1786,* though since the middle of December the season has been unusually mild.

One of Professor Smyth's periods "corresponds to the sun spot period, 11·1 years, as deduced by Schwabe from his long observation of the solar phenomena." Professor Smyth thinks this merely a coincidence. Whether it be so or not other observers seem to be taking up the question as to how far our knowledge of the changes constantly taking place in the sun's atmosphere, which knowledge is being added to every year, may not in time lead to a better understanding of the conditions under which our seasons are so variable as regards temperature and rain. The sun is undoubtedly the prime mover of all the atmospheric changes that take place on the earth, though these changes may be often complicated by the influence of local circumstances, so as to necessitate us to take in, with a view to their explanation, other considerations besides the state of the sun, at the particular time of observation.

But I leave these higher questions, which are not likely to engage the attention of many of our members, and pass on to what more nearly concerns us—the meteorology of the Bath district. On this head I would remark that the meteorological observations made in the Institution Gardens, which commenced in 1865, will have been carried on for seven years this next spring, and when completed for that period, I hope to be able to get some results from them that may prove an addition to our knowledge of the Bath climate. But it must be remembered that Bath has, so to speak, several climates, according as we fix our station near the river, or at a greater or less elevation on the slope of the hills which rise up from it and on which a large part of the town is built. For this reason it will not do to confine ourselves entirely to observations made so low down as in the Institution Gardens, however serviceable these may be in their way. To give completeness to the inquiry, others should be made higher up as well; and it would be a great boon to science if gentlemen could be found, members of this Club or not, who would take the subject up, and keep a register, commencing next month, and running parallel with that kept at the

* According to Mr. Glaisher.—See Reg. Gen. Quart. Returns of Weather No. 92, p [illegible]

Institution, for another seven years. The observations should be made wherever possible in an exposed spot; and for a central locality, neither too far up nor too low down the hill, none could be better chosen than the open space in front of the Royal Crescent, could it be made available for the purpose. The thermometer and the wet-and-dry bulb would be the instruments alone required; and a single observation in the day, made always at the same hour, 9 a.m., and with tolerable regularity, would be sufficient. The only important points to be attended to are, that the instruments before being used be ascertained to be thoroughly trustworthy, that they are so fixed as to be properly screened from all sources of error, and that the observer himself be very careful in noting down the observations correctly. From neglecting these three precautions a large number of registers are worthless for all purposes of science.

But the matter which I am more particularly anxious to bring under your notice just now is the subject of rain-fall. No part of meteorology has of late years received more attention, or been more closely inquired into by observers in this country than that which relates to the "British Rainfall." This is mainly, if not entirely, due to the zeal and activity of Mr. G. J. Symons, Secretary to a Committee appointed several years back by the British Association for the investigation of this subject. Mr. Symons has been the means of getting raingauges to the number of nearly two thousand set up in various parts of the British Islands, the same being watched over by an "amateur staff of observers having no equal in the world." A large number of these gauges are visited annually by himself or others appointed by him, and the whole system of observations is carried on under his directions.

The question what is the mean annual rainfall in this country, as also whether it has remained the same for as long a period back as our observations reach, or whether the quantity that falls now is greater or less than formerly; these are questions which have excited lately a good deal of interest from apprehensions in many quarters caused by several remarkably dry seasons, that in consequence of excessive sub-soil drainage and a too extensive felling of timber, the average quantity of rain might be diminishing, and a permanent deficiency of water for agricultural, manufacturing and domestic purposes likely to follow.

It is doubtful whether there is any real ground for this alarm, and whether the diminished rainfall at certain periods is not rather due to a secular variation, the same as is thought to occur in temperature.

Of the two supposed causes of deficiency above mentioned excessive drainage perhaps, as far as this country is concerned, is more likely to have had an influence than timber felling, from the system having been so widely adopted throughout England,* whereas the felling of woods has been a more partial operation. That the latter, however, when carried to a great extent has really an injurious effect on climate we can hardly doubt, from the many complaints that have been made on this head in other countries, not only in some parts of the Continent, but in India and Australia.†

But to bring this matter also nearer to ourselves I would appeal to the members of this Club whether they might not render Mr. Symons some assistance in his arduous undertaking. He wants returns of rainfall from as many stations as possible throughout Great Britain; and notwithstanding the number of gauges already at work, there are yet several places still without them, where it would be very desirable to have them set up. A list of these localities will be found in the "Meteorological Magazine" for December last; and among them the following places occur in the county of Somerset:—*Minehead*, *Dulverton*, *Castle Cary*, and *Weston-super-Mare*. In a letter, however, which I have received from Mr. Symons since this list was published, he expresses a desire that to the above-named places these be added:—*Thornbury*, *Gloucester*, *Watchet*, *Axbridge*, *Wincanton* and *Bridgwater*, and especially *Exmoor*. These places, though not all in Somerset, are most of them within the distance to which the Club often extends its excursions, and it would seem strange indeed if, among our members, none could be found having friends in some of the places, or who were in other ways connected with them, so as to be able to procure the additional observers so much wanted. I need only add on this point that if any new observers can be obtained, they should

* See a paragraph in the "Times" for Aug. 30, 1870, headed "Rainfall in England."

† See "Nature," vol. i., p. 291; and vol. ii., p. 234; and vol. iii., p. 496.

put themselves in communication with Mr. Symons, who will give them full directions as to the right sort of gauge and the proper method of fixing it.*

But there is another way in which we may help Mr. Symons. He is not only desirous of having new gauges fixed in certain localities, but he wants to get all the information he can respecting old registers of rainfall kept formerly, though perhaps long since discontinued, wherever such exist. These would help him to determine, by comparison with those of the present day, whether the average rainfall in this country is the same now or not as in the days of the last generation. There are some registers indeed which go back much earlier, which would allow us to compare the rainfall of the latter half of the last century with that of the first half of the present one if they could be hunted up. I think the Club might do something in this way, if its members in their excursions and weekly walks would only take the trouble to inquire of the clergy or other intelligent persons in the towns and villages they come to whether they know of any parties who formerly measured the rain in their respective neighbourhoods, and where the registers are likely to be found now if the parties are dead or gone elsewhere. Other Naturalists' Clubs have assisted Mr. Symons in his rainfall investigations,† and why should not ours assist him? I put this question with the greater earnestness, feeling that our good name with those among whom we move, if not the very existence of the Club, depends upon our activity and usefulness in the walks of science.

For these are days, gentlemen, in which all public institutions—even private enterprises when taken in hand for the public good—are watched with extreme jealousy and closely scrutinized in respect of what they do and what they leave undone. No office of trust or power having privilege and opportunity attached to it is allowed to be held by those who are not duly qualified, and who are not prepared to give an account of their proceedings when called upon to do so. Nor is this confined to offices in the civil department, to charitable institutions, or those for the promotion of

* Met. Mag. vol. vi., pp. 189-190.

† See "British Rainfall," 1870, pp. 66, 67.

literature and the fine arts. It extends to scientific institutions. Formerly science was little understood or cared for. Very few were those who made it a study or who took any interest in its pursuits. But how different at the present day. Now science is the one thing we seem to hear most about go where we will, and in behalf of which louder demands are being made every year. Scientific societies have multiplied beyond enumeration, and all who belong to them are expected to do their share in the work they profess to undertake. You know, in the case of the Royal Society, how much more the qualifications of those who seek its fellowships are inquired into than formerly. But it is not merely these higher bodies to which the public eye is directed. Those occupying a much more humble position are equally looked after. It is beginning to be asked in some quarters what are our Field Clubs doing? What have they to show in proof that they have not forgotten their proper calling? These questions closely concern ourselves. For though we may have our volumes of "Proceedings" to produce, in which are many valuable papers and some of great local interest, complaint has still been made that, with a few praiseworthy exceptions, Field Clubs are not attending generally or at least sufficiently attending to that particular department of inquiry which they engaged to undertake. The natural history properly so called of the district in which they are located—its zoology more especially—is left in a great measure untouched, while many of the papers they print, however excellent in themselves, might find a place equally well in the publications of any other society; and there is yet another complaint, viz., that the published "Proceedings" of these Clubs have so very limited a circulation beyond their own locality that they are unavailable to the great body of naturalists scattered over the country.

I will not dwell on the first of these charges brought against us, having spoken of it before. But perhaps the time is come when it may be desirable to give our consideration to the second. Those who were present at the last meeting of the British Association at Edinburgh, or who, like myself, have only read a report of its proceedings in the different periodicals, are aware that the matter last referred to was the subject of a paper read to the biological

section by Sir Walter Elliot. Its author mentioned that he had ascertained the existence of no less than 115 provincial natural history societies in Great Britain and Ireland, and that the way in which these societies were isolated from each other, without "systematic co-operation" among themselves, few knowing anything of the work done by others, was detrimental to each of them. "Two modes of remedying the evil suggested themselves to his mind. One was to have a central committee or single editor to collect and condense the most useful materials in all the local Transactions, and the other to form groups of societies, and publish the more original and valuable papers in each group under a joint editorship."

As I was not present at the meeting I know but little of the discussion which took place after the reading of Sir Walter Elliot's paper. But I think the suggestions he threw out may be productive of good, and I fully look for some well-considered scheme being brought forward before long for the better organization of these local societies, which, while they continue to be mere independent units, may prove a check to any healthy growth of the sciences to which they attach themselves. The present time will not serve for deliberation on this matter. I am quite aware also that there are two sides to this question as there are to so many other questions. It may be said that, in surrendering that exclusive control we now have over our own affairs, we relinquish to a certain extent our present standing, and fall back into a lower position shared by others associated with us. In other words we let go somewhat of our self-importance. But if it be for the interests of science that we merge our individuality in the general community of scientific bodies similar to our own, such considerations should not weigh with us for a moment.

But whatever course we determine on when this question comes properly before us, we must see that we do not lose ground with the public. We must not only keep our Club together, but get more men into it who will really do work in the field or in the closet. Perhaps our Club labours under some disadvantage in this respect from the circumstances which led to its formation. We were in the first instance, as is probably known to all, not so much

a working Club as a walking Club. That is the name by which outsiders still call us, and many know us by no other. Our object was to join in visiting the most remarkable spots in the neighbourhood of Bath, rich in its scenery and abounding in objects of general interest, mainly for the walk's sake, heightened in enjoyment by the companionship of friends. The few who first met weekly for this purpose were in time joined by others, and the idea of combining with the walk Natural History and Antiquarian pursuits, and forming ourselves into a society, was an after thought, very desirable in itself, but leading naturally to many men becoming members for the walk's sake alone, which was still kept up, in addition to the four more distant excursions during the summer.

It were useless now to regret this circumstance ; but it seems to call upon us to do what we can in the way of counteracting any prejudicial influence it may have on the interests of the Club in a scientific point of view. Nothing suggests itself to me except for the future limiting membership, as some other societies limit it, to working-men. Our numbers are now considerable ; why seek to increase them, or even keep up our present number, if, calling ourselves a scientific body, no advantage to science arise from doing so. I think in this large town or its neighbourhood, there must be some unknown to us fond of Natural History pursuits. I have myself in the summer time seen collectors in the fields and lanes busily plying their occupations, showing that there are such men in the district. Let them be inquired for, sought after and encouraged. To get them to join us would be a reciprocal benefit. Young naturalists would be stimulated to give an increased attention to the subject that interests them when countenanced in this way, while the Club would profit by their researches. I think also it might lead to an increased number of short communications to our proceedings, which I have always thought desirable, if they only contained notices of a few facts of interest or importance. Such records would help forward the mass of details which have to be got together before making any approach to a complete Natural History of the district. At present, I apprehend, short papers are not unfrequently held back, under the idea that we only care to have longer treatises or lectures, such as make up the bulk of our hitherto

published proceedings. To see more exactly what I mean I would ask you to open any of the volumes of the Proceedings of the Berwickshire Naturalists' Club, and observe how many short papers there are there of the kind I allude to. That Club is the oldest of all the Field Clubs. It exists to this day in as much life and vigour as when first started. It has done an immense deal of work in the district to which its labours are directed ; and younger Clubs may well copy after its example in all that relates to their own operations and method of carrying them on.*

Gentlemen, I hope you will bear with me in these remarks, which—though I fear I am detaining you rather long—I have been the more anxious to make on this occasion, feeling that the time is near when I must ask your permission either to retire from the office of President of this Club, which by your indulgence I have now held for several years beyond the period when I was able to join in its excursions, or, still retaining the office, to delegate to others its more onerous duties. Conditions of health I need not enter into oblige me to solicit this at your hands. In either case, if you accede to my request, this anniversary would be my last opportunity of addressing you in this way on the affairs of the Club. My own work for science is nearly done. But my love for science continues, and will remain by me. I might almost say my interest in the sciences increases as I grow in years, when I reflect from time to time on the wondrous advances they have made since the day when I first took up and began to read the vast book of Nature. Yet more am I carried away by them when I note the way in which the sciences have gradually inter-penetrated almost all other branches of human learning, serving to check and regulate our often too hasty judgments and interpretations of the events and phenomena of this lower world—even such events as belong to history and social progress, and which would seem to be removed from the province of science properly so called—nor stopping there, but shedding their light upon that other great volume, the Book of Revelation, which we all look up to and revere as man's highest source of life

* See two good articles on Field Clubs, and what should be their aims, and how best managed, &c., in "Nature," vol. ii., p. 469, and vol iii., p. 141.

and happiness—true in all its teachings as regard his moral and religious welfare, but demanding the same care and caution that is required in the study of other things, in order to elicit the truth before applying it to his own heart and conscience.

