

PSYCHE.

THE WORK OF A DECADE UPON FOSSIL INSECTS, 1880-1889.

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[Annual address of the retiring president of the Cambridge Entomological Club, 10 Jan. 1890.]

Some years ago I published an annotated and tolerably complete list of papers on fossil insects. It contained nearly three times as many titles as were referred to by Hagen in his entomological bibliography nearly twenty years previously, but, as the multiplication of periodical literature had brought in a train of minor papers, largely abstracts and compilations, I remarked that the far greater extent of my list was no proof of an increased recent interest in this field of research, but thought it doubtful whether in the intervening period there had been as much activity as when the works of Heer were opening the wealth of material at hand.

So marked a change has now come about in this respect that I venture this evening to invite your attention to a review of the advance that has been made during the past ten years in this previously neglected field. In doing this I do not by any means propose to cite every paper that has been published, but only to call your attention to the more important or interesting, from

whatever cause, and thus endeavor to picture our progress as vividly as possible. Indeed, the mere list of authors would be wearisome, for one could make a catalogue of the writings of the last ten years considerably longer than the entire list given by Hagen in 1863. To be precise, I can cite 94 authors and about 225 papers published in this decade, against 78 authors and about 140 papers quoted by Hagen. Or to picture it in another way, about one third of a complete catalogue of papers on fossil insects would belong to the decade just closed. Nor is the bulk of this literature its only value; it is quite as remarkable for its quality, for by far the most important of the discoveries yet made in fossil insects are embodied in the researches of the last ten years, and there is no reason to suppose that we have reached their conclusion.

Note, first, the relatively great number of striking discoveries that have been made within this period. The discovery and careful study of Silurian scorpions in several different parts of

the world,—in Sweden by Thorell and Lindström, in Scotland by Peach and Hunter, and in New York by Whitfield, all brought out at very nearly the same time, are unprecedented in the annals of this division of science. These were followed almost immediately by Brongniart's surprising discovery of one of the hexapods, *Palaeoblattina*, in the Silurian of France, still the only known true insect in this ancient deposit. Coming down a stage later we have the remarkable Devonian insect-fauna of New Brunswick, about the nature of which there has been so much dispute, first announced, it is true, before our period, but only fully published with figures of the species in 1880; a single addition or two has recently been made to them by Matthew. With them must be classed the Devonian myriopods, the earliest known members of that group, fully elaborated by Peach. In the carboniferous period we have the striking wealth of forms from Mazon Creek and other deposits in our country which I have described at various times, including so extraordinary a number of blattarians that I have ventured to call this period, so far as its insect-fauna is concerned, "the age of cockroaches." These discoveries, largely due in this country to the activity and zeal of Mr. Lacoe, have been even more than paralleled by the unexampled wealth rightly claimed for Commeny in France by Brongniart, who as yet has published hardly more than an outline sketch to whet the appetite of the zealot. At this place are found, as Mr. Brong-

niart informs me in a recent letter, a considerable number of types already signalized in America, which indeed we had a right to anticipate by the comparisons that had been made between the forms already published from other localities in the two countries, new discoveries on one continent having repeatedly been followed sooner or later by very similar finds on the other. The abundance of cockroaches in both countries is fully sustained at Commeny, which has yielded the vast number of nearly six hundred specimens, or many more than are known from all other carboniferous localities in the world taken together. Still another striking discovery in the carboniferous rocks is the recent finding in Silesia of coleoptera, the first time that these have been signalized at this early epoch, but their description is yet to come.

These are the principal larger discoveries in the paleozoic series, but they have been accompanied by the publication of many striking forms which indicate the ancestral types of living insects, or by the better elucidation of types already known but whose significance had not been understood. To specify some of these we may mention *Palaeocampa* and *Acantherpestes* among the myriapods, the former with the curious and highly developed structure of the spinous hairs, the latter with its possession of segmental organs or branchial supports as well as stigmata, indicating a probable amphibious habit; *Anthracomartus*, *Kreischeria*, and *Geralinura*, the two former examples

