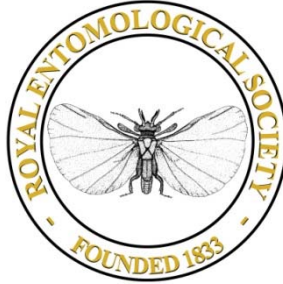


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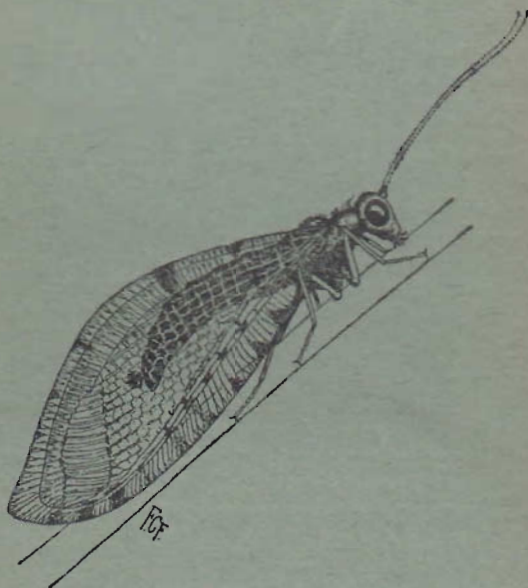
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HANDBOOKS FOR THE IDENTIFICATION OF BRITISH INSECTS



MECOPTERA MEGALOPTERA
NEUROPTERA

BY

Lt.-Col. F. C. FRASER, I.M.S.

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HANDBOOKS FOR THE IDENTIFICATION OF BRITISH INSECTS

The aim of this series of publications is to provide illustrated keys to the whole of the British Insects (in so far as this is possible), in ten volumes, as follows :

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Orthoptera. | " 13. Mecoptera. |
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A list of parts now available appears on the back cover

MECOPTERA, MEGALOPTERA AND NEUROPTERA

By Lt.-Col. F. C. FRASER, I.M.S.

PREFACE

The Orders **MECOPTERA**, **MEGALOPTERA** and **NEUROPTERA** (Planipennia) at one time formed part of the Linnaean Order Neuroptera, a miscellany of veined-winged insects classified without regard to their larval characters or whether they passed through a complete or incomplete metamorphosis. Studies of this group and more especially of their life-histories, with the knowledge thereby gained, has led to a gradual splitting of the Order and the creation of a number of other smaller ones, until only a remnant, the Planipennia or true Neuroptera, remains of the original. All three Orders dealt with here belong to the Holometabola or Endopterygota, *viz.*, those insects which pass through a complete metamorphosis, their wings developing internally in the larval and pupal states; their life is divided into four definite stages—the egg, larva, pupa and imago.

The Order Megaloptera is still considered by some specialists to belong to the Neuroptera but the wide differences in their morphology and ecology, both in the imaginal and, more especially, in the larval state, must ultimately confirm their status as an independent Order.

The fossil history. Abundant remains of the Mecoptera found in the Lower Permian show that they were a dominant Order at that early date, but so highly specialized are they that we may feel certain that their ancestors arose in the Upper Carboniferous or even earlier. Fossils of their near relatives have been found in the Jurassic of England.

Fossil remains of the Megaloptera and Neuroptera have also been found in the Permian but not to the same extent as those of the Mecoptera; it is probable, although debatable, that all three Orders arose from a mecopterous stem in the Carboniferous.

COMPARATIVE ANATOMY AND ECOLOGY OF THE THREE ORDERS

The Mecoptera (fig. 1, *a* and *d*) are determined at a glance by the marked production of the front of the head to form a rostrum (fig. 2, *a*), which gives a grotesque bird-like appearance to the insect's head. Species included in the Order fall naturally into two families, the Panorpidae (or Scorpion-flies) and the Boreidae (or Moss-flies), the former being sun-loving insects, found only in spring and summer, and possessing a pair of fully developed membranous wings, which, in repose, are held horizontally and slightly divergent. The males have the end of the abdomen greatly swollen, the apex carrying a pair of formidable forceps held curved forwards over the preceding segments in the attitude of a scorpion, from which fact the popular name is derived.

The females are without a macroscopic ovipositor and deposit their eggs in soil. The Boreidae are autumn and winter insects and are quite wingless save for vestigial remnants in the female and highly specialized setose-like

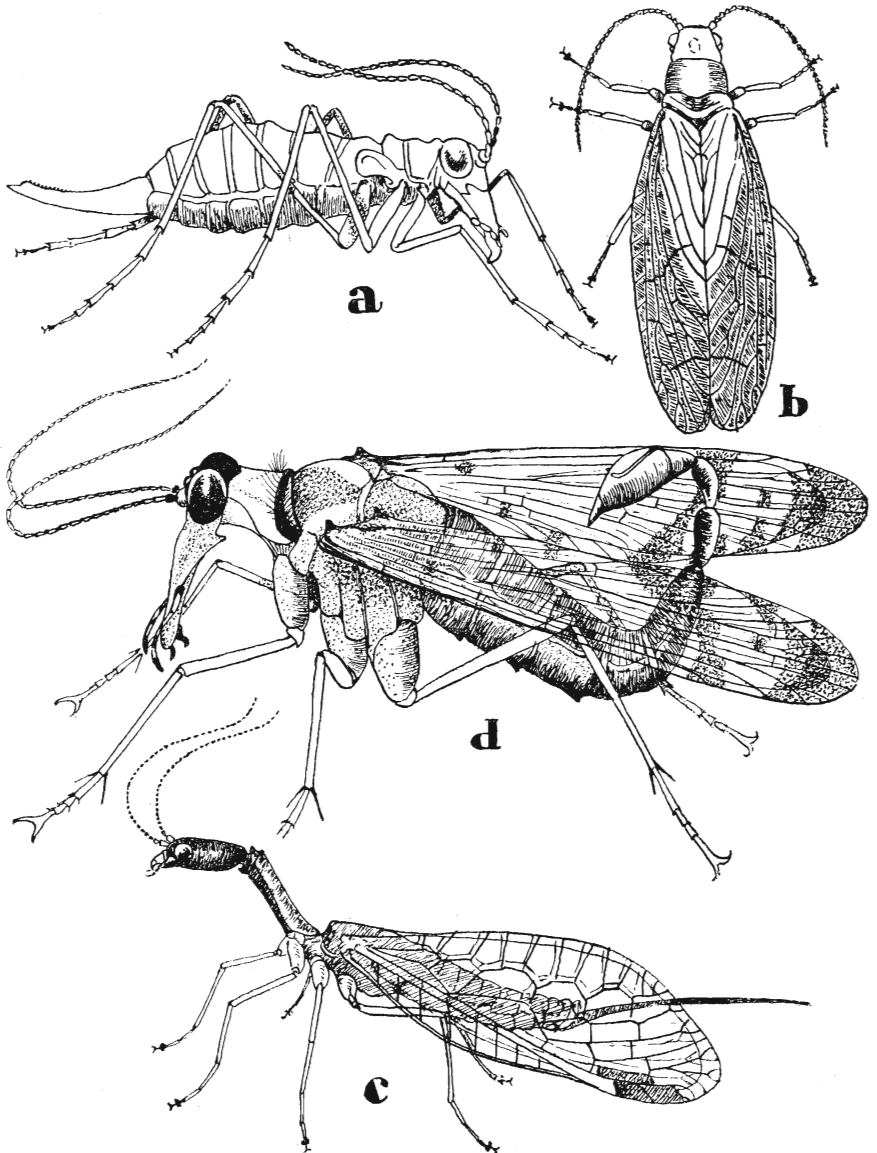


FIG. 1.—Imagines of: (a) *Boreus hyemalis* L.; (b) *Sialis lutaria* L.; (c) *Raphidia maculicollis* Stephens; (d) *Panorpa communis* L.

structures, held stiffly over the back, in the male. The females possess a long slender segmented ovipositor with which they thrust their eggs deep

into moss. Both families possess biting mouth-parts and are either vegetable or carrion feeders, the Boreidae appearing to live entirely on moss. In the larval state they are rather helpless eruciform, grub-like insects living in underground burrows.

The only insects with which the Panorpidae may be confused are Diptera, and from these they may be distinguished by the possession of two pairs of wings. The diminutive Boreidae resemble ants running about on the soil or moss, but they are to be found at a season when ants have gone into hibernation underground.

The Megaloptera (fig. 1, *b* and *c*) have a normally shaped head, not produced anteriorly but broad and quadrangular or constricted posteriorly (fig. 2, *b-e*). Like the Mecoptera, they fall naturally into two families, the Raphidiidae (Snake-flies) and the Sialidae (Alder-flies), the former with the prothorax narrowed and greatly elongated to form a neck on which the head is held erect and deflexed (like a snake rearing up prepared to strike, from which attitude the popular name is derived). The wings are hyaline, subequal and possess a sharply defined pterostigma traversed by one or more nervures; in repose they are held roof-wise, sloping and closely apposed to the sides of the thorax and abdomen. The females possess a long slim ovipositor (fig. 1, *c*) with which they deposit their eggs into chinks of bark or the surface openings of beetle burrows. The imagines appear in spring and early summer and are active diurnally and, to a lesser extent, nocturnally, mating usually taking place at dusk. All have biting mouth-parts and are predaceous on aphides and other small insects. In the larval state they are active and predaceous, living in burrows of Coleoptera or under bark; they also, like the imago, possess biting jaws and live almost exclusively on the smaller larvae of Coleoptera. The Sialidae are very different insects, their morphology and ecology being the antithesis of the Raphidiidae. The head is short and broad (fig. 2, *b*); the prothorax equally short and broad; the wings are subequal, evenly infuscated and without a defined pterostigma; in repose they are held roof-wise, slightly overlapping at the bases and closely apposed over body and abdomen. The females have no well-defined ovipositor but deposit their eggs in large masses in the open on foliage or any objects in the neighbourhood of water. The imagines are sun-loving insects and may be seen in late spring rising in numbers from the water or sunning themselves on the parapets of bridges, stumps, etc., near water. The larvae are aquatic and possess seven pairs of gills on the first seven segments of the abdomen, which are used for respiration as well as for swimming; they have well developed biting mouth-parts and are exceedingly predaceous.

The Neuroptera are widely separated from the two foregoing Orders by characters of the larva, in which the mandibles and maxillae are specialized as suctorial organs. The two organs are elongated, hollow throughout their length and closely interlocked to form a tube through which the body fluids of their victims are sucked; the imagines, however, possess biting mouth-parts, as do the other two Orders, and devour their prey in their entirety. All species are crepuscular and only take to flight in the day-time when disturbed and, even then, frequently feign death and drop to the ground. The British species fall into five families, in two of which (Osmylidae and Sisyridae), the larvae are semi-aquatic and aquatic respectively, whilst those of the others are terrestrial and mostly arboreal. Of these, the Conioptery-

gidae differ most sharply from the others by their minute size and their opaque white, waxy wings which have a very reduced venation; in some species the hind wings are much smaller than the fore wings, or vestigial.

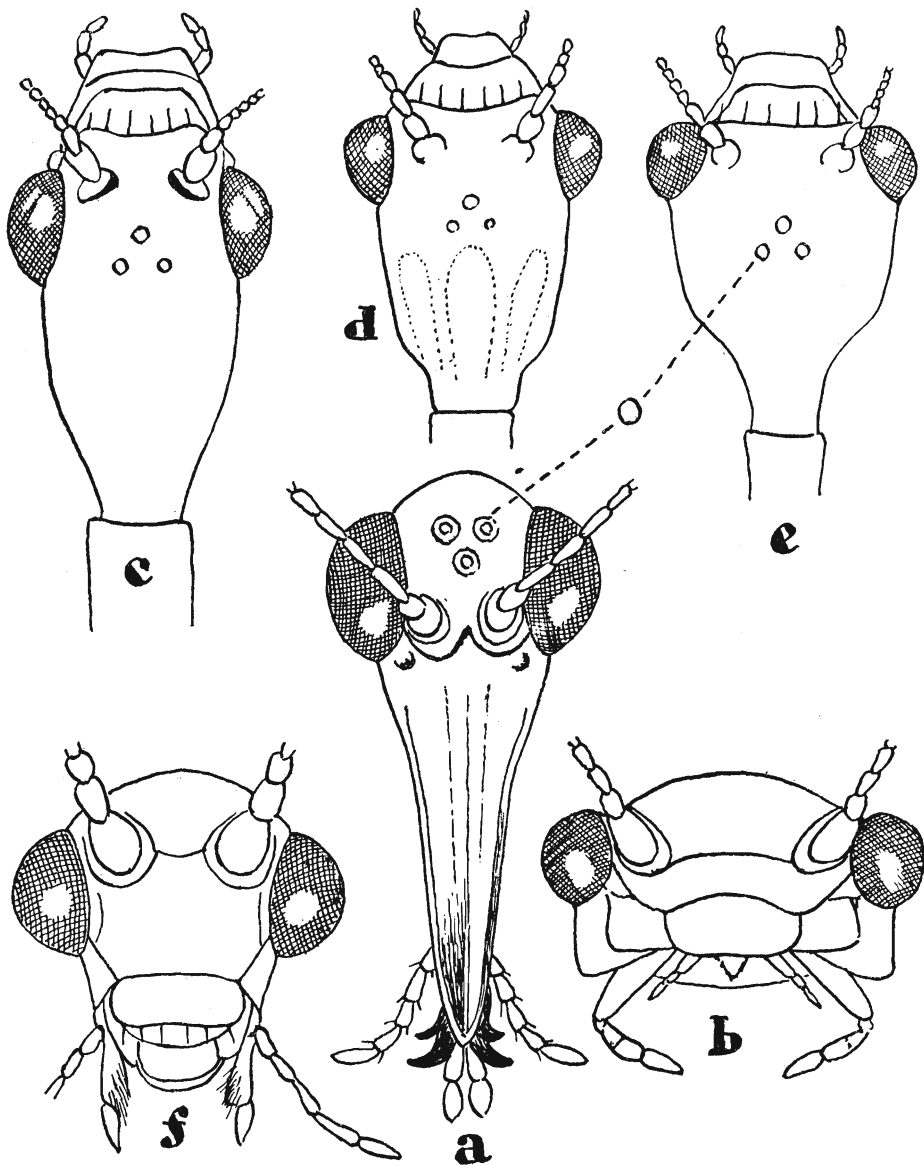


FIG. 2.—Heads of: (a) *Panorpa communis* L.; (b) *Sialis lutaria* L.; (c) *Raphidia notata* Fab.; (d) *Raphidia maculicollis* Stephens; (e) *Raphidia cognata* Rambur (f) *Hemerobius* sp. o, ocelli.