But apart from such high considerations, it is a pleasant thing in the evening of life to look back on the unalloyed enjoyment, I might add the improvement of mind, derived from the study of science taken up in boyhood and carried on to that maturity of years when the ripened judgment is able to discern its true worth. St. Pierre, in his "Studies of Nature," has left this record of what he had himself gleaned from those studies. "I can say with truth," he remarks, "that I have not permitted a single day to pass without picking up some agreeable or useful observation."* A much more recent author, Sir Henry Holland, a man of general literature and science though not a naturalist, in his "Recollections of Past Life," quite lately published, thus speaks of the advantages enjoyed by the mere collector of specimens of natural history:— "Were I devoid of other pursuits there are none I should so much desire to assume as those of a collector, whatever the object of his research. The collector of beetles or moths, of ferns or fungi, is a happier man, *cæteris paribus*, than one who has no such definite object of pursuit. The interest here is one which augments with its gratification, is never exhausted by completion, and often survives when the more tumultuous business or enjoyments of life have passed away."†

I feel the force of both these remarks. I have sought to copy after St. Pierre in what he states to have been his daily habit, while I can aver upon my own experience that never were any commendations more just than those bestowed by Sir Henry Holland on the Naturalist's pursuits. But the satisfaction I have myself derived from those pursuits does not stop here. It has been enhanced by a desire to get others to drink of the same well-spring of intellectual enjoyment which has so thoroughly slacked my own thirst; and I trust I may, without vanity or boast, point to this Club as the issue of my endeavours, feeble though they have been,

* English Translation by Hunter, vol i., p. 2.

† Recollections of Past Life, pp. 53, 54.

to get a more sure footing for the natural sciences in this place. I feel called upon, however, to speak of the Club in other terms than what relate simply to the work which it has done. That work is good as far as it goes, and it will endure. But I cannot forget that to this Club I am indebted for many friendships I might never otherwise have enjoyed, while from all its members I have uniformly received marks of kindness and regard which demand my most sincere thanks. Those thanks I beg now to proffer. May the Club long continue to act out its chosen part, and hold its place as one of the institutions which this ancient city of Bath "delights to honour."

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Vol. II., No. 3.

PROCEEDINGS

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AND

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1873.

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Local Biology, followed by remarks on the Faunas of Bath and Somerset. By the Rev. Leonard Blomefield, M.A., F.L.S., F.G.S., &c., *President. Read November 13th,* 1872.

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Erratum.

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* Ireland's Natural History, by Gerard Boate, 1652. † Britannia Baconica, or the Natural Rarities of every Shire of England, Scotland, and Wales, by S. Childrey, 1662. ‡ Pinax Rerum Naturalium Britannicarum, by Christopher Merrett, 1667. § Scotia Illustrata, 1684. ‖ Synopsis of the Natural History of Great Britain and Ireland, by John Berkenhout, 1789. ¶ British Zoology, by Thomas Pennant, 1776.


NAT HISTORY

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Local Natural History, rightly studied, is a very different thing in these days from what it was formerly. If we look to the older works on the Natural History of these Islands published towards the end of the 17th century, such as those of Boate-*, Childrey †, Merrett ‡, and Sibbald §, we either find Natural History, in the ordinary sense of the word, largely mixed up with Topography; and only notice taken of those objects which attract by their rarity or curiosity; or, as in the case of Merrett, who confines himself more to the subject, little more than a bare list of species of animals and plants without reference to their characters and habits, though still valuable from the localities in which they are to be found being added in many instances. Coming down to a later period we find in Berkenhout || and Pennant ¶ more information on the subject, the latter being the first author who treats of British Zoology, detached from all other branches of Natural History; though as in the case of Bewick, who followed only a few years after—his work is more of a popular than a scientific character.

From the time of Bewick downwards, able and accurate works have been written by Montagu, Selby, Bell, Yarrell, Curtis, Stephens, and many others on the Birds, Quadrupeds, Fishes, Reptiles, Shells, and Insects of this country,—but in few of these works do we find more than an endeavour to ascertain in the first instance what species in each class are natives, or occasional visitants, of Great Britain and Ireland, and then to give full descriptions of the several species as regards their external characters, adding what is known of their haunts and habits, along with any particular facts that give an interest to their history.

* Ireland's Natural History, by Gerard Boate, 1652. † Britannia Baconica, or the Natural Rarities of every Shire of England, Scotland, and Wales, by S. Childrey, 1662. ‡ Pinax Rerum Naturalium Britannicarum, by Christopher Merrett, 1667. § Scotia Illustrata, 1684. || Synopsis of the Natural History of Great Britain and Ireland, by John Berkenhout, 1789. ¶ British Zoology, by Thomas Pennant, 1776.

It seldom occurred to any of these writers to take up the questions which draw the attention of Naturalists at the present day; questions as to the evolution of species and varieties—the causes of variation—the relationship between the animals of a particular country, and the same animals as met with in other countries—the local influences which operate, sometimes on the structure, sometimes on the habits of certain species, giving them a local character, often to the extent of causing them to be considered distinct from others, which do not possess this local character, though in all essential respects the same—the causes which act in confining some species to very limited districts, while others nearly allied are found ranging over a whole country; in a word, questions arising out of that interaction which is constantly going on between every living creature and its surroundings as regards both the organic and the inorganic world, giving rise to changes, not perceivable at first, but tending ultimately to an entire alteration of the Fauna of any particular country or district.

For these questions had not at that time been brought forward. It is only since the appearance of Darwin's important work on the "Origin of Species" in 1859, that they have offered themselves for solution; or if thought upon by a few before that time, that they have become a general study, opening up indeed quite a new branch of Science—Philosophical Biology.

Professor Huxley, speaking of that work, says—"In a dozen years it has worked as complete a revolution in biological science as the "Principia" did in astronomy—and it has done so, because, in the words of Helmholtz, it contains "an essentially new creative thought;"* and a writer in a late number of "Nature," alluding to this revolution, remarks that it "has augmented the number of special problems in such enormous proportions that Biology is now completely at a loss to solve all these problems by the aid of the means placed hitherto at its disposal." It is this felt difficulty which led to a suggestion, at the Edinburgh meeting of the British Association in 1871, that Zoological Laboratories or Observatories, which is the subject of the article in "Nature" just mentioned, should be established at suitable stations in different parts of the

* Contemp. Rev., Nov. 1871, p. 443.

globe, and especially on our own coast for the study of the embryology, development, and habits of marine animals, and their relationship to all those conditions under which their life is carried on. * With the marine department of Zoology we have nothing to do on the present occasion. But the same system of careful observation is needed for the study of animals inhabiting the land and fresh waters. And wherever Field Clubs exist they should consider themselves as an associated band of observers for collecting the Natural History facts of their own district. Every local Faunist should have his own little private Observatory, where he may watch over the ever-shifting phenomena of the animal world, where, too, he may carry on those investigations and experiments, which I shall have to speak of in the course of this paper, and which can only be properly undertaken by those resident on the spot.

It may be remembered that I made some allusion to this subject in my Anniversary Address for 1871. Speaking of Biology, and the questions it gave rise to at the present time in connection with the Darwinian theories, I went on to mention the opportunities afforded to the local naturalist to take up some of these inquiries. They might call for much patient and lengthened research, but the result would be of great value. It would have the more value from being entirely the result of personal observation. There is nothing like a man's "own autopsia," to use Gilbert White's expression, for verifying facts in Natural History. Indeed, had White belonged to the present generation, no man would have been better fitted than he was to undertake such work as is required at the hands of the local naturalist at the present day. A close and accurate observer, he let nothing escape him. He watched nature with untiring patience and assiduity, content to labour on for a considerable term of years in his own narrow field, which never lost its interest with him, nor failed to yield something new so long as he continued to give it his attention. And from the habit of "keeping a sharp look out," he was able to record many little points and features in the history of the animals about him, which, though of common occurrence, had never been noticed by any

* See "Nature," vol. v., p. 277.

previous observer. No work of its kind has indirectly had more influence upon the study and advancement of local natural history than his charming volume on the "Natural History of Selborne;" the fascinating way in which he has treated the subject having stirred up in the minds of unnumbered readers, youthful readers especially, just beginning to feel a taste for such pursuits, a desire to investigate after a similar manner the natural productions of their own neighbourhood.

But to return to the matter alluded to above. I did not in my Address, for it was impossible then, go into any of the details of local biology, but I expressed a hope to do so at some future time.* The object of my present paper is to supply some of these details; or rather to state, in the way of suggestion, such observations as have been made of late years by various naturalists relating to the habits, characters, and economy of animals, the same serving to illustrate what kinds of facts are wanted from the local zoologist to give value to his researches, and to make them available for modern science. To go fully into the subject, and follow it up through each department of the animal kingdom would require a volume.

I assume then that he wishes to know and understand thoroughly the Fauna of a particular district—say the Bath district—in all its entirety. In addition to selecting certain fixed stations in woods or other retired spots best adapted for getting a knowledge of the habits of animals †, he must provide himself with a note-book wherein to enter upon the spot every little fact and occurrence that offers itself, even when his mind is not particularly set to Natural History researches. White here furnishes an example. In one of his letters to Daines Barrington on the singing of birds he says, "For many months I carried a list in my pocket of the birds that were to be remarked, and, as I rode or walked about my business, I noted each day the continuance or omission of each bird's song, so that I am as sure of the certainty of my facts as a man can be of any transaction whatsoever." But a Journal of a more enlarged character than White's, and adapted to receive the more numerous entries which the Naturalist is called upon to make at the present day, if

* See Proc. of Bath Nat. Hist. Field Club, vol. ii., pp. 256, 257.

† See "Observations in Natural History. Introduction on Habits of Observing," pp. 40-44.

thoughtfully devised, may be kept without much trouble or taking up much time. It may be done almost entirely by signs and symbols; and as a specimen of such a Journal, or rather note-book, I would refer to a paper by Professor Alfred Newton in the "Transactions of the Norfolk and Norwich Naturalist's Society for 1870–71," † in which he has given full details respecting one kept by himself for ten years, accompanied by a lithographed copy of two pages of the Register, so as to present to the eye the arrangement of the entries, and the particular symbols used for the different kinds of observations. Moreover, to show the value of such a Journal, he states that the very first autumn of his using it he ascertained a new fact respecting the Song Thrush, which the observations of succeeding years fully confirmed, viz., that this species "was one of the most regular migrants among birds," disappearing in November, and reappearing the end of January or the beginning of February; "a fact which although well known on the continent had never been suspected by any English Ornithologist." This shows how much there is yet to be learned respecting our native animals, if naturalists will only take up the inquiry in some such way as Professor Newton has done.

But even in the case of species thought to be the best understood differences of character are noticeable in different localities; nay, in the very same locality many changes will occur in the habits and instincts of certain animals with the lapse of years. Instincts have often been considered as invariable. With many persons the very idea of instinct is that of a blind impulsion prompting animals to move always in one beaten track, to work by a rule for the supply of life's wants which never fails, and from which there is no deviation,—a rule they never learnt, and which their offspring equally observe without any teaching from their parents. It is now, however, getting to be more and more allowed, as Zoological Science advances, that this is not the case. Instincts do vary, and not only this; they are sometimes at fault. Mr. Maclachan mentions the case of a caddis worm, which, when attaching itself to the stem of an aquatic plant, previous to assuming the pupa form, in accordance with its usual habits, did not make allowance for the

† p. 24.

growth of the plant, in consequence of which the pupa, instead of remaining under the water, was gradually lifted up two feet above it and perished. * Insects also not unfrequently lay their eggs in wrong places, where the larvæ when hatched can get no suitable food. The flesh-fly, attracted by the carrion smell, will deposit its eggs in the flowers of the stinking Stapelia; at another time, where the eye or touch may direct it, but where the right odour cannot exist, on a fur cap. Kirby and Spence mention the case of the common house-fly even laying its eggs in a snuff-box, the snuff being mistaken for dung. †

In reference to the general subject of instincts it may be remarked that they depend for the most part on the conditions of the outer world as manifested in the particular locality in which animals are placed. These conditions act differently upon different constitutions. If we suppose the conditions of a country changed, the result will probably be that some species of animals who cannot accommodate themselves to the change fall victims to it and at once perish; "others more or less affected may continue through several generations, but with decreasing vigour, and die out gradually;" while all those who are suited to it, or who can adjust their habits to meet the requirements of the case, thrive and prosper. The adjustment may not be made at once, or completed in the life time of an individual, but if at all successful, the advantage arising from it will be inherited and improved by the offspring, and each generation in this way will gain upon the one that preceded it. The changes above supposed may arise from various causes. There may be a change of climate, or a change affecting the supplies of food, or the face of a country may be so altered as to bring about the destruction of the fittest places for rearing young, or the change besides being unfavourable for some of its old inhabitants may be favourable to other species, strangers, which come and live there, and which may be the natural enemies of the former. But whatever the change may be, it is obvious that unless an animal can accommodate itself to the new circumstances, or go elsewhere, which not all species have it in their

* See Ent. Trans., 3rd Ser., vol. v., Proceed. pp. xiv., xv.

† Introd. to Entomol., vol. ii., p. 471.

power to do, it must necessarily succumb and take its fate. Unless its constitution can get accustomed to a warmer or colder, a drier or wetter climate, or to some different food from what it has been used to, or its young can be reared in some different way from formerly with precautions against its coming to harm, or the animal can contrive some new stratagems for evading its enemies, as the case may be, it can never hold its place long where it is. What evidence have we then to shew that with very many animals there is that elasticity of constitution, if we may use the expression, as opposed to anything rigid and unalterable in their nature, which enables them to meet and get over the difficulty? We might appeal in the first instance to the case of domestic animals, which, from long living under the care and tutelage of man, have some of them become so different in their habits and even in structural characters, that we can no longer point with certainty to the stocks from which they originally sprung; as on the other hand, if after long domestication, they are neglected and turned adrift, they lose the characteristics they had acquired in their reclaimed state, and gradually reassume their feral habits.

Though not directly connected with our subject, it might be mentioned that it is the same with the Cerealia among plants. Either the original stocks of some species have passed away altogether, or they are become so metamorphosed by continued cultivation as to be no longer recognizable. Here, too, cultivation being withheld, the plants fall back in luxuriance and fertility, making probably an approach to their original condition.

