frants have been discovered by the Rev. R. T. Lowe on the mountains of the Cays of the's islands. This creation of the same temperate forma, almost under the equator, arows the whole continent of Alfres and to the accession by the Rev. R. T. Lowe on the mountains of the Cays of the clear the equator, arows the whole continent of Alfres and to the accession for the same temperate forma, almost mode the equator, arows the whole continent of Alfres and to the semishine fract every recorded in the distribution of durin.

On the Himalaya, and on the isolated monthin-meanse of the penniane la foliak, on the heights of Copien, and on the volcanic cones of dway, many plants occur, either identically the same or representing each other, and at the same three representing plants of Europe, not found in the interventing hel lowing. A first of the genera of plants olicited on the blue ther packs of dway, mikes a picture of a collection made on a hillock in Europe-I Still more stifting in the first that peculiar Astronian forms are represented whereas. Know of these Astronian for may at 16.1 the more Robot Version Same of these Astronian for may at 16.1 the more Robot version shared the collection of the lower lands of Malacox, and are thirdly southered on the cone hand over India, and on the other hand as far north a Japan.

On the southern mountains of Australia, Dr. F. Miller has discovered several furgrams projects, order species, port introduced by man, over on the lowinaits; and a long list can be given, at 1 minimum by Dr. Hockey, of European genera, found in Australia, but not in the intermediato torid regions. In the adminibubar maintain the Fine of New Zakada (by Dr. Hocker, analolaw maintain the Fine of New Zakada (by Dr. Hocker, and large island. Hince we are that in regard to the joints of that large island. Hince we are that and worth, are either the same project or variaties of the man species. It hand, however, be observed

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that these plants are not strictly arctic forms; for, as Mr. H. C., Watson has remarked, "in receding from polar towards equatorial latitudes, the Alpine or mountain florus really become less and less Arctic." Besides those identical and closely allied forms, may species inhabiting the same widely sundered areas, belong to geners not prov found in the intermediate topical lowlands.

These heid remarks apply to phasts alows ; but some few makges, facts could be given in regard to terrestill animatic. In markin preductions, similar cases illowise occur; as at example, I may expect a statement by the lightest unbody; Porf, Dana, Hat^{ard} is certainly as wonderful fact that New Zealand stream about some statement of the world." Site 1: Biochardon, along space of the rangements on the aboves of New Zealand, Tamania fac, in ordering forms of this. Dr. Holwer informs and that tensyfive spaces of Alap are common to New Zealand and to Enzyth always obtained and the tensy.

on the highlands across the whole of equatorial Africa, and along the Peninsula of India, to Cevlon and the Malay Archipelago, and in a less well-marked manner across the wide expanse of tropical period, no doubt during the most severe part of a Glacial period, the lowlands of these great continents were everywhere tenanted under the equator by a considerable number of temperate forms. At this period the equatorial climate at the level of the sea was probably about the same with that now experienced at the height of from five to six thousand feet under the same latitude, or perhaps even rather cooler. During this, the coldest period, the on the lower slopes of the Himalaya, but with perhaps a still greater preponderance of temperate forms. So again in the mountainous island of Fernando Po, in the Gulf of Guinea, Mr. Mann of about five thousand feet. On the mountains of Panama, at the like that of Mexico, "with forms of the torrid zone harmoniously blended with those of the temperate."

Now let us see whether Mr. Croll's conclusion that when the northern hemisphere suffered from the extreme cold of the great Glacial period, the southern hemisphere was actually warmer, throws

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in the North and South.

any clear light on the present apparently inexplicable distribution of various organisms in the temperate parts of both hemispheres, and on the mountains of the tropics. The Glacial period, as measured by years, must have been very long ; and when we remember over what vast spaces some naturalised plants and animals have spread within a few centuries, this period will have been ample for any amount of migration. As the cold became more and more intense, we know that Arctic forms invaded the temperate regions; and, from the facts just given, there can hardly be a doubt that some of the more vigorous, dominant and widest-spreading temperate forms invaded the equatorial lowlands. The inhabitants of these hot lowlands would at the same time have migrated to the tropical and subtropical regions of the south, for the southern hemisphere was at this period warmer. On the decline of the Glacial period, as both hemitemperate forms living on the lowlands under the equator, would have been driven to their former homes or have been destroyed, being replaced by the equatorial forms returning from the south. Some, however, of the northern temperate forms would almost certainly have ascended any adjoining high land, where, if sufficiently lofty, they would have long survived like the Arctic forms on the mountains of Europe. They might have survived, even if the climate was not perfectly fitted for them, for the change of temperature must have been very slow, and plants undoubtedly possess a their offspring different constitutional powers of resisting heat and cold.

In the regular course of events the southern hemisphere would in its turn be subjected to a severe Glacial period, with the northern hemisphere rendered warmer; and then the southern temperate forms would invade the equatorial lowlands. The northern forms which had before been left on the mountains would now descend and mingle with the southern forms. These latter, when the warmth returned, would return to their former homes, leaving some few species on the mountains, and carrying southward with them some of the northern temperate forms which had descended from their mountain fastnesses. Thus, we should have some few species identically the same in the northern and southern temperate zones and on the mountains of the intermediate tropical regions. But the species left during a long time on these mountains, or in opposite hemispheres, would have to compete with many new forms and they would be eminently liable to modification, and would generally now exist as varieties or as representative species ; and this is the

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case. We must, also, hear in mind the occurrence in both hemispheres of former Glacial periods; for these will account, acaccodance with the same principles, for the many quite distinct species inhabiting the same widely separated areas, and belonging to genera not now found in the intermediate torid zones.

It is a remarkable fact strongly insisted on by Hooker in regard to America, and by Alph, de Candolle in regard to Australia, that the north to the south, than in a reversed direction. We see however, a few southern forms on the mountains of Borneo and Abyssinia. I suspect that this preponderant migration from the and to the northern forms having existed in their own homes in greater numbers, and having consequently been advanced threach dominating power, than the southern forms. And thus, when the two sets became commingled in the equatorial regions, during the alternations of the Glacial periods, the northern forms were the more nowerful and were able to hold their places on the monntains. and afterwards to migrate southward with the southern forms; but not so the southern in regard to the northern forms. In the same manner at the present day, we see that very many European lesser degree in Australia, and have beaten the natives; whereas extremely few southern forms have become naturalised in any part of the northern hemisphere, though hides, wool, and other objects likely to carry seeds have been largely imported into Europe during forty or fifty years from Australia. The Neitgherrie mountains in India, however, offer a partial exception ; for here, as I hear from Dr. Hooker, Australian forms are rapidly sowing themselves and becoming naturalised. Before the last great Glacial period, no doubt the intertropical mountains were stocked with endemic Alpine forms; but these have almost everywhere yielded to the more dominant forms, generated in the larger areas and more efficient workshops of the north. In many islands the native productions are nearly equalled, or even outnumbered, by those which have become naturalised; and this is the first stage towards their extinction. Mountains are islands on the land, and their inhabitants have yielded to those produced within the larger areas of the north, just in the same way as the inhabitants of real islands have everywhere yielded and are still yielding to continental forms naturalised through man's agency.

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This same principles apply to the distribution of terresticil mainsh and of mains productions, in the northern and southern temporate zones, and on the intertrepical monthins. When, during the height of the Giash performance of the same widely different to what they now are, some of the inhaltata of the coden currents, while show angles, the equator; of theses for would perform a some is able to migrate combined, by longing to elocide a glash unit the scattering the remain and survey in the colder does glash the scattering of the performance of the local scattering the scattering of the performance of the scattering of the scattering of the performance of inhaltent by Actic productions exist to the present day in the decare ratio of the nother tomperator seas.

I can far from appending that all the difficulties in regard to the distribution and all distributions of the likelihood and all dist projects, which more like us which generated in the neutrin and south, and southings on the intermediate mountain-arrays, as we moved us the views two generations. The provident and a south provide the two stars are also been as a stars of the stars and the view of provide the stars and the stars are stars and the stars of the stars are stars and the stars are stars and the form, while others have remained underset. We cannot hope to another becomes miturained by marks agoing in a foreign hard to another becomes miturained by marks agoing in a foreign hard to account a sea starting regions with the tore however.

Varians special differsibut and remain to be solved 1 for instance, the occurrence, as always by D. Hooker, do wanne plants at points as anomously remote as Kegnelow Land, New Zankada, and Pengei Ander and Sander Sander and Sander Sand

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been already widely dispersed to various points of the southern benisphere by occasional means of transport, and by the aid as haltingplaces, of now sunken islands. Thus the southern shores of America, Australia, and New Zealand, may have become slightly tinted by the same peculiar forms of life.

Sir C. Lyell in a striking passage has speculated, in language almost identical with mine, on the effects of great alternations of we have now seen that Mr. Croll's conclusion that successive Glacial the same and of the allied forms of life in all parts of the globe. The living waters have flowed during one period from the north and during another from the south, and in both cases have reached the equator ; but the stream of life has flowed with greater force from the north than in the opposite direction, and has consequently more freely inundated the south. As the tide leaves its drift in horizontal lines, rising higher on the shores where the tide rises highest, so have the living waters left their living drift on our monstain summits, in a line gently rising from the Arctic lowlands to a great altitude under the equator. The various beings thus left stranded may be compared with savage races of man, driven up and surviving in the mountain fastnesses of almost every land, which serve as a record, full of interest to us, of the former inhabitants of the surrounding lowlands,

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CHAPTER XIII.

GEOGRAPHICAL DISTRIBUTION-continued.

Distribution of fresh-water productions — On the inhabitants of cocanic islands — Absence of Batrachias and of terrestrial Mammals — On the relation of the inhabitants of islands to those of the nearest mainland — On colonisation from the nearest source with subsequent modification — Summary of the last and present chapter.

Fresh-water Productions.

As lakes and river-systems are separated from each other by barriers of and, it might seve been thought that fresh-water productions would not have maps) withly within the same country, and a the verse barrier through the distance on the same country, and the three several barrier through the distance on the same several the research to distance country. But the case is exactly the reverse. Not only have many fresh-water protects, belonging to different classes, an enerones many, but called a species proved in a remarkable manner throughout the world. When first collecting in the fresh waters of Braid. I well remember fedlug much arprite as the similarity of the fresh-water insects, adults, dec, and with these of Birting is.

But the wide ranging power of feed-water productions and, 11 think, in not cases be explained by their having become fitted, in a namer highly useful to them, for short and frequent migrations from pool to peak, or from stream to stream within their own countries, and habitity to wide dispersal would islate 'toos misdoy's few scase's of them, same of the most difficult to explain any reveated by finds. It was formerly believed that the same disputation of the strength of the strength of the strength and the strength of the strength and product by finds of the strength of the stren

Fresh-water Productions.

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the same continent fresh-water fish often range widely, and as if may be the same, and some wholly different. It is probable that they are occasionally transported by what may be called accidental vitality for a considerable time after removal from the water into each other. Instances, also, could be given of this having occurred during floods, without any change of level. The wide difference of the fish on the opposite sides of most mountain-ranges, which are continuous, and which consequently must from an early period have completely prevented the inosculation of the riversystems on the two sides, leads to the same conclusion. Some fresh-water fish belong to very ancient forms, and in such cases there will have been ample time for great geographical changes, and consequently time and means for much migration. Moreover Dr. Günther has recently been led by several considerations to infer that with fishes the same forms have a long endurance. Salt-water fish can with care be slowly accustomed to live in fresh water; and, according to Valenciennes, there is hardly a single group of which all the members are confined to fresh water, so that a marine species belonging to a fresh-water group might travel far along the shores of the sea, and could, it is probable, become adapted without much difficulty to the fresh waters of a distant land.

Some species of fead-senser shalls have very wide many, and likel species which, no our theory, are descended from a semme parent, and must have preceded from a single source, permithroughout the work. Their distribution at first perpixels me mesh, as their own are not likely to be transported by kinkly, and here any swill as holding an immunolity killed by assessmer. I would apply the understand how some naturalized species have a see a start of the adding an immunolity. But two facts, which have observed—a many address commutational species have three any start of the start of the start of the start three starts and the start of the start of the start of the phone light on this subject. When should have these mades induced the start of the start of the start of the start phone allower that the start of the start of the start of the start phone allower the start of the star

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Fresh-water Productions.

have unitarentically stacked the case with feed-worts delift form the other. But and other engress is periphene more difficult 1.2 aspended the feet of a duck in an aparatime, where many or so if robutor is a starting of the starting of the starting of the starting term in the starting and 1. Grand that numbers of the extremely minute and park-latched shifts enswite on the feet, and indig to them so from the starting and 1.2 means that the starting of the starting starting of the starting they would volume the starting starting of the starting and a factor later and high values at its or were hundred unidage, and a factor later and high values at its or were hundred unidage, and a factor later on a later to a later or a pool or rivelate. Site Charles (a factor-harder and in Dyriteen lass bound on unidate in Anaylia (a factor-harder and high the latest at the one mought with an Anaylia (a factor-harder and high the latest at the one mought with an Anaylia (b) when fact-factoring high the latest at the one mought with an Anaylia (b) when fact-factoring high the latest at the mought have a nonal the 'Bangly' when fact-factoring high have been the factor on local the 'Bangly' when fact-factoring high have been the factoring the inone case stat (b).

With respect to plants, it has long been known what enormous ranges many fresh-water, and even marsh species, have, both over terrestrial plants, which have very few aquatic members; for the latter seem immediately to acquire, as if in consequence, a wide range. I think favourable means of dispersal explain this fact. I have before mentioned that earth occasionally adheres in some quantity to the feet and beaks of birds. Wading birds, which frequent the muddy edges of ponds, if suddenly flushed, would be the most likely to have muddy feet. Birds of this order wander more than these of any other; and they are occasionally found on the most remote and barren islands of the open ocean : they would not be likely to alight on the surface of the sea, so that any dirt on their feet would not be washed of; and when gaining the land, they would be sure to fly to their natural fresh-water haunts. I do not believe that botanists are aware how charged the mud of ponds is with seeds : I have tried several little experiments, but will here give only the most striking case ; I took in February three tablespoonfuls of mud from three different points, beneath water, on the I kept it covered up in my study for six months, pulling up and counting each plant as it grew; the plants were of many kinds, and were altogether 537 in number; and yet the viscid mud was all

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contained in a breakfast cup! Considering these fasts, I think it would be an inceplicable circumstance if water-birds did not transport the seeds of fresh-water plants to unstocked ponds and stream, situated at very distant points. The same agency may have come into play with the eggs of some of the smaller fresh-water animals,

Other and unknown agencies probably have also played a part. I have stated that fresh-water fish eat some kinds of seeds, though small fish swallow seeds of moderate size, as of the yellow waterlily and Potamozeton. Herons and other birds, century after ontury, have gone on daily devouring fish ; they then take flight and go to other waters, or are blown across the sea; and we have seen that seeds retain their power of germination, when rejected many hours afterwards in pellets or in the excrement. When I saw the great size of the seeds of that fine water-lily, the Nelumbium and remembered Alph, de Candolle's remarks on the distribution of this plant. I thought that the means of its dispersal must remain inexplicable; but Audubon states that he found the seeds of the great southern water-lily (probably, according to Dr. Hooker, the Nelumbium luteum) in a heron's stomach. Now this bird must often have flown with its stomach thus well stocked to distant ponds, and then getting a hearty meal of fish, analogy makes me believe that it would have rejected the seeds in a pellet in a fit state

In considering these several means of distribution, it should be on a rising islet, it will be unoccupied ; and a single seed or egg will have a good chance of succeeding. Although there will always be a struggle for life between the inhabitants of the same pond, however few in kind, yet as the number even in a well-stocked pond is small in comparison with the number of species inhabiting an equal area of land, the competition between them will probably be less severe than between terrestrial species; consequently an intruder from the waters of a foreign country would have a better chance of seizing on a new place, than in the case of terrestrial colonists. We should also remember that many fresh-water productions are low in the scale of nature, and we have reason to believe that such beings become modified more slowly than the high ; and this will give time for the migration of aquatic species. We should not forget the probability of many fresh-water forms having formerly ranged continuously over immense areas, and then having become extinct at intermediate points. But the wide distribution of fresh-water plants and of the lower animals, whether

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retaining the same identical form or in some degree modified, apparently depends in main part on the wide disperal of their seeds and eggs by animals, more especially by fresh-water binks, which have great powers of flight, and naturally travel from one piece of water to another.

On the Inkabitants of Oceanic Islands.

We now came to the hat of the three chance of fasts, which is have selected as presenting the gravated amount of difficulty with respect to distribution, on the view that not only all the individuals of the same species have simpted for means one case, but that distributions are also as a start of the same set of the same properties. It are already at a same, which bittly have the constructed extension within the prefot of extintion of the same, respectively. The same set of the same set of the same properties is a start at the many ishes on the same set of the same set of the same set of the same set of the same respective set of the same set of the same set of the same respective set of the same set of the same set of the same respective set of the same set of the same set of the same respective set of the same set of the same set of the same respective set of the same set of the same set of the same respective set of the same set of the same set of the same respective set of the same set of the same set of the same respective set of the same set of the same set of the same respective set of the same set of the same set of the same respective set of the same set of the same set of the same respective set of the same set of the same set of the same respective set of the same set of the same set of the same respective set of the same se

number compared with those on equal continental areas : Alph, de Candolle admits this for plants, and Wollaston for insects. New Zealand, for instance, with its lofty mountains and diversified stations, extending over 780 miles of latitude, together with the outlying islands of Auckland, Campbell and Chatham, contain altogether only 960 kinds of flowering plants; if we compare this South-Western Australia or at the Cape of Good Hope, we must admit that some cause, independently of different physical conditions, has given rise to so great a difference in number. Even the uniform county of Cambridge has 847 plants, and the little island of Anglesca 764, but a few ferns and a few introduced plants are included in these numbers, and the comparison in some other respects is not quite fair. We have evidence that the barren island of Ascension aboriginally possessed loss than half-a-dozen flowering plants; yet many species have now become naturalised on it, as they have in New Zealand and on every other oceanic island which can be named. In St. Helena there is reason to believe that the naturalised plants and animals have nearly or quite exterminated many native productions. He who admits the doctrine

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of the creation of each separate species, will have to admit that a sufficient number of the best adapted plants and animals were not created for oceanic islands; for man has unintentionally stocked them far more fully and perfectly than did nature.

the number of endemic land-shells in Madeira, or of endemic birds in the Galapagos Archipelago, with the number found on any continent, and then compare the area of the island with that of occasionally arriving after long intervals of time in a new and isolated district, and having to compete with new associates, would of modified descendants. But it by no means follows that, because in an island nearly all the species of one class are peculiar, those of another class, or of another section of the same class, are peculiar: and this difference seems to depend partly on the species which are not modified having immigrated in a body, so that their mutual relations have not been much disturbed ; and partly on the frewith which the insular forms have intercrossed. It should be borne in mind that the offspring of such crosses would certainly gain in vigour; so that even an occasional cross would produce more effect than might have been anticipated. I will give a few illustrations of the foregoing remarks ; in the Galanagos Islands there are 26 land-birds; of these 21 (or perhaps 23) are peculiar, whereas of the 11 marine birds only 2 are peculiar; and it is obvious that marine birds could arrive at these islands much more easily and frequently than land-birds. Bermuda, on the other hand, which lies at about the same distance from North America as the Galapagos Islands do from South America, and which has a very peculiar soil, does not possess a single endemic land-bird; and we know from Mr. J. M. Jones's admirable account of Bermuda, that very many North American birds occasionally or even frequently visit this island. Almost every year, as I am informed by Mr. E. V. Harcourt, many European and African birds are blown to Madeira ; this island is inhabited by 99 kinds, of which form; and three or four other species are confined to this island and to the Canaries. So that the Islands of Bermuda and Madeira

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which for long ages have three struggled together, and have becomes mutually co-solution. Hence when solution in their new homese, each kind will have been kept by the others to its rouge and the solution of the large of the solution of the large of the solution of the solution of the solution of the large of the solution of the solution of the solution of the solution of the large of the solution of the solution of the solution of the solution of the large of the solution of the solution of the solution of the large of the solution of the solution of the solution of the large of the solution of the large of the solution of the s

Occasini islands are severilizes deficient in minulas of certain whole chanes, and theri places are coordial by other classes: thus in the Galayages blands reptiles, and in New Zauland gigautic whighes likely, inc, er eventy to obla, the place of manuals, Alle in New Gages denktiful whether it should be no ranked; it is of large sing, and in not separated from Australia by a preformally deep use; from its geological character and the direction of its in Galarges in a mole there. W. R. Charke has la lately maintained that this hakaal, as well as New Caldonia, should be considered as appretuneous of Australia. Yarang be place, har. Henchen of the different enders are yest different from what they are elserbers. Masch differences in number, and the absence of certain whole groups of animals and platta are generally accounted for by areposed differences on the physical conditions of the inlands, but this explanation is not a fifthe obtabuti. Futility of immigration of these.

Many remarkable little facts could be given with respect to the inhibitants of cosmic islands. For instance, in certain islands not temantical by a single maximal, some of the endemic plants have benefitiy looked seed; yet for vehicus are more manifest than that hooks serve for the transportal of seeds in the work an island by obtain remains; and the plant then becoming multified would form an useless appendixed like the sharvelled twings multified would form an useless appendixed like the sharvelled twings under

the soliteral wing-covers of many lumitar bottles. Again, indust, only posses trees or bubbs belonging to oviers which describes include only harkaccous species; now trees, as Alph, de Candid as above, generally harks the little higher trees and the soliton industry of the second second second second second second industry and an herbaccous plants by general dataset of mesonding cover of any herbaccous plants by general dataset of a continent, might, when established on an island, gain an abave, are continent, might, when established on an island, gain an abave overtopping them. In this saws sustain works would little us overtopping them. In this saws sustain works would be also than fast coveres it into a basis and them cover in the same stars.

Absence of Batrachians and Terrestrial Mammals on Oceanie Islands,

With respect to the absence of whole orders of animals on cosmic binds, bory St. Ninowi loss ago yavemarked that Bartahians (flexg, tooka, point) are never found on any of the many likeling (flexg, tooka, point) are never found on any of the many likeling voltage of the strain of the strain strain the description of New Zoahand, New Calokuta, the Andmann Jianha, and purpher the Schomen bands and the Scychelles. But Have analy remarked that it is doubtiful whether New Zoahand and New Calotan and the strain strain strain strain the strain of New Zoahand, New Calokuta the New Zoahand and New Calotan equal to resolve the score that in the strain strain the Scychelles. This general absence of freqs, tonks, and nevtre on many two cosmic islands cannot be accounted for by this physical conditions: indeed in the score introduced into Mafield for these animals, for freqs have been introduced into Mabocome a nutannee. But as these animals and their gapsen are imperial across the sca, and therefore we can see why physic b not train, they should not have been introduced there is would be preduced by the cospetion, action there of the strain scale and the scale we can see why physic b not train, they should not have been interdenced there is would be strain the scale and there is would be preduced the scale and the scale we have been been then the scale and the scale we can be aveling the scale and the scale would be scale and the scale we have the barrow of the strain the scale and the scale we can be aveling the scale and the scale and the scale would be scale and the scale would be scale and the scale we have the scale and the scale and the scale we can be aveling the scale and the scale would be scale and the scale would be scale and the scale would be scale and the scale we have the scale and the scale would be scale and the scale would be scale and the scale would be scale and the scale we have the scale and the scale would be scale and the scale would be scale and the scale would be scale and the scale wo

Maximals offer another and similar case. Thave carefully asserbed the oldest voyages, and have not found a single instance, free from doubt, of a terrestrial maximal (excluding domesticated animals kept by the natives) inhabiting an island situated above 300 milles from a continent or great continential island; and many islands situated at a much less distance are equally burren. The Fallkland

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on Occanic Islands.

