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To the knowledge of fossil insects from Jurassic beds in Turkestan.

By A. Martynov.

(Présenté par A. Karpinskij de l'Académie le 24 Décembre 1924).

1. *Raphidioptera.*

In the summer of 1924 I was sent by the Academy of Sciences of Russia for collecting of fossil insects in Jurassic beds in the East part of the chain Kara-tau, Turkestan. These fossiliferous Jurassic slates were discovered in 1920 by the Eng. A. Aniskovič and the investigation thereof was continued thanks to the initiative of the Turkestanian Committee of Preservation of Antiquity and Nature.

I have found the representatives of nearly all orders of Pterygotan insects. The majority of specimens, *Raphidioptera* included, were collected near the village Galkino, 25 kilom. from the station Tchak-pak, Centr.-Asiat. Railway; only few specimens were found at the current Karabas-tau, in the upper parts of the river Boroldaj, East Kara-tau[1].

This paper contains the description of *Raphidioptera*; other groups will be described in several separate articles under the common title.

First of all, I must make some remarks regarding the terminology of the wing's nervation.

I consider it more convenient to designate the sector radii as RS and its branches as RS_1, RS_2 etc.; the cell between the principal branches of RS

[1] Data concerning the age of these slates will be given in another paper; here it may be noticed only, that the occurence of such forms, as *Kaligramma* and several others, allied to those of lithographic stone of Bavaria, proves that the age of these slates is, probably, upper-jurassic.

I denominate *DC* (discoidal cell, on the analogy with *Trichoptera*); in *Mesoraphidia* as also in *Inocellia* Schneid. there is one *DC*, in *Raphidia* L. there are often several ones. Concerning the Cubitus, I. H. Comstock[1] and some other authors consider it as consisting, from the beginning, of two branches, Cu_1 and Cu_2, and in the same manner the author names it in *Neuroptera*, *Megaloptera* and *Mecoptera*, as well as in *Orthoptera* (s. l.) and *Plecoptera*. Thus the number of anales is three in all *Neuroptera* and *Mecoptera*, two in *Orthoptera* (s. l.) and *Plecoptera*. However, for the remaining *Holometabola*, for instance, for *Trichoptera* and *Lepidoptera*, prof. Comstock gives a different interpretation of this Cu_2 and anales, denominating this Cu_2 as A_1. Thus, the number of anales is here (primarily), according to Comstock, four. But doubtless, the nervure, which the author names here as A_1, is wholly homologous with Cu_2 in *Neuroptera*, *Mecoptera*, *Orthoptera* etc. Either A_1 (of Comstock) in *Trichoptera*, *Lepidoptera*, *Diptera* we must designate as Cu_2 (as in *Neuroptera*, *Orthoptera* etc.), or, on the contrary, Cu_2 (of Comstock) in *Neuroptera*, *Orthoptera* and allied denominate as A_1 (as in *Trichoptera* etc.) and, consequently, attribute to *Neuroptera*, *Raphidioptera*, *Mecoptera*, as well as to *Trichoptera* and, primarily, to other Holometabolous insects, the number of anales is four. The second way of denomination seems to be at present more preferable[2]. Until it is not shown that *Cu* and A_1 wholly correspond with *CuA* and *CuP* of more archaic *Palaeodictyoptera*[3], *Protephemeroidea* Handl. etc., it is, probably, premature to consider them only as branches of one nervure *Cu*. By Cu_1, Cu_2 I will name only the apical branches of *Cu*. The line of transverse nervules, connecting also the bases of apical nervures, I shall call the anastomosis; the space outside (or behind) the anastomosis is the apical region, with apical nervures, cells and forks.

Order **Raphidioptera** (Nav.) (**Raphidioidea** Handl.).

Family **Mesoraphidiidae** n. fam.

Head not very large, somewhat narrowing to the base (only in *M. elongata* it is lengthened); eyes not large, but prominent; antennae either not long,

[1] I. H. Comstock. The wings of insects. Ithaca, New-York, 1918.

