

No. 14. — *The Devonian Insects of New Brunswick.*

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HAVING lately had occasion to examine anew the venation of Neuroptera with special reference to their affinities with the older fossil insects, I have made a detailed comparison of the majority of the types of the Devonian Insects with the Neuroptera and Pseudoneuroptera of the present day. The conclusions at which I have arrived from this study are radically different from the views entertained by Mr. Scudder. I have thought that the simplest method of presenting my views would be to give them in the form of a detailed review of the last memoir on the subject by Mr. Scudder.

This memoir is a part of the "Anniversary Memoirs of the Boston Society of Natural History," 1880, 4to, p. 41, Plate I. The fragments of the six described insects were discovered in 1862 by the late Prof. C. F. Hartt, and are considered to be the six oldest known fossil insects. They are especially interesting, not only as the most ancient representatives of their class yet discovered, but as (p. 30) "nearly all are synthetic types of a comparatively narrow range," filling in some way the gaps between more or less widely separated families and orders of the actually existing insects. Indeed, four of them are reported to belong to new families, all of a synthetic character: Atocina, Homothetidæ, Cronicosialina, Xenoneuridæ. The prominent value of those fragments justifies a large number of more or less detailed communications by the same author since 1865, which are now followed by this very elaborate memoir, with entirely new and improved figures, and with a number of important conclusions as the final result of his work. It must be acknowledged that these conclusions would be of the greatest importance for the history of the evolution of insects, if the descriptions, the determinations, and the statements by the author could be accepted without any further reserve. Of course, they must be able to stand the most severe tests, if they are to be accepted. The obvious importance of these questions, and the fact that I have studied through many years the living and fossil insects of the families to which these fragments belong, may explain why I give here in detail the result of my studies, and my objections to the views of the author. Science needs truth, and consists in truth. Otherwise no advance in the solution of the great

question here treated — the evolution of this class of insects — is possible. The facts to be registered for such an advance must be unquestionable facts, and that is not the case with those stated in this publication.

“As the simpler Devonian Insects have certain special relations with the Ephemeridæ, their description is preceded by an account of the wing structure of the modern Mayflies, as a basis of comparison.” (p. 4.)

The simple fact that none of the fossils has any relation whatsoever to the Ephemeridæ, is a sufficient objection to the descriptions and conclusions relating to this family. Some exceptions made by the author in the account of the wing-structure of *Lachlania* and *Oligoneuria* prove erroneous after a careful examination of the insects. The mediastinal vein is present in *Lachlania* and *Oligoneuria*, and the scapular vein terminates at the tip in *Lachlania*. The intercalary vein of *Coloburus* is to be found also in *Ephemerella gibba* and in *Heptagenia Bellieri*.

Platephemera antiqua.

The specimen is in excellent condition; I have before me the type, Fig. 9. This species has nothing whatsoever to do with the Ephemeridæ, and I remark here that my deliberate determination is not based upon a difference of opinion, but merely on the simple evidence of facts. The specimen is a part of the apical half, without the tip, of a wing of a gigantic dragonfly. Fig. 10 shows on the hind margin the end of the sector medius, where the margin is often a little retracted. Nearer the tip (in Figs. 9 and 10) the sector nodalis and sub-nodalis run one near the other, as commonly in dragonflies. No pterostigma is visible; but we find it wanting or sometimes slightly indicated in other fossil species. The statement of the author, that “the marginal vein runs close to, but does not form, the margin,” confirms my determination, as just in Odonata this structure is very common, but not in Ephemeridæ. The conclusion of the author that a general similarity of structure of *P. antiqua* “with *Dictyoneura* may be conceded,” will not be shared on comparing the figures of the species published by Goldenberg. The existing part of the wing compared with the known fossil species from Solenhofen cannot be larger than about one third of the whole length of the wing. To judge from the termination of the sector nodalis, something less than 20 mm. of the tip are wanting, much more than is indicated by the outline of the figure. To judge from the distance and the direction of the mediana and the sector nodalis to the base, about 20 mm. must be wanting to the nodus. It would be the largest known species, the length of the wing about 100 mm. There is no character in the fragment for a closer determination except the suddenly narrowed second cubital space; and this is not mentioned by the author. We find a similar arrangement in *Stenophlebia*.

