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## KANSAS PERMIAN INSECTS.

### PART 17. THE ORDER MEGASECOPTERA AND ADDITIONS TO THE PALAEODICTYOPTERA, ODONATA, PROTOPERLARIA, COPEOGNATHA AND NEUROPTERA.

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#### ABSTRACT.

The following new genera and species are described: Megasecoptera: *Elmoa trisecta*\* n. g. et sp. Palaeodictyoptera: *Kansasia pulchra*\* n. g. et sp. Odonata, Suborder Protanisoptera: *Camptotaxineura ephialtes*\* n. g. et sp. Copeognatha, Suborder Embiopsocida: *Nugonioneura problematica*\* n. g. et sp. Neuroptera, Suborder Sialoidea: *Promartynovia venicosta*\* n. g. et sp. Suborder Planipennia: *Dictyobiella nervosa*\* n. g. et sp. *Permobiella perspicua*\* n. g. et sp. *Permoberothesia convergens*\* n. sp. Protoperlaria: *Paraprisca stigmatica*\* n. sp.

In Part 16 of this series of studies (1936), I gave my reasons for considering the Protohymenoptera to be a distinct Order, and not a Suborder of the Megasecoptera. Apart from a fairly abundant fauna of Protohymenoptera, no Megasecopteroid types have so far been found in the Lower Permian beds of Kansas. It is therefore of considerable interest to record here the first discovery of such a type, especially as it is one which stands very far apart from the more specialized types already recorded as Protohymenoptera.

At the same time, I take the opportunity to put on record some interesting additions to the Orders Palaeodictyoptera, Odonata, Protoperlaria, Copeognatha and Neuroptera. Most of these specimens were not easily classified without prolonged study, and thus they came to be put aside, years ago, when I began my work on the Yale University Collection, in a separate "puzzle-box," and were only worked at from time to time, as opportunity offered, and long after the principal representatives of the Orders concerned had been dealt with. Two of them, the new Odonate type and the finest of the new Planipennia, were lucky discoveries through removing the overlying

rock from mere fragments of wings which did not suggest anything definite at all, and which were very nearly put aside as useless for description.

### Order MEGASECOPTERA.

#### Family ELMOIDAE fam. nov.

Insects of medium size having the base of the wing somewhat narrowed and the main veins R, M and CuA<sup>1</sup> all arising from a stout common stalk, with Sc just above it and CuP just below it. The veins Rs and MA are connected near their origins by a cross-vein, and MA arches upwards from M, as usual in this Order. In the anal region, there is only one well developed main vein, 1A, and a very short remnant of a second, 2A. Cross-veins were present, but not abundant, and, with few exceptions, very weak.

#### Genus ELMOA n. g.

(Fig. 1.)

*Forewing* with costa only of moderate strength and apparently not serrated or denticulate. Sc close to R at origin, but distinct, and diverging slightly from it distally (as far as the wing is preserved). Main common stem of R, M and CuA bends slightly downwards away from Sc before dividing into its component parts, all three of which diverge from a single point, M being a very weak concave vein dividing somewhat unequally the wide angle between R and CuA. Rs arises about twice as far from base as the origin of M and CuA and is connected with the upwardly arching MA below it by a cross-vein *rm*. In the preserved portion of the wing, Rs remains simple; MA is branched; MP and CuA are simple. CuA curves slightly downwards on leaving R and then runs slightly divergently from MP. CuP arises as a definite concave vein, distinct from CuA almost from base of wing, and arching strongly below the beginning of the curve of R + M + CuA; it then runs obliquely downwards, diverges slightly from CuA, is markedly bent at the first cross-vein connecting it with 1A, and gives off a short posterior distal branch to the wing-margin. 1A is an almost straight vein, short, ending at about

<sup>1</sup> The notation CuA, CuP will be adopted here and in succeeding Parts for the anterior (convex) cubitus and posterior (concave) cubitus respectively. Branches of CuA will become CuA<sub>1</sub>, CuA<sub>2</sub>, etc., instead of Cu<sub>1a</sub>, Cu<sub>1b</sub>, etc.

the level of the origin of Rs, slightly curved in its distal half and strongly bent downwards after meeting the second cross-vein from CuP; just before the first cross-vein from CuP, it sends off a strong, oblique descending branch to the posterior margin. 2A is a very short sigmoidal vein; it appears to be connected with CuP, through 1A, by a strong transverse strut or cross-vein close to base of wing. There are two cross-veins in costal space near base of wing, one before and one after the origin of M and CuA, and possibly some others more faintly developed distally in costal and subcostal spaces.

Genotype:—*Elmoa trisecta* n. sp.

Horizon:—Lower Permian of Kansas.

The generic name is taken from Elmo, the locality where the fossils are found. It is difficult to indicate its relationships, apart from placing it within the Order Megasecoptera and outside the Order Protohymenoptera. It is clearly a very primitive type in certain respects, notably in the complete separation of the main veins except basally. I consider that it shows some relationship to the Upper Carboniferous genus *Brodia* Scudder. But it cannot be descended from this genus, because, even in this primitive type, the basal portion of the wing is more narrowed than in *Elmoa* and MA arches upwards so as to approach more closely to Rs.

Apart from the specialized fusion of the three main veins R, M and CuA, the genus *Elmoa* shows, as beautifully as in any genus known to me, the alternating origins of the convex and concave main veins in the primitive Order Megasecoptera. A section taken across the distal portion of the preserved part of the wing shows a perfect succession of ridges and furrows in the order C (+), Sc (—), R<sub>1</sub> (+), Rs (—), MA (+), MP (—), CuA (+) and CuP (—), with, a little more basad, 1A (+). Actually, R, M and CuA form a perfect positive triad at their origins, and Rs, MA and MP form an almost equally good negative triad.

There is only a distant relationship between this wing, which is a true Megasecopteran, and the genera *Protohymen*, *Permohymen*, *Asthenohymen*, etc., which form the Order Protohymenoptera. In that Order, Sc and R<sub>1</sub> approach so close to the costa that they practically form together a strongly chitinized costal margin, while the secondary fusions of the veins below R mask the true nature of the venation, MA fusing with Rs and MP with CuA. But it would appear probable that the Protohymenoptera arose from some form not unlike

*Elmoa*, rather than from any of the known Upper Carboniferous forms, and therefore we may regard *Elmoa* as a remnant of a very old Megasecopterous group which must have obtained a footing in North America long before Lower Permian times. Unfortunately, very little is known about the Upper Carboniferous Megasecoptera of North America.

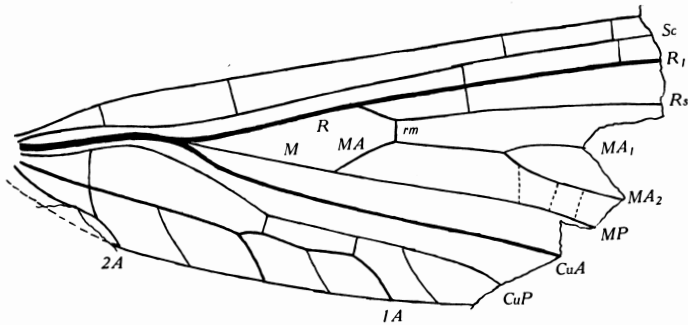


Fig. 1. *Elmoa trisecta* n.g. et sp. Order Megasecoptera, fam. Elmoidae. Right forewing. Specimen No. 15591a. Length of fragment 7.0 mm.

#### ELMOA TRISECTA n. sp.

(Fig. 1.)

*Forewing*:—Length of fragment 7.0 mm., indicating a complete wing about 12 mm. long by 3 mm. wide.

