

CHARLES ROBERT DARWIN

(1809-1882)

BY E. RAY LANKESTER



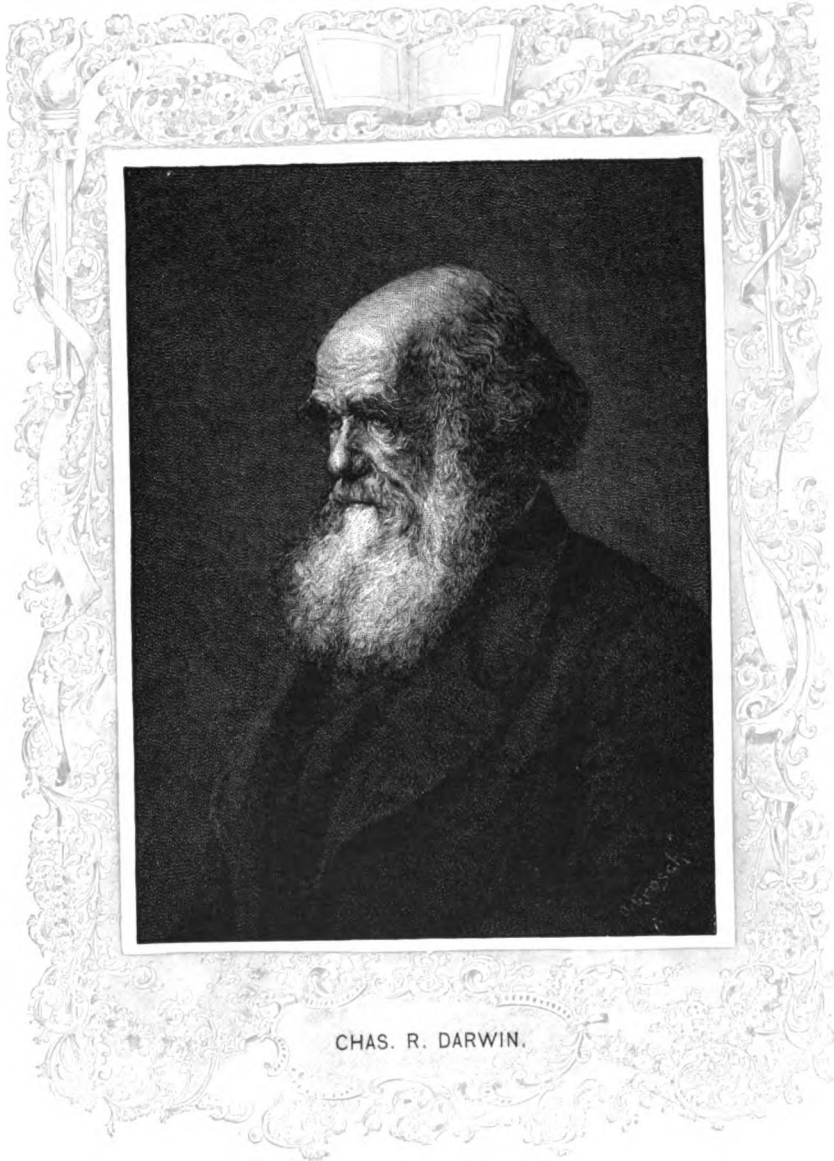
CHARLES ROBERT DARWIN, the great naturalist and author of the "Darwinian theory," was the son of Dr. Robert Waring Darwin (1766-1848) and grandson of Erasmus Darwin (1731-1802). He was born at Shrewsbury on February 12th, 1809. W. E. Gladstone, Alfred Tennyson, and Abraham Lincoln were born in the same year. Charles Darwin was the youngest of a family of four, having an elder brother and two sisters. He was sent to a day school at Shrewsbury in the year of his mother's death, 1817. At this age he tells us that the passion for "collecting" which leads a man to be a systematic naturalist, a virtuoso, or a miser, was very strong in him, and was clearly innate, as none of his brothers or sisters had this taste. A year later he was removed to the Shrewsbury grammar school, where he profited little by the education in the dead languages administered, and incurred (as even to-day would be the case in English schools) the rebukes of the head-master Butler for "wasting his time" upon such unprofitable subjects as natural history and chemistry, which he pursued "out of school."

When Charles was sixteen his father sent him to Edinburgh to study medicine, but after two sessions there he was removed and sent to Cambridge (1828) with the intention that he should become a clergyman. In 1831 he took his B. A. degree as what is called a "pass-man." In those days the injurious system of competitive examinations had not laid hold of the Universities of Oxford and Cambridge as it has since, and Darwin quietly took a pass degree whilst studying a variety of subjects of interest to him, without a thought of excelling in an examination. He was fond of all field sports, of dogs and horses, and also spent much time in excursions, collecting and observing with Henslow the professor of botany, and Sedgwick the celebrated geologist. An undergraduate friend of those days has declared that "he was the most genial, warm-hearted, generous and affectionate of friends; his sympathies were with all that was good and true; he had a cordial hatred for everything false, or vile, or cruel, or mean, or dishonorable. He was not only great but pre-eminently good, and just and lovable."

Through Henslow and the sound advice of his uncle Josiah Wedgwood (the son of the potter of Etruria) he accepted an offer to

accompany Captain Fitzroy as naturalist on H. M. S. Beagle, which was to make an extensive surveying expedition. The voyage lasted from December 27th, 1831, to October 2d, 1836. It was, Darwin himself says, "by far the most important event in my life, and has determined my whole career." He had great opportunities of making explorations on land whilst the ship was engaged in her surveying work in various parts of the southern hemisphere, and made extensive collections of plants and animals, fossil as well as living forms, terrestrial as well as marine. On his return he was busy with the description of these results, and took up his residence in London. His 'Journal of Researches' was published in 1839, and is now familiar to many readers in its third edition, published in 1860 under the title 'A Naturalist's Voyage; Journal of Researches into the Natural History and Geology of the Countries visited during the Voyage of H. M. S. Beagle round the World, under the command of Captain Fitzroy, R. N.'

This was Darwin's first book, and is universally held to be one of the most delightful records of a naturalist's travels ever produced. It is to be placed alongside of Humboldt's 'Personal Narrative,' and is the model followed by the authors of other delightful books of travel of a later date, such as Wallace's 'Malay Archipelago,' Moseley's 'Naturalist on the Challenger,' and Belt's 'Naturalist in Nicaragua.' We have given in our selections from Darwin's writings the final pages of 'A Naturalist's Voyage' as an example of the style which characterizes the book. In it Darwin shows himself an ardent and profound lover of the luxuriant beauty of nature in the tropics, a kindly observer of men, whether missionaries or savages; an incessant student of natural things—rocks, plants, and animals; and one with a mind so keenly set upon explaining these things and assigning them to their causes, that none of his observations are trivial, but all of value and many of first-rate importance. The book is addressed, as are all of Darwin's books, to the general reader. It seemed to be natural to him to try and explain his observations and reasonings which led to them and followed from them to a wide circle of his fellow-men. The reader at once feels that Darwin is an honest and modest man, who desires his sympathy and seeks for his companionship in the enjoyment of his voyage and the interesting facts and theories gathered by him in distant lands. The quiet unassuming style of the narrative, and the careful explanation of details in such a way as to appeal to those who have little or no knowledge of natural history, gives a charm to the 'Naturalist's Voyage' which is possessed in no less a degree by his later books. A writer in the *Quarterly Review* in 1839 wrote, in reviewing the 'Naturalist's Voyage,' of the "charm arising from the freshness of heart which is thrown



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over these pages of a strong intellectual man and an acute and deep observer." The places visited in the course of the Beagle's voyage, concerning each of which Darwin has something to say, were the Cape Verd Islands, St. Paul's Rocks, Fernando Noronha, parts of South America, Tierra del Fuego, the Galapagos Islands, the Falkland Islands, Tahiti, New Zealand, Australia, Tasmania, Keeling Island, the Maldives, Mauritius, St. Helena, Ascension. The most important discoveries recorded in the book—also treated at greater length in special scientific memoirs—are the explanation of the ring-like form of coral islands, the geological structure of St. Helena and other islands, and the relation of the living inhabitants—great tortoises, lizards, birds, and various plants—of the various islands of the Galapagos Archipelago to those of South America.

In 1839 (shortly before the publication of his journal) Darwin married his first cousin, Emma Wedgwood, daughter of Josiah Wedgwood of Maer, and in 1842 they took the country-house and little property of Down near Orpington in Kent, which remained his home and the seat of his labors for forty years; that is, until his death on April 19th, 1882. In a letter to his friend Captain Fitzroy of the Beagle, written in 1846, Darwin says, "My life goes on like clockwork, and I am fixed on the spot where I shall end it." Happily, he was possessed of ample private fortune, and never undertook any teaching work nor gave any of his strength to the making of money. He was able to devote himself entirely to the studies in which he took delight; and though suffering from weak health due to a hereditary form of dyspepsia, he presented the rare spectacle of a man of leisure more fully occupied, more absorbed in constant and exhausting labors, than many a lawyer, doctor, professor, or man of letters. His voyage seems to have satisfied once for all his need for traveling, and his absences from Down were but few and brief during the rest of his life. Here most of his children were born, five sons and three daughters. One little girl died in childhood; the rest grew up around him and remained throughout his life in the closest terms of intimacy and affection with him and their mother. Here he carried on his experiments in greenhouse, garden, and paddock; here he collected his library and wrote his great books. He became a man of well-considered habits and method, carefully arranging his day's occupation so as to give so many hours to noting the results of experiments, so many to writing and reading, and an hour or two to exercise in his grounds or a ride, and playing with his children. Frequently he was stopped for days and even weeks from all intellectual labor by attacks of vomiting and giddiness. Great as were his sufferings on account of ill health, it is not improbable that the retirement of life which was thus forced on him, to a very large

extent determined his wonderful assiduity in study and led to the production by him of so many great works.

In later years these attacks were liable to ensue upon prolonged conversation with visitors, if a subject of scientific interest were discussed. His wife, who throughout their long and happy union devoted herself to the care of her husband so as to enable him to do a maximum amount of work with least suffering in health, would come and fetch him away after half an hour's talk, that he might lie down alone in a quiet room. Then after an hour or so he would return with a smile, like a boy released from punishment, and launch again with a merry laugh into talk. Never was there an invalid who bore his maladies so cheerfully, or who made so light of a terrible burden. Although he was frequently seasick during the voyage of the *Beagle*, he did not attribute his condition in later life in any way to that experience, but to inherited weakness. During the hours passed in his study he found it necessary to rest at intervals, and adopted regularly the plan of writing for an hour and of then lying down for half an hour, whilst his wife or daughter read to him a novel! After half an hour he would again resume his work, and again after an hour return to the novel. In this way he got through the greater part of the circulating libraries' contents. He declared that he had no taste for literature, but liked a story, especially about a pretty girl; and he would only read those in which all ended well. Authors of stories ending in death and failure ought, he declared, to be hung!