Gerephemera simplex.

I have not seen the type, but only the unfigured and undescribed reverse of a small portion, belonging to the Boston Society of Natural History. Therefore my opinion is based chiefly upon Fig. 8 and the very detailed description. The description differs from the figure (of natural size) in the statement (p. 13) that "the merest fragment of the costal border 2 to 3 mm. long is preserved," whereas the figure has it 8 mm. long, with two oblique cross veins and indications of quadrangular cells between them. As these cells are not mentioned in the description, they were perhaps not present in the specimen. These cells would be of prominent importance if they were really situated near the costal border. But it is not uncommon to find in badly preserved fossil wings some parts folded up and appearing in the wrong place. If they are present as figured, they could be explained in another manner, which will be quoted hereafter. The specimen is unfortunately not on a level, but upon a somewhat rounded ground-floor, and shows a kind of sulcus, which certainly does not belong to the wing. Therefore all parts of the wing situated in the sulcus are not quite in a natural position. The statement of the author (p. 14), "that the mediastinal vein is never a depressed one in such insects," should have been just the contrary.

The fragment represents a diagonal part of the middle of the wing of a dragonfly. What is called "the uppermost vein of the lower set" is probably the sector medius, and the vein running a little below in the same direction is the sector brevis. All the parallel veins above those sectors, which give so much trouble to the author, are easily to be accounted for in the venation of the Odonata. The fragment is very rudimentary, and it seems by no means certain that the two veins indicated on the tip (if figured in the right place) belong to the marginal veins. Perhaps they may belong to the sector nodalis and sub-nodalis. The determination of Fig. 8 cannot go farther than to state that the specimen belongs to the Odonata and to a very large species. All important characters for the determination of the genus, and even of the sub-family, are to be found in parts of the wing which are not here preserved. It seems, to judge from the veins which are visible, that the small part called the front margin was situated behind the nodus. Species are known with an irregular venation just behind the nodus, but not of a similar irregularity. Considering the other characters agreeing with the Odonata, this peculiar feature would not indeed warrant us in excluding this species from this family. But it is more probable that the small part does not belong to the front margin, and similar cells are likewise found in *Isophlebia*.

The new family *Atocina*, created by the author for this specimen, and the whole discussion about it, cannot be accepted as it is. In his first letter, in 1865, the author states that "this species borrows some striking points of the peculiar wing-structure of the Odonata, and combines with them those of families remote from that, and even belonging to a distinct section of the Neuroptera, exhibiting to our view a synthetic type combining the Pseudoneuroptera and the Neuroptera. I am unable to find in the figure and in the new

description any character not agreeing with the Odonata, except the dubious cells of the front margin, and these are nowhere mentioned in the description.

The small portion of the reverse, which I have examined, is a triangular fragment 20 mm. long and 2 to 8 mm. broad. It belongs to a part of the base of the wing, which is not preserved in Fig. 8. It does not reach the costal margin, and contains several sectors crossed by a straight vein (sector trigonuli inferior) similar to the arrangement in *Isophlebia*. The reverse strongly confirms my determination. This sector is to be found only in Odonata, never in Ephemerae. The specimen was probably a hind wing.

Lithentomum Harttii.