In the Order generally, the head (fig. 2, *f*) is rounded or subtriangular in the imago, with biting mouth-parts, long filiform, many segmented antennae and large compound eyes which are conspicuously golden in many species. The prothorax is of variable shape, and like the meso- and metathorax, of primitive build, being subdivided into an anterior short spiracular portion and a posterior deeper portion, furnished on the dorsum with a pair of pigmented, chitinized sclerites which serve for attachment of the leg muscles. The wings are subequal, hyaline but often tinted or maculated and richly veined—the radial sector (*Rs*) pectinate, with four or more branches; the longitudinal veins bifurcate at the wing border (terminal twigging) and the borders of the wings are fringed with small warts (*trichosors*) beset with stiff hairs, these alternating with the ends of the veins. In addition, the whole surface of the wings and the veins themselves are beset with stiff hairs, short (*microtrichia*) in the case of the first, but longer (*macrotrichia*) on the course of the veins.

In repose, the wings are held roof-wise, as in the Megaloptera, but sloping at a greater angle. The female has no well developed ovipositor but deposits her eggs singly or in groups on foliage, twigs or in the bracts of leaves and fir-cones, *etc.* The larvae, except those of the Osmylidae and Sisyridae, are active predaceous insects feeding on aphides and other noxious pests; six of their Malpighian tubes are specialized to act as silk glands, the silk being stored in the anus and finally employed to construct a cocoon in which the prepupal and pupal stages are passed. This cocoon is constructed by the tenth segment, the apex of which is specialized as a spinaret; the end of the same segment is also modified to form an extra prehensile foot to enable the larva to anchor itself firmly under certain conditions. Some of the larvae (*Chrysopidae*) are furnished with setiferous tubercles on the sides and dorsum, on which they place, with the help of their jaws, any debris or old cast-off skins to serve for concealment and camouflage.

COLLECTING AND MOUNTING

Mecoptera, Megaloptera and Neuroptera may be collected by sweeping, beating and netting or by rearing the larvae. A stout canvas net with an iron frame is necessary for sweeping, especially for those Neuroptera which lurk amidst heavy lush vegetation such as nettle-beds, or for the Panorpidae which favour the roughest type of hedge or the most impenetrable bramble thickets, where an ordinary muslin net would soon be torn to shreds. For beating, the ordinary entomological beating-tray is required, a white cloth one for preference, as Neuroptera seem to lie quiescent for a longer time on white than on black and they are also more easily seen. An ordinary kite net is invaluable for sleeving branches, the insects being shaken off by rapid lateral strokes with the rim of the net, or the net may be inserted very gently under branches trailing on the ground and any insects resting on them (*Nesomicromus angulatus*, *N. paganus* and *Megalomus hirtus*) secured by rapid, sweeping, vertical strokes. The majority of specimens may be obtained by use of the kite net in this manner. The same net is again useful for catching species of *Chrysopa* which take readily to flight when tapping branches. Many species may be found emerging in spring in the early morning, at the foot of pine trees, especially species of *Raphidia*, *Kimmisia* and other Hemerobiids, and *Nathanica*. These should be kept alive for a few days and fed during this time so that their wings may harden

and develop markings. Larvae may be obtained by the same methods as the imagines, and those of *Raphidia* by breaking up dead wood, especially the ends of dead branches. For securing captures, pill boxes or small corked tubes are the most suitable, but not more than one specimen should be placed in each tube as the insects tend to fight and mutilate each other; this applies especially to the Raphidiidae.

Breeding, except in the case of the few aquatic species, is extremely easy, but, as most larvae prey upon one another, it is advisable to keep each one separate. For this purpose, nothing is better than a number of largish test-tubes corked with a plug of wool; the tubes may be kept in a test-tube rack, the whole series forming a "tubarium". The insects should be fed on a diet of aphides which are easily procured anywhere; clusters of eggs of *Pieris brassicae*, usually to be found in numbers on the undersides of cabbage leaves, form a good diet for the larger specimens and are greedily sucked dry.

Mounting and storing. As most species of these insects are very fragile, all should be mounted pinned on strips of pith, which can then be employed to take a heavier pin for handling the specimens; this latter should carry the label on which full data should be written or printed. Stainless steel pins of a suitable size must be used for the insects, the smallest size for the Hemerobiids, as they prevent the formation of verdegris, which can be so destructive. To prevent the thinnest pins buckling or bending, as they are apt to do when thrust into cork, the groove in the setting-boards should be filled, flush with the board, with plasticine; this will be found soft enough to prevent bending of the pin and yet firm enough to hold it. Strips of cellophane or tracing paper through which the wings can be viewed clearly may be used to hold them in position. Most specimens will be dry enough to be removed from the boards by the end of a week, when they can be stored in cabinets or store-boxes. Samples of larvae, eggs, cocoons, etc., may be mounted on strips of celluloid and placed alongside their respective species.

I MECOPTERA

The Order **Mecoptera** is a small one, containing about 250 species of world-wide distribution, of which only four are found in the British Isles.

CHARACTERS OF THE ORDER. *Head* (fig. 2, *a*) produced in front to form a kind of beak (rostrum); 3 ocelli present (fig. 2, *o*) or absent; large compound eyes well separated; antennae of numerous segments, filiform, their bases closely apposed; mouth-parts hypognathous, more or less lengthened, suggesting an early stage of evolution into piercing, sucking jaws; labrum elongate; mandibles slender and elongate, with acuminate apices; maxillae with 5-segmented palps; labial palps 2-segmented, ligula absent or vestigial. *Prothorax* small; meso- and metathorax large, subequal. *Legs* long and slender, with greatly elongated coxae, tarsus 5-segmented, furnished with a pair of claws. *Wings* (fig. 3, *a* and 5, 10-12) well developed in the Panorpidae but vestigial or modified in the Boreidae; in the former held flatly and diverging posteriorly, elongate, narrow, with rounded apices, subequal, hyaline but more or less spotted with black, the pattern very variable even in the same species. Venation (fig. 3, *a*) closely similar in fore- and hind wings but the latter with narrower basal and costal areas, the subcosta (*Sc*) shorter than in the fore wings and the posterior cubitus (*CuP*) partially fused with the anal vein. Subcosta and radius (*Ri*) simple; pterostigma obsolete; radial sector (*Rs*) and median vein (*M*) with 4 or 5 branches; *CuA* a strong convex unbranched vein; *CuP* a weak concave, also unbranched vein; usually 3 anal veins present; no costal veinlets present; cross-veins moderately numerous, with a tendency to form gradate series. *Abdomen* (fig. 4, *a-c*) cylindrical, elongate, tapering posteriorly,

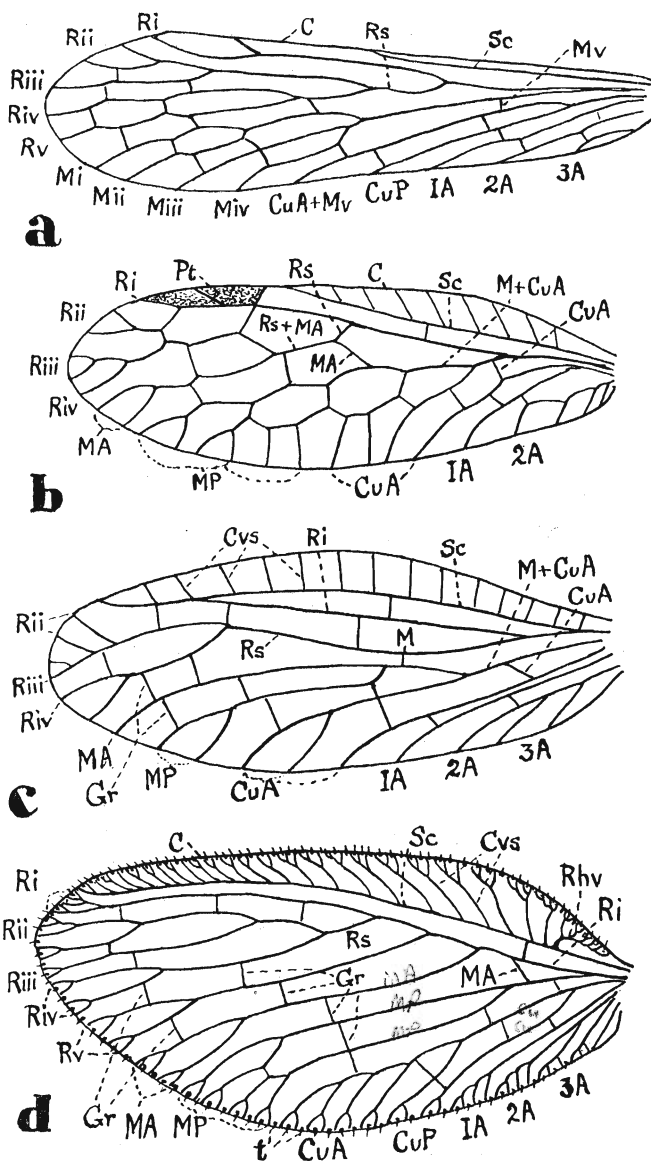


FIG. 3.—Wing-venation of: (a) *Panorpa*; (b) *Raphidia*; (c) *Sialis*; (d) *Hemerobius*.
 Notation: *C*, costa; *Sc*, subcosta; *Ri*, radius; *Rs*, radial sector; *Rii–Rv*, branches of radial sector; *Mi–Miv*, median vein and its branches; *MA*, anterior median; *MP*, posterior median; *CuA*, anterior cubitus; *CuP*, posterior cubitus; *CuA + Mv*, fusion of median and cubital veins; *IA*, *2A* and *3A*, anal veins; *Rs + MA*, fusion of median vein with radial sector; *M + CuA*, fusion of median and cubital veins; *Gr*, gradate cross-veins; *Pt*, pterostigma; *t*, trichosors; *Cvs*, costal cross-veins; *Rhv*, recurrent humeral vein.

10-segmented ; segment 10 very small and concealed. In the male, segment 9 greatly expanded and bulbous and showing a high specialization, the tergite and sternite fused to form a basal collar from which project two gonocoxites ; between the latter ventrally are two narrow appendages (fig. 4, *ai*, *bi* and *ci*) of varying shape in the species and therefore of taxonomic importance ; cerci present. Female with the end segments tapering, of varying relative length in the species ; the tenth segment very small and bearing a pair of 2-segmented cerci.

BIONOMICS. The early stages are terrestrial. The eggs are oval in shape, rather soft and laid in clusters in damp soil. The larva is eruciform in type with three pairs of short, segmented thoracic and eight pairs of abdominal legs which are well developed in the first instar to enable the larva to make its way into the soil ; these degenerate in the later instars, the number of which has not been observed, the grub then being a rather soft helpless creature whose motility is dependent on short dorsal thoracic processes. In the larval state, the eyes are compound with numerous hexagonal facets ; the antennae are short, 3-segmented and provided with a Johnston's organ on the second segment. The pupa (fig. 15, *b*) is also soft and quiescent, lying free in moist tunnels or earthen cells ; it is peculiar in having the three terminal abdominal segments strongly reflexed over the preceding ones. Little is known about their dietary, but larvae of the Boreidae appear to live exclusively on moss. The imagines are active diurnal insects, showing great awareness and rapidly taking flight when disturbed. The wingless Boreidae run about rapidly on soil or moss (or even over snow in winter !) and engage in short jumps when alarmed ; they continue to feed on moss as in the larval stage. Imagines of the Panorpidae are to be found in thickets, especially of bramble, but often in beds of nettles ; they are pure scavengers, feeding not only on juices of plants but more especially on dead insects or other carrion.