The impression lies on a rather rough surface; the basal portion is well preserved, but distally it tails off, and the torn edge is very faint and irregular. In addition to the cross-veins mentioned in the generic definition, there would appear to have been some faint cross-veins developed here and there between the main veins; in particular, a slightly oblique one descending from the posterior branch of MA just after its origin, and two faint veinlets descending from 1A in between the two strong branches already noted. The slenderness of the three concave main veins, Sc, M and CuP makes a striking contrast with the strength of the ridges of R and CuA and with that of the almost equally strong convex vein 1A.

*Types*:—*Holotype obverse*, Specimen No. 15591a and *reverse* No. 15591b in Yale University Collection.

This species is the only true Megasecopteran so far recorded from the Kansas beds. As I have already indicated (Tillyard, 1924 and 1936) I consider the Protohymenoptera as a distinct

Order on account of the very specialized type of venation and the presence of a complete ovipositor in the female, which is not known to occur in any type of true Megasecopteran.

Order PALAEODICTYOPTERA.

Family SPILAPTERIDAE.

Genus KANSASIA n. g.

(Fig. 2.)

Insects of moderate size, having a clear, glassy membrane with strongly developed main veins but only one cross-vein (*rm*). Pterostigma strongly chitinized. Sc very long, extending through pterostigma, which also touches  $R_1$  below it, running subparallel to Sc. Rs arising well away from base and, near its origin, is connected with MA by means of a cross-vein; Rs is branched dichotomically in its distal half. MA arches anteriorly upwards from M to the cross-vein *rm* and then runs subparallel to MP and remains a simple vein. MP continues the line of the main stem of M and is branched distally. CuA is a strong convex vein diverging slightly from M basally; in its distal portion it gives off a beautiful series of descending pectinate veins. CuP simple. (Anal veins missing.)

Genotype:—*Kansasia pulchra* n. sp.

Horizon:—Lower Permian of Kansas.

It is unfortunate that this extremely clear and beautiful wing is not complete basally. Enough, however, is preserved to indicate that it should be placed in the Spilapteridae and not far from *Dunbaria* Till., from which it differs markedly by the absence of any marked colour-pattern, the much less branched Rs, the simple MA and the more specialized branching of CuA.

KANSASIA PULCHRA n. sp.

(Fig. 2.)

*Forewing*:—*Length of fragment* 12.5 mm., indicating a total length of wing of about 16 mm.; *breadth* at level of first branch of CuA 5 mm.; this is probably almost the greatest breadth of the wing.

The veins are very clearly marked, even, and darkly pigmented. The whole membrane was hyaline and evidently of firm texture; the only pigmented part is the curiously shaped pterostigma, which is semi-lanceolate, occupying 2.2 mm. along the costal margin and bulging downwards so as to meet  $R_1$

at about two-thirds of its total length from base; its colour is a medium brown, distinctly paler than the veins. The dark vein Sc can be seen passing right through the pterostigma in its upper half, and ending gently on costa just beyond it.  $R_1$  makes contact with the pterostigma for about 0.5 mm. and ends on costa about 0.5 mm. beyond the end of Sc.  $R_s$  is strongly strutted on to MA, close to its origin, by means of the cross-vein *rm*; it leaves R at an angle of about  $75^\circ$  and bends markedly at the cross-vein; distally it divides about half-way into  $R_{2+3}$ , which remains simple, and  $R_{4+5}$ , which again divides,

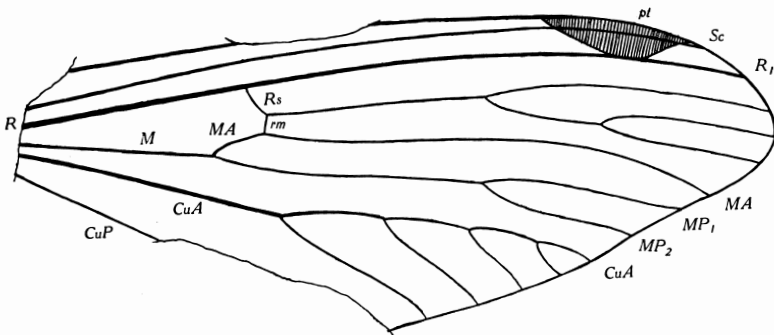


Fig. 2. *Kansasia pulchra* n.g. et sp. Order Palaeodictyoptera, fam. Spilapteridae. Left forewing, with apex turned to right for comparison with other figures. Specimen No. 15589. Length of fragment 12.5 mm.

below the level of the pterostigma, into two subparallel branches. M is seen at base of fragment diverging markedly from R and running straight for the first third of its length, where it divides into MA and MP. MA arches up markedly at this point, but does not diverge from M at as great an angle as does  $R_s$  from  $R_1$ ; also, the basal piece of MA, from its origin to cross-vein *rm*, is considerably longer than the corresponding basal piece of  $R_s$ . MA remains simple and runs for most of its length subparallel to  $R_s$ ; but, as it approaches the apical margin of the wing, it curves markedly downwards, diverging strongly from  $R_s$ . The cross-vein *rm* is short, about half as long as the basal piece of  $R_s$ , and is strongly pigmented and almost as strongly chitinized as the main veins which it joins. MP continues the line of M with only the slightest of bends at the fork; it divides into two distally. CuA runs as a strong straight vein for nearly half its visible length, diverg-

ing slightly from M; at a point below *rm* it gives off the first of a series of four descending branches arranged in pectinate series; between these branches, the main stem of CuA is gently arched. CuP is mostly missing, but a short basal portion can be seen diverging rather strongly from CuA and placed about twice as far from it as CuA is from M.

Type:—*Holotype obverse*, Specimen No. 15589 in Yale University Collection.

This species is the third undoubted Palaeodictyopteron so far discovered in the Lower Permian beds of Kansas, the other two being *Dunbaria fasciipennis* Till. and *Permoneura lameerei* Carp. The former belongs, like *Kansasia* n.g., to the family Spilapteridae; but it should be noted that the Lower Permian genera stand well apart from the Upper Carboniferous forms in having lost the fairly abundant system of cross-veins which their ancestors originally possessed. Carpenter (1931) placed *Permoneura* in a new family Permoneuridae on well marked characters in its venation, notably the fusion at a single point of MA with Rs, and the complete absence of CuA. It should be noted, however, that the mode of branching of both Rs and MP in *Permoneura* closely resembles that of *Dunbaria*. I should regard *Permoneura* as a very highly specialized offshoot from the ancestral stem of *Dunbaria*. The complete loss of the important convex vein CuA is very hard to account for, and is an occurrence unique within the Order Palaeodictyoptera. But, as only the hindwing of *Permoneura* is known, I think we should not attach too much importance to it, as it is possible that the forewing may have retained this vein or portion of it. There is also the chance that this particular specimen may be a freak; certainly the curious branching of the second anal vein would suggest that this is possible. If the hindwing be somewhat expanded compared with the fore, a failure to expand completely at metamorphosis might have kept CuA and CuP fused together and so turned CuP into a branching vein. Another suggestion, which I make with some diffidence, is that the true vein CuA has become folded over on to the line of CuP; in this case, it would show as a concave vein in the impression, and its branches would be an anterior pectinate series instead of a posterior one, which is exactly the case as shown in Carpenter's figure. If this suggestion proves correct, then I think that, in spite of the contact between Rs and MA, the genus *Permoneura* should be removed back into the Spilapteridae and placed not far from *Dunbaria*.

## Order ODONATA.

## Suborder PROTANISOPTERA.

## Family CAMPTOTAXINEURIDAE fam. nov.

Radial sector with a posterior series of descending concave branches, not separated by convex intercalated sectors. Pterostigma strongly formed, situated very close to apex of wing.

