

that the time of maximum may be ascertained as well as the aggregate number visible during the period covered by the watch. The other will register the individual paths of well-observed meteors on a star chart or celestial globe, determine the place of the radiant and its character, especially note large meteors and any other peculiarities that may offer themselves. One observer, working single-handed, may do a great deal by dividing his attention between the various points alluded to. It is always important to separate the number of meteors visible in a special shower from the total number seen, for the aggregate counted must exceed the actual strength of a particular stream, since it includes the sporadic meteors. When reckoning the visible meteors, therefore, the observer will do well to keep an account of the number unconformable with the radiant of the main display. The radiant of the Leonids can be readily assigned, not only because of the afterflows or phosphorescent streaks left by the meteors, which assist the eye in fixing their exact directions, but also on account of the well-known asterism involving it. The Leonids exhibit a more contracted area of radiation than the Andromedes, but it is a feature not yet thoroughly investigated. By selecting a number of well-observed tracks near the radiant, the extent of its diffusion may be readily determined. The writer has sometimes found the centre so definite that the conformable paths have intersected at a point.

W. F. DENNING.

THE OLD AND NEW NATURALISTS.

NATURALISTS, like the animals and plants of which they discourse, are subject to the process of evolution. The naturalist of the latter end of the nineteenth century is not quite the same species as that which bore the name at the end of the eighteenth. Differentiation has been at work. So markedly indeed is this the case, that one is tempted to ask whether the species, as such, is not well-nigh extinct. To-day there are biologists, comparative anatomists and physiologists, systematic botanists and systematic zoologists, palæontologists and embryologists. But where is the naturalist? Has he not been swallowed up by and distributed among his poly-logical progeny? And yet the word is still in use, and carries with it a more or less specialised implication. The other day a friend, who was discussing with me the work of an acquaintance, said: "He's a capital anatomist; it's a pity he's not more of a naturalist"; and I had no difficulty in catching his meaning. It may be worth while to consider the relative position and status of the old and of the new naturalist.

In one of his luminous essays—that on the study of biology—Prof. Huxley reminds us that Hobbes of Malmesbury (*Leviathan* Hobbes) said: "The register of knowledge of fact is called history. Whereof there be two sorts, one called natural history; which is the history of such facts or effects of nature as have no dependence on man's will; such as are the history of metals, plants, animals, regions, and the like. The other is civil history; which is the history of the voluntary actions of men in commonwealths." In Hobbes's terminology, then, naturalist was synonymous with man of science. Indeed, until quite a recent date, as I am told, the Professor of Zoology in one of our northern universities bore as his technical title the designation Professor of Natural and Civil History. Gradually the field of the naturalist was restricted. Those branches of science which seemed to be specially susceptible of mathematical treatment were allotted to the natural philosopher; the naturalist, as such, continued to deal with physical geography, geology, mineralogy, and the history of plants and animals. The names of Buffon and of Humboldt at once rise to our minds as those of naturalists of this encyclopædic type.

But the progress of knowledge, and the vast accumulation of facts, necessitated further division of labour; and by this further differentiation the field of the naturalist was yet further limited to the natural history of animals and of plants. Nor did the process of differentiation stop here. To-day we have herpetologists and ichthyologists; we have zootomists and embryologists; we have systematic botanists and evolutionists; but where, one may again ask, is the naturalist?

I take it that the term "naturalist," as we now use it, implies the sympathetic study of animals and plants in their varied relations to each other under the natural conditions of their customary habitat. In short the naturalist is in great part what Prof. Ray Lankester would call a student of bionomics, or what Semper called an investigator of the higher physiology of organisms. His calling is a protest, first, against the wide-spread error that physiology ends with the individual; and secondly, against the no less erroneous view that science ends with analysis. The naturalist sees in the individual animal or plant merely a constituent unit in a connected whole; and welcomes the most minute analysis chiefly as a means to a more complete synthesis.

Looking back to naturalists of the past in the light of this conception, it is of Gilbert White of Selborne that we feel the term to be exactly descriptive; and in the old days it was the man of leisure like White, the sportsman like St. John, or the angler like Izaak Walton, that was the best and most characteristic naturalist. They started with no equipment of special training, indeed, but with a keen eye, an observant habit, and a generous love of all that ran wild and all that grew free in the face of heaven. They gave their hearts to nature for its own sake; their lavish interest therein had no ulterior motive; they accepted the plain unvarnished tale of creation, and were troubled by no problems of evolution, and in their writings their main object was close, accurate, and sympathetic description rather than reasoned and logical explanation.