KEY TO FAMILIES OF ORDER **MECOPTERA**

- 1 (2) Very small insects with the wings spine-like and modified in the male, vestigial in the female ; ocelli absent ; female with well-developed ovipositor (fig. 1, *a*).....BOREIDAE
- 2 (1) Larger insects with all four wings well developed and functional ; ocelli present ; female without ovipositor (fig. 1, *d*).....PANORPIDAE

Family **PANORPIDAE**

KEY TO GENERA

A single British genus (fig. 1, *d*).....**Panorpa** Linnaeus (p. 8)
 Characters those of the family. Wing markings very variable in all species, most pronounced in *communis* L., least so in *cognata* Rambur, but all have the apices more or less black.

KEY TO SPECIES OF **Panorpa** LINNAEUS

- 1 (6) Males.
- 2 (5) Segment 6 conical, tapering posteriorly, its apex but slightly broader than segment 7 ; segments 6 and 7 conical (fig. 4, *a* and *b*).
- 3 (4) Appendages on segment 9 calliper-shaped, converging at apices, slender, of even thickness (fig. 4, *ai*) ; wing-markings usually pronounced (fig. 5, 12). Fore wing 13-15 mm. Exp. 30 mm.....**P. communis** Linnaeus
Frequents hedge-rows, bramble thickets or lush vegetation, especially nettle-beds. C. v-vii. Widely distributed and found on any soil. Flight rapid and evasive but unsustained.

- 4 (3) Appendages on segment 9 parallel, closely apposed, apices expanded and truncate, hairy (fig. 4, *bi*); wing-markings usually pronounced (fig. 5, 10). Fore wing 12–15 mm. Exp. 32 mm. *P. germanica* Linnaeus
Found in the same situations as P. communis. C. v-vii. Widely distributed and found on any soil. Flight as for last species.
- 5 (2) Segment 6 rectangular, very broad, apical border at least three times as broad as segment 7 (fig. 4, *c*); segments 6 and 7 cylindrical; appendages on segment 9 divergent, slender, acute at apex (fig. 4, *ci*); wing-markings often poorly defined (fig. 5, 11). Fore wing 12–14 mm. Exp. 24–28 mm.
P. cognata Rambur

Frequents hedge-rows but more especially bramble thickets on chalky soils. Flight as for the last two species. P. cognata begins to appear as the other species are going over but all three may be found together, cognata then being the dominant one. L.C. vii-viii.

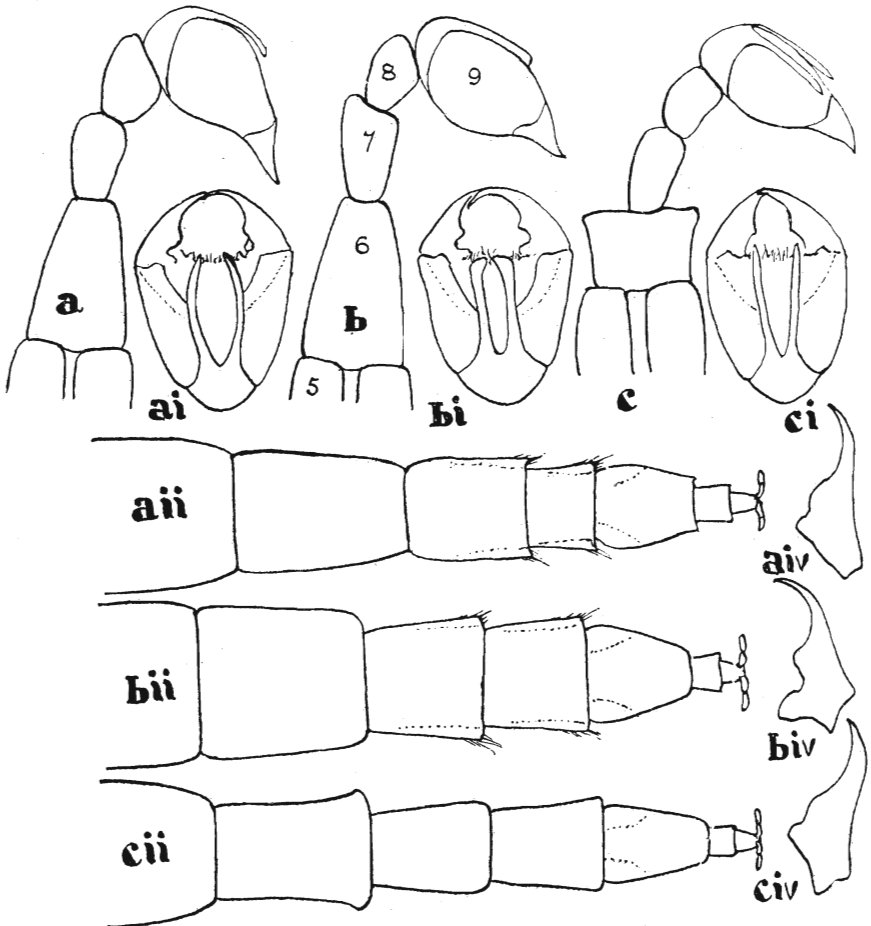


FIG. 4.—(a) Terminal abdominal segments of *Panorpa communis* L.; (*ai*) ninth segment, ventral aspect; (*aii*) terminal abdominal segments of female; (b), (*bi*) and (*bii*) the same of *P. germanica* L.; (c), (*ci*) and (*cii*) the same of *P. cognata* Rambur. Anal forceps of : (*aiv*) *P. communis*; (*biv*) *P. germanica* and (*civ*) *P. cognata*.

- 6 (1) Females.
- 7 (8) Abdominal segment 6 tapering posteriorly.
- 8 (7) Abdominal segment 6 truncated posteriorly; the following segments progressively shorter (fig. 4, *cii*).....**P. cognata** Rambur
- 9 (10) Segments 7 and 8 of the same length (fig. 4, *bii*).....**P. germanica** L.
- 10 (9) Segment 8 the shortest of all, only half the length of segment 7 (fig. 4, *aii*).....**P. communis** L.

Family BOREIDAE

KEY TO GENERA

A single British genus (fig. 1, *a*).....**Boreus** Latreille (p. 10)

Characters as described for the Order Mecoptera but the ocelli absent and the wings of the female vestigial, whilst those of the male are modified as curved spine-like processes held erect over the dorsum and serrate on the inner side of the curve; they are employed during the act of copulation to carry the female on the dorsum of the male. In addition to these characters, *Boreus* differs from *Panorpa* by its short stout abdomen which has the apex curved upwards and modified dorsally into two tubes, from each of which springs an appendix directed forward over the dorsum; the hypandrium is a large triangular plate. In the female, the abdomen ends in a long slender 3-segmented ovipositor with which the eggs are inserted deep into moss. In the female, the wings exist as small scale-like processes on each side of the mesothorax. Larva a soft pale yellowish grub with only the head and three pairs of 3-segmented thoracic legs fully chitinized; short, stout and curved in posture, resembling a small coleopterous larva. Larva lives in channels constructed in soil at the roots of moss and pupates in the blind end, just below the surface. The moss favoured is short, compact and velvety, growing on a loose sandy loam (*Polytrichum commune*). Both sexes are saltatorial and able to leap a distance of some two inches but exactly how this is performed is not known.

KEY TO SPECIES OF **Boreus** LATREILLE

A single British species (fig. 1, *a*).....**B. hyemalis** Linnaeus

Greenish-yellow when first emerged but assuming a metallic or dark bronzy sheen after some five days; the ovipositor a bright orange. Length about 5 mm.

L.C. Widely distributed in England and Scotland north of a line drawn from Kent to N. Wales. *x-iv.* Larvae from *v-ix.* Essentially a winter and autumn insect which has been frequently observed running about over snow, against which background it is quite conspicuous.

II MEGALOPTERA

The Order Megaloptera is a small one containing less than 200 species throughout the world, of which only 6 are found in the British Isles. It includes two very different Suborders, the Sialoidea, commonly known as Alder-flies, and the Raphidioidea, or Snake-flies (fig. 1, *b* and *c*). These two are treated as families or divisions of the true Neuroptera by some authors, but others have raised each to ordinal rank and it is probable that this latter classification will be ultimately accepted as the correct one.

CHARACTERS OF THE ORDER. *Head* broader than long or quadrate (Sialoidea) (fig. 2, *b*); front not produced as a rostrum; ocelli present (Raphidioidea) (fig. 2, *c-e*) or absent (Sialoidea); antennae with scape and pedicel, long and slender; mandibles toothed internally; maxillary palps filiform, 5-segmented; labial palps 3-segmented. *Prothorax* short, as broad as the head (Sialoidea) or very elongate and narrow (Raphi-

of *R. cognata*; (10) fore wing of *Panorpa germanica* L.; (11) apex of fore wing of *P. cognata* Rambur; (12) the same of *P. communis* L. (Markings liable to much variation in all species).

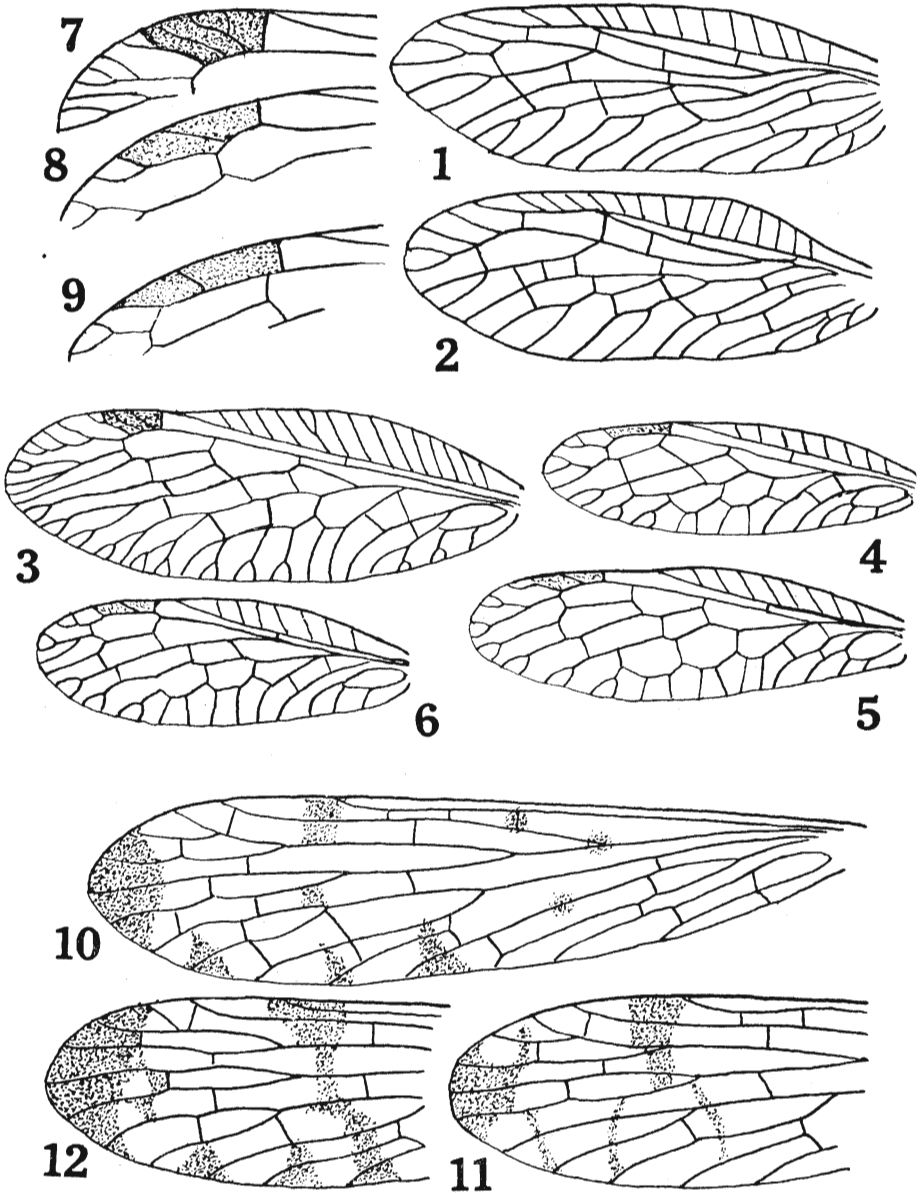


FIG. 5.—Wings of: (1) *Sialis lutaria* L.; (2) *S. fuliginosa* Pictet; (3) *Raphidia notata* Fab.; (4) *R. xanthostigma* Schummel; (5) *R. maculicollis* Stephens; (6) *R. cognata* Rambur; (7) pterostigma of *R. notata*; (8) the same of *R. maculicollis*; (9) the same [continued opposite

dioidea). *Thorax* robust, of primitive build with the divisions into metathorax and mesothorax clearly delineated by sutures. *Legs* moderately long, slim; tarsus 5-segmented, the third (Raphidioidea) or the fourth (Sialoidea) segment cordate. *Wings* (fig. 5, 1-9) ovate, rounded at apices, subequal, anal field in hind wing only slightly developed; subcosta (*Sc*) fusing with costa before apex of wing (Raphidioidea) or confluent with the radius (Sialoidea); radius running parallel with the subcosta, with 2 or more sectors; nearly all longitudinal veins forked at margins of wings and connected by a number of cross-veins, thus forming numerous cells; pterostigma well-defined (Raphidioidea) or not (Sialoidea). Larvae aquatic, with jointed abdominal gills (Sialoidea) or subcortical, terrestrial and without abdominal gills (Raphidioidea). *Abdomen* robust, fusiform, 10-segmented. Ovipositor not exerted (Sialoidea), or long and flexile (Raphidioidea).