of new extinct family types of arachnids, the last the first instance of the discovery of the *pedipalpi* earlier than the tertiaries, and found at brief intervals on two continents; other than this last of Kuřta's striking discoveries in the Bohemian coal field might well be cited; the gigantic ephemerid, *Palingenia*, of Bohemia; *Dasyleptus*, an extraordinary form of thysanura, a group not previously known earlier than the tertiaries; *Corydaloides*, like the preceding, one of Brongniart's discoveries at Commen-try, remarkable for the extensive display of branchiae on the sides of the abdomen; *Petrablattina subtilis* of Kliver (Strophocladus) with its strange neuration; *Brodia* of England with its remarkable coloration; the gigantic *Titanophasma*, also from Commen-try; the nymph of *Eto-blattina* Woodward has published from England, showing the same mode of development among the ancient as the modern cockroaches; and, finally, *Phthanocoris*, the only hemipteroid type yet found in our own paleozoic rocks.

All these memoranda relate to the insects of the older formations only, but the statements regarding them in no proper way indicate the immense strides we have made in our knowledge of the earlier types. The decade has been marked not only by extensive and striking additions to known types, far more than doubling the number that had been previously published; it has witnessed also the advent of many original workers previously wholly unknown in this field, such as Beecher, Deichmüller, Karsch,

Kliver, Kuřta, Matthew, Peach, Sterzel, Thorell, and Whitfield; but it has also seen the beginning of a new epoch in the study of the earlier types, in that for the first time the subjects have been treated in much more than a scattered way, by fuller discussions of the systematic status of the insects described, by attempts to systematize our knowledge, and by the treatment in single groups of insects from various or from all deposits, and not alone in the simple discussion of collections from a given deposit. Let us hope that the constantly increasing material and our larger knowledge may permit in a new decade a further correlation, by the comparative study of insects of different horizons, especially in the carboniferous age.

Previous to the last decade there had been scarcely a single attempt at the systematic study of all the older insects, or even of any of the minor groups found in the paleozoic rocks. Hagen, indeed, had treated briefly of the few *termitina* known over thirty years ago; Heer had attempted a grouping of the cockroaches; and Goldenberg had summarized our knowledge of all by an attempted classification; but besides these I do not recall a single instance where any serious attempt had been made to collate in a broad way our knowledge of paleozoic insects as a whole or in any of the parts. Only because it has so happened that the present speaker has been perhaps the most active worker in this narrow field during the last decade, is he obliged here to mention mainly his own work, since

it has fallen to his lot, in however imperfect a way, to attempt a more or less monographic treatment of the extinct type of *archipolypoda*, for instance, comprising most of the paleozoic myriopoda; of the paleozoic arachnida as a whole, in which he had been preceded by this decade by Karsch, working on much slenderer material and therefore at much smaller advantage; also on the paleozoic cockroaches, and on the species of *Mylacris*, a genus of cockroaches known from several American deposits; and on the genera allied to *Dictyoneura*, regarded as ancient types of *phasmida*. Reference should here also be made to Peach's careful work on the carboniferous arachnida of Scotland. In my memoir on the cockroaches, embracing the discussion of fifty-eight species referred to eleven genera, it was claimed that their differences from modern types were so fundamental as to warrant their separation from all subsequent and from living cockroaches as a distinct and equivalent group, called *palaeoblattariae*, and that they could be further separated into two divisions, called respectively *mylacridae* and *blattinariae*, of which the former was confined to the New World. Brauer has since questioned the value of the *palaeoblattariae* as a group, and Brongniart has recently stated that in the enormous crowd of cockroaches found at Commentry, the *mylacridae* are as numerous as the *blattinariae*, which probably means that the fauna of Commentry is older than that of the other carboniferous deposits of Europe

and synchronous or nearly so with most of the cockroach-yielding deposits of America.