But not to dwell upon the case of domestic animals we have plenty of instances of changed instincts among the wild ones. And it is worthy of note that many such changes must have occurred in the case of species, which though not kept or cared for by man have long attached themselves to his dwelling or its immediate neighbourhood. Such are the rat and mouse, the house sparrow, chimney swallow, and several others. The rat and the mouse have been carried by man unwittingly all over the world. The sparrow which now generally places its nest under the eaves of buildings, no doubt in former ages built in trees, which it still does occasionally, the nest in such cases being better constructed,

and the materials not so loosely put together as when placed in the holes of walls. It has also become so habituated to man that "by its boldness it secures food not available to its congeners, and as a result has several broods in a season, while its field-haunting kindred have none of them more than two broods, and some have only one."* Other animals, though not usually approaching houses, keep in great measure to the lands on which man raises his crops, deriving their chief support from the produce of his labours. These, which are often much molested on account of the damage they do, have evidently been made more wary in the course of generations, and are not easily approached. † It may be remarked indeed that the fear of man which shows itself more or less among all wild animals living in the same countries with him, is itself evidently an acquired instinct, not being exhibited by species entirely unacquainted with him, as in the case of animals living in islands where man has not got a footing. ‡ According as they are brought more into contact with civilization and the human race, they find cause more or less to alter their mode of life, shaping their course in reference as well to the advantages which man sometimes throws in their way, as, on the other hand, to the power he has over them derived from his superior faculties and intelligence.

A curious instance of the former, leading to an entire change of habit, is recorded in the case of a rare bird called the *Kea* (Nestor notabilis) one of the brush-tongued parrots found in New Zealand. This bird appears to have formerly derived its food "from the nectar of hardy flowers, the drupes and berries of dwarfed shrubs" that grow at a high elevation, to which may be added, "insects found in the crevices of rocks or beneath the bark of trees;" but since the European has come in, and it has got acquainted with the flocks of sheep introduced by him, it has acquired a taste for

* Herbert Spencer's Principles of Biology, vol. ii., p. 458.

† See some remarks by Weissenborn on the "Transmission of experience in birds, in the form of instinctive knowledge;" with instances adduced to show "that the collective experience of many generations of animals has a much more powerful influence on their behaviour, than their individual experience." Mag. of Nat. Hist., 2nd Ser., vol. ii., p. 50.

‡ See some remarks by Darwin on the tameness of the birds in the Galapagos Archipelago. Journal of Researches, &c., p. 475.

mutton. In fact it has gradually become carnivorous, taking advantage of the carcases hung up by the settlers in winter in the open air, or even tearing away pieces of flesh from the living animal, "exhibiting, it is said, an amount of daring akin to the savage fierceness of a raptorial." *

It may be remarked also that many animals that have been brought into contact with man feed upon artificial substances which they could not have obtained formerly. M. Fatio, in a work on the Swiss mammals, describes a little black mouse found in the Grisons and supposed to be a new species, which "lives on tobacco. It was first noticed in a tobacco-factory, and was found to make great ravages among the stores of the nicotian weed." †

Darwin also has observed that there are "many British insects which now feed on exotic plants, or exclusively on artificial substances." ‡ Among the latter might be mentioned certain species of moth which in the larva state make the same havoc in stores of tea which the mouse above alluded to makes in the tobacco stores.

Another remarkable fact connected with man's movements is noticed in a paper in the "American Naturalist" for October, 1871, where Mr. T. Martin Trippe speaks of "the difference in habits, note, time of breeding, &c., in the same species of bird in the eastern and newly-settled western portions of the American continent, and the manner in which the indigenous avi-fauna of the Western States is becoming gradually superseded by Eastern forms, along with the advance of man." §

But irrespectively of man, many facts are on record serving to show the altered habits and instincts of animals under particular circumstances. Thus it has been ascertained, a fact I can confirm by my own observation, that the reproduction of frogs and toads occasionally takes place without the intermediate stage of tadpole, the occasion being that, in which they have accidentally got into places from which there is no escape, and where the tadpole state would be impossible for lack of water. || Efts also lose many

* See "Nature," vol. iv., p. 489, and vol. v., p. 262. † "Nature," vol. i., p. 282. ‡ Origin of Species, 1st Ed., p. 183. § Id., vol. v., p. 313. || Edinb. New Phil. Journ., vol. 55 (1853), p. 184. See also Ann. and Mag. Nat. Hist., 2nd Ser., vol. xi., p. 341., Id. p. 482.

of their characters when found on land, and in dry places and dry seasons are often found in the perfect form so extremely small, that there can be little doubt these too like frogs and toads are occasionally reproduced without first going through the larva state. *

A remarkable case of altered instincts in a small species of spider (*Neriene errans*) found in coal mines is mentioned by Mr. Tuffen West. In its natural state this spider is met with in fields about the time of hay-harvest, and is only known as a *solitary wanderer*, making *no web* of any kind, further than a few scattered lines. In the coal-pits, into which they are supposed to have been carried down originally by accident with the provender for the horses, they become gregarious, and live in large colonies, constructing sheets of web of vast size. Mr. West saw one 30 feet long by 4½ feet wide, hanging from about the middle of the roof. †

Another striking instance of animals accommodating themselves in time to localities not originally natural to their organization and habits, was that noticed some years back by Professor Lovèn of certain Crustacea occurring in the Swedish lakes, which had previously only been known as marine species inhabiting the Arctic and Baltic seas. The explanation of it was thought to be "that the gradual elevation of the Scandinavian Peninsula had cut off these originally marine creatures from their natural habitat, and that they had been able to accommodate themselves successfully to altered conditions of life." ‡ This fact is suggestive, and should not be lost sight of by those who study the productions of our fresh waters, whether fish or any lower forms of animal life, especially waters communicating with the sea or not far distant from it.

Instances such as the above might be adduced to almost any extent, in proof that the habits of animals are dependent mainly upon outward circumstances. But we will now confine ourselves to those more particularly connected with the subject before us. Among the vertebrate animals the class of birds is that which to the local naturalist will open up the widest field for observation. The mammals, fish, and reptiles, found in a limited district, such

* See Man. Brit. Vert. An., pp. 304-305.

† Rep. Brit. Assoc. 1861. Sections, p. 163. ‡ "Nature," vol. i., p. 455.

as for instance the Bath district, are few in number, and the life history of most of them is tolerably well understood. The birds are more numerous, and the particular species we may expect to meet with more uncertain. From their powers of flight, and from various circumstances, some of regular occurrence, others accidental, birds often wander far and wide from the place of their nativity. Unlike mammals, more fixed to the spot, they can in a very short time transport themselves elsewhere in the case of food failing, or under any other influences which affect their welfare. Hence it occasionally happens that while some species desert a particular locality, others new to it introduce themselves in their stead. Nor can we always argue that because a country or district seems well suited to a particular species it is likely to occur there. For no accident may have brought it over the boundary that separates that country or district from an adjoining one, in whatever plenty it may be found in this latter. The rule seems to be that having once got a footing in any locality, if it find everything there requisite for its support and safety, unless it be a migratory species, there it will remain; and even if it do migrate to any other place at certain seasons, unless hindered in its flight by opposing circumstances, it will return to the locality it had left. It has been noted as a remarkable circumstance in the geographical distribution of birds that, notwithstanding the large rivers and other waters in America, "a continent with more rivers and more fish than any other," there should be so few kingfishers; whereas in the Australian regions, where rivers are smaller and less numerous, kingfishers abound. We even find there nearly half the species of the whole world.* We may easily suppose, however, Australia to have been the centre in which, from some particular cause, many species originated, and that nothing has led to the dispersal of such species over other parts of the globe.

But to take a case nearer home; we know that the nightingale, which is a migrant, returns to the same parts of England every spring, leaving other parts year after year unvisited, though in many of the counties which it seems to avoid there is nothing we can fix upon as prejudicial to its welfare if it chose to resort to them.

* See "Nature," vol. iii., p. 467.

Let us proceed then to consider those points in bird-life to which the local naturalist should particularly give his attention. After having ascertained what birds are to be found, or are known to have occurred, in the district he has marked out for himself, he will first separate these into the usual classes of fixed residents, regular or occasional migrants, stragglers, &c. But this part of their history has been so generally noted down in faunas, it is unnecessary to say much about it.

At the same time there is one question connected with our regular summer migrants which the local naturalist might well attend to, not often considered, viz., what are the relative numbers of each species that return to a given locality in the spring, where an estimate can be made, compared with the numbers that left the autumn previous? White, speaking of the house martin, has remarked that "the birds that return yearly bear no manner of proportion to the birds that retire." This is, however, probably to be explained by the old birds driving the young away and "obliging the latter to seek for new abodes"—an explanation given by White himself in another part of his work in reference to the swift, of which he "was confirmed in the opinion" that they had at Selborne "every year the same number of pairs invariably."* Observations bearing on this matter made in other places would be valuable.

But let us pass to other particulars. It will be remembered that we want facts for the support or otherwise of what is commonly called the Darwinian theory, viz., that every species of animal has been derived from a preceding one, through the instrumentality of causes acting slowly over a long period of time. Now any plain facts speaking to an alteration of character or habit will have a certain weight one way or the other in this argument. In the case of birds, any variation of plumage or song, or mode of nidification, or of food, which sometimes affects the colour of the plumage,† should be especially noted. Plumage we know varies in certain

* Nat. Hist. of Selb. Letters xvi. and xxxix. to Daines Barrington.

† White has remarked that "bullfinches, when fed on hempseed, often become wholly black." [Letters xv. and xxxix. to Pennant.] See other instances of "the effects of different kinds of food on the colours of birds,"

species with age, with sex, or with season. In some birds the sexes are alike, but the young different from either; in others the sexes are different and the young like the female. In some the male during the nuptial season assumes brighter colours than the female but is like her at other times; occasionally he is adorned with a crest or other long plumes found at no other period of the year. It would be a very important fact if a case occurred at any time in which the rule of the species, whatever it might be, was not observed. For it would seem not always to be observed in other countries. Thus Mr. Blyth has noticed that the ruff *(Machetes pugnax)* is "tolerably common" in the vicinity of Calcutta, "but never met with in breeding plumage."* This is a remarkable circumstance, and its interest would be much increased if in only a single instance a parallel case was met with, as regards this species, in England. The ruff on the neck, by which the male bird is distinguished in the breeding season, and from which it receives its name, is notoriously variable in its colours, hardly being found exactly alike in two individuals, and the same or similar causes which bring about this variability, might possibly lead occasionally to there being no ruff at all.

Again in very many species, especially among the aquatic birds, the summer and winter plumage differ considerably, and the degree of difference seems to be dependent in some measure on the character of the season. This question is of greater interest when we take the case of migrants which are generally travelling at a time when this change of plumage is taking place, and which may possibly be affected by the climate or state of the weather in the countries it traverses in its flight, especially if it stop to sojourn anywhere for a time before resuming its journey.† For the change sometimes takes place very

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as also the influence of temperature, mentioned by the late Mr. E. T. Bennett, in his edition of White's Selborne, p. 165, note 19.

* Ann. and Mag. Nat. Hist., vol. 12 (1843), p. 170.

† See some remarks by myself, many years ago, on the variation of plumage in birds as affected by climate, seasons, and other conditions, with reference to a memoir by M. Gloger, in which he states he has "no doubt that individuals of one and the same species of bird present different arrangements of colouring, according to the climates which they inhabit, and that

rapidly. Mr. Yarrell mentions the case of a common black-headed gull in the Zoological Gardens, in which the change of colour on the head from white to dark brown in the spring was completed in five days; "it was a change of colour, and not an act of moulting, no feather was shed."* Some light might be thrown by the local faunist upon this subject, as also upon the still larger question of species generally, especially when established upon slight differences of plumage only, if those in which any of the above particularities were conspicuous were compared with the same or closely allied species obtained in other localities in England or abroad at the same seasons of the year, and if this were done for several years in succession. By close comparison of specimens in this way many formerly supposed species among the waders and swimmers are now recognized as mere varieties of others, or different states of plumage dependent upon season or other circumstances. Also among our land birds, we know that there are many other European species closely allied to some of them, and it would be important to note if in any of our home specimens we ever found an approach to the slight variations of character by which some of these foreigners are distinguished, or any thing intermediate that tends to bring them together.† That many local races or sub-species only retain their peculiarities and distinctness from other nearly allied forms, so long as they are confined to their own locality, seems shown by the remarkable circumstance mentioned by M. de Selys-Longchamps, that the Cisalpine sparrow, when transferred to Paris and made to build there, had for its progeny the common house sparrow.‡ But in fact the whole question as to the light in

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one and the same individual, amongst the birds of passage, changes during nearly the whole year the colours of its plumage, according to the different climates through which it passes."—Mag. of Zool. and Bot., vol. 1, pp. 24-25. Mr. Gould, too, has remarked "that birds from the central parts of continents are always more brilliantly coloured than those inhabiting insular or maritime countries. He attributes this principally to the greater density and cloudiness of the atmosphere in islands and countries bordering the sea."—Ann. and Mag. Nat. Hist., vol. xvii., p. 510. * Brit. Birds, vol. iii., p. 438.