I have examined the type (Fig. 3) of the Boston Society of Natural History. It is very difficult to determine the fragment. A part of the base and of the lower part of the wing lies below (or perhaps above, as some fragments seem to indicate) a *Calamites*. The base with the stronger triangular basal attachment of the wing is seen on the other side of the plant. There are strong indications that the other wing of the same side lies below this wing, and the margin of it a little before the margin of the fragment that is figured. A deeper linear impression on the opposite side of the *Calamites* makes it probable that here the upper wing of the other side of the insect may be in the slab. The fragment is 36 mm. long; the breadth (at 24 mm. from the base) is 15 mm., where a very short portion of the hind border is to be seen. Farther off the hind border is broken, so that at 32 mm. from the base only 9 mm. of the breadth is preserved. The veins are very faint, and in some parts the veins of the underlying wing make them somewhat uncertain. In the costal space some very weak oblique cross veins are visible. What is to be seen of the longitudinal veins, of their forms, and of some oblong cells between them, which are contracted at both ends, reminds us of the venation of the actually living *Sialids*, and more of the *Chauliodes* type. The base of the externomedian shows above and below an arrangement which is to be found in the wing of *Chauliodes*. The other parts of the venation give no help for a nearer determination. The paucity of the off-shoots of the scapular branch is by no means exceptional, as the author believes; the living *Chauliodes* possesses only one, the character claimed by the author for his new family *Croniosialina*. Therefore I do not understand why we should consider the fossil species as a precursor of the *Sialina*, before a better knowledge of the species supports this suggestion. Fig. 3 is less accurate than the other figures.

Homothetus fossilis.

This interesting fragment, of which I have not seen the type, shows near the tip of the wing some irregularities of the venation, as if a fragment of another wing lay above or beneath the specimen. The author declares it to belong to

a family allied to the *Sialina*. A small basal vein considered to be homologous with the arculus of the Odonata induced him to consider the specimen as a connecting link between the Neuroptera and Pseudoneuroptera. Therefore a new synthetic family, Homothetidæ, is proposed.

It is obvious that the wing belongs to the *Sialina*, and is perhaps a fore wing. But then the basal vein is easily explained. The fore wings of *Corydalis* possess a horny basal part, ending in front in a straight line; here a softer membrane connects the wing with the basal part. When broken off here — and the formerly published figure makes this more evident — the basal vein is explained. Some *Hemerobidæ* show an arrangement similar to the arculus, without giving us a right to consider them as a synthetic type. The fossil fragment recalls some of the figures published long ago by Westwood as belonging to a genus but little known, *Orthophlebia*, related to *Corydalis*, but the living species possess a larger number of transversals. Perhaps some of the restored connections in the missing parts of the wing will have to be transferred in another way. A more exact determination cannot be made; we may state, however, that the fragment shows nothing foreign to the *Corydalis* type, excepting a smaller number of transversals.

Xenoneura antiquorum.

I have examined the type of Fig. 7. This is the interesting wing which was formerly supposed to exhibit at the base a character to be compared only to the stridulating organ of some male saltatorial Orthoptera. The wing seems to have been very delicate, and is a very difficult object. I have not seen the type of Fig. 6, and Fig. 5 (p. 41) is stated to be a composite drawing made up from both specimens. The "small fragment at the extremity of the anal vein and the cross vein," and "the larger apical piece with part of the lower margin," are drawn from the reverse. Both are to be seen in the obverse (type of Fig. 7), but not so distinctly. The whole wing is shown by numerous parallel and very close longitudinal lines to have been placed beneath or above some part of a plant; on account of these lines some parts of the venation are less distinguishable. What is more important is, that the wing of the opposite side is lying upon the one which is figured, not exactly in the same direction, but nearly so. Its hind margin is a little below the hind margin of the main wing. This fact is not mentioned by the author. The quadrangular part of the hind margin, enclosed in the figure by broken lines, belongs to the upper wing, of which the sectors are elevated; the corresponding sectors of the main wing are depressed. This fact once accepted, we find some small remains of the upper wing on the basal part of the main wing near the scapularis, where the fork (of the author) is to be seen. The difficulty increases on account of the cross veins of the marginal field (Fig. 5); one of them, about the middle of the wing, is very conspicuous, — I may say, considering the delicacy of the other parts of the venation, too conspicuous. Indeed, examined with the compound microscope, this vein projects outside the margin as much as a quarter of the breadth of the