KEY TO SUBORDERS OF MEGALOPTERA

- 1 (2) Subcosta fusing with costa; cubital and anal veins fused in the hind wing (fig. 3, *b*); prothorax elongate; larvae terrestrial. (Fig. 1, *c*). . **Raphidioidea**
- 2 (1) Subcosta fusing with radius; cubital and anal veins not fused in the hind wing (fig. 3, *c*); prothorax short and broad; larvae aquatic. (Fig. 1, *b*)
Sialoidea

Suborder RAPHIDIOIDEA

CHARACTERS OF THE SUBORDER. *Head* elongated and more or less contracted posteriorly (fig. 2, *c-e*); 3 ocelli present; antennae moderately long and slender; clypeus transverse; labrum rectangular, small; maxillae bifurcate, the lobes short, maxillary palps with short segments, apical one obtuse; labial palps 3-segmented, the apical one the shortest; mandibles robustly toothed, labium deeper than broad. *Prothorax* elongate and narrow, broadening slightly posteriorly; held erect at an angle to thorax, with the head deflexed (in the attitude of a snake rearing up ready to strike). *Meso-* and *metathorax* subequal, broader than prothorax. *Legs* moderately long and slim; first segment of tarsus long, the third bilobate and overlapping the fourth. *Abdomen* robust, especially in the female, in which it ends in a long flexible ovipositor. *Wings* subequal, hyaline (fig. 1, *c*, 5, 3-9 and 3, *b*), reticulation very open, costal area deep, highly convex, traversed by some 7 to 15 costal veinlets; subcosta (*Sc*) becoming confluent with costa well before the apex and at or just proximal to pterostigma, which latter is well-defined and opaque, traversed by 1 or more veinlets; radius (*Ri*) extending to apex of wing, where it ends in one or more bifurcations; a single cross-vein connecting *Sc* with *Ri* proximal to middle of wing; *Rs* with 2 to 3 branches which bifurcate or fuse irregularly to end in the four branches *Rii* to *Riv* (variation in the arrangement of these branches is often present in the right and left wings of a single species); gradate cross-veins connecting the longitudinal veins as an inner and outer series and breaking up wing into a number of elongate cells; median vein bifurcating into *MA* (*Medianus anticus*) and *MP* (*Medianus posticus*), the former becoming confluent with *Rs* for a short distance; cubitus (*CuA*) becoming confluent with stem of median anteriorly and anal vein posteriorly; anal field small, traversed by two anal veins.

LARVA (fig. 15, *c*) depressed, with subquadrate head and fusiform abdomen, highly chitinized on dorsum which is dark reddish-brown to blackish. Prothorax of similar size and shape to head; thorax smaller and narrower; mandibles robust; antennae 3-segmented; legs short.

PUPA resembling imago but with wings undeveloped and apposed to sides; extremely active.

ECOLOGY. The female deposits her eggs in chinks in bark on dead and decaying trees infected by coleopterous larvae. The ovipositor may be introduced into the borings of beetles, especially where frass is exuding. The larvae feed on coleopterous larvae or other insects found in dead and decaying wood, especially in the stumps of dead branches. When full grown, the larvae leave their burrows, descend the trunks and construct a loose cell either in the interstices of the bark or in debris at the foot of the parent tree. A mass emergence takes place in early spring, when the specimens are rendered conspicuous by their opaque white expanding wings.

The imagines live chiefly in the upper branches of trees, where their food appears to be mainly aphides and other small insects. They are extremely pugnacious and if enclosed together will soon tear each other to pieces. Only four species are met with in Britain, and two of these have been placed incorrectly in genus *Agulla* Navás. This is, however, a purely North American genus and all the British species are best retained, as formerly, in *Raphidia* L. The venational details of these insects are so unstable and so subject to variation that it is unsafe to rely solely on venation for purposes of classification.

KEY TO FAMILIES OF THE SUBORDER **Raphidioidea**

One family only.....**RAPHIDIIDAE**
 Characters as described for the Suborder.

Family **RAPHIDIIDAE**

KEY TO GENERA

A single British genus (fig. 1, c).....**Raphidia** Linnaeus (p. 13)
 Characters as described for the Suborder.

KEY TO SPECIES OF **Raphidia** LINNAEUS

- 1 (2) Large species with a wing expanse of 22–28 mm.; 12–15 costal veinlets; pterostigma with 2 cross-veins or one weakly forked; 4 (rarely 3) external discoidal cells; subcosta joining costa at inner end of pterostigma. Figs. 2, c and 5, 3 and 7.....**notata** Fabricius
May be beaten from any trees or bushes in pine woods, but shows a preference for oaks. Larvae in the stumps of dead branches, chiefly of oak. F.C. v-vii.
- 2 (1) Smaller species with a wing expanse of not more than 20–22 mm.; only 6–8 costal veinlets; only 1 cross-vein to pterostigma; only 3 external discoidal cells.
- 3 (4) Radius without fork or branches at its distal end; subcosta joining costa well before pterostigma, at about the length of the latter. Figs. 2, d and 5, 5 and 8
maculicollis Stephens
Appears to be confined to pine woods, especially Scots pine and larch. Our commonest species; may be found emerging in numbers at the foot of pine trees during early May. C. v-vii.
- 4 (3) Radius forked or branched at its distal end; subcosta meets costa quite near to pterostigma.
- 5 (6) Head narrowing posteriorly, coarsely punctured above and below; pterostigma very pale yellow; the two distal branches of *Rs* fusing distal to the outer line of gradate veinlets (fig. 5, 4).....**xanthostigma** Schummel
Appears to be solely confined to willows. L.R. v-vi.
- 6 (5) Head not tapering posteriorly, abruptly narrowed (fig. 2, e); very finely punctured above and below; pterostigma dark brown to black; the distal branches of *Rs* not fused, discrete throughout (figs. 2, e and 5, 6 and 9)
cornata Rambur
Habits and habitats similar to those of maculicollis but appears later in the season. L.R. vi-viii.

Suborder **SIALOIDEA**

CHARACTERS OF THE SUBORDER. *Head* broader than long, front not produced (fig. 2, b); antennae simple, short; ocelli absent; labrum subtriangular, deeply emarginate in the male but transversely oval and with rounded free border in the female; maxillary palps filiform, 5-segmented; labial palps 3-segmented; labium small. *Prothorax* robust, quadrangular, rather broader than head. *Meso- and meta-thorax* bulky, forming the broadest part of the body. *Abdomen* short, robust, of 10 segments. *Legs* of moderate length and robust; *tarsus* 5-segmented, the fourth segment cordate. *Wings* evenly infuscated, subequal, rounded at apices, anal area of

hind wing small ; subcosta (*Sc*) fusing with radius before apex of wing ; costal veinlets numerous, only one cross-vein in the subcostal space situated near middle of wing ; gradate series of veins irregularly arranged in three rows.

LARVA (fig. 15, *a*) aquatic, elongately fusiform and cylindrical in shape, the tenth segment prolonged as a long tapering spine ; three pairs of thoracic legs and seven pairs of abdominal, one on each of the first seven segments, each traversed by a trachea, these legs combining the functions of respiration, swimming and anchoring.

ECOLOGY. The eggs are laid in large masses of 500 or more, and are elongately cylindrical with a short cylindrical micropile. They are deposited on any objects near water but usually on foliage overhanging streams or ditches. Incubation lasts about ten days to a fortnight, the young larvae falling or making their way to water. They may be found in canals, large ponds and lakes, but *fuliginosa* is found only in running water ; they live principally in the mud and silt at the bottom of such habitats and are exceedingly predaceous. Larval life is about a year or rather more, at the end of which they enter a pupal stage which is spent in a cell constructed by the larva amongst debris or in the soil close to the watery habitat. The pupal state lasts for some three weeks, after which it leaves its cell, climbs up some neighbouring object and discloses the imago. The latter may be seen rising in numbers or reposing on foliage or wooden piles of bridges on sunny days.

KEY TO FAMILIES OF THE SUBORDER Sialoidea

One British family only.....SIALIDAE
 Characters as described for the Suborder.

Family SIALIDAE

KEY TO GENERA

A single British genus (fig. 1, *b*).....*Sialis* Latreille (p. 14)
 Characters as described for the Suborder.

KEY TO SPECIES OF *Sialis* LATREILLE

- 1 (2) Wings of brownish tint, costa pale at base ; 10-11 costal veinlets ; 3 gradate cross-veins in strict alignment in apical portion of wing (fig. 5, 1)
lutaria Linnaeus

Frequents the borders of rivers and dykes. C. v-vi.

- 2 (1) Wings of a blackish-brown tint, costa dark at base ; 12-15 costal veinlets ; gradate cross-veins in apical portion of wing not in alignment (fig. 5, 2)

fuliginosa Pictet

In the same situation as lutaria and, like it, has a habit of settling on posts in the neighbourhood of water. Begins to appear just as lutaria is becoming over. V.L. vi-vii.

III NEUROPTERA (PLANIPENNIA)

The Order Planipennia or true Neuroptera (Lacewings) is far larger and contains far more homogeneous insects than do the Mecoptera and Megaloptera ; it comprises insects of very small to very large size, but of the 54 species found in Britain, few attain to more than medium size. The Order has been split into 16 families but only 5 of these have representatives in the British fauna.

CHARACTERS OF THE ORDER. *Head* about as broad as long, the epistome not prolonged into a rostrum (fig. 2, *f*) ; large compound eyes widely separated ; ocelli absent (save in *Osmylus*) ; antennae moniliform, long and slender, with scape, pedicel and numerous bead-like segments ; mandibles with robust internal tooth ; maxillary palps

5-segmented, labial palps 3-segmented. *Prothorax* variable, usually well-developed, subquadrate or longer than broad. *Thorax* robust, of primitive build. *Meso-* and *metathorax*, scutum and scutellum outlined in well-defined sutures. *Legs* rather short, slim; tibiae with or without distal spurs; tarsi 5-segmented, the proximal segment elongate, claws rarely serrated. *Wings* (figs. 3, *d*, 10 and 11) membranous, richly veined, hyaline or maculated, the veins and margins ciliated (except in the Coniopterygidae); most veins bifurcate at wing-margins and usually with trichosors between the forks (fig. 3, *d*, *t*); the wings subequal, ovate or more rarely falcate or subfalcate, apices rounded in some genera (*Megalomus*, *Psectra*), acute in most; costal space broad or very broad in some species, traversed by many costal veinlets many of which are bifurcated; the most basal often reflexed towards base of wing (*recurrent humeral vein*, *Rhv*, fig. 3, *d*); subcosta (*Sc*) and radius running closely parallel to apex of wing; radial sector (*Rs*) with 3, 4 or more pectinate branches (most numerous in *Osmylus* and *Drepanepteryx*) which run more or less parallel and obliquely to the wing border; these branches connected by two series of cross-veins, an inner and an outer, arranged step-wise (fig. 3, *d*, *Gr*), known as "gradate veins"; median vein rather complex, bifurcating into anterior (*MA*) and posterior (*MP*) divisions (fig. 3, *d*), the former anastomosing for a space with *Rs*, the latter usually bifurcating; anal field small and inconspicuous, 2 to 3 anal veins. *Abdomen* slim in the male, robust in the female; 10-segmented; ninth and tenth segments in both sexes considerably modified (figs. 8, 9 and 12), of great importance in separating the species; in the male, tergite of tenth segment split into two lateral plates (*anal plates*) which vary greatly between the species, some bearing specialized teeth or spines at the apices; a small raised circular area present on upper part of each plate, beset with tubercles, each of which bears a small spine, constituting the *trichobothria* (figs. 8, *trb* and 9) and believed to be auditory organs; in the female, ninth segment developed greatly at the expense of tenth which is generally very small and inconspicuous.

