

A contribution to the phylogeny of the Dilaridae and the Raphididae. (Neuroptera).

By

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The relationship between the families of the Order *Neuroptera* has been much discussed and many attempts have been made to arrange them in a natural system. The existing arrangements have been particularly based on the wing venation of fossil and recent species [cf. Handlirsch (2, 3), Comstock (1), and Tillyard (5, 6, 7, 8)]. Withycombe (9), however, based his arrangement on the internal morphology and the early stages. Dr. Holger Klingstedt (4) has recently commenced to attack the problem from the cytological standpoint, apparently successfully.

The wings and the wing venation show throughout all orders of winged insects the most different forms and are subject to the most obvious specializations, and the venation is therefore, of course, a very doubtful base for phylogenetical studies. This is also evident from the contradictory results which have been published from such studies. The results of studies of fossil wings seem to me to be in many cases merely conjectural.

The internal morphology is no doubt a safe way for further studies, but, the difficulty of getting suitably prepared material of especially exotic species stops many such studies.

The larvae are in many cases unknown and their evidently great specialization is troublesome for phylogenetical researches.

The cytology will — I think — show a safe way to definite results as far as this method will prove to be sufficient in details. But the obstacles of getting living material of a sufficient number of species must be almost insuperable.

During my studies on the genitalia of the order I have found that the abdominal skeleton and especially the genital structures show less specialization than could have been expected, when compared with other characters. I think that in many cases the relationship can be distinctly traced, not only between the species but also between the genera and even between the families. In many cases the female genitalia show the most easily recognized characteristics of value for phylogenetical studies. This fact seems to me to be quite natural, as the most important functions of the female abdominal apex, the copu-

lation and the oviposition, do not seem to have been forced to undergo considerable changes during the evolution.

The existing arrangements of the neuropterous families show altogether the tendency towards a division into two suborders, the *Megaloptera* (including *Sialidae*, *Corydalidae*, and *Raphididae*) and the *Planipennia* (including all other families). Certain authors divide the order into three suborders, the *Megaloptera* (*Sialidae* and *Corydalidae*), the *Raphidioidea* (*Raphididae*), and the *Planipennia*. Others have considered these as distinct orders, and thus they do not consider the *Sialidae*, the *Corydalidae*, and the *Raphididae* as true *Neuroptera* (*s. str.*). The *Dilaridae* seem to have been studied almost only from the venational standpoint and, consequently, their relationship with the other families has been disputed. Comstock (1) referred to the family as belonging to the hemerobiid group of families (together with *Sisyriidae*, *Sympheroibiidae*, and *Hemerobiidae*). Withycombe (9) placed them in the superfamily *Osmyloidea* (with *Berothidae*, *Mantispidae*, *Osmylidae*, *Sisyriidae*, and *Mjiodactylidae*). Tillyard (5) proposed the suborder *Hemerobioptera* for the *Hemerobiidae*, the *Ithonidae*, and the *Dilaridae*. Later (6) he modified this view and placed the *Dilaridae* in the superfamily *Hemerobioidea* (with *Psychopsidae*, *Berothidae*, *Sisyriidae*, *Hemerobiidae*, *Chrysopidae*, *Mantispidae*, *Polystoechotidae*, and *Osmylidae*). Finally (8) he stated that the *Berothidae* is the oldest existing family of the *Planipennia* with *Ithonidae*, *Dilaridae*, and *Hemerobiidae* representing one line of evolution.

The ♂ *Dilaridae* differ from all other *Planipennia* in having pectinate antennae. The ♀ has a very long ovipositor. The internal morphology is — as far as I know — not yet studied, and the larva is unknown. The insects are always found on brooks or rivers or at least in very moist localities, and the larva has therefore been supposed to be aquatic or semi-aquatic.

Dilar corsicus Nav. ♀ (Fig. 1, 2).

By the kindness of Mr. Martin E. Mosely and Mr. D. E. Kimmins I have had the opportunity of examining one ♀ of *Dilar corsicus* Nav., captured by Mr. Mosely on Corsica and now placed in the British Museum.