† See remarks "on the variation of species," with reference to many very closely allied European species of birds.—Rep. Brit. Assoc., Cheltenham meeting in 1856. Trans. of Sect., pp. 103-4. ‡ Faune Belge, p. viii.

which we are to consider sub-species and local races, as they have been called at different times, is one that can be taken up by none better than the local naturalist.*

On the subject of song it may be remarked that, though in the case of what are usually called song-birds, each species ordinarily keeps to its own note, and which is often characteristic of it, yet certain variations in that note may be noticed in different localities. Practised bird-catchers can often tell by the song the exact county in which some of our native cage birds have been taken. I remember a blackbird at large when I lived in Cambridgeshire, whose song was so peculiar that I could at once distinguish it from all the other blackbirds in the neighbourhood; this continued for three years, at the end of which period I missed it, it having probably met with its death. In any similar case that might occur to the local naturalist it would be interesting to discover the nest of the particular individual, and rear the young brood with the view of ascertaining whether their song was like that of the parent bird or not. It is quite certain that many birds acquire their song by imitation. Wallace says "that young birds never have the song peculiar to their species if they have not heard it, whereas they acquire very easily the song of almost any other bird with which they are associated."† When birds are kept in cages, too, they not unfrequently lose in part the song they have when at liberty, or it is mixed up with that of other birds in cages near them. I remember many years back a nightingale in a cage kept by Mr. Yarrell, which it was quite disappointing to hear, the song being so little like that of the wild bird in its native haunts.‡ Some birds, like the great titmouse and reed warbler, have a great variety of notes. The peculiar note of the former, like the whetting of a saw, so often heard in the early part of the year, was noticed by White, though attributed by him, I think erroneously, to the marsh tit,§ but it has many other notes besides, which it

* See the whole subject of the variation of plumage in birds, treated at much length in Darwin's "Descent of Man," vol. ii., ch. xiii., pp. 71-98; also ch. xiv., pp. 124-153; also ch. xvi., especially "Rules or Classes of Cases," pp. 187-223. † Natural Selection, p. 220. ‡ See also Wallace, Nat. Select., p. 222. § Nat. Hist., Selb., Letter xl. to Pennant.

often takes up in succession, harping for a longer or shorter time first on one and then on another.*

All these facts are of importance, especially when we take into consideration the case of those birds, in which we not only find the song never varying, but in which the peculiar note is characteristic of the species, as distinguished from others, in almost all respects except the note, most closely allied to it. Thus the willow wren and chip chop, even in the living state but still more in the dead, are so extremely similar as regards plumage, size, and proportions, that it is difficult to believe they have not sprung originally from one stock. Yet supposing this to have been the case, there must have been a time when the song of the two species, which is now quite different, was similar also; and there must have been a gradually increasing divergence in this particular until the difference became what it is.

And as with the song of birds, so with the nests. These last are not always alike in the same species, nor constructed of the same materials, nor placed in the same kind of situations. Allusion has already been made to the difference in the nest of the house-sparrow, according as it is placed in trees or buildings. The jackdaw's nest is found in various situations, most often perhaps in steeples or hollow trees; in Cambridgeshire, they build much in chimneys; in some open places, where there are neither trees nor towers, according to White, in rabbit-burrows. † White also long ago remarked that the form and material of the nest of the same species of bird, in certain cases he noticed, were adapted to the "circumstances of place and convenience." ‡ Quite recent observers, comparing the nest of the house-martin as constructed at the present day with the way in which it was constructed formerly, have come to the conclusion that they have undergone with the lapse of time "certain progressive modifications of structure." § This if correct would be an alteration not arising directly from any

* See Knapp's Journ. of Naturalist, 3rd ed., p. 164. † Nat. Hist. Selb. "Lett. xxi. and xxii. to Pennant. ‡ Id. Lett. lvi. to Daines Barrington. § "Nature," vol. i., p. 522. See also Wallace, Nat Select., p. 228A.

outward circumstances, but due to a modification of instinct in the course of several generations.

With regard to the material used by birds in building, it seems to depend very much upon what comes to hand. Some keep more to the same materials than others; but that they will often abandon the old material for a new and a better one if thrown in their way, is shown by a circumstance mentioned by the late Mr. W. Thompson, of Belfast, that "the chaffinches and sparrows at Whitehouse, near that city, which build around two cotton-mills, always use cotton in the construction of their nests." * Wallace also has remarked that "thread and worsted are now used in many nests instead of wool and horse-hair." †

A curious case occurred at Cambridge many years ago when the Botanic Garden was in the midst of the town. The jackdaws that frequented the buildings about there were very much in the habit of stealing the wooden labels attached to the plants, and carrying them off when the gardeners were not on the watch for constructing their nests. These labels on being searched for were found in large numbers in holes in the steeples and towers of the churches and colleges near, as well as in the chimneys of houses. From one chimney shaft in the immediate neighbourhood of the garden which was found "stopped up below," no less than eighteen dozen labels were got out and brought back to the curator. ‡

As the song of caged birds often differs from that of the same species when at liberty, so too it would seem to be with the nests. On this point Wallace remarks that "birds brought up from the egg in cages do not make the characteristic nest of their species, even though the proper materials are supplied them, and often make no nest at all, but rudely heap together a quantity of materials." § He also quotes Wilson as "strongly insisting on the variety in the nests of birds of the same species, some being so much better finished than others, and he believes *that the less perfect nests* are built by the younger, the more perfect by the older birds." ||

* See Ann. and Mag. of Nat. Hist., vol. viii., p. 412. † Wallace, p. 227. ‡ See Loud. Mag. Nat. Hist., vol. vi., pp. 397-8. § Wall., pp. 219, 20. || Id., p. 224. See also an Article by Wallace, on the "Philosophy of Bird's Nests." *Intellectual Observer*, vol. xi., p. 413.

The above facts recorded by different observers—and they are a mere sample of what might be got together on this subject—serve to show that there is a certain amount of variability in the plumage, song, and nidification of our native birds. They are influenced by circumstances; they profit by their experiences; they can learn to do things differently from the way in which they did them formerly; they know how to turn to good account any accidental advantage favourable to the purposes they have in view.

To what extent all this may be carried, and whether the accumulated results of small advances year by year towards an entire change of character, of instincts and aptitudes, may not lead in time to such a divergence as we now see, in so many cases, between two closely allied forms thought to be distinct—this is a question that must be left to be determined by local naturalists in different parts of the country, when they shall have brought a much larger number of facts and observations than we at present possess to bear upon the points at issue.

Let us now pass to the invertebrate division of the animal kingdom. None of the classes of animals in this division offer a more promising field for the consideration of the Darwinian theories than the class of insects. This arises from the circumstance of the immense number of known species of insects, and the still larger number probably which remain to be discovered, from the great variety of forms which every order in the class exhibits, and the remarkable changes which most of the species undergo before arriving at maturity. In the larger families too, the species are not only numerous, but often so variable and connected with each other by such close affinities, that it is extremely difficult to determine them at all, still more to group them into genera. This is particularly the case with the Longicorn Coleoptera, a family of beetles containing 8000 species, in which variability would seem to have attained its highest pitch. Mr. Bates remarks that "if we except the two or three primary divisions of the Longicorns, there is no portion of structure which retains a given form throughout a number of species, sufficient to form a well-defined genus of ordinary length or a group of genera." *

* See his Address to Ent. Soc. Trans., 1868, p. lxv.

We might also refer to the economy and habits of many insects, of those especially living in societies, which taken in connection with the low development of their nervous system, have no parallel in the rest of the animal world.

But no adequate study can be made of the remarkable peculiarities of the insect race, except where the observer is long stationary in a given locality, and content patiently to watch and record what comes under his eye from season to season, while confining his attention, for a time at least, to some particular genus or family. The life-long history of even a single species will throw more light upon our reasonings about development, and do more for the science of entomology than the most extensive collection, in which every insect in the district finds a place without more being known about it than when and where it was taken. Many active workers in this desired way are already in the field, and what sort of work they are doing may be gathered from the papers they have published in the Transactions of different Natural History Societies. There ought to be similar workers wherever there exists a Natural History Field Club.

We have a praiseworthy instance in one of our most distinguished entomologists, Sir John Lubbock, who has devoted much of his valuable time to the study of some of the obscurer forms of insect life, in connection with biological questions of the deepest philosophical import. It is perhaps by the study of the lower forms of animals generally that we shall arrive at any sure knowledge of the laws of development in the higher forms. But it is especially so in the class of insects, where the departures from a given type of structure are much more marked and diverse than among the vertebrate animals, not merely when we compare together orders and families, but when we compare the different stages of development in the same species.

In a series of papers in the Linnean Transactions commenced some years back, Sir John Lubbock has given a detailed account of the *Thysanura* of Latreille, a group of very small wingless insects found in woods and other damp places, low down in the scale of insect life, undergoing no well marked metamorphosis, and by some entomologists hardly accounted as true insects, a group to which few

in our own country besides himself have given any attention. He has carefully described all the species met with in his own neighbourhood in Kent, he has "watched them in their native haunts," noted their habits, "kept them for some time in confinement," experimented upon them in order to ascertain their power of reproducing lost parts, and even worked out all the details of their inmost anatomy, small though they be, and insignificant as they would appear to an ordinary observer.*

In other papers he has traced the whole process of development in a small species of May-fly, *Chloeon dimidiatum*, from birth to maturity, showing that the larva, which is aquatic, passes through no less than twenty changes of form before emerging from the water to assume the winged state, all of which he has described and illustrated by figures. † These numerous changes, which tend very much to modify our old views respecting the metamorphosis of insects, which was generally thought to be confined to the three well-marked stages of larva, pupa, and imago, he considers as having no exclusive relation to the form ultimately assumed, but "bearing reference only to the existing wants" of the insect, and brought about "through the influence of external conditions." And the remarks he makes upon this point, in connection with others relating to the general question—What are the circumstances and conditions which necessitate the striking metamorphoses which most insects pass through? more especially, what calls for that death-like repose of the pupa, sometimes extending over many months, before the imago appears, with structure and habits so entirely opposite to what it had in the larva state?—take us at once to the subject of Darwin's views, whether we accept natural selection, or any other agency, as a right explanation of the matter.‡

* Linn. Trans., vols. xxiii., pp. 429, 589; and xxvi., p. 295; and xxvii., p. 277.

† It has been asserted "that the pupæ of Hymenoptera go through a series of mutations of form, analogous to those of Chloeon, as detailed by Sir J. Lubbock," and Prof. Westwood has "suggested that the hive bee affords a good subject for observations in corroboration of this theory." See *Ent. Trans.*, 3rd Ser., vol. v., Proceed., p. xxiii.

‡ Linn. Trans., vols. xxiv., p. 61; and xxv., p. 477.

In another paper, read to the Linnean Society only last year, Sir John Lubbock has returned to the subject of the metamorphosis of insects, and in connection with it has been led to speculate even on that highest of questions relating to insect life "the Origin of Insects." What may we conceive to have been the parent stock of the whole race? or which of all known existing forms probably most nearly resembles it? He thinks he sees the answer to this question in the *Collembola*, a name applied by him to certain families of the Thysanura described in the series of papers first alluded to, in some of the forms of which group he finds the structure of the mouth intermediate between mandibulate and suctorial, to one or other of which two types the mouth of all other insects may be referred. *

I have dwelt the longer on these papers of Sir John Lubbock, because they afford a notable instance of the way in which Local Natural History may be brought to bear upon some of the great questions of the day in the science of biology.

But there are many other inquiries besides those relating to the development and metamorphosis of insects which suggest themselves to a thoughtful observer. The strange habits of certain species arrest our attention and excite our curiosity to know more of insect life in general. On a former occasion I spoke of the remarkable fact ascertained by Sir J. Lubbock, of a small Hymenopterous insect that swam on the surface of the water by the help of its wings.† We have now on record the still more remarkable case of a winged insect—by some thought to belong to the Phryganeidæ, but more probably a truly Lepidopterous insect, and having wing scales like the Lepidoptera, of the genus *Acentropus*—which is not only born in the water, the larva having gills and feeding on aquatic plants below the surface, but the pupa state is also passed under water,

* Journ. of Linn. Soc. (Zool.), vol. xi., p. 422. See also a Lecture on "Insect Metaphorphosis" by Prof. Duncan, delivered before the British Association, 1872, in which are many details connected with the Development of Insects, with conjectures as to what were probably the earliest forms of insect life from which all others have been derived. "Nature," vol. vii., pp. 30 and 50.

† Proceed. of the Bath Nat. Hist. Field Club, vol. ii., p. 156.

so that the moths themselves are born in the water, and these last have even the faculty of entering the water in their perfect state, having been seen to "creep down a pond-weed stem for an inch or two, emerging again with unwetted wings."*

And then to pass to other questions of more general import. What is the relation of insects to the particular spots in which they are found living? What are the causes which operate in the general distribution of insects? Very many species seem to migrate instinctively at certain seasons, and if carried by storms and adverse winds beyond their mark may easily make their appearance in countries in which they had not been seen before. Many travellers and voyagers testify to having witnessed, on different occasions, countless myriads of butterflies, as well as of other insects, all traversing the air in one direction, the passage of the whole body occupying several hours. The migrations of the locust tribe in the East are notorious. Even in our own country, towards the end of summer, we may often observe large flights of aphides, winged ants, and occasionally insects belonging to other orders, when they have increased beyond their usual numbers, quitting their homes and seeking spots where they may found new colonies. Indeed all insects that are in the habit of taking wing, without any intention of migrating, are liable to be transported by sudden gusts to regions far distant from the places where they were bred, or to be carried out to sea and borne upon "floating timber and other drift materials" to entirely a different quarter of the globe.†

It is perhaps to migration that we are to attribute the circumstance of the appearance in this country, some years in considerable abundance, of certain species of butterfly well known on the Continent, but of which in other years no specimens are to be seen here even for several seasons in succession. Such has been the case this last autumn with the *Vanessa antiopa*, or Camberwell beauty; which "appeared in scattered localities all over the country, the capture of upwards of 200 specimens" having been recorded in different places "from the Channel Islands to Aberdeen." This is usually

* Ent. Trans., 1872, pp. 134 and 138.

† See a Paper on the "Dispersal of Insects," by Albert Müller, Trans. Ent. Soc., 1871, p. 175.

considered as one of our rarest as well as most beautiful butterflies; and it is long since there has been any record of its occurrence in England, with the exception of solitary individuals taken at distant intervals.

If this species comes over to us from the Continent, as some think, it is a remarkable circumstance that nearly all the English specimens "differ in colouring to a perceptible extent from the Continental variety, the border being creamy-white instead of buff-coloured." This, however, may perhaps be explained by the circumstance of their being two broods on the Continent, at least in Silesia, the spring brood "having the border of the wings sulphur yellow, whilst the autumnal brood, like British specimens, have a white margin." It is generally in autumn that the insect appears in this country. If it is a genuine native, the question arises, and it is one not easily answered, what are the peculiar conditions of season or local influences to which we may attribute its very irregular appearance? *

It is more difficult to explain the appearance of insects, naturally stationary, in places where they had not been seen before, especially if apterous, or which having wings very rarely use them. This is a question which calls for close investigation on the part of the local entomologist.