Islands, which are inhabited by a wolf-like fox, come nearest to an its western shores, and they may have formerly transported foxes, as now frequently happens in the arctic regions. Yet it cannot be said that small islands will not support at least small mammals, for they occur in many parts of the world on very small islands. when lying close to a continent; and hardly an island can be named on which our smaller quadrupeds have not become naturalised and greatly multiplied. It cannot be said, on the ordinary view of creation, that there has not been time for the creation of mammals; many volcanic islands are sufficiently ancient, as shown by the stupendous degradation which they have suffered, and by their tertiary strata : there has also been time for the production of endemic species belonging to other classes; and on continents it is known that new species of mammals appear and disappear at a quicker rate than other and lower animals. Although terrestrial mammals do not occur on oceanic islands, aerial mammals do occur on almost every island. New Zealand possesses two bats found nowhere else in the world : Norfolk Island, the Viti Archipelago, the Bonin Islands, the Caroline and Marianne Archinelagoes, and Mauritius, all possess their peculiar bats. Why, it may be asked, has the supposed creative force produced bats and no other mammals on remote islands ? On my view this question can easily be answered ; for no terrestrial mammal can be transported across a wide space of sea, but bats can fly across. Bats have been seen wandering by day far over the Atlantic Ocean; and two North American species either regularly or occasionally visit Bermuda, at the distance of 600 miles from the mainland. I hear from Mr. Tomes, who has specially studied this family, that many species have enormous ranges, and are found on continents and on far distant islands. Hence we have only to suppose that such wanto their new position, and we can understand the presence of endemic bats on oceanic islands, with the absence of all other

Another interesting relation exists, namely between the depth of the sea separating islands from each other or from the nearest continent, and the degree of affinity of their maximalian inhabitants. Mr. Windor Earl has made some striking observations on this head, since gravity extended by Mr. Wallace's admirable researches, in regard to the gravet Malay Archipelaze, which is

Absence of Terrestrial Mammals CHAP. XIII.

traversed near Gelsen by a space of deep count, and this segregates traversed near Gelsen by a share we show the one of the states stand on a moderately shallow evaluation in the state time. This is a set of the states of the states of the states of the world is plut as far as 1 have gone, the relation body good. They channes, Dirktin is separated by a shallow channel from Enzyand the mammals are the same on both sides rank as it is with all binations in the backers of a startistic. The West Hubble from Enzygen and the mammals are the same on both sides rank as it is with all binations in the backers of a startistic. The West Hubble from Enzygen the dimension of the west with the starts. As the a amount of fragment which minimals of all kinds undergay, burget depends on the post of the starts have equivalent the are separated from each older or from the mainland by shallow channels, are more likely taken of the starts burget were built of the set separated by the bination starts with the starts were channels, we can understand here is that a relation theory depend on the bination starts of relation bination in the start which we depend the start was separated bination in the start were bindly and the start was and the starts are bindly descer channels, we can understand here is related as the start were also being of the start we separated bindly descer channels, we can be bindly the start was start were start was main functions the theory of independent arts of relation.

The forgoing statements in regard to the inhibituats of censis inhan,—manity, the forwards of the species, with a large preperturconsisting of endemic forms—the numbers of certain promp, but not those of other groups in the same characher and the special methods of the special spectra of the spectra of the special restrict anomals, notwithstanding the presence of archit largerestrict anomals, notwithstanding the presence of archit largether special on during a long course of time, then noticed perter with the bising in the efficiency of coexisional means of transport, carried on during a long course of time, that are written consistent of a car this latter view it is probable that the written consistent of a car this latter view it is probable that the view consistent of a car then have been consistent on the source there are an under the spectra of the spectra of the spectra have been much disturbels, and consequently they would either have.

I do not deny that there are many and serious allifedities in understanding how many of the inhabitants of the more remote islands, whether still retaining the same specific form or subsquently modified, have reached their present homes. But the probability of other islands having once existed as halting-places of which not a wreck now remains, must not be overlooked. I will

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specify one difficult case. Almost all oceanic islands, even the striking instances of which have been given by Dr. A. A. Gould in relation to the Pacific. Now it is notorious that land-shells are easily killed by sea-water; their eggs, at least such as I have but occasionally efficient means for their transportal. Would the on the ground, and thus get transported ? It occurred to me that land-shells, when hybernating and having a membranous diaphragm over the mouth of the shell, might be floated in chinks of drifted timber across moderately wide arms of the sea. And I find that several species in this state withstand uninjured an immersion in sea-water during seven days : one shell, the Helix pomatia, after having been thus treated and again hybernating was put into seaof time the shell might have been carried by a marine current of average swiftness, to a distance of 660 geographical miles. As this Helix has a thick calcareous operculum, I removed it, and when it had formed a new membranous one, I again immersed it for fourteen days in sea-water, and again it recovered and crawled away. Baron Aucapitaine has since tried similar experiments : he placed 100 land-shells, belonging to ten species, in a box plerced with holes, and immersed it for a fortnight in the sea. Out of the hundred shells, twenty-seven recovered. The presence of an operculum seems to have been of importance, as out of twelve specimens of Cyclostoma elegans, which is thus furnished, eleven revived. It is remarkable, seeing how well the Helix pomatia resisted with me the salt-water, that not one of fifty-four specimens belonging to four other species of Helix tried by Aucapitaine, recovered. It is, however, not at all probable that land-shells have often been thus transported ; the feet of birds offer a more probable method.

On the Relations of the Inhabitants of Islands to those of the nearest Mainland.

The most striking and important fact for us is the affinity of the species which inhabit ialmost to those of the neurost mainland, without being actually the same. Numerous instances could be given. The Galanges Architecture of the equator, lies at the distance of between 500 and 600 miles from the shores of South America. Here almost every product of the hand and of the water bears the unmitakable stamp of the American continent.

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There are twenty-six land-birds; of these, twenty-one or perhaps twenty-three are ranked as distinct species, and would commonly be assumed to have been here created ; yet the close affinity of most of these birds to American species is manifest in every character. in their habits, gestures, and tones of voice. So it is with the other animals, and with a large proportion of the plants, as shown by Dr. Hooker in his admirable Flora of this archipelago. The naturalist, looking at the inhabitants of these volcanic islands in the Pacific, distant several hundred miles from the continent, feels that he is standing on American land. Why should this be so? why should the species which are supposed to have been created in the Galaragos Archinelago, and nowhere else, hear so plainly the stamp of affinity to those created in America? There is nothing in the conditions of life, in the geological nature of the islands, in their height or climate, or in the proportions in which the several classes are associated together, which closely resembles the conditions of the South American coast : in fact, there is a considerable dissimilarity in all these respects. On the other hand, there is a considerable degree of resemblance in the volcanic nature of the soil, in the climate, height, and size of the islands, between the Galapagos and Cape de Verde Archipelagoes : but what an entire and absolute difference in their inhabitants ! The inhabitants of the Cape de Verde Islands are related to those of Africa, like those of the Galaragos to America. Facts such as these, admit of no sort of explanation on the ordinary view of independent creation; pagos Islands would be likely to receive colonists from America, whether by occasional means of transport or (though I do not believe in this doctrine) by formerly continuous land, and the Cape de Verde Islands from Africa; such colonists would be liable to modification,-the principle of inheritance still betraying their

Mary malogues facts could be given: indeed it is an allow lurveal rule that the endencir productions of induces are wided to those of the nearest continuous, of them can be explained. This attraction of them can be explained. This attraction of the enders in the explained of America, the plants are related, and there were closely, as we have describe the plants are related on the twee relations, and the thet this island. In how no holy of America is been of the work and effective on the relation of the the prevalues (in the theory of the theory of the the the second of the this atomaly disappears. Now Zealand in its endeming latest is not have closely related to America in the nearest maintain dark in the how closely related to America in the nearest maintain dark in the theory of the related to the the relation of the the relation of the the how closely related to America in the nearest maintain dark in the nearest maintain dark in the nearest maintain dark in the second se

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going other region; and this is what might have here negressical, in it is also plashing related to South Americs, which, although the next nearest continent, is so enormously renords, that the fact becomes an anomaly. But this difficulty partially disappears on the view that New Zoukad, South America, and the other southerm indication that the extension of the south America, and the other southerm distant point, namely from the antarctic islands, when they were added with vegetation, during a werman teating period, before the commutation of the south antarctic islands, when they were distant point, anonely from the antarctic islands, when they were distant point, among the most south the south of the tage of food the southersterm course of Antartant and of the Cage of food Hops, is far more remarkable case; but this dimity is confind to the plants, and Will, no obudy, now of by be explained.

The same law which has determined the relationship between the inhabitants of islands and the nearest mainland, is sometimes displayed on a small scale, but in a most interesting manner, within the limits of the same archipelago. Thus each separate island of the Galanagos Archinelago is tenanted, and the fact is a marvellous one, by many distinct species ; but these species are related to each other in a very much closer manner than to the inhabitants of the American continent, or of any other quarter of the world. This is what might have been expected, for islands situated so near to each other would almost necessarily receive immigrants from the same original source, and from each other. But how is it that many of the immigrants have been differently modified, though only in a small degree, in islands situated within sight of each other, having the same geological nature, the same height, climate, &c. ? This long appeared to me a great difficulty : but it arises in chief part from the deeply-seated error of considering it cannot be disputed that the nature of the other species with which each has to compete, is at least as important, and generally a far more important element of success. Now if we look to the species which inhabit the Galapagos Archipelago and are likewise found in other parts of the world, we find that they differ considerably in the several islands. This difference might indeed have been expected if the islands have been stocked by occasional means of transport-a seed, for instance, of one plant having been brought to one island, and that of another plant to another island, though all proceeding from the same general source. Hence, when in former times an immigrant first settled on one of the islands, or when it subsequently spread from one to another, it would undonhtedly be exposed to different conditions in the different

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islands, for it would have to comptee with a different art, of organisms ; plants for instance, would find the ground best fitted for it cocycled by somewhat different species in the different islands, and would be exposed to the tatalast of emergentia ferent essentise. If then it varied, natural selection would prohibit ferent essentise. If then it varied, natural selection would prohibit only one provide the sense of the sense of the sense over the plot period and syst steinth the same of nateer displot out the group, just as we so men species spreading widely throughent a continuent and remaining the same.

The really surprising fact in this case of the Galanagoa Archine lago, and in a lesser degree in some analogous cases, is that each new species after being formed in any one island, did not spread quickly to the other islands. But the islands, though in sight of wider than the British Channel, and there is no reason to suppose that they have at any former period been continuously united. The currents of the sea are rapid and sweep between the islands, and gales of wind are extraordinarily rare; so that the islands are far more effectually separated from each other than they appear on a map. Nevertheless some of the species, both of those found in other parts of the world and of those confined to the ambindam are common to the several islands; and we may infer from their present manner of distribution, that they have spread from one island to the others. But we often take, I think, an erroneous view of the probability of closely-allied species invading each other's territory, when put into free intercommunication. Undoubtedly, if one species has any advantage over another, it will in a very brief time wholly or in part supplant it ; but if both are equally well fitted for their own places, both will probably hold their separate places for almost any length of time. Being familar with the fact that many species, naturalised through man's agency, have spread with astonishing rapidity over wide areas, we are apt to infer that most species would thus spread ; but we should remember that the species allied to the aboriginal inhabitants, but are very distinct forms, belonging in a large proportion of cases, as shown by Alph. de Candolle, to distinct genera. In the Galanagos Archinelago, many even of the birds, though so well adapted for flying from island to island, differ on the different islands; thus there are three closely-allied species of mocking-thrush, each confined to its own island. Now let us suppose the mocking-thrush of Chatham Island to be blown to Charles Island, which has its own mockingthrush: why should it succeed in establishing itself there? We

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may safely infer that Charles Island is well stocked with its own species, for annually more eggs are laid and young birds hatched, than can possibly be reared; and we may infer that the mockingthrush peculiar to Charles Island is at least as well fitted for its home as is the species peculiar to Chatham Island. Sir C. Lvell and Mr. Wollaston have communicated to me a remarkable fact bearing on this subject ; namely, that Madeira and the adjoining islet of Porto Santo possess many distinct but representative species of land-shells, some of which live in crevices of stone ; and although large quantities of stone are annually transported from Porto Santo to Madeira, yet this latter island has not become colonised by the Porto Santo species; nevertheless both islands have been colonised by European land-shells, which no doubt had some advantage over the indigenous species. From these considerations I think we need not greatly marvel at the endemic species which inhabit the several islands of the Galapagos Archipelago, not having all spread from island to island. On the same continent, also, preoccupation has probably played an important part in checking the commingling of the species which inhabit different districts with nearly the same physical conditions. Thus, the south-east and south-west corners of Australia have nearly the same physical conditions, and are united by continuous land, yet they are inhabited by a vast number of distinct mammals, birds, and plants; so it is, according to Mr. Bates, with the butterflies and other animals inhabiting the great, open, and continuous valley of the Amazons.

The same principle which governs the general character of the inhabitants of oceanic islands, namely, the relation to the source whence colonists could have been most easily derived, together with their subsequent modification, is of the widest application throughout nature. We see this on every mountain-summit, in every lake and marsh. For Alpine species, excepting in as far as the same species have become widely spread during the Glacial epoch, are related to those of the surrounding lowlands; thus we have in South America, Alpine humming-birds, Alpine rodents, Alpine plants, &c., all strictly belonging to American forms; and it is obvious that a mountain, as it became slowly upheaved, would be colonised from the surrounding lowlands. So it is with the inhabitants of lakes and marshes, excepting in so far as great facility of transport has allowed the same forms to prevail throughout large portions of the world. We see this same principle in the character of most of the blind animals inhabiting the caves of America and of Europe. Other analogous facts could be given.

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It will, I believe, he found universally true, that wherever in two regions, let them be ever so distant, many closely allied or representative species occur, there will likewise be found noon identical species; and wherever many closely-allied species occur, there will be found many forms which some naturalists rank as distinct species, and others as more varieties; these doubtful forms showing us the steps in the progress of modification.

The relation between the power and extent of migration in certain species, either at the present or at some former period, and the existence at remote points of the world of closely-allied species. is shown in another and more general way. Mr. Gould remarked to me long ago, that in those genera of birds which range over the world, many of the species have very wide ranges. I can hardly doubt that this rule is generally true, though difficult of proof Amongst mammals, we see it strikingly displayed in Bats, and in a lesser degree in the Felida and Canida. We see the same rule in the distribution of butterflies and beetles. So it is with most of the inhabitants of fresh water, for many of the genera in the most distinct classes range over the world, and many of the species have enormous ranges. It is not meant that all, but that some of the species have very wide ranges in the genera which range very widely. Nor is it meant that the species in such genera have on an average a very wide range; for this will largely depend on how far the process of modification has gone ; for instance, two varieties of the same species inhabit America and Europe, and thus the species has an immense range; but, if variation were to be carried a little further, the two varieties would be ranked as distinct species, and their range would be greatly reduced. Still less is it meant, that species which have the capacity of crossing barriers and ranging widely, as in the case of certain powerfully-winged hirds, will necessarily mance widely; for we should never forget that to range widely implies not only the power of crossing barriers, but the more important power of being victorious in distant lands in the struggle for life with foreign associates. But according to the view that all the species of a genus, though distributed to the most remote points of the and I believe as a general rule we do find, that some at least of the species range very widely.

We should bear in mind that many genera in all classes are of ancient origin, and the species in this case will have had ample time for dispersal and subsequent modification. There is also reason to believe from geological evidence, that within each great

class the lower organized charge at a slower rate than the higher, sumporthy they will have had a better chance of ranging workly and, of still retaining the same specific character. This fact, together with that the he seeds and egg of most lowly organized forms bright years minute and better fitted for distant transportation of the same which have been been been been been as which amonity, that the lower any group of erganisms stands, the more yields it mores.

The relations just discussed,—namely, how communit mights new widely than the higher,—some of the species of widelymaging genera themselves ranging widely—each facts, as a plays instruction, and name broadcomb to well and an each species in the second main of the species of the species of the artiking relationship between the inhibitants of histories and the other second mainform—the sill closed relationship of the distinct inhibitant of the islands in the same archipelang—artiking relationship but are explanable if we with colonization relationship of the distinct has a second structure of the independent relationship of the distinct indication of the islands in the same archipelang—artiking in the specific second structure of the independent relationship of the distinct indication of the islands in the same archipelang—artiking in the specific second structure of the independent relationship of the distinct outplies to disting the boxes.

Summary of the last and present Chapters.

In these chapters I have endeavoured to show, that if we make due allowance for our ignorance of the full effects of changes of climate and of the level of the land, which have certainly occurred within the recent period, and of other changes which have probably occurred,-if we remember how ignorant we are with respect to the many curious means of occasional transport,-if we bear in mind, and this is a very important consideration, how often a species may have ranged continuously over a wide area, and then have become extinct in the intermediate tracts,-the difficulty is not insuperable in believing that all the individuals of the same species, wherever found, are descended from common parents. And we are led to this conclusion, which has been arrived at by many naturalists under the designation of single centres of creation, by various general considerations, more especially from the importance of barriers of all kinds, and from the analogical distribution of sub-genera, genera, and families,

With respect to distinct species belonging to the same genus, which on our theory have spread from one parent-source; if we make the same allowances as before for our ignorance, and remember that some forms of life have changed very slowly,

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enormous periods of time having been thus granted for their migration, the difficulties are far from insuperable; though in this case, as in that of the individuals of the same species, they are often great.

As ecceptifying the effects of climatal changes on nitratibular. It have attempted to also how how important a part the last Ginkal period has played, which affected even the equatorial region, and which, during the alternations of the cold in the sent and nonth, allowed the predictions of opposite hemispheres to mingo. The hemisphere is the strength of the mornitario-munitis in all of consideral transport. Have discussed at some little length the mann of dispress of forth-owner productions.

If the difficulties be not insuperable in admitting that in the long course of time all the individuals of the same species, and likewise of the several species belonging to the same genus, have of geographical distribution are explicable on the theory of cation of new forms. We can thus understand the high importance apparently forming the several zoological and botanical provinces. We can thus understand the concentration of related species within the same areas; and how it is that under different latitudes, for instance in South America, the inhabitants of the plains and mountains, of the forests, marshes, and deserts, are linked together in so mysterious a manner, and are likewise linked to the extinct beings which formerly inhabited the same continent. Bearing in mind that the mutual relation of organism to organism is of the highest importance, we can see why two areas having nearly the same physical conditions should often be inhabited by very different since the colonists entered one of the regions, or both ; according to the nature of the communication which allowed certain forms and not others to enter, either in greater or lesser numbers ; according or not, as those which entered happened to come into more or less direct competition with each other and with the aborigines; less rapidly, there would ensue in the two or more regions, independently of their physical conditions, infinitely diversified conaction and reaction,-and we should find some groups of beings greatly, and some only slightly modified,-some developed in great

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force, some existing in scanty numbers—and this we do find in the several great geographical provinces of the world.

On these same principles we can understand, as I have endeawonred to show, why oceanic islands should have few inhabitants, but that of these, a large proportion should be endemic or peculiar; and why, in relation to the means of migration, one group of beings the same class, should have all its species the same with those in an adjoining quarter of the world. We can see why whole groups of organisms, as batrachians and terrestrial mammals, should be reasess their own peculiar species of aerial mammals or bats. We can see why, in islands, there should be some relation between the presence of mammals, in a more or less modified condition, and the depth of the sea between such islands and the mainland. We can clearly see why all the inhabitants of an archipelago, though specifically distinct on the several islets, should be closely related to each other; and should likewise be related, but less closely, to these of the nearest continent, or other source whence immigrants might have been derived. We can see why, if there exist very closely allied or representative species in two areas, however distant. from each other, some identical species will almost always there be

As the late Edward Forbes often insisted, there is a striking narallelism in the laws of life throughout time and space ; the laws governing the succession of forms in past times being nearly the same with those governing at the present time the differences in different areas. We see this in many facts. The endurance of each species and group of species is continuous in time ; for the apparent exceptions to the rule are so few, that they may fairly be attributed to our not having as yet discovered in an intermediate deposit certain forms which are absent in it, but which occur both above and below : so in space, it certainly is the general rule that the area inhabited by a single species, or by a group of species, is continuous, and the exceptions, which are not rare, may, as I have attempted to show, be accounted for by former migrations under different circumstances, or through occasional means of transport, or by the species having become extinct in the intermediate tracts. Both in time and space, species and groups of species have their points of maximum development. Groups of species, living during the same period of time, or living within the same area, are often characterised by trifling features in common, as of sculpture or colour. In looking to the long succession of past ages, as in

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looking to datant provinces throughout the world, we find that opecies in certain classes differ little rom each other, while these in another class, or only in a different section of the same endre, different sections of the same endre. The short here and space the lexity organized numbers of each cive in both cases marked exception to the rule. Accessing to our theory, these several ratio throughout time and space are initialligibles for whether we look to the rule. Accessing to our theory, these several ratio and the short of the which have changed during unconsistent and throughout time and space are initialligibles for whether we look or to those which have changed after having migrated into diatantic orders which have changed after having migrated into diatantic orders and the seven have been accumulated by the same mass of ration selection.

CHAPTER XIV.

MUTUAL AFFINITIES OF ORGANIC BEINGS : MORPHOLOGY : Embryology : Rudimentary Organs,

Classification.

FROM the most remote period in the history of the world organic beings have been found to resemble each other in descending degrees, so that they can be classed in groups under groups. This classification is not arbitrary like the grouping of the stars in constellations. The existence of groups would have been of simple significance, if one group had been exclusively fitted to inhabit the land, and another the water ; one to feed on flesh, another on vegotable matter, and so on ; but the case is widely different, for it is notorious how commonly members of even the same sub-group have different habits. In the second and fourth chapters, on Variation country it is the widely ranging, the much diffused and common, that is the dominant species, belonging to the larger genera in cach class, which vary most. The varieties, or incipient species, thus produced, ultimately become converted into new and distinct species; and these, on the principle of inheritance, tend to produce other new and dominant species. Consequently the groups which tend to go on increasing in size. I further attempted to show that from the varying descendants of each species trying to occupy as many and as different places as possible in the economy of nature, they constantly tend to diverge in character. This latter conclusion

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is supported by observing the great diversity of forms which, in any small area, come into the closest competition, and by certain facts in naturalisation.