The abdomen shows the following characteristics. The chitinisation is very weak and faintly pigmented. Only the 1st and 2nd segments show distinct tergites and sternites (cf. fig. 1). In the 3rd segment the limits of the tergites and sternites are faintly indicated, but, in the segments 4—7 they can only be concluded by the hairity. The vertical limits between these segments are, on the other hand, very distinct. Spiracles 8 pairs, on segments 1—8. That of the first segment is very

large, and the spiracle has there a strong, darkpigmented, listformed reinforcement (fig. 1 B). The 1st segment is well developed and scarcely reduced. The 8th tergite is divided in the dorsal middle-line and forms thus a pair of oval lateral plates, reaching well down the sides. The 8th pair of spiracles opens in its lateral surfaces. Also these spiracles are large and have a darkpigmented reinforcement (fig. 2 B sp). The 9th tergite is not dorsally divided. It is dorsally narrow but broadens considerably in its ventrally extended sides, which reach to the under surface of the abdomen. The 8th and 9th tergites are stronger chitinised and pigmented than the preceding segments. After the 9th

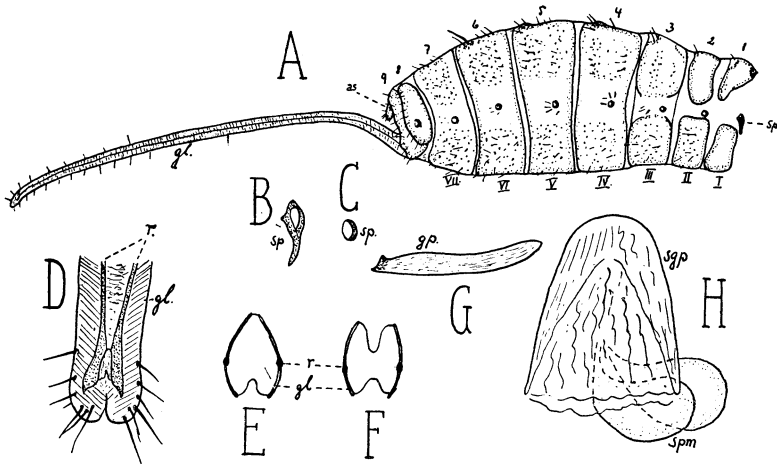


Fig. 1. *Dilar corsicus* Nav. ♀.

A. Abdomen in lateral view. — B. Spiracle of segment 1. — C. Spiracle of segments 2—7. — D. Apex of ovipositor in ventral view. — E. Transverse section of median part of ovipositor. — F. Ditto of apical part of ovipositor. — G. Right gonapophysis posterior in lateral view. — H. Subgenital plate and spermatheca from below.

tergite follows dorsally the superior appendages (fig. 2 sa), which are small and faintly pigmented. They appear in lateral view oval, from behind somewhat clubshaped, rounded. They do not carry trichobothria. The anus (fig. 2 A a) opens between them. A subgenital plate (fig. 1 H, fig. 2 B sgp) is present, situated between the lower ends of the 9th tergite. The plate is weakly chitinised and appear to be composed by two rods, which are membranously connected and apically fused. Above this plate there is a pair of short rod-like appendages (fig. 1 G, fig. 2 B gp), the apex of which is somewhat excavated and darkpigmented. They extend with the apex into the base of the ovipositor and they are altogether membranously fused with one another as well as with the subgenital plate. The ovipositor is a very long and slenderly

curved structure. Its lower basal margin is strengthened by a dark-pigmented, strongly chitinised reinforcement. The ovipositor is composed by a pair of blades, membranously connected to one another, above as well as below. The ventral membrane is folded upwards between the blades (cf. 1 E, transverse section of the middle part of the ovipositor). The dorsal membrane is very narrow in the basal and intermediate parts, but becomes wider towards the apex and is there folded downwards between the blades (cf. fig. 1 F, transverse section