field. Therefore it does not belong to the wing. Several fainter cross veins — I have counted six — are therefore very doubtful, the more as some are only to be seen near the margin. A little before the end of the costal field the mediastina turns in a sudden curve to the scapularis. The transversal vein going from the same spot to the costalis is not straight, as represented in the figure, but waved, much finer, perhaps forked, with indications of similar veins near by. Shortly before its end the costalis seems to start externally in a very acute angle another vein. This doubtful vein may belong to another wing, or it may be a dilatation of the costalis, or it could represent very long cilia, of which indications seem to appear in other places. The fork, as it is called by the author, I believe to be represented only by a fragment of the wing, which lies above the main wing. The two veins nearer to the base (the external one believed to be the internal branch of the fork) belong to the main wing. The length of the main wing is about 15 mm., the breadth 5 mm., probably a little smaller than the dimensions given by the author (18 mm.). Formerly the insect was said to have an expanse of wings of two or two and a half inches. Of the basal part of the marginal field the marginal half seems to be broken off. I purposely say seems, because the slab shows here some indications of breaking; but the costalis can be followed around the curve and partly on the narrowed part of the field. There are here indications of a recurrent vein, which is common in some Hemerobidæ. A light impression around the wing on the slab suggests perhaps the presence of another wing, a little larger and bluntly pointed. If this should be the case, the main wing would represent a hind wing, and what is to be seen of the base speaks in favor of it. The venation of the base is much disturbed by the circular elevated lines formerly supposed to represent a stridulating organ; a view now formally retracted by the author. It might be, as he states, a malformation on the base of the wing, or produced by something lying underneath. Perhaps the circular lines are the margins of the telescoped segments of the abdomen, which, if present at all, must have been here. In this case the more crystallized parts of the stone are easily explained, as such occurrences are found commonly in the abdomen of Odonata and other insects from Solenhofen, and in the mouth parts of *Eugereon*.

I am not able to classify the insect except that it belongs to the Neuroptera (*sensu strictiori*). There is nothing in the venation similar to Pseudoneuroptera. When the mediastina ends before the tip and is connected with the costalis and scapularis in Pseudoneuroptera, the upper connection is entirely different, and by a straight cross vein, which is not to be found here. Only some Pteronarcys belonging to the Perlidæ have a connection somewhat similar to that of the Xenoneura. What we see of the venation is more nearly allied to the Chauliodes type than to any other. The mediastinal field is somewhat related to *Sialis*, but more to some Mantispidæ, to the genera *Trichoscelis* and *Symphrasis*, namely, to the costal half of *S. varia*. The venation has no similarity to *Coniopteryx*, *Raphidia*, and *Ephemera*, and bridges in no way the gulf between the Neuroptera and Pseudoneuroptera, as stated by the author.

Dyscritus vetustus.

A very small fragment, said to belong to the hind margin of a wing, with two series of eight square-shaped cells between three veins, one of them branched at the base, is all that is preserved. It can belong to Orthoptera, to Pseudoneuroptera, or to Neuroptera, but it is too insignificant to be identified. Similar cells are found in *Isophlebia*.

The conclusions to be made from the results of my examination of the Devonian Insects are the following:—

1. The known fragments belong to five species.

Two are Odonata, belonging to the Pseudoneuroptera. The very imperfect fragments do not permit us to say more than that some characters are similarly represented in the gigantic species of the Solenhofen state, in *Stenophlebia* and in *Isophlebia*. These characters are the suddenly narrowed second cubital space in *Platephemera*, and the straight sector trigonuli inferior in *Gerephemera*, neither mentioned by the author.

The three other fragments belong to the Neuroptera, and probably all to the Sialina. One of them is more related to the *Corydalis* type, the two others to the *Chauliodes* type.

2. None of them have any relation to the Ephemeridæ, as is asserted by the author.

3. None of the Devonian Insects are of a synthetic type. Besides that such a type could hardly be derived from the wing only of living species, these specimens are too fragmentary for such conclusions.

4. The previous stages of all were probably aquatic.

5. No related species is known from the North American carboniferous strata. Probably all insects known from them are terrestrial. Till a more complete account is given of *Euephemerites*, it cannot be considered to be an insect wing.

6. Concerning the four families proposed by the author, one, the *Atocina*, is out of the question, because belonging to the Odonata. The other three are based upon extremely vague characters, which are not justly to be considered family characters at all.

The study of fossil insects, and especially the study of fragments of fossil insects, is doubtless extremely difficult. The most detailed knowledge of the living fauna is indispensable, and, as the specialist will inevitably find, the actual literature is entirely insufficient for the details needed for comparison, and a very complete collection, such as does not yet exist here for any group, is necessary in order to avoid grave errors.