LARVA (fig. 14, *a-h*). These vary with the families but their morphology is built on the same general plan. Though mostly terrestrial and arboreal, a few are aquatic or semi-aquatic; more or less elongately fusiform in shape, tapering from posterior end of thorax towards head and anal end respectively; thorax bulky and about as long as whole length of abdomen. Head rather small, subrotundate, mouth parts sealed by membrane, feeding being conducted by suction through the apposed mandibles and maxillae which are hollowed out to form a tube or suctional jaws which project prominently in front of head; antennae filiform, 2 to 15-segmented, but in most species only three segments present; labial palps 2- to 5-segmented, of variable length. Eyes of a primitive compound type made up of 5 or 6 isolated facets resembling ocelli. Thorax bulky and equal in length to abdomen; prothorax divided by sulci into a narrow anterior portion and a much larger and broader posterior which carries the forelegs; meso- and metathorax much broader and bulkier, each divided by sulci into an anterior shallow and a posterior deeper portion, the former furnished with a pair of spiracles, the latter carrying the posterior pairs of legs; on the dorsum all three segments have a pair of reniform pigmented plates, the dorsal sclerites, which give attachment to the leg muscles. In some species (Chrysopidae) all thoracic segments bear on each side large setiferous, wart-like tubercles which are employed to carry debris, such as the cast-off skins and fragments of leaves, on the dorsum to camouflage and conceal the larvae (fig. 14, *a* and *f*). Abdomen of 10 segments, each of the first 8 bearing spiracles and each of the first 9 subsegmented, as in the case of the thoracic segments. Tenth segment also functions as an extra foot by means of two eversible suckers which enable the larva to obtain a very firm grip; towards the end of larval life, this segment functions as a spinaret, the silk being stored in an anal reservoir after secretion from 6 of the Malpighian tubes which have become specialized into silk producing glands. Legs short and robust, femora and tibiae of the same length but the former the stouter; tarsus of only a single segment furnished with a pair of claws and an empodium at its distal end of variable shape, pointed in *Osmylus* but trumpet-shaped in the Chrysopidae and short and pad-like in the remainder.

BIONOMICS. Practically all Neuroptera are crepuscular by nature, although when roused during daylight they will take to lively and prolonged flight, especially the Chrysopidae. Most species are arboreal and the apparent rarity of some is certainly due to their ascending and keeping to the tops of trees (*Nathanica*): even the smaller Hemerobiidae, emerging at

the foot of trees, rise as soon as their wings are sufficiently hardened to bear them, and flutter to great heights to the tops of pines and oaks with which they are associated. The small Sisyridae, leaving their watery habitats, will also take to the tops of trees overhanging streams.

The larvae feed by sucking the fluids from their prey but the imagines devour the whole, though, unlike the larvae, they are not entirely carnivorous and some visit flowers to extract the nectar, whilst others show a marked predilection for the honey-dew on foliage.

Pairing takes place at night, the male exuding a spermatophore which is passed to the female; copulation may last for any time up to one hour, after which the female may proceed to devour the spermatophore, an action which probably releases the sperm by breaking up the sac in which this is contained. Pairing may take place within a few days of the emergence of the imago but may be delayed until the following spring in the case of species which hibernate. The ova are deposited in numerous positions, on the undersides of foliage, on twigs, in crevices of bark or the bracts of pine-needles or between the leaves of fir-cones. The Chrysopidae lay stalked eggs, a fine silken thread being first exuded; this rapidly hardens, and the egg is then passed and remains poised on top of the stalk. Such eggs may be laid singly or in groups, or as many as a dozen may be poised on top of a common silken stalk (fig. 14, *i* and *k*). The eggs are elongately oval in shape and incubate over a period varying between 10 days and 3 weeks (those of *Wesmaelius* are laid in the autumn but do not hatch until the following spring). The larvae pass through three instars, the first two being of but short duration, 3 to 6 days in the case of the first instar and rather longer in the case of the second; the third instar may last for a few days or a few weeks or even months in the case of some species which hibernate as the third instar. When fully grown the larva rests for a while and then proceeds to look for a place in which to spin its cocoon; this may be a rolled-up leaf, a crevice in bark or between the leaves of a fir-cone; most appear to prefer a site at the foot of the tree on which they have bred, especially species which are associated with pine trees. *Wesmaelius* spins its cocoon between the needles of Scots pine or larch, where they are quite conspicuous. The cocoon is constructed with the anal spinaret mentioned above, and the end of the abdomen may be seen moving actively and restlessly about as it spins the strands, first as a loose outer envelope and then as a more compact inner cocoon. Chrysopid larvae reinforce the walls with the debris which they have carried on their backs during larval life and this serves to camouflage them. The cocoon finished, the larva enters a short prepupal or resting stage (longer in those which spend the winter hibernating as such). The pupa which emerges from the prepupa is always a *pupa libera* capable of active movement and very much like the imago except that the wings are but small pads held closely apposed to the sides of the thorax and the base of the abdomen. Its attitude in the cocoon is one of extreme flexion, the head tucked under the thorax and the latter and abdomen strongly curled ventrally. On emergence the pupa opens the cocoon with its powerful jaws, climbs out and usually walks for some distance before it chooses a site for further development; this is often at the foot of a tree where, in early spring, many of the disclosed imagines may be seen, rendered conspicuous by their opaque white expanding wings, an opacity which may last for some days in early imaginal life.

When attacked or disturbed many Hemerobiids feign death, dropping to the ground and remaining motionless on their sides for an appreciable time ; if then disturbed again, some species will flip their wings violently against the ground, causing them to leap into the air (*Wesmaelius* and *Psectra*). The habit of some Chrysopid larvae of coating themselves with debris for purposes of concealment is performed very deliberately, the larva curling its head over the thorax and abdomen carrying a piece of discarded skin or debris in its jaws and impaling it on the spines.

ECONOMIC IMPORTANCE. The Neuroptera are of considerable economic importance to man ; both in the larval and imaginal stages their principal food consists of aphides, Coccids and other small noxious insects. Larvae of some species, especially those of the Chrysopidae, may devour as many as a thousand aphides during their life ; others are known to devour the eggs of Lepidoptera and the larvae of Microlepidoptera. The aquatic

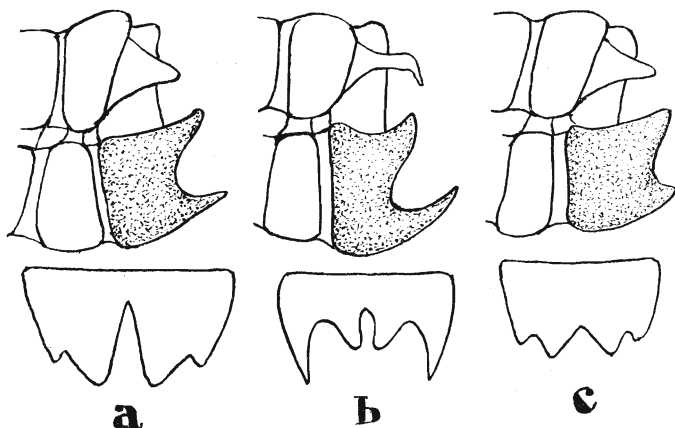


FIG. 6.—Male genitalia of *Coniopteryx* spp. : (a) *tineiformis* Curtis ; (b) *borealis* Tjeder ; (c) *pygmaea* Enderlein. Shaded areas in the upper figures show the shape of the hypandrium as seen from the left side. The lower figures show the ventral aspect of the hypandrium.

species are of less importance, the Sisyridae feeding on fresh-water sponges, whilst those of the Osmylidae live principally on dipterous larvae, especially those of Chironomidae.

KEY TO FAMILIES OF ORDER NEUROPTERA

- 1 (2) Costal space of fore wings without cross-veins (except in genus *Conwentzia*, which has two near the base) ; longitudinal veins not forked or branched at borders of wing. Body, including wings, coated with a white or greyish powder secreted from wax glands (fig. 7, 1-6) CONIOPTERYGIDAE (p. 18)
- 2 (1) Costal area of fore wings with numerous cross-veins ; longitudinal veins forked or branched at wing borders. Wax glands absent.
- 3 (6) Radius (*Ri*) and subcosta (*Sc*) fused near apex of wing or *Sc* bending posteriorly to end on *Ri*.
- 4 (5) Large insects with a wing expanse of over 40 mm. ; numerous black spots scattered about the wing ; venation very close and cross-veins numerous ; ocelli present (fig. 10, 3 and 10A) OSMYLIDAE (p. 22)
- 5 (4) Smaller insects with a wing expanse not exceeding 15 mm. ; wings unmarked, uniformly coloured ; venation open ; few cross-veins ; ocelli absent (fig. 10, 4) SISYRIDAE (p. 22)

- 6 (3) Radius and subcosta not fusing near wing apex.
 7 (8) Large to medium-sized insects coloured yellow or bright green; eyes brilliant golden; antennae filiform; *Ri* and *Rs* separated in fore wing and all branches of the latter arising after its departure from *Ri*; microtrichia and trichosors absent from wing membrane and wing borders respectively (figs. 11, 8 and 9; and 13, *d-f*)..... **CHRYSOPIDAE** (p. 30)
 8 (7) Smaller insects of fuscous or greyish colouring; eyes not so conspicuously golden; antennae moniliform; *Ri* and *Rs* fused in the fore wing so that all branches of the latter arise from a common stem; microtrichia and trichosors present (figs. 10, 1, 2, 5-8 and 11, 1-7)..... **HEMEROBIDAE** (p. 24)

Family CONIOPTERYGIDAE

KEY TO GENERA

- 1 (2) Two bristle-like hairs on median vein of fore wings; median and cubital veins of hind wing closely apposed for three-fourths of their length (fig. 7, 2)..... **Aleuropteryx** Loew (p. 18)
 2 (1) Median vein of fore wing without bristle-like hairs; median and cubital veins of hind wings well separated.
 3 (4) Hind wing vestigial, less than half length of fore wing, its venation greatly reduced; 2 veinlets at base of costal space; antennae with about 40 segments (fig. 7, 6)..... **Conwentzia** Enderlein (p. 18)
 4 (3) Hind wing fully developed, considerably more than half length of fore wing; venation much as in fore wing; costal space without basal cross-veins.
 5 (6) Median vein not forked in hind wing; antennae with 24-32 segments, the scape swollen and as long as broad, pedicel narrower, flagellum moniliform, segments of latter fringed distally with scale-like hairs in the male, which are absent in the female; wings subequal, coated with white wax (fig. 7, 4 and 5)..... **Coniopteryx** Curtis (p. 21)
 6 (5) Median vein forked in hind wing (fig. 7, 1 and 3).
 7 (8) Body and wings white; the cross-vein between median and cubital veins situated distal to forking of median (fig. 7, 3).... **Semidalis** Enderlein (p. 18)
 8 (7) Body and wings sooty-grey; the cross-vein between the median and cubital veins situated proximal to forking of the median vein (fig. 7, 1); antennae with 27-32 segments..... **Parasemidalis** Enderlein (p. 19)

KEY TO SPECIES OF Aleuropteryx LOEW

- A single British species..... **lutea** (Wallengren)
 Exp. 5-8 mm. Wings subequal, coated with white waxy secretion (fig. 7, 2); antennae with about 26 segments.
Reported only from near Durham. V.R. vii.

KEY TO SPECIES OF Conwentzia ENDERLEIN

- A single British species..... **psociformis** (Curtis)
 Exp. 7-8 mm. Body and wings coated with a white waxy secretion (*C. pineticola* Enderlein is only a form of *psociformis*, differing in that the whole insect is darker, including its wings, and in that the antennae have fewer segments, which average about 30).
Frequents deciduous trees as well as evergreens, conifers and holly, the latter being particularly favoured. Widely distributed throughout the British Isles. V.C. iv-xi.

KEY TO SPECIES OF Semidalis ENDERLEIN

- A single British species..... **aleyroformis** (Stephens)
 Exp. 7-8 mm. Wings subequal, the hind with the same venation as the fore wings.
Found in almost any kind of tree, whether deciduous or evergreen. South England, rare in the North; known only from Perth in Scotland; unknown in Wales and from Ireland. L.C. v-ix.