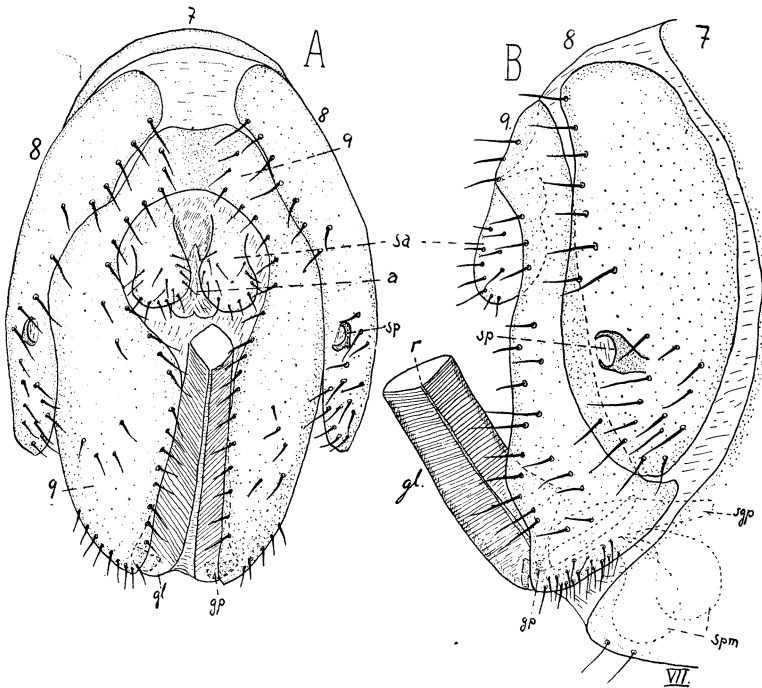


Fig. 2. *Dilar corsicus* Nav. ♀.

A. Apex of abdomen, seen in front. — B. Ditto in lateral view.

of the apical part of the ovipositor). Each blade is strengthened by a longitudinal rim and shows further a distinct vertical striation. The mentioned rim (fig. 2 B r) is dark-pigmented and runs in the middle-line of the blade from the base to the opening, which is situated ventrally close before the apex (fig. 1 D). The rims end in a flattened acute flap on each side of the opening. It should further be noted, that there is a pair of chitinised but wholly unpigmented sacs, connected to the subgenital plate (Fig. 1 H and fig. 2 B spm).

I consider that these mentioned parts of the genitalia may be homologized with those of primitive insects thus:

the *subgenital plate* (sgp) is either a secondary structure, or, most probably, it forms the remainders of the *gonapophyses anteriores* (ventral valves of ovipositor), which have become highly reduced and fused,

the *short rod-like appendages* (gp) seem to form the remainders of the *gonapophyses posteriores* (inner valves of ovipositor), which are reduced in length but else appear distinct,

the *blades which form the actual ovipositor* (gl) seem doubtless to be the *gonapophyses laterales* (dorsal valves of ovipositor); the absence of styles and the fusion by means of dorsal and ventral membranes should be noted as important facts of specialization,

the *pair of sacs*, connected to the subgenital plate, seems to be the spermatheca, which thus in this genus is paired or carries a pair of vesicles.

This latter characteristic is of the greatest value from phylogenetical standpoint. It at once indicates that the genus (and the family) must be placed close to the *Raphididae*, in which family the spermatheca shows just the peculiarity of carrying a pair of vesicles. I have not found this characteristic in any other *Neuroptera*, hitherto examined by me, and I have neither seen any records of it in the literature.

The ♀ *Raphididae* possess also a long ovipositor, and this character affords to them a certain resemblance to the ♀ *Dilaridae*.

I have examined ♀ representatives of two genera of the *Raphididae*, *Inocellia* Schneid., and *Raphidia* L. I give below a short summary of the abdominal structures.

Inocellia crassicornis Schumm. ♀. (Fig. 3).