But assuming that both are at hand, — a very detailed knowledge and a very complete collection, — it is obvious that at the present time both can exist only for some specialty, and not for the whole class of insects. Every attempt to go beyond those limits commonly entails errors in a geometrical progression. Undoubtedly the smallest fragment of an insect belonged to a species, to a genus, to a family. Nevertheless it cannot be an advantage to science, it cannot mark a progress for science, if such fragments are named and determined as a species, and as possibly belonging to such and such a genus and family. It is evident from the "insignificant fragment" of *Dyscritus vetustus*, discussed at length in page 22, that any scientific judgment, and therefore any scientific classification of it is impossible. It can belong to several different families, and it is quite as probable that it belongs to Platephemera, or to Gerephemera, or to some entirely different insect. The fragment is so insignificant, that, if the whole fauna of the Devonian Insects was known, it would be impossible to ascertain its place with certainty. Therefore such names are not only useless, but a hindrance to science. Ten years ago the Rev. Mr. Eaton, of Croydon, England, expressed the same opinion in strong terms; but Mr. Scudder (p. 11) objects to these strictures in the most emphatic manner, without giving any satisfactory reasons.

Palæontological works are and can only be studied and understood in our days by specialists, and for special groups. Others must take the conclusions for granted, which they are not able to control, for want of special knowledge. I must frankly declare that it is for the interest of science that such nomenclature should be discontinued, as it is sure to be with a little knowledge of facts.

CAMBRIDGE, March, 1881.

Additional Remarks upon a Fern in the same Slab with Platephemera.

Some doubt has been expressed as to the age of those insects by Dr. Geinitz (Sitz. ber. Isis, 1866, p. 22), who considered them as probably belonging to the Carboniferous formation from the fact that *Platephemera* is on the same slab with a fern characteristic of that formation, *Cyatheites* (*Pecopteris*) *plumosa*. Mr. Scudder (Geol. Mag., Vol. V. p. 174) says: "If, however, Dr. Geinitz's determination of this species were certainly correct, it would not invalidate the statements of geologists, who refer this deposit to Devonian, for several species of plants are stated to be common to this formation and to the Carboniferous."

This may be: nevertheless an important gap is still here to be filled. Mr. Scudder does not mention the occurrence of this plant together with *Platephemera*, nor is that done in the geological note (p. 40) by Prof. Dawson. Among the plants belonging to bed No. 7, no species of *Pecopteris* or *Cyatheites* is enumerated by Prof. Dawson. I cannot in the Canadian literature at my command find this fern quoted as occurring in the Devonian formation.

I applied to a prominent authority, Mr. Leo Lesquereux, for information, and had the following answer: "*Pecopteris* (*Cyatheites*) *plumosa* is a common species of our middle Carboniferous, found in the strata immediately above the millstone grit. As yet it has not been found in the subconglomerate, still less in the Devonian of the United States, which is separated from the conglomerate by the subcarboniferous or the Mauch Chunk red shale, very thick formations. This species is even described by White and Fontaine from the Permo-carboniferous. Some of Prof. Dawson's species from the Devonian in Canada are found in the true Carboniferous of the United States. We have no positive means of ascertaining the geological relation, as the identity of some of Prof. Dawson's species is as yet uncertain. This is about all I can say on the subject. For common species like *P. plumosa*, which is the equivalent of *P. dentata*, the geological distribution is generally well marked between the European and North American series. We have, however, some types, which are found here in the lower Carboniferous, even in the subconglomerate, while in Europe they have not been found until now at a lower stage than the Permian and the Trias. This difference, however, cannot

be taken into account in comparing the plants of the United States Coal measures with those of Canada. From this you cannot derive any reliable conclusion. *Pecopteris plumosa* in the Devonian would appear to me quite an anomaly, but not more so than to see it in the lower Permian."

I suppose that everybody will agree that the plant in question should be studied and determined with the utmost care to avoid any further doubt concerning the age of those interesting insects.



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