KEY TO SPECIES OF *Parasemidalis* ENDERLEIN

A single British species.....*annae* Enderlein
Exp. 5-6 mm. Easily recognized by its dark wings, all other species

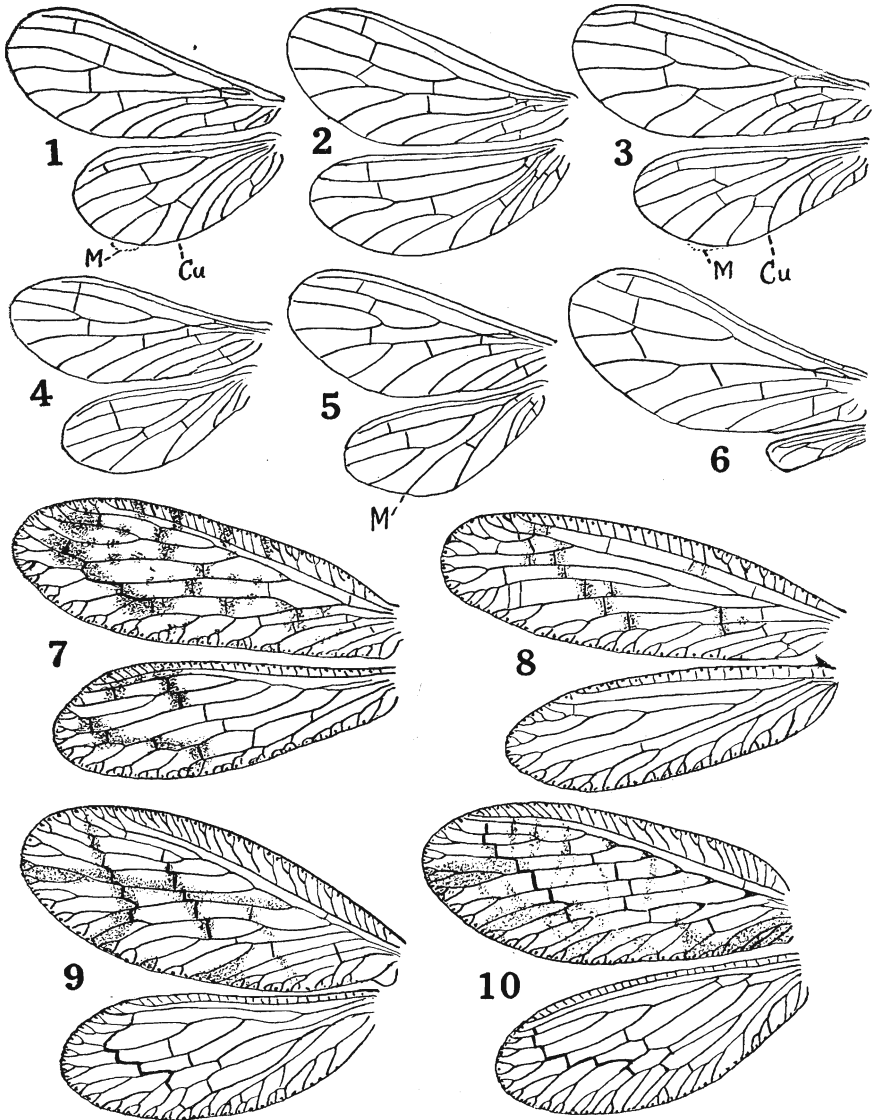


FIG. 7.—Wings of: (1) *Parasemidalis annae* Enderlein; (2) *Aleuropteryx lutea* (Wallengren); (3) *Semidalis aleyrodiformis* (Stephens); (4) *Coniopteryx pygmaea* Enderlein; (5) *C. tineiformis* Curtis; (6) *Conwentzia psociformis* (Curtis); (7) *Micromus variegatus* (Fab.); (8) *Psectra diptera* (Burmeister), macropterous form; (9) *Micromus angulatus* (Stephens); (10) *N. paganus* (L.).

of the family having these white (except *C. pineticola* mentioned above, a form of *psociformis*).

Frequents conifers and their neighbourhood ; has been swept from woodsage beneath conifers. V.R. vi-vii.

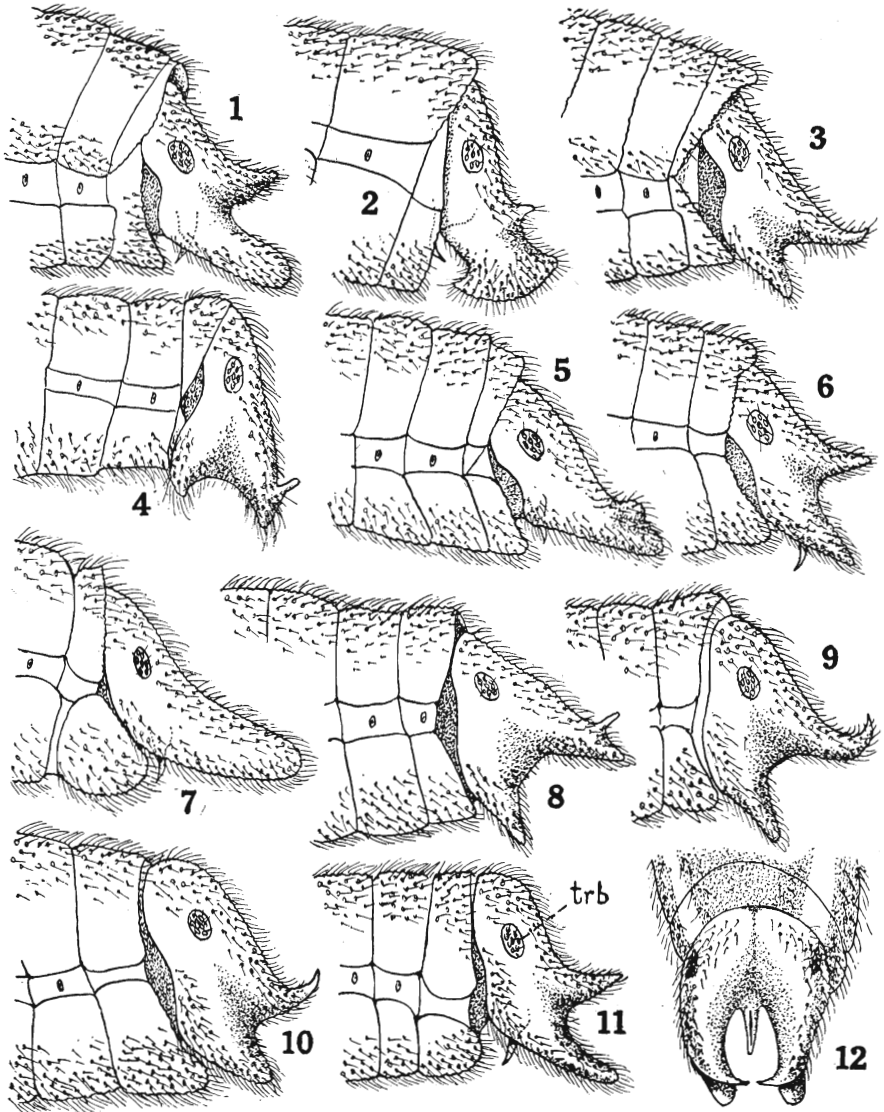


FIG. 8.—Apex of male abdomen of *Hemerobius* spp.: (1) *nitidulus* Fab.; (2) *lutescens* Fab.; (3) *stigma* Stephens; (4) *humulinus* L.; (5) *micans* Olivier; (6) *atrifrons* McLachlan; (7) *marginatus* Stephens; (8) *perelegans* Stephens; (9) *simulans* Walker; (10) *contumax* Tjeder; (11) *pini* Stephens; (12) *micans*, seen from behind. *trb*, trichobothria.

KEY TO SPECIES OF *Coniopteryx* CURTIS

- 1 (2) The two outer anterior gradate cross-veins of fore wings in line with one another (fig. 7, 4). Exp. 5–6 mm. (Antennae usually 25-segmented; abdomen carneous; hypandrium much as in *tineiformis* but the median incision less deep (fig. 6, c).).....*pygmaea* Enderlein
Confined to conifers. C. v-x.

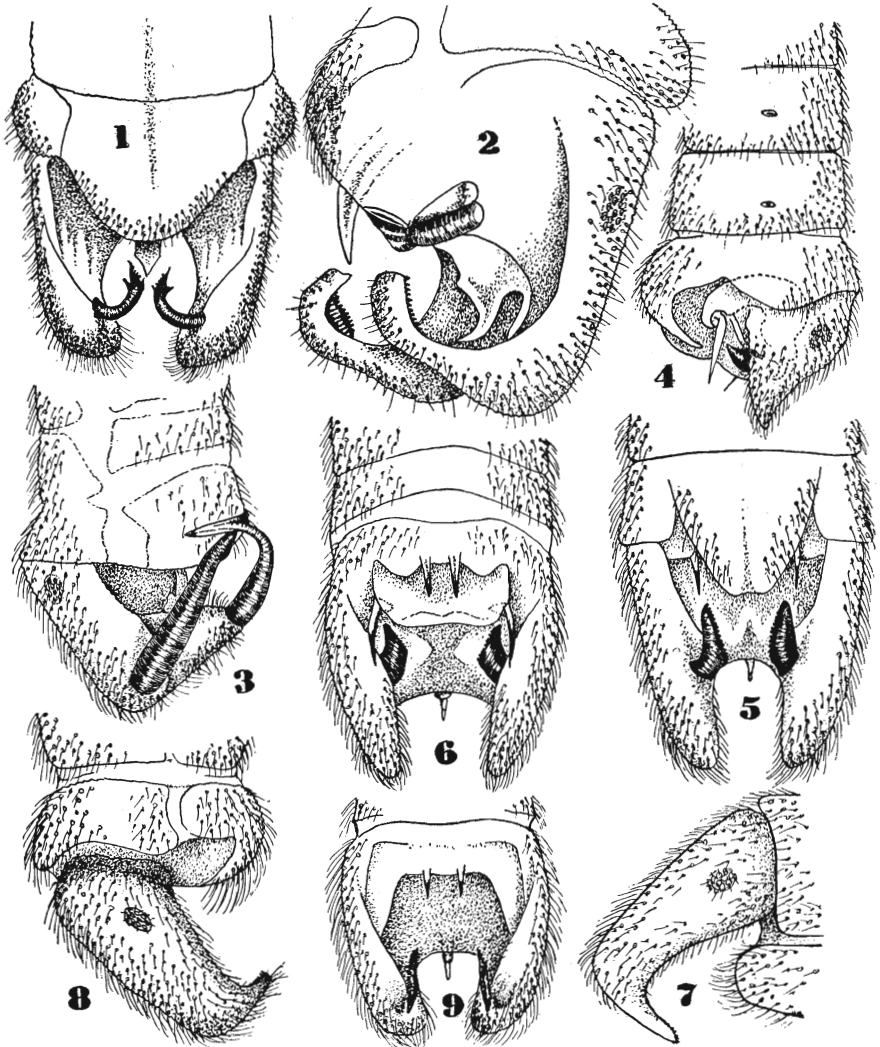


FIG. 9.—Apex of male abdomen of : (1) *Kimminsia rava* (Withycombe), ventral aspect; (2) *K. nervosa* (Fab.), lateroventral aspect; (3) *K. subnebulosa* (Stephens), lateroventral aspect; (4) *Wesmaelius concinnus* (Stephens), seen from the left side; (5) the same, ventral aspect; (6) *W. quadrifasciatus* (Reuter), ventral aspect; (7) *Kimminsia mortoni* (McLachlan), seen from the right side; (8) *K. killingtoni* Morton in Fraser, seen from the right side; (9) *K. ballica* (Tjeder).

- 2 (1) The outer anterior gradate cross-veins of fore wings not in alignment, usually widely spaced (fig. 7, 5).
- 3 (4) Hypandrium seen from below with a deep median incision, the sides of which are divergent (V-shaped) (fig. 6, a). Exp. 6-7 mm. (Antennae 25-27-segmented; abdomen yellow.).....**tineiformis** Curtis
Frequents woods and hedges, in any kind of tree, oak and sallow being the most preferred. Widely distributed like the last species but most common in the south. C. v-viii.
- 4 (3) Hypandrium seen from below with a median incision, of which the sides are parallel, narrower and less deep than in *tineiformis* (U-shaped) (fig. 6, b). Exp. 5-6.5 mm. (Antennae 27-29-segmented.).....**borealis** Tjeder
Frequents sallow and birch. Known only from Scotland in the British Isles and from only two specimens. V.R. v-vi.

Family OSMYLIDAE

KEY TO GENERA

A single British genus of which the species are by far the largest of the British Neuroptera (fig. 10, 3 and 10A).....**Osmylus** Latreille

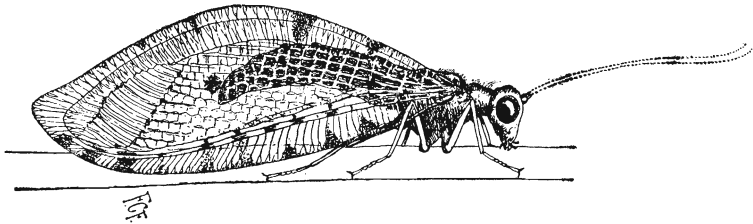


FIG. 10A.—*Osmylus fulvicephalus* (Scopoli).

KEY TO SPECIES OF **Osmylus** LATREILLE

A single British species (fig. 10A).....**fulvicephalus** (Scopoli)

Exp. 40-50 mm. Easily recognized by its large size and strongly maculated wings with very close venation and wealth of cross-veins; wings subfalcate with two prominent fuscous spots on costal border at apex of fore and hind wings and four more near base of fore wings; subcosta and radius with alternating dark and light streaks.