The tergites 1—9 and the sternites 1—7 are strongly chitinised and pigmented. Spiracles 8 pairs, on segments 1—8. The 1st tergite is well developed as also the 1st sternite. Its spiracle very large with a strong list-formed reinforcement, which is attached to the 1st tergite. There are pale stripes in the chitin of the 1st and 2nd tergites and the 2nd sternite. The vertical limits between the segments are faintly indicated. The 7th sternite is prolonged backwards, and its apex proceeds free below the base of the ovipositor. Seen from below the apex appears to be deeply excised. The 8th tergite is not divided dorsally. It reaches down the sides and the spiracles open in its lateral surfaces. The 9th tergite forms a narrow dorsal half-ring. Its acute lower ends reach the base of the ovipositor. It is dorsally narrow, but broadens slightly in its ventrally extended sides. The tergite shows further on each side an inwards directed vertical, listformed structure, which seems to act as fastenings for the ovipositor. The anal segment forms a dorsal half-

to its apex. The ovipositor (Fig. A, B, C, E, F gl) is composed by a pair of valves and proceeds out of the abdomen between the prolonged parts of the 9th tergite. The valves are vertically striated. Their dorsal margins are membranously connected to one another, but no ventral connection exists. Their ventral margins are inwardly curved and bear short and stiff hairs. In the middle-line (basally more close to the ventral margin) runs from base to apex a strengthening rim (r), which basally is nearly unpigmented but becomes darker towards the apex. Fig. F shows a transverse section of the ovipositor. In the utmost apex the valves run free. They bear at apex each a short but distinct style

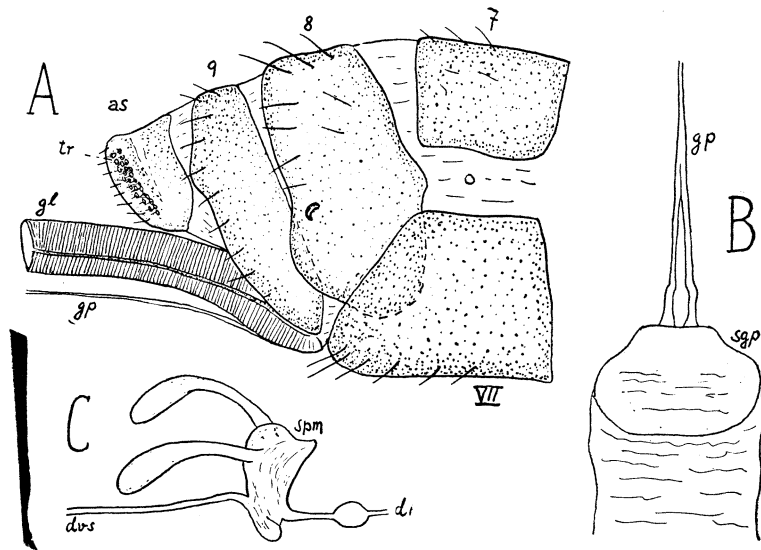


Fig. 4. *Raphidia notata* Fabr. ♀.

A. Apex of abdomen in lateral view. — B. Subgenital plate and base of gon. post. from below. — C. Spermatheca.

(st), which carries some stiff hairs. The styles appear to be movably attached to the valves. The spermatheca (Fig. J, K) is situated above the subgenital plate and consists of a median vesicle from which a pair of large elliptical sacs proceeds. The fastenings of the duct from the vagina (dvs) are listformed and brownish pigmented. The spermatheca is otherwise wholly unpigmented.

The mentioned parts are easily homologized with those of the *Dilar* ♀. I consider that the subgenital plate of *Dilar* is quite homologous with that of *Inocellia*. The short rod-like appendages of *Dilar* are doubtless homologous with the long tread-like fused appendages of *Inocellia* (gonapophyses posteriores). The valves of the ovipositor show great similarity in the two genera and are doubtless homologous

(gonapophyses laterales). And I do not doubt that the elliptical sacs of *Dilar* are homologous with the sacs of the spermatheca of *Inocellia*.

Raphidia notata F. ♀ (Fig. 4).