I attempted also to show that there is a steady tendency in the improved forms. I request the reader to turn to the diagram illustrating the action, as formerly explained, of these several principles; and he will see that the inevitable result is, that the up into groups subordinate to groups. In the diagram each letter on the uppermost line may represent a genus including several species; and the whole of the genera along this upper line form together one class, for all are descended from one ancient rarrest and, consequently, have inherited something in common. But the three genera on the left hand have, on this same principle, much in next two genera on the right hand, which diverged from a common parent at the fifth stage of descent. These five genera have also much in common, though less than when grouped in sub-families: and they form a family distinct from that containing the three genera still farther to the right hand, which diverged at an earlier period. And all these genera, descended from (A), form an order distinct from the genera descended from (I). So that we here have many species descended from a single progenitor grouped into genera ; and the genera into sub-families, families, and orders, all under one great class. The grand fact of the natural subordination of organic beings in groups under groups, which, from its familiarity, does not always sufficiently strike us, is in my judgment thus explained. No doubt organic beings, like all other objects, can be classed in many ways, either artificially by single characters or more naturally by a number of characters. We know, for instance, that minerals and the elemental substances can be thus arranged. In this case there is of course no relation to genealogical successive, and no cause can at present be assigned for their falling into groups. But with organic beings the case is different, and the

Naturalists, as we have seen, try to arrange the species general and families in each class, on what is called the Natural System. But what is meant by this system? Some authors look at in medy as a scheme for arranging together those living objects which are most alike, and for separating those which are most unlike; or as

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an artificial method of enunciating, as briefly as possible, general propositions,-that is, by one sentence to give the characters common, for instance, to all mammals, by another those common then, by adding a single sentence, a full description is given of each kind of dog. The ingenuity and utility of this system are indisputable. But many naturalists think that something more is meant by the Natural System ; they believe that it reveals the plan of the Creator: but unless it be specified whether order in time or space. or both, or what else is meant by the plan of the Creator, it seems to me that nothing is thus added to our knowledge. Expressions such as that famous one by Linnæus, which we often meet with in a more or less concealed form, namely, that the characters do not make the genus, but that the genus gives the characters, seem to imply that some deeper bond is included in our classifications than mere resemblance. I believe that this is the case, and that community of descent-the one known cause of close similarity in organic beings-is the bond, which though observed by various degrees of

Let us now consider the rules followed in classification, and the difficulties which are encountered on the view that classification either gives some unknown plan of creation, or is simply a scheme for enunciating general propositions and of placing together the forms most like each other. It might have been thought (and was in ancient times thought) that those parts of the structure which determined the habits of life, and the general place of each being in the economy of nature, would be of very high importance in classification. Nothing can be more false. No one regards the external similarity of a mouse to a shrew, of a dugong to a whale, of a whale to a fish, as of any importance. These resemblances, though so intimately connected with the whole life of the being, are ranked as merely "adaptive or analogical characters;" but to the consideration of these resemblances we shall recur. It may even be given as a general rule, that the less any part of the organisation is concerned with special habits, the more important it becomes for classification. As an instance : Owen, in speaking of the dugong, says, "The generative organs, being those which are always regarded as affording very clear indications of its true affinities. We are least likely in the modifications of these organs to mistake a merely adaptive for an essential character." With plants how remarkable it is that the organs of vegetation, on which their nutrition and life depend, are of little signification ; whereas the

organa of reproduction, with their product the seed and embryo, as of paramount importancel. So equits in formerly discussing certain morphological characters which are not functionally important, as have seen that they are often of the highest service in cassification. This depends on their constancy throughout many allied groups, and their constancy chiefly depends on any allight derivations not having hear preserved and accumulated by natural selection, which acts only on serviceable characters.

That the mere physiological importance of an organ does not determine its classificatory value, is almost proved by the fact, that to suppose, has nearly the same physiological value, its classificatory value is widely different. No naturalist can have worked long at any group without being struck with this fact; and it has been fully acknowledged in the writings of almost every author. It will suffice to quote the highest authority, Robert Brown, who, in speaking of certain organs in the Proteacæ, says their generic importance, "like that of all their parts, not only in this, but, as I the genera of the Connaraceae "differ in having one or more valvular astivation. Any one of these characters singly is frequently of more than generic importance, though here even when all taken together they appear insufficient to separate Cnestis from vision of the Hymenoptera, the antennae, as Westwood has remarked, are most constant in structure ; in another division they differ much, and the differences are of quite subordinate value in classification; same order are of unequal physiological importance. Any number of instances could be given of the varying importance for classification of the same important organ within the same group of

Again, no cone will are that realizentary or attrophilo ergns are of high physiological or viral importance ; eye, undotbelly, ergns in this could or viral importance ; eye, undotbelly, ergns will chapted that the realizentary texts in the upper jave of year runnians, and certain realizentary texts in the upper jave of year excitable in rulning the down affitty between running enclosed in rulning the down affitty between running for the classification of the radius of the highest important in the classification of the grantse.

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Sumerous instances could be given of characters derived from parts table must be considered of very triling physiological importance, hat which are universally admitted as highly surviseable in the draining of which groups. For instance, whicher ero not three is an equipa-the influence of the angle of the lower physical engine-the influence of the angle of the lower physical Maranyiak -this manner in which the wings of insets are folded-more grammed-methy and the order of the lower physical methy and only in certain Alge-metry physicames in parts of the forcer in grammed-methy and the order of the lower physical methy and in the Verbitant. If the ordinal overring, as half or for allower in the Verbitant.

The importance, for classification, of trifling characters, mainly denends on their being correlated with many other characters of more or less importance. The value indeed of an aggregate of characters is very evident in natural history. Hence, as has often been remarked a species may depart from its allies in several characters, both of high physiological importance, and of almost universal prevalence, and yet leave us in no doubt where it should be ranked. Hence, also, it has been found that a classification founded on any single character, however important that may be, has always failed; for no part of the organisation is invariably constant. The importance of an aggregate of characters, even when none are important, alone explains the aphorism enunciated by Linnmus, namely, that the characters do not give the genus, but the cenus gives the characters; for this seems founded on the appreciation of many trifling points of resemblance, too slight to be defined. Certain plants, belonging to the Malpighiaceau, bear perfect and degraded flowers ; in the latter, as A. de Jussieu has remarked, " the greater number of the characters proper to the species, to the genus, to the family, to the class, disappear, and thus laugh at our classification." When Aspicarpa produced in France. during several years, only these degraded flowers, departing so wonderfully in a number of the most important points of structure from the proper type of the order, yet M. Richard sagaciously saw, the Malpighiaceae. This case well illustrates the spirit of our classifications.

Practically, when naturalists are at work, they do not trouble themselves about the physiological value of the characters which they use in defining a group or in allocating any particular species.

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If they find a character nearly uniform, and common to a great high value; if common to some lesser number, they use it as of subordinate value. This principle has been broadly confessed hy some naturalists to be the true one; and by none more clearly than by that excellent botanist, Aug. St. Hilaire. If several triffing charactors are always found in combination, though no apparent bond of connection can be discovered between them, especial value is set on them, As in most groups of animals, important organs, such as those for propelling the blood, or for aerating it, or those for nropagating the race, are found nearly uniform, they are considered as highly serviceable in classification; but in some groups all these the most important vital organs, are found to offer characters of quite subordinate value. Thus, as Fritz Müller has lately remarked. in the same group of crustaceans, Cypridina is furnished with a heart, whilst in two closely allied genera, namely Cypris and Cytherea, there is no such organ ; one species of Cypridina has welldeveloped branchiæ, whilst another species is destitute of them.

We can see why characters derived from the embryo should be of equal importance with those derived from the adult, for a natural classification of course includes all ages. But it is by no means obvious, on the ordinary view, why the structure of the embryo should be more important for this purpose than that of the adult, which alone plays its full part in the economy of nature. Yet it has been strongly urged by those great naturalists. Milne Edwards and Agassiz, that embryological characters are the most important of all ; and this doctrine has very generally been admitted as true. owing to the adaptive characters of larvæ not having been excluded; in order to show this. Fritz Müller arranged by the aid of such characters alone the great class of crustaceans, and the arrangement did not prove a natural one. But there can be no doubt that embryonic, excluding larval characters, are of the highest value for classification, not only with animals but with plants. Thus the main divisions of flowering plants are founded on differences in the mode of development of the plumule and radicle. We shall immediately see why these characters possess so high a value in

Our classifications are often plainly influenced by chains of affinitics. Nothing can be easier than to define a number of characters common to all birds; but with crustaceans, any such definition has

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hitherto been found impossible. There are crustaceans at the apposite ends of the series, which have hardly a character in common ; yet the species at both ends, from being plainly allied to chers, and these to others, and a so onwards, can be recognised as maquirocally belonging to this, and to no other class of the Articulats.

Geographical distribution has often been used, though perhaps not quite logically, in classification, more especially in very large groups of closely allied forms. Terminick insists on the utility or even necessity of this practice in certain groups of birds; and it has been followed by several entomologists and botamists.

Finally, with respect to the comparative value of the variangenge of species, we has earless, sub-interfa, families, sub-families, and genera, they seem to be, at least at present, almost arbitrary. Sevend of the hot totanists, and as a Mr. Bentham and ethers, have strongly insisted on their arbitrary value. Instances could be given amongly finalism and insects, of a group first ranked by predicted instantiants as only a genes, and then rated to the rank of predicted instantiants and insection of the strong strong strong memory instantiants and the strong strong strong strong strong memory in a detection important structured differences at final overlooked, but because numerous alled species with alightly differentions of difference, there been subsequently discovered.

All the foregoing rules and aids and difficulties in classification may be explained, if I do not greatly decive wayed, on the view that the Natural System is founded on descent with modification z—that between any two z more appead, as it is an initial have been inbertied from a common parent, all true classification being grounding and the system many two could yeak that, and not not be the haritantist have been unconscioudly save king, and not some unknown with the parent and sensitive and the structure of the system of the system structure and the same structure of the system sensitive in the system were relative operations and the system of the system of the system of the system is the system and sensitive functions more not non-

But I music explain my meaning more fully. I believe that the wavegeneous of the groups within each case, in due melevillantion and relation to each other, must be strictly generalized in other by estantial; but that the meaned of difference in the several by the strictly strictly of the strictly strictly and their encourses programmers and the strictly strictly and their encourses programmers and the strictly strictly and different dappess of configuration which we undergone ; and this is expressed by the forms being ranked under the strictly and is many if the will induce the track at low the diagram in the fourth dapper. We will suppose the tites at low Lie systemet with the strictly well suppose the tites at low Lie systemet at the strictly of the strictly strictly and the strictly strictly at the strictly strictly strictly strictly at the strictly string strictly stri

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allied genera existing during the Silurian epoch, and descended from some still earlier form. In three of these genera (A, F, and I), a species has transmitted modified descendants to the present day. represented by the fifteen genera (a14 to z14) on the uppermost horizontal line. Now all these modified descendants from a single species, are related in blood or descent in the same degree; they may metaphorically be called cousins to the same millionth degreeyet they differ widely and in different degrees from each other. The forms descended from A, now broken up into two or three families constitute a distinct order from those descended from I, also broken up into two families. Nor can the existing species, descended from A, he ranked in the same genus with the parent A; or these from I, with the parent I. But the existing genus FH may be sunposed to have been but slightly modified ; and it will then mak with the parent-genus F; just as some few still living organisms belong to Silurian genera. So that the comparative value of the differences between these organic beings, which are all related to each other in the same degree in blood, has come to be widely different. Nevertheless their genealogical arrangement remains strictly true, not only at the present time, but at each successive period of descent. All the modified descendants from A will have inherited something in common from their common parent, as will all the descendants at each successive stage. If, however, we suppose any descendant of of its parentage, in this case, its place in the natural system will be All the descendants of the genus F, along its whole line of descent, are supposed to have been but little modified, and they form a single genus. But this genus, though much isolated, will still occupy its proper intermediate position. The representation of the groups, as here given in the diagram on a flat surface, is much too simple. The branches ought to have diverged in all directions. If the names of the groups had been simply written down in a linear series, the representation would have been still less natural; and it is notoriously not possible to represent in a series, on a flat surface, same group. Thus, the natural system is genealogical in its arrangement, like a pedigree : but the amount of modification which

. It may be worth while to illustrate this view of classification, by

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taking the case of languages. If we possessed a perfect pedigree of mankind, a genealogical arrangement of the races of man would afford the best classification of the various languages now spoken throughout the world ; and if all extinct languages, and all intermediate and slowly changing dialects, were to be included, such an arrangement would be the only possible one. Yet it might be that some ancient languages had altered very little and had given rise to few new languages, whilst others had altered much owing to the spreading, isolation, and state of civilisation of the several codescended races, and had thus given rise to many new dialects and languages. The various degrees of difference between the languages of the same stock, would have to be expressed by groups subordinate to groups; but the proper or even the only possible arrangement would still be genealogical; and this would be strictly natural, as it would connect together all languages, extinct and recent, by the closest affinities, and would give the filiation and origin of each tongue.

In confirmation of this view, let us glance at the classification of varieties, which are known or believed to be descended from a single species. These are grouped under the species, with the sub-varieties under the varieties; and in some cases, as with the domestic pigeon, with several other grades of difference. Nearly the same rules are followed as in classifying species. Authors have insisted on the necessity of arranging varieties on a natural instead of an artificial system; we are cautioned, for instance, not to class two varieties of the pine-apple together, merely because their fruit, though the most important part, happens to be nearly identical : no one puts the Swedish and common turnip together, though the esculent and thickened stems are so similar. Whatever part is found to be most constant, is used in classing varieties : thus the great agriculturist Marshall says the horns are very useful for this purpose with cattle, because they are less variable than the shape or colour of the body, &c. ; whereas with sheep the horns are much less serviceable, because less constant. In classing varieties, I apprehend that if we had a real pedigree, a genealogical classification would be universally preferred ; and it has been attempted in some cases. For we might feel sure, whether there had been more or less modification, that the principle of inheritance would keep the forms together which were allied in the greatest number of points. In tumbler pigeons, though some of the sub-varieties differ in the important character of the length of the beak, yet all are kept together from having the common habit of tumbling; but the short-faced breed has nearly or quite lost this habit : nevertheless,

without any thought on the subject, these tumblers are kept in the same group, because allied in blood and alike in some other respects.

With process in a state of nature, every naturality has in facbrought assemb in the is classification (or be includes in his lowest gradue, that of species, the two sexes; and how enormously how enormously in the net of the state of the intervention of the intervention of the state state of the state of the state of the state of the state which had previously been ranked as three distinct graves, were known to be sometimes produced on the same plant, they were immediately considered as varieties paral. Heremaphenelities form of the same species. The naturalist includes a new production of the same species of the same individual, however much they may differ from each other and from the adult, and well as the classical advantage of the same individual. The fields technical herea tageneous the same individual. The fields measurement of the same individual form the state of the same technical account for the same individual. The fields are stated as the same individual form the state of the state of the same spectrum. The state of the same individual, however much they may differ from each other and from the adult, and the same based of the same base of the same individual. The fields are specified by the same spectrum the same based of the same individual form the same based of the same based of the same based of the same individual form the same based of the same based of the same based of the same based of the sam

As descent has universally been used in classing together the individuals of the same species, though the males and females and larvæ are sometimes extremely different ; and as it has been used in classing varieties which have undergone a certain, and sometimes a considerable amount of modification, may not this same element of descent have been unconsciously used in grouping species under genera, and genera under higher groups, all under used ; and thus only can I understand the several rules and guides which have been followed by our best systematists. As we have no written pedigrees, we are forced to trace community of descent by resemblances of any kind. Therefore we choose those characters which are the least likely to have been modified, in relation to the conditions of life to which each species has been recently exposed. Rudimentary structures on this view are as good as, or even sometimes better than, other parts of the organisation. We care not how trifling a character may be-let it be the mere inflection of the angle of the jaw, the manner in which an insect's wing is folded, whether the skin be covered by hair or feathers-if it prevail throughout many and different species, especially those having very different habits of life, it assumes high value; for we can account

Analogical Resemblances.

for its presence in so many forms with each different habits, only up instrinates from a common power. We may erin this respect to a regard to single points of structure, but when several characters, its them be ever so triffing, concurs throughout a large group of brings having different habits, we may feel almost sure, on the heavy of desent, that these characters have been inherited from a common ancestor; and we know that such aggregated characters have aprecial value in classification.

We can understand why a species or a group of species may depart from its allies, in several of its most important characteristics, and yet be safely classed with them. This may be safely done, and is often done, as long as a sufficient number of characters, let them he ever so unimportant, betrays the hidden bond of community of descent. Let two forms have not a single character in common, yet, if these extreme forms are connected together by a chain of intermediate groups, we may at once infer their community of descent, and we put them all into the same class. As we find organs of high physiological importance---those which serve to preserve life under the most diverse conditions of existence-are generally the most constant, we attach especial value to them; but if these same organs, in another group or section of a group, are found to differ much, we at once value them less in our classification. We shall presently see why embryological chameters are of such high classificatory importance. Geographical distribution may sometimes be brought usefully into play in classing large genera, because all the species of the same genus, inhabiting any distinct and isolated region, are in all probability descended from the same parents.

Assigned Resultances—We can understand, on the above views, the very inopertant distinction between real affinities mal analogical or adaptive resembiances. Lamark first called interim to this subject, and he has been ably followed by final the states. They rules have been ably followed by and is the states. They rules have been ably followed by the state of the states of the lower have two orders of manuals and finkes, are analogisd. So is the resemblance between a mouse and a shrew-rouse main interpolar lange to different orders in an unsult is closer resultances, insisted on by Mr, Mivari, between the mouse and walk interpolar land (Antochium) of Antoriha. These latter two for similarly active movements through thickets and herbegs, toppinger with concessions in from closes.

Amongst insects there are innumerable similar instances; thus

Lineaus, minded by external appearances, astually classed as homoparons inners as a moth. We see sconsthing of the same kind even with our domestic varieties, as in the strictingly milling about the same striction of the same stricting striction of the the similarly thickneed stense of the common and nepefulgation distinct Swedia turnity. The resemblance between the grapheng and the reacheses is hardly more facilitat species using the similarly distinct by more facilitat species with different minutes.

On the view of characters being of real importance for classification, only in so far as they reveal descent, we can clearly understand why analogical or adaptive characters, although of the utmost importance to the welfare of the being, are almost valueless to the systematist. For animals, belonging to two most distinct lines of descent, may have become adapted to similar conditions, and thus have assumed a close external resemblance : but such resemblances will not reveal-will rather tend to conceal their blood-relationship. We can thus also understand the apparent paradox, that the very same characters are analogical when one group is comnared with another, but give true affinities when the members of the same group are compared together: thus, the shape of the body and fin-like limbs are only analogical when whales are compared with fishes, being adaptations in both classes for swimming through the water ; but between the several members of the whale family, the shape of the body and the fin-like limbs offer characters exhibiting true affinity; for as these parts are so nearly similar throughout the whole family, we cannot doubt that they have been inherited from a common ancestor. So it is

Numerous cases could be given of striking resemblance in quild distict bring between single parts or creans, which have been shapted for the same fractions. A good instance is afforded by the closer resemblance or of the jave of the dog and Tamamian wolf or Thylerims,—saminals which are widely sendered in the natural system. But this resemblance is correlated to general appenance, as in the promisence of the canine, and in the cutting above of the module reach. For the test reality differ much that the ble moders, while the difference of the contrast and only moders, while the difference of the contrast and only moders, while the difference of the contrast in the ble moders, while the difference of the contrast in the difference of the moder and only the moders, while the difference of the test of the system of the moders is striked as the strike of the system of the moder has a difference. The adult dentition is preceded by a widely different mith dentities. Are not may or course due that the test

in either case have been adapted for tearing flesh, through the natural selection of accessive variations; but if this be admitted in the one case, it is unintelligible to me that it should be denied in the other. I am glad to find that so high an authority as Professor Flower has come to this same conclusion.

The extraordinary cases given in a former chapter, of widely different fishes possessing electric organs,-of widely different insects possessing luminous organs,-and of orchids and asclepiads having pollen-masses with viscid discs, come under this same head of analogical resemblances. But these cases are so wonderful that they were introduced as difficulties or objections to our theory. In all such cases some fundamental difference in the growth or development of the parts, and generally in their matured structure, can be detected. The end gained is the same, but the means, though appearing superficially to be the same, are essentially different. The principle formerly alluded to under the term of analogical variation has probably in these cases often come into play that is, the members of the same class, although only distantly allied, have inherited so much in common in their constitution, that they are apt to vary under similar exciting causes in a similar manner : and this would obviously aid in the acquirement through natural selection of parts or organs, strikingly like each other, independently of their direct inheritance from a common progenitor.

A species belonging to distinct classes have often been abyed by smeasure align incollations to bive under nearly similar dremantances—to inhabit, for instance, the three elements of lass), and water—exe can perhaps understand how it is that a numerical parallelium has sometimes hene observed between the absence of distinct classes. A naturalist, struck with a parallelium of this nature, by abilitarily missing or stabing the whose of the manifestime star should be able to be able to be distingt and the star of the star should be able to be a

There is another and carbon class of cases in which does external remembrance does not depend on adaptation to similar habits of life, but has been gained for the sales of protection. I allele to the observation of the sales of the sales of the sales of the described by Mr. Bates, other and quite distinct sectors. This excludes the sales of the sales of the sales of the sales butterfy manely, a Legalair, is does found mingled in the same back; and the hater do classer remeats the other the theorem in every matterfy manely.

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shade and stripe of colour and even in the shape of its wings, that Mr. Bates, with his eyes sharpened by collecting during eleven years, was, though always on his guard, continually deceived. When the mockers and the mocked are caught and compared they are found to be very different in essential structure, and to belong not only to distinct genera, but often to distinct families have been passed over as a strange coincidence. But, if we proceed from a district where one Leptalis imitates an Ithomia, another meetclose in their resemblance, may be found. Altogether no less than ten genera are enumerated, which include species that imitate other butterflies. The mockers and mocked always inhabit the same region; we never find an imitator living remote from the form which it imitates. The mockers are almost invariably rare insects; the mocked in almost every case abound in swarms. In the same district in which a species of Leptalis closely imitates an Ithomia, there are sometimes other Lepidoptera mimicking the same Ithomia; so that in the same place, species of three genera of butterflies and even a moth are found all closely resembling a hutterfly belonging to a fourth genus. It deserves especial notice that many of the mimicking forms of the Leptalis, as well as of the mimicked forms, can be shown by a graduated series to be merely varieties of the same species ; whilst others are undoubtedly distinct species. But why, it may be asked, are certain forms treated as the mimicked and others as the mimickers ? Mr. Bates satisfactorily answers this question, by showing that the form which is imitated keens the usual dress of the group to which it belongs, whilst the counterfeiters have changed their dress and do not resemble their nearest allies.

We are not led to implies what reason can be assigned for earlash batterilies and moties to often assuming the draws of another and quick divides form; why, to the perplexity of naturalists, has no doub, hit on the true explanation. The models forms, while a large extent, otherwise the year of the stage? Mr. Rates has no doub, hit on the true explanation. The models forms, while a large extent, otherwise they could not exist in such assumited by the stage of the stage of the stage of the stage of the stage stage. The stage of the district, are comparisod to stage that may be able to the stage of the they must affer holding forms, on the other hand, is built output, hence they must affer habitually from some damps, for otherwise, forms the number of eggs and by all by attractions, here would in three st

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Analogical Resemblances.

of one of these persecuted and rare groups were to assume a dress so like that of a well-protected species that it continually deceived daccous birds and insects, and thus often escape destruction. Mr. Bates may almost be said to have actually witnessed the process by which the mimickers have come so closely to resemble the mimicked ; for he found that some of the forms of Leptalis which mimic so many other butterflies, varied in an extreme degree. In one district several varieties occurred, and of these one alone resembled to a certain extent, the common Ithomia of the same district. In another district there were two or three varieties, one of which was much commoner than the others, and this closely meeked another form of Ithomia. From facts of this nature, Mr. Bates concludes that the Leptalis first varies; and when a variety happens to resemble in some degree any common butterfly inhabiting the same district, this variety, from its resemblance to a fourishing and little-persecuted kind, has a better chance of escaping destruction from predaceous birds and insects, and is consequently oftener preserved ;-"the less perfect degrees of resemblance being generation after generation eliminated, and only the others left to propagate their kind." So that here we have an excellent illustration of natural selection.