Nor can we read the works of the older naturalists without feeling that they were humanists as well. It is true that the more typical humanists of their time regarded their naturalist proclivities in the light of amiable eccentricities, as hobbies with little or no intimate bearing on man, the central figure in all rational and serious study and investigation; little dreaming of the influence natural history was destined to exercise in their own proper sphere of work. But the naturalists were wiser than they knew; wiser perhaps than some modern humanists on the one hand, and some modern naturalists on the other. They included man in their field of view.

Is it too much to say that the connecting link between the old and the new naturalists is to be found in Charles Darwin? The author of the "Naturalist's Voyage" had received but little systematic training, as we now count systematic training; he had the keen eye and the observant habit; he had the generous love for, and sympathy with, nature in all her aspects; he was indeed an encyclopædist in his width of interests, which included physical geography and geology as well as the world of plants and animals; and man was assuredly not absent from his field of view. Is any one likely to question the assertion that Charles Darwin was a great naturalist of the old type? And after more than twenty years of experimenting, investigating, collecting an enormous mass of data, and thinking of the careful patient type which brilliant little bodies even now fail to appreciate, he gave to the world his "Origin of Species," by which the work of all future naturalists was set in a new light. And after that, did he not write his "Orchids," his "Insectivorous Plants," his "Climbing Plants," his "Earthworms," all of them full of the spirit of the new natural history? Had Darwin made another voyage, and had he given us another journal of a naturalist, what we should have

looked for would have been a new description of the animal and vegetable world in their natural relations under the observed conditions of their life, interpreted in the light of the new principles which he himself had gone so far to establish. And this, as it seems to me, marks out the field of work of the naturalist of to-day and to-morrow. He must have grasped the nature of the great biological problems which the latter half of this century has opened up; he must retain the keenness of eye and quickness of observation which characterised the older naturalists; he must deal chiefly in accurate and graphic description, and not too much indulge in speculation—keeping his more speculative work for other modes of presentation; but he must also be to us the interpreter of the facts of animal and vegetable life *as it is lived in the open face of nature*, in terms of recognised principles of biology, and yet wholly without prejudice, forcing no dogma upon nature, expecting daily to discover new truths, and aware of the provisional character of so many of the conclusions of the evolutionist.

If then we attempt to define the naturalist, we may say: first, that his subject-matter is animate nature as it is; the inter-relations of living things in the web of life, the bionomics or higher physiology of organisms. Secondly, that his method is primarily observational; but that, if the synthetic picture is to be achieved, he must be aware to the full of the results of analysis in physiology, psychology, and ætiology. And thirdly, that his mood must be sympathetic, and that to be successful in his presentation he must combine the qualities, not only of the man of science, but also of the artist.

While much admirable and fascinating work has been done by traveller-naturalists in many parts of the world, it must be remembered that there is abundant work for the stay-at-home naturalists in the ponds and hedgerows, woods and shores, of our own country. The members of our field-clubs may do excellent service to the general cause of natural history. But, without denying the value of cataloguing the local faunas and floras, we must recognise that many field-clubs and naturalists' societies err in confining themselves too exclusively to this. Precise observations as to the habits of animals, and the environmental relations are needed even more urgently than systematic work of this kind.

And here a word or two may be said on "Natural Histories." Most of the natural histories of animals have not sufficiently shaken themselves free from the bondage of the systematist. They are to a large extent hybrid works with a foundation of more or less popularly expressed systematic zoology, and sections or paragraphs on habit and instinct. Brehm's "Tierleben" is, however, a treasure-house of observations as to the life and habits of animals to which Darwin and many others have freely acknowledged their indebtedness, while others have not. The "natural history," as such, should have for its primary subject the inter-relation of animals and plants, the web of life as it is presented to our study; and to this all reference to anatomical structure, systematic position, and individual habit, should be made subsidiary. In botany, Kerner's great work, a translation of which by Prof. Oliver is now published, affords an admirable example of what a natural history should be. The bionomic note is here distinctly dominant.

Of course under the new conditions of the present time the preliminary training of the naturalist needs to be both wider and fuller than was either possible or necessary for the older naturalists. He must be not only well read in, but must have real practical acquaintance with, physiological and biological investigation. There is, moreover, one point in connection with the preliminary training of the naturalist which appears to me to be important. In his description of animal life he will have to interpret many of their actions in terms of the underlying mental processes. To do this with any success he should have

a training in psychological methods. Such training has been too much neglected in the naturalists of the past; and even now it is often assumed, or so it would seem, that whereas when biological problems are concerned, the guidance of untrained mother-wit is, by itself, scarcely adequate, yet, when psychological problems are concerned, this is amply sufficient.