The abdominal structures are of the same type as those of *Inocellia*. The segments 1—6 show no remarkable differences. The 7th sternite is, however, less specialized, not possessing a long and free apical part as in *Inocellia*. Its hind border is thus directly fixed to the subgenital

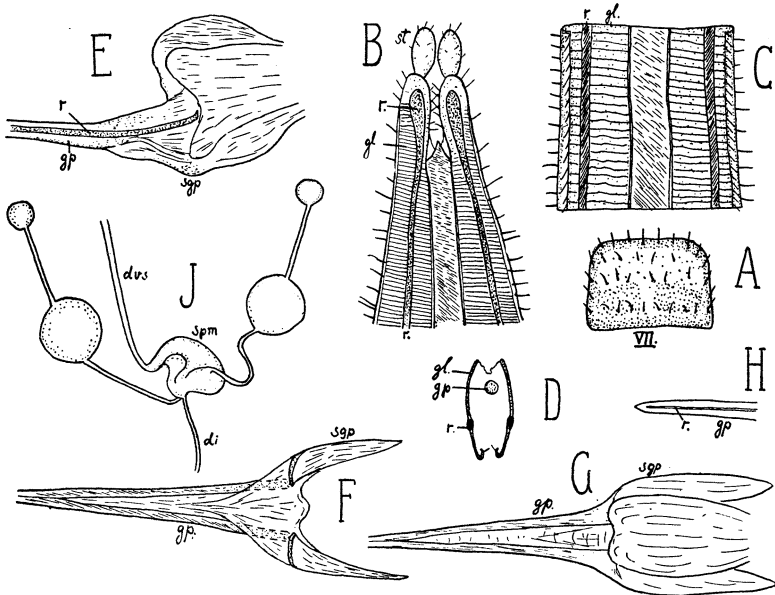


Fig. 5. *Raphidia xanthostigma* Schumm. ♀.

A. Subgenital plate from below. — B. Apex of ovipositor from below (blades outwards bent). — C. Median part of ovipositor from below, section (blades outwardly bent). — D. Transverse section of median part of ovipositor. — E. Subgenital plate and basal part of gon. post. in lateral view. — F. Ditto in ventral view. — G. Ditto in dorsal view. — H. Apex of gon. post. in lateral view. — J. Spermatheca.

plate. The subgenital plate (Fig. B sgp) is faintly pigmented and chitinised. It forms a simple plate. The gonapophyses posteriores are developed in the same manner as in *Inocellia*, uniting into a tread-like appendage, situated between the valves of the ovipositor. These are also of the shape as in *Inocellia* and carry similar styles. The paired vesicles of the spermatheca are finger-shaped. It is to be noted, that the duct, which leads forwards from the spermatheca, is at short distance from the spermatheca dilated into an almost sphaerical small vesicle.

Raphidia xanthostigma Schumm. ♀ (Fig. 5).

The abdominal structures are similar to those of *notata*. The 7th sternit is, however, even shorter (Fig. A). The subgenital plate (Fig. E, F, G sgp) appears to be of a more primitive shape than in *notata*. It is distinctly composed of a pair of narrow, blade-like structures (probably the remainders of the gonapophyses anteriores). These are apically membranously connected to one another as well as to the gonapophyses posteriores (cf. Fig. F). The gonapophyses posteriores appear in lateral view rather broad and a narrow, but distinct, strengthening rim runs from base to apex (Fig. E, H, r). The spermatheca shows a peculiar appearance. The paired vesicles are wholly sphaerical and they are united with the median vesicle with very narrow ducts. From each of them proceeds an equally narrow duct, which ends in another quite sphaerical small vesicle (cf. Fig. J).

The two genera *Raphidia* and *Inocellia* show thus a very great agreement in the genital structures. The most important differences appear to me to be that the 7th sternit and the subgenital plate are more specialized in *Inocellia* than in *Raphidia*. The genus *Raphidia* is therefore apparently to be considered as the most archaic of them. The presence of ocelli in *Raphidia* (absent in *Inocellia*) seems to support this view. Comstock (1) has from a study of the venation arrived at a contrary result.