Both Brongniart and myself have also attempted new classifications of the paleozoic hexapods as a whole, which differ considerably in character, but which cannot yet fairly be compared; first because mine discusses nearly all the known types, but includes hardly any of those found at Commentry, then almost wholly unknown, while Brongniart, writing later, confines himself almost entirely to those of Commentry, with only an occasional allusion to previously described types; but principally because Brongniart's work is, so far, the merest sketch with hardly any structural details, a forerunner of what he will soon publish *in extenso* concerning this wonderful fauna, while mine contains full structural details as a basis for discussion and generalization. In it I have endeavored to point out that the existing orders of insects were not differentiated in paleozoic times except in a feeble way, prophetic as it were of the future, so that the Palaeodictyoptera, as, after Dohrn and Goldenberg, but with an extension of their usage, I had classed for the first time all known paleozoic insects, could only be separated into neuropteroid, orthopteroid and hemipteroid groups. These views, which I urged also in a special paper showing the development of the insect-type in time, have been so strenuously opposed by Brauer and others, that their further discussion can hardly be profitable except for those who have an unfortunate

taste for polemics, at least until the fauna of Comentry, which will certainly double the field of observation, gives us a fairer basis for judgment. Meanwhile it may be said that Brongniart in his sketch hints by many of his terms that he has found the same difficulties as those which faced me, and has been forced to admit a synthesis of structure in at least some of the older types, which indeed the very laws of evolution would render probable.

At the beginning of this decade our knowledge of mesozoic insects was very limited; it was almost entirely confined to the researches of Germar, Giebel, Hagen and Weyenbergh on the Jura of Eichstätt and Solenhofen; to Heer's account of the Liassic insects of Aargau; and to Brodie's and Westwood's publications on the secondary insects of England. The horizon has been somewhat extended of late years by the thorough discussion of the Bavarian insects by Deichmüller and by Oppenheim; by the careful exploitation of a new locality for Liassic insects at Dobbertin, Germany, by F. E. Geinitz; by the considerable number of new generic and specific types of cockroaches from the secondary rocks of England described by myself; by the repeated, though not extensive, discoveries of Fritsch in Bohemia, adding interesting material for our very meagre knowledge of cretaceous insects; and by the discovery at Fairplay, Col., of a collection of triassic cockroaches of special interest and importance.

Among noteworthy contributions to

our knowledge of the insects of this epoch may be mentioned Oppenheim's study of the group he called *rhipidorhabdi*, which he regarded as a distinct order and an ancestral type of lepidoptera. The discussion of the structure of these insects, especially by Oppenheim and Deichmüller, has made clear many points regarding the Solenhofen insects which have always been obscure, and brought about the agreement that the *rhipidorhabdi* must be regarded as hymenoptera and in no sense predecessors of lepidoptera. Geinitz in his study of the Liassic fauna of Dobbertin has been able to extend considerably our knowledge of the structure of that prevailing mesozoic type, *Orthophlebia*, known entirely by its wings, and which he regards as phryganideous. In our own country, the triassic cockroach-fauna of Fairplay, just referred to, shows an interesting transition from the older to the newer forms, which goes far to substantiate the differences I have pointed out between paleozoic and later cockroaches; while the study of a large number of specimens of *Mormolucoides*, long but imperfectly known from the red sandstone of Connecticut, has enabled me to render it in a high degree probable that this oldest known insect-larva was a sialid.

In the monographic treatment of mesozoic insects we have only to record the discussion of the *rhipidorhabdi* already mentioned, and a systematic revision of the mesozoic cockroaches, based on a considerable collection of English forms new and old, lent me by

that veteran in their study the Rev. P. B. Brodie, a work which included more than seventy-five species, treated after the method employed in the revision of the paleozoic forms. The publication of both these memoirs on the ancient cockroaches, it may fairly be remarked, has since brought to light many more new forms, so that during the past decade there have actually been added to the number of pretertiary forms over a hundred species of cockroaches, about equally divided between paleozoic (53) and mesozoic (57) times. A general account of fossil cockroaches based on these data was given in my "Cockroach of the Past," in Miall and Denny's "Structure and life history of the cockroach" (London, 1886).

Passing now to tertiary times, we naturally cannot expect to meet with discoveries of equal importance and interest to those which throw light upon the origin of insect-forms, for it is a well known fact that the earliest tertiary insects are to all general intents and purposes identical with those of to-day. They differ no doubt specifically, and even to a considerable degree generically. Most of those so far recovered from temperate regions indicate a then warmer climate, but, taken as a whole, the grand features of insect-life appear to have been essentially the same since the beginning of tertiary times. By our present researches upon them we no doubt greatly widen our horizon, and as with modern types there always are found problems of interest, so will there be with fossil insects, however recent.