## Genus CAMPTOTAXINEURA n. g.

(Fig. 3.)

(Distal portion of wing only preserved.) Apex of wing very blunt, the costa,  $R_1$  and  $R_s$  being all strongly curved downwards near apex. Pterostigma occupying the area just above the apex and reaching posteriorly as far as the apex itself; in form, it is apparently trapezoidal, covering the apical portion of  $R_1$  and most of the apical portion of  $R_s$ .  $R_s$  with five posterior, descending, concave branches, all close together in the distal portion of the wing, and all converging towards one another distally. MA bent strongly at level of origin of the most basal descending branch of  $R_s$  and having a concave posterior sector attached to it at the point of bending. CuP strongly forked. Cross-veins abundant, well marked in costal and radial spaces, faint elsewhere. (Rest of wing missing.)

Genotype:—*Camptotaxineura ephialtes* n. sp.

Horizon:—Lower Permian of Kansas.

The generic name is derived from the Greek *καμπτός* bent, *ραξίς* arrangement and *νεῦρον*. The specific name *ephialtes* is the Greek word for a *nightmare*; the venational system disclosed in this fossil may, I think, fairly be considered to be so freakish as to constitute a veritable venational nightmare. For a distant comparison, we can only turn to somewhat similar but far less striking freaks amongst recent genera of Zygoptera; in particular, one should mention the family Pseudostigmatidae, in which there is a similar tendency to blunting of the apex and migration of the pterostigma towards it. The nearest approach to the condition found in *Camptotaxineura* is, perhaps, that seen in *Mecistogaster* or *Pseudostigma*.

One of the most remarkable things about the genus *Camptotaxineura* is, to my mind, the fact that there are no interpolated sectors between the descending branches of  $R_s$ . In all recent genera in which the apical venation is excessive, the additions have been made by means of interpolated sectors,



## CAMPTOTAXINEURA EPHIALTES n. sp.

(Fig. 3.)

*Wing*:—Length of apical fragment 8.0 mm., breadth 5.3 mm., indicating a complete wing about 25 mm. long and 7 mm. wide. The costal margin is fairly stout and definitely denticulate. There are no signs of Sc in the preserved portion; this indicates that some kind of nodus must have been formed

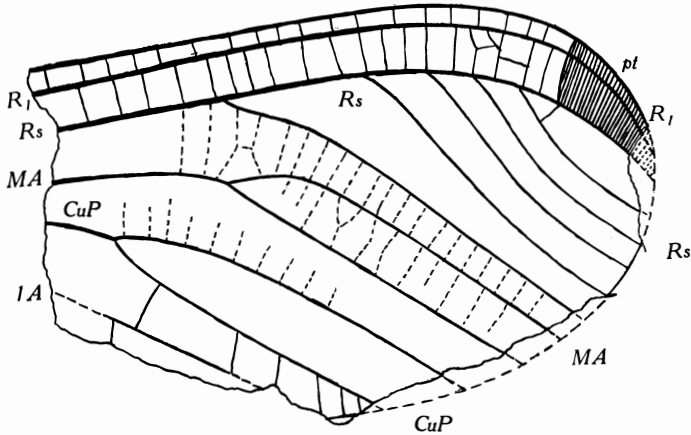


Fig. 3. *Camptotaxineura ephialtes* n.g. et sp. Order Odonata, Suborder Protanisoptera, fam. Camptotaxineuridae. Apical portion of a right wing, reverse, with apex turned to right for comparison with other figures. Length of fragment 8.0 mm. Specimen No. 15590.

in this genus.  $R_1$  runs close to costa and is connected with it by an irregular series of very short cross-veins. Nearing the apex of the wing, both C and  $R_1$  turn downwards in a deeply rounded curve, as does also Rs, which runs parallel to  $R_1$  but about three times as far from it as  $R_1$  is from C. Between  $R_1$  and Rs there is a well developed but irregular series of cross-veins. The pterostigma is not completely preserved, as the actual apex of the wing is slightly broken; it has been restored as shown in Fig. 3. The preserved portion is pigmented a medium brownish, but does not appear to have been very heavily chitinized.

Of the five descending branches of Rs, the three most distal ones arise close together, the fourth from apex arises nearly twice as far from the third as the third is from the second, and the most basal branch arises as far from the one after it

as the latter is from the most apical branch; all five branches converge, so that the slope of the most basal branch away from  $R_1$  is much gentler than that of the others, which become progressively steeper.

Cross-veins are not visible between the branches of Rs, but are probably present and very faintly developed. Between Rs, its most basal branch and both branches of MA, a complete series of weak, irregular cross-veins is developed; signs of cross-veins can also be made out between MA and CuP. Below the posterior branch of CuP there appears to be portion of another straight vein, very faintly marked, and connected with CuP by a few cross-veins.

As is often the case with veins placed on high ridges, particularly in the Odonata, the actual crown of the ridge has been carried away. The specimen being a reverse impression, this results in the convex portion of MA and the distal end of  $R_1$  appearing very faintly marked in rather deep grooves. The concave veins, on the other hand, are all very well marked.

Type:—*Holotype reverse*, Specimen No. 15590 in Yale University Collection. It is impossible to say whether the specimen represents portion of a fore or a hindwing.

This wing was a most fortunate find. As it came to me in the collection, only about the basal third of the wing shown in Fig. 3 was visible. This lay on a rough projecting piece of rock on which there was a perfect forewing of the genus *Probnis*. In shaping this latter wing up, I broke off the piece containing the fragmentary wing. As there was not enough of it to determine, I put it aside in what I called the "puzzle box." In working over the material collected there, I thought it worth while trying to uncover the rest of the wing, which was hidden by a rather steep, jagged edge of rock. The attempt was almost completely successful, although the rock broke away slightly from the actual apical and posterior margin of the wing and carried with it a portion of the newly exposed pterostigma. The exposure of the branches of Rs made me realize that the wing was an unexpected treasure.

#### Order COPEOGNATHA.

##### Suborder EMBIOPSOCIDA.

This subordinal name was suggested by me for the reception of the family Delopteridae, inclusive of the genus *Permbia* Till. (Tillyard, p. 483, 1928). A new wing, of larger

size than that of the remainder of the group, is here taken from my "puzzle-box" and added, somewhat tentatively, to this group, whose actual relationships will, I think, remain a considerable problem for many years to come. Carpenter (pp. 450-461, 1933) has dealt very fully and clearly with the much larger collection of fifty-five specimens of Delopteridae which he has had for study, and has, on the whole, supported my contention that they belong essentially to the Copeognatha, while, at the same time, correcting some errors into which I fell owing to the poor preservation of the material studied. He does not, however, mention the genus *Permembia*, which is the most aberrant and problematical genus of the whole group. I assume, therefore, that it is not represented in the Harvard Collection.

I think that the Suborder should now be divided into two distinct families, as follows:

Wings comparatively broad basally, with very few cross-veins; Sc short, straight, forking distally so as to end on both C and  $R_1$ . CuA forked in forewing.....Fam. DELOPTERIDAE Sell.

Wings narrowed basally, with more numerous cross-veins; Sc arching upwards distally and then turning downwards to make a strong contact with  $R_1$ , the connection with C being by a weaker veinlet. CuA simple in forewing..Fam. PERMEMBIIDAE fam. nov.

#### Family PERMEMBIIDAE fam. nov.

This family, defined as in the key given above, now contains two genera, separated by the following key:

Small wings, length 2 to 3 mm., with about ten cross-veins present: Sc ending about half-way;  $R_1$  not forked distally; Rs arising well before half-way and forking only far distally; CuA not strongly arched convexly to R.....Genus *Permembia* Till.