It is also a curious fact, that while a large number of species of insects, irrespective of the causes which first brought them into a particular district, are found generally diffused through it, others are so extremely local as to be confined to a very small space of ground, perhaps to a single field, or to a particular hedge. Haworth, the great Lepidopterist in the early part of this century, alludes to this circumstance in his work, which being very scarce I give the passage at length. He is speaking of the *Papilio cinxia* (the Glanville fritillary butterfly), and he mentions it as one of those insects—"So extremely attached to particular plants and to peculiar situations and places, that a collector on one side of a hedge often finds plenty, while another on the opposite side, the hedge alone intervening, cannot procure a single specimen. They appear to fly up and down, backward and forward, for a few score yards only;

* See "Nature," vol. vi., p. 461; and "Zoologist," vol. iii., p. 888.

playing joyously at intervals with each other; or, gaily perched, sip nectar from their favourite flowers." * What keeps such insects from wandering?

Mr. Bates, in reference to the limited ranges of closely allied species of butterfly in the plains of tropical America, remarks that the most effective possible barriers are sometimes opposed to the spread of species "without any physical barrier existing which is perceptible by our senses." And he believes the explanation of the fact to be—"That there really are subtle differences of physical conditions from place to place, even in a uniform region; slight differences in soil, humidity, succulence of foliage, and so forth, which require in each a readjustment of the constitution of any new immigrants from adjoining areas; but that each area being kept well stocked with allied species already adjusted to its minute conditions, such migration rarely occurs." †

This reasoning would probably be found to apply to numerous cases in our own country, in which we find closely allied species inhabiting contiguous areas of greater or less extent without intermixing; and it is suggestive of many points of inquiry to be made by the local entomologist in connection with the circumstance. Perhaps in the case of the *Papilio cinxia*, alluded to above, we may suppose that, being naturally slow fliers, and meeting with all they require in a particular spot, they have no inducement to leave it, unless their numbers so increase as to oblige them to do so.

There are other remarkable cases in which species met with generally on the coast, and from which they seldom if ever wander, are found to occur in places far inland. Thus it is recorded by Mr. Barrett, an entomologist in the eastern counties, that at Brandon, in Suffolk, he finds several species of Lepidoptera, some in abundance, which have always been considered as "most exclusively coast sand-hill insects;" the soil of Brandon being "a loose light sand, precisely such as is found on the North Denes, at Yarmouth, at the present time." His explanation of the phenomenon, on the authority of an eminent geologist, is "that this

* Lepidoptera Britannica, p. 149.

† Ent. Trans., 1869. Proceed., p. xlvi.

tract of country was actually a range of *coast* sands, at a comparatively recent point of the post-glacial period, while the great valley of the fens was still submerged;" and that the species in question have occupied the ground there from that time to the present. Nor is this the only remarkable circumstance. "They have remained," it is stated, "unchanged in form, and even in colour, all through the changing conditions of life occurring during the upheaval of the fen valley, and the consequent alteration of the coast line, and particularly those caused by the change from the saline influences of the neighbouring sea, to those of a warm inland district." *

This fact is of importance in all discussions about the variation and origin of species, and the more so from the circumstance of most of the lepidopterous insects above mentioned "belonging to large genera of closely allied and abundant species (*Agrotis, Mamestra, Gelechia*), genera such as have been pointed out as most likely to produce new species by natural selection, dominant groups in fact."

And this leads to the subject of variation in insects, and the causes which affect it, while it is suggestive of the amount of information that might be got on these points by local entomologists if they would take up the inquiry.

It was formerly the practice of entomologists to pay very little attention to varieties, and to collect species only, or what were considered such. But it is now found that however fixed in their characters some species may be, as in the case above mentioned, or even whole genera, the greater part are more or less unstable; stability being probably due to the forms in which it prevails having been for a long time back cut off and isolated from their congeners, combined with some peculiar circumstances in the localities to which they have been since confined. Where we find stable and unstable species living together in the same area of dispersal, and exposed to the same physical influences, we must look to their economy and habits, or to peculiarities of structure, if existing, as affording the only probable hope of explanation of the phenomenon.

* Trans. of Norfolk and Norwich Naturalists' Society, 1870-71, p. 61.

We must see, then, the importance of getting together in our cabinets in all cases as large a number of varieties as can be obtained. It is by the study of these alone, in connection with the particular circumstances under which they are found living, that we can arrive at any theory of variation, much more approach the question, how species have originated ?*

Britain is said to be considered by foreign entomologists as rich in varieties ; and Mr. MacLachan, who has paid great attention to the variation of Lepidopterous insects, attributes the circumstance as "due, 1st, to our insular position ; 2ndly, to our anomalous and variable climate, and 3rdly, and perhaps chiefly, to the diversity in the geological structure of these islands." † He doubts, himself, the influence of food in causing variation ; at least he doubts its influence on the imago, though he seems to think it may have some effect upon the larvæ or caterpillars, the colours of which often assimilate themselves to those of the plants on which they subsist, being a case of mimicry for protective purposes. Other entomologists, however, are of a different opinion on this last point. Professor Westwood has recorded an instance in which there would seem to have been clear evidence of the influence of food upon the perfect insect. A number of caterpillars having been hatched from a particular lot of eggs of the *Liparis dispar*, or gypsey moth, they were divided into two portions, some being fed on elm, others on whitethorn. There was no difference in the larvæ, cocoons, or pupæ ; but the male moths fed on elm were larger, and the colours

* So long back as 1839, Isidore Geoffroy St. Hilaire spoke of the importance of attending to local varieties of animals, and appreciating those slight differences arising from the influence of local circumstances "tending to establish the passage of one species into another." He considered such inquiries as possibly one day affording a key to the solution of the difficulties which beset the study of zoology, and an answer to "important questions affecting the very philosophy of science." He says, "if it be of importance to zoology to enumerate animal species with exactness, and carefully to note the differences which distinguish them, are not the origin and formation of species, the nature and causes of their differences, likewise questions of real, nay, of immense interest." This was written twenty years before the publication of Darwin's "Origin of Species."—See Edinb. New Phil. Journ., vol. xxviii., pp. 55 and 65-67.

† Ent. Trans., 3rd Ser., vol. 2, p. 458.

much darker and richer, than the males of those fed on whitethorn. The elm-fed females were not so large as those of the hawthorn-fed larvæ; and most of them were crippled and imperfectly developed. There were also many of the whitethorn-fed females crippled; and the whole experiment went to show that had the species depended solely on the existence of either elm-fed or whitethorn-fed individuals, it would probably have soon degenerated or become extinct.* Further experiments on this point, carefully conducted, are much needed; and it is just the inquiry for the local entomologist to take in hand, rearing from year to year successive broods of the same species, feeding the larvæ upon such different plants as they can be got to eat, taking care to preserve all other conditions the same, and then from time to time noting down the results.†

Cases of variation, however, and to a great extent, have been known to occur in some species of moths among specimens reared from the eggs of one parent, even when all were fed upon the same food. Mr. MacLachan mentions that of the *Sterrha sacraria*, L., in his paper above alluded to on the variation of the Lepidoptera. He has there described and figured a series of varieties of this moth so remarkably different from each other, that had they been taken separately on the wing, instead of having been brought up by the hand, it is not likely that any one of them would have been referred to the species from which the eggs had been obtained. And this fact leads him to think that several supposed foreign species which he notices are in like manner all one and the same, and identical with the *S. sacraria* of this country, from which the above varieties were derived.‡

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* See Ent. Trans., 3rd Ser., vol. v., Proceed., p. xliv. Id., vol. i., Proceed., p. 15.

† Other experiments might be made in reference to the influence of the various rays of light upon the larvæ of butterflies and moths. See a case mentioned in the "Zoologist" (vol. iii., p. 1198), in which several caterpillars of the peacock butterfly *(Vanessa io)* were confined in different boxes covered with glass of different colours. This treatment seems to have affected the development and colours of the imago. Some that were kept wholly in the dark produced butterflies in general larger than the others, and their colours brighter. Other results are recorded, though not very decisive ones.

‡ Ent. Trans. 3rd ser., vol. ii., p. 453., pl. xxiii.

That climate is a more powerful and a more frequent cause of variation than food, would appear from several facts adduced by Mr. MacLachan as well as others. In the above paper Mr. MacLachan gives instances of more than thirty species of Lepidoptera, in addition to some whole genera, which become more or less "melanised" when occurring in the North of England or Scotland, "the darkening becoming more marked the further we proceed northwards." * On the other hand, he says "there are a few species which become *paler* the further we proceed north." A yet more remarkable fact has been noticed in the Shetland Isles, where "locality actually changes and confuses the normal sexual variation in the colour;" a form of *Hepialus humuli* (ghost moth) being met with there, in which the male is coloured the same as the female, the fine white silvery hue, which characterises the male in England, being entirely lost. Variation is found also to extend to other particulars beside colouring. It has been observed that some species "which are double brooded in the South of England have only one brood in Scotland." It has been also said that "many species in Scotland habitually remain there in the pupa state for two or three years, although in the south this would form quite the exception to the same species;" and it is thought that "this retardation of development may probably have some effect in causing variation."

Without reference to locality, it is a well-known fact that some species which are variable in the larva state are constant in the imago, and, on the contrary, that others which "are very variable in the imago state, are constant, or nearly constant in the larval."†

Variation in insects prevails mostly in species which are widely dispersed. This we might expect; as, when spread over a far-extended region, they are exposed to very varying conditions of life. But Mr. Wallace tells us that "what is commonly called variation consists of several distinct phenomena which have been too often confounded." These he enumerates as, "1st, simple variability;

* A similar remark is made by a writer in the "Zoologist," (p. 1731), who thinks, however, that "this deep colour is given them by the quantity of iron in the soil, which is taken up by the vegetation on which they feed."

† Ent. Trans., 3rd Ser., vol. ii., pp. 460 and 465.

2nd, polymorphism ; 3rd, local forms ; 4th, co-existing varieties ; 5th, races or sub-species ; and 6th, true species." The first is the case of those insects " in which the specific form is to some extent unstable," differences of form continually arising, between which there are gradations that are not capable of being easily defined. By *polymorphism* or *dimorphism*, he understands " the co-existence in the same locality of two or more distinct forms, not connected by intermediate gradations, and all of which are occasionally produced by common parents. These distinct forms generally occur in the female sex only." Mr. Wallace believes " it will be found that a considerable number of what have been classed as varieties are really cases of polymorphism ;" and this may be suspected in most instances " in which well-marked varieties occur in company with the parent species, but without any intermediate forms." *Local forms* " constitute the first step in the transition from variety to species." They " occur in species of wide range, when groups of individuals have become partially isolated in several points of its area of distribution, in each of which a characteristic form has become segregated more or less completely." On *coexisting varieties*, or cases in which a slight variation of form " exists in company with the parent or typical form, without intermediate gradations," he does not lay much stress as of doubtful occurrence. *Race or sub-species* is the name applied to " local forms completely fixed and isolated," and it is a mere matter of opinion which are to be " considered as species and which varieties." *

The above distinctions should be carefully attended to by the local entomologist. For though Mr. Wallace's observations in the paper referred to below, relate to the Papilionidæ alone, he has no doubt that facts similar to those he has collected would " be found to occur in other groups of insects, were local faunas carefully studied in relation to those of the surrounding countries ; and they seem to indicate that climate and other physical causes have, in some cases, a very powerful effect in modifying specific form and

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* See Mr. Wallace's instructive paper, " On the Phenomena of Variation and Geographical Distribution, as illustrated by the Papilionidæ of the Malayan Region."—Linn. Trans., vol. xxv. p. 5.

colour, and thus directly aid in producing the endless variety of nature."

"Local forms" are perhaps what are most likely to come under the notice of the local entomologist, or what at least he should look for, reference being had to the physical and geological features of particular situations. Sand-hills and sand-plains, chalkpits, marshy spots, the undrained residuum of extensive fens that existed formerly, but which have long since disappeared, mountainous ravines and glens, or hills composed of the older rocks thrown up amid the newer; all these places not only have their peculiar species, but are likely to impart a peculiar character to other species also found in them, though at the same time free rangers over the country around.* It needs, of course, much inquiry and comparison to ascertain the fact of such peculiarities, for which it is necessary to examine other local collections; and any similar conditions of soil, &c., occurring in two different localities in which the same form prevails should be carefully noted.

Cases of "dimorphism" and "polymorphism," which have only of late years attracted the attention of naturalists, and which are now found to be so frequent both in the animal and vegetable kingdoms, should be equally sought for, and wherever suspected to exist, the economy and habits of the species in question must be closely looked into, which will often throw light on the phenomenon.

We are all familiar with the phenomenon itself as exemplified in some of the social Hymenoptera; the hive-bee, for instance, in which there is a second imperfect form of the female, the neuter or worker bee; and the different species of ants, in which we find three or more distinct forms associated together in the same nest, each form being "specialised to a distinct function in the economy of the species." British coleopterists in this country have also long

* Thus *Elaphrus riparius* in sandy districts is said to be "of a clear brown colour, in meadow lands green."—Ent. Trans., 3rd Ser., vol. v., Proceed., p. cxxiv. *Gnophos pullata* is said to be "found nearly white on the chalk downs, and to vary from nearly white to sooty black according to the geological formation of the locality where it occurs." Again, *Apion germari*, when found on *Mercurialis perennis* to be constantly of one form, and when found on *Mercurialis tomentosa* constantly of another form."—Ent. Trans., 1870, Proceed., p. xiv.

noticed the fact that some of the larger water-beetles belonging to the genus *Dyticus* "have females of two forms, the most common having the elytra deeply sulcate, the rarer smooth as in the males." Mr. Wallace remarks that it is in "the female sex alone that these distinct forms generally occur;" and in his work on "Natural Selection" he has largely illustrated this fact by reference to the Papilionidæ of the Malay Archipelago. He has even suggested the way in which "dimorphism may be produced." Taking the case of a particular species of butterfly found in most of those islands, and in which there are two extreme forms of the female, one occurring in Sumatra, the other in Java, Borneo, and Timor, he goes on to remark that an allied species is found in the Phillipine Islands with the same two extreme forms of females, along with a number of intermediate varieties. If then we suppose "the extreme Phillippine forms to be better suited to their conditions of existence than the intermediate connecting links, the latter will gradually die out, leaving two distinct forms of the same insect, each adapted to some special conditions. As these conditions are sure to vary in different districts, it will often happen, as in Sumatra and Java, that the one form will predominate in the one island, the other in the adjacent one."