Activity in this field can hardly be said to be relatively so great as in the others, nor so great indeed as some time ago when Heer and Heyden were publishing extensively, but it nevertheless has not been insignificant, and it is noteworthy that more special work with groups has been undertaken; thus Buckton has summarized our knowledge of the fossil aphides, Schlechtendahl has elaborated the *psysopoda* of Rott, Gourret the arachnida of Aix, Hagen and Kolbe the *psocidae* of amber, and I the *termitina* of Florissant. I might also add the butterflies of Florissant, as my paper, though not yet published, has been months in type, and the general results were given in a brief paper on "Fossil butterflies" in general, in my "Butterflies of New England." Akin to these can only be mentioned the paper by Flach on the pleistocene coleoptera of Hösbach, Schlechtendahl's revision of Germar's tertiary fossils, Williston's notice of the Florissant *Syrphidae*, and mine of the Florissant arachnida, my comparison of the *Odonata* of Florissant and Green River, the detailed study of *Planocephalus* from Florissant, regarded by me as a new and practically headless type of thysanura, and, finally, the discussion of the structure of this strange type and of the supposed mite of the Rhenish brown coal, *Limnochares*, both of which Bertkau regards as *Galgulidae*. To this period also belongs my general survey of the paleontology of Florissant.

The additions to our knowledge of the amber insects of Prussia during the

past decade is surprisingly little. Besides the papers of Hagen and Kolbe on the *psocidae*, already alluded to, we have only a description of an *Embia* by Hagen, of three species of *Nothrus* by Karsch, of two *Bothrioderes* by Stein, an account of *Elephantomyia* by Osten Sacken, and a generic list of hymenoptera by Brischke. Malfatti also describes two small insects from the Sicilian amber. A meagre showing indeed when the collections of unworked material are known to be so extensive. I have also noted but a single paper on the insects found in the recent gum copal, a description of two or three species by Quedenfeldt.

Here may fairly be mentioned a paper or two on recent insects which throw light on the structure of extinct types. One of these is the recent notice by de Selys Longchamps of the Japanese dragonfly, *Palaeophlebia*, which he makes the type of a new legion, to which he refers also *Heterophlebia* and other forms from the secondary rocks of England and Bavaria, and the tertiary deposits of the Rhine. In the other, on the post-embryonic development of *Fulus*, Heathcote points out that the relations of the dorsal and ventral regions of the body of the young *Fulus* correspond exactly with their permanent condition in *Euphoberia*, a carboniferous myriopod; and he further holds that the traces of the division of the dorsal plates found in the *archi-poly-poda* lend additional strength to the belief that they are composed in modern diplopods of two fused segments origi-

nally distinct; which the doubling of the internal organs and of the mesoblastic segmentation also indicates.

Among the new tertiary fields which have been opened, and which have given rise to some of these researches, and to others upon which I must not touch, are Felek in Hungary by Staub and others, Kutschlin, Bohemia, by Deichmüller, and various localities in upper Alsatia by Foerster, in the last of which about a hundred species have already been found, though none have yet been worked up. Peat beds have also begun to be sounded, and notes of their contents have been made by Früh, Geinitz, and Hollingworth, while similarly recent deposits have yielded a little to Brongniart, Kendall, and Sordelli. Wilkinson and Woodard have also shown us that insects may be expected from the tertiaries of Australia. To some places in our country I will refer later.

The more general diffusion of knowledge regarding fossil insects has been marked during the past decade. Important new discoveries have found their way into journals and into papers before scientific bodies, to such a degree that it is hard for the bibliographer to keep track of them. But besides these we have had very full analyses of the larger papers, among which those given by de Borre to the Belgian entomological society easily hold the first place. Bibliographies, like those of Malfatti and my own, annual reviews of the literature, like those given by Bertkau, Trouessart, Dalton, White, Marcou and others; general compilations of col-