[2] The first way of designation is, for instance, adopted by R. I. Tillyard (Descrip. of four new sp. of Australian Caddis-flies, in Australian Zoolog., vol. II, pt. III, 1922, p. 77).

[3] *CuA* (Cubitus Anterior) and *CuP* (Cu. Posterior) correspond, serially, to *MA* and *MP*, as also to *R* (*RA*) and *RS* (*RP*). See Martynov, Sur l'interprétation de la nervuration des ailes des Odonates et des Agnathes. Rev. Russe d'Entomol., 1924, vol. 18, № 4

slender, or long and rather thick; the joints short; mouth parts prominent. Prothorax shorter than the head and sometimes rather transverse or subquadrate. The wings somewhat stretched and nearly elliptical at the end; *Sc* ending at the costal margin not far behind the middle of the wing and not farther than $^3/_5$ from the base of the wing; costal area is much narrower than in the recent species of *Raphidia* and *Inocellia*, without anterior projection; the number of its transverse nervules does not exceed 10; behind the *Sc* R runs parallel to the costal margin and curves with it to the apex; near the end it is connected with *C* by an oblique transverse nervule, and only in *M. elongata* there are several ones; pterostigma absent. In the anterior wings *RS* separates from *R* approximately at $^1/_3$ from the base of the wing, then it is connected with *R* by two transverse nervures, forming thus two elongated cells between *R* and *RS*; *DC* is elongated; behind it both branches of *RS* divide, partly, repeatedly; *M* divides at the level of the commencement of *RS* and is connected with *RS* by three transverse nervules; not far from the base M_{3+4} divides and forms a special (third) cell; thus in the region of *M* there are three[1] cells (as in living *Inocellia*); outside the cells *M* divides, partly, repeatedly; Cu_1, apparently, confluent near the base with M_4, then running freely; basal parts of A_2 and A_3 forming, as usually, an elliptical basal cell, from hinder margin of which depart some branches of A_3.

Nervuration of the hind wings is similar, but M_{3+4} does not form the third cell and in the region of *M* there are two cells (as in *Raphidia*); Cu_1 is connected with M_{3+4} by a transverse nervule, but is not confluent with it. Ovipositor known only in one species (*M. parvula*) and here it is short, slightly longer than half of the abdomen.

Four species, which I refer to one genus—

Genus **Mesoraphidia**, n. gen.

With the family's features.

Typical species is *Mesoraphidia grandis* Mart.

The four species found may be easily divided into following three groups:

1) *M. grandis* and *M. similis*; 2) *M. elongata*; 3) *M. parvula*.

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[1] In *M. parvula* the nervuration in the middle and in the basal portions of the wings is not distinct, and therefore the presence of the third median cell is doubtful.

Key to the species.

1 (2). Head rather large and elongate, antennae long and thick, pronotum elongate; between *C* and *R* there is, before the end, a row of several transverse nervules . . . . . *M. elongata.*

2 (1). Head smaller, not elongate, antennae shorter and more slender; pronotum transverse or subquadrate; between *C* and *R* there is only one distinct transverse nervule.

3 (4). The main-branches of *RS* and also of *M*, each, divide once; size small, the length of the body about 6,5 mm. . . . *M. parvula.*

4 (3). Both main-branches of *RS* and *M* divide, mostly, repeatedly; size larger, length of the body 20—21 mm.

5 (6). In the anterior wings RS_{1+2} divides into two branches, the anterior of which gives 4 apical nervures; Cu_2 ending with a small fork . . . . . *M. grandis.*

6 (5). The anterior branch of *RS* forms only 3 apical nervures; Cu_2 in anterior wings without apical fork . . . . . *M. similis.*

1. **M. grandis**, n. sp.

(Fig. 1—3).

The body (fig. 1) with the appendages and wings is preserved, but in the posterior wings the nervation can be deciphered only in the middle region.