The same reasoning might be found to bear upon cases of dimorphism in the British Isles, or in different localities in England, and serve perhaps to explain the marked variations of form and colouring that occur in certain species of our own Lepidoptera, the varieties being sometimes widely apart, and confined to very limited districts.

A remarkable case of dimorphism in a British moth (*Acronycta leporina*) was not long since exhibited to the Entomological Society, "the right hand wings being coloured and marked as in the variety known as *bradyporina* (at one time considered a distinct species), whereas those of the left hand were entirely typical of *leporina*. The body also partook of the two forms, being divided longitudinally into two tints."* This circumstance is of much interest, as not only speaking to the fact of the existence of dimorphism, but as presenting us with a clear case in which two varieties of a moth,

* Ent. Trans., 1872. Proceed., p. x.

considered, at a time when dimorphism was unknown, as distinct species, are proved to be the same. It encourages us to search for other cases of variation, in which dimorphism may play a part, though not hitherto suspected.

Mr. Wallace considers as "analogous" to dimorphism, though "not of an identical nature" with it, the phenomenon of the dissimilarity of the spring and autumnal broods in many species of the Lepidoptera which have two broods in the year. It is one that a local entomologist may investigate with advantage. He can ascertain what species there are in his neighbourhood having this habit; observe whether the differences in the two broods are constant from year to year; whether they vary according to the character of the season;* whether they are found in both sexes alike; whether there is any difference in the food of the larvæ of the two broods, or other circumstances that throw light upon the question.

Leaving the subject of variation, I proceed to notice another matter for inquiry likely to yield important results, if taken up by the local entomologist, namely, all that relates to the reproduction of insects. Many anomalies in this part of their history have been noticed of late years, and there are probably others as yet unobserved, showing how imperfect our knowledge is on this subject, and how mistaken were some of the views formerly entertained. It was at one time generally supposed that among insects, as is universally the case among vertebrates, there could be no continuance of the species without the united influence of the two sexes. And no doubt this is the general rule, but there are many exceptions to it. The phenomena now comprised under the names of parthenogenesis, pseudo-parthenogenesis, and metagenesis, lead us to the knowledge of other ways in which "the production of new organisms is carried on," and involve considerations that tend to enlarge our views respecting development.

We have an example of pseudo-parthenogenesis in the case of

* The occasionally dwarfed size of certain species of butterfly has been attributed in some instances to peculiarly hot seasons, as in 1868.—If this be correct, it shows that seasons do exercise an influence according to their character. See Ent. Trans. 1868. Proceed., xxxviii.

Aphides, where there is a succession of generations of imperfect females, viviparously produced, derived from fertilised eggs laid in the spring by perfect females, the last generation in the series giving birth in the autumn to both perfect males and perfect females.* True parthenogenesis is the case in which reproduction is carried on for a longer or shorter time by unimpregnated females. In some instances this parthenogenesis is exceptional, as in the case of the silkworm-moth, only taking place under particular circumstances. In a few other Lepidoptera it "appears to be the normal process." †

It is not known within what limits parthenogenesis may continue to be carried on where no access to the male can be obtained. Very few experiments have been made in reference to the question. In a case, however, recorded in "Nature," in which some very carefully conducted experiments were made by a Dutch entomologist upon *Liparis dispar*, it was found that "after the first impregnation of the female, in the autumn of 1866, three successive broods of caterpillars, and ultimately of moths made their appearance; and four successive times eggs were laid without further impregnation, in three of which they proved endowed with vitality." As the writer of this notice justly observes, the value of these experiments is very great, "as bearing on the theories of spontaneous generation;" and they are so easily conducted that they commend themselves to all those disposed to help in carrying on the researches which science needs at the present day,—who are unable perhaps to do much, but who from local circumstances can best undertake such investigations as the above. ‡

There is also a remarkable form of reproduction recently ascertained to exist in certain Diptera, to which has been given the name of "internal metagenesis," to distinguish it from ordinary metagenesis, such as occurs in the Polypi and other low forms of animal life, which propagate by budding outwards. Here the larva

* For a full account of the nature of the process of development in the Aphis, see two memoirs by Professor Huxley in Linn. Trans., vol. xxii., pp. 193 and 221. † Herbert Spencer, Princ. Biol., vol. i., p. 215.

‡ See "Nature," vol. v., p. 149. Also vol vi., pp. 483 and 523, where a detailed and interesting account is given of the latest researches on the subject of "true parthenogenesis" by Siebold, who was the first to demonstrate

of a species of *Cecidomyia* "develops in its interior a brood of larvæ of a like structure with itself," these again giving birth to other larvæ in succession. It is thought by Herbert Spencer that, as in the case of the Aphides, the fact may be explained by the circumstance of there being "abundant food combined with low expenditure." The larvæ of the Cecidomyia "are found in such habitats as the refuse of beet-root sugar factories, where each of them has a practically unlimited supply of sustenance imbedding it on all sides." * If this be the explanation, it seems not at all unlikely that internal metagenesis may prevail in the case of many other insects, the larvæ of which are similarly circumstanced, and such cases should be diligently sought for by the local entomologist and carefully looked into.

Sir John Lubbock considers this case of the larvæ of the Cecidomyia as "a distinct case of alternation of generations, as characterized by Steenstrup." And he thinks "probably other cases will be discovered in which insects, undeniably in the larval state, will be found to be fertile. It even seems to him possible, if not probable, that some larvæ which do not now breed, in the course of ages may come to do so." †

And there are yet other cases of abnormal reproduction which have been noticed of late years equally at variance with our preconceived ideas on the subject. Two instances are on record of viviparous insects; *i.e.*, insects in the *perfect* state, instead of depositing eggs, producing living larvæ. One of these is that of a species of Tinea *(Tinea vivipara)* found in New South Wales. ‡ The other that of a small species of *Staphylinus* found in the nests of the *Termites*, or white ants, in Brazil. § It is true these are both cases of foreign insects, but there is no *a priori* reason why

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the occurrence of this phenomenon in moths and bees. In a recent work he has recorded many new observations in support of "his position that not only do unimpregnated eggs develop into perfect animals, but that such an event is by no means an exceptional occurrence among certain groups, and has a definitely-fixed and orderly recurrence amongst them."

* Princ. of Biol., vol. 2, p. 467. † Linn. Trans., vol. xxv., p. 488. ‡ Ent. Trans., 3rd Ser., vol. i., Proceed. p. 153. § Nature, vol. iii., p. 330.

the same phenomenon might not occur in this country, and it is one that it would be interesting to discover.

Another circumstance connected with the subject we are considering, which has not been satisfactorily explained and needs further investigation, is the fact of a large proportion of the females of many Lepidoptera, especially those of the larger *Sphingidæ*, when bred in the autumn, being perfectly barren. Some have thought this to be a provision of nature, in the case of double brooded species, to meet the circumstance of the scarcity of the right sort of food for the larvæ, if hatched in large numbers, at a season when the leaves are about to fall. But this can hardly be sustained; it having been observed by others that though "the females of some species are mostly barren when disclosed in the autumn, in cases where there are two distinct broods of a species, a vernal and an autumnal brood, both are fertile."* It is clearly a physiological phenomenon only to be elucidated by a series of observations continued for several years, and extended to a large number of species, all particulars respecting time, place, character of the season, condition and sex, being carefully noted down.

Another remarkable phenomenon in the history of insects, and well worth the attention of the local naturalist is the fact of the extreme disproportion of the sexes in some species, so far beyond anything that occurs in the higher animals. It is allied to the phenomena before treated of, so far as it may be due to parthenogenesis or perhaps to dimorphism. Instead of the sexes being pretty equally balanced in numbers, as we might be led to expect, in certain cases we find the males largely predominating over the females, or on the contrary the females over the males. Mr. Darwin, in his last work on the "Descent of Man," has gone very closely into this subject, and collected a large number of instances in point.† "From various sources of evidence, all pointing to the same direction, he infers that with most species of Lepidoptera, the males in the imago state generally exceed the females in number, whatever

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* Ent. Trans., 2nd Ser., vol. 4., Proceed. pp. 72, 73. † Vol. 1, pp. 309-314.

their proportions may be at their first emergence from the egg." With reference to the other orders of insects, he has not been able to get much reliable information; but he mentions some instances among the Coleoptera, in which the males are thought to be much more numerous than the females; others in which the females are greatly in excess over the males. As an instance of the latter he quotes a statement made by Mr. Janson to the Entomological Society, "that the females of the bark-feeding *Tomicus villosus* are so common as to be a plague, whilst the males are so rare as to be hardly known." * In the orders of Hymenoptera and Neuroptera he adduces many instances of the same extreme disproportion, sometimes one sex and sometimes the other predominating. "In some European species of *Psocus*, thousands of females may be collected without a single male, whilst with other species of the same genus both sexes are common."

There is one group of Hymenoptera, the gall-making *Cynipidæ*, in which the males of some species "have never been discovered or are excessively rare," and which, from the great ignorance in which we are with regard to many parts of their economy, call for particular investigation. The habits of an American species found on the Black Oak *(Quercus tinctoria)* are thus described by Mr. Walsh. "The Oak-apples are first observed in May, and reach their full growth in a few weeks; by the middle of June, male and female gall-flies emerge from a small proportion of them, say one-fourth; the remaining three-fourths do not develop flies until the autumn, and then produce gall-flies closely allied to, yet quite distinct from those produced in June, and out of thousands of the autumnal flies examined not one was a male." From the result of many experiments in the breeding of these gall-insects, Mr. Walsh was led to infer that "the two forms were not distinct species, but dimorphous forms of the same species." †

The account of this insect, though a foreigner, deserves notice, from its giving us a clue which may be serviceable in working out the history of some of our own native gall-flies, and it is not at all unlikely that dimorphism will be found to prevail in many other

* See Ent. Trans. for 1868, Proceed. p. x.

† Ent. Trans. for 1869, Proc. p. xii.

species besides the above. Also it is of the more importance to get at the true economy of this family of insects, from the damage done by some species to our forest trees. A few years back the oaks in this country suffered greatly from their attacks, and I believe the evil still prevails in places. The young shoots and leaves were loaded with galls of the size of hazel nuts caused by the punctures of the parent insects, the gall being both the nidus and the food of the larva; and the healthy growth of the trees in young plantations was much interfered with by these abnormal excrescences. Whether the particular species of gall-fly in this instance was actually new to this country or not I am ignorant, but it does not appear to have been noticed before in such abundance; it came like a plague, appearing first in the western counties and gradually spreading from thence in different directions. It was in Devon in 1853, the following year in Somerset, and all the woods about Bath were full of it as I myself witnessed; in 1855 and 1856 in Gloucestershire, in 1857 in Worcestershire, and within three or four years afterwards it had reached N. Wales, Sussex, and Kent. *

There is yet another subject to which I would briefly call the attention of the Local Entomologist, as one which we cannot as yet be said thoroughly to understand, though different theories have been put forth to explain it, and that is mimicry. This name, as many are aware, has been applied to cases in which we find certain species of animals adopting the form and colouring of other species to which they bear no direct affinity; so that in a general way and without close examination we might easily be led to mistake one for another. Such cases of similarity are sparingly met with in many very different classes of animals, but it is amongst insects, and especially the diurnal Lepidoptera, or *Papilionidæ*, that they are found to prevail most. They have been long known to Naturalists, and at one time attracted much attention, as relations of analogy, a name given to them, in contradistinction to relations of affinity, by Macleay and Swainson, who brought

* This gall-fly is alluded to by Sir John Lubbock (Phil. Trans. 1857, p. 95), under the name of *Cynips lignicola*, and he remarks that among "several thousand specimens not a male occurred."

them to bear upon their peculiar views respecting the classification of animals. It is to Mr. Bates, and to his observations on the butterflies of S. America, embodied in an able and elaborate paper in the Linnean Transactions * that we are indebted for those details on the subject which have given it so much attraction of late years, and which have led to a reconsideration of the causes to which mimicry may be attributed and the object of its existence. Darwin and Wallace have followed in the inquiry, the latter gentleman especially testing, by the results of his own observations in the Malay Archipelago, the correctness of the theory by which Mr. Bates would explain the circumstance. The explanation rests on the belief that the imitation is for protective purposes, and that it is gradually brought about by natural selection seizing hold of any little accidental variations in the form or colouring of the mimicker, by which it makes the slightest approach towards the species mimicked, and constantly increasing the variations in that direction until the two species are outwardly similar. The mimicked and mimickers are almost always found together in "the same district, and in most cases on the very same spot;" the former being in much larger numbers than the latter. Mr. Wallace observes "that the forms imitated always belong to dominant groups, or those excessively abundant in species and individuals, and therefore presumptively free from the attacks of those insect-enemies that keep down the numbers and threaten the extinction of other species." In some cases it is thought to be a powerful odour emitted by species enjoying this immunity which serves for their protection. Where this is the case, other species not possessing this odour, and therefore more often falling a prey to birds, would have great advantage in assuming the colour and markings of the species mimicked so as to be mistaken for it, and to escape being devoured.

For further illustration of this subject the reader is referred to Mr. Wallace's book on "Natural Selection," where ample details are given.† All the most striking cases of mimicry among the Lepidoptera hitherto recorded are from the tropics. Not many

* Linn. Trans., vol. xxiii, p. 495. † Contributions to the Theory of Natural Selection, p. 75, &c.

have been noticed in this country, but this may be from insufficient search after them. One instance of probable mimicry is mentioned by Mr. Wallace, that of "a very common white moth *(Spilosoma menthrasti)* which was found by Mr. Stainton to be rejected by young turkeys among hundreds of other moths on which they greedily fed. Each bird in succession took hold of this moth and threw it down again, as if too nasty to eat." Its odour or taste evidently serves to protect it from its enemies. Now there is another white moth *(Diaphora mendica)* appearing about the same time as the Spilosoma menthrasti, of about the same size, and sufficiently resembling it in the dusk, whose female only is white, * and this moth is much less common. And he thinks it not improbable that these two species may stand to each other in the relation of mimicked and mimicker. He even goes so far as to anticipate that all white moths, if at the same time very common, will be found to be generally rejected by birds, "because white is the most conspicuous of all colours, and had they not some other protection would certainly be very injurious to them." † This is a matter of trial and experiment for the Local Entomologist and is suggestive of other experiments. It leads to the general inquiry what are the species of moths and butterflies eaten with avidity by birds, and what species are rejected, also whether the same rule holds with the caterpillars that holds with the perfect insects, and what is the degree of frequency or infrequency of occurrence in the case of each particular species, or the circumstances of locality, &c., by which it is conditioned. This enquiry has been already taken up by a few Entomologists, but it needs to be continued by other observers, and in reference to a larger number of species of birds and insects than have hitherto been experimented upon. ‡

The above remarks relate to Lepidopterous insects exclusively.