Occurs in colonies by the sides of shady woodland streams. Distributed throughout England, Wales and Ireland but only one record for Scotland. V.L.C. v-vii. May be beaten up from dense shade in holly, yew or alders beside streams.

Family SISYRIDAE

KEY TO GENERA

A single British genus (fig. 10, 4).....**Sisyra** Burmeister

KEY TO SPECIES OF **Sisyra** BURMEISTER

- 1 (2) Antennae blackish with the apical fourth pale yellow; wings grey, almost colourless, cross-veins pale. Exp. 12-14 mm. (Easily distinguished by the pale tips of its antennae, and from any species of *Hemerobius* by the subcosta bending posteriorly to join the radius near the wing apex.)
terminalis Curtis
Frequents the sides of streams and less often ponds, resting in alder or sallows from which it may be beaten. V.L. v-vii. All Britain except Scotland.
- 2 (1) Antennae blackish throughout; wings fuscous or yellowish-brown.

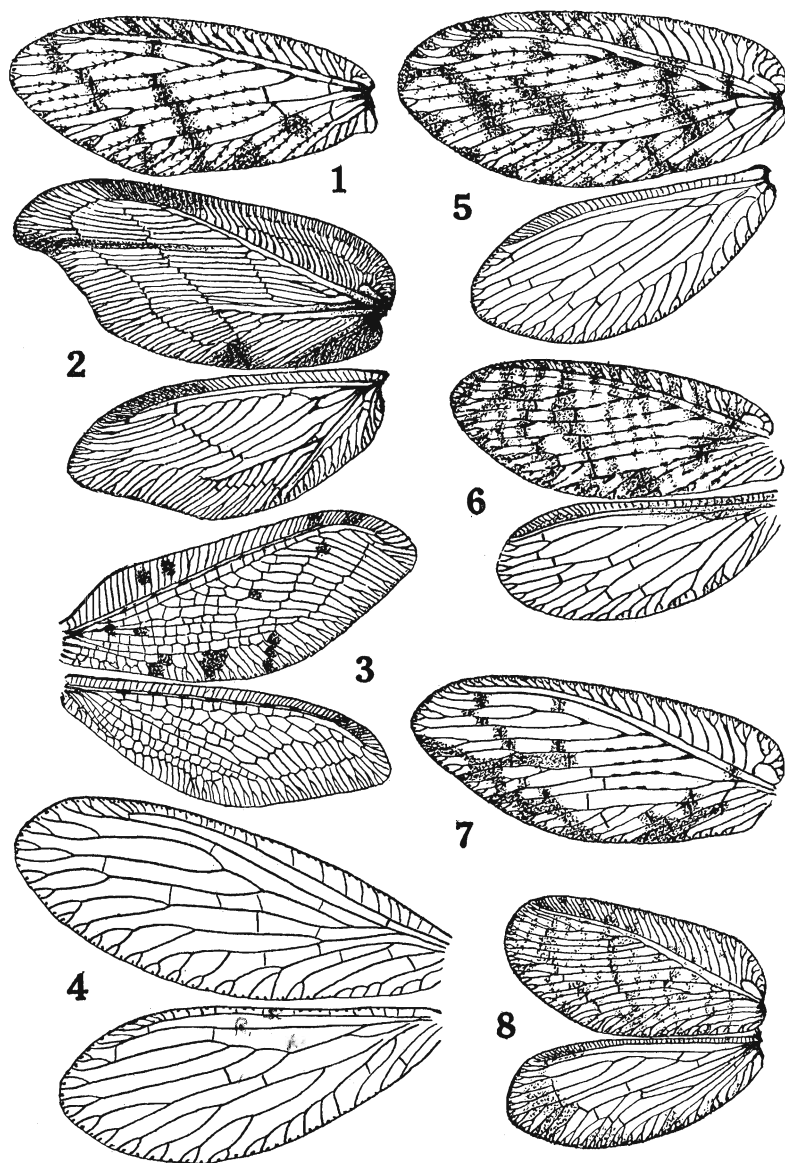


FIG. 10.—(1) Fore wing of *Kimminsia nervosa* (Fab.); wings of: (2) *Drepanepteryx phalaenoides* (L.); (3) *Osmylus fulvicephalus* (Scopoli); (4) *Sisyra fuscata* (Fab.); (5) *Wesmaelius quadrifasciatus* (Reuter); (6) *Hemerobius atrifrons* McLachlan; (7) *H. marginatus* Stephens; (8) *Megalomus hirtus* (L.).

- 3 (4) Fore wings fuscous, unicolorous, the gradate cross-veins not darker than the rest of wings (fig. 10, 4). Exp. 12-14 mm. (A dull nondescript insect resembling a small teneral *Hemerobius* but easily distinguished from it by the subcosta ending on the radius, and from *S. terminalis* by the colour of the antennae.)..... **fuscata** (Fabricius)
Frequents similar situations to the last species with a preference for the shade of alders. Distributed widely throughout the British Isles. C. v-ix.
- 4 (3) Fore wings yellowish-brown; the gradate cross-veins, as well as many forks of longitudinal veins, where branches come off, darker than the adjacent membrane of wing. Exp. 12-14 mm. (Distinguished from other species by its brownish colouring and from species of the Hemerobiidae by its venational characters.)..... **dalii** McLachlan
Distributed widely throughout the British Isles except Scotland. L.C. v-viii. Found in similar situations to the last two species but of stronger flight and rises high into trees overhanging streams, oaks being preferred.

Family HEMEROBIIDAE

KEY TO GENERA

- 1 (12) Fore wing with the basal costal veinlet (fig. 3, d) (*recurrent humeral*) curved strongly towards the base of wing.
- 2 (3) Wings falcate (fig. 10, 2) (shaped as in the Hook-tip moth *Drepana falcataria* L.); vein *Rs* with not less than 10 branches; 3 series of gradate cross-veins; costal veinlets connected by a line of additional cross-veins
Drepanopteryx Leach (p. 30)
- 3 (2) Wings not falcate and with less than 10 branches to *Rs*; not more than 1 or 2 series of gradate cross-veins.
- 4 (5) Radial sector (*Rs*) in fore wing with 6 to 7 branches; 2 series of gradate veins (fig. 10, 8)..... **Megalomus** Rambur (p. 30)
- 5 (4) Fore wing with less than 5 branches to *Rs*.
- 6 (9) Median vein in hind wing forked distal to origin of first branch of *Rs*.
- 7 (8) In the fore wing the cross-vein connecting the radius and median veins situated at the level of the first branch of *Rs* or slightly basal to it; 3 branches to *Rs*; a complete series of gradate cross-veins in the hind wing (figs. 10, 6 and 7, and 11, 1-5)..... **Hemerobius** Linnaeus (p. 26)
- 8 (7) In the fore wing, the cross-vein connecting *R* with *M* at the level of or distal to the origin of the first branch of *Rs*; 2 to 3 branches to *Rs*; no other series of gradate cross-veins in the hind wing (fig. 11, 6 and 7)
Symphorobius Banks (p. 27)
- 9 (6) Median vein in hind wing forked at or basal to origin of the first branch of *Rs*.
- 10 (11) Comparatively large species with a wing expanse of usually more than 20 mm.; usually 4 branches to *Rs*; cross-vein connecting *R* with *Rs* at base of wing situated distal to origin of first branch of *Rs*; male anal plates triangular in side view; female with ninth sternite greatly elongated and turned up at apex (fig. 10, 5)..... **Wesmaelius** Krueger (p. 30)
- 11 (10) Smaller species with wing expanse usually under 20 mm.; usually only 3 branches to *Rs* (rarely 4); cross-vein between *R* and *Rs* at base of wing situated basal to level of origin of first branch of *Rs*; male anal plates rectangular as viewed laterally; female with ninth sternite short and rounded (fig. 10, 1)..... **Kimminsia** Killington (p. 28)
- 12 (1) Fore wing with basal costal veinlet sloping obliquely distalwards (*recurrent humeral* absent).
- 13 (16) *Rs* with 3 to 4 branches; costal veinlets largely forked; 2 series of gradate cross-veins present; hind wings never rudimentary.
- 14 (15) Wings elongately oval; only 3 branches to *Rs*; median and cubital veins partly fused in the hind wing (fig. 7, 7)..... **Micromus** Rambur (p. 29)
- 15 (14) Wings broadly oval; at least 4 branches to *Rs*; median and cubital veins not fused in the hind wing (fig. 7, 9 and 10)..... **Nesomicromus** Perkins (p. 29)
- 16 (13) Only 2 branches to *Rs*; but few of the costal veinlets forked; only a single complete series of gradate veins in the hind wings, which latter are usually rudimentary (4-winged in the macropterous form) (fig. 7, 8)
Psectra Hagen (p. 27)

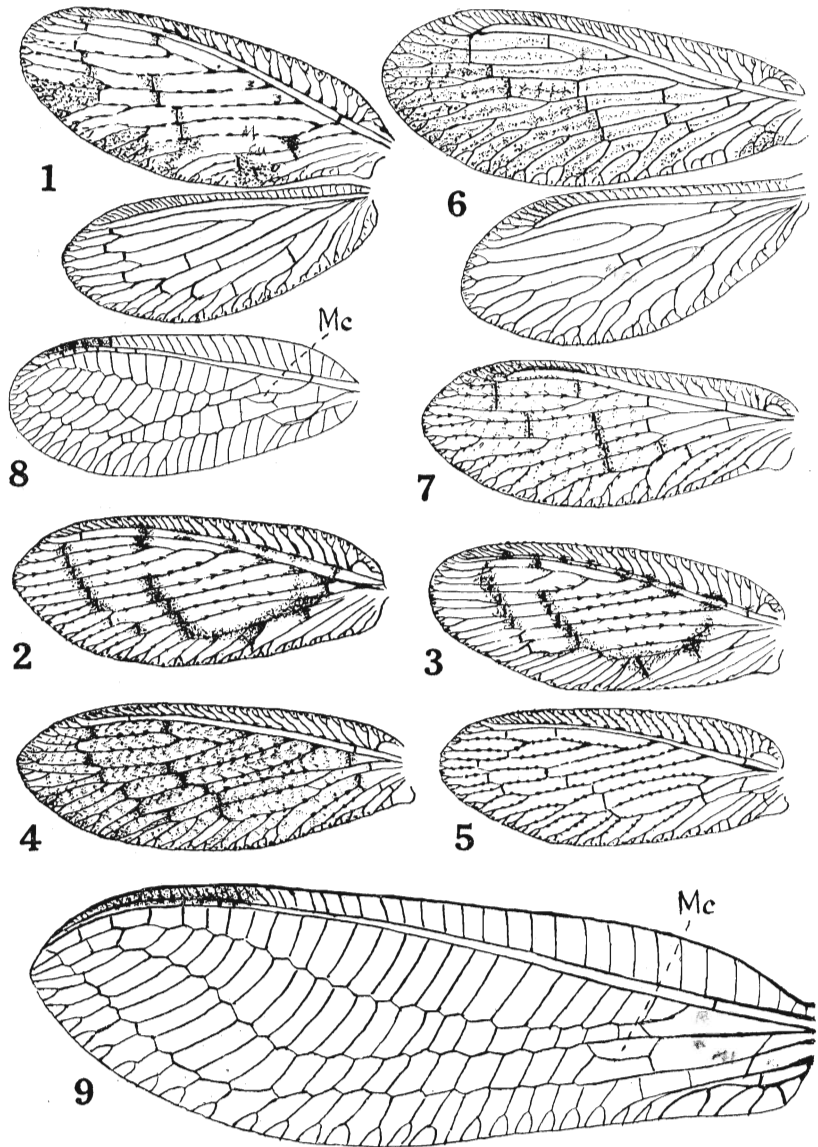


FIG. 11.—(1) Wings of *Hemerobius humulinus* L.; (2) fore wing of *H. pini* Stephens; (3) *H. contumax* Tjeder; (4) *H. perelegans* Stephens; (5) *H. nitidulus* Fab.; (6) wings of *Symphorobius elegans* (Stephens); (7) fore wing of *S. pygmaeus* (Rambur); (8) *Chrysopa perla* (L.); (9) *Nathanica fulviceps* (Stephens). *Mc*, median or discoidal cell.