lated material covering the whole field, like the excellent series published by Goss; others more or less partial or local, like the lists of Lacoë and Brongniart, or the dictionaries of Lesley and Miller, or some papers by Brodie and Goss; still others which pass the whole subject under one general review, like one of my own and those of Maurice and Vidal y Careta, — all these have served to advance in one way and another an interest in this department of science and to bring more or less order out of previous confusion or misunderstanding. The most pretentious of these undertakings is the general systematic survey entrusted to me by Zittel for his "handbook of paleontology," in which for the first time since Pictet and Giebel, or for more than thirty years, a systematic technical treatment of the entire series of fossil insects, myriopods, and arachnids was attempted, including tolerably full definitions throughout the paleozoic series and to some extent in the later, with a fullness and variety of illustration never before given. To gather together, as I believe is there done, even the smallest references and weld all into a connected whole would have been almost impossible, had I not begun at least twenty years ago a systematic card reference-catalogue in which every such allusion great or small is entered and which has been constantly perfecting and kept up to date. For English readers, the text of my contribution to Zittel's *Handbuch* was also published by our Geological survey, with a somewhat fuller treat-

ment of the tertiary series, but without illustrations.

And now, in bringing this too long address to a close, you may perhaps ask what the outlook is for the future. I venture to predict that it will be quite as brilliant as the past. In the first place, publications bringing the whole known series of discoveries in systematic order up to date, like that just published, always have a tendency to bring out new facts and discoveries. Again, new localities are being found, and in fact, the public has as yet only tasted of the good things of Comentry and Florissant, the richest known fields in the world, respectively, for carboniferous and tertiary insects. When Brongniart tells us that he has six hundred cockroaches alone at Comentry, we may well hold our breath, and it is not to be believed that he will delay longer than he is compelled by the very richness of his field, the publication of the results of his study on the other insects whose classification has already been outlined by him. As to Florissant and our other tertiary fields, the work of illustrating the insects, for which thousands of drawings are already made, has, owing to unavoidable engagements, marched far ahead of text; but a volume, with descriptions of over five hundred insects, including mainly the lower orders, and with over eight hundred figures, is nearly ready for the printer. It will show that Florissant alone is as productive as all the tertiary fields of Europe taken together, if we exclude the insects found in amber. Yet during the

past summer, in explorations for the Geological survey, I found that the strata of a considerable tract of country, certainly many, probably hundreds of, square miles in extent, lying in western Colorado and eastern Utah, were packed with fossil insects as closely as at Florissant, where they occupy a lake basin of relatively small proportions: whether these new localities will excel or even equal that place in the variety of their fossil treasures, is yet to be determined; but there can hardly be any doubt that we shall soon be able in our western territories to rehabilitate successive faunas as successfully as has been done

with many of our vertebrate types, and as has not yet been done for insects in any country in the world. Nor are we confined to our later beds; insect deposits have now been found in a score of places in our extensive carboniferous series, and it is in no way improbable that we may find our own Commeny to double the value of the French discovery. What we really need is a score of trained workers to "go in and possess the land." No one would welcome them more heartily than one who is almost a solitary worker in the American field.

THE AMERICAN PLUM BORER 'EUZOPHERA SEMI-FUNERALIS' WALK.

BY STEPHEN ALFRED FORBES, CHAMPAIGN, ILL.

Although various boring insects have occasionally attacked the plum, these have been species whose principal injuries are done to other trees, and no distinctive plum borer has hitherto been known in this country. Among these incidentals enemies are the peach borer (*Sannina exitiosa*) the flat-headed apple-tree borer (*Chrysobothris femorata*) the so-called pear-blight beetle (*Xyleborus pyri*), and one of the twig borers (*Elaphidion villosum*). Somewhat recently a newly imported European bark beetle, *Scolytus rugulosus*, has attacked a variety of fruit trees, the plum among them, but by none of these insects has any constant and serious injury been done to the latter fruit, so far as I am

now aware. In a species first described (in this country) in 1887, and whose immature stages have remained unknown until the present time, we have our first example of a borer devoted, so far as now known, to the plum alone.

This species was first reported to me as injurious 21 August 1887, in a letter from Farmingdale, Sangamon county, Illinois, accompanied by a few borers found in young Chinese plum trees (*Prunus simoni*), one of which was nearly killed by them.

The attack was described as most general near the forks of the trees, especially at the bases of the lower limbs, but the larvae were sometimes found an inch, or less, within the earth. The



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