Length of the body 21 mm.; that of the anterior wings 16 mm. Head

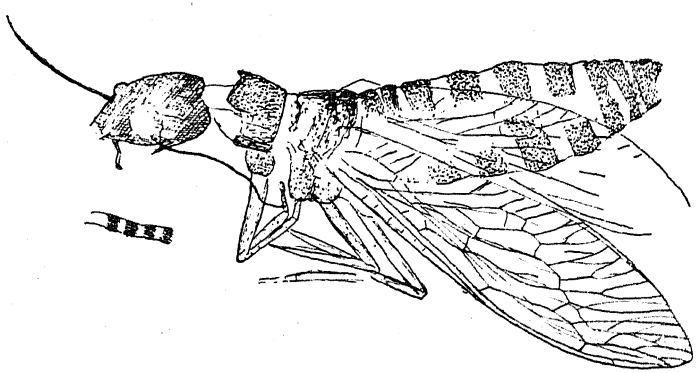


Fig. 1.

rather small, less lengthened, than in *Inocellia* Schn.; antennae not long, about one and a half times as long, as the head, slender; joints not lengthened (1a);

pronotum forming a feeble projection anteriorly and rather transverse, its length being apparently shorter than the breadth; meso- and metanotum badly preserved; coxae rounded, legs apparently as in *Raphidia* L.; the last three segments of abdomen entire, i. e. their tergites and sternites are not disunited by a pale intersegmental membrane. Anterior wings only slightly dilated in the middle (fig. 2), after the end of subcosta narrowing somewhat elliptically; in the costal area 8 transverse nervules are evident, but at the base and near the end the vestiges of two more nervules are to be noticed; *R* curves parallel to the costal margin and ends nearly at the apex of the wing, being connected, before the end, by a transverse nervule

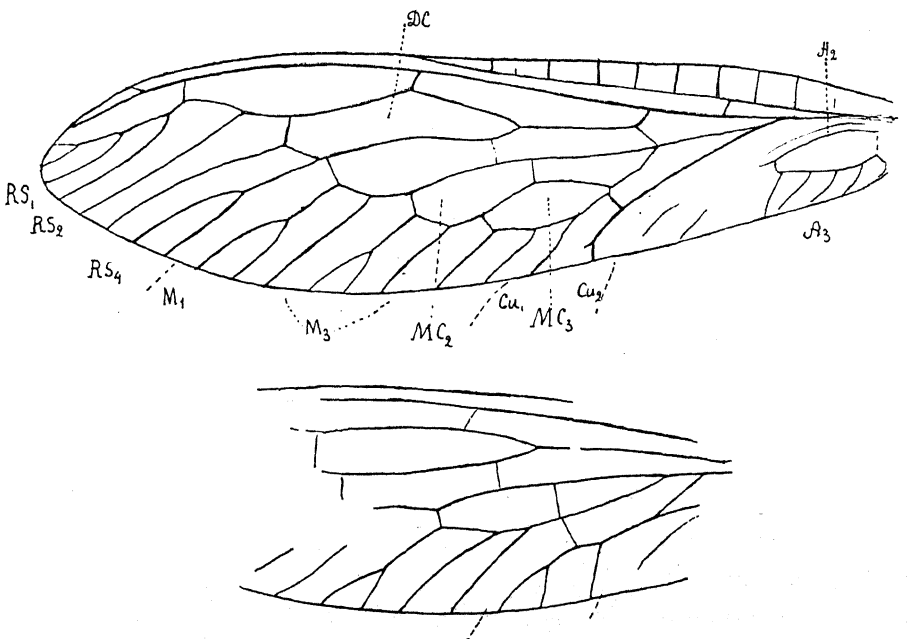


Fig. 2 and 3.