Larger wings, length about 10 mm., with numerous cross-veins, particularly distally;  $R_1$  strongly forked distally; Rs arising after half-way and forking at about one-third of its length; CuA very strongly arched convexly to R.....Genus *Nugonioneura* n. g.

#### Genus NUGONIONEURA n. g.

(Fig. 4.)

*Forewing* narrow, elongate oval in shape, with apex evenly rounded. Costal margin gently and evenly arched from base to apex. Faint, irregular cross-veins can be made out in all parts of the wing except between the cubital veins and in the

anal area. The space between C and  $R_1$  forms a very elongate and narrow lanceolate area, owing to  $R_1$  being curved slightly concavely to the costa; within this space the well developed Sc arches even more strongly upwards than does the costa, thus forming, with  $R_1$ , a smaller but more markedly lanceolate area with its apex at the point where Sc meets  $R_1$ , well beyond half-way along the wing. This point is taken as the end of Sc, but it is possible that the distal forking of  $R_1$  indicates a separation of the true distal ends of Sc and  $R_1$  as in some of the *Perlaria*.  $R_s$  arises beyond half-way, just before the ending of Sc on  $R_1$ ; it is a weak vein and forks just before the level of the forking of  $R_1$ . The main stems of R, M and CuA are fused together for about one-fifth of the wing-length in a single strong stem, from which CuA diverges, carrying M with it, in a very strongly formed vein arched convexly to R. This formation is so striking that, although the wing is very poorly preserved, it can be seen quite clearly with the naked eye, though the rest of the venation cannot; the formation at the angle suggests the Greek uncial letter  $\nu$ . CuA arches strongly downwards to end about half-way along the posterior margin, and gives off anteriorly four separate veins, all of which are concave and obviously represent the remains of the partially fused M; of these, the first, or most anterior,  $M_1$ , arches upwards towards R and is connected with  $R_s$  near its origin by an oblique cross-vein, after which it runs almost straight to end up somewhat below the apex; the second,  $M_2$ , arises close to the first, and arches similarly to it, running sub-parallel below it for most of its length but diverging distally; the third,  $M_3$  arises about twice as far from the second as the second does from the first and is considerably shorter and scarcely arched at all; it also diverges distally from  $M_2$ ; the fourth,  $M_4$ , arises close to  $M_3$ , and is only a short branch diverging from CuA and ending up somewhat beyond it. 1A is a very strong vein which can be seen situated well below CuA near the base of the wing, but which converges strongly towards it distally and nearly meets it. Between the two strong veins CuA and 1A there can be made out a faint groove, CuP, which runs closely in front of 1A and almost, if not quite, meets CuA at the margin. Most of the anal area is missing, but the distal portion of 2A can be seen arching downwards and diverging strongly from 1A.

Genotype:—*Nugonioneura problematica* n. sp.

Horizon:—Lower Permian of Kansas.

This remarkable genus has been named from the Greek words  $\nu\bar{\nu}$  the letter N (uncial),  $\gamma\omega\nu\acute{\iota}\alpha$  an angle, and  $\nu\epsilon\acute{\upsilon}\rho\omega\nu$ , in order to emphasize the outstanding character of the strong  $\nu$ -shaped angle formed between R and CuA. Equally striking, to my mind, is the whole formation of the partial fusion between M and CuA. The method by which the four branches of M arise separately from CuA is very striking, and suggests an original dichotomy,  $M_1$  and  $M_2$  arising close together, and then  $M_3$  and  $M_4$  close together. This suggests that CuA originally only absorbed the main stem of an originally four-branched M of dichotomic type, and that, later on in the evolution of the genus, the fusion reached first to the fork of  $M_{1+2}$  and then to the fork of  $M_{3+4}$ . In whatever way the formation was arrived at, it is, to my mind, one of the most striking specializations so far met with in the Kansas fossils, and places this genus far apart from all others except *Permembia*, in which a similar arching of M from CuA can be seen; but the wing in that genus being so much smaller, and M only forking once well beyond the middle of the wing, the absorption of its separate branches by the dominant CuA was not possible. Of course, there is a similar fusion of the main stems of CuA and M in the forewings of Delopteridae, but in that case CuA itself is strongly forked distally.

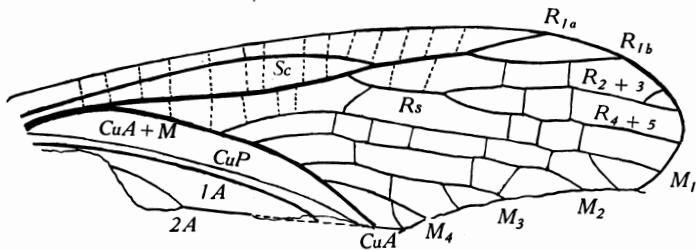


Fig. 4. *Nugonioneura problematica* n.g. et sp. Order Copeognatha, Suborder Embiopsocida, fam. Permembiidae. Left forewing, reverse. Length 9.2 mm. Specimen No. 15561.

NUGONIONEURA PROBLEMATICA n. sp.

(Fig. 4.)

*Forewing*:—Length of broken wing 9.2 mm., indicating a complete wing of about 10 mm. in length; greatest breadth 2.5 mm., at about one-third from apex.

To the full description of the venation given for the genus

we may add here that the cross-veins in costal and subcostal spaces appear to have been fairly numerous but irregular; in the distal part of the wing they were also fairly numerous, but are probably not all visible. There is a tendency for slight zigzagging of the main veins distally at the points where the cross-veins meet them, especially in the case of  $R_{3+4}$  and  $M_2$ .

The wing-membrane can be seen to have been very finely granulate. The impression is rather a poor one, on a rough rock surface; but the contrast between the irregular, rough grain of the rock itself and the very minute and regular granulations of the wing-membrane is very marked. It is clear that this wing was of a semi-tegminous nature, reminding one of many similar wing-membranes found within the Order Homoptera.

Type:—*Holotype reverse* (forewing). Specimen No. 15561 in Yale University Collection.

#### AFFINITIES OF THE EMBIOPSOCIDA.

The discovery of the wing of *Nugonioneura* appears to me to take the evolutionary history of the Psocoid Complex one stage further backwards. For, if we reconstruct the immediate ancestor of *Nugonioneura* by eliminating the high specializations connected with the fusion of M and CuA, we get a hypothetical ancestor which clearly combined characters which we find in three very distinct Orders, viz. the Copeognatha, the Homoptera and the Protorthoptera. As Copeognathous characters I would name the form of Sc and particularly its arched union with  $R_1$ , which is a very marked feature of many Permian Copeognatha. To these must be added the two-branched Rs and the four-branched M. Characters found in the Permian Homoptera are the finely granulate membrane of the forewing and the tendency of CuA to fuse with R. The tendency of CuP to become degraded into a mere furrow and to approach 1A is found in both Copeognatha and Homoptera. The existence of a fairly complete system of cross-veins, with slight tendency to zigzagging of the main veins distally, must be regarded as a Protorthopterous or Protoperlarian character; the loss of cross-veins in Permian Copeognatha, Delopteridae, and Homoptera is probably correlated with their small size and reduced wing-venation generally. The only character which appears abnormal for all these groups is the unbranched CuA; but the branches of M arising from CuA in the fore-

wing of *Nugonioneura* are so faintly preserved that it is possible that I am in error in naming the fourth branch  $M_4$ ; it might just possibly have been a weak convex vein,  $CuA_1$ , resembling that found in the hindwings of the genus *Probnis*.