He rarely went to London, on account of his health, and consequently kept up a very large correspondence with scientific friends, especially with Lyell, Hooker, and Huxley. He made it a rule to preserve every letter he received, and his friends were careful to preserve his; so that in the 'Life and Letters' published after his death by his son Frank—who in later years lived with his father and assisted him in his work—we have a most interesting record of the progress of his speculations, as well as a delightful revelation of his beautiful character. His house was large enough to accommodate several guests at a time; and it was his delight to receive here for a week's end not only his old friends and companions, but younger naturalists, and others, the companions of his sons and daughters. Over six feet in height, with a slight stoop of his high shoulders, with a brow of unparalleled development overshadowing his merry blue eyes, and a long gray beard and mustache,—he presented the ideal picture of a natural philosopher. His bearing was, however, free from all pose of superior wisdom or authority. The most charming and unaffected gayety, and an eager innate courtesy and goodness of heart, were its dominant notes. His personality was no less

fascinating and rare in quality than are the immortal products of his intellect.

The history of the great works which Darwin produced, and especially of his theory of the Origin of Species, is best given in his own words. The passage which is here referred to is a portion of an autobiographical sketch written by him in 1876, not for publication but for the use of his family, and is printed in the 'Life and Letters.' Taken together with the statement as to his views on religion, it gives a great insight both into the character and mental quality of the writer. It is especially remarkable as the attempt of a truly honest and modest man to account for the wonderful height of celebrity and intellectual eminence to which he was no less astonished than pleased to find himself raised. But it also furnishes the reader with an admirable *catalogue raisonné* of his books, arranged in chronological order.

A few more notes as to Darwin's character will help the reader to appreciate his work. His friendships were remarkable, characterized on his side by the warmest and most generous feeling. Henslow, Fitzroy, Lyell, Hooker, and Huxley stand out as his chief friends and correspondents. Henslow was professor of botany at Cambridge, and took Darwin with him when a student there for walks, collecting plants and insects. His admiration for Henslow's character, and his tribute to his fine simplicity and warmth of feeling in matters involving the wrongs of a down-trodden class or cruelty to an individual, are evidence of deep sympathy between the natures of Darwin and his first teacher. Of Fitzroy, the captain of H. M. S. Beagle—with whom he quarreled for a day because Fitzroy defended slavery—Darwin says that he was in many ways the noblest character he ever knew. His love and admiration for Lyell were unbounded. Lyell was the man who taught him the method—the application of the causes at present discoverable in nature to the past history of the earth—by which he was led to the solution of the question as to the origin of organic forms on the earth's surface. He regarded Lyell, who with Mrs. Lyell often visited him at Down, more than any other man as his master and teacher. Hooker—still happily surviving from among this noble group of men—was his "dear old friend"; his most constant and unwearied correspondent; he from whom Darwin could always extract the most valuable facts and opinions in the field of botanical science, and the one upon whose help he always relied. Huxley was for Darwin not merely a delightful and charming friend, but a "wonderful man,"—a most daring, skillful champion, whose feats of literary swordsmanship made Darwin both tremble and rejoice. Samples of his correspondence with these fellow-workers are given below. The

letter to Hooker (September 26th, 1862) is particularly interesting, as recording one of the most important discoveries of his later years,—confirmed by the subsequent researches of Gardiner and others,—and as containing a pretty confession of his jealous desire to exalt the *status* of plants. Often he spoke and wrote in his letters of individual plants with which he was experimenting as “little rascals.”

Darwin shared with other great men whose natures approach perfection, an unusual sympathy with and power over dogs, and a love for children. The latter trait is most beautifully expressed in a note which was found amongst his papers, giving an account of his little girl, who died at the age of ten years. Written for his own eyes only, it is a most delicate and tender composition, and should be pondered side by side with his frank and—necessarily to some readers—almost terrifying statement of his thoughts on religion.

Darwin's only self-indulgence was snuff-taking. In later years he smoked an occasional cigarette, but his real “little weakness” was snuff. It is difficult to suppose that he did not benefit by the habit, careful as he was to keep it in check. He kept his snuff-box in the hall of his house, so that he should have to take the trouble of a walk in order to get a pinch, and not have too easy an access to the magic powder.

The impression made on him by his own success and the overwhelming praise and even reverence which he received from all parts of the world, was characteristic of his charming nature. Darwin did not receive these proofs of the triumphs of his views with the solemnity of an inflated reformer who has laid his law upon the whole world of thought. Quite otherwise. He was simply delighted. He chuckled gayly over the spread of his views, almost as a sportsman—and we must remember that in his young days he *was* a sportsman—may rejoice in the triumphs of his own favorite “racer,” or even as a schoolboy may be proud and happy in the success of “the eleven” of which he is captain. He delighted to count up the sale of his books, not specially for the money value it represented, though he was too sensible to be indifferent to that, but because it proved to him that his long and arduous life of thought, experiment, and literary work was not in vain. To have been or to have posed as being indifferent to popular success, would have required a man of less vivid sympathy with his fellow-men; to have been puffed up and pretentious would have needed one less gifted with a sense of humor, less conscious of the littleness of one man, however talented, in the vast procession of life on the earth's surface. His delight in his work and its success was of the perfect and natural kind, which he could communicate to his wife and daughters, and might have been shared by a child.

I, who write of him here, had the great privilege of staying with him from time to time at Down, and I find it difficult to record the strangely mixed feeling of reverential admiration and extreme personal attachment and affection with which I came to regard him. I have never known or heard of a man who combined with such exceptional intellectual power so much cheeriness and love of humor, and such ideal kindness, courtesy, and modesty. Owing to the fact that my father was a naturalist and man of letters, I as a boy knew Henslow and Lyell, Darwin's teachers, and have myself enjoyed a naturalist's walk with the one and the geological discussions of the other. I first saw Darwin himself in 1853, when he was recommended to my boyish imagination as "a man who had ridden up a mountain on the back of a tortoise" (in the Galapagos Islands)! When I began to work at and write on zoölogy he showed his kindness of heart by writing to me in praise of my first book: he wrote to me later in answer to my appeal for guidance, that "physiological experiment on animals is justifiable for real investigation; but not for mere damnable and detestable curiosity. It is a subject which makes me sick with horror, so I will not say another word about it, else I shall not sleep to-night." When I prosecuted Slade the spiritualistic impostor, and obtained his conviction at Bow Street as a common rogue, Darwin was much interested, and after the affair was over wrote to say that he was sure that I had been at great expense in effecting what he considered to be a public benefit, and that he should like to be allowed to contribute ten pounds to the cost of the prosecution. He was ever ready in this way to help by timely gifts of money what he thought to be a good cause, as for instance in the erection of the Zoölogical Station of Naples by Dr. Anton Dohrn, to which he gave a hundred pounds. His most characteristic minor trait which I remember, was his sitting in his drawing-room at Down in his high-seated arm-chair, and whilst laughing at some story or joke, slapping his thigh with his right hand and exclaiming, with a quite innocent and French freedom of speech, "O my God! That's very good. That's capital." Perhaps one of the most interesting things that I ever heard him say was when, after describing to me an experiment in which he had placed under a bell-jar some pollen from a male flower, together with an unfertilized female flower, in order to see whether, when kept at a distance but under the same jar, the one would act in any way on the other, he remarked:—"That's a fool's experiment. But I love fools' experiments. I am always making them." A great deal might be written as comment on that statement. Perhaps the thoughts which it suggests may be summed up by the proposition that even a wise experiment when made by a fool generally leads to a false conclusion, but that fools' experiments

conducted by a genius often prove to be leaps through the dark into great discoveries.

As examples of Darwin's writings I have chosen, in addition to those already mentioned, certain passages from his great book on the 'Origin of Species,' in which he explains what he understands by the terms "Natural Selection" and the "Struggle for Existence." These terms invented by Darwin—but specially the latter—have become "household words." The history of his thoughts on the subject of the Origin of Species is given in the account of his books, written by himself and already referred to. His letter to Professor Asa Gray (September 5th, 1857) is a most valuable brief exposition of his theory and an admirable sample of his correspondence. The distinguished American botanist was one of his most constant correspondents and a dear personal friend.

I have also given as an extract the final pages of the 'Origin of Species,' in which Darwin eloquently defends the view of nature to which his theory leads. A similar and important passage on the subject of 'Creative Design' is also given: it is taken from that wonderful collection of facts and arguments published by Darwin under the title of 'The Variation of Plants and Animals under Domestication.' It cannot be too definitely stated, as Darwin himself insisted, that his theory of the Origin of Species is essentially an extension of the argument used by Lyell in his 'Principles of Geology.' Just as Lyell accounted for the huge masses of stratified rocks, the upheaved mountain chains, the deep valleys, and the shifting seas of the earth's surface, by adducing the long-continued cumulative action of causes which are at this present moment in operation and can be observed and measured at the present day: so Darwin demonstrates that natural variation, and consequent selection by "breeders" and "fanciers" at the present day, give rise to new forms of plants and animals; and that the cumulative, long-continued action of *Natural Selection* in the Struggle for Existence, or the survival of favorable variations, can and must have effected changes, the magnitude of which is only limited by the length of time during which the process has been going on.

The style of Darwin's writings is remarkable for the absence of all affectation, of all attempt at epigram, literary allusion, or rhetoric. In this it is admirably suited to its subject. At the same time there is no sacrifice of clearness to brevity, nor are technical terms used in place of ordinary language. The greatest pains are obviously given by the author to enable his reader to thoroughly understand the matter in hand. Further, the reader is treated not only with this courtesy of full explanation, but with extreme fairness and modesty. Darwin never slurs over a difficulty nor minimizes it. He

states objections and awkward facts prominently, and without shirking proceeds to deal with them by citation of experiment or observation carried out by him for the purpose. His modesty towards his reader is a delightful characteristic. He simply desires to persuade you as one reasonable friend may persuade another. He never thrusts a conclusion nor even a step towards a conclusion upon you, by a demand for your confidence in him as an authority, or by an unfair weighting of the arguments which he balances, or by a juggle of word-play. The consequence is that though Darwin himself thought he had no literary ability, and labored over and re-wrote his sentences, we have in his works a model of clear exposition of a great argument, and the most remarkable example of persuasive style in the English language—persuasive because of its transparent honesty and scrupulous moderation.