with costal margin; pterostigma absent; basal furcation of *RS* forming only one lengthened discoidal cell (*DC*) of a very characteristical angulated and curved shape; slightly before the middle RS_{1+2} is connected by a transverse nervule with *R*, thus dividing the area between *R* and *RS*, from the base of *RS* to the second transverse nervule, in two nearly equal long cells; the region of apical nervures, behind the anastomosis, is broad, the apical cells being narrow and lengthened; RS_1 connected, near the base, with *R* by a transverse nervule, then it forms successively three parallel

apical branches (in all with its continuation 4 apical branches); RS_2 and RS_3 simple, RS_4 with a long fork; M connected with RS by two transverse nervules; M_{3+4} separating from M at the level of the transverse nervule between M and RS, and soon dividing and forming a nearly elliptical lower (or third) cell; the area between M_{1+2} and M_3 subdivided into two cells (first and second) in the middle; M_1 forming a long fork (the length of the fork is not shorter than the length of its footstalk), M_2 simple; M_3^1 with a similar fork, as M_1, M_3^2 simple; from M_4 (or hind margin of the third median cell) arise three parallel branches, but the last one I consider, — on the analogy with *Raphidia* — as Cu_1, which is confluent for some time with M_4; Cu rather short, converging with M at an acute angle; Cu_2 with a short apical fork; A_1 is not distinct; A_2 and A_3 forming in the basal portion an elongated eggshaped anal cell, from hind margin of which (i. e. from A_3) four somewhat curved apical branches arise. Apical branches of RS — Cu run parallely; principal apical cells of RS are nearly as long as the discoidal cell. Posterior wings (fig. 3): DC more lengthened, its margins subparallel; third median cell missing, the first one elongate triangular; from M_{3+4} three branches arise, the first one forming a short fork at the end; Cu is not confluent with M (it is only connected by a transverse nervure with M_{3+4} at the level of the transverse nervure between the cells 1 and 2); it divides near the end into two branches, the first of which forming a short apical fork; between M and Cu we observe a very oblique transverse nervure (as in some living *Inocellia*).

An excellent specimen of this form is preserved in a hard grey layer (near Galkino). Head and thorax of black colour, abdominal segments blackish-brown, nervures black.

The left anterior wing lies on the right posterior and right anterior ones, and therefore the nervuration is not easily deciphered; in the hind wing the nervation of the middle portion only is distinct.

2. **M. similis**, n. sp.

(Fig. 4 and 5).

Only two wings, anterior and posterior, are preserved, one wing laying upon the other, but their nervuration is very distinct.

By the form and nervation of the wings this form is closely allied to the foregoing species. Size similar, the length of anterior wing reaching about

15 mm. The nervuration of the anterior wings (fig. 4) differs only in details. In the narrow area between *C* and *R* one can observe, before the apical transverse nervule, vestiges of still two transverse adjacent nervules; RS_1 dividi g into three apical branches (in *M. grandis* there are four); M_1 forming a long fork, M_2 also with a fork, equal to its pedicel; M_3 and M_4 giving, each, two simple branches; *Cu* dividing into two simple branches, the anterior of which being confluent with M_4, as in foregoing species. The posterior wing is also well preserved, save the base (fig. 5). Between *C* and *Sc* about