When comparing the genital structures of *Dilar* with those of the *Raphididae* the following differences seem to be of great importance.

	<i>Dilar</i>	<i>Raphididae</i>
8th tergite	divided dorsally	a complete half-ring
Anal segment	divided into two lobes	a complete half-ring
Trichobothria	absent	present
Gonapophyses post.	short, not reaching the apex of the ovipositor, apparently not in use at oviposition	long, fused, reaching the apex of the ovipositor, certainly in use at oviposition
Gonapophyses lat.	connected to one another dorsally as well as ventrally	connected to one another dorsally but not ventrally
Styles of ditto	absent	present.

Taking as ground the well-known facts, that in archaic insects the tergites are formed as complete half-rings, that the presence of tricho-

bothria is a character of primitivity, that the gonapophyses posteriores in primitive insects are of about the same length as the gonapophyses laterales, and that these latter in primitive insects are free from one another and carry styles, the result is easily arrived at, that the *Raphididae* is a more archaic family than the *Dilaridae*.

However, as shown above, a very great similarity between the two families exists, and the following common characteristics must be considered as a proof of the fact, that the relationship between them is not very remote:

1:0. The 1st segment and especially the 1st sternit shows the same completeness and primitivity.

2:0. The similarity of the 1st pair of spiracles (its listformed strengthening).

3:0. The presence of apparently homologous subgenital plates.

4:0. The presence of distinct gonapophyses posteriores (not to be traced in most *Neuroptera*).

5:0. The similarity of the ovipositor (lateral gonapophyses); the same important length, the same lateral list of strengthening, the same vertical striation, and the same dorsal membranous connection.

6:0. The paired vesicles of the spermatheca.

I consider that these common characters sufficiently serve to prove the close relationship between the two families. Consequently the family *Dilaridae* has to be placed in the superfamily *Raphidioidea* (together with *Raphididae*). I find it unsound to deal with these two families as belonging to different superfamilies, to different suborders, or to different orders (as several authors even have done). Klingstedt (4) has recently stated, from cytological evidence, that »*Raphidioidea* may be even closer to *Planipennia* than to *Sialoidea* and that the distinction between *Megaloptera* and true *Neuroptera* therefore is unsound».

It remains now to be proved, if any other of the known families has to be placed in *Raphidioidea*, which surely forms a distinct suborder. I think that the paired spermatheca has to be considered as a fundamental character for representatives of this suborder.

I think it to be worthy of notice that the geographical distribution of the *Dilaridae* and the *Raphididae* is similar. Both families occur in Europe, Northern Africa, Asia, North and South America. Both families are totally lacking in Australia and in Central and South Africa.

Abbreviations used in the figures:

a	= anus	sa	= superior appendages
as	= anal segment	sgp	= subgenital plate
di	= duct leading forwards from the spermatheca	sp	= spiracles
dvs	= duct between vagina and spermatheca	spm	= spermatheca
gl	= gonapophyses laterales	st	= styli
gp	= gonapophyses posteriores	tr	= trichobothria
r	= strengthening rim	1—9	= 1st—9th tergite
		I—VII	= 1st—7th sternite.

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Insekter från ön Anholt.

Av

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Under den resa som Prof. B. Hanström tillsammans med sin hustru, Amanuensen E. Dahl och fil. mag. E. Svensson företog 1937 till ön Anholt, den lilla sandiga ön i Kattegatt mellan Jylland och Halland, närmast med uppgift att studera dess fågelliv, insamlades under tiden 5—8 aug. även en del insekter, som godhetsfullt överlämnats till det Entomologiska Museet i Lund. Trots den mycket korta insamlings-tiden och ehuru det största intresset ägnades naturförhållandena och vertebratfaunan, varom Prof. Hanström kommer att meddela sina iakttagelser i sista häftet av »Fauna och Flora» för 1937, blev det entomologiska resultatet ganska intressant. Mest givande blevo fångsterna