Darwin enjoyed rather better health in the last ten years of his life than before, and was able to work and write constantly. For some four months before his death, but not until then, it was evident that his heart was seriously diseased. He died on April 19th, 1882, at the age of seventy-three. Almost his last words were, "I am not the least afraid to die." In 1879 he added to the manuscript of his autobiography already referred to, these words:—"As for myself, I believe that I have acted rightly in steadily following and devoting my life to Science. I feel no remorse from having committed any great sin, but have often and often regretted that I have not done more direct good to my fellow-creatures."

From his early manhood to old age, the desire to do what was right determined the employment of his powers. He has done to his fellow-creatures an imperishable good, in leaving to them his writings and the example of his noble life.



IMPRESSIONS OF TRAVEL

From 'A Naturalist's Voyage'

AMONG the scenes which are deeply impressed on my mind, none exceed in sublimity the primeval forests undefaced by the hand of man; whether those of Brazil, where the powers of Life are predominant, or those of Tierra del Fuego, where Death and Decay prevail. Both are temples filled with the varied productions of the God of Nature; no one can stand in

these solitudes unmoved, and not feel that there is more in man than the mere breath of his body. In calling up images of the past, I find that the plains of Patagonia frequently cross before my eyes; yet these plains are pronounced by all wretched and useless. They can be described only by negative characters: without habitations, without water, without trees, without mountains, they support merely a few dwarf plants. Why then—and the case is not peculiar to myself—have these arid wastes taken so firm a hold on my memory? Why have not the still more level, the greener and more fertile pampas, which are serviceable to mankind, produced an equal impression? I can scarcely analyze these feelings; but it must be partly owing to the free scope given to the imagination. The plains of Patagonia are boundless, for they are scarcely passable, and hence unknown; they bear the stamp of having lasted, as they are now, for ages, and there appears no limit to their duration through future time. If, as the ancients supposed, the flat earth was surrounded by an impassable breadth of water, or by deserts heated to an intolerable excess, who would not look at these last boundaries to man's knowledge with deep but ill-defined sensations?

Lastly, of natural scenery, the views from lofty mountains, though certainly in one sense not beautiful, are very memorable. When looking down from the highest crest of the Cordillera, the mind, undisturbed by minute details, was filled with the stupendous dimensions of the surrounding masses.

Of individual objects, perhaps nothing is more certain to create astonishment than the first sight in his native haunt of a barbarian—of man in his lowest and most savage state. One's mind hurries back over past centuries, and then asks: Could our progenitors have been men like these? men whose very signs and expressions are less intelligible to us than those of the domesticated animals; men who do not possess the instinct of those animals, nor yet appear to boast of human reason, or at least of arts consequent on that reason. I do not believe it is possible to describe or paint the difference between savage and civilized man. It is the difference between a wild and tame animal; and part of the interest in beholding a savage is the same which would lead every one to desire to see the lion in his desert, the tiger tearing his prey in the jungle, or the rhinoceros wandering over the wild plains of Africa.

Among the other most remarkable spectacles which we have beheld may be ranked the Southern Cross, the cloud of Magellan, and the other constellations of the southern hemisphere—the water-spout—the glacier leading its blue stream of ice, overhanging the sea in a bold precipice—a lagoon island raised by the reef-building corals—an active volcano—and the overwhelming effects of a violent earthquake. These latter phenomena perhaps possess for me a peculiar interest, from their intimate connection with the geological structure of the world. The earthquake, however, must be to every one a most impressive event: the earth, considered from our earliest childhood as the type of solidity, has oscillated like a thin crust beneath our feet; and in seeing the labored works of man in a moment overthrown, we feel the insignificance of his boasted power.

It has been said that the love of the chase is an inherent delight in man—a relic of an instinctive passion. If so, I am sure the pleasure of living in the open air, with the sky for a roof and the ground for a table, is part of the same feeling; it is the savage returning to his wild and native habits. I always look back to our boat cruises and my land journeys, when through unfrequented countries, with an extreme delight, which no scenes of civilization could have created. I do not doubt that every traveler must remember the glowing sense of happiness which he experienced when he first breathed in a foreign clime, where the civilized man had seldom or never trod.

There are several other sources of enjoyment in a long voyage which are of a more reasonable nature. The map of the world ceases to be a blank; it becomes a picture full of the most varied and animated figures. Each part assumes its proper dimensions; continents are not looked at in the light of islands, or islands considered as mere specks, which are in truth larger than many kingdoms of Europe. Africa, or North and South America, are well-sounding names, and easily pronounced; but it is not until having sailed for weeks along small portions of their shores that one is thoroughly convinced what vast spaces on our immense world these names imply.

From seeing the present state, it is impossible not to look forward with high expectations to the future progress of nearly an entire hemisphere. The march of improvement consequent on the introduction of Christianity throughout the South Sea probably stands by itself in the records of history. It is the

more striking when we remember that only sixty years since, Cook, whose excellent judgment none will dispute, could foresee no prospect of a change. Yet these changes have now been effected by the philanthropic spirit of the British nation.

In the same quarter of the globe Australia is rising, or indeed may be said to have risen, into a grand centre of civilization, which at some not very remote period will rule as empress over the southern hemisphere. It is impossible for an Englishman to behold these distant colonies without a high pride and satisfaction. To hoist the British flag seems to draw with it, as a certain consequence, wealth, prosperity, and civilization.

In conclusion, it appears to me that nothing can be more improving to a young naturalist than a journey in distant countries. It both sharpens and partly allays that want and craving which, as Sir J. Herschel remarks, a man experiences although every corporeal sense be fully satisfied. The excitement from the novelty of objects, and the chance of success, stimulate him to increased activity. Moreover, as a number of isolated facts soon become uninteresting, the habit of comparison leads to generalization. On the other hand, as the traveler stays but a short time in each place, his descriptions must generally consist of mere sketches instead of detailed observations. Hence arises, as I have found to my cost, a constant tendency to fill up the wide gaps of knowledge by inaccurate and superficial hypotheses.

But I have too deeply enjoyed the voyage not to recommend any naturalist,—although he must not expect to be so fortunate in his companions as I have been,—to take all chances, and to start, on travels by land if possible, if otherwise on a long voyage. He may feel assured he will meet with no difficulties or dangers, excepting in rare cases, nearly so bad as he beforehand anticipates. In a moral point of view the effect ought to be to teach him good-humored patience, freedom from selfishness, the habit of acting for himself, and of making the best of every occurrence. In short, he ought to partake of the characteristic qualities of most sailors. Traveling ought also to teach him distrust; but at the same time he will discover how many truly kind-hearted people there are with whom he never before had, or ever again will have, any further communication, who yet are ready to offer him the most disinterested assistance.

THE GENESIS OF 'THE ORIGIN OF SPECIES'

From 'Life and Letters'

AFTER several fruitless searches in Surrey and elsewhere, we found this house and purchased it. I was pleased with the diversified appearance of vegetation proper to a chalk district, and so unlike what I had been accustomed to in the Midland counties; and still more pleased with the extreme quietness and rusticity of the place. It is not however quite so retired a place as a writer in a German periodical makes it, who says that my house can be approached only by a mule-track! Our fixing ourselves here has answered admirably in one way which we did not anticipate,—namely, by being very convenient for frequent visits from our children.

Few persons can have lived a more retired life than we have done. Besides short visits to the houses of relations, and occasionally to the seaside or elsewhere, we have gone nowhere. During the first part of our residence we went a little into society, and received a few friends here; but my health almost always suffered from the excitement, violent shivering and vomiting attacks being thus brought on. I have therefore been compelled for many years to give up all dinner parties; and this has been somewhat of a deprivation to me, as such parties always put me into high spirits. From the same cause I have been able to invite here very few scientific acquaintances. . . .

During the voyage of the *Beagle* I had been deeply impressed by discovering in the Pampean formation great fossil animals, covered with armor like that on the existing armadillos; secondly, by the manner in which closely allied animals replace one another in proceeding southwards over the Continent; and thirdly, by the South-American character of most of the productions of the Galapagos Archipelago, and more especially by the manner in which they differ slightly on each island of the group; none of the islands appearing to be very ancient in a geological sense.

It was evident that such facts as these, as well as many others, could only be explained on the supposition that species gradually become modified; and the subject haunted me. But it was equally evident that neither the action of the surrounding conditions, nor the will of the organisms (especially in the case of plants), could account for the innumerable cases in which

organisms of every kind are beautifully adapted to their habits of life; for instance, a woodpecker or a tree-frog to climb trees, or a seed for dispersal by hooks or plumes. I had always been much struck by such adaptations, and until these could be explained it seemed to me almost useless to endeavor to prove by indirect evidence that species have been modified.

After my return to England it appeared to me that by following the example of Lyell in *Geology*, and by collecting all facts which bore in any way on the variation of animals and plants under domestication and nature, some light might perhaps be thrown on the whole subject. My first note-book was opened in July 1837. I worked on true Baconian principles; and without any theory collected facts on a wholesale scale, more especially with respect to domesticated productions, by printed inquiries, by conversation with skillful breeders and gardeners, and by extensive reading. When I see the list of books of all kinds which I read and abstracted, including whole series of Journals and Transactions, I am surprised at my industry. I soon perceived that selection was the keystone of man's success in making useful races of animals and plants. But how selection could be applied to organisms living in a state of nature, remained for some time a mystery to me.

In October 1838—that is, fifteen months after I had begun my systematic inquiry—I happened to read for amusement 'Malthus on Population'; and being well prepared to appreciate the struggle for existence which everywhere goes on from long-continued observation of the habits of animals and plants, it at once struck me that under these circumstances favorable variations would tend to be preserved, and unfavorable ones to be destroyed. The result of this would be the formation of new species. Here then I had at last got a theory by which to work; but I was so anxious to avoid prejudice that I determined not for some time to write even the briefest sketch of it. In June 1842 I first allowed myself the satisfaction of writing a very brief abstract of my theory in pencil in thirty-five pages; and this was enlarged during the summer of 1844 into one of two hundred and thirty pages, which I had fairly copied out and still possess.

But at that time I overlooked one problem of great importance; and it is astonishing to me, except on the principle of Columbus and his egg, how I could have overlooked it and its

solution. This problem is the tendency in organic beings descended from the same stock to diverge in character as they become modified. That they have diverged greatly is obvious from the manner in which species of all kinds can be classed under genera, genera under families, families under sub-orders, and so forth: and I can remember the very spot in the road, whilst in my carriage, when to my joy the solution occurred to me; and this was long after I had come to Down. The solution, as I believe, is that the modified offspring of all dominant and increasing forms tend to become adapted to many and highly diversified places in the economy of nature.