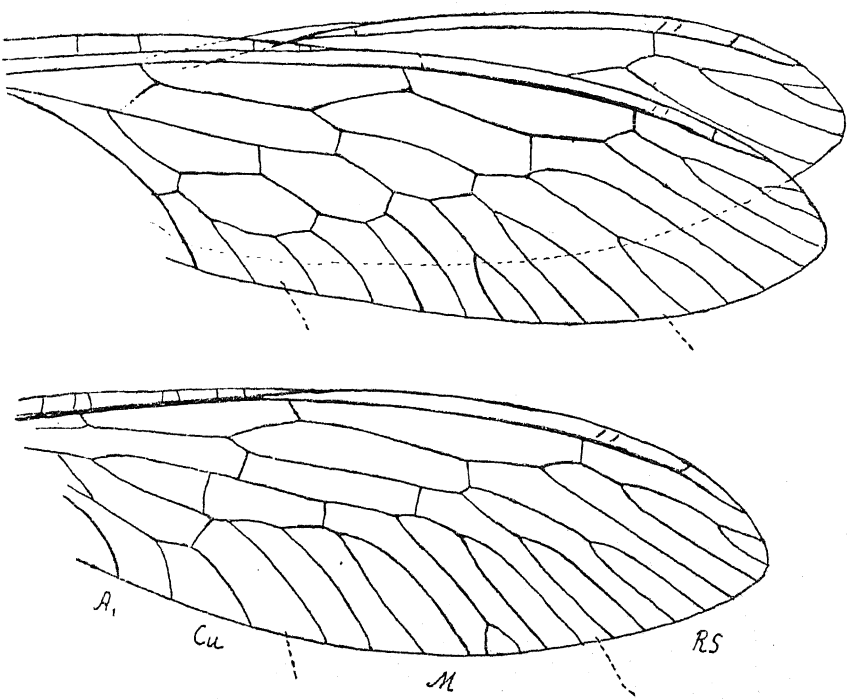


Fig. 4 and 5.

5—6 transverse nervules are perceptible, but these nervules are disposed unequally; between *C* and *R* there are, in the apical region, two rudimentary but distinct transverse nervules; *DC* somewhat lengthened, with nearly parallel margins; second cell between *R* and *RS* is much longer than the first one; from the base of *RS* a feeble nervule separates, running basally (as in most *Neuroptera* and *Megaloptera*); the branching of *RS* similar to that in anterior wings, but RS_3 furcates; M_2 with a very small fork at the end;

M_{3+4} gives successively four simple branches, the first two branches united with transverse nervule, closing the 2-nd median cell, by a short common pedicel; Cu_1 free, connected with M_{3+4} by a transverse nervule; anal region not preserved.

No doubt, this form is closely allied to the foregoing one.

Both wings are found on a little piece of very delicate paper shale of dark-reddish colour (Galkino). Such delicate slates somewhat resemble the sheets of wrapping paper.

3. **M. elongata**, n. sp.

(Fig. 6).

This species is represented by the head, prothorax, anterior wings and three or four legs.

Rather small form; the length of anterior wings about 9,5 mm. Head comparatively large and lengthened, with prominent mouth-parts; antennae

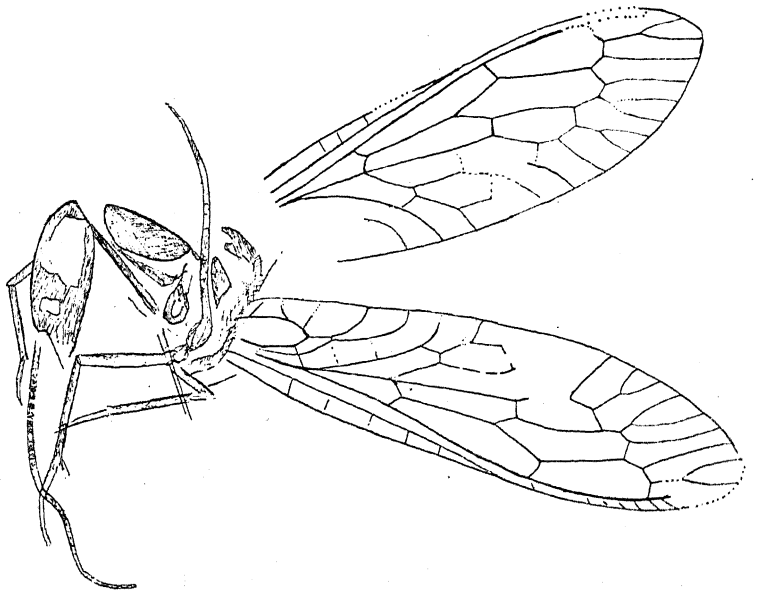


Fig. 6.