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* p. 89.

† See Wallace's remarks on "Mimicry by Female Insects only," p. 110.

‡ See two important papers on this subject, one by Mr. Jenner Weir "On Insects and Insectivorous Birds; and especially on the Relation between the Colour and the Edibility of *Lepidoptera* and their Larvæ" : the other by Mr. A. G. Butler, containing "Remarks upon certain Caterpillars, &c., which are unpalatable to their enemies." Ent. Trans., 1869, pp. 21 and 27; also another paper by Mr. Jenner Weir, on the same subject. Ent. Trans., 1870, p. 337.

There are other cases in which the mimicked and the mimicker belong to distinct orders of insects. Among the Lepidoptera, there are "two families of day-flying moths, the Sesiidæ and Ægeriidæ, particularly remarkable in this respect from their strange resemblance to stinging Hymenoptera." There are several dipterous insects also so extremely like bees and wasps as often quite to deceive persons who are not entomologists. In these and numerous other examples that might be adduced, the object of mimicry no doubt is to give immunity from attacks, being probably connected with the habits of the mimicker, and its dependance in some way upon the species mimicked for carrying out the conditions of its existence, as in the case of "flies whose larvæ feed upon the larvæ of bees," and who by their resemblance to these last "can enter the nests unsuspected to deposit their eggs."

Mimicry shows itself also in the form and colouring of insects being adapted to the surrounding conditions of the spots which they inhabit. Caterpillars are often found so closely resembling twigs of wood, or so exactly the colour of the leaves of the plants on which they feed, as to deceive the most practised eye. If this is for protection against enemies it would be curious to ascertain how it would be with a succession of broods raised under artificial conditions, where no enemies could come, or when brought up on other food.

In like manner the *Cicindela campestris* (tiger beetle), and some other insects found on grassy plains, are of a bright green like the grass itself. Other insects are of the colour of dead leaves, or resemble small lumps of dirt. Certain moths, which are in the habit of resting upon the bark of trees during the day time, can hardly be distinguished from the lichens which grow close by. Such might easily escape the notice of birds, which are much influenced by colour in the selection of insect food.

Nor is mimicry confined to insects. Birds inhabiting sandy plains conform to the colour of the ground in the general colouring of their plumage. Many animals in northern climates are white, or, like the hare and ptarmigan, turn white in winter, and are then hardly distinguishable upon the snow. Even in our own country,

in severe winters, the stoat, or ermine as it is then called, assumes a white dress, the white being more or less pure according to the character of the season.

In fact cases of mimicry, of one sort or another, occur throughout the whole animal kingdom. Some of these resemblances may be due to accident. In many instances, however, mimicry must afford some protection to the mimicker against the attacks of its enemies, though it may be questioned whether "natural selection" is sufficient to account for its origin, and whether some other cause must not be sought for and brought in fully to explain the phenomenon. The whole subject needs further inquiry.*

Below insects there are few classes among the Invertebrata which call for particular consideration in this paper. The myriads of forms inhabiting the sea do not form part of our subject. There still remain, however, certain groups of invertebrate animals, found either on land or in fresh water, which the local naturalist should attend to, though the species are few compared with those of insects, while their instincts and habits offer less variety to the observer. The Entomostraca, Annelida, Entozoa, and Mollusca, all open up to him an important field for investigation, in which there is much yet to be done and learnt for the furtherance of biological science. In reference to the Entomostraca, which abound in our ponds and ditches, he will do well to read Sir J. Lubbock's admirable memoir on the *Daphnia* (water-flea),† which is a model for those who desire to take up the study of the structure and habits of these aquatic animalculæ.

Fresh-waters indeed, no less than the sea, teem with life, and deserve all the more consideration, as not merely having a fauna of their own, consisting of species which never quit the water at any period of their life, but as being the nursery of many other species, mostly belonging to the class of insects, which are born in

* See Wallace, p. 108, for some of the objections that have been made to Mr. Bates' Theory of Mimicry.

† Phil. Trans. 1857, p, 79.—See also another paper by him "on some new or little-known species of fresh-water entomostraca." Linn. Trans. vol. xxiv., p. 197. Baird's work on the British Entomostraca, published by the Ray Society, should also be consulted.

the water and pass there the first and often the longest part of their existence, though they leave that element when arrived at maturity.

The Mollusca, too, must not be passed over, though by far the greater number of species in this large group are marine. A few are found in fresh water; more upon land. And there is one circumstance connected with these last which I think deserves mention, as showing that the distinguishing characters of animals are affected by the medium in which they live, and so far of importance in respect to the Darwinian theory, viz., that the land species are as a whole less variable than the aquatic.* Of land shells in this country we have about 65 species; and there are scarcely more than 10 of these which present any difficulty in the determination of the specific characters, the most variable being the *Succineæ*, which though not actually aquatic, are always found in the neighbourhood of water, and often upon aquatic plants. Among the true aquatic shells, less numerous than the land, a large proportion are variable; and in many instances there is difference of opinion among conchologists as to what are to be accounted species and what are varieties, the variation being especially noticeable in the fresh-water bivalves, one-half at least of which have been split into two or more species according to the views of those who have made a study of them. It is also observable how, even in the case of those aquatic shells about which most are agreed, we find the species varying according to the nature of the water in which they live, rapid streams generally having the effect of making the shell smaller, and the valves of bivalves thicker and stronger, and often more rugged outwardly; the same shells in stagnant waters growing to a much larger size, with the valves thinner and of a more delicate texture.

* See, however, an important article in "Nature" (vol. vi., p. 222) on the variation of land-shells, as illustrated in the *Achatinellidæ*, in one of the Sandwich Islands; where a remarkable number of species and varieties of the group in question are found within a very limited area, being much influenced in character by the circumstances of their geographical distribution.—Though relating to a single family of shells in a distant region of the globe, the statement is suggestive of what might come of a more close inquiry into any other group similarly studied in any other locality.

It is very probable too that something depends upon the quality of the water. In a paper read to the British Association at Brighton last August by Prof. Semper "On the normal and abnormal growth of Lymnæus," it is remarked that "separated individuals grow more rapidly than those remaining and reared in company together," though all are reared under the same conditions as regards water, food, and temperature. And it is suggested "that there may exist in the water a substance, probably chloride of calcium, the presence of which, at a certain low per centage, will determine the growth of the animal."* This is a fact not to be lost sight of by those who make a study of the fresh-water shells of any particular district.

I have thus gone over some of the chief matters for inquiry to be attended to by the local Faunist, in order that his researches may be available for the furtherance of modern science. It may be useful to recapitulate them. In a general way, then, we want a detailed account, not merely of the species of animals found in a particular district, but of the varieties of each species, and this especially in the class of insects. We want to know how far these varieties can be traced to local circumstances, and for this purpose to have them compared with others of the same species met with in other places. We want a record of any changes noticed from time to time in the habits and instincts of animals, especially as to how far they can accommodate themselves to new conditions of life forced upon them by accident; any variations in their food, or mode of obtaining it, or mode of defending themselves against their enemies.

In birds, we want a register kept of their movements, whether migratory or otherwise, strict account being taken of the appearance of any new species in the district, or of the disappearance of old ones; details respecting variation of plumage, especially in birds of passage, as also in those species whose plumage is subject to sexual or seasonal changes; times of commencing and ceasing song, with record of any variations in the note of particular individuals; any variations in the manner of making their nests,

* See "Athenæum," No 2340 (Aug. 31, 1872) p. 276.

or in the materials employed; we may mention also remarks on the habits of species in captivity compared with the same species at liberty.

In the amphibious reptiles, it would be desirable to have further observations as to whether under any circumstances metamorphosis is arrested, and the adult state never arrived at; or, on the other hand, whether in some cases they are not born adults as regards form and structure, the larva state being passed over altogether.

In insects, we need a closer investigation of their economy and habits, especially of those that live in societies; of their structure, development, and transformations. We desire to know the relation of insects to the particular localities they inhabit; how far their characters are influenced by climatal or geological considerations; to what extent variation is connected with wide diffusion of the species, and whether in any cases it is dependent upon the food of the larva, or on the season of hatching in double-brooded species. We want more facts throwing light on dimorphism and polymorphism; a record of any cases of abnormal modes of reproduction; inquiry to be made into the cause of barrenness in the females of autumnal broods of Lepidoptera; also respecting the relative numerical proportion of the sexes in all insects generally; this last question to be especially taken up in the case of the gall-making Cynipidæ, in connection with their economy. Lastly, the whole subject of mimicry, not merely as it occurs in insects, but in all other classes of the animal kingdom as well, calls for much further and long-continued attention in order to be thoroughly understood.

It is not expected, nor is it to be desired, that any one observer should take up all these questions at once. The science of biology will be best promoted by his selecting such as fall in with his particular taste, the knowledge he already has of the subject, and the habits of research he has been most used to. But, having made his choice of one or more according to circumstances, let him give his chief attention to these points, only gathering information on others as it may come to hand. There is enough in any one of these inquiries to employ the leisure hours of a man's life if he

will give his mind to it. Results of value, however, can only be obtained after many years of close observation, carried on for the most part in the same locality. It is the Local Faunist to whom I particularly address myself in this paper; and such surely there ought to be—many we might suppose—in every Local Natural History Society.

And here I might stop, did I not feel that this paper would be imperfect if it had no bearing on the Fauna of the district, which it belongs to our own Field Club to investigate. Before concluding, therefore, I would say a few words respecting the Zoology of the West of England, stating more especially what has been done towards a knowledge of the animals found about Bath. Having spent all the first part of my life in Cambridgeshire, while for the last twenty years I have been resident in the Bath neighbourhood, it has afforded me an opportunity of comparing in a general way the Fauna of the Eastern counties with that of the Western.

Our knowledge of the actual species of animals met with round Bath rests mainly on the lists furnished by Mr. Charles Terry to "Wright's Historic Guide to Bath."* These lists embrace the Mammals, Birds, Fishes, Reptiles, and Lepidopterous Insects. The mammals amount to 29; to which not many additions are likely to be made, except in the bats, of which there are a considerable number of species in Great Britain, and several others are likely to occur in this neighbourhood besides those mentioned by Mr. Terry. On some of the species mentioned in his list I will make a few remarks. The *Vespertilio emarginatus* is a species ill understood; first described by Geoffroy in France, and it must be considered a very doubtful native of the Bath district, if really found in this island.†

The common bat of Mr. Terry is probably not the Pipistrelle, of which I have seen only one or two Bath specimens, though

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* Pp. 415-446.

† See some remarks by Mr. Tomes on this species of bat, which he does not believe to occur in the British Islands. He is of opinion that the *Vespertilio mystacinus* has been mistaken for it. Proceed. Zool. Soc., 1858, p. 80.

extremely common in Cambridgeshire, but more likely the *V. mystacinus*, which he has not included in his list, and which though rare in Cambridgeshire, seems to be of frequent occurrence in Bath, many individuals having been brought to me captured in shops and houses. The genus *Rhinolophus*, containing the two horse-shoe bats, is unknown in Cambridgeshire. The Great Horse-shoe is met with in some other of the eastern and south-eastern counties; but the Lesser Horse-Shoe seems to be confined to the West. Both species I believe occur in the hollows of Hampton Rocks, and some other places.

The Black Rat, no doubt formerly plentiful in the old city of Bath, must be very rare now if not extinct; the brown Norway rat, a more powerful animal, having, as in so many other towns, taken its place. The Oared Shrew, *Sorex remifer*, I consider as only a variety of *S. fodiens.*

The Badger and Otter seem to be more frequent about Bath than in Cambridgeshire, where both animals have become very rare.

The bird fauna in Mr. Terry's list numbers 159 species; many more probably occur as occasional visitants, if not constant residents. As some species in their flights range over a wide extent of country, and are much less locally fixed than other animals; no result of any value can be got by comparing the eastern and western counties in this class with reference to Mr. Terry's list alone. It will be better here to take for our standard of comparison Smith's Birds of Somerset,* which enables us to set county against county. The number of birds in Cambridgeshire, when I left that part of England, amounted to 225 species; of these 105 were land birds and 120 aquatic. The number found in Somerset, according to Smith, is 215 species, 115 being land birds and 100 aquatic. Thus it appears there is no very marked difference between the two counties in this respect; east and west fare much alike, proximity to the Bristol Channel, Glastonbury and Shapwick Moors, and other moors in the county of Somerset, attracting many water birds, and proving an equivalent to the fens of Cambridgeshire. The parallel is equally exact, or very nearly so, if we take the orders

* Cecil Smith. "The Birds of Somersetshire," 1869.

and families separately, and compare the relative numbers of species in each in the two counties.

The only species in Somerset among those constantly resident, quite unknown in Cambridgshire, are the Dipper, the Cirl Bunting, and the Black Grouse. The first of these inhabits rocky streams chiefly in mountainous districts; the second is plentiful in some of the southern and western counties, but does not get to the eastern; the third, common in Scotland, and the North of England, is only met with in a few localities further South, the Quantocks in Somerset being one of them.