Early in 1856 Lyell advised me to write out my views pretty fully, and I began at once to do so on a scale three or four times as extensive as that which was afterwards followed in my 'Origin of Species'; yet it was only an abstract of the materials which I had collected, and I got through about half the work on this scale. But my plans were overthrown, for early in the summer of 1858 Mr. Wallace, who was then in the Malay Archipelago, sent me an essay 'On the Tendency of Varieties to depart Indefinitely from the Original Type'; and this essay contained exactly the same theory as mine. Mr. Wallace expressed the wish that if I thought well of his essay, I should send it to Lyell for perusal.

The circumstances under which I consented, at the request of Lyell and Hooker, to allow of an abstract from my MS., together with a letter to Asa Gray dated September 5th 1857, to be published at the same time with Wallace's essay, are given in the 'Journal of the Proceedings of the Linnean Society,' 1858, page 45. I was at first very unwilling to consent, as I thought Mr. Wallace might consider my doing so unjustifiable, for I did not then know how generous and noble was his disposition. The extract from my MS. and the letter to Asa Gray had neither been intended for publication, and were badly written. Mr. Wallace's essay, on the other hand, was admirably expressed and quite clear. Nevertheless, our joint productions excited very little attention, and the only published notice of them which I can remember was by Professor Houghton of Dublin, whose verdict was that all that was new in them was false, and what was true was old. This shows how necessary it is that any new view should be explained at considerable length in order to arouse public attention. . . .

My habits are methodical, and this has been of not a little use for my particular line of work. Lastly, I have had ample leisure from not having to earn my own bread. Even ill health, though it has annihilated several years of my life, has saved me from the distractions of society and amusement.

Therefore my success as a man of science, whatever this may have amounted to, has been determined as far as I can judge by complex and diversified mental qualities and conditions. Of these, the most important have been the love of science, unbounded patience in long reflecting over any subject, industry in observing and collecting facts, and a fair share of invention as well as of common-sense. With such moderate abilities as I possess, it is truly surprising that I should have influenced to a considerable extent the belief of scientific men on some important points.

CURIOUS ATROPHY OF ÆSTHETIC TASTE

From 'Life and Letters'

THERE seems to be a sort of fatality in my mind, leading me to put at first my statement or proposition in a wrong or awkward form. Formerly I used to think about my sentences before writing them down; but for several years I have found that it saves time to scribble in a vile hand whole pages as quickly as I possibly can, contracting half the words; and then correct deliberately. Sentences thus scribbled down are often better ones than I could have written deliberately.

Having said thus much about my manner of writing, I will add that with my large books I spend a good deal of time over the general arrangement of the matter. I first make the rudest outline in two or three pages, and then a larger one in several pages, a few words or one word standing for a whole discussion or a series of facts. Each one of these headings is again enlarged and often transferred before I begin to write *in extenso*. As in several of my books facts observed by others have been very extensively used, and as I have always had several quite distinct subjects in hand at the same time, I may mention that I keep from thirty to forty large portfolios in cabinets with labeled shelves, into which I can at once put a detached reference or

memorandum. I have bought many books, and at their ends I make an index of all the facts that concern my work; or if the book is not my own, write out a separate abstract, and of such abstracts I have a large drawer full. Before beginning on any subject I look to all the short indexes and make a general and classified index, and by taking the one or more proper portfolios, I have all the information collected during my life ready for use.

I have said that in one respect my mind has changed during the last twenty or thirty years. Up to the age of thirty, or beyond it, poetry of many kinds, such as the works of Milton, Gray, Byron, Wordsworth, Coleridge, and Shelley, gave me great pleasure; and even as a schoolboy I took intense delight in Shakespeare, especially in the historical plays. I have also said that formerly pictures gave me considerable, and music very great delight. But now for many years I cannot endure to read a line of poetry: I have tried lately to read Shakespeare, and found it so intolerably dull that it nauseated me. I have also almost lost my taste for pictures or music. Music generally sets me thinking too energetically on what I have been at work on, instead of giving me pleasure. I retain some taste for fine scenery, but it does not cause me the exquisite delight which it formerly did. On the other hand, novels which are works of the imagination, though not of a very high order, have been for years a wonderful relief and pleasure to me, and I often bless all novelists. A surprising number have been read aloud to me, and I like all if moderately good, and if they do not end unhappily—against which a law ought to be passed. A novel, according to my taste, does not come into the first class unless it contains some person whom one can thoroughly love, and if a pretty woman, all the better.

This curious and lamentable loss of the higher æsthetic tastes is all the odder, as books on history, biographies, and travels (independently of any scientific facts which they may contain), and essays on all sorts of subjects, interest me as much as ever they did. My mind seems to have become a kind of machine for grinding general laws out of large collections of facts; but why this should have caused the atrophy of that part of the brain alone on which the higher tastes depend, I cannot conceive. A man with a mind more highly organized or better constituted than mine would not, I suppose, have thus suffered:

and if I had to live my life again, I would have made a rule to read some poetry and listen to some music at least once every week; for perhaps the parts of my brain now atrophied would thus have been kept active through use. The loss of these tastes is a loss of happiness, and may possibly be injurious to the intellect, and more probably to the moral character, by enfeebling the emotional part of our nature.

PRIVATE MEMORANDUM CONCERNING HIS LITTLE DAUGHTER

From 'Life and Letters'

OUR poor child Annie was born in Gower Street on March 2d, 1841, and expired at Malvern at midday on the 23d of April, 1851.

I write these few pages, as I think in after years, if we live, the impressions now put down will recall more vividly her chief characteristics. From whatever point I look back at her, the main feature in her disposition which at once rises before me is her buoyant joyousness, tempered by two other characteristics; namely, her sensitiveness, which might easily have been overlooked by a stranger, and her strong affection. Her joyousness and animal spirits radiated from her whole countenance, and rendered every movement elastic and full of life and vigor. It was delightful and cheerful to behold her. Her dear face now rises before me, as she used sometimes to come running down-stairs with a stolen pinch of snuff for me, her whole form radiant with the pleasure of giving pleasure. Even when playing with her cousins, when her joyousness almost passed into boisterousness, a single glance of my eye, not of displeasure (for I thank God I hardly ever cast one on her), but of want of sympathy, would for some minutes alter her whole countenance.

The other point in her character, which made her joyousness and spirits so delightful, was her strong affection, which was of a most clinging, fondling nature. When quite a baby this showed itself in never being easy without touching her mother when in bed with her; and quite lately she would, when poorly, fondle for any length of time one of her mother's arms. When very unwell, her mother lying down beside her seemed to soothe her in a manner quite different from what it would have

done to any of our other children. So again she would at almost any time spend half an hour in arranging my hair, "making it," as she called it, "beautiful," or in smoothing, the poor dear darling! my collar or cuffs—in short, in fondling me.

Besides her joyousness thus tempered, she was in her manners remarkably cordial, frank, open, straightforward, natural, and without any shade of reserve. Her whole mind was pure and transparent. One felt one knew her thoroughly and could trust her. I always thought that come what might, we should have had in our old age at least one loving soul which nothing could have changed. All her movements were vigorous, active, and usually graceful. When going round the Sand-walk with me, although I walked fast, yet she often used to go before, pirouetting in the most elegant way, her dear face bright all the time with the sweetest smiles. Occasionally she had a pretty coquettish manner towards me, the memory of which is charming. She often used exaggerated language, and when I quizzed her by exaggerating what she had said, how clearly can I now see the little toss of the head, and exclamation of "Oh, papa, what a shame of you!" In the last short illness, her conduct in simple truth was angelic. She never once complained; never became fretful; was ever considerate of others, and was thankful in the most gentle, pathetic manner for everything done for her. When so exhausted that she could hardly speak, she praised everything that was given her, and said some tea "was beautifully good." When I gave her some water she said, "I quite thank you;" and these I believe were the last precious words ever addressed by her dear lips to me.

We have lost the joy of the household and the solace of our old age. She must have known how we loved her. Oh that she could now know how deeply, how tenderly, we do still and shall ever love her dear joyous face! Blessings on her!

April 30th, 1851.

RELIGIOUS VIEWS

From 'Life and Letters'

I AM much engaged, an old man, and out of health, and I cannot spare time to answer your questions fully,—nor indeed can they be answered. Science has nothing to do with Christ, except in so far as the habit of scientific research makes a man cautious in admitting evidence. For myself, I do not believe that there ever has been any revelation. As for a future life, every man must judge for himself between conflicting vague probabilities. . . .

During these two years [October 1836 to January 1839] I was led to think much about religion.

Whilst on board the *Beagle* I was quite orthodox, and I remember being heartily laughed at by several of the officers (though themselves orthodox) for quoting the Bible as an unanswerable authority on some point of morality. I suppose it was the novelty of the argument that amused them. But I had gradually come by this time—*i. e.*, 1836 to 1839—to see that the Old Testament was no more to be trusted than the sacred books of the Hindoos. The question then continually rose before my mind and would not be banished,—is it credible that if God were now to make a revelation to the Hindoos, he would permit it to be connected with the belief in Vishnu, Siva, etc., as Christianity is connected with the Old Testament? This appeared to me utterly incredible.

By further reflecting that the clearest evidence would be requisite to make any sane man believe in the miracles by which Christianity is supported,—and that the more we know of the fixed laws of nature the more incredible do miracles become,—that the men at that time were ignorant and credulous to a degree almost incomprehensible by us,—that the Gospels cannot be proved to have been written simultaneously with the events,—that they differ in many important details, far too important, as it seemed to me, to be admitted as the usual inaccuracies of eye-witnesses;—by such reflections as these, which I give not as having the least novelty or value, but as they influenced me,—I gradually came to disbelieve in Christianity as a divine revelation. The fact that many false religions have spread over large portions of the earth like wild-fire had some weight with me.

But I was very unwilling to give up my belief; I feel sure of this, for I can well remember often and often inventing day-dreams of old letters between distinguished Romans, and manuscripts being discovered at Pompeii or elsewhere, which confirmed in the most striking manner all that was written in the Gospels. But I found it more and more difficult, with free scope given to my imagination, to invent evidence which would suffice to convince me. Thus disbelief crept over me at a very slow rate, but was at last complete. The rate was so slow that I felt no distress.