long, about twice and a half as long as the head, and rather thick; the length of the joints apparently equal to their breadth; prothorax somewhat elongated, but pronotum is shorter, than the head. The shape and nervation of the anterior wings is very similar to those in the foregoing species;

general habitus of nervation seems to be different, but it is a result of the region of apical branches being here much narrower and the number of apical nervures fewer. In costal area I found five transverse nervules, but it is possible, that their number is somewhat greater; between C and R there is a row of oblique transverse nervules, about six in number; special pterostigma wanting; the branching of RS and the shape of DC as in foregoing species, the first subradial cell being longer, than the second one; RS_1 forming a simple fork, RS_2 and RS_3 are simple nervures, RS_4 forms a longer fork; the area between RS and M is divided by a transverse nervule in two unequal cells; M_1 furcates, M_2 simple; both branches of M_3 and of M_4 apparently are also simple; third median cell (between M_3 and M_4) angulate. Cubitus perhaps simple, but it seems more probable, that the basal branch of M_4 belongs to the cubitus; A_1 is a slender nervure, which is attracted in the middle to A_2 (or $A_2 + A_3$) by a short transverse nervule; basal cell between A_2 and A_3 is rather large and elliptical; from A_3 arise about three branches. Posterior wings unknown, but one may suppose, that they are deprived of the third median cell, as in foregoing species; in other features they are, probably, very similar to the anterior ones.

The specimen is preserved on a piece of hard grey slate (Galkino).

4. **M. parvula**, n. sp.

(Fig. 7—9).

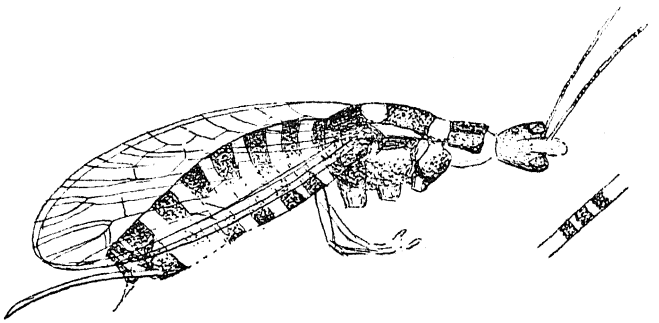
One ♀ specimen; we see the whole body from antennae to ovipositor, but unfortunately all four wings are folded together, and it is very difficult to decipher their nervuration; figures 8 and 9 give the nervation only in the distal half.

Very small form; the length of the body 6,5 mm., with wings — 7,5 mm., the length of anterior wings about 5,5 mm., that of the antennae about 2,2 mm.

Head narrowing to the base, but not stretched, the breadth near the eyes being nearly equal to the length; antennae about twice as long as the head, and rather thick; pronotum seems to be subquadrate or slightly transverse; mesonotum slightly longer than the pronotum; segments of abdomen distinct; ovipositor short, only slightly longer than the half of the abdomen; seen from side it forms a low arch, convex upward. The wings are somewhat more rounded at the end, than in foregoing species; R only very

slightly bent in the apical portion and is connected here with costal margin by an usual transverse nervule; the form of *DC* apparently is similar to that in the foregoing species; anterior and posterior branches of *RS* dividing only once; in the anterior wings[1] the 2-nd transverse nervule between *R* and *RS* separates from the basal part of RS_1, in the posterior ones from the point of union of RS_1 and RS_2; *DC* connected with *R* by a usual transverse nervule; RS_3 and RS_4 forming together a fork, which is slightly shorter, than its footstalk; in the region of *M* the third median cell is, perhaps, absent; transverse nervule between M_1 and RS_{3+4} forming nearly a continuation of the transverse nervule, closing the discoidal cell; *M* forming only four simple

Fig. 7.



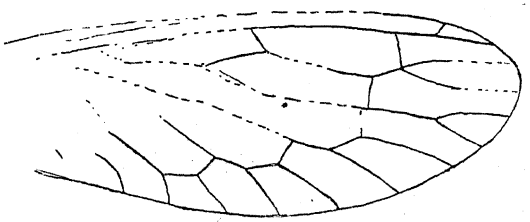


Fig. 9.

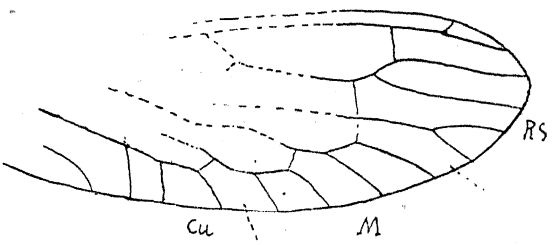


Fig. 8.

apical branches; *Cu* with two or, perhaps, with three apical branches (anterior wings).