One can only conclude that the Copeognatha and Homoptera must have had a common origin in an ancestral type which combined the more generalized characters of the venation of both Orders as found in the Lower Permian, and that this type was related in some manner to the Protoperlaria and those more reduced members of the Protorthoptera which are more or less annectant between the two main Orders Protoperlaria and Protorthoptera, e.g. the Probnisidae, etc. Such an ancestral type must be sought for amongst the smaller types of wings present in Upper Carboniferous times. Unfortunately, these still remain comparatively unknown to us.

## Order PROTOPERLARIA.

### Family LEMMATOPHORIDAE.

Inadvertently included in the box containing the larger of the wings classified by Sellards in the Protorthoptera, I find two species of rather large insects which, when studied, are seen to fall into the genus *Paraprisca* Handl. One of these belongs to *Paraprisca grandis* Carp., described by Dr. F. M. Carpenter in 1935, or some seven years later than the completion of my own work on the Protoperlaria in the Yale University Collection. The other is undoubtedly a new species.

The following key is now offered for the three known species of *Paraprisca*:

1. Forewing comparatively small, 9-11 mm. long, with Sc very long, reaching nearly as far as  $R_1$ ,.....*P. fragilis* (Sell.)  
Forewing comparatively large, 14-18 mm. long, with Sc markedly shorter than  $R_1$ , ending up about one-quarter to one-third of the wing-length from apex.....2
2. Forewing with only very slight dark pigmentation in pterostigmatic region, confined to the space between costal and distal portion of  $R_1$ ;  $CuA_1$  dividing distally only into three short branches.....*P. grandis* Carp.  
Forewing with deep pigmentation of the pterostigma, reaching down below  $R_1$ ;  $CuA_1$  with a large fork arising before half-way and with the anterior branch again forked distally.  
*P. stigmatica* n. sp.

## PARAPRISCA GRANDIS Carp.

Carpenter, p. 128 and Fig. 6, 1935.

In Carpenter's figure there appears to be an error in the interpretation of the branches of Cu. The family Lemmatophoridae always has two fully developed anal veins, 1A and 2A, both strongly convex; 2A may have a short posterior branch also. I think that the vein labelled CuP in Carpenter's Fig. 6 is in reality 1A and his CuA<sub>3</sub> is in reality CuP. With this alteration, the branching of CuA in this species is as follows:—after leaving the main stem of Cu very close to the base of the wing, CuA divides into two main branches, CuA<sub>1</sub> and CuA<sub>2</sub>, slightly before the level of the primary fork of M; these two branches proceed obliquely across the wing and subparallel; distally, CuA<sub>1</sub> divides into three short branches, while CuA<sub>2</sub> remains unbranched.

Specimen No. 15576a-b in the Yale University Collection represents practically the whole obverse and the basal two-thirds of the reverse impression of a fine forewing of *Paraprisca grandis* Carp. *Length* (obverse) approximately 15 mm., *breadth* 4.6 mm., compared with a length of 17-18 mm. for the holotype and a breadth of 4.5 mm. The principal differences between the two wings are that the Yale specimen has much shorter distal forks on Rs and MA, and that there is a slight brownish pigmentation between costa and R<sub>1</sub> in the pterostigmatic region; this latter is not mentioned by Carpenter in the holotype. The colour of the wing, "uniformly light brown, due mainly to the covering of brown microtrichia" mentioned by Carpenter for the holotype is also well seen in the *reverse* impression only of the Yale specimen. This, of course, indicates that the microtrichia were chiefly developed on the *upper* surface of the wing. The mode of forking of CuA and the comparative shortness of Sc would appear to be good specific characters.

## PARAPRISCA STIGMATICA n. sp.

(Fig. 5.)

*Forewing* (complete except for broken apex): *Length of fragment* 13.0 mm., indicating a complete wing 14 mm. long; *breadth* 4.4 mm. at pterostigma.

The reverse impression shows an extremely fine covering of microtrichia, imparting an extremely faint brownish tinge to the whole wing. Apart from this, the wing is colourless,

except for deep brown pigmentation covering the whole of  $R_1$  and a very strong development of dark brown pigment forming a large pterostigma. Sc runs close to the costa all the way, and ends up just within the pterostigma; there are no visible costal veinlets.  $R_1$  and Sc are well separated, and at least three rather oblique subcostal veinlets connect them. The large, dark pterostigma begins at about two-thirds of the wing-length or a little less, and continues, apparently, almost to the apex (at any rate, as far as the break along costa); it

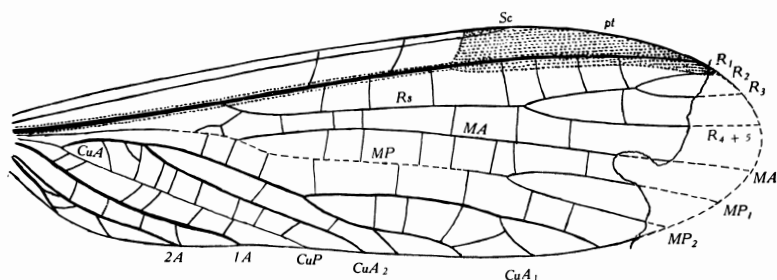


Fig. 5. *Paraprisca stigmatica* n. sp. Order Protoperlaria, fam. Lemmatophoridae. Left forewing, with apex turned to right for comparison with other figures. Specimen No. 15579a. Length 13.0 mm.

entirely occupies the space between costa and radius beyond Sc and also extends somewhat below  $R_1$ . Rs and M both fork at the same level, at slightly beyond one-fourth of the wing-length; Rs is three-branched, both forks being distal; MA is simple: MP is distally forked at about the same level as the first fork of Rs. CuA arises from Cu very close to base, and soon forks into  $CuA_1$  and  $CuA_2$ , both running rather close and subparallel to one another; before half-way,  $CuA_1$  again divides into two branches, which separate more widely than the original two; each of these has a short terminal fork also. CuP and the anal veins are very much as in *P. grandis* Carp.

Specimen No. 15596a-b shows an equally well preserved forewing of this same species, but the apical portion is broken off obliquely in both obverse and reverse impressions; in addition, in the reverse, a good deal of the base and costal margin are missing also. The pterostigma and all parts of the main veins are beautifully preserved. The forking of  $CuA_1$  is even more distinct from that of *P. grandis* than in the previous specimen, there being two deep forks distally, the branching of  $CuA_{1a}$  being fairly close to the more basal fork.

Specimen No. 15597*a-b* consists of a nearly complete insect, unfortunately badly preserved, but of value in showing the general shape, the small, rather short head with laterally placed compound eyes, the small prothorax with rather small lobes, the large pterothorax and long body. Of special interest are the two hind legs, which project on either side of the body with their femora at right-angles to it and the tibiae bent backwards. Length of femur 4.2 mm., of tibia 6.0 mm., of exposed portion of tarsus 3.4 mm., most of which belongs to the first segment. All parts of the leg are slender and both femur and tibia are ridged longitudinally. The wings lie folded back over the abdomen at a very slight angle. Total length of body 17.5 mm.

Types:—*Holotype obverse*, Specimen No. 15579*a* and *reverse* No. 15579*b*. *Paratypes* Nos. 15596*a-b* and 15597*a-b*. All in the Yale University Collection.

This species can be easily distinguished from *P. grandis* Carp. by its somewhat smaller size, its strongly developed pterostigma and by the markedly different form of branching of CuA. I do not attach more than individual importance to the form of branching of Rs, MA and MP.

#### Order NEUROPTERA.

##### Suborder SIALOIDEA.

##### Family MARTYNOVIIDAE.

##### Genus PROMARTYNOVIA n. g.

(Fig. 6.)