Although I did not think much about the existence of a personal God until a considerably later period of my life, I will here give the vague conclusions to which I have been driven. The old argument from design in Nature, as given by Paley, which formerly seemed to me so conclusive, fails, now that the law of natural selection has been discovered. We can no longer argue that for instance the beautiful hinge of a bivalve shell must have been made by an intelligent being, like the hinge of a door by man. There seems to be no more design in the variability of organic beings, and in the action of natural selection, than in the course which the wind blows. But I have discussed this subject at the end of my book on the 'Variations of Domesticated Animals and Plants'; and the argument there given has never, as far as I can see, been answered.

But passing over the endless beautiful adaptations which we everywhere meet with, it may be asked, How can the generally beneficent arrangement of the world be accounted for? Some writers indeed are so much impressed with the amount of suffering in the world, that they doubt, if we look to all sentient beings, whether there is more of misery or of happiness; whether the world as a whole is a good or bad one. According to my judgment happiness decidedly prevails, though this would be very difficult to prove. If the truth of this conclusion be granted, it harmonizes well with the effects which we might expect from natural selection. If all the individuals of any species were habitually to suffer to an extreme degree, they would neglect to propagate their kind; but we have no reason to believe that this has ever, or at least often, occurred. Some other considerations moreover lead to the belief that all sentient beings have been formed so as to enjoy, as a general rule, happiness.

Every one who believes as I do, that all the corporeal and mental organs (excepting those which are neither advantageous nor disadvantageous to the possessor) of all beings have been developed through natural selection, or the survival of the fittest, together with use or habit, will admit that these organs have been formed so that their possessors may compete successfully with other beings, and thus increase in number. Now an animal may be led to pursue that course of action which is most beneficial to the species by suffering, such as pain, hunger, thirst, and fear; or by pleasure, as in eating and drinking, and in the propagation of the species, etc.; or by both means combined, as in the search for food. But pain or suffering of any kind, if long continued, causes depression and lessens the power of action, yet is well adapted to make a creature guard itself against any great or sudden evil. Pleasurable sensations, on the other hand, may be long continued without any depressing effect; on the contrary, they stimulate the whole system to increased action. Hence it has come to pass that most or all sentient beings have been developed in such a manner, through natural selection, that pleasurable sensations serve as their habitual guides. We see this in the pleasure from exertion, even occasionally from great exertion of the body or mind,—in the pleasure of our daily meals, and especially in the pleasure derived from sociability, and from loving our families. The sum of such pleasures as these, which are habitual or frequently recurrent, give, as I can hardly doubt, to most sentient beings an excess of happiness over misery, although many occasionally suffer much. Such suffering is quite compatible with the belief in natural selection, which is not perfect in its action, but tends only to render each species as successful as possible in the battle for life with other species, in wonderfully complex and changing circumstances.

That there is much suffering in the world, no one disputes. Some have attempted to explain this with reference to man by imagining that it serves for his moral improvement. But the number of men in the world is as nothing compared with that of all other sentient beings, and they often suffer greatly without any moral improvement. This very old argument from the existence of suffering against the existence of an intelligent First Cause seems to me a strong one; whereas, as just remarked, the presence of much suffering agrees well with the view that

all organic beings have been developed through variation and natural selection.

At the present day, the most usual argument for the existence of an intelligent God is drawn from the deep inward conviction and feelings which are experienced by most persons.

Formerly I was led by feelings such as those just referred to (although I do not think that the religious sentiment was ever strongly developed in me), to the firm conviction of the existence of God and of the immortality of the soul. In my Journal I wrote that whilst standing in the midst of the grandeur of a Brazilian forest, "it is not possible to give an adequate idea of the higher feelings of wonder, admiration, and devotion, which fill and elevate the mind." I well remember my conviction that there is more in man than the mere breath of his body. But now the grandest scenes would not cause any such convictions and feelings to rise in my mind. It may be truly said that I am like a man who has become color-blind, and the universal belief by men of the existence of redness makes my present loss of perception of not the least value as evidence. This argument would be a valid one if all men of all races had the same inward conviction of the existence of one God; but we know that this is very far from being the case. Therefore I cannot see that such inward convictions and feelings are of any weight as evidence of what really exists. The state of mind which grand scenes formerly excited in me, and which was intimately connected with a belief in God, did not essentially differ from that which is often called the sense of sublimity; and however difficult it may be to explain the genesis of this sense, it can hardly be advanced as an argument for the existence of God, any more than the powerful though vague and similar feelings excited by music.

With respect to immortality, nothing shows me [so clearly] how strong and almost instinctive a belief it is, as the consideration of the view now held by most physicists, namely, that the sun with all the planets will in time grow too cold for life, unless indeed some great body dashes into the sun, and thus gives it fresh life. Believing as I do that man in the distant future will be a far more perfect creature than he now is, it is an intolerable thought that he and all other sentient beings are doomed to complete annihilation after such long-continued slow progress. To those who fully admit the immortality of

the human soul, the destruction of our world will not appear so dreadful.

Another source of conviction in the existence of God, connected with the reason, and not with the feelings, impresses me as having much more weight. This follows from the extreme difficulty or rather impossibility of conceiving this immense and wonderful universe, including man, with his capacity of looking far backward and far into futurity, as the result of blind chance or necessity. When thus reflecting I feel compelled to look to a First Cause, having an intelligent mind in some degree analogous to that of man; and I deserve to be called a Theist. This conclusion was strong in my mind about the time, as far as I can remember, when I wrote the 'Origin of Species'; and it is since that time that it has very gradually, with many fluctuations, become weaker. But then arises the doubt: Can the mind of man, which has, as I fully believe, been developed from a mind as low as that possessed by the lowest animals, be trusted when it draws such grand conclusions?

I cannot pretend to throw the least light on such abstruse problems. The mystery of the beginning of all things is insoluble by us; and I for one must be content to remain an Agnostic.

C. DARWIN TO MISS JULIA WEDGWOOD: ON DESIGN

From 'Life and Letters'

JULY 11th [1861].

SOME one has sent us 'Macmillan,' and I must tell you how much I admire your article; though at the same time I must confess that I could not clearly follow you in some parts, which probably is in main part due to my not being at all accustomed to metaphysical trains of thought. I think that you understand my book perfectly, and that I find a very rare event with my critics. The ideas in the last page have several times vaguely crossed my mind. Owing to several correspondents I have been led lately to think, or rather to try to think, over some of the chief points discussed by you. But the result has been with me a maze—something like thinking on the origin of evil, to which you allude. The mind refuses to look at this universe, being what it is, without having been designed; yet

where one would most expect design,—viz., in the structure of a sentient being,—the more I think on the subject, the less I can see proof of design. Asa Gray and some others look at each variation, or at least at each beneficial variation (which A. Gray would compare with the rain-drops which do not fall on the sea, but on to the land to fertilize it), as having been providentially designed. Yet when I asked him whether he looks at each variation in the rock-pigeon, by which man has made by accumulation a pouter or fantail pigeon, as providentially designed for man's amusement, he does not know what to answer; and if he or any one admits [that] these variations are accidental, as far as purpose is concerned (of course not accidental as to their cause or origin), then I can see no reason why he should rank the accumulated variations by which the beautifully adapted woodpecker has been formed, as providentially designed. For it would be easy to imagine the enlarged crop of the pouter, or tail of the fantail, as of some use to birds in a state of nature, having peculiar habits of life. These are the considerations which perplex me about design; but whether you will care to hear them, I know not. . . .

[On the subject of design, he wrote (July 1860) to Dr. Gray:—]

One word more on "designed laws" and "undesigned results." I see a bird which I want for food, take my gun and kill it; I do this *designedly*. An innocent and good man stands under a tree and is killed by a flash of lightning. Do you believe (and I really should like to hear) that God *designedly* killed this man? Many or most persons do believe this; I can't and don't. If you believe so, do you believe that when a swallow snaps up a gnat, that God designed that that particular swallow should snap up that particular gnat at that particular instant? I believe that the man and the gnat are in the same predicament. If the death of neither man nor gnat is designed, I see no good reason to believe that their *first* birth or production should be necessarily designed.

CORRESPONDENCE

From 'The Life and Letters'

C. DARWIN TO J. D. HOOKER

DOWN, February 24th [1863].

My Dear Hooker:

I AM astonished at your note. I have not seen the Athenæum, but I have sent for it, and may get it to-morrow; and will then say what I think.

I have read Lyell's book ['The Antiquity of Man']. The whole certainly struck me as a compilation, but of the highest class; for when possible the facts have been verified on the spot, making it almost an original work. The Glacial chapters seem to me best, and in parts magnificent. I could hardly judge about Man, as all the gloss of novelty was completely worn off. But certainly the aggregation of the evidence produced a very striking effect on my mind. The chapter comparing language and changes of species seems most ingenious and interesting. He has shown great skill in picking out salient points in the argument for change of species; but I am deeply disappointed (I do not mean personally) to find that his timidity prevents him giving any judgment. . . . From all my communications with him, I must ever think that he has really entirely lost faith in the immutability of species; and yet one of his strongest sentences is nearly as follows: "If it should *ever* be rendered highly probable that species change by variation and natural selection," etc., etc. I had hoped he would have guided the public as far as his own belief went. . . . One thing does please me on this subject, that he seems to appreciate your work. No doubt the public or a part may be induced to think that as he gives to us a larger space than to Lamarck, he must think there is something in our views. When reading the brain chapter, it struck me forcibly that if he had said openly that he believed in change of species, and as a consequence that man was derived from some quadrumanous animal, it would have been very proper to have discussed by compilation the differences in the most important organ, viz., the brain. As it is, the chapter seems to me to come in rather by the head and shoulders. I do not think (but then I am as prejudiced as Falconer and Huxley, or more so) that it is too

severe. It struck me as given with judicial force. It might perhaps be said with truth that he had no business to judge on a subject on which he knows nothing; but compilers must do this to a certain extent. (You know I value and rank high compilers, being one myself.) I have taken you at your word, and scribbled at great length. If I get the *Athenæum* to-morrow, I will add my impression of Owen's letter. . . .

The Lyells are coming here on Sunday evening to stay till Wednesday. I dread it, but I must say how much disappointed I am that he has not spoken out on species, still less on man. And the best of the joke is that he thinks he has acted with the courage of a martyr of old. I hope I may have taken an exaggerated view of his timidity, and shall *particularly* be glad of your opinion on this head. When I got his book I turned over the pages, and saw he had discussed the subject of species, and said that I thought he would do more to convert the public than all of us; and now (which makes the case worse for me) I must, in common honesty, retract. I wish to Heaven he had said not a word on the subject.