That his work may be effectual, the naturalist should be not only a man of science but a man of letters. This will give to his interpretation a special value. But he must be both in equal degree. He must not, as is too often the case with magazine writers, regard natural history as merely a subject on which may be written a certain number of bright and pleasing pages which shall not require any undue amount of exercise of thought on the part of his readers. Not that in saying this I would utter one word in disparagement of such writers as Kingsley, Jefferies, and Burroughs, of Mr. Warde Fowler, and a number of keen observers who have made their observations the subjects of delightful essays. Nay, rather I would contend that these writers have done good service in illustrating the value of the sympathetic mood, in emphasising a healthy reaction against "mere necrology," in vindicating the right of the amateur to contribute towards the end all naturalists have in view. But I still feel that, for the naturalist as such, his first and foremost object must not be to give us pleasure by his manner and method, by his delicacy of touch and his imaginative treatment; it must rather be to tell us something which in and for itself is worth knowing, since it will give us a deeper and truer insight into the world of living things. Literary finish, grace of style, imagination and graphic power should be there; but this should be like the cutting and polishing of the gem which, though it enhances its value, does not by any means constitute the chief element thereof.

The species naturalist, then, is not dead but liveth. It includes not only the professional, but the so-called amateur. The naturalist has been of late in La Plata, in Borneo, in Celebes; he has told us of the wonders of animal life on the ocean surface; he has watched the struggle for existence in a tropical forest and on the sea-shore; he is at work among aquatic insects, and learns the ways of birds and insects on Bindon Hill; he knows not only the zoology but the natural history of rotifers, and can discourse delightfully to the Royal Microscopical Society on the unnecessary difficulties in the way of studying natural history; and he still looks out across the waters of Poole Harbour to Corfe Castle, and tells us of the days of his youth in the Malay Archipelago.

In conclusion we may say that just as the early poets were frankly and naïvely descriptive, so too were the early naturalists. Neither dealt in deep and subtle analysis. But the time of analysis came and flooded the world. The modern poet profits by all this analysis, is indeed a subtle analyst himself; but, as poet, he keeps his analysis out of sight, and gives us a new presentation of nature in descriptive and synthetic form. So too must the modern naturalist profit to the full by all the biological and psychological analysis of his times; but, as naturalist, he must keep all this out of sight, and give us a new presentation of animal and vegetable life in descriptive and synthetic form. And he must remember that his picture will not be complete unless it include man himself. For man is also in the web of life, influencing and being influenced by all around him; nowise to be ignored, but to be taken account of to-day as he was by Humboldt, and by the stronger naturalists of the old school. And this new descriptive presentation of nature, as it reveals itself to the eye and brain of the modern naturalist, will differ chiefly from that of his predecessor, first, in that it is no longer a piece of amiable eccentricity, but is in close touch with the

gravest problems that man has to grapple with; and secondly, in that it has more or less distinct reference to a past of which the present is but an outcome and a development. C. LLOYD MORGAN.

HERMANN HELLRIEGEL

PROF. HERMANN HELLRIEGEL, whose death took place at Bernburg, Anhalt, on September 24 last, was born at Pegau, Saxony, on October 21, 1831, so that he was within a month of completing his sixty-fourth year. His life, on the whole, was uneventful, for he devoted himself with studious zeal almost entirely to investigations, both chemical and physiological, into the phenomena of plant nutrition. One of his earliest official posts was that of Director of the Agricultural Experiment Station at Dahme, in Brandenburg, which was founded in 1857 by an association of agriculturists in Jüterbog-Rückenwalder. During his tenure of this post he studied experimentally the alimentary needs of certain plants which are cultivated as field crops, notably cereals, potatoes, and sugar-beet, his method involving the use of sterilised soil, both by itself and with the addition of various chemical salts. His physiological inquiries embraced observations on the growth and development of roots, on the quantity of water used in the growth and maturation of field crops, and on the minimum amounts of nitrogen, phosphoric acid, potash, and other ingredients required by plants. Supplemented by observations on crops grown in the open field, these investigations led Hellriegel to conclusions of great practical importance, notably in connection with sugar-beet, a crop which Germany grows more extensively than any other European country, its annual average area for the last twelve years having been 800,000 acres, or more than one-fourth of the entire European acreage.