Costal space rather wide at base, and carrying a small bunch of costal veins far removed from Sc. Sc and R fused basally, or nearly so, diverging slightly distally. Costal veinlets oblique, widely spaced. Rs arising slightly beyond level of end of last costal vein. M dividing just beyond origin of Rs into a convex MA and a concave MP, both simple as far as they are preserved; MA not fused with Rs at all, but connected with it by a cross-vein close to origin. CuA a strong convex vein, slightly curved and with descending veinlets from it distally. CuP apparently entirely absent. Three anal veins.

Genotype:—*Promartynovia venicosta* n. sp.

Horizon:—Lower Permian of Kansas.

This rather puzzling genus is placed in the same family as *Martynovia* Till. (p. 13, Fig. 5, 1932), on account of the gen-

eral venational scheme, which is closely similar, as far as it is preserved. It is, however, more primitive than *Martynovia* in the absence of any fusion of Rs with MA, and in the presence of a set of short costal veins, which must be a remnant of some formation carried over from a Protoblattoid ancestor. In *Martynovia*, CuP is represented by a very faint groove, but this is absent in the new genus. *Martynovia* possessed very few cross-veins basally; the new genus has a fair number, irregularly spaced.

It is a pity that only the basal half of the wing is preserved, as the true relationships of this puzzling group cannot be fully worked out until more complete material is made available.

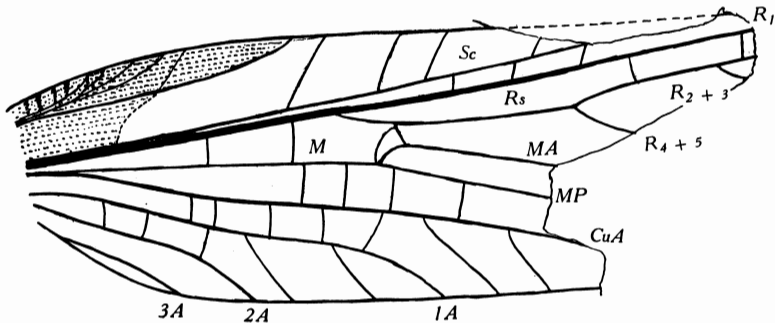


Fig. 6. *Promartynovia venicosta* n.g. et sp. Order Neuroptera, Suborder Sialoidea, fam. Martynoviidae. Fragment of a left wing, with apex turned to right for comparison with other figures. Specimen No. 15594. Length of fragment 7.0 mm.

PROMARTYNOVIA VENICOSTA n. sp.

(Fig. 6.)

*Wing* (fragment):—*Length of fragment* 7.0 mm., *breadth* 2.5 mm., indicating a complete wing of about 11 mm. in length by little more than 2.5 mm. wide.

The membrane is slightly tinted in pale brown, the base being a little darker; at the base of the costal veins, extending to costa, there is quite a dark patch shading gradually to paler outwards. The costal veins are three in number, all very short and sending out a series of veinlets to the costa itself; all three costal veins arise very close together and far from Sc. The first two pectinate branches of Rs can be seen just preserved on the distal portion of the fragment; judging by *Martynovia*, there should be at least two more distally from

these. Probably only an individual peculiarity is the triangle formed by two cross-veins and the arching base of MA, below Rs near its origin. 1A and 2A are both slightly sigmoid and 1A gives off descending branchlets. 2A and 3A are simple veins, unconnected by cross-veins.

Type:—*Holotype obverse*, Specimen No. 15594 in Yale University Collection.

Suborder PLANIPENNIA.

Family PERMOBEROTHIDAE Tillyard.

Subfamily PERMOBIELLINAE subfam. nov.

This subfamily may be distinguished at once from the rest of the Permoberothidae (subfam. Permoberothinae nov.) by the complete absence of the groove between Rs and M, and also by lacking even the slightest signs of zigzagging in any of the main veins. It contains so far only a single genus, *Permobiella* n. g.

Genus PERMOBIELLA n. g.

(Fig. 7.)

Insects of medium size (forewing about 11 mm. long), having a very simple venational plan and only slight development of terminal twigging. All main veins strongly formed, without zigzagging. Cross-veins stout in all parts of the wing, darkly pigmented and appearing quite as strong as the main veins, if not more so. Sc ends a little beyond half-way along costa. R runs close below Sc, and curves downwards distally to end at the apex, which is well rounded. Costal and subcostal spaces narrow, with numerous short veinlets. Rs arising at about one-fourth from base, three-branched. M entirely a concave vein, dividing before half-way into two branches. CuA a straight vein running obliquely to about middle of posterior margin, where it ends in a small, twigged arch. CuP slightly curved, close below CuA basally but diverging from it markedly further distally, unbranched. 1A a nearly straight vein, placed far apart from CuP. 2A fairly close to 1A, slightly curved. Cross-veins very evenly developed all over the wing, mostly simple and at right-angles to the main veins.

Genotype:—*Permobiella perspicua* n. sp.

Horizon:—Lower Permian of Kansas.

This remarkably interesting genus is clearly a very primitive type and would appear to me to stand very close to the base

of the Suborder Planipennia in the extremely primitive development (one might almost say, lack of development) of terminal twigging, the absence of zigzagging of main veins and the absence of the development of hairiness on the veins which is so marked in *Permoberotha* Till. and the new genus *Dictyobiella*. The only really specialized character appears to me to be the great strength and thickness of the cross-veins, which, owing to their dark pigmentation, appear in the fossil to be even stouter than the main veins which they link together.

The very simple venational scheme represents that of a Planipennian reduced to its lowest terms. Sc and R<sub>1</sub> have no terminal forks. Rs is as simple as is possible for a vein which is developing a pectinate series of descending branches, i.e. it has only two such branches and shows, by the upward arching of the main stem of Rs after each branch, clear evidence of evolution from an older dichotomic type, the original branching of R<sub>4+5</sub> being just suppressed, but no new branches added. M again is as simple as possible. There is no sign whatever of MA. In this connection, it is necessary now to correct the interpretation which I put upon the venation of *Permoberotha* (Tillyard, p. 24 and Fig. 11, 1932). It is now clear that the vein there labelled "MA" should be correctly "R<sub>4+5</sub>" and that MP should merely be labelled "M", as is usual in types in which the media is wholly concave.

The very simple condition of CuA would appear to be derivable from a Mecopterous condition rather than from a distally forked vein; the small arched end is merely the beginning of twigging, and not derived from an original dichotomic fork. It appears to be of the type which reaches its logical end-development in the series of twigs developed along the posterior margin in the Berothidae. It is interesting to note also that CuP is slightly arched convexly to CuA, i.e. in the same manner as is seen, though more conspicuously, in Blattoidea and Protoblattoidea.

PERMOBIELLA PERSPICUA n. sp.

(Fig. 7.)

*Wing* (probably a forewing, practically complete) :—*length* 11.0 mm., *breadth* 3.6 mm.