Perhaps the most interesting addition to the ornithology of Somerset of late years is the Great Bustard. A flock of these fine birds appeared at Braunton, near Barnstaple, in Devonshire, during the severe winter of 1870–71, whence they dispersed themselves over the country, and individuals were seen about the same time in several different places, one occurring at Shapwick. The bustard is well known to have been formerly plentiful on Salisbury Plains, as well as on open heaths in Cambridgeshire and Norfolk, but has long since been extinct as a permanent resident in this country, though stragglers have been occasionally met with. The appearance of the flock in the above instance was probably connected with the severity of the weather that season, causing a scarcity of food in their native haunts, and obliging them to migrate elsewhere.*

The reptiles and fish in Mr. Terry's lists do not contain so many species as are found in Cambridgeshire, and the number of fish probably might be increased. I do not think it at all likely that the Sand Lizard, said to have been "killed in Bennett Street, in 1840," really belonged to this species. The sand lizard was first described by myself as a native of this country from specimens taken at Poole, in Dorsetshire, and it so nearly resembles a large variety of the common kind that unless great attention be paid to the structural characters the two species may easily be confounded.

The Viper which abounds in the west of England is very rare in Cambridgeshire, as I mentioned at the reading of Dr. Bird's paper on this reptile, in which he gave so full an account of its whole

* See "Nature," vol. iii., p. 198.

history.* The Ringed Snake, on the contrary, seemingly the less plentiful of the two in this neighbourhood, abounds in Cambridgeshire, especially in the fenny districts, where it attains a great size. This may be accounted for by a difference in their habits, the viper preferring a dry soil, the ringed snake thriving best in wet or damp places.

I have never collected the insects of this neighbourhood myself, and can therefore say very little about them. Mr. Terry has given a list of the Lepidoptera alone, including 541 species. This list appears a tolerably full one, and probably contains the greater part of those inhabiting the district. Some of the Papilionidæ, however, of which fifty-five species are given, judging from a paper by Mr. Herbert Jenner Fust, on the "Distribution of Lepidoptera in Britain," † are perhaps doubtful. Mr. H. J. Fust only assigns 46 species of Papilionidæ to the whole of Somerset, besides five that he considers doubtful, and four of these doubtful ones, viz., the swallow-tail (*Papilio machaon*), the brown hairstreak (*Thecla betulæ*), the mazarine blue (*Polyommatus acis*), and the silver-spotted skipper (*Hesperia comma*), are included in Mr. Terry's list. At the same time it is possible that they may have occurred in the Bath district in rare instances.

Though I am not able to make any direct comparison between the insects of Somerset and the insects of Cambridgeshire, there is one circumstance I cannot help mentioning, which has often struck me since I first exchanged the east of England for the west, and that is the greater number of insects in the eastern counties than in the western. I am not now speaking of the number of species in any particular family. There may be no great difference here, though I suspect the actual number of species preponderates in the eastern counties. And this idea seems borne out by the statements of others. Mr. Stainton, in a paper on the "Geographical Distribution of British Butterflies," remarks that there are fewer species of butterflies in the western counties of England than in the eastern."‡ Mr. Bates also, in his Address to

* See Proc. Bath Nat. Hist. Field Club, vol. 2., p. 299.

† Ent. Trans., 3rd Ser., vol. iv., p. 417.

‡ Ent. Trans., New Ser., vol. v., p. 229.

the Entomological Society in 1870, speaking of the "distribution of insects between the east and west in the southern part of our island," remarks, "I am not aware that comparative lists have yet been published, but it will not be disputed that many hundreds of species of Coleoptera are known in the east, many of them abundant, which are totally unknown in the west, and a smaller number are known in the west which are not found in the east." *

But in the present instance I refer to insect life generally. The hosts of insects that appear on wing on a fine spring or summer's day in Cambridgeshire, the many ground beetles that are to be seen, Carabidæ and other Coleoptera, crossing one's path, or found concealing themselves beneath clods on the arable lands, other insects nestling in the flowers by the way-side, or hovering over the trees and shrubs, is such as I never saw to the same extent anywhere about Bath. And this is especially the case in the fen districts, where there are a large number of species, many too of great rarity, peculiar to marshy places, affording a rich harvest to the collector.

I feel inclined also to the opinion, though here I may be mistaken, that birds as well as insects—taken in the aggregate and not in reference to any particular species—are more abundant in the eastern counties than in the western. If this be so, in the case of either class some explanation of the fact might be given from the circumstance, generally allowed both by Zoologists and Geologists, of our island having received the main part of its Fauna from the continent previous to the separation of the two lands. This might lead very naturally to a larger number of species as well as individuals settling down in the eastern parts—if they found there all they wanted, and other species permitted them to stop—without seeking a residence further off. That birds soon contract a partiality for a fixed home, is seen by the fact of their returning year after year at the breeding season to the same spots, even such species as are migratory, and which have to traverse large tracts of land and water, in order to reach their accustomed haunts.

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* Ent. Trans. for the year 1869, Proceed., p. xlvi.

I am quite aware that there are many local species, birds as well as insects, some rare, others of frequent occurrence, found in the west of England and not in the east. I have already mentioned three instances in the case of birds. But this may probably be accounted for by such species having found no spots suitable to their habits till after travelling long distances, or to their having first got footing in the country by some other road.

What has been just said respecting the Fauna of this part of England relates only to the Fauna of the present day. But, taking a more extended view of the subject, we may regard that Fauna in connection with what it was in days past, as also in reference to the changes it is likely to undergo hereafter. It has been for modern science to discover and trace out the unbroken law of continuity which not only pervades all physical phenomena, but the whole of the organic world. In working out the Natural History of any district we cannot entirely dissociate living forms from those which have ceased to act their part in nature, and which have disappeared. For we can draw no marked line between them. We see, indeed, a broad distinction between the Fauna of these islands at a remote geological epoch and what it is now; but by slow continuous change one has passed insensibly into the other. Taken at intervals of one or two generations only, scarce any change is perceptible, though still silently going on. It is like watching the hour hand of a clock which, if observed at intervals only of a few minutes, remains to all appearance unmoved, though, when noted at the end of a whole hour, its advance is manifest. Let us illustrate this by reference to the British Mammals, and those of the Bath district especially. Mr. Moore tells us* that in the gravel deposits of this district constituting the Mammal drift are found remains of more than one species of elephant or mammoth, the long-haired rhinoceros, the great *Bos primigenius*, the musk ox (*Ovibos moschatus*), the reindeer, the wild boar, and the wild horse. None of these animals are now found living in this country, and two, the mammoth and the long-haired rhinoceros, have been long extinct everywhere, though believed to have been contemporaneous with man in the earliest periods of his existence on this earth. The Bos primigenius lived on to historic times. The musk ox and

* Proceed. of Bath Field Club, vol. ii., p. 51.

reindeer continue at the present day, but only in high northern latitudes.

Mr. Boyd Dawkins, so well known for his palæontological researches, introduces us to yet another large mammal, formerly an inhabitant of Britain, the fossil lion, *Felis spelœa*, probably identical with the existing lion still abounding in Africa, and in times previous to the Christian era found also in Europe. This carnivore was not merely an inhabitant of this part of England, but it seems to have been plentiful. Mr. Boyd Dawkins even considers West Somerset to have been its "Metropolis." He says it was in the greatest abundance in the western half of the Mendips —from Wells to Weston-super-Mare, where were also the "feeding grounds of incalculable numbers of reindeer, bison, horse, and tichorine rhinoceros," on which it preyed. In another place he says—"There is evidence that a larger number of lions, bears, and hyænas dwelt in this neighbourhood than have been proved to have lived in a similar area at any time in the past history of the earth."*

Could we for a moment gaze upon the scene that must have presented itself in those days, when huge mammoths and other wild beasts roamed over the hills and valleys surrounding this fair city —now given up to man and his works—how astonished we should be. But even coming down to within a few hundred years of our own time—a short period to look back upon, and but as yesterday, compared with the ages that have elapsed since the days of the mammoth and the lion of Somerset, during the whole of which period changes upon changes were following in slow succession—what a novel sight would open upon us. Fitz-Stephen, who wrote in the 12th century, tells us—"that the vast forest that in his time grew on the north side of London was the retreat of stags, fallow-deer, wild boars, and bulls."† Contrast this picture with the modern north of London. Where have all these beasts gone to, along with others that might be mentioned—the bear, the beaver, and the wolf—which equally existed in this country not long before, some till long after, the time of that author? They have, one by one, silently dropped off. The bear is stated by

* See a paper on "The British Lion" in Pop. Sci. Rev., No. 31, p. 150.

† Penn. Brit. Zool., 4th Edit., vol. i., p. 58.

Pennant to have infested Scotland up to the year 1057. The beaver, formerly an inhabitant of Wales and Scotland, and in earlier times of various parts of England, was observed in Wales by Giraldus de Barri in the year 1188. It is not known exactly when the wild boar or wild cattle were extirpated. Some of the latter are still preserved in a semiferal state in a few large parks, as at Chillingham, in Northumberland, where I once saw them myself. The wolf was formerly abundant throughout Great Britain. It has been thought that, "in the wilder parts of England—the fells of Yorkshire, and the Forest of Dartmoor—wolves still existed in the fifteenth, and perhaps in the sixteenth century, if we are to give any credence to local traditions."* In Scotland they kept their ground till the year 1680,† and in Ireland they were not exterpated till the late period of 1710.

And how is it at the present day? The scene is still shifting under our very eyes. Other species, though yet living, are gradually dying out, or soon would do so, but for the preserving hand of man in a few favoured cases. They are driven from their former haunts, and, where left to themselves, only to be found in wild fastnesses or the thickest forests. The stag, once common everywhere in the island, is now confined to the Highlands of Scotland, with the exception of those still to be found on Exmoor, and a few yet remaining in the New Forest and in two or three other places, being strictly preserved. The roe, equally dispersed formerly over the country, now exists in the Highlands only. The wild cat likewise is now rarely found except in extensive woods in the northern counties. The martin, the badger, the otter, and the black rat, are all greatly reduced in numbers; the first three of these being now hardly ever met with in some parts of the country, though more plentiful in others,—the badger and otter certainly much more frequent about Bath and in the western counties generally than in the eastern,—while the black rat is confined to London and a few other old towns.

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* "Nature," vol. i., p. 352.

† See an interesting Paper on the "History of the Wolf in Scotland," by Mr. Hardy, in Proceed. of Berwickshire Naturalists' Club, vol. iv., No. 5, p. 268.—The Author is disposed to think, from existing traditions, "that the final extinction of the wolf must have happened at a period considerably later than has been usually assigned.

I have illustrated this part of the subject we are considering by reference to the mammals alone, but similar cases of species, gradually getting more and more scarce, and ultimately becoming extinct, might be brought forward in other classes of animals—in birds and insects especially.

And what of the future? The same changes will continue to take place, slowly and silently, not perceptible to ourselves, nor perhaps to those who immediately succeed us, though, after a longer or shorter period, making their effects visible, and not ceasing till every species of mammal of any size now living, and not wanted by man for his own use, shall have passed away, and been added to the remains of those myriads of dead already entombed in the great graveyard beneath our feet. Man, indeed, is the chief exterminator at the present day, so far as regards the larger animals. Wherever he plants his foot he lets his power and dominion over them forthwith be felt. He reclaims those which can be brought to share his home and do his work. He hunts and catches those not easily domesticated, but still serviceable for food or clothing; while all others, dangerous from their size or ferocity, or which interfere in any way with his property, he mercilessly destroys.*

We may gather the extent to which this destruction is carried on from statements occasionally published expressing it in actual figures. In the "American Naturalist" for September, 1871, Mr. W. J. Hays, after speaking of the diminishing numbers and the contracted range at the present day of many wild animals in North America, "reckons that not fewer than half-a-million bisons are annually destroyed by the hand of man."† In like manner—"Indian papers state that during only the first six months of last year (1871) as many as 183 tigers and cubs, 393 panthers and

* "The history of man . . . involves the condition of a great many species of the lower animals, and on account of the strict dependence of *all* the species on others, or on the rest of the natural productions which man likewise modifies, we are, perhaps, warranted in concluding that there is no species whose natural relations have not been materially affected by human influence."—*Weissenborn.* See an interesting article "On the influence of Man in modifying the Zoological features of the Globe, &c.," in Mag. of Nat. Hist., Ser. ii., vol. ii., pp. 13, 65, 122, 239. See also an article by Fleming on the "Influence of Society on the Distribution of British Animals." Edinb. Phil. Journ., vol. xi., p. 287.

† See "Nature," vol. iv., p. 399.

leopards, 203 bears, 281 wolves, and 188 hyænas were destroyed in the Central Provinces, at a cost to the Government of about 9,000 rupees (£900)."*

Verily it would seem as if man were destined in the end to stand alone upon the earth, or with only those animals about him needed for his own purposes, all noxious animals having been got rid of, except those which, by their small size and sequestered habits, escape his vigilance.

And this appears to be the view really taken by some Naturalists at the present day. A writer in the Anthropological Review remarks that—"the animal constantly loses territory which man gains. The day will arrive when there will be on the surface of the earth only such animals as are useful to man."† More lately we find Mr. Wallace, taking a yet broader view of things, and extending the same reasoning to the vegetable world, where it may equally be applied, writing thus:—"We can anticipate the time when the earth will produce only cultivated plants and domestic animals; when man's selection shall have supplanted 'natural selection'; and when the ocean will be the only domain in which that power can be exerted, which for countless cycles of ages ruled supreme over all the earth." ‡

Thus, in conclusion, have we seen biology, even mere local biology, to be indeed a large subject. It regards life in all its manifold forms and phases. It investigates the several changes through which each animal passes, from life's first beginning to its full maturity. It seeks to determine the laws upon which depends the stability or instability of the species itself, in connection with the outward conditions under which it exists. It looks into all time—past, present, and future. It turns from the consideration of those animals which walk the earth now to those which once roamed over it, the lords and possessors of the soil before man was, but which, having fulfilled their mission, have long since disappeared; and it looks onward to the day when, perhaps, all the races of animals now living shall, in like manner, have made way for other forms, better suited to the age in which human progress shall have reached its highest point, and civilization have spread over the face of the whole earth.

* "Nature," vol. v., p. 171. † Anthrop. Rev. (1869) vol. vii., p. 170.
‡ "Natural Selection," p. 326.