It was with no little regret that in 1873 Hellriegel gave up his directorship at Dahme, though for a post with greater emoluments. But his capacity as an investigator had made its mark, and when in 1882 the Verein für Zucker-Industrie, in co-operation with the Government of the Duchy of Anhalt, established an experimental station at Bernburg, for the special investigation of problems bearing upon the cultivation of sugar-beet, it was felt that Hellriegel possessed special and peculiar claims to the directorship, which was accordingly offered to him. He accepted with avidity a post which enabled him again to devote his time and energy solely to those investigations into plant-life, which had previously exercised upon him so strong a fascination. The station at Bernburg is admirably equipped, and Hellriegel found himself in a position to at once resume his inquiries into the nutrition of leguminous plants, a subject that had previously received his attention at Dahme. It was here that after a dozen years' work he, in collaboration with Dr. Wilfarth, made the great discovery with which his name will ever be inseparably associated, namely, the capacity of leguminous (or at least of papilionaceous) plants to take up, or fix, through the agency of the micro-organisms of their root-nodules, the free or uncombined nitrogen of the atmosphere.

The intimation—the revolutionary announcement—of this startling discovery was made on September 20, 1886, in a communication to the Naturforscher Versammlung, held at Berlin, and over the agricultural chemistry section of which Dr. (now Sir Henry) Gilbert happened to be presiding—a coincidence of exceptional interest in view of the circumstance that Sir Henry Gilbert was one of the joint authors of the celebrated memoir by Lawes, Gilbert, and Pugh, "On the sources of the nitrogen of vegetation, with special reference to the question whether plants assimilate free or uncombined nitrogen" (*Phil. Trans.* 1861), which, at

the time of its appearance, and for long after, was regarded as setting at rest the question as to the capacity of plants to assimilate the free nitrogen of the atmosphere, and of confirming upon this point the negative results previously obtained by Boussingault. Hellriegel's momentous discovery furnished an explanation of the long-known fact that a clover-crop leaves the soil richer in nitrogen than it finds it, and is therefore a suitable crop to precede the wheat-crop in a rotation, clover being—as we now understand through Hellriegel's discovery—a nitrogen-accumulating plant, and wheat a nitrogen-consuming one. Indeed, the fact itself is a very old one, for it was observed by the farmers of the Roman Republic that beans, lupins, vetches, and other plants belonging to the sub-order Papilionaceæ, as now defined, rendered the soil "more fruitful" for the crops that followed. But nearly 2000 years elapsed from the time when Varro recorded this, to that when Hellriegel, a brief nine years ago, supplied the explanation. It in no way detracts from the value and significance of the discovery that Hellriegel and Wilfarth should have happened upon it in the course of investigations which were really directed to quite a different object. Those who devote their lives to research are not unaware that gems, hitherto unseen, may sometimes be picked up on the wayside.

We have spoken of Hellriegel's discovery as revolutionary, and it certainly upset a long-cherished belief. The opposition which his announcement received at the outset was a testimony to its importance. Subsequent research, both in Europe and in North America, has, however, only strengthened the position which Hellriegel took up, whilst it has suggested new lines of investigation for which there will probably be no lack of workers. Bréal, Frank, Hiltner, Lawes and Gilbert, Schloësing fils and Laurent, are but a few of the investigators who have proved the accuracy of the discovery made at Bernburg. In recognition of his work, Hellriegel was elected an honorary member of the Royal Agricultural Society of England, a rare distinction, which he enjoyed in common with such continental workers as Pasteur, Fleischmann, and Chauveau. In France his merits were recognised by his election as a foreign associate of the Société nationale d'Agriculture, and as a Correspondant of the Academy of Sciences.

NOTES.

THE German committee for the exploration of the South Polar regions met at Berlin on Sunday, and decided to send two vessels southwards from Kerguelen Island, leaving full liberty of action to the leaders. The total sum to be allotted for the expedition, which is to last three years, has been fixed at 950,000 marks (£47,500).

CHICAGO UNIVERSITY continues to be the recipient of Fortune's favours. Mr. John D. Rockefeller has (says the New York correspondent of the *Daily Chronicle*) added £200,000 to his previous gift of £800,000 for the endowment of the Chicago University. He promises £400,000 more if any one else will subscribe a like sum. When will the day come for such generous gifts to education and research in England?

THE Municipal Council of Arbois, the birthplace of Pasteur, has decided to erect a statue to his memory, and also to call the municipal college the Pasteur College.

M. BERTHELOT, the distinguished chemist, has been appointed Minister of Foreign Affairs in the new French Cabinet. He was Minister of Education in the Cabinet of 1886-87.

It is reported that the Paris Municipality have granted £800 to the Salpêtrière Hospital for the erection of new buildings in which to treat nervous and mental affections by electricity.