WEDNESDAY MORNING.—I have read the *Athenæum*. I do not think Lyell will be nearly so much annoyed as you expect. The concluding sentence is no doubt very stinging. No one but a good anatomist could unravel Owen's letter; at least it is quite beyond me. . . .

Lyell's memory plays him false when he says all anatomists were astonished at Owen's paper: it was often quoted with approbation. I *well* remember Lyell's admiration at this new classification! (Do not repeat this.) I remember it because, though I knew nothing whatever about the brain, I felt a conviction that a classification thus founded on a single character would break down, and it seemed to me a great error not to separate more completely the Marsupialia. . . .

What an accursed evil it is that there should be all this quarreling, within what ought to be the peaceful realms of science.

I will go to my own present subject of inheritance and forget it all for a time. Farewell, my dear old friend.

C. DARWIN.

C. DARWIN TO T. H. HUXLEY

OCTOBER 3d, 1864.

My Dear Huxley:

IF I do not pour out my admiration of your article on Kölliker, I shall explode. I never read anything better done. I had much wished his article answered, and indeed thought of doing so myself, so that I considered several points. You have hit on all, and on some in addition, and oh, by Jove, how well you have done it! As I read on and came to point after point on which I had thought, I could not help jeering and scoffing at myself, to see how infinitely better you had done it than I could have done. Well, if any one who does not understand Natural Selection will read this, he will be a blockhead if it is not as clear as daylight. Old Flourens was hardly worth the powder and shot; but how capitally you bring in about the Academician, and your metaphor of the sea-sand is *inimitable*.

It is a marvel to me how you can resist becoming a regular reviewer. Well, I have exploded now, and it has done me a deal of good.

C. DARWIN TO E. RAY LANKESTER

DOWN, March 15th [1870].

My Dear Sir:

I do not know whether you will consider me a very troublesome man, but I have just finished your book, and cannot resist telling you how the whole has much interested me. No doubt, as you say, there must be much speculation on such a subject, and certain results cannot be reached; but all your views are highly suggestive, and to my mind that is high praise. I have been all the more interested, as I am now writing on closely allied though not quite identical points. I was pleased to see you refer to my much despised child, 'Pangensis,' who I think will some day, under some better nurse, turn out a fine stripling. It has also pleased me to see how thoroughly you appreciate (and I do not think that this is general with the men of science) H. Spencer; I suspect that hereafter he will be looked at as by far the greatest living philosopher in England; perhaps equal to any that have

lived. But I have no business to trouble you with my notions. With sincere thanks for the interest which your work has given me,

I remain, yours very faithfully,

CH. DARWIN.

FROM A LETTER TO J. D. HOOKER

CLIFF COTTAGE, BOURNEMOUTH, September 26th, 1862.

My Dear Hooker:

Do NOT read this till you have leisure. If that blessed moment ever comes, I should be very glad to have your opinion on the subject of this letter. I am led to the opinion that *Drosera* must have diffused matter in organic connection, closely analogous to the nervous matter of animals. When the glans of one of the papillæ or tentacles in its natural position is supplied with nitrogenized fluid and certain other stimulants, or when loaded with an extremely slight weight, or when struck several times with a needle, the pedicel bends near its base in under one minute. These varied stimulants are conveyed down the pedicel by some means; it cannot be vibration, for drops of fluid put on quite quietly cause the movement; it cannot be absorption of the fluid from cell to cell, for I can see the rate of absorption, which, though quick, is far slower, and in *Dionæa* the transmission is instantaneous; analogy from animals would point to transmission through nervous matter. Reflecting on the rapid power of absorption in the glans, the extreme sensibility of the whole organ, and the conspicuous movement caused by varied stimulants, I have tried a number of substances which are not caustic or corrosive, . . . but most of which are known to have a remarkable action on the nervous matter of animals. You will see the results in the inclosed paper. As the nervous matter of different animals is differently acted on by the same poisons, one would not expect the same action on plants and animals; only, if plants have diffused nervous matter, some degree of analogous action. And this is partially the case. Considering these experiments, together with the previously made remarks on the functions of the parts, I cannot avoid the conclusion that *Drosera* possesses matter at least in some degree analogous in constitution and function to nervous matter. Now do tell me what you think, as far as you can judge from my abstract. Of course many more experiments would have to be

tried; but in former years I tried on the whole leaf, instead of on separate glands, a number of innocuous substances, such as sugar, gum, starch, etc., and they produced no effect. Your opinion will aid me in deciding some future year in going on with this subject. I should not have thought it worth attempting, but I had nothing on earth to do.

My dear Hooker, yours very sincerely,

CH. DARWIN.

P. S. — We return home on Monday 28th. Thank Heaven!

THE STRUGGLE FOR EXISTENCE

From the 'Origin of Species'

BEFORE entering on the subject of this chapter, I must make a few preliminary remarks, to show how the struggle for existence bears on Natural Selection. It has been seen in the last chapter that amongst organic beings in a state of nature there is some individual variability; indeed, I am not aware that this has ever been disputed. It is immaterial for us whether a multitude of doubtful forms be called species, or sub-species, or varieties; what rank, for instance, the two or three hundred doubtful forms of British plants are entitled to hold, if the existence of any well-marked varieties be admitted. But the mere existence of individual variability and of some few well-marked varieties, though necessary as the foundation for the work, helps us but little in understanding how species arise in nature. How have all those exquisite adaptations of one part of the organization to another part, and to the conditions of life, and of one organic being to another being, been perfected? We see these beautiful co-adaptations most plainly in the woodpecker and the mistletoe; and only a little less plainly in the humblest parasite which clings to the hairs of a quadruped or feathers of a bird; in the structure of the beetle which dives through the water; in the plumed seed which is wafted by the gentlest breeze: in short, we see beautiful adaptations everywhere and in every part of the organic world.

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 genera, and which differ from each other more than do the species of the same genus, arise? All these results, as we shall more fully see in the next chapter, follow from the struggle for life. Owing to this struggle, variations, however slight and from whatever cause proceeding, if they be in any degree profitable to the individuals of a species, in their infinitely complex relations to other organic beings and to their physical conditions of life, will tend to the preservation of such individuals, and will generally be inherited by the offspring. The offspring also will thus have a better chance of surviving; for of the many individuals of any species which are periodically born, but a small number can survive. I have called this principle, by which each slight variation, if useful, is preserved, by the term Natural Selection, in order to mark its relation to man's power of selection. But the expression often used by Mr. Herbert Spencer, of the Survival of the Fittest, is more accurate and is sometimes equally convenient. We have seen that man by selection can certainly produce great results, and can adapt organic beings to his own uses, through the accumulation of slight but useful variations given to him by the hand of Nature. But Natural Selection, as we shall hereafter see, is a power incessantly ready for action, and is as immeasurably superior to man's feeble efforts as the works of Nature are to those of Art.

We will now discuss in a little more detail the struggle for existence. In my future work this subject will be treated, as it well deserves, at greater length. The elder De Candolle and Lyell have largely and philosophically shown that all organic beings are exposed to severe competition. In regard to plants, no one has treated this subject with more spirit and ability than W. Herbert, Dean of Manchester, evidently the result of his great horticultural knowledge. Nothing is easier than to admit in words the truth of the universal struggle for life, or more difficult—at least I have found it so—than constantly to bear this conclusion in mind. Yet unless it be thoroughly ingrained in the mind, the whole economy of nature, with every fact on distribution, rarity, abundance, extinction, and variation, will be dimly seen or quite misunderstood. We behold the face of nature bright with gladness, we often see superabundance of food; we do not see, or we forget, that the birds which are idly

singing round us mostly live on insects or seeds, and are thus constantly destroying life; or we forget how largely these songsters, or their eggs, or their nestlings, are destroyed by birds and beasts of prey; we do not always bear in mind that though food may be now superabundant, it is not so at all seasons of each recurring year.

I should premise that I use this term in a large and metaphorical sense, including dependence of one being on another, and including (which is more important) not only the life of the individual, but success in leaving progeny. Two canine animals, in a time of dearth, may be truly said to struggle with each other which shall get food and live. But a plant on the edge of a desert is said to struggle for life against the drought, though more properly it should be said to be dependent on the moisture. A plant which annually produces a thousand seeds, of which only one on an average comes to maturity, may be more truly said to struggle with the plants of the same and other kinds which already clothe the ground. The mistletoe is dependent on the apple and a few other trees, but can only in a far-fetched sense be said to struggle with these trees, for if too many of these parasites grow on the same tree, it languishes and dies. But several seedling mistletoes, growing close together on the same branch, may more truly be said to struggle with each other. As the mistletoe is disseminated by birds, its existence depends on them; and it may metaphorically be said to struggle with other fruit-bearing plants, in tempting the birds to devour and thus disseminate its seeds. In these several senses, which pass into each other, I use for convenience's sake the general term of Struggle for Existence.

THE GEOMETRICAL RATIO OF INCREASE

From 'Origin of Species'

A STRUGGLE for existence inevitably follows from the high rate at which all organic beings tend to increase. Every being which during its natural lifetime produces several eggs or seeds must suffer destruction during some period of its life, and during some season or occasional year; otherwise, on the principle of geometrical increase, its numbers would quickly become

so inordinately great that no country could support the product. Hence, as more individuals are produced than can possibly survive, there must in every case be a struggle for existence, either one individual with another of the same species, or with the individuals of distinct species, or with the physical conditions of life. It is the doctrine of Malthus applied with manifold force to the whole animal and vegetable kingdoms; for in this case there can be no artificial increase of food, and no prudential restraint from marriage. Although some species may be now increasing, more or less rapidly, in numbers, all cannot do so, for the world would not hold them.

There is no exception to the rule that every organic being naturally increases at so high a rate that if not destroyed, the earth would soon be covered by the progeny of a single pair. Even slow-breeding man has doubled in twenty-five years; and at this rate, in less than a thousand years there would literally not be standing-room for his progeny. Linnæus has calculated that if an annual plant produced only two seeds—and there is no plant so unproductive as this—and their seedlings next year produced two, and so on, then in twenty years there would be a million plants. The elephant is reckoned the slowest breeder of all known animals, and I have taken some pains to estimate its probable minimum rate of natural increase; it will be safest to assume that it begins breeding when thirty years old: and goes on breeding till ninety years old, bringing forth six young in the interval, and surviving till one hundred years old: if this be so, after a period of from 740 to 750 years there would be nearly nineteen million elephants alive, descended from the first pair.

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 of nature, when circumstances have been favorable to them during two or three 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 Falconer, from Cape Comorin 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 favorable, 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.