Nervation in the basal part of wings is not deciphered.

The specimen with its counterpart is found on a piece of hard grey slate (Galkino). Although the nervuration is cleared only partially, judging by the distal parts it is constructed on the same pattern, as in *M. elongata*,

[1] I suppose that the figure 8 represents an anterior wing, fig. 9 a posterior one.

for instance. Apical nervures and cells are comparatively as short, as in *M. elongata*, but the number of branches is much reduced, and therefore the interspaces between the nervures became comparatively broad. The second difference is the presumed absence of the third median cell, that is correlated with the diminution of the number of apical nervures (in *M* to four). By the presence of only one transverse nervule between *C* and *R* it resembles to the first group, by the short prothorax and head it also resembles more to *M. grandis*, than to *M. elongata*.

The reduction of nervuration in the apical region being in correlation with the very small size of our species, I do not think it possible to rise this species in a distinct genus and I include it, as well as *M. elongata*, into the same genus.

Some general conclusions.

If in the shape and relative size of prothorax, head and antennae one notices among various species important differences, in the shape and in the whole nervation of the wings,—if we do not take into consideration the apical portion and some simplification of the mediana in *M. parvula*, — we see in all the four species such an uniformity, that we are induced to refer them to only one genus, which we divide in three above mentioned groups. In the apical portion *M. elongata* and *M. parvula* differ from the first group, chiefly, by the reduction of the number of the apical branches, which are particularly scarce in *M. parvula*, but this is in definite correlation with the diminution of the general size. In *M. grandis* the length of the anterior wing reaches 16 mm., in *M. similis* it is about 15 mm., in *M. elongata* 9,5 mm. and in *M. parvula* 5,5 mm. In exactly the same proportion the number of the apical nervures is diminishing. These nervures are, in general, frequently subject to variations in the most various *Neuroptera*. The relatively smaller breadth of the apical area, behind the anastomosis, in the two last species is also in connection with their smaller size. Therefore one cannot attribute too great an importance to such differences. The presumed reduction of the branches of *M* (with the want of the third median cell) is distinctly correlated with the diminution of the number of apical branches and, finally, with particularly small size of this species (*M. parvula*).

The configuration of *R*, *RS* and, apparently, of the other principal veins remains in *M. parvula* similar to that in other species. The preservation of a row of transverse nervules between *C* and *R*, before the end of *R*,

is a more primitive feature of *M. elongata*. In *M. similis* we notice here only two rudimentary nervures, whereas in *M. grandis* and *M. parvula* there is not a single one (not taking into consideration the last apical transverse nervule).

And thus, the construction of the principal nervuration, similar in main features in all four species, induces us to consider them as belonging to one complex of related species, to one genus. *M. elongata* differs from others in certain stretching or lengthening of the prothorax and of the head, but it is hardly possible to estimate it as a separate genus for that reason. The stretching of the prothorax, so very characteristic of *Raphidiidae*, then only began and ran, certainly, in parallel and independent ways in various species and genera. The same phenomenon took place also in many *Neuroptera*. Naturally, this lengthening was not equal in various species, and this only feature is not sufficient for the sharp discrimination between any kinds of species, which are similar in other features.

In what relation does the genus *Mesoraphidia* stand to other living and fossil forms of *Raphidioptera*?

Until recent time only two genera have been attributed to this order, *Raphidia* L. and *Inocellia* Schneid., but in 1918 Navas[1] ranged both genera into distinct families and divided them into several genera. Nevertheless, whether families or genera, the position remains unaltered; both groups are complexes of allied species. In the foregoing pages I considered genera *Raphidia* and *Inocellia* in the old sense (s. lato). Up to the present time fossil *Raphidioptera* were known only from the tertiary beds. According to Handlirsch[2], from 9 tertiary species 7 belong to independent genera *Megaraphidia* Cock., *Dictyoraphidia* Handl., *Archiinocellia* Handl., *Archiraphidia* Handl. However, all these genera are evidently allied to *Inocellia* or, partly, to *Raphidia*. «*R. erigena*» of Hagen Handlirsch refers to the genus *Inocellia*, although its nervature in many features differs from that of *Inocellia*. If one refers this species to a separate genus, it is, at any case, closely allied to *Inocellia*.