*Specimen No. 15593* is a splendid reverse impression of a right wing, complete except for a slight portion of the anal area, which is broken away, and slight irregularity along the

margins. The wing lies in quite a deep cut in a piece of rough and irregular rock. Originally, as received by me, it showed only a few strong cross-veins at the base, connecting short portions of main-veins, and was relegated years ago to the box containing the Protoblattoidea, as a remnant. While working recently over the contents of this box, I was struck by the remarkable clearness of the cross-veins, and decided to attempt to open up the wing, which could be seen passing

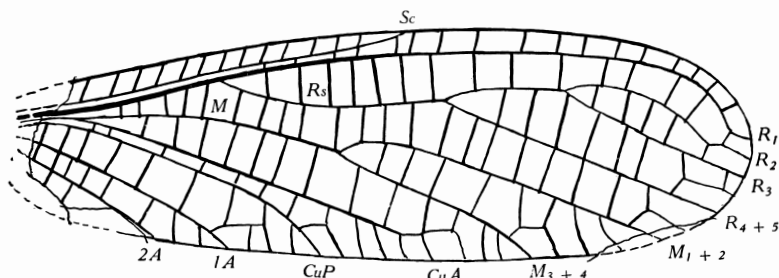


Fig. 7. *Permobiella perspicua* n.g. et sp. Order Neuroptera, Suborder Planipennia, fam. Permoberothidae. Right forewing, reverse. Length 11.0 mm.

deeply into the overlying rock. With the aid of scalpels, I cut deeply down into the rock around the place where I thought the rest of the wing would lie, and was finally successful in clearing practically the whole of it, the apex lying fully 2.5 mm. below the level of the rock removed. The resulting discovery is one of several remarkable finds which have been made as a result of working at the removal of rock from exposed portions of wings in the Collection.

The specific characters are, I consider, the strength and dark pigmentation of the cross-veins, the actual form of the distal ends of Sc, R<sub>1</sub> and CuA, the marked arching of R<sub>s</sub> between branches, the convergence of R<sub>1</sub>, R<sub>2</sub> and R<sub>3</sub> distally, the rudimentary terminal arch of CuA and the general elongate oval shape of the wing. The latter resembles somewhat that seen in *Dictyobiella* n.g., and both, curiously enough, recall to mind the wings of Chrysopidae.

Type:—*Holotype reverse*, Specimen No. 15593 in Yale University Collection.

The specific name refers to the outstanding strength and clearness of the cross-veins.

## Subfamily PERMOBEROTHINAE subfam. nov.

This subfamily is proposed for the reception of the more advanced types in which a deep groove is developed between Rs and M longitudinally, and there is at least a small amount of zigzagging of some of the main veins.

The two known genera can be distinguished by the following Key:—

Basal half of costa straight, distal portion strongly curved. Sc very short, ending well before half-way. The whole of Rs,  $M_{3-4}$  and CuA zigzagged.....Genus *Dictyobiella* n.g.

Basal half of costa raised near middle in a low arch or hump, distal portion not strongly curved. Sc ending about half-way. At most only  $R_{2-3}$  and part of  $M_{3-4}$  zigzagged  
Genus *Permoberotha* Till.

## Genus DICTYOBIELLA n. g.

(Figs. 8, 9.)

The wing-margins and all veins except the costal veinlets exceedingly hairy in forewing (Fig. 9A), less so in hind. In both wings, Sc is short, running close to  $R_1$  and ending by a fork on both C and  $R_1$  at about one-third of the wing-length.  $R_1$  runs subparallel to the costa and ends not far above apex. Both C and  $R_1$  are strongly curved distally, so that the general shape of the wing is oval. Rs arises at about one-sixth from base and is three-branched, all the branches being strongly zigzagged and connected by numerous cross-veins. A very strongly marked, straight furrow separates Rs from M, but these two veins are otherwise quite close to one another. M is quite distinct from R basally, its primary fork being situated somewhat distad from the level of the origin of Rs;  $M_{1+2}$  continues the line of the main stem of M, and forks distally, each fork carries terminal twigs;  $M_{3+4}$  descends from M so as to run parallel with CuA below it, and gives off, about the middle of the wing, a series of terminal forks and twigs. CuA arches up from Cu very close to base of wing and apparently touches M at top of the arch; it then runs subparallel to  $M_{3+4}$ , and is unbranched except for terminal twigging. Both  $M_{3+4}$  and CuA are slightly zigzagged at the points of origin of numerous cross-veins. CuP a rather weak vein running parallel to and slightly below CuA. Anal veins not clear, but apparently three in number, close together.

Genotype:—*Dictyobiella nervosa* n. sp.

Horizon:—Lower Permian of Kansas.

This genus is placed in the Permoberothidae on account of the excessive hairiness of the wings, the early origin of Rs, the freedom of that vein entirely from M and the retention of the complete original concave vein CuP. It differs greatly from the other known genus of this family, *Permoberotha* Till. (1932), in the shape of the wing, which is of the oval shape found in the Chrysopidae, instead of being long and narrow, and also in the form of Sc and the general arrangement of the cross-veins into a polygonal meshwork suggestive of that of certain Chrysopidae, with slight zigzagging of certain main veins. In *Permoberotha*, this formation is not present. Both genera agree in possessing a marked groove or furrow separating Rs from M and in having these two veins otherwise quite close together.

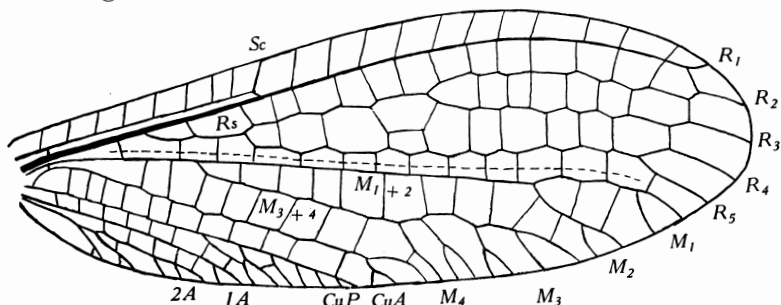


Fig. 8. *Dictyobiella nervosa* n.g. et sp. Order Neuroptera, Suborder Plannipennia, fam. Permoberothidae. Wing restored from Specimen No. 15592, chiefly from hindwing. Length 7.2 mm.

#### DICTYOBIELLA NERVOSA n. sp.

(Figs. 8, 9.)

Although I have defined the genus purely on characters taken from the forewing, the type specimen shows the body complete, as well as both forewings and one hindwing. The *head* is of medium size, with large and apparently strongly projecting compound eyes separated from one another by a space about equal to their own width; the clypeus is seen as a clear, somewhat projecting plate; only the scape of one antenna can be seen. The *thorax* was short and stout, the prothorax apparently small, the meso- and metathorax well developed; the femur and tibia of one foreleg are visible, each about as long

as the head is wide, the femur not very stout, fusiform, and carrying many stiff hairs (Fig. 9B). The *abdomen* is short, only about half as long as the forewing; the last three segments are dark and strongly chitinized, the rest paler and more weakly chitinized. The last segment shows, in the obverse only, a terminal triangular notch or incision, suggestive of a division into paired male genitalia of the Hemerobioid type, closely appressed to the last segment on either side; it also

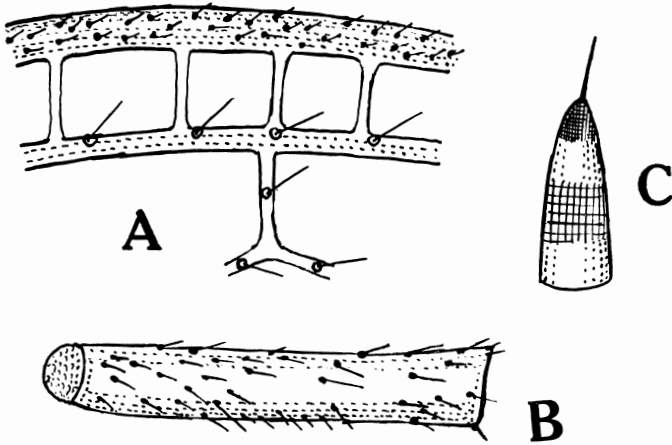


Fig. 9. *Dictyobiella nervosa* n.g. et sp. A. Portion of costa and radius of forewing, with connecting veinlets and small portion of the cross-vein meshwork below  $R_1$ . Note macrotrichia on all parts except costal veinlets ( $\times 50$ ). B. Fore femur ( $\times 50$ ). C. Terminal appendage of abdomen, presumably a reduced cercus, with terminal bristle ( $\times 100$ ).

carries a short, very pointed process, black at apex and ending in a stiff bristle, which I take to be one of a pair of reduced cerci (Fig. 9C).