Means: Walkies and Thimm have likewise described several equality striking cases of initiation in the Lepfophera of the Makay Arshipinga and Africa, and with seme other invests. Mr. Walkes also dotted on cases were with builds, fat we also are none with his dash of the section cases were also builds, fat we also set with insect than, with other animals, in probably the consequence of their mult large inneric a most during the more large of the minute of sense index nodes in more large of minutes of sense index nodes of the more inners models) insects cannot easily easipe by flight from the larger models insects cannot easily easipe by flight from the larger were realistical theory and distantionality.

I takonk be observed that the process of imitation prohably never commoned between forms widely disimilar in colour. Thus starting with species already somewhat like each other, the closest resumand if the imitated form was subsequently and gradually molified theorgh any agency, the imitating form would be lead along the same track, and thus be altered to almost any extent, so that if wight utilizaties same an appearance or colouring wholly unlike

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that of the other members of the family to which it belongs, There is, however, some difficulty or this band, for it is necessary to suppose in some cases that ancient members belonging to serve distinct groups, before they had diverged to their present extract, accidentally resembled a member of another and protected group in a sufficient depres to affect some eight protection; this having given the basis for the subsequent acquisition of the most perfect resemblance.

On the Nature of the Affinities connecting Oryania Enigomethods and the observations of containing the that larger genera, total to indicit the advantages which unde the group the servation of the servation of the server and the server have the server of the server and the server have in the second with which we have the server and the consequently angle at many market and fielder groups. This we indicate the server and the server and more obtained groups consequently angle at many market and fielder groups. This we indicate the server and the server and the server and the consequently angle at many market and fielder groups. This we indicate the server and the analysis of the server and the server and the server of the analysis of the server and the server and the server the analysis of the server and the server the server and the server the server and the serv

In the chapter on Geological Succession I attempted to show, on the principle of each group having generally diverged much in character during the long-continued process of modification, how it is that the more ancient forms of life often present characters in some degree intermediate between existing groups. As some few of descendants but little modified, these constitute our so-called osculant or aberrant species. The more aberrant any form is, the greater must be the number of connecting forms which have been exterminated and utterly lost. And we have some evidence of aberrant groups having suffered severely from extinction, for they are almost always represented by extremely few species ; and such species as do occur are generally very distinct from each other, which again implies extinction. The genera Ornithorhynchus and Lepidosiren, for example, would not have been less aberrant had each been represented by a dozen species, instead of as at present by a single one, or by two or three. We can, I think, account for this fact only by looking at aberrant groups as forms which have been conquered by more successful competitors, with a few members

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Mr. Waterhouse has remarked that, when a member belonging to one group of animals exhibits an affinity to a quite distinct mum this affinity in most cases is general and not special ; thus, according to Mr. Waterhouse, of all Rodents, the bizcacha is most nearly related to Marsupials; but in the points in which it appreaches this order, its relations are general, that is, not to any one marsupial species more than to another. As these points of affinity are believed to be real and not merely adaptive, they must be due in accordance with our view to inheritance from a common progenitor Therefore we must suppose either that all Rodents, including the bizcacha, branched off from some ancient Marsupial, which will naturally have been more or less intermediate in character with respect to all existing Marsuplals; or that both Rodents and Marsunials branched off from a common progenitor, and that both groups have since undergone much modification in divergent directions. On either view we must suppose that the bizcacha has retained, by inheritance, more of the characters of its ancient progenitor than have other Rodents ; and therefore it will not be specially related to any one existing Marsupial, but indirectly to all or nearly all Marannials from having partially retained the character of their common progenitor, or of some early member of the group. On the other hand, of all Marsupials, as Mr. Waterhouse has remarked, the Phaseolomys resembles most nearly, not any one species, but the general order of Rodents. In this case, however, it may be strongly suspected that the resemblance is only analogical, owing to the Phaseolomys having become adapted to habits like those of a Rodent. The elder De Candolle has made nearly similar observations on the general nature of the affinities of distinct families of plants.

On the principle of the multiplication and gradual divergence in densitier of the species descended from a common progenitor, together with their retention by laberitation of roose characters in multiple symbols, and the species of the same family or higher group are connected together. For the common progenitor of a subgroup, will have transmitted none of its character, molinds and specific symbols. The specific spectra of the spectra spectra of the s

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ordinary difficulty which naturalists have experienced in describing, without the aid of a diagram, the various affinities which they perceive between the many living and extinct members of the same great natural class.

Extinction, as we have seen in the fourth chapter, has played an important part in defining and widening the intervals between the several groups in each class. We may thus account for the distinctness of whole classes from each other-for instance, of birds from all other vertebrate animals-by the belief that many ancient forms of life have been utterly lost, through which the early progenitors of birds were formerly connected with the early progenitors of the other and at that time less differentiated vertebrate classes connected fishes with batrachians. There has been still less within some whole classes, for instance the Crustacea, for here the most wonderfully diverse forms are still linked together by a long and only partially broken chain of affinities. Extinction has only defined the groups ; it has by no means made them ; for if every though it would be quite impossible to give definitions by which each group could be distinguished, still a natural classification, or at least a natural arrangement, would be possible. We shall see this by turning to the diagram; the letters, A to L, may represent eleven Silurian genera, some of which have produced large groups of modified descendants, with every link in each branch and subbranch still alive; and the links not greater than those between existing varieties. In this case it would be quite impossible to give definitions by which the several members of the several groups could be distinguished from their more immediate parents and in common. In a tree we can distinguish this or that branch, though at the actual fork the two units and blend together. We could not, as I have said, define the several groups ; but we could value of the differences between them. This is what we should be any one class which have lived throughout all time and space. tion : nevertheless, in certain classes, we are tending towards this end ; and Milne Edwards has lately insisted, in an able paper, on

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the high importance of looking to types, whether or not we can separate and define the groups to which such types belong.

extinction and divergence of character in the descendants from any one parent-species, explains that great and universal feature in in group under group. We use the element of descent in classing the individuals of both sexes and of all ages under one species, although they may have but few characters in common : they may be from their parents; and I believe that this element of descent is the hidden bond of connexion which naturalists have sought under the term of the Natural System. On this idea of the natural system being, in so far as it has been perfected, genealogical terms genera, families, orders, &c., we can understand the rules which we are compelled to follow in our classification. We can understand why we value certain resemblances far more than others : why we use rudimentary and useless organs, or others of between one group and another, we summarily reject analogical or adaptive characters, and yet use these same characters within the limits of the same group. We can clearly see how it is that all living and extinct forms can be grouped together within a few great classes ; and how the several members of each class are connected together by the most complex and radiating lines of affinities. We shall never, probably, disentangle the inextricable web of the affinities between the members of any one class ; but when we have a distinct object in view, and do not look to some unknown plan of creation, we may hope to make sure but slow progress.

Professor Highed In his "Generalle Morphologie" and in other whys, has recently hought high grad households and altilities to bear on what he calls phylogeny, or the lines of descent of all cogain bings. In driving up the several series he trusts shifty to milryholgical characters, but receives aid from househouse and dimension of the second second second second second molecular descent and the second second second second molecular descent second second second second second molecular descent second second second second second molecular descent second second second second second descent second seco

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Morphology.

We have seen that the members of the same class, independently of their habits of life, resemble each other in the general plan of their organisation. This resemblance is often expressed by the term "unity of type;" or by saying that the several parts and organs subject is included under the general term of Morphology. This is almost be said to be its very soul. What can be more curious than that the hand of a man, formed for grasping, that of a mole for digging, the leg of the horse, the paddle of the porpoise, and the wing of the bat, should all be constructed on the same pattern, and should include similar bones, in the same relative positions? How curious it is, to give a subordinate though striking instance, that the hind-feet of the kangaroo, which are so well fitted for bounding over the open plains,-those of the climbing, leaf-cating koals equally well fitted for grasping the branches of trees, -those of the ground-dwelling, insect or root eating, bandicoots .- and those of same extraordinary type, namely with the bones of the second and so that they appear like a single toe furnished with two claws. Notwithstanding this similarity of pattern, it is obvious that the hind feet of these several animals are used for as widely different purposes as it is possible to conceive. The case is rendered all the more striking by the American opossums, which follow nearly the same habits of life as some of their Australian relatives, having feet constructed on the ordinary plan. Professor Flower, from whom these statements are taken, remarks in conclusion: "We may call this conformity to type, without getting much nearer to an explanation of the phenomenon;" and he then adds " but is it

Occurry St. Illiaire has strongly instaled on the high imperture or relative position or connexion in homologous parts; they may differ to almost any extent in form and size, and yet remain cornected together in the same invariable order. We neversifiel, for instance, the boxes of the arm and fore-arm, or of the high mail logour boxes in which different names can be given to the high maillogour boxes in which different names are involved to the high maillogour boxes in which different names in reduces the high maillayer in boxes are high different names in reduces the high maillayer in the construction of the months of insects - what name incomdifferent than the immensively one particular produces of a subine-such behaviour different to the strong of the subine-such behaviour different to the interval of the strong of the subine-such behaviour different to the interval of the strong of the subine-such behaviour different to the interval of the strong of the subine-such behaviour different to the interval of the strong of the subine-such behaviour different to the interval of the strong of the subine-such behaviour different to the interval of the strong of the subine-such behaviour different to the interval of the strong of the subine-such behaviour different to the interval of the strong of the str

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the extraors folded one of a bee or bug, and the great javes of a bendra-yet all these organs, serving. for such widely different septement, are formed by infinitely numerous medifications of an upper lip, manibles, and two pairs of maxillas. The same law governs the construction of the months and limbs of crustaceans. So it is with the flowers of plants.

Subjace can be more heppings than to attempt to explain this indicity of pattern in numbers of the same class, by utility or by the dorithm of final cause. The heppelessness of the attempt absence spreasely samitable by Owen in his most interesting work on the X-latters of Limba². On the cellurary view of the independent centulon of each height, we can only say that say it is y_{--} plants in each prost class on a uniform plan; but this is not a scientific explanation.

The explanation is to a large extent simple on the theory of the selection of successive slight modifications,-cach modification being profitable in some way to the modified form, but often affecting by correlation other parts of the organisation. In changes of this nature, there will be little or no tendency to alter the original nattern, or to transpose the parts. The bones of a limb might be shortened and flattened to any extent, becoming at the same time enveloped in thick membrane, so as to serve as a fin ; or a webbed hand might have all its bones, or certain bones, lengthened to any extent, with the membrane connecting them increased, so as to serve as a wing ; yet all these modifications would not tend to alter the framework of the bones or the relative connexion of the parts. If we suppose that an early progenitor-the archetype as it may be called-of all mammals, birds, and reptiles, had its limbs constructed on the existing general pattern, for whatever purpose they served, we can at once perceive the plain signification of the homolozous construction of the limbs throughout the class. So with the mouths of insects, we have only to suppose that their common progenitor had an upper lip, mandibles, and two pairs of maxillae, these parts being perhaps very simple in form ; and then natural selection will account for the infinite diversity in the structure and functions of the mouths of insects. Nevertheless, it is conceivable that the general pattern of an organ might become so much obscured as to be finally lost, by the reduction and ultimately by the complete abortion of certain parts, by the fusion of other parts, and by the doubling or multiplication of others,-variations which we know to be within the limits of possibility. In the paddles of the gigantic extinct sea-lizards, and in the mouths of certain

suctorial crustaceans, the general pattern seems thus to have become partially obscured.

There is another and equally carries branch of our subject, annely, serial homolesie, or the comparison of the different parts or organs in different metrics of the anne parts or organs in different members of the same least. Most physioltic series of the same least of the same parts of elemental parts of a certain number and in white comments and posterior limber of the same least least of enumbers and the same least of the same least of

How inceptionable are the cases of serial howodayie on the columny view of centerion I. Way should the brain be enclosed in a loc composed of such numerous and such extraoulinative Owen, has crawteeld, the brendit derived from the y-biology of the separate pieces in the set of perturbition by maximally will by you means explain the same construction from the y-biology of the separate pieces in the set of perturbition by maximally will by you different purposes, monity fully and walking? Why should one cratatorsan, which has an extremely complex mouth formed of errations, which has an extremely complex mouth formed of these with many logs have simpler to each frome, thengh fields of each distingt purpose, beal constructed on the same pattern?

On the theory of natural selection, we can, to a certain extent, answer these questions. We need not here consider how the bolies of some animals first became divided into a series of segments, or how they became divided into right and left sides, with certasponding organs, for such questions are almost beyond invarigation. It is, however, probable that some serial structures are the result of cells multiplying by division, entailing the multi-

plication of the parts developed from such cells. It must suffice for our narrose to bear in mind that an indefinite repetition of the same part or organ is the common characteristic, as Owen has remarked, of all low or little specialised forms : therefore the unknown progenitor of the Vertebrata prohably possessed many vertebra: the unknown progenitor of the Articulata, many segments; and the unknown progenitor of flowering plants, many leaves arranged in one or more spires. We have also formerly seen that parts many times repeated are eminently liable to vary, not only in number, but in form, Consequently such parts, being already present in considerable numbers, and being highly variable would naturally afford the materials for adaptation to the most different purposes ; yet they would generally retain, through resemblance. They would retain this resemblance all the more, as the variations, which afforded the basis for their subsequent modification through natural selection, would tend from the first to be similar; the parts being at an early stage of growth alike, and being subjected to nearly the same conditions. Such rarts, whether more or less modified, unless their common origin became

In the great class of molluos, though the parts in distinct species can be shown to be homologous, only a for ward homologies, such as the valves of Chitora, can be indicated; that is, we are soldenn enabled to say that one part is homologous with another part in the same individual. And we can understand this divert is fin additional to the same transmission of the class, were divert in the other great classes of the animal and vegetable kingdown.

But morphology is a much more complex subject than it at first pure, as this has leady been well shown in a remarkable paper by Mc E. Buy Lankoster, who has drawn an important distinction between critin (naises) of cases which have all been originally maked by automistics as homologous. He proposes to call the structures which resonable each due in distinct animals, owing to their discutt from a common proputing with subsequent modifications, for large part of the transmission of the structures of the large transmission of the structure of the large transmission of the structure of the structure with heat of hinds and maximals are as a whole homogeners, which is, have been directed for the structure of the structure of the is, have been independently developed. Mr. Lankoster also

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address the close resultilizer of the parts on the right and the disks of the body, and in the successive segments of the same indivalual atimal; and heps we have parts commonly called houses houses which been no relation to the descent of distinct species because the second second second second second second second with these which. I have closed, the distinct organization may be attributed in part to distinct organizations, or to distantion say be attributed in part to distinct organizations manage parts of the same comparison, having wavelet in an analogous summary that may be attributed in part to distinct organization many parts of the same comparison, having wavelet in an analogous summary parts of the same comparison, having wavelet in an analogous summary parts of the same comparison, and the same of which many instance have been given.

Maturalisa frequently space of the shull as formed of maximuplosed verticles: It is pars of calaxies metamorphone (legg), the world in must cases be more correct, as Eroich Entry ($z_{\rm eff}$) would in must cases be more correct, as Eroich Entry ($z_{\rm eff}$) would in must cases be more correct, as Eroich Entry ($z_{\rm eff}$) would in must cases be more correct, as Eroich entry ($z_{\rm eff}$) would in must cases be more correct and simpler element. More maturalists, however, use such larguage only in a mainplexic energy. How and from manning that during a long correr of and legs in the other–have actually here converted into shifts plan signification. According to the views here maintained, such language may be used intendly; and the wooderlift fair of the language may be used intendly; and the wooderlift fair of the language may be used intendly; and the wooderlift fair of the language having hyber metamorphoned from true though extremely simple legs, is in part capathole.

Development and Embryology.

This is one of the most important subjects in the value must of maturh history. The metamorphones of inserts, with value every one is familiar, are generally effected atenptly by a for minithe the maximum and the second strength of the second theory of the second strength of the second strength theory of the second strength of the second strength temperature of the second strength of the second strength temperature of the second strength of the second strength temperature and in this case we see the act of metamorphoning metation of the second strength of the second strength of the formed in a spirmary and gradial manner. Many insect, and strength of the second strength of the

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specially certain crutaceous, show us what weaderful change of arrentre can be effected atruit generopment. Such changes, jowerser, reach their climax in the so-called alternate generations of some of the lower animals. It is for instance, an anomalying fast that a deduct branching combine, studied with polyi and the source of the source of the source of the source and that these should problem equations are barried and many source of the source of the source of a source generation, which at the threadwork are hoteled a source of alternate generation and of colliary maternate loss the processes of alternate generation and of colliary metamophois has been englist strengthened by Wagner's discovery of the larce as emaged and these others, which finally are developed in inture males and and has others, which finally are developed in iterature males and and has others, which finally are developed in iterature males and the source of the source of the larce as a source of alternate of the kines in the specson of the source of the kines in the operation of the source of the larce as a source of the source of the kines in the operation of the source of the larce as a source of the source of the source of the source of the kines in the source of the larce of the source of the

It may be worth notice that when Wagner's remarkable discovery was first announced, I was asked how was it possible to account for the larva of this fly having acquired the power of asexual reproduction. As long as the case remained unique no answer could be given. But already Grimm has shown that another fly, a Chironomus, reproduces itself in nearly the same manner, and he believes that this occurs frequently in the Order. It is the pupa, and not the larva, of the Chironomus which has this power; and Grimm further shows that this case, to a certain extent, " unites that of the Cecidomyia with the parthenogenesis of the Coccidm ;"---Coccida are capable of producing fertile eggs without the concourse of the male. Certain animals belonging to several classes are now known to have the power of ordinary reproduction at an unusually early age; and we have only to accelerate parthenogenetic reproduction by gradual steps to an earlier and earlier age, -Chironomus showing us an almost exactly intermediate stage, viz., that of the pupa-and we can perhaps account for the marvellous case of the Cecidomyia.

It has already been stated that various parts in the same indivalues when the county allue during an early embyronic period, bycome widely different and serve for widely different purpose in embryon of the most distinct species belonging to the same class at closely similar, but beyons, when fully developed, widely distingling the statement by You fare that "the embryon of mammalia, of the statement by You fare that "the embryon of mammalia."

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" birds, lizards, and snakes, probably also of chelonia, are in their "earliest states exceedingly like one another, both as a whole and " in the mode of development of their parts; so much so, in fact, "that we can often distinguish the embryos only by their size, " In my possession are two little embryos in spirit, whose names "I have omitted to attach, and at present I am quite unable to say "to what class they belong. They may be lizards or small birds, "or very young mammalia, so complete is the similarity in the "mode of formation of the head and trunk in these animals. The "extremities, however, are still absent in these embryos. But "even if they had existed in the earliest stage of their develop-" ment we should learn nothing, for the feet of lizards and mam-" mals, the wings and feet of birds, no less than the hands and feet " of man, all arise from the same fundamental form." The larvae of most crustaceans, at corresponding stages of development, closely resemble each other, however different the adults may become ; and so it is with very many other animals. A trace of the law of embryonic resemblance occasionally lasts till a rather late age: thus birds of the same genus, and of allied genera, often resemble each other in their immature plumage; as we see in the spotted feathers in the young of the thrush group. In the cat tribe, most of the species when adult are striped or spotted in lines; and stripes or spots can be plainly distinguished in the whelp of the lion and the puma. We occasionally though rarely see something of the same kind in plants ; thus the first leaves of the ulex or furze, and the first leaves of the phyllodineous acacias, are pinnate or divided like the ordinary leaves of the leguminosee,

The points of structure, in which the embryos of widely different numbar within the same class resemble each enter, etch have no direct relation to their conditions of existence. We cannot, for function, suppose that in the embryos of the vertebenta the peculiar loop-like corners of the arteries near the branchial sint are related to the works of its mother, in the egg of the birds which is harded the works of its mother, in the egg of the birds which is harded more reason to birds were in such as writen the same state of the birds that the similar boxes in the hand of a man, wing of a hard, and if a spropsing are writed to similar conditions of His. No one suppose that the stripts on the whelp of a lion, or the spate on they work birds. Note of the sympt set of the source summary the simular boxes is not suppose that the stripts on the whelp of a lion, or the spate on the yourg birds. Note of the source summary the same simular to the simular boxes in the same simular boxes in the spate on the young birds. The same simular boxes is the same simular boxes in the power birds. The same simular boxes is the same simular boxes in the same simular

The case, however, is different when an animal during any part of its embryonic career is active, and has to provide for itself. The period of activity may come on earlier or later in life; but whenever

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it comes on, the adaptation of the larva to its conditions of life is just as perfect and as beautiful as in the adult animal. In how important a manner this has acted, has recently been well shown by Sir J. Lubbock in his remarks on the close similarity of the larvæ of some insects belonging to very different orders, and on the dissimilarity of the larvæ of other insects within the same order, according to their habits of life. Owing to such adaptations, the similarity of the larvæ of allied animals is sometimes greatly obscured ; especially when there is a division of labour during the different stages of development, as when the same larva has during one stage to search for food, and during another stage has to search for a place of attachment. Cases can even be given of the larvæ of allied species, or groups of species, differing more from each other than do the adults. In most cases, however, the larva, though active, still obey, more or less closely, the law of common embryonic resemblance. Cirripedes afford a good instance of this; even the illustrious Cuvier did not perceive that a barnacle was a crustacean : but a glance at the larva shows this in an unmistakable manner, So again the two main divisions of cirripedes, the pedunculated and sessile, though differing widely in external appearance, have larva in all their stages barely distinguishable.

The embryo in the course of development generally rises in organisation ; I use this expression, though I am aware that it is hardly possible to define clearly what is meant by the organisation being higher or lower. But no one probably will dispute that the butterfly is higher than the caterpillar. In some cases, however, the mature animal must be considered as lower in the scale than the larva, as with certain parasitic crustaceans. To refer once again to cirripedes ; the larvæ in the first stage have three pairs of locomotive organs, a simple single eye, and a probosciformed mouth, with which they feed largely, for they increase much in size. In the second stage, answering to the chrysalis stage of butterflies, they have six pairs of beautifully constructed natatory legs, a pair of magnificent compound eves, and extremely complex antennae ; but they have a closed and imperfect mouth, and cannot feed : their function at this stage is, to search out by their well-developed organs of sense, and to reach by their active powers of swimming, a proper place on which to become attached and to undergo their final metamorphosis. When this is completed they are fixed for life: their less are now converted into prehensile organs; they and their two eyes are now reconverted into a minute, single, simple eye-spot. In this last and complete state, cirripedes may

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be considered as either more highly or more lowly organised than they were in the larval condition. But is more generate the larves become developed into hermaphrolites having the ordinary strucner, and hito what I have called complemental makes and in the latter the development has assuredly been retorgrade, for the male is a mere ack, which lives for a hort time and is dedittint of month, atomach, and every other organ of importance, excepting those for rerorduction.

We are so much accustomed to see a difference in structure bethere the endpose on the adult, that we are tempted to look at this differences as in seme necessary nanzer contingent on growth find of a proprise, should not have been about the structure of the theory of the second structure of the second structure of the groups this is the case, and the endpoy of second structure widthe. In some whole groups of animals and in certain numbers of other groups this is the case, and the endpoy of second structure fight, "there is no metamorphosis; the capital point distribution imministed leng before the parts of the endpoy are compiled." Landschedu and fresh-enter crusteness are born orgin their propernent. Spilers, again, having undergo any metamorphosis. There are active and adapted to diversified habits, or me hardworf from hears point and other parts character from being fell by their parents; but in zones for any a minimate of the single of their places in the source space, as an that of adplied, if we hear theory association was any single structure of the second single fell being placed in the result of proper numbers. These matters from long places in the source space space space space space space space of the second space spac

Sometimes it is only the onlife developmental atages which full The Write Miller is made the remarkable discovery that errain absimplible createcosms (allele to Penceus) first appear make the single namples-from, and after passing through two or mere zonestages, and then through the mysis-tage, finally acquire their matter structure: now in the whole guara makeostranean eeler, to which these errataenas belong, no other members is as yel known to first development on there the apple-array mathematications of the single structure of the single structure of the single structure of the single structure of a single structure of a single structure whole have represent a nampli.