Thus, although the most fossil species from Oligocene and Miocene belong to separate genera, they are allied to living genera (or families) and,

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[1] L. Navas. Monogr. d. Rafidiopteros. Barc. Arch. Inst. Catal., 1918.

[2] A. Handlirsch. Canadian Fossil Insects. Canada Departm. of Mines, Geol. Survey branch, Mem. 12 — P, Contrib. to Canad Palaeontology, II, 1910.

according to Handlirsch, all belong to one and the same family *Raphidiidae*[1]. Prof. Cockerell even doubts (Ent. News, XXIII, 216) «whether *Megaraphidia* is more than a subgenus» and considers, that it is «impracticable to separate (Florissant-sp.) *R. exhumata* Cock. and *R. mortua* Rohw. from *Raphidia*».

Are we entitled to include the genus *Mesoraphidia* into the same family? To this question we must reply negatively.

Our genus differs rather sharply from *Raphidia* and *Inocellia* by the structure of the thorax and, partly, of the head, as well as by the nervuration of the wings. By the relative shortness of prothorax and head and by that of the ovipositor (judging by *M. parvula*) it stands on a lower degree of evolution, but in the nervuration of the wings, on the contrary, it surpassed in some respects the living, as well as, seemingly, the tertiary genera. Taking into consideration the lesser number of transverse nervules, narrowing of the costal area, reduction of pterostigma, lacking of apical branches of *R*, more narrow and regular shape of the wings, lengthened apical region (in the first group) and more regular, parallel running of its nervures, and adopting the functional point of view, we can declare, that in *Mesoraphidia* disappeared nearly all those nervures, which are superfluous from the mechanical point of view, and that also the shape and the whole nervuration of the wings became in *Mesoraphidia* more adapted to mechanical requirements of flight, than it is in recent, as also, probably, in tertiary fossil species. In other words, the wings in *Mesoraphidia* (in the first group especially) are much more «mechanized». The lacking of pterostigma, which is so characteristic of all known *Raphidiidae* (s. l.), is also very important. Pterostigma has no mechanical significance; from the mechanical point of view its presence is even superfluous, and it is not surprising, that in «mechanized» wings of *Mesoraphidia* it is missing. However, pterostigma is not a useless structure, its utility being demonstrated by its presence in many Holometabolous insects (some *Neuroptera*, *Hymenoptera*, *Mecoptera*, *Trichoptera*, *Diptera*), *Hemiptera* and also in recent *Odonata*. For a long time the supply of blood is preserved in pterostigma, and this, probably, maintains the elasticity of nervures during imaginal life. Thus, pterostigma is a useful structure, but for another reason. In most *Neuroptera*, — *Mantispidae* excluding, — pterostigma is lacking, but in the whole this group is

[1] A. Handlirsch. Palaeontologie in Schröder's Handbuch der Entomologie, 6 Lief., 1921, Jena, S. 255.

now in the state of degradation. It is, therefore, very interesting, that *Mesoraphidia* became extinct, whereas *Raphidia* and *Inocellia*, in which pterostigma is preserved, like in *Mantispidae*[1], *Hymenoptera* etc., live until present time. *Mesoraphidia* followed a quite different way of evolution, than *Raphidia* and *Inocellia*; it represents an independent evolutionary stem and therefore must be separated into an independent family.

Retaining primitive features in the structure of the prothorax and head, this group specialized very quickly its wings, and this disharmony was, probably, one of the most efficient causes of its early extinction.

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[1] And, in general, *Mantispidae* in many features resemble *Raphidiidae*.