The wings are not easy to study, because the specimen is crushed down irregularly on to the rock. In the reverse impression, the study is made more difficult owing to the presence of a complete abdomen of a Protoperlarian larva, joining on to the thorax of the insect and in line with the true abdomen, but at the opposite end. This is barely, if at all, visible in the obverse. In both specimens, the forewings are folded back together over the short abdomen, which curves away from them posteriorly, and in such a way that they lie with their margins almost coinciding and each set of veins closely duplicated throughout. There is, fortunately, only a

single hindwing present, and this projects at right-angles to the thorax with its base overlying it and showing the origins of the main veins quite clearly. The forewings are tinted brown and are much hairier than the hind; the hindwing is hyaline, or nearly so, with weaker venation, and the wing is slightly infolded along the groove between  $R_s$  and  $M$ , thus causing an overlap of these two veins and a slight notch in the apical margin. As far as they can be compared, the venations of the two wings appear to be alike, but the forewing is not quite as broad distally as the hind, though possibly somewhat broader basally. In the reconstruction of the venational scheme given in Fig. 8, the more complete hindwing has been taken as the basis, and portions of the venation which are not clearly seen in that wing have been added from the forewing.

As the general venational scheme has been defined for the genus, it is only necessary to add here that the cross-venation system appears to have been very complete and fairly regular, much more so than in *Permoberothes* Till. In the forewings, the costal margin is considerably thickened distally and carries abundant short, stiff hairs (Fig. 9A); in the hindwing, the corresponding margin is only slightly thickened and carries, for the most part, only a single row of similar hairs. In the forewing, short, stiff macrotrichia were carried on all the main veins and cross-veins alike, their bases of insertion appearing as strong black dots and their average length being about 0.09 mm. In the hindwing, they are much more feebly developed, and are only clearly visible along  $R_1$  and the costal veinlets.

In the restoration in Fig. 8, the fold along the radio-median groove has been smoothed out and the two veins  $R_s$  and  $M$  separated by the same width as occurs in *Permoberothes*. Measurement of the overfold of the apical margin of the hindwing gives under 0.1 mm., so that the unfolded space between  $R_s$  and  $M$  could not have exceeded 0.2 mm.

*Length of complete hindwing* 7.2 mm.; *breadth* 3.3 mm.

*Types*:—*Holotype obverse*, Specimen No. 15592a, and *reverse*, No. 15592b, in Yale University Collection. As the hindwing is folded back across and above the thorax, it shows a reverse impression in the specimen in which the body and forewing show obverse impressions, and *vice-versa*. The label 15592a is attached to the specimen in which the radius of the forewing is clearly convex. It should be noted that the strong impressions of the macrotrichia of the forewing occur

only on the *reverse* impression, thus indicating that these strong hairs occurred on the *upper* surface of the wing.

This species should have been included in Part 14, Neuroptera. But, at the time of writing that Part, I thought that I might be able to prove that this specimen belonged to Sellards' genus *Urba* (Sellards, p. 169, 1909, type *Urba punctata*) which he placed at the end of his family Delopteridae in the Order Protorthoptera. Sellards' description (without figure) for the genus and species combined is, however, too brief and fragmentary for any accurate determination to be made. It reads as follows:—

“This genus is characterized by a slender elongate anal area traversed by three or four veins. The wing membrane has a punctate appearance, due probably to the presence of short spines bordering the veins. Length of front wing, 9 mm.; width, 3 mm. Type No. 1117.”

As, presumably, this type has been lost with Sellards' other types, I do not think we shall ever know what *Urba punctata* really was. The only part of the description which might associate it with *Dictyobiella* is the reference to the punctate appearance of the veins, and this would apply almost equally to the veins of *Permoberotha* and some other Lower Permian genera.

#### Genus PERMOBEROTHA Tillyard.

(Fig. 10.)

Tillyard, p. 24, Fig. 11, 1932.

Genotype:—*Permoberotha villosa* Tillyard (l.c. p. 25).

A second species is here added to this genus, and may be distinguished at once by the following Key:—

Wings excessively hairy, with strong setae along vein 3A and darkly pigmented sets of marginal hairs at the ends of the twigs of the main veins from CuA outwards along the posterior margin  
*P. villosa* Till.

Wings only slightly hairy, without strong setae on any of the veins; no tufts of marginal hairs at ends of the twigs of the main veins.....*P. convergens* n. sp.

The genus is distinguished, amongst other characters, by the marked groove in the narrow space between Rs and M (in

Fig. 11 of my 1932 paper, these veins are wrongly labelled MA and MP respectively), by the shape of the costa, which arches upwards into a low hump not far from base, and by the formation of a true Y-vein between 2A and 3A.

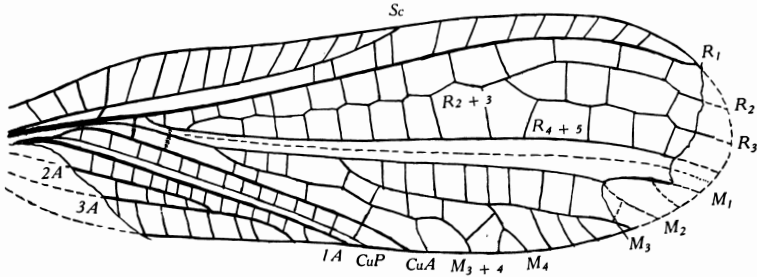


Fig. 10. *Permoberotha convergens* n. sp. Order Neuroptera, Suborder Plannipennia, fam. Permoberothidae. Left forewing, obverse, with apex turned to right for comparison with other figures. Length 7.7 mm.

PERMOBEROTHA CONVERGENS n. sp.

(Fig. 10.)

*Forewing* (practically complete):—*Length* 7.7 mm.; *breadth* 2.7 mm. The new species agrees with the genotype in the form of the costa, but the costal veinlets are all simple and without any strong macrotrichia. Sc appears to turn up distally more than in the genotype.  $R_1$  curves downwards slightly distally but ends considerably short of the apex. Rs has, as in the genotype, a long posterior branch leaving it soon after its origin (this is the vein originally considered by me to be MA); the next branch lies far distad from this, well beyond the level of the end of Sc. M is separated from  $R_{4-5}$  by a deep, straight groove, but the two veins run fairly close together and are not zigzagged or, apparently, connected by cross-veins across the groove. The main stem of Rs is definitely zigzagged, whereas it is straight in the genotype. CuA, CuP and 1A are all straight, simple veins; possibly this is also true of the genotype, if the branching portion which I originally labelled  $Cu_{1a}$  really belongs to M. CuP, 1A, and the Y-vein formed by 2A and 3A combined all converge together closely distally, so that the anal area seems unduly crowded with veins in this fossil.

Type:—*Holotype obverse*, Specimen No. 15595 in the Yale University Collection. This specimen represents a left forewing, but has been reversed in Fig. 10 for comparison with other types.

The addition of the new genera and species described above adds considerably to our knowledge of Lower Permian Neuroptera. The Sialoids are still a very puzzling lot, and better material is needed before their relationships will be understood. The Planipennia, on the other hand, appear now definitely as a very ancient stem allied to our recent family Berothidae, of which so many curious archaic types still remain in Australia.

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CANBERRA, AUSTRALIA.