How, then, can we explain these several facts in embryology,namely, the very general, though not universal, difference in structure between the embryo and the adult :-- the various varus in the

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many individual embrys, which ultimately become very unlike and game failwave purpose, being at an easily protoi of growth allike; —the summer, but roti invariable, resemblance between the employe or herror of the most distint spreader in the same class the embrys of the soft software in the same class the embrys of the software in the same of the software period of like; on the other hand harva, which have to provide for more software are in the other hand harva, which have to provide for more software in the other hand harva, which have to provide for more and harving the fact of contain the second software in the same comparison of the fact of contain the second software in the software variable? In before that it there fact can be explained, as follows:

It is commonly assumed, perhaps from monstrosities affecting the embryo at a very early period, that slight variations or individual differences necessarily appear at an equally early period. We have little evidence on this head, but what we have certainly points the other way; for it is notorious that breeders of cattle, horses, and various fancy animals, cannot positively tell, until some time after birth, what will be the merits or demerits of their young animals. child will be tall or short, or what its precise features will be. The question is not, at what period of life each variation may have been caused, but at what period the effects are displayed. The cause may have acted, and I believe often has acted, on one or both parents before the act of generation. It deserves notice that it is of no importance to a very young animal, as long as it remains in its mother's womb or in the egg, or as long as it is nourished and protected by its parent, whether most of its characters are acquired a little earlier or later in life. It would not signify, for instance, to a bird which obtained its food by having a much-curved beak whether or not whilst young it possessed a beak of this shape, as long as it was fed by its parents.

These stands in the first charger, that at whatever are a variation first appears in the parent, it structs for supposer at corresponding agains in the distance, perturbitives in these estimations of many structures are also been appeared at the structure of many structures are also been appeared at the structures of the structure of the support of the structure of the structure of the support of the structure of the structure of the structure structure of the structure of the structure of the structure structure of the structure of the structure of the structure structure of the structure of the structure of the structure structure of the structure of the structure of the structure structure of the structure of the structure of the structure structure of the s

These two principles, namely, that slight variations generally appear at a not very early period of life, and are inherited at a corresponding not carly period, explain, as I believe, all the above analogous cases in our domestic varieties. Some authors who have written on Dogs, maintain that the greyhound and buildog, though so different, are really closely allied varietics, descended from the same wild stock : hence I was curious to see how far their puppies differed from each other : I was told by breeders that they differed just as much as their parents, and this, judging by the eve, seemed almost to be the case ; but on actually measuring the old does and their six-days-old puppies, I found that the puppies had not acquired nearly their full amount of proportional difference. So, again, I was told that the foals of cart and race-horses-breeds which have been almost wholly formed by selection under domesticareful measurements made of the dams and of three-days-old colts of race and heavy cart-horses. I find that this is by no means the case.

As we have conclusive evidence that the breeds of the Piceon are descended from a single wild species, I compared the young within twelve hours after being hatched ; I carefully measured the proportions (but will not here give the details) of the beak, width of mouth, length of nostril and of evelid, size of feet and length of leg, in the wild parent-species, in pouters, fantails, runts, barbs, mature, differ in so extraordinary a manner in the length and form of beak, and in other characters, that they would certainly have been ranked as distinct genera if found in a state of nature. But when the nestling birds of these several breeds were placed in a row, in the full-grown birds. Some characteristic points of differencefor instance, that of the width of mouth-could hardly be detected in the young. But there was one remarkable exception to this rule. for the young of the short-faced tumbler differed from the young of the wild rock-pigeon and of the other breeds, in almost exactly the same proportions as in the adult state.

These facts are explained by the above two principles. Fanciers select their dogs, horses, pigeons, &c., for breeding, when nearly grown up: they are indifferent whether the desired qualities are acquired earlier or later in life, if the full-grown animal possesses them. And the cases just given, more especially that of the

pignors, there the characteristic differences which have been genumbated by many solution, and which fave value to bia breeds, do not generally appear at a very easily period of this, and are ningenia a a corresponding not easily period. Bot the asso of the shortfaced number, which where twelves hours dot posses of its programanners, prosversion must not be a structure and the posses of the posgenization of the structure of the structure of the possibility period than musil, or, if mot so, the differences must have been initaricity, not at a corresponding, but as an cartier a po-

Now let us apply these two principles to species in a state of nature. Let us take a group of birds, descended from some ancient form and modified through natural selection for different habits, Then, from the many slight successive variations having supervened in the several species at a not early age, and having been inherited at a corresponding age, the young will have been but little modified, and they will still resemble each other much more closely than do the adults,-just as we have seen with the breeds of the pizzon. We may extend this view to widely distinct structures and to whole classes. The fore-limbs, for instance, which once served as legs to a remote progenitor, may have become, through a long in another as paddles, in another as wings; but on the above two principles the fore-limbs will not have been much modified in the embryos of these several forms; although in each form the fore-limb will differ greatly in the adult state. Whatever influence long-continued use or disuse may have had in modifying the limbs or other parts of any species, this will chiefly or solely have affected it when nearly mature, when it was compelled to use its full powers to gain its own living; and the effects thus produced will have been transmitted to the offspring at a corresponding nearly mature age. Thus the young will not be modified, or will be modified only in a slight degree, through the effects of the increased use or disuse of parts,

With some animals the successive variations may have superverse it a vary early prior of 166 or the step may have been inherited at an uniter age than that at which they first scenared. In other distance, the step of the step of the step of the step of the distance step of the step of the step of the step of the And this is the rule of development in certain whole groups, or iteration sub-spectra step of the step of the step of the distance step of the distance step of the step of the step of the step of the distance step of the step of the step of the step of the distance step of the distance step of the distance step of the distance step of the distance step of the distance step of the distance step of the distance step of the distance step of the distance step of the step Development and Embryology.

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would follow from the following contingences; manaly, from the source lawring to previse at a x-rey ordy pay for their own wants, for in this case, it would be indiposable for their existence that they should be mainlife in the same manner as their previse. Again, with respect to the singular fact that many termstrial and from the second to not undergo any metamorphoid, whilst mations, Pritz Muller has suggested. that the prevess of lowery completions of the second be pready singular by the second previse the second second be pready singular by its not water, instead of in the sea, would be greatly singular by its not used algorid for how here ray on the second second second and algorid for how here ray of any answer and prevent of the second and second for how the law of any anner stage, such with new and greatly changed habits of life, would commutely be found are graded acquiring at a single to be low.

If, on the other hand, it profits the young of an animal to follow halts of this shiply different from them so of the protect-form, and consequently to be constructed on a alightly different plan, or if it profits a large mainly different from the protect to change still the young or the large might be readered by matrix and selection more and more different from their protect by matrix and selection more sets range or it is decrement. The decrement of the first stage, might come to different particles of the decrement of the first stage, might come to differe greatly from the large in the first stage, might come to differ greatly from the large in the first stage. In the cases with many maintak. The additional trajkin also become fitted Δe_{2} would be minor and in this case the metamorphosis would be retrograde.

From the remarks just make we can see how by denages of strucperter in the young, in contonity with the alanged halts of H $_{0}$, togester with inheritance at corresponding ages, animals might come to pass through suppose of development, prefetty d'alistic from the primordial condition of their adult progenitors. Most of our base mathematical energy of the structure of Statistica-based within present theory, are found at any development—will illustrate how this might corrur. The furth array of development—will illustrate how this might corrur. The furth array of the rule development and the structure of th

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with all legs two long antenna, and four eyes. These hars an anlatched in the noise of been just which the male-bese energy from their burrows, in the spring, which they do before the female, the grange methods of the spring which they do before the female, for the spring the spring which is the spring of the spring energy of the surface of the hency stored in the orbit, the lerva of the Staria legs on the eggs and decour them. Afterwards they minergo a complete change i their eyes disappear [their legs and minergo as complete change i, their eyes disappear [their legs and miner become role). The spring of the spring of the targe methods are spring as the spring of the spring of the targe methods are spring as the spring of the spring of the spring the strain spring of the spring behaviour of the spring the spring of the spring of the spring of the spring or spring the spring of the

On the other hand it is highly probable that with many animals the embryonic or larval stages show us, more or less completely, the condition of the progenitor of the whole group in its adult state. In the great class of the Crustacea, forms wonderfully distinct from each other, namely, suctorial parasites, cirripedes, entomostraca, and even the malacostraca, appear at first as larvæ under the naupliusadapted for any peculiar habits of life, and from other reasons assigned by Fritz Müller, it is probable that at some very remote period an independent adult animal, resembling the Nauplius, existed, and subsequently produced, along several divergent lines of descent, the above-named great Crustacean groups. So again it is probable, from what we know of the embryos of mammals, birds, fishes, and reptiles, that these animals are the modified descendants of some ancient progenitor, which was furnished in its adult state with branchize, a swim-bladder, four fin-like limbs, and a long tail, all fitted for an aquatic life.

At all the expanse beings extinds and recent, which have ever being, can be arranged within a for gravitation (allows) and all within each data have, according to our theory, here constrol despite for figs graduation. It bests and, if car ollections were availy jerfer, the ourly cossible arrangement, would be promotion have been finding the hidden bound on ∞ . Natural System, On this view we can understand how it is that, in the eyes of most naturalists, have been there of the employs in even more important for classification structure of the employs in even more important for classification. Development and Embryology. Cus

than that of the adult. In two or more groups of animals, however much they may differ from each other in structure and habits in stages, we may feel assured that they all are descended from one in embryonic structure reveals community of descent; but dissidescent, for in one of two groups the developmental stages may have been suppressed, or may have been so greatly modified through adaptation to new habits of life, as to be no longer recognisable. Even in groups, in which the adults have been modified to an extreme degree, community of origin is often revealed by the structure of the larvæ; we have seen, for instance, that cirripedes, though externally so like shell-fish, are at once known by their larve to belong to the great class of crustaceans. As the embryo often shows us more or less plainly the structure of the less modified and ancient progenitor of the group, we can see why ancient and extinct forms so often resemble in their adult state the embryos of existing species of the same class. Agassiz believes this to be a universal law of nature ; and we may hope hereafter to see the law proved true. It can, however, be proved true only in those cases in which the ancient state of the progenitor of the group has not been wholly obliterated, either by successive variations having supervened at a rited at an earlier age than that at which they first appeared. It should also be borne in mind, that the law may be true, but yet, owing to the geological record not extending far enough back in time, may remain for a long period, or for ever, incapable of demonstration. The law will not strictly hold good in those cases in which an ancient form became adapted in its larval state to some special line of life, and transmitted the same larval state to a whole group of descendants; for such larva will not resemble any still more ancient form in its adult state.

Thus, as it seems to use, the leading facts in embryology, which are second to nose in importance, are explained on the perinciple of variations in the many descendants from some one ancient progelino, lawing approach at a not very early period of this, and having been inherited at a corresponding period. Embryology rises greatly in intrest, when we look at the embryos a a picture, more or less obscured, of the progenitor, either in its ability or larval state, of all the members of the same great class.

Rudimentary, Atrophied, and Aborted Organs,

Opgase of parts in this strange condition, barring the plain stamp, of putility, see even parent, bicongloud nature. It would be impossible to name one of the higher animals in which sawn part or other is not, in a sufficient sequence of the in makes one lobe of the lungs is radiumentary ediptic, and in some species the whole wing is so far radiumentary digit, and in some species the whole wing is so far radiumentary digit, and is some species the whole wing is so far radiumentary digit, mands be used for flight. What can be more carries than the presence of tesh in first which, which when grown up have and a sings. In the super uses of universe varies of the strange distribution of the set o

Rudimentary organs plainly declare their origin and meaning in various ways. There are beetles belonging to closely allied species. or even to the same identical species, which have either full-sized and perfect wings, or mere rudiments of membrane, which not rarely lie under wing-covers firmly soldered together ; and in these cases it is impossible to doubt, that the rudiments represent wings, Rudimentary organs sometimes retain their potentiality : this ocbeen known to become well developed and to secrete milk. So again in the udders in the genus Bos, there are normally four developed and two rudimentary teats; but the latter in our domestic ours sometimes become well developed and yield milk. In recard to plants the petals are sometimes rudimentary, and sometimes welldeveloped in the individuals of the same species. In certain plants having separated sexes Kölrenter found that by crossing a species, in which the male flowers included a rudiment of a pistil, with an bermaphrodite species, having of course a well-developed nistil, the radiment in the hybrid offenring was much increased in size ; and this clearly shows that the rudimentary and perfect pistils are essentially alike in nature. An animal may possess various parts in a perfect state, and yet they may in one sense be rudimentary, for they are useless ; thus the tadpole of the common Salamander or Water-newt, as Mr. G. H. Lewes remarks, " has gills, and rasses " its existence in the water; but the Salamandra atra, which lives " high up among the mountains, brings forth its young full-formed. "This animal never lives in the water. Yet if we open a gravid " female, we find tadpoles inside her with exquisitely feathered " gills ; and when placed in water they swim about like the tad-" poles of the water-newt. Obviously this aquatic organisation has

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" no reference to the future life of the animal, nor has it any adap-" tation to its embryonic condition; it has solely reference to " ancestral adaptations, it repeats a phase in the development of its " prozenitors."

An encar, severing for two purposes, may become radionstray or uterly absent for one, even the mose input supproxy, and emain particulty difficult for this other. Thus in plants, the effect of this original effective effective effective effective effective eventsm. The plant location of a significant support of an arbitry in the most of the start of the effective effective effective in some Composite, the main ferency, which if or source emants be argues, it has a syle munitary well developed and its obtained in the momentalized and conjutional starts are start, an organ may well argues the start of the start of the start of the start of the momentalized and conjutional starts. And, and one may start momentalized and conjutional starts. And, and one may start momentalized and conjutional starts are start, and organ may start for its proper function of giving beging any, but has been an entropy of the starts of the starts of the starts are starts and starts or each starts. And the starts are starts are start and the starts of the starts are starts and the starts are starts and starts are starts in flatter in flatter starts are starts are starts are starts in flatter in flatter starts are starts and and the starts are starts and the starts are starts are starts are starts are starts in flatter in flatter and the start and the starts are starts are starts in flatter in flatter are starts are starts are starts are starts in flatter in flatter are starts are starts are starts are starts in flatter in flatter are starts are starts are starts are starts are starts in flatter and starts are starts are starts are starts are starts in flatter in flatter are starts are starts are starts are starts are starts and are starts are starts are starts are starts are starts are starts and are starts are

have reason to suppose that they were formerly more highly devein a nascent condition, and in progress towards further developuseless, such as the wings of an ostrich, which serve merely as sails. As organs in this condition would formerly, when still less which acts solely by the preservation of useful modifications. They have been partially retained by the power of inheritance, and relate to a former state of things. It is, however, often difficult to distinguish between rudimentary and nascent organs; for we can judge only by analogy whether a part is capable of further development, in which case alone it deserves to be called nascent. Organs in this condition will always be somewhat rare; for beings cessors with the same organ in a more perfect state, and consequently will have become long ago extinct. The wing of the penguin is of high service, acting as a fin; it may, therefore, represent the pascent state of the wing ; not that I believe this to be the case ; it is more probably a reduced organ, modified for a new function : the wing of the Aptervx, on the other hand, is quite

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unsing, and is furly realimentary. Over consider the simple fluxmeantry links of the Lepidowirus and the "beginnings of ergans many links of the Lepidowirus and the "beginnings of ergans has according to the view lately avecated by Ir. Guinher, they are peakly remains, consisting of the periodstart takis of a flux, with the lateral rays or learables alorted. The mamoary glatads the Ornitodrybrawing may be considered, in comparison with the ability interpret, which have coased on two starbursters from of erg and are fieldly orderological and the starburster from of erg and are fieldly orderological and the starburster from of the orderological and the starburster theorem.

Indimensive organs in the individual of the same species are very link to vary in the degree of their development and in other reperts. In closely allied species, also, the extent to which the more organ has been verticed co-assistability differs much. This latter more special has been verticed on the same special special backging to the same family. Indimensity compares may be strately assessed in the same family. Indimensity compares may be strately are antirely a bent which analogy would load us to except to full a turn and which are occasionally form in momentous midvisuits, Then in most of the Scraphalazione the full starms in stretcy are individually abent which analogy would load us to except to full a radium of the fixed in a many species of the fully, and this ruliment of the fourion in many species of the fully, and this ruliment of the normon same-freetly developed, as may semilar show parts in different numbers of the same class, nothing in some common, or, in order fully to understand the variation of there in the drawning signar by Owen of the lap-bone of the horse, eq. and hindners.

It is an important fact that radimentary organs, such as test his the upper jaws of whales and runniants, can othen be detected in the emptys, but afterwards wieldy disappear. It is also, I bleines, an universal rule, inta a radiumentary part is of greater size in the emptys relatively to the adjoining parts, than in the solity what the oppus at this sardy age is less relativistic, success to the solution of the solution of the solution of the solution large solution of the solution of the solution of the solution tary organs in the saidly are often solid to have related where therein consistion.

Linew now given the leading facts with respect to radiamentary organs. In reflecting on them, every one must be struck with assonialment; for the same reasoning power which tells us that most parts and organs are exquisitely adapted for certain purposes, tells us with equal balances that these rudimentary or atrophied

organs are imperfect and useless. In works on natural history, rudimentary organs are generally said to have been created "for the sake of symmetry," or in order " to complete the scheme of nature." But this is not an explanation, merely a re-statement of the fact. Nor is it consistent with itself : thus the boa-constrictor why, as Professor Weismann asks, have they not been retained by other snakes, which do not possess even a vestige of these same that the satellites revolve in elliptic courses round their planets " for the sake of symmetry," because the planets thus revolve round the sun? An eminent physiologist accounts for the presence act? Can we suppose that rudimentary teeth, which are subsequently absorbed, are beneficial to the rapidly growing embryonic a man's fingers have been amputated, imperfect nails have been known to appear on the stumps, and I could as soon believe that these vestiges of nails are developed in order to excrete horny matter, as that the rudimentary nails on the fin of the manatee have been developed for this same purpose.

On the view of densent with multivation, the origin of railment programs in comparityly simple, nuw can understand to a large extent the laws governing their imperfect development. We have plenyt or asso of railmentary organs in our domain present present the laws of the second states of the second angling harms in hornless breads of earth, nore especially, according to Yozatt, in young animals,—and the state of the vision force in the cardithecer. We often user railments of rouses labele like to the exciting the second state of the state of the state like the labele like the second state of the second rouses further than by absoring that realizents can be prokened [often the state] of evidence elevity indicates that we laws from the state) of our domark predictions that the result is believed.

It appears probable that disuse has been the main agent in

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redshift organs relineating: It would at first lead by does single, to the more all one complete reduction of a part, multi at last its beams relineating—as in the case of the case of animals institution of the star of the star of the star of the star indiget, which have solubon been found by heats of grave to take fight, and have ultimately lots the power of flying. Again, an engine stells there exists of the star of the star of the charge, as with the string of heating if the star of the charge, as with the string of heating if the star of the charge as with the string of heating if the star of the star of the string and the string of the star of the star of the star of the string of the star of the

Any change in structure and function, which can be effected by small stages, is within the power of natural selection; so that an organ rendered, through changed habits of life, useless or injurious for one purpose, might be modified and used for another purpose, An organ might, also, be retained for one alone of its former functions. Organs, originally formed by the aid of natural selection, when rendered useless may well be variable, for their variations can no longer be checked by natural selection. All this agrees well with what we see under nature. Moreover, at whatever period of life either disuse or selection reduces an organ, and this will generally be when the being has come to maturity and has to exert its full powers of action, the principle of inheritance at corresponding ages will tend to reproduce the organ in its reduced state at the same mature age, but will seldom affect it in the embryo. Thus we can understand the greater size of rudimentary organs in the embryo relatively to the adjoining parts, and their lesser relative size in the adult. If, for instance, the digit of an adult animal was used less and less during many generations. owing to some change of habits, or if an organ or gland was less and less functionally exercised, we may infer that it would become reduced in size in the adult descendants of this animal, but would retain nearly its original standard of development in the embryo.

These remains, however, this difficulty. After an egan has small being used, and has become in consequence much reduced, low can it be still further reduced in size until the merest vestige bifty and how can it be manly quite distanced. It is saready proble that dismo can go on producing any further effect after descent has one been reduced functions. Seen a fixing theorem is non-the percent data every part of the expansion is not theory, in could be preved that every part of the expansion to normal summations of sing, then we should be able to understand how an egun mutation of sing, then we should be able to understand how an egun

Summary.

Finally, as realimentary organ, by whatever steps they may have been degraded lice their present uselss condition, are the record of a former state of things, and have been retained ody threads they never of classification, how it is that systematistic, in generalized view of classification, how it is that systematistic, in the systematic systematic state of the systematistic system useful than, parts of high physicalization in the systematistic. Realizations in the splittic, but become useless in the proximation, but which modification, we may conclude that the existence of organs in a model that, we may conclude that the existence of organs in a frequency of the systematic state of the system is and doctrino of creation, might even have been anticipated in accordance with the view size explanation.

Summary,

Darwin Online: By permission of the Trustees of the Natural History Museum (London).

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and divergence of character. In considering this view of charaftering its should be borne in muld that the element of descent has been universally used in ranking together the secon, age, discreption and high run yill difference on other in structures. If we extend that use of this element of descent.—the one certainly known cause of minirity in organization beings—we also this internation. If we extend the use of this element of the second. In its a transmit by the Xintun System: it is genealogical in its at meant of the second sec

On this same view of descent with modification, most of this grant facts in Morphology become intelligible,—whether we look to the same pattern displayed by the different species of the same class in their homologous organs, to whatever purpose applied ; or to the serial and lateral homologies in each individual animal and plant.

On the principle of successive slight variations, not necessarily or generally supervening at a very early period of life, and being inherited at a corresponding period, we can understand the leading facts in Embryology ; namely, the close resemblance in the individual embryo of the parts which are homologous, and which when matured become widely different in structure and function; and the resemblance of the homologous parts or organs in allied though distinct species, though fitted in the adult state for habits as different as is possible. Larvæ are active embryos, which have habits of life with their modifications inherited at a corresponding early age. On these same principles,-and bearing in mind, that when organs are reduced in size, either from disuse or through natural selection, it will generally be at that period of life when the being has to provide for its own wants, and bearing in mind how strong is the force of inheritance-the occurrence of rudimentary organs might even have been anticipated. The importance of embryological characters and of rudimentary organs in classification is intelligible, on the view that a natural arrange-

Finally, the several classes of facts which have been considered in this claster, seem to me to preclaim so plainly, that the immmerable species, genera and families, with which this world is peopled, are all descended, each within its own class of group, from common parents, and have all been molified in the consord descent, that I should without hesization adopt this view, even if it were muumoroted by under facts or arroments.

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CHAPTER XV.

RECAPITULATION AND CONCLUSION.

Becopiculation of the objections to the theory of Natural Selection— Becopiculation of the general and special circumstances in its favour —Causes of the general belief in the immutability of species—How far the theory of Natural Selection may be extended—Effects of its adoption on the study of Natural History—Concluding remarks.

As this whole volume is one long argument, it may be convenient to the reader to have the leading facts and inferences briefly recapitulated.