In a state of nature almost every full-grown plant annually produces seed, and amongst animals there are very few which do not annually pair. Hence we may confidently assert that all plants and animals are tending to increase at a geometrical ratio,—that all would rapidly stock every station in which they could anyhow exist,—and that this geometrical tendency to increase must be checked by destruction at some period of life. Our familiarity with the larger domestic animals tends, I think, to mislead us: we see no great destruction falling on them, but we do not keep in mind that thousands are annually slaughtered for food, and that in a state of nature an equal number would have somehow to be disposed of.

The only difference between organisms which annually produce eggs or seeds by the thousand, and those which produce extremely few, is that the slow breeders would require a few more years to people, under favorable conditions, a whole district, let it be ever so large. The condor lays a couple of eggs and the ostrich a score, and yet in the same country the condor may be the more numerous of the two; the Fulmar petrel lays but one egg, yet it is believed to be the most numerous bird in the world. One fly deposits hundreds of eggs, and another, like the hippobosca, a single one; but this difference does not determine how many individuals of the two species can be supported in a district. A large number of eggs is of some importance to those species which depend on a fluctuating amount of food, for

it allows them rapidly to increase in number. But the real importance of a large number of eggs or seeds is to make up for much destruction at some period of life; and this period in the great majority of cases is an early one. If an animal can in any way protect its own eggs or young, a small number may be produced, and yet the average stock be fully kept up; but if many eggs or young are destroyed, many must be produced, or the species will become extinct. It would suffice to keep up the full number of a tree which lived on an average for a thousand years, if a single seed were produced once in a thousand years, supposing that this seed were never destroyed, and could be insured to germinate in a fitting place. So that, in all cases, the average number of any animal or plant depends only indirectly on the number of its eggs or seeds.

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

OF THE NATURE OF THE CHECKS TO INCREASE

From 'The Origin of Species'

THE causes which check the natural tendency of each species to increase are most obscure. Look at the most vigorous species: by as much as it swarms in numbers, by so much will it tend to increase still further. We know not exactly what the checks are, even in a single instance. Nor will this surprise any one who reflects how ignorant we are on this head, even in regard to mankind, although so incomparably better known than any other animal. This subject of the checks to increase has been ably treated by several authors, and I hope in a future work to discuss it at considerable length, more especially in regard to the feral animals of South America. Here I will make only a few remarks, just to recall to the reader's mind some

of the chief points. Eggs or very young animals seem generally to suffer most, but this is not invariably the 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 with other plants. Seedlings also are destroyed in vast numbers by various enemies: for instance, on a piece of ground three feet long and two wide, dug and cleared, and where there could be no choking from other plants, I marked all the seedlings of our native weeds as they came up, and out of 357 no less than 295 were destroyed, chiefly by slugs and insects. If turf which has long been mown—and the case would be the same with turf closely browsed by quadrupeds—be let to grow, the more vigorous plants gradually kill the less vigorous though fully grown plants; thus out of twenty species growing on a little plot of mown turf (three feet by four) nine species perished, from the other species being allowed to grow up freely.

The amount of food for each species of course gives the extreme limit to which each can increase; but very frequently it is not the obtaining food, but the serving as prey to other animals, which determines the average numbers of a species. Thus there seems to be little doubt that the stock of partridges, grouse, and hares in any large estate depends chiefly on the destruction of vermin. If not one head of game were shot during the next twenty years in England, and at the same time if no vermin were destroyed, there would in all probability be less game than at present, although hundreds of thousands of game animals are now annually shot. On the other hand, in some cases, as with the elephant, none are destroyed by beasts of prey; for even the tiger in India most rarely dares to attack a young elephant protected by its dam.

Climate plays an important part in determining the average numbers of a species, and periodical seasons of extreme cold or 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 sight to be quite independent of the struggle for existence; but in so far as climate chiefly acts in reducing food, it brings

on the most 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 got 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 conspicuous, 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 degree favored by any slight change of climate, they will increase 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 favored 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 northward; hence in going northward, 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 southward or in descending a mountain. When we reach the arctic regions, or snow-capped summits, or absolute deserts, the struggle for life is almost exclusively with the elements.

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

When a species, owing to highly favorable circumstances, increases inordinately in numbers in a small tract, epidemics—at least, this seems generally to occur with our game animals—often ensue; and here we have a limiting check independent of the struggle for life. But even some of these so-called epidemics appear to be due to parasitic worms, which have from some cause, possibly in part through facility of diffusion amongst the

crowded animals, been disproportionally favored: and here comes in a sort of struggle between the parasite and its prey.

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, etc., in our fields, because the seeds are in great excess compared with the number of birds which feed on them; nor can the birds, though having a superabundance of food at this one season, increase in number proportionally to the supply of seed, as their numbers are checked during winter; but any one who has tried, knows how troublesome it is to get seed from a few wheat or other such plants in a garden: I have in this case lost every single seed. This view of the necessity of a large stock of the same species for its preservation, explains I believe 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 verge of their range. For in such cases, we may believe that a plant could exist only where the conditions of its life were so favorable that many could exist together and thus save the species from utter destruction. I should add that the good effects of inter-crossing, and the ill effects of close inter-breeding, no doubt come into play in many of these cases; but I will not here enlarge on this subject.

THE COMPLEX RELATIONS OF ALL ANIMALS AND PLANTS
TO EACH OTHER IN THE STRUGGLE FOR EXISTENCE

From the 'Origin of Species'

MANY cases are on record, showing how complex and unexpected are the checks and relations between organic beings which have to struggle together in the same country. I will give only a single instance, which though a simple one interested me. In Staffordshire, on the estate of a relation where I had ample means of investigation, there was a large and extremely barren heath which had never been touched by the hand of man; but several hundred acres of exactly the same nature had been inclosed twenty-five years previously

and planted with Scotch fir. The change in the native vegetation of the planted part of the heath was most remarkable, more than is generally seen in passing from one quite different soil to another: not only the proportional numbers of the heath-plants were wholly changed, but twelve species of plants (not counting 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 inclosed so that cattle could not enter.

But how important an element inclosure is, I plainly saw near Farnham in Surrey. Here there are extensive heaths with a few clumps of old Scotch firs on the distant hill-tops: within the last ten years large spaces have been inclosed, 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, whence I could examine hundreds of acres of the uninclosed heath, and literally I could not see a single Scotch fir except the old planted clumps. But on looking closely between the stems of the heath, I found a multitude of seedlings and little trees which had been perpetually browsed down by the cattle. In one square yard, at a point some hundred yards distant from one of the old clumps, I counted thirty-two little trees; and one of them, with twenty-six 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 inclosed 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 cattle absolutely determine the existence of the Scotch fir; but in several parts of the world insects determine the existence of cattle. Perhaps Paraguay offers the most curious instance of this; for here neither cattle nor horses nor dogs have ever run wild, though they swarm southward and

northward in a feral state; and Azara and Rengger have shown that this is caused by the greater number in Paraguay of a certain fly, which lays its eggs in the navels of these animals when first born. The increase of these flies, numerous as they are, must be habitually checked by some means, probably by other parasitic insects. Hence if certain insectivorous birds were to decrease in Paraguay, the parasitic insects would probably increase; and this would lessen the number of the navel-frequenting flies; then cattle and horses would become feral, and this would certainly greatly alter (as indeed I have observed in parts of South America) the vegetation; this again would largely affect the insects; and this, as we have just seen in Staffordshire, the insectivorous birds,—and so onwards in ever increasing circles of complexity. Not that under nature the relations will ever be as simple as this. Battle within battle must be continually recurring with varying success; and yet in the long run the forces are so nicely balanced that the face of nature remains for long periods of time uniform, though assuredly the merest trifle would give the victory to one organic being over another. Nevertheless, so profound is our ignorance and so high our presumption, that we marvel when we hear of the extinction of an organic being; and as we do not see the cause, we invoke cataclysms to desolate the world, or invent laws on the duration of the forms of life!

OF NATURAL SELECTION; OR THE SURVIVAL OF THE FITTEST

From the 'Origin of Species'

SEVERAL writers have misapprehended or objected to the term Natural Selection. Some have even imagined that Natural Selection induces variability, whereas it implies only the preservation of such 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 selection implies conscious choice in the animals which become 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 said that I speak of Natural Selection as an active power or Deity; but who objects to an author speaking of the attraction of gravity as ruling the movements of the planets? Every one knows what 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 the aggregate action and product of many natural laws, and by laws the sequence of events as ascertained by us. With a little familiarity such superficial objections will be forgotten.

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 inhabitants will almost immediately undergo a change, and some species will probably become extinct. We may conclude, from what we have seen of the intimate and complex manner in which the inhabitants of each country are bound together, that any change in the numerical proportions of the inhabitants, independently of the change of climate itself, would seriously affect the others. If the country were open on its borders, new forms would certainly immigrate, and this would likewise seriously disturb the relations of some of the former inhabitants. Let it be remembered how powerful the influence of a single introduced tree or mammal has been shown to be. But in the case of an island, or of a country partly surrounded by barriers, into which new and better adapted forms could not freely enter, we should then have places in the economy of nature which would assuredly be better filled up if some of the original inhabitants were in some manner modified; for had the area been open to immigration, these same places would have been seized on by intruders. In such cases, slight modifications which in any way favored the individuals of any species by better adapting them to their altered conditions, would tend to be preserved; and Natural Selection would have free scope for the work of improvement.

We have good reason to believe, as shown in the first chapter, that changes in the conditions of life give a tendency to

increased variability; and in the foregoing cases the conditions have changed, and this would manifestly be favorable to Natural Selection by affording a better chance of the occurrence of profitable variations. Unless such occur, Natural Selection can do nothing. Under the term of "variations," it must never be forgotten that mere individual differences are included. As man can produce a great result with his domestic animals and plants by adding up in any given direction individual differences, so could Natural Selection, but far more easily from having incomparably longer time for action. Nor do I believe that any great physical change, as of climate, or any unusual degree of isolation to check immigration, is necessary in order that new and unoccupied places should be left, for Natural Selection to fill up by improving some of the varying inhabitants. For as all the inhabitants of each country are struggling together with nicely balanced forces, extremely slight modifications in the structure or habits of one species would often give it an advantage over others; and still further modifications of the same kind would often still further increase the advantage, as long as the species continued under the same conditions of life and profited by similar means of subsistence and defense. No country can be named, in which all the native inhabitants are now so perfectly adapted to each other and to the physical conditions under which they live, that none of them could be still better adapted or improved; for in all countries the natives have been so far conquered by naturalized productions that they have allowed some foreigners to take firm possession of the land. And as foreigners have thus in every country beaten some of the natives, we may safely conclude that the natives might have been modified with advantage, so as to have better resisted the intruders.