That many and serious objections may be advanced against the theory of descent with modification through variation and natural selection. I do not deny. I have endeavoured to give to them their full force. Nothing at first can appear more difficult to believe than that the more complex organs and instincts have been perfected. not by means superior to, though analogous with, human reason, but by the accumulation of innumerable slight variations, each good for the individual possessor. Nevertheless, this difficulty, though appearing to our imagination insuperably great, cannot be considered real if we admit the following propositions, namely, that all parts of the organisation and instincts offer, at least, individual differences-that there is a struggle for existence leading to the preservation of profitable deviations of structure or instinct-and, lastly, that gradations in the state of perfection of each organ may have existed, each good of its kind. The truth of these propositions cannot, I think, be disputed.

It is no obolt, extremely difficult even to employee by built pradatons may structures have been perfected, more sepecially amongst broken and failing groups of engusic beings, which have instance in the structure of the enternel practice of the strucin nature, that we ought to be extremely ensuring in any structure of the structure of the structure of the strucsorties of the structure of the structure of the structure of the animited, cases of seedal difficulty opposed to the large of matrix absolutions of the most entries of the structure of the structure of the structure of these
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is the existence in the same community of two or three defined castes of workers or sterile female ants; but I have attempted to show how these difficulties can be mastered.

With respect to the almost universal sterility of species when first crossed, which forms so remarkable a contrast with the almost universal fertility of varieties when crossed. I must refer the reader to the recapitulation of the facts given at the end of the ninth chanter, which seem to me conclusively to show that this sterility is no more a special endowment than, is the incapacity of two distinct kinds of trees to be grafted together; but that it is incidental on differences confined to the reproductive systems of the intercrossed species. We see the truth of this conclusion in the yast difference in the results of crossing the same two species reciprocally,-that is, when one species is first used as the father and then as the mother. Analogy from the consideration of dimorphic and trimorphic plants clearly leads to the same conclusion, for when the forms are illegitimately united, they yield few or no seed, and their offspring are more or less sterile; and these forms belong to the same undoubted species, and differ from each other in no respect except in their reproductive organs and

Ablogh the firtility of varieties when intercovaed and of their magnet offspring has been asseted by no many authors to be mixereal, this cannot be considered as quite sources there the facts the varieties which have been experimented on have been produced model and the source of the source of the source of the varieties which have been experimented on have been produced model and extended the source of the direction (arcsmatraneous) and this again appearedly follows from the source which allows our dimension in proper discussion of direction (arcsmatraneous) and this again appearedly follows from the conditions of the file.

A double and parallel series of facts seems to threw much light on the sterility of apeies, when first crossed, and of their hybrid effagring. On the one side, there is good reason to believe that slight changes in the conditions of life give vigour and fertility to all ergnic beings. We know also that a cross between the dilution individuals of the same variety, and between distinct varieties, increases the number of their offspring, and certainty gives to thum

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increased size and vigour. This is chiefly owing to the forms which are crossed having been exposed to somewhat different conditions of life: for I have ascertained by a laborious series of experiments that if all the individuals of the same variety be subjected during several generations to the same conditions, the good derived from crossing is often much diminished or wholly disappears. This is one side of the case. On the other side, we know that species which have long been exposed to nearly uniform conditions, when they are subjected under confinement to new and greatly changed conditions, either perish, or if they survive, are rendered sterile, though retaining perfect health. This does not occur, or only in a long been exposed to fluctuating conditions. Hence, when we find few in number, owing to their perishing soon after conception or at a very early age, or if surviving that they are rendered more or less sterile, it seems highly probable that this result is due to their having been in fact subjected to a great change in their conditions of life, from being compounded of two distinct organisations. He who will explain in a definite manner why, for instance, country, whilst the domestic pig or dog will breed freely under the most diversified conditions, will at the same time be able to give a definite answer to the question why two distinct species, when crossed, as well as their hybrid offspring, are generally rendered more or less sterile, whilst two domesticated varieties when crossed and their mongrel offspring are perfectly fertile.

Turning to goognaphial iditivitation, the difficulties ecconstruct on the theory of decars with molfation are arrive as equal, All the inividuals of the same species, and all the species of the many parameters of the same species, and all the species of the array of the same species of the same species of the species of the same species of the same species of the species of the species have related by make seven to conjecture how this could have been effected. Use as a wave specific form for very long periods of time, immemping long as measured by years, too much stress ought not to be hild on the exactional work with show have been effected. Use you have the will show have been equivalent to be hild on the exactional while difficult of the same or interrupted mang may often be accounted for by the existence of the species in the intermulation regions. It cannot be defined the species.

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ing we are a yet very ignorant as to the full extent of the variase ignals and any groupshile i charge which have affected the earth during moleurs periods; and such charges will often have facilitated inguino. As as example, 1 have attempted to how how potenhas been the influence of the Glucial period on the distribution of the anse and of allel species throughout the world. We are as yet periodically ignorant of the many cascadion the world. We are easy to the distribution of the same guess inhihing distantly how slow, at the of the same guess inhiling distantly how slow, at the of the function, with how any periodic slow, at the of the same guess of the same gashed during a very long period, and consequently the difficulty of the wide diffusion of the species of the same gurea is in some degree second.

As according to the theory of natural selection an interminable number of intermediate forms must have existed, linking together all the species in each group by gradations as fine as are our existing varieties, it may be asked, Why do we not see these linking forms all around us? Why are not all organic beings blended together in an inextricable chaos? With respect to existing forms, we should remember that we have no right to exbetween them, but only between each and some extinct and supplanted form. Even on a wide area, which has during a long period remained continuous, and of which the climatic and other conditions of life change insensibly in proceeding from a district allied species, we have no just right to expect often to find intermediate varieties in the intermediate zones. For we have reason the other species becoming utterly extinct and leaving no modified progeny. Of the species which do change, only a few within the same country change at the same time; and all modifications are slowly effected. I have also shown that the intermediate would be liable to be supplanted by the allied forms on either hand; for the latter, from existing in greater numbers, would generally be modified and improved at a quicker rate than the intermediate varieties, which existed in lesser numbers; so that the intermediate varieties would, in the long run, be supplanted

On this doctrine of the extermination of an infinitude of connecting links, between the living and extinct inhabitants of the world, and at each successive period between the extinct and still 408

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older species, why is not every geological formation charged with such links? Why does not every collection of fossil remains afford plain evidence of the gradation and mutation of the forms of life? Although geological research has undoubtedly revealed the former existence of many links, bringing numerous forms of life much closer together, it does not yield the infinitely many fine gradations between past and present species required on the theory ; and this is the most obvious of the many objections which may be urged against it. Why, again, do whole groups of allied species appear, though this appearance is often false, to have come in suddenly on the successive geological stages? Although we now know that organic beings appeared on this globe, at a period incalculably remote, long before the lowest bed of the Cambrian system was deposited, why do we not find beneath this system great piles of strata stored with the remains of the progenitors of the Cambrian fossils? For on the theory, such strata must somewhere have been deposited at these ancient and utterly unknown enochs of the world's history.

I can answer these questions and objections only on the supposition that the geological record is far more imperfect than most geologists believe. The number of specimens in all our museums is absolutely as nothing compared with the countless generations of countless species which have certainly existed. The parentform of any two or more species would not be in all its characters directly intermediate between its modified offspring, any more than the rock-pigeon is directly intermediate in crop and tail between its descendants, the pouter and fantail pigeons. We should not be able to recognise a species as the parent of another and modified species, if we were to examine the two ever so closely, unless we possessed most of the intermediate links; and owing to the imperfection of the geological record, we have no just right to expect to find so many links. If two or three, or even more linking forms were discovered, they would simply be ranked by many naturalists as so many new species, more especially if found in different geological sub-stages, let their differences be ever so slight. Numerous existing doubtful forms could be named which are probably varieties; but who will pretend that in future ages so many fossil links will be discovered, that naturalists will be able to decide whether or not these doubtful forms ought to be called varieties? Only a small portion of the world has been geologically explored. Only organic beings of certain classes can be preserved in a fossil condition, at least in any great number. Many species when once formed never undergo any further change but become extinct

without leaving modified descendants; and the periods, during which species have undergone modification, though long as measured by years, have probably been short in comparison with the periods during which they retained the same form. It is the dominant and widely ranging species which vary most frequently and vary most, and varieties are often at first local-both causes rendering the discovery of intermediate links in any one formation less likely. Local varieties will not spread into other and distant regions until they are considerably modified and improved; and when they have spread, and are discovered in a geological formation, they appear as if suddenly created there, and will be simply classed as new species. Most formations have been intermittent in their accumulation ; and their duration has probably been shorter than the average duration of specific forms. Successive formations are in most cases separated from each other by blank intervals of time of great length; for fossiliferous formations thick enough to resist future degradation can as a general rule be accumulated only where much sediment is deposited on the subsiding bed of the sea. During the alternate periods of elevation and of stationary level the record will generally be blank. During these latter periods there will probably be more variability in the forms of life; during periods of subsidence, more extinction,

With respect to the absence of strata rich in fould beneath the Cardinal formation. I can recur only to the hypothesis given in the tenth chapter; namely, that though our continuum and comma position, we have no reason to assume that this has a viery been down may be have no reason to assume that this has a viery been down may be haved in boost the grant constraints of the down may be haved in boost the grant constraints of the source may be haved in boost the grant constraints of the source may be haved in the samed amount of organic change, and the objection, as unged by Site William Theorem 1 by views and onto the gravest any taking change as measured by views and one of the gravest any philosophics are not of the mirrors and one of the interface of the source of anony as the source and one output, that may plicosophics are not of the mirrors and the interface of our globe to speculate with anoty on its past duration.

That the geological record is imperfect all will admit; but that it is imperfect to the degree required by our theory, few will be inclined to admit. If we look to long enough intervals of time, geology plainly declares that species have all changed; and they have changed in the manner required by the theory, for they have

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changed slowly and in a graduated manner. We clearly see this in the fossil remains from consecutive formations invariably being much more closely related to each other, than are the fossils from widely separated formations.

Such in the sum of the several chief objections and difficulties which may be justicy good against the theory: and 1 have now briefly respiration to the givens. Tawe for the theory difficulties for two havely during many reases to show that the difficulties for two havely during many reases to show that the difficulties for two havely during many reases to show that the show the difficulties for the show the seven set of the show that the show the show the linear state of the second show the show the show the show have financian to which we conclusively ground to the show have financian the weak. We do note all the possible transitional prachations between the simplest and the two knows how imperfect the during the large large of years, or that we know how imperfect in any judgment they are by no mana sufficient to everthrow the theory of descent with nebusepoint moliforation.

Now it is turn to the other side of the argument. Tuble domelication we are much variability, usuals, or at last excitel, by changed chalitions of life; but often in so observe a manner, that we are tempted to consider the variations as apontarous. Variability is povened by many complex laws,—by correlation provide, compensation, the forwards we and damos of parts, and altificatly is accentaining how largely our densetite predictions have been molified but we may assignify infer that the anomuhas been largely, and that modifications can be inherited for lange periods. As long as the conditions of life remain the same, we have reason to believe that a modification, which has already hene interiet for many generations, may commiss to be inherited for any almost inherited for many generations, and commiss to be inherited for almost inherited for many estartions, the other hand, we have evidence that variability when it has accrease the main years that it ever eases, for new varieties an still occasionally produced by or odeled demonstration productions.

Variability is not actually caused by man; he only unintentionally exposes organic beings to new conditions of life, and then nature acts on the organisation and causes it to vary. But man can and does select the variations given to him by nature, and thus accumulates them in any desired manner. He thus adapts animals and blants for his own benefit or viteasure. He may do this

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and additionality, or the may do it unconsistently by preserving the individual non-uncolled or pleasing to hist without any intention of altering the breed. It is certain that he can arayly infinence the answer of a breed by selecting, in one homomory generation, individual differences so aligns as to be inappreciable except by an anizated syx. This moreosciem process of selection has been the great agong in the formation of the most jubiced has been the great agong scientific declarater of maturing species, in allow by the instruction doubts whether many of them are varieties or aloriginally distinct species.

There is no reason why the principles which have acted so efficiently under domestication should not have acted under nature. In the survival of favoured individuals and races, during the to all organic beings. This high rate of increase is proved by calculation,-by the rapid increase of many animals and plants during a succession of peculiar seasons, and when naturalised in new countries. More individuals are born than can possibly survive. A grain in the balance may determine which individuals shall live and which shall die,-which variety or species shall increase in number, and which shall decrease, or finally become extinct. As the individuals of the same species come in all respects into the closest competition with each other, the struggle will generally be most severe between them; it will be almost equally severe between the varieties of the same species, and next in severity between the species of the same genus. On the other hand the struggle will often be severe between beings remote in the scale of nature. The slightest advantage in certain individuals, at any age or during any season, over those with which they come into competition, or better adaptation in however slight a degree to the surrounding physical conditions, will, in the long run, turn the

With animals having separated sexes, there will be in most cases a struggle between the makes for the possession of the females. The most vigorous makes, or those which have most successfully struggled with their conditions of life, will generally lave most progeny. But success will often depend on the males having special weapons, or means of defence, or charms; and a slight signature will had to victory.

As geology plainly proclaims that each land has undergone great

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physical changes, we might have expected to find that organic beings have varied under nature, in the same way as they have varied under domestication. And if there has been any variability had not come into play. It has often been asserted, but the assertion is incapable of proof, that the amount of variation under nature is a strictly limited quantity. Man, though acting on external characters alone and often capriciously, can produce within in his domestic productions; and every one admits that species present individual differences. But, besides such differences, all naturalists admit that natural varieties exist, which are considered sufficiently distinct to be worthy of record in systematic works, No one has drawn any clear distinction between individual differand sub-species, and species. On separate continents, and on any kind, and on outlying islands, what a multitude of forms exist, which some experienced naturalists rank as varieties, others as geographical races or sub-species, and others as distinct, though

It from, animals and plants do vary, let it be vere so digitly copoly, why should not variations or individual differences, which are in any way beneficial, perserved gala accumulated through partness select variations used to bim, why, under changing and complex conditions of ling should be variations useful by 200 partness select variations useful by 200 per solutions of the structure of the solution of the structure of the solution of the remaining the whole constitution, structure, and hubbs of order creature,—structure, the solution of the solution of the solution of the error or levels of the solution of t

On the view that species are only strongly marked and permanent varieties, and that each species first existed as a variety, we can see why it is that no line of demarcation can be drawn between species, commonly supposed to have been produced by special ace of cration, and varieties which are acknowledged to have been

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penghesi by secondary laws. On this many view we can understand here it is that in a reside where many precised of a genus have been produced, and where they new fourish, these same specieus should be marken we might expects as a ground rate of the same actions, and this is the case if varieties be incipated as earlied a genus of the same second residence of the same second energy of varieties are incipated as precises. Merssame of difference that of the same second energy of a static rate of the same second energy of the same action rates, and in their affinishes they are classers of his difference that of the same second energy of the same rate of an energy of the same second energy of the same rate of an energy of the same second energy of the same rate of an energy of the same second energy of the same rate of an energy of the same second energy of the same rate of an energy of the same second energy of the same rate of an energy of the same second energy of the same rate of an energy of the same second energy of the same rate of an energy of the same second energy of the same second same of the same second energy of the same second same second energy of the same second energy of the same second same second energy of the same second energy of the same second same second energy of the same second energy of the same second same second energy of the same second energy of the same second same second energy of the same second energy of the same second same second energy of the same second energy of the same second same second energy of the same second energy of the same second same second energy of the same second energy of the same second same second energy of the same second energy of the same second same second energy of the same second energy of the same second same second energy of the same second energy of the same second same second energy of the same second second second energy of the same second second energy of the same sec

As each species tends by its geometrical rate of reproduction to increase inordinately in number ; and as the modified descendants of each species will be enabled to increase by as much as they become more diversified in habits and structure, so as to be able to seize on many and widely different places in the economy of nature, there will be a constant tendency in natural selection to preserve the most divergent offspring of any one species. Hence, during a long-continued course of modification, the slight differences characteristic of varieties of the same species, tend to be augmented into the greater differences characteristic of the species of the same genus. New and improved varieties will inevitably supplant and exterminate the older, less improved, and intermediate varieties; and thus species are rendered to a large extent defined and distinct objects. Dominant species belonging to the larger groups within each class tend to give birth to new and dominant forms; so that each large group tends to become still larver, and at the same time more divergent in character. But as all groups cannot thus go on increasing in size, for the world would not hold them, the more dominant groups beat the less dominant, This tendency in the large groups to go on increasing in size and diverging in character, together with the inevitable contingency of much extinction, explains the arrangement of all the forms of life in groups subordinate to groups, all within a few great classes, which has prevailed throughout all time. This grand fact of the grouping of all organic beings under what is called the Natural

As natural selection acts solely by accumulating slight, successive, favourable variations, it can produce no great or sudden modifica-

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tions ; it can not only by short and alow steps. Thence the ansato of "starts are no field subma," which every fresh addition to our knowledge tends to confirm, is on this theory inside the start and the start a

¹ Maay ether facts are, as it means to me, exploable or this theory, how strange it is that a bird, under the form of a woolpeeler, abculi peep on insects on the ground; that putual gees which into high abculi diverse the babts and strategies which a thrushlithe high should dive and denotes the strategies of the tills of an ank it and so in crystics of a strategies which strategies below the strategies of the strategies of the strategies with strategies and under the strategies of the strategies with strategies the strategies of the strategies of the strategies of each to any unccerpised or ill-scenario dipoly raying desconsings of each to any unccerpised or strategies the strategies of each to any unccerpised or ill-scenario dipole in an inter, these facts case to be strategies or unicid very have been anticipated.

We can to a serial a start understand how it is that there is so much leastly throughout antarce (rd thin may be largely attributed to the agency of selection. That beauty, according to series of the in a theread and the selection of the second range of the second range brick, but telling and other series and the second range brick, but telling and observed metals. With briefs it has often readered resemblance in the human factor has conditioned by the second range brick, but telling and observed ranges of the mask musical to the second range brick, but telling and observed ranges of the second range brick but telling and observed ranges of the second range brick, but telling and observed ranges brink and the second range brink but telling brink but telling

As natural selection acts by competition, it adapts and improves the inhabitants of each country only in relation to their coinhabitants; so that we need feel no surprise at the species of any

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are control, athlough on the collarry view supposed to have been contained any special solution of the control, being between and application to mark a single productions from another hand. Morality was marked at the prefere and the control of the human ergs of the large prefere and the control of the mark ergs of the strength set of the solution of the mark ergs of the strength set of the solution of the another set of the solution of the production of the solution of the solution of the solution production of the solution of the solution of the solution for even first boundaries at is theremuch for field production of the solution of starty filters or at other such according to the solution of the solution of the solution of the solution of a solution of the solution

The complex and little known laws governing the production of varieties are the same, as far as we can judge, with the laws which have governed the production of distinct species. In both cases physical conditions seem to have produced some direct and definite effect, but how much we cannot say. Thus, when varieties enter any new station, they occasionally assume some of the characters proper to the species of that station. With both varieties and species, use and disuse seem to have produced a considerable effect; for it is impossible to resist this conclusion when we look, for instance, at the logger-headed duck, which has wings incapable of flight, in nearly the same condition as in the domestic duck : or when we look at the burrowing tucu-tucu, which is occasionally blind, and then at certain moles, which are habitually blind and have their eyes covered with skin; or when we look at the blind animals inhabiting the dark caves of America and Europe. With varieties and species, correlated variation seems to have played an important part, so that when one part has been modified other parts have been necessarily modified. With both occur. How inexplicable on the theory of creation is the occasional appearance of stripes on the shoulders and legs of the several species of the horse-genus and of their hybrids ! How simply is this fact explained if we believe that these species are all descended from a striped progenitor, in the same manner as the several domestic breeds of the pigeon are descended from the blue and barred rock-

On the ordinary view of each species having been independently created, why should specific characters, or those by which the

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species of the same genus differ from each other, be more variable than generic characters in which they all agree? Why, for instance, should the colour of a flower be more likely to vary in any one species of a genus, if the other species possess differently coloured flowers, than if all possessed the same coloured flowers? If species are only well-marked varieties, of which the characters have become in a high degree permanent, we can understand this fact ; for they have already varied since they branched off from a to be specifically distinct from each other; therefore these same characters would be more likely again to vary than the generic chaperiod. It is inexplicable on the theory of creation why a part developed in a very unusual manner in one species alone of a genus, and therefore, as we may naturally infer, of great importance to that species, should be eminently liable to variation ; but, on our view, this part has undergone, since the several species branched off from a common progenitor, an unusual amount of variability and modification, and therefore we might expect the part generally to be still variable. But a part may be developed in the most unusual manner, like the wing of a bat, and yet not be more variable than any other structure, if the part be common to many subordinate this case it will have been rendered constant by long-continued

Glancing at instincts, marvellous as some are, they offer no greater difficulty than do corporeal structures on the theory of the natural selection of successive, slight, but profitable modifications. We can thus understand why nature moves by graduated steps in endowing different animals of the same class with their several instincts. I have attempted to show how much light the principle of gradation throws on the admirable architectural powers of the hive-bee. Habit no doubt often comes into play in modifying instincts; but it certainly is not indispensable, as we see in the case of neuter insects, which leave no progeny to inherit the effects genus having descended from a common parent, and having inherited much in common, we can understand how it is that allied species, when placed under widely different conditions of life, yet follow nearly the same instincts; why the thrushes of tropical and temperate South America, for instance, line their nests with mud like our British species. On the view of instincts having been slowly acquired through natural selection, we need not marvel

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at some instincts being not perfect and liable to mistakes, and at many instincts causing other animals to suffer.

If species be only well-marked and permanent varieties, we can at once see why their rowsed offspring abouth failout the same complex laws in their degrees and kinds of resemblance to their paratisk.—In being aborded into each other by successive crosses, and in other such pionts,—as do the crossed offspring of acknows label wells, the state of the state of the state of the label wells. This similarity would be a strange fact, if species had been independently created and varieties had been produced through secondary laws.

If we admit that the geological record is imperfect to an extreme degree, then the facts, which the record does give, strongly support the theory of descent with modification. New species have come on the stage slowly and at successive intervals ; and the amount of change, after equal intervals of time, is widely different in different groups. The extinction of species and of whole groups of species, which has played so conspicuous a part in the history of the organic world, almost inevitably follows from the principle of natural selection ; for old forms are supplanted by new and improved forms. Neither single species nor groups of species reappear when the chain of ordinary generation is once broken. The gradual diffusion of dominant forms, with the slow modification of their descendants, causes the forms of life, after long intervals of time, to appear as if they had changed simultaneously throughout the world. The fact of the fossil remains of each formation being in some degree intermediate in character between the fossils in the formations above and below, is simply explained by their intermediate position in the chain of descent. The grand fact that all extinct beings can be classed with all recent beings, naturally follows from the living and the extinct being the offspring of common parents. As species have generally diverged in character during their long course of descent and modification, we can understand why it is that the more ancient forms, or carly progenitors of each group, so often occupy a position in some degree intermediate between existing groups. Recent forms are generally looked upon as being, on the whole, higher in the scale of organisation than ancient forms; and they must be higher, in so far as the later and more improved forms have conquered the older and less improved forms in the struggle for life; they have also generally had their organs more specialised for different functions. This fact is perfectly compatible with numerous beings still retaining simple and but little improved structures, fitted for simple conditions of life; it is likewise compatible with some

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forms having retrograded in organisation, by having become at each stage of descent better fitted for new and degraded halits of life. Lastly, the wooderful law of the long endurance of allied forms on the same continent,—of mansupials in Australia, of edentata in America, and other such casse,—is incluigible, for within the same country the existing and the extinct will be closely allied by descent.

Looking to geographical distribution, if we admit that there has been during the long course of ages much migration from one part of the world to another, owing to former climatal and geographical changes and to the many occasional and unknown means of dispersal, then we can understand, on the theory of descent with can see why there should be so striking a parallelism in the disconnected by the bond of ordinary generation, and the means of modification have been the same. We see the full meaning of the wonderful fact, which has struck every traveller, namely, that on the same continent, under the most diverse conditions, under heat and cold, on mountain and lowland, on deserts and marshes, most with modification, we can understand, by the aid of the Glacial and southern temperate zones; and likewise the close alliance of ocean. Although two countries may present physical conditions as closely similar as the same species ever require, we need feel no been for a long period completely sundered from each other ; for as the relation of organism to organism is the most important of all relations, and as the two countries will have received colonists at various periods and in different proportions, from some other country or from each other, the course of modification in the two areas will inevitably have been different.

On this view of migration, with subsequent modification, we see why oceanic islands are inhabited by only few species, but of these, why many are peculiar or endemic forms. We clearly see why species belonging to those groups of animals which cannot

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cross wide spaces of the ocean, as frogs and terrestrial mammals, do not inhabit oceanie islands; and why, on the other hand, new and pogular species of bats, animals which can traverse the ocean, are often found on islands far distant from any continent. Such cases as the presence of opecular species of bats on coceanic islands and the absence of all other terrestrial mammals, are facts utterly inexplicible on the theory of independent acts of creation.

The existence of closely allied or representative species in any up areas, huples, on the theory of descent with modification, that the same parent-forms formerly inhibited both areas: and was about invariably find that wherever emary closely allied regions inhibit to areas, some identical species are still common to both. Wherever many closely allied yiel distant precision court, adoubtical the strice of high generality that the inhibition of each zero area might have been derived. We see this in the striking relation of yields and animals of the carboxy American minimum anglet alow the inhibition of the carboxy American minimum plates and minimals of the carboxy American minimum and that and minimals of the outper American minimum is shown by the African mainimal. Is must be adminished that these facts review no explanation on the howy of carboxy of minimals of the answers).

The fact, as we have seen, that all past and present organic beings can be arranged within a few great classes, in groups subordinate to groups, and with the extinct groups often falling in between the its contingencies of extinction and divergence of character. On these same principles we see how it is, that the mutual affinities of the forms within each class are so complex and circuitous. We see why certain characters are far more serviceable than others for classification :- why adaptive characters, though of paramount importance to the beings, are of hardly any importance in classification ; why characters derived from rudimentary parts, though of no service to the beings, are often of high classificatory value ; and why embryological characters are often the most valuable of all. The real affinities of all organic beings, in contradistinction to their adaptive resemblances, are due to inheritance or community of descent. The Natural System is a genealogical arrangement, with the acquired grades of difference, marked by the terms, varieties, species, genera, families, &c.; and we have to discover the lines of descent by the most permanent characters whatever they may

2 E 2

The similar framework of bones in the hand of a man, wing of a bat, fin of the porpoise, and leg of the horse,-the same number the theory of descent with slow and slight successive modifications. The similarity of pattern in the wing and in the leg of legs of a crab,- in the petals, stamens, and pistils of a flower is likewise, to a large extent, intelligible on the view of the gradual modification of parts or organs, which were aboriginally alike in an early progenitor in each of these classes. On the principle of successive variations not always supervening at an early age, and being inherited at a corresponding not early period of life, we clearly see why the embryos of mammals, birds, reptiles, and fishes should be so closely similar, and so unlike the adult forms. We may cease marvelling at the embryo of an air-breathing mammal or bird having branchial slits and arteries running in loops, like those of a fish which has to breathe the air dissolved in water by the aid of well-developed

Disuse, aided sometimes by natural selection, will often have reduced organs when rendered useless under changed habits or conditions of life ; and we can understand on this view the meaning of rudimentary organs. But disuse and selection will generally act on each creature, when it has come to maturity and has to play its full part in the struggle for existence, and will thus have little power on an organ during early life; hence the organ will not be reduced or rendered rudimentary at this early age. The calf, for instance, has inherited teeth, which never cut through the gums of the upper jaw, from an early progenitor having well-developed teeth ; and we may believe, that the teeth in the mature animal were formerly reduced by disuse, owing to the tongue and palate, or lips, having become excellently fitted through natural selection to browse without their aid ; whereas in the calf, the teeth have been left unaffected, and on the principle of inheritance at corresponding ages have been inherited from a remote period to the present day. On the view of each organism with all its separate parts having been specially created, how utterly inexplicable is it that organs bearing the plain stamp of inutility, such occur. Nature may be said to have taken pains to reveal her scheme of modification, by means of rudimentary organs, of em-

Conclusion.

bryological and homologous structures, but we are too blind to understand her meaning.

I have now recapitulated the facts and considerations which have thoroughly convinced me that species have been modified, during a long course of descent. This has been effected chiefly through the natural selection of numerous successive, slight, favourable variations; aided in an important manner by the inherited effects of the use and disuse of parts; and in an unimportant manner, that is in relation to adaptive structures, whether past or present, by the to us in our ignorance to arise spontaneously. It appears that I formerly underrated the frequency and value of these latter ture independently of natural selection. But as my conclusions have lately been much misrepresented, and it has been stated that I attribute the modification of species exclusively to natural selection. I may be permitted to remark that in the first edition of this work, and subsequently, I placed in a most conspicuous position-namely, at the close of the Introduction-the following words : "I am convinced that natural selection has been the main but not the exclusive means of modification." This has been of no avail, Great is the power of steady misrepresentation; but the history of science shows that fortunately this power does not long endure.

It on hardly be any post that a failer theory of natural selection, the wardle dynamics and theory and theory of natural selection, the wardle large classes of facts above specified. It is a resterily the selection of the sele

I see no good reason why the views given in this volume should shock the religious feelings of any one. It is satisfactory, as showing how transient such impressions are, to remember that the greatest discovery ever made by man, namely, the law of the

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attraction of gravity, was also attached by Leibnitz, "as subversive of natural, and inferentially of revealed, religion." A colebrated author and divine has written to me that "he has gradning "harnt to see that it is just as noble a canoption of the Deiry to "a believe that He crasted a few original forms capable of said," "development into other and needful forms, as to believe that He "required a final act of crastion to supply the voids caused by the "science of His new,"

Why, it may be asked, until recently did nearly all the more eminent living attractionals and geological solubileves in the matability of species. It cannot be assoried that erganic brings in a dist of nature way under the variation; it cannot be proved quantity, no clars distinction has hene, or can be private species and well-entrol variations. It cannot be maintained that species when intercrossed are invariably attrifts, and variation is availably fertile (rath sterility in a smark) semistimized that species when intercrossed are invariably attrifts, and variation of creation. The belief that species were immutable productions was almost nan-to-disked as idea gat at the history of the world was thenglit to be of abort dimition; and now that we have acquired provid: hat the geological record is no perfect that it would have afforded up lain evidence of the mutation of species, if they had undergraon mutation.

But the chief cases of our natural unwillingness to shift that one species has given births to obtain and distinst appears, its that we are always abow in solutioning graves, changes of which we do not new any strength of the strength being strength, and grave values exceeded, by the species which are seen still at very do. The strengt cannot possibly grave the full meaning of the form of even a million years i I cound add up and disting a million the strength of the streng

Although I am fully convinced of the truth of the views given in the volume mode the form of an alternet, I by no means expert to convince experienced naturalists where imilate are stocked with a point of view directly oppoint to mino. It is no story to history dimension under and increasion of the story of the story of the dimension of the story of the only mostate a fact. Any case where disposition induces have the only re-state a fact. Any case where disposition induces have the story works to non-story show of the story works to non-story show of the story of the sto

a centia number of facts will certainly reject the theory. A fact maintainst, endowed with much factikitity of mind, and wich have already beguns to doubt the immutability of mind, and wich have already beguns to the second second second second second of the question with impuriability. More will be able to their out and disc question with impuriability. More will be able to their out and pressing his convections, for thus only can the load of prejudice by which this subject in overrelations to meroyed.

Several eminent naturalists have of late published their belief that a multitude of reputed species in each genus are not real species; but that other species are real, that is, have been independently created. This seems to me a strange conclusion to arrive at. They admit that a multitude of forms, which till lately they themselves thought were special creations, and which are still thus looked at by the majority of naturalists, and which conseopently have all the external characteristic features of true species, -they admit that these have been produced by variation, but they refuse to extend the same view to other and slightly different forms. Nevertheless they do not pretend that they can define, or even conjecture, which are the created forms of life, and which are those produced by secondary laws. They admit variation as a vera causa in one case, they arbitrarily reject it in another, without assigning any distinction in the two cases. The day will come when this will be given as a curious illustration of the blindness of preconceived opinion. These authors seem no more startled at a miraculous act of creation than at an ordinary birth. But do they really believe that at innumerable periods in the earth's history certain elemental atoms have been commanded suddenly to flash into living tissues? Do they believe that at each supposed act of creation one individual or many were produced? Were all the infinitely numerous kinds of animals and plants created as eggs or seed, or as full grown ? and in the case of mammals, were they created bearing the false marks of nourishment from the mother's womb? Undoubtedly some of these same questions cannot be answered by those who believe in the appearance or creation of only a few forms of life, or of some one form alone. It has been maintained by several authors that it is as easy to believe in the creation of a million beings as of one; but Maupertuis' philosophical axiom "of least action " leads the mind more willingly to admit the smaller number; and certainly we ought not to believe that innumerable beings within each great class have been created with plain, but deceptive, marks of descent from a single parent.

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As a record of a former state of things, I have retained in the foregoing paragraphs, and elsewhere, several sentences which imply that naturalists believe in the separate creation of each species; and I have been much censured for having thus expressed myself. But undoubtedly this was the general belief when the first edition of the present work appeared. I formerly spoke to very with any sympathetic agreement. It is probable that some did meaning. Now things are wholly changed, and almost every naturalist admits the great principle of evolution. There are, however, some who still think that species have suddenly given high through quite unexplained means, to new and totally different a scientific point of view, and as leading to further investigation, but little advantage is gained by believing that new forms are suddenly developed in an inexplicable manner from old and widely different forms, over the old belief in the creation of species from the dust of the earth.

It may be asked how far I cattend the doctrine of the modification of operless. The question is of difficult to answer, because the more distinct the forms are which we consider, by so much the arguments in force of community of descent because forcer in number and hear in force. But some arguments of the greatest weight extend very end of the strength of the str

Organs in a realimentary condition phalpi show that an early preparative hald be enquin to fully developed conditions; and this is some cases implies an ensurement of mollification in formed on the same pattern, and at a very early case the endry formed on the same pattern, and at a very early case the endry closely resemble each other. Therefore I cannot don't that the theory of descent with moldification embers of the same pract class or kingdom. I believe that animals are theory and pattern pattern, and a start an endry of the same pract class or kingdom. I believe that animals are then an equal or lenge number,

Analogy would lead me one step farther, namely, to the belief that all animals and plants are descended from some one prototype. But analogy may be a deceitful guide. Nevertheless all living

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cellular structure, their laws of growth, and their liability to ininvious influences. We see this even in so trifling a fact as that the same poison often similarly affects plants and animals : or that the poison secreted by the gall-fly produces monstrous growths on the wild rose or oak-tree. With all organic beings, excepting perhaps some of the very lowest, sexual reproduction seems to be essentially similar. With all, as far as is at present known, the germinal vesicle is the same; so that all organisms start from a common origin. If we look even to the two main divisionsnamely, to the animal and vegetable kingdoms-certain low forms are so far intermediate in character that naturalists have disputed to which kingdom they should be referred. As Professor Asa Gray has remarked, "the spores and other reproductive bodies of many "of the lower algae may claim to have first a characteristically "animal, and then an unequivocally vegetable existence." Therefore, on the principle of natural selection with divergence of character, it does not seem incredible that, from some such low and intermediate form, both animals and plants may have been developed; and, if we admit this, we must likewise admit that all the organic beings which have ever lived on this earth may be descended from some one primordial form. But this inference is chiefly grounded on analogy, and it is immaterial whether or not it be accepted. No doubt it is possible, as Mr. G. H. Lewes has urged, that at the first commencement of life many different forms were evolved ; but if so, we may conclude that only a very few have left modified descendants. For, as I have recently remarked in regard to the members of each great kingdom, such as the Vertebrata, Articulata, &c., we have distinct evidence in their embryological, homologous, and rudimentary structures, that within each kingdom all the members are descended from a single

When the views advanced by me in this volume, and by Mr. Walks, or when analogous views on the origin of species are given by admitted, we can dimly forese that there will be a considerable revolution in matruch labour, Systematist will be also to prome their labours as at present; but itdey will not be summary lammed by the singlety of both whether this or that we have the second state of the second state experisons, with the true species, This, I design and I quark store specieous, will be the present of the harmboar og product with the second state of the second states of the second states of the second state of the second states of the statist will have only to deside (not that this states from other forms, $S = 10^{-10}$ for the statistic states of the forms of the second states of the states of the second states of

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to be capable of definition; and if definable, whether the differences be sufficiently important to deserve a specific name. This latter point will become a far more essential consideration than is it are present; for differences, however slight, between any two forms, if not blended by intermediate gradations, are looked at by most naturalists as sufficient to rules both forms to the rank of surveise.

Herearder we shall be compelled to acknowledge that its only distriction between species and well-method variaties is, that the latter ark known, or believel, to be connected at the present day by intermediate graditions, whereas a peck wave formary thus connector. Hence, without rigiting the consideration of the presented below the structure of the present of the present amount of difference between them. It is quite parallel that form or generally acknowledged to be merely variations may hereafter be thought vortiky of specific manney, and in this case scientific and samount of difference between them. It is quite parallel that form or generally acknowledged to be merely variations may hereafter be thought vortiky of specific manney, and in this case scientific and have to treat species in the same manner as those maturalists true preserv, who soluti the gravan are unrely artifield combinations we shall a teast be freed from the vain smarch for the unsubscover and undiscoverships ensone of the term receive.

The other and more general departments of rankum history will regressly in hierarch. The terms used by naturalisis, of affinity, relationship, community of types, paternity, morphology, adaptive relationship, community of types, paternity, morphology, adaptive the analysis of the start of the start of the start of the start line whole based also comprehension, when we regard every protection of nature as non-which has had a long history is thus we they do nave of the start of the start of the start of many conversion, such useful to the possions, in the same way as any great mechanical investion is the summing up of the linear, the start of the start of the start of the start room vortunes, the number of the start of the start room vortunes is when we thus size each expansion binding, here fars not another in the start of the start of the start of the start room vortunes is the start of the start of the start of the start room vortunes is the start of the start of

A grand and almost untrolden field of Inquiry will be opened, on the causes and laws of variation, on correlation, on the effects of use and disus, on the direct action of external conditions, and so forth. The study of domestic productions will rise immersity in value. A new variety raised by man will be a more important and interesting subject for study than one more species addet to the infimitude of

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analy encoded species. Our classifications will come to be a soft adaption as how makes, permelogies, and will then truly give what mup ho called the plan of creation. The rules for classifying will module become simpler when we have a definite object in view. We passes no pedigress or amorial barrings ; and we have to disstorer and rune the many diverging lines of descent in our natural genelogies, by characters of any kind which have long ben interid. Indimensionary organs will regold infallibly with wrepect to the anisor of long-bact structures. The functional period and the structure of the software of the structure, the software of handly will often reveal to us the structure, how edgers observed, full for periodynes of classical rule and structure.

When we can feel searced that all the individuals of the same species, and all the colony allied species of most genera, have within a not very remote period seconded from one parent, and have impated from some one birth-phere. The same second second the many means of migration, then, by the light which goolegy or throws, and will continue to those, on former changes of climats and of the level of the hard, we shall study be enabled to the size as a diminibus means the former migrations of the instaliants of the whole work. Here, of has seen the repetite instald a continent, and the nature of the same migrations of the continuent in relation to their apparent means of numingration, some lists can be thrown on ancients geography.

The noble science of Geology loses glory from the extreme imperfection of the record. The crust of the earth with its embedded remains must not be looked at as a well-filled museum, but as a poor collection made at hazard and at rare intervals. The accumulation of each great fossiliferous formation will be recognised as having depended on an unusual concurrence of favourable circumstances, and the blank intervals between the successive stages as having been of vast duration. But we shall be able to gauge with some security the duration of these intervals by a comparison of the preceding and succeeding organic forms. We must be cautious in attempting to correlate as strictly contemporaneous two formations, which do not include many identical species, by the general succession of the forms of life. As species are produced and exterminated by slowly acting and still existing causes, and not by miraculous acts of creation ; and as the most important of all causes of organic change is one which is almost independent of altered and perhaps suddenly altered physical conditions, namely, the

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mutual relation of erganiams to organiams—the improvement of one organiam entaling the improvement of the externitation of others 1 is follows, that the amount of other the externitation fiscalis of consecutive from the start of the start of the start of the relative, though not actual large of time. A mean speech, soverey, thereing in a body major transit of a body probaqueed, while within the same priod, several of them speech unchanged, while within the same priod, several of them speech overate the ascency of organic changes as measure of time.

In the future I see open fields for far more important researches, Psychology will be security based on the foundation already well laid by Mr. Herbert Spencer, that of the necessary acquirement of each mental power and capacity by gradation, Much light will be thrown on the origin of man and his history.

Authors of the highest eminence seem to be fully satisfied with the view that each species has been independently created. To my matter by the Creator, that the production and extinction of the past and present inhabitants of the world should have been due to individual. When I view all beings not as special creations, but the first bed of the Cambrian system was deposited, they seem to me to become ennobled. Judging from the past, we may safely to a distant futurity. And of the species now living very few will manner in which all organic beings are grouped, shows that the many genera, have left no descendants, but have become utterly extinct. We can so far take a prophetic glance into futurity as to foretell that it will be the common and widely-spread species. belonging to the larger and dominant groups within each class, which will ultimately prevail and procreate new and dominant species. As all the living forms of life are the lineal descendants of those which lived long before the Cambrian epoch, we may feel certain that the ordinary succession by generation has never once been broken, and that no cataclysm has desolated the whole world. Hence we may look with some confidence to a secure future of great length. And as natural selection works solely by and for the to progress towards perfection.

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It is interesting to contemplate a tangled bank, clothed with the damp earth, and to reflect that these elaborately constructed in so complex a manner, have all been produced by laws acting around us. These laws, taken in the largest sense, being Growth duction ; Variability from the indirect and direct action of the conditions of life, and from use and disuse : a Ratio of Increase so high as to lead to a Struggle for Life, and as a consequence to Natural Selection, entailing Divergence of Character and the Extinction of less-improved forms. Thus, from the war of nature, from famine and death, the most exalted object which we are capable of conceiving, namely, the production of the higher animals, directly follows. There is grandeur in this view of life, with its several newers, having been originally breathed by the Creator into a few forms or into one ; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved.

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GLOSSARY OF THE

PRINCIPAL SCIENTIFIC TERMS USED IN THE PRESENT VOLUME.*

- ARERRANT.—Forms or groups of animals or plants which deviate in important characters from their nearest allies, so as not to be easily included in the same group with them, are said to be aberrant.
- Amenuarizoto (in Optico)—In the refraction of light by a convex lens the rays possing through different parts of the lens are brought to a focus at alightly different distances,—this is called *spherical describing*, at this same time the coloured rays are separated by the prismatic scient of the lens and likewise brought to a focus at different distances,—this is *dromatic describing*.

ABNORMAL .- Contrary to the general rule.

- ABORTED.-An organ is said to be aborted, when its development has been arrested at a very early stage.
- ALBINISM.—Albinos are animals in which the usual colouring matters characteristic of the species have not been produced in the skin and its appendages. Albinism is the state of being an albino.
- ALG.E.-A class of plants including the ordinary sea-weeds and the filamentous fresh-water weeds.
- ALTERNATION OF GENERATIONS.—This term is applied to a pseuliar mode of reproduction which prevails among many of the lower animals, in which the egg produces a living form quite different from its parent, but from which the parent-form is reproduced by a process of budding, or by the division of the substance of the first product of the egg.
- AMMONITES.—A group of fossil, spiral, chambered shells, allied to the existing pearly Nantilus, but having the partitions between the chambers waved in complicated patterns at their junction with the outer wall of the shell.
- ANALOGY.—That resemblance of structures which depends upon similarity of function, as in the wings of insects and birds. Such structures are said to be gradpous, and to be analogues of each other.

* I am indebted to the kindness of Mr. W. S. Dallas for this Glosskery, which has been given because several readers have complained to me that seems of the terms used were unintelligible to them. Mr. Dallas has endeavoured to give the explanations of the terms in as popular a form as possible. Aggregation—A similar dominant generally applied to how taking any by-Aggregation—A similar dominant generally applied to how taking any by-Aggregation—A similar dominant have the sequences approaching periodic and the sequence of the sequences and the sequences approaching the sequences and the sequences applied on the boolds. A sequence of the sequences applied applied on the sequences and the looks. A sequence Aggregation applied on the sequences and the sequences and applied on the sequences and the looks. A sequence of the aggregation of the sequences and the looks and the sequences and applied on the sequences and the looks. A sequence of the aggregation of the sequences and the looks and the sequences and aggregation of the sequences and the sequences and the sequences applied by the sequences of the look developed and the sequences applied by the sequences of the look developed and the sequences applied by the sequences of the look developed and the sequences applied by the sequences of the look developed and the sequences applied by the sequences of the look developed and the sequences applied by the sequences of the look developed and the sequences applied by the sequences of the look developed and the sequences applied by the sequences and constraints of the looks applied by the sequences of the look of the look of the looks applied by the sequences and the looks applied by the sequences and the looks applied by the look of the look of the look of the looks applied by the looks and the looks and looks applied by the looks and looks and looks and looks and looks applied by the looks and looks and looks and looks and looks applied by the looks and looks and looks and looks and looks and looks applied by the looks and looks and

BATEACHIANS.—A class of animals alled to the Keptiles, but undergoing a peculiar metamorphosis, in which the young animal is generally aguatic and breathers by gills, (Ezamples, Frogs, Toads, and Newts.)

BOULDERS.-Large transported blocks of stone generally imbedded in clays or gravels.

BRACHUNGDEA.—A class of marine Mollusca, or soft-bolied animals, furnished with a bivative shell, attached to submarine objects by a stalk which passes through an aperture in one of the valves, and furnished with fringed arms, by the action of which food is carried to the mouth.

BRANCHLE,-Gills or organs for respiration in water.

BRANCHIAL .- Pertaining to gills or branchize.

CAMMBIAN SYSTEM.—A Series of very ancient Palsozoic rocks, between the Lauventian and the Silurian. Until rocently these were regarded as the oldest fossiliferous rocks.

CANID.E .- The Dog-family, including the Dog, Wolf, Fox, Jackal, &c.

CARAPACE.-The shell enveloping the anterior part of the body in Crustaceans generally; applied also to the hard shelly pieces of the Cirripedes.

CARDONIFFEBOUS.-This term is applied to the great formation which includes, among other rocks, the coal-measures. It belongs to the object, or Palaozoic, system of formations.

CAUDAL .- Of or belonging to the tail.

CEFHALOPORS.—The highest class of the Mollusca, or soft-bodied animals, characterised by having the mouth surrounded by a greater or less number of ficshy arms or tentacles, which, in most living species, are furnished with anchron-curas. (Examples, Cutile-fish, Nautilus.)

CETACEA, -An order of Mammalia, including the Whales, Dolphins, &c.,

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having the form of the body fish-like, the skin maked, and only the forelimbs developed.