As man can produce, and certainly has produced, a great result by his methodical and unconscious means of selection, what may not 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 same country: he seldom exercises each selected character in some peculiar and fitting manner; he feeds a long and a short-beaked pigeon on the same food; he does not exercise a long-backed or long-legged quadruped in any peculiar manner; he exposes sheep 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 rigidly destroy all inferior animals, but protects during each varying season, as far as lies in his power, all his productions. He often begins his selection by some half-monstrous form; or at least by some modification prominent enough to catch the eye or to be plainly useful to him. Under Nature, the slightest differences of structure or constitution may well turn the nicely balanced scale in 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 during whole geological periods! Can we wonder then that Nature's productions should be far "truer" in character than man's productions; that they should be infinitely better adapted to the most complex conditions of life, and should plainly bear the stamp of far higher workmanship?

It may metaphorically be said that Natural Selection is daily and hourly scrutinizing, throughout the world, the slightest variations; rejecting those that are bad, preserving and adding up all that are good; silently and insensibly working, *whenever and wherever opportunity offers*, at the improvement of each organic being in relation to its organic and inorganic conditions of life. We see nothing of these slow changes in progress until the hand of time has marked the lapse of ages, and then so imperfect is our view into long-past geological ages, that we see only that the forms of life are now different from what they formerly were.

In order that any great amount of modification should be effected in a species, a variety when once formed must again, perhaps after a long interval of time, vary or present individual differences of the same favorable nature as before; and these must be again preserved, and so onward step by step. Seeing that individual differences of the same kind perpetually recur, this can hardly be considered as an unwarrantable assumption. But whether it is true, we can judge only by seeing how far the hypothesis accords with and explains the general phenomena of nature. On the other hand, the ordinary belief that the amount

of possible variation is a strictly limited quantity, is likewise a simple assumption.

Although Natural Selection can act only through and for the good of each being, yet characters and structures, which we are apt to consider as of very trifling importance, may thus be acted on. When we see leaf-eating insects green, and bark-feeders mottled gray; the Alpine ptarmigan white in winter, the red grouse the color of heather,—we must believe that these tints are of service to these 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 prey—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 color to each kind of grouse, and in keeping that color, when once acquired, true and constant. Nor ought we to think that the occasional destruction of an animal of any particular color 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 color of 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 color of the flesh are considered by botanists as characters of the most trifling importance; yet we hear from an excellent horticulturist, Downing, that in the United States smooth-skinned fruits suffer far more from a beetle, a *curculio*, than those with down; that purple plums suffer far more from a certain disease than yellow plums; whereas another disease attacks yellow-fleshed peaches far more than those with other colored flesh. If with all the aids of art, these slight differences make a great difference in cultivating the several varieties, assuredly, in a state of nature, where the trees would have to struggle with other trees and with a host of enemies, such differences would effectually settle which variety, whether a smooth or downy, a yellow or a purple-fleshed fruit, should succeed.

In looking at many small points of difference between species, which, as far as our ignorance permits us to judge, seem quite unimportant, we must not forget that climate, food, etc., have no doubt produced some 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 modifications, often of the most unexpected 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 same period;—for instance, in the shape, size, and flavor of 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 color 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 the pods on his cotton-trees. Natural Selection may modify and adapt the larva of an insect to a score of contingencies wholly different from those which concern the mature insect; and these modifications may effect, 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 insure that they shall not be injurious: for if they were so, the species would become extinct.

Natural Selection will modify the structure of the young in relation to the parent, and of the parent in relation to the young. In social 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 modify the structure of one species, without giving it any advantage, for the good of another species; and though statements to this effect may be found in works of natural history, I cannot find one case which will bear investigation. A structure used only once in an animal's life, if of high importance to it, might be modified to any extent by Natural Selection; for instance, the great jaws possessed by certain insects, used exclusively for opening the cocoon, or the hard tip to the beak of unhatched birds, used for breaking the eggs. It has been asserted that of the best short-beaked tumbler-pigeons a greater

number perish in the egg than are able to get out of it; so that fanciers assist in the act of hatching. Now if Nature had to make the beak of a full-grown pigeon very short for the bird's own advantage, the process of modification would be very slow, and there would be simultaneously the most rigorous selection of all the young birds within the egg, which had the most powerful and hardest beaks, for all with weak beaks would inevitably perish; or more delicate and more easily broken shells might be selected, the thickness of the shell being known to vary like every other structure.

It may be well here to remark that with all beings there must be much fortuitous destruction, which can have little or no influence 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 seeds would perhaps, if not destroyed, have yielded individuals better adapted to their conditions of life than any of those which happened to survive. So again a vast number of mature animals and plants, whether or not they be the best adapted to their conditions, must be annually destroyed by accidental causes, which 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 favorable 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 undergo modification and improvement at the same time in the same area.

PROGRESSIVE CHANGE COMPARED WITH INDEPENDENT
CREATION

From the 'Origin of Species'

AUTHORS of the highest eminence seem to be fully satisfied with the view that each species has been independently created. To my mind it accords better with what we know of the laws impressed on matter by the Creator, that the production and extinction of the past and present inhabitants of the world should have been due to secondary causes, like those determining the birth and death of an individual. When I view all beings not as special creations, but as the lineal descendants of some few beings which lived long before the first bed of the Cambrian system was deposited, they seem to me to become ennobled. Judging from the past, we may safely infer that not one living species will transmit its unaltered likeness to a distant futurity. And of the species now living, very few will transmit progeny of any kind to a far distant futurity; for the manner in which all organic beings are grouped shows that the greater number of species in each genus, and all the species in 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 good of each being, all corporeal and mental endowments will tend to progress towards perfection.

It is interesting to contemplate a tangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent upon each other in so complex a manner, have all been produced by laws acting around us. These laws, taken in the largest

sense, being Growth with Reproduction; Inheritance, which is almost implied by reproduction; 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 powers, 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.

CREATIVE DESIGN

From 'The Variation of Animals and Plants under Domestication'

SOME authors have declared that natural selection explains nothing, unless the precise cause of each slight individual difference be made clear. If it were explained to a savage utterly ignorant of the art of building, how the edifice had been raised stone upon stone, and why wedge-formed fragments were used for the arches, flat stones for the roof, etc.; and if the use of each part and of the whole building were pointed out, it would be unreasonable if he declared that nothing had been made clear to him, because the precise cause of the shape of each fragment could not be told. But this is a nearly parallel case with the objection that selection explains nothing, because we know not the cause of each individual difference in the structure of each being.

The shape of the fragments of stone at the base of our precipice may be called accidental, but this is not strictly correct; for the shape of each depends on a long sequence of events, all obeying natural laws: on the nature of the rock, on the lines of deposition or cleavage, on the form of the mountain, which depends on its upheaval and subsequent denudation, and lastly on the storm or earthquake which throws down the fragments. But in regard to the use to which the fragments may be put, their shape may be strictly said to be accidental. And here we

are led to face a great difficulty, in alluding to which I am aware that I am traveling beyond my proper province. An omniscient Creator must have foreseen every consequence which results from the laws imposed by him. But can it be reasonably maintained that the Creator intentionally ordered, if we use the words in any ordinary sense, that certain fragments of rock should assume certain shapes so that the builder might erect his edifice? If the various laws which have determined the shape of each fragment were not predetermined for the builder's sake, can it be maintained with any greater probability that he specially ordained for the sake of the breeder each of the innumerable variations in our domestic animals and plants;—many of these variations being of no service to man, and not beneficial, far more often injurious, to the creatures themselves? Did he ordain that the crop and tail-feathers of the pigeon should vary, in order that the fancier might make his grotesque pouter and fan-tail breeds? Did he cause the frame and mental qualities of the dog to vary in order that a breed might be formed of indomitable ferocity, with jaws fitted to pin down the bull for man's brutal sport? But if we give up the principle in one case,—if we do not admit that the variations of the primeval dog were intentionally guided in order that the greyhound, for instance, that perfect image of symmetry and vigor, might be formed,—no shadow of reason can be assigned for the belief that variations, alike in nature and the result of the same general laws, which have been the groundwork through natural selection of the formation of the most perfectly adapted animals in the world, man included, were intentionally and specially guided. However much we may wish it, we can hardly follow Professor Asa Gray in his belief that "variation has been led along certain beneficial lines," like a stream "along definite and useful lines of irrigation." If we assume that each particular variation was from the beginning of all time preordained, then that plasticity of organization which leads to many injurious deviations of structure, as well as the redundant power of reproduction which inevitably leads to a struggle for existence, and as a consequence, to the natural selection or survival of the fittest,—must appear to us superfluous laws of Nature. On the other hand, an omnipotent and omniscient Creator ordains everything and foresees everything. Thus we are brought face to face with a difficulty as insoluble as is that of free-will and predestination.

THE ORIGIN OF THE HUMAN SPECIES

From 'The Descent of Man'

THE main conclusion arrived at in this work—namely, that man is descended from some lowly organized form—will, I regret to think, be highly distasteful to many persons. But there can hardly be a doubt that we are descended from barbarians. The astonishment which I felt on first seeing a party of Fuegians on a wild and broken shore will never be forgotten by me, for the reflection at once rushed into my mind—Such were our ancestors. These men were absolutely naked and bedaubed with paint. . . . They possessed hardly any arts, and like wild animals, lived on what they could catch; they had no government, and were merciless to every one not of their own small tribe. He who has seen a savage in his native land will not feel much shame if forced to acknowledge that the blood of some more humble creature flows in his veins. For my own part, I would as soon be descended from that heroic little monkey who braved his dreaded enemy in order to save the life of his keeper; or from that old baboon who, descending from the mountains, carried away in triumph his young comrade from a crowd of astonished dogs,—as from a savage who delights to torture his enemies, offers up bloody sacrifices, practices infanticide without remorse, treats his wives like slaves, knows no decency, and is haunted by the grossest superstitions.

Man may be excused for feeling some pride at having risen, though not through his own exertions, to the very summit of the organic scale; and the fact of his having thus risen, instead of having been aboriginally placed there, may give him hopes for a still higher destiny in the distant future. But we are not here concerned with hopes or fears, only with the truth as far as our reason allows us to discover it. I have given the evidence to the best of my ability; and we must acknowledge, as it seems to me, that Man with all his noble qualities, with sympathy which feels for the most debased, with benevolence which extends not only to other men but to the humblest living creature, with his godlike intellect which has penetrated into the movements and constitution of the solar system,—with all these exalted powers, Man still bears in his bodily frame the indelible stamp of his lowly origin.