CHELONIA .- An order of Reptiles including the Turtles, Tortoises, &c.

- CINENTEDDE.—An order of Crustaceans including the Barnacles and Acorashells. Their young resemble those of many other Crustaceans in form ; but when mature they are always attached to other objects, either directly or by means of a stalk, and their bodies are enclosed by a
- alcourse whall assessed of a stank, and their bodies are enclosed by a
- give issue to a bunch of curled, jointed tentacles, which represent the limbs.
- Coccus.-The genus of Insects including the Cochineal. In these the male is a minute, wingod fly, and the female generally a motionless, berrylike mass.
- Coccon.—A case usually of silky material, in which insects are frequently enveloped during the second or resting-stage (pupa) of their existence. The term " coccon-stage" is here used as equivalent to "pupa-stage."
- COLLOSFILMOUS.-A term applied to those fruits of the Umbelliferm which have the seed hollowed on the inner face.
- COLEDFTERA.—Beetles, an order of Insects, having a biting mouth and the first pair of wings more or less horny, forming sheaths for the second pair, and usually meeting in a straight line down the middle of the back.
- COLUMN.-A peculiar organ in the flowers of Orchids, in which the stamens, style and stigma (or the reproductive parts) are united.
- COMPOSITÆ OF COMPOSITOUS PLANTS.—Plants in which the inflorescence consists of numerous small flowers (floreta) brought together into a dense head, the base of which is enclosed by a common envelope. (*Ecomples*, the Daisy, Dandelion, &c.)
- CONFERV.E .- The filamentous weeds of fresh water.
- CONGLOMERATE.-A rock made up of fragments of rock or pebbles, cemented together by some other material.
- CONDILA.—The second envelope of a flower, usually composed of coloured, leaf-like organs (petals), which may be united by their edges either in the basal part or throughout.
- CONNELATION.-The normal coincidence of one phenomenon, character, &c., with another.
- CONTWAL—A bunch of flowers in which those apringing from the lower part of the flower stalk are supported on long stalks so as to be nearly on a level with the upper coses.

COTVLEDONS .- The first or seed-leaves of plants.

- GRUSTACEANS.—A class of articulated animals, having the skin of the body generally more or less hardened by the deposition of calcareous matter, breathing by means of cills. (Economics Crab. Labeter, Shrimm & a)
- CUBCULIO.—The old generic term for the Beetles known as Weevils, characterised by their four-jointed feet, and by the head being produced into a sort of beak, upon the sides of which the antenne are inserted.

CUTANEOUS .- Of or helonging to the skin.

DEGRADATION .- The wearing down of land by the action of the sea or of meteoric agencies.

DENUDATION .- The wearing away of the surface of the land by water.

- DEVONIAN SYSTEM or formation .--- A series of Palseozoic rocks, including the Old Red Sandstone,
- DROTTIZEDONS OR DICOTTIZEDONOUS PLANTS.—A class of plants characterised by having two seed-laves, by the formation of new wood between the bark and the old wood (axogenous growth) and by the reticulation of the veins of the leaves. The parts of the flowers are generally in multiples of five.
- DIFFERENTIATION .- The separation or discrimination of parts or organs which is simpler forms of life are more or less united.
- DIMORPHIC.-Having two distinct forms.-Dimorphism is the condition of the annearance of the same species under two dissimilar forms.

Duncious,-Having the organs of the sexes upon distinct individuals.

Dypear.-Of or belonging to the back.

- EDENTATA.—A peculiar order of Quadrupeds, characterised by the absence of at least the middle incisor (front) toeth in both jaws. (*Examples*, the Sloths and Armadillos.)
- ELYTEA.-The hardened fore-wings of Beetles, serving as sheaths for the membraneous hind-wings, which constitute the true organs of flight.
- EMBBYO,-The young animal undergoing development within the egg or womb.

EMBRYOLOGY .- The study of the development of the embryo.

Expressio .-- Peculiar to a given locality.

- ENTOMOSTRACA.—A division of the class Crustacea, having all the segments of the body usually distinct, gills attached to the feet or organs of the month, and the feet fringed with fine hairs. They are generally of small size.
- EDCENE.—The earliest of the three divisions of the Tertiary epoch of geologists. Rocks of this age contain a small proportion of shells identical with species now living.

EPHEMEROUS INSPORTS .- Insects allied to the May-fly.

FAUNA .- The totality of the animals naturally inhabiting a certain country or region, or which have lived during a given geological region.

FELID.A.,-The Cat-family.

FERAL-Having become wild from a state of cultivation or domestication.

- FIGEA .- The totality of the plants growing naturally in a country, or during a sizen coological period.
- FIGHERS.-Flowers imperfectly developed in some respects, and collected into a dense spike or head, as in the Grasses, the Dandelion, &c.
- Furnal .- Of or belonging to the fotus, or embyro in course of develop-
- FORAMINIFERA.—A class of namials of very low organisation, and generally of small size, having a jelly-like body, from the surface of which delione filaments can be given off and retracted for the probension of external objects, and having a cularonos or naily shell, usually dividel into chambers, and performated with small apertures.

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FOSSILIFEROUSContaining fossils.
FOSSORIALHaving a faculty of digging. The Fossorial Hymenoptera are a group of Wasp-like Insects, which burrow in sandy soll to make nests
for their young.
FRENUM (pl. FRENA) A small band or fold of skin.
FUNGI (sing, FUNGUS),-A class of cellular plants, of which Mushreoms, Toadstools, and Moulds, are familiar examples.
FURCULA.—The forked bone formed by the union of the collar-bones in many birds, such as the common Fowl.
GALLINACEOUS BIRDS.—An order of Birds of which the common Fowl, Turkey, and Pheasant, are well-known examples.
GALLUSThe genus of birds which includes the common Fowl.
GANGLION A swelling or knot from which nerves are given off as from a centre.
GANOID FISHES.—Fishes covered with peculiar enamelled bony scales. Most of them are extinct.
GERMINAL VESICLE.—A minute vesicle in the eggs of animals, from which the development of the embyro proceeds.
GLACAL PERIOD.—A period of great cold and of enormous extension of ice upon the surface of the earth. It is believed that glacial periods have occurred repeatedly during the geological history of the earth, but the term is generally applied to the close of the Tertiary epoch, when nearly the whole of Europe was subjected to an arctic climate.
GLAND.—An organ which secretes or separates some peculiar product from the blood or sap of animals or plants.
GLOTTISThe opening of the windpipe into the cosphagus or gullet.
GNEISS.—A rock approaching granite in composition, but more or less laminated, and really produced by the alteration of a sedimentary deposit after its consolidation.
GRALLATORES.—The so-called Wading-birds (Storks, Cranes, Snipes, &c.), which are generally furnished with long legs, bare of feathers above the heel, and have no membranes between the toes.
GRANITEA rock consisting essentially of crystals of felspar and mica in a mass of quartz.
HABITAT The locality in which a plant or animal naturally lives.
HEMIFTERA.—An order or sub-order of Insects, characterised by the posses- sion of a jointed beak or rostrum, and by having the fore-wings horny in the basel portion and membraneous at the extremity, where they cross each other. This group includes the various species of Bugs.
HERMAPHRODITE Possessing the organs of both sexes.
HOMOLOGY.—That'relation between parts which results from their down lopment from corresponding emberyonic parts, either in different animals as in the case of the arm of man, the fore-leg of a quadruped, and the wing of a bird; or in the same individual, as in the cuse of the fore and hind legs in quadrupeds, and the segments or rings and their appea- dages of which the holy of a worm, a controlped, &c, is composed. Thu
latter is called sevial homology. The parts which stand in such a relation to each other are said to be homologous, and one such part or organ is

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called the *homologoue* of the other. In different plants the parts of the flower are homologous, and in general these parts are regarded as *homologous* with leaves.

HOMOFTERA.—An order or sub-order of Insects having (like the Homiptera) a jointed beak, but in which the fore-wings are either wholly membranous or wholly leathery. The Ciozda, Frog-hoppers, and Arbides, are well-known examples.

Hynnin-The offspring of the union of two distinct species.

HTMENOPTERA.—An order of Insects possessing biting jaws and usually four membranous wings in which there are a few volas. Bees and Wassa are familiar examples of this group.

HYPERTROPHIED,-Excessively developed.

ICHNEUMONID.R .--- A family of Hymenopterous insects, the members of which lay their eggs in the bodies or eggs of other insects.

IMAGO .- The perfect (generally winged) reproductive state of an insect.

- INDIGEENS. The aboriginal animal or vegetable inhabitants of a country or region.
- INFLORESCENCE .- The mode of arrangement of the flowers of plants. ?
- Jørgsontz.—A. class of microscopic Animalcules, so called from their having orgically been observed in influsions of vegetable matters. They consist of a gelatinous material enclosed in a delicate membrane, the whole or part of vyhch is far furnished with short vibrating haltra: (called elila), by means of which the azimalcules avein through the water or convey the minute particles of their food to the oritice of the mouth.

INSECTIVOROUR.-Feeding on Insects.

INVERTEBRATA, or INVERTEBRATE ANIMALS.-Those animals which do not possess a backbone or spinal column.

LACUN M. — Spaces left among the tissues in some of the lower animals, and serving in place of vessels for the circulation of the fluids of the body. LAWEL VER — Remeinded with hemelin or little plates.

LARVA (pl. LARV.E).-The first condition of an insect at its issuing from the egg, when it is usually in the form of a grub, caterpallar, or maggot.

LARYNX .- The upper part of the windpipe opening into the gullet.

- LAURENTIAN.--- A group of greatly altered and very ancient rocks, which is greatly developed along the course of the St. Laurence, whence the name. It is in these that the earliest known traces of organic bodies have been found.
- LEGUMINORAL—An order of plants represented by the common Peas and Beans, having an irregular flower in which one petal atands up like a wing, and the atamens and pistil are enclosed in a shoath formed by two ether petals. The fruit is a ped (or legumo).
- LEMURIDA.—A group of four-handed animals, distinct from the Meakeys and approaching the Insectivorous Quadrupeds in some of their characters and habits. Its members have the nostrils curved or twisted, and a claw include of a mail uncen the first finger of the hind hands.
- LEFIDOTERA.—An order of Insects, characterised by the possession of a spiral proboseis, and of four large more or less scaly wings. It includes the well-known Butterflies and Moths.

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LITTORAL .- Inhabiting the seashore.

- LOBSS.-A marly deposit of recent (Post-Tertiary) date, which occupies a great part of the valley of the Rhine.
- MALACOSTRACA.--The higher division of the Crustacea, including the ordinary Craba, Lobsters, Shrimps, &c., together with the Woodlice and Sand-howers.
- MARALLA.—The highest class of sainable fixed-ling the welfarery helps of living results with an available after britth by smaller from the task (Raman, Ramoney jobals) of the starker. A striking districts great groups in some of the sain strike the interpret star stark (Raman, Ramoney jobals) of the starker. A striking district group array on the soft flow, when the interpret stark and stark is reached association of the stark of the interpret stark (Raman, Ramoney Jobals). The stark of the stark stark is reached association of the stark of the interpret stark of the stark of the stark of the stark of the stark array resolution is nevel interpret and the flow of the stark presser part of the data, are stalk flowed as starked; it he listor of declapsitors).

MANMIFEROUS.-Having mamma or teats (see MANMALIA).

- MANDIBLES, in Insects.—The first or uppermost pair of jaws, which are generally solid, horny, biting organs. In Birds the term is applied to both jaws with their horny coverings. In Quadrupeds the mandible is properly the lower iaw.
- MARSUPIALS.—An order of Mammalia in which the young are born in a very incomplete state of development, and carried by the mother, while sucking, in a ventral pouch (marsuplum), such as the Kangaroos, Oposemus, &c. (see MAMMALIA).
- MAXILLE, in Insects.-The second or lower pair of jaws, which are composed of several joints and furnished with peculiar jointed appendages called paiol. or feelers.
- MELANISM.-The opposite of albinism ; an undue development of colouring material in the skin and its appendages.
- METAMORPHIC ROCKS.—Sedimentary rocks which have undergone alteration, generally by the action of heat, subsequently to their deposition and comoldation.
- MOLLEXX...-One of the great divisions of the Animal Kingdom, including those animals which have a soft body, mouth furnished with a shell, and in which the zerous ganglia, or centres, present no definite general arrangement. They are greerally known under the demonization of "shell-fish ?" the cuttle-fish, and the common smalls, whelks, oysters, mussely, and occides, may serve as examples of them.
- MONOCYTLIDORS, or MONOCYTLIDOROUS FLANTS.—Plants in which the seed sends pointy a single seed-leaf (or oxiv)leolog); characterised by the absence of consecutive layers of wood in the stem (endogenous growth), by the veins of the leaves being generally straight, and by the parts of the flowers being generally in multiples of three. (Ecomples, Grasses, Lilles, Orchids, Palles, &c.)
- MORAINES .- The accumulations of fragments of rock brought down by claciers.

MORPHOLOGY .- The law of form or structure independent of function.

MYRIS-STAGE.—A stage in the development of cortain Crustaceans (Prawns), in which they closely resemble the adults of a genus (Mysic) belonging to a slightly lower group.

NASCENT .--- Commencing development,

NATATORY .- Adapted for the purpose of swimming.

- XAUPLIUS-FORM.—The earliest stage in the development of many Crustacea, especially belonging to the lower groups. In this stage the animal has a short body, with indistance indivations of a division into segments, and three pairs of fringed limbs. This form of the common fresh-water Carlos was described as a divinct crum under the name of Nuccline.
- NEURATION .- The arrangement of the veins or nervures in the wings of Insects.
- NEWTERS.—Imperfectly developed females of certain social insects (such as Ants and Brees), which perform all the labours of the community. Hence they are also called socretes.
- NETITATING MEMBILANE.—A semi-transparent membrane, which can be drawn across the eye in Birds and Reptiles, either to moderate the effects of a strong light or to sweep particles of dust, &c., from the surface of the eye.
- OCENLL.-The simple eyes or stemmata of Insects, usually situated on the crown of the head between the great compound eves.

ESOPHAGUS .- The gullet.

- OULTIC.--A great series of secondary rocks, so called from the texture of some of its members, which appear to be made up of a mass of small cys-like calcaroous bodies.
- OPERCULUM.—A calcareous plate employed by many Mollusca to close the aperture of their shell. The opercular values of Cirripodes are those which close the aperture of the shell.
- ORBIT .- The bony cavity for the reception of the eve.
- OBGANHEM .- An organised being, whether plant or animal.
- ORTHOSPERMOUS,-A term applied to those fruits of the Umbelliferse which have the seed straight.
- OSCULANT .- Forms or groups apparently intermediate between and conmeeting other groups are said to be exculant.

OVA .- Ezes.

OVARIUM or OVARY (in plants).—The lower part of the pistil or female organ of the flower, containing the ovules or incipient seeds; by growth after the other organs of the flower have fallen, it usually becomes converted into the frait.

OVEGEROUR-Egg-bearing.

OVULES (of plants) .- The seeds in the earliest condition.

PACHYDERMS.—A group of Mammalia, so called from their thick skins, and including the Elephant, Rhinoceros, Hippopotamus, &c.

PALEOZOIC .- The oldest system of fossiliferous rocks.

PALPL.-Jointed appendages to some of the organs of the mouth in Insects and Crustacea

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PAPILIONACE.#.—An order of Plants (see LEGUMINOS.R.).—The flowers of these plants are called <i>popilionaccous</i> , or butterfly-like, from the fancied resemblance of the expanded superior petals to the wings of a butterfly.
PARASITEAn animal or plant living upon or in, and at the expense of, another organism,
PARTHENOGENESISThe production of living organisms from unimpreg- nated eggs or seeds.
PEDUNCULATEDSupported upon a stem or stalk. The pedunculated cak has its nearns borne upon a footstalk.
PELORIA or PELORISM The appearance of regularity of structure in the flowers of plants which normally bear irregular flowers.
PELVIS,-The bony arch to which the hind limbs of vertebrate animals are articulated.
PETALSThe leaves of the corolla, or second circle of organs in a flower. They are usually of delicate texture and brightly coloured.
PHYLLODINEOUS Having flattened, leaf-like twigs or leafstalks instead of true leaves.
PIGMENT.—The colouring material produced generally in the superficial parts of animals. The cells secreting it are called <i>pigment-cells</i> .
PINNATE Bearing leaflets on each side of a central stalk.
PISTILE.—The female organs of a flower, which occupy a position in the centre of the other floral organs. The pistil is generally divisible into the ovary or germen, the style and the stigma.
PLACENTALIA, PLACENTATA, or Placental MammalaSee MAMMALIA.
PLANTIGRADESQuadrupeds which walk upon the whole sole of the foot like the Bears.
PLASTIC Readily capable of change.
PLEISTOCENE PERIOD The latest portion of the Tertiary epoch.
PLUMULE (in plants) The minute bud between the seed-leaves of newly germinated plants.
PLUTONIC ROCKS,-Rocks supposed to have been produced by igneous action in the depths of the earth,
POLEXS.—The male element in flowering plants; usually a fine dust produced by the anthers, which, by contasts with the sigma effects th fermulation of the seeds. This impregnation is brought about by mean of tubes (gride-nuclear) which is usen from the pollen-grains albering t the stigma, and penetrate through the tissues until they reach the every.
POLYANDROUS (flowers) Flowers having many stamens.
POLYGAMOUS PLANTS.—Plants in which some flowers are unisexual an others hermaphredite. The unisexual (male and female) flowers, may be on the same or on different plants.
POLYMORPHIC Presenting many forms.
POLYZOANY The common structure formed by the cells of the Polyzos such as the well-known Sea-mats.
PREHENSILE Capable of grasping.
Proposition Having a superiority of power

PRIMARIES.-The feathers forming the tip of the wing of a bird, and inserted upon that part which represents the hand of man.

- PROCESSES-Projecting portions of homes, usually for the attachment of muscles, ligaments, &c.
- PROPOLIS .- A resinous material collected by the Hive-Bees from the opening buds of various trees.

PROTEAN .- Exceedingly variable.

- Phorozoa.—The lowest great division of the Animal Kingdom. These animals are composed of a gelatinous material, and show scarcely any trace of distinct organs. The Infusoria, Foruminifera, and Sponges, with some other forms, belong to this division.
- PUFA (pi. PUFA).—The second stage in the development of an Insect, from which it emerges in the perfect (winged) reproductive form. In most insects the pupal stage is passed in perfect repose. The obvysalls is the pupal state of Butterfles.

RADICLE .--- The minute root of an embryo plant,

- RAMUE.—One half of the lower jaw in the Mammalia. The portion which rises to articulate with the skull is called the ascending ramus.
- RANGE.—The extent of country over which a plant or animal is naturally apread. Range in time expresses the distribution of a species or group through the fossiliferous bels of the earth's crust.
- RETINA.—The delicate inner coat of the eye, formed by nervous filaments spreading from the optic nerve, and serving for the perception of the impressions produced by light.
- BETMOONEMENN.—Backward development. When an animal, as it approaches maturity, becomes less perfectly organised than might be expected from its early stages and known relationships, it is said to undergo a retrograde development or metamorphosis.
- BHIZOFODS.—A class of lowly organised animals (Protozoa), having a gelatisous body, the surface of which can be protruded in the form of rostlike processes or filaments, which serve for locomotion and the prebenske of food. The meet important order is that of the Foraminifera.
- RODENTS. The gnawing Mammalia, such as the Rats, Rabbits, and Squirrels. They are especially characterised by the possession of a single pair of chisel-like cutting teeth in each jaw, between which and the grading teeth there is a great gap.

RUBUS .---- The Bramble Genus.

RUDIMENTARY .--- Very imperfectly developed.

- RUMINANTS.-The group of Quadrupeds which ruminate or chew the cud, such as exen, sheep, and deer. They have divided hoofs, and are destitute of front teeth in the upper jaw.
- SACRAL.—Belonging to the sacrum, or the bone composed usually of two or more united vertebra to which the sides of the pelvis in vertebrate animals are attached.
- SARCODE. .- The gelatinous material of which the bodies of the lowest animals (Protozoa) are composed.

SCUTELLE_-The horny plates with which the feet of birds are generally more or less covered, especially in front.

SEDIMENTARY FORMATIONS .- Rocks deposited as sediments from water.

Glossary.

- SEGMENTS .- The transverse rings of which the body of an articulate animal or Annelid is composed.
- SEFALS.—The leaves or segments of the calyx, or outermost envelope of an ordinary flower. They are usually green, but sometimes brightly coloured.

SERRATURES .- Teeth like those of a saw.

SESSILE .- Not supported on a stem or footstalk.

SILURIAN SYSTEM.—A very ancient system of fossiliferous rocks belonging to the earlier part of the Palaozoic series.

SPECIALISATION.—The setting spart of a particular organ for the performance of a particular function.

SPINAL CHORD.—The central portion of the nervous system in the Vertebrata, which descends from the brain through the arches of the vertebra, and gives off nearly all the nerves to the various organs of the body.

STANDAM—The male organs of flowering plants, standing in a circle within the petals. They usually consist of a filament and an anther, the anther being the essential part in which the pollen, or fecundating dust, is formed.

STERNUM .- The breast-bone.

STIGMA.—The apical portion of the pistil in flowering plants.

- STIPULES.-Small leafy organs placed at the base of the footstalks of the leaves in many plants.
- STYLE.—The middle portion of the perfect pistil, which rises like a column from the ovary and supports the stigma at its summit.

SUBCUTANEOUR .- Situated beneath the skin,

SUCTORIAL,-Adapted for sucking.

SUTURES (in the skull) .- The lines of junction of the bones of which the skull is composed.

TARSUS (pl. TARSI) .- The jointed feet of articulate animals, such as Insects.

having the skeleton usually completely ossified and the scales horny.

TENTACULA or TENTACLES.—Delicate fleshy organs of prehension or touch possessed by many of the lower animals.

TERTIARY.—The latest geological epoch, immediately preceding the establishment of the present order of things.

TRACHEA .- The wind-pipe or passage for the admission of air to the lungs.

- TRIDACTYLE.—Three-fingered, or composed of three movable parts attached to a common base.
- TRILOWITES.—A peculiar group of extinct Crustaceans, somewhat resembling the Woollice in external form, and, like some of them, capable of rolling themselves up into a ball. Their remains are found only in the Palmozoic rocks, and most abundantly is those of Silurian age,

TRIMORPHIC,-Presenting three distinct forms,

, wires of an umbrella, so as to bring all the flowers in the same head (umbel) nearly to the same level. (Examples, Parsley and Carrot.)

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UNGULATA.—Hoofed quadrupeds. UNICELLULAR.—Consisting of a single cell.

VASCULAR .--- Containing blood-vessels.

VERMIFORM .- Like a worm.

- VERTIMATA: or VERTIMATE ANDMAIS.—The highest division of the animal kingdom, so called from the presence in most cases of a hackbone composed of numerous joints or reverieves, which constitutes the centre of the skeleton and at the same time supports and protects the central parts of the neurons system.
- WHORES.-The circles or spiral lines in which the parts of plants are arranged upon the axis of growth.

WORKERS .- See Neuters.

- ZOEA-STAGE.....The earliest stage in the development of many of the higher Crustaces, so called from the name of ZoEr applied to these young animals when they were supposed to consitute a poculiar genus.
- Zeottes—Im many of the lower animals (note) as the 'Carala, Moduna, &co.' reproduction lakes place in two ways, namely, by means of eggs and by a precise of building with or without separation from the parent of the predict of the latter, which is often very different from that of the other precise of the latter, which is often very different from that of the the form preduced between two scenal reproductions' by the whole of which are separately individual animal, have been called avoid.

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