KEY TO SPECIES OF *Hemerobius* LINNAEUS

- 1 (18) Cross-vein joining *M* with *Cu* near base of fore wing centred over an oblique blackish spot (fig. 11, 1-3).
- 2 (3) Thorax uniform dark reddish-brown and without a median pale longitudinal stripe; pterostigma of fore wings rust red; anal plates of male deeply furcate, the forks elongate, the upper, the longest, curled slightly upwards and inwards (fig. 8, 3). Exp. 12-16 mm. **stigma** Stephens
Confined to conifers but may be found on adjacent deciduous trees. Found throughout the British Isles. Hibernates in winter as an imago. C. i-xii.
- 3 (2) Thorax bicolorous and with distinct pale yellow longitudinal mid-dorsal stripe.
- 4 (5) Face glossy black; fore wing with irregular pattern of dark streaks and interrupted transverse fasciae; male anal plates similar to *stigma* but of equal length (figs. 8, 6 and 10, 6). Exp. 12-17 mm. **atrifrons** McLachlan
Almost entirely confined to larch but occasionally on other conifers. Distributed throughout the British Isles but more common in the south. Double brooded. L. v-ix. Most specimens occur from v-vi.
- 5 (4) Face brown or yellowish.
- 6 (7) Costal space of fore wings abnormally wide, rising abruptly at the base; fore wing with pale fuscous arcuate streaks along outer and hinder borders enclosing hyaline lunate spots (fig. 10, 7); anal plates of male greatly extended, not furcate (fig. 8, 7). Exp. 18-20 mm. **marginatus** Stephens
Frequents deciduous trees, especially birch. Distributed in the north of England, Scotland and Ireland. N.C.L. vi-x.
- 7 (6) Costal space of fore wing of normal width.
- 8 (9) Basal cross-vein connecting *Sc* with *R* pale coloured; fore wings pale yellow with poorly defined greyish markings; anal plate of male narrow, non-furcate, dilated apically and hatchet-shaped in profile, with a small obtuse spine on upper margin just before apical dilatation (fig. 8, 2). Exp. 14-18 mm. **lutescens** Fabricius
Found on deciduous trees, especially oak and hazel, throughout the British Isles. V.C. i-ix.
- 9 (8) Basal cross-vein connecting *Sc* with *R* black; fore wings darker, greyish or brownish with better marked transverse fasciae or irregular streaks; male anal plate broad and furcate.
- 10 (13) Outer and hinder borders of fore wings uniformly grey; the inner row of gradate cross-veins black and forming with a similarly coloured line along *Cu* and the black spot on the cross-vein connecting *M* with *Cu*, a semicircular line enclosing a semitransparent area.
- 11 (12) Inner and outer series of gradate veins of fore wings closely parallel; male anal plates furcate, with the forks of equal length (figs. 8, 10 and 11, 3). Exp. 16-18 mm. **contumax** Tjeder
Confined to conifers. England only. V.R. v-vii.
- 12 (11) Inner and outer series of gradate veins not parallel, diverging anteriorly; male anal plates furcate, the posterior fork longer than the anterior (figs. 8, 11 and 11, 2). Exp. 15-18 mm. **pini** Stephens
Confined to conifers, especially spruce and larch. England and Scotland. L.R. v-viii.
- 13 (10) Outer and inner borders of fore wings with distinct alternating dark and light spaces; the dark fascial line on inner series of gradate veins not forming a continuous semicircular line with basal dark markings of wing, which latter are more or less isolated.
- 14 (15) Comparatively large species with wing expanse as wide as 20 mm., the wings rather elongated and narrow; inner gradate series of cross-veins straight; male anal plates deeply furcate, with forks of equal length, the upper fork without a subapical spine (fig. 8, 9). Exp. 18-20 mm. **simulans** Walker
Generally confined to larch and spruce, especially the former. Distributed throughout the British Isles. Double brooded. V.L. v-ix.
- 15 (14) Rather smaller species with wing expanse not exceeding 18 mm.; wings shorter and broader; inner row of gradate cross-veins sinuous or angulated at the middle; male anal plates furcate, the upper fork the longest and with subapical spine or process.

- 16 (17) Fore wings pale and lightly marked as a whole but the gradates and three markings on the hinder border may be distinct (fig. 11, 1); male anal plates with the upper one broad and long and bearing a slender spine (fig. 8, 4). Exp. 15–18 mm. **humulinus** Linnaeus
Closely resembles H. lutescens from which it is distinguished by the cross-vein joining Sc with R black instead of pale. Frequents deciduous woods and their undergrowth. Widely distributed throughout the British Isles. V.C. iv-x.
- 17 (16) Fore wings richly and closely marked with dark reddish-brown; the gradates forming dark prominent zigzag lines; longitudinal veins bearing numerous dark arrow-shaped spots (fig. 11, 4); male anal plates much like those of *humulinus* but the posterior fork much longer and narrower (fig. 8, 8). Exp. 16–18 mm. **perelegans** Stephens
Appears to be confined to deciduous trees, especially birch. Found only in Scotland. (Stephens' New Forest record is no doubt an error.) R. v-vii.
- 18 (1) Cross-vein joining *M* with *Cu* near base of wing colourless or without a fuscous surround.
- 19 (20) Fore wings pale yellowish-brown, translucent, with the whole of the veins closely and regularly outlined with dark points (fig. 11, 5); male anal plates furcate, the upper fork acute and curled slightly upwards and inwards, the lower fork broader, longer and obtusely rounded at apex (fig. 8, 1). Exp. 14–16 mm. **nitidulus** Fabricius
Frequents conifers, larch, spruce and Scots pine, with a preference for the last. Several broods during the year. Distributed throughout the British Isles. C. iv-ix.
- 20 (19) Fore wings shiny iridescent yellow with the venation bearing short widely spaced dark streaks. Male anal plates scarcely furcate, narrowly elongate, dilating somewhat at apex and with the upper angle curled inwards (fig. 8, 5). Exp. 12–16 mm. **micans** Olivier
Found on deciduous trees, especially beech to which it is almost confined. Distributed throughout the British Isles. Several broods during the year. C. iv-x.

KEY TO SPECIES OF *Symphorobius* BANKS

- 1 (4) Only two branches to radial sector in fore wings.
- 2 (3) Ninth sternite of male greatly prolonged (fig. 12, c); venation of wings black throughout, membrane marbled with fuscous (fig. 11, 6). Exp. 10–12 mm. (A very dark species, mainly blackish-brown.) **elegans** (Stephens)
Frequents deciduous trees with a preference for beech, oak and hazel. Unknown in Scotland and Ireland. L.R. vi-viii.
- 3 (2) Ninth sternite of male shorter and stouter (fig. 12, d); venation streaked alternately with dark and pale areas, membrane mottled with pale spaces on a brownish ground colour (fig. 11, 7). Exp. 8–10 mm. (A small paler species than *elegans*; thorax dark brown with a median pale band.)
pygmaeus (Rambur)
Confined to oaks, especially those infested with blight. C. v-ix.
- 4 (1) Three branches to radial sector.
- 5 (6) Ninth sternite of male very elongate; apical process of anal plates with the two forks divergent (fig. 12, a); wings uniform pale smoky grey. Exp. 10–11 mm. (A dark, mainly blackish species. Ninth male sternite much longer than in any other species of the genus.) **fuscescens** (Wallengren)
Confined to conifers, chiefly Scots pine. Cocoons may be found in abundance deep between the scales of old pine cones. Well distributed in England and Scotland, but not recorded from Ireland. L.C. vi-ix.
- 6 (5) Ninth sternite of male shorter; apical process of anal plates with the minute forks closely parallel (fig. 12, b); wings pale grey, the cross-veins framed in darker grey. Exp. 9–11 mm. **pellucidus** (Walker)
Restricted to conifers, mainly Scots pine. No records from Scotland or Ireland but distributed widely through the southern counties of England. R. v-xi.

KEY TO SPECIES OF *Psectra* HAGEN

A single British species, which exists in two forms, a *micropterous* in which the hind wings are rudimentary, and a *macropterous* where all four wings are well developed, this latter by far the rarer of the two

diptera (Burmeister)

Exp. 5-7 mm. The smallest of the British Hemerobiids. Fore wings highly chitinized, narrow, elongate and slightly convex; the apex obtusely rounded; pale testaceous; gradate veinlets dark and conspicuous and framed in an areola of fuscous; hind wing in the micropterous form with only two longitudinal veins and no cross-veins; *Rs* with only 2 branches (fig. 7, 8).

Frequents low vegetation or long grass overhung by sallows or heather, into which it ascends after dusk. Widely distributed throughout the British Isles but most common in Scotland. *R.*, perhaps *L. vi-viii*.

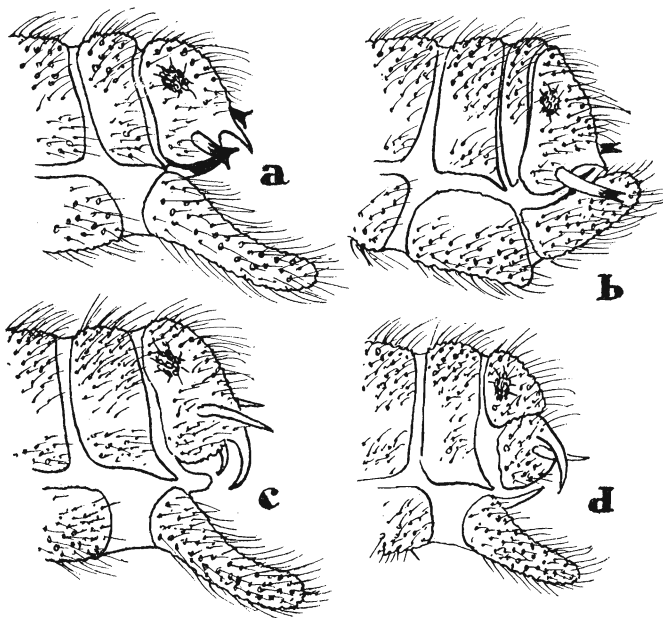


FIG. 12.—Male genitalia of *Sympherobius* spp.: (a) *fuscescens* (Wallengren); (b) *pellucidus* (Walker); (c) *elegans* (Stephens); (d) *pygmaeus* (Rambur).

KEY TO SPECIES OF *Kimminsia* KILLINGTON

- 1 (8) Anal plate of male ending apically in a tuft or cushion of small black spines.
- 2 (5) Small species with wing expanse not exceeding 14 mm. (7, 9, 4)
- 3 (4) Male anal plate narrowly elongate, the apex curled inwards and forwards and ending in a brush-like process coated with small black spines (fig. 9, 9). Exp. 12-14 mm. (A pale yellow coloured species; wing venation pale and the membrane almost devoid of markings).....*baltica* (Tjeder)
Only recorded from the southern counties of England. Frequents coastal sand-dunes coated with coarse marram grass from which it may be obtained by sweeping. *L.R. vi-viii*.
- 4 (3) Anal plates of male narrowly elongate, the apical portion turned abruptly downwards and inwards at a right angle and tapering almost to a point which is furnished with a tuft of small black spines (fig. 9, 7). Exp. 14 mm. (A much darker species than *baltica* with variegated markings on the fore wings approaching those seen in *K. nervosa* (vide infra) but more poorly defined. Dorsum of abdomen coated densely with golden hair.)
mortoni McLachlan

Reported only from Scotland. *L.R. vi-viii*.

- 5 (2) Larger species with wing expanse exceeding 14 mm.

- 6 (7) Anal plates of male similar to the last but the apical portion much abbreviated and with its inner surface coated with a cushion of small black spines (fig. 9, 8); fore wings greyish-yellow marked with pale sagittate spots along the longitudinal veins and alternating light and dark areas along the margins of the wing. Exp. 18–20 mm. (A rather paler species than *mortoni*. Abdomen coated with golden hair as in that species.)

killingtoni Morton in Fraser

Reported from the Highlands of Scotland only. L.R. vi-vii.

- 7 (6) Anal plates of male broad and long but narrowing abruptly towards the apex which is curled under at a right angle and the extreme tip forwards, the angle thus formed enclosing a small field of closely-set, black spines (fig. 9, 2); fore wings rather longer and narrower than in other species, smoky-grey variegated with blackish sagittate points and some markings on the borders, save for a clear colourless area in the middle of the posterior half of the wings (fig. 10, 1). Exp. 16–20 mm. (A dark species distinguished from *K. subnebulosa* by the shape of the apical processes on the anal plates and the clear area of the wings). *nervosa* (Fabricius)

Frequents deciduous trees with a marked preference for birch. Distributed throughout the British Isles. C. iv-x.

- 8 (1) Male anal plates ending in a chitinous petiolated process bearing small spines at its apex. ^{9, 9.5}

- 9 (10) Male anal plates with an elongate black process at apex shaped like the human forearm and hand with the thumb abducted, spines at the apex representing the digits (fig. 9, 1); fore wings greyish with poorly defined sagittate spots on the veins and dark areolae around the gradate veins. Exp. 14–16 mm.

rava (Withycombe)

Confined to Scots pine and reported only from pine woods in Kent, Surrey and Hampshire, more especially in the latter county. L. v-viii. May be found in numbers emerging during the first week of May at the foot of old pines.

- 10 (9) Male anal plates with a long barbed process at the apex shaped like a fish-hook (fig. 9, 3); fore wings dark grey with the whole surface covered with fuscous sagittate spots, and the long veins and borders of wings with short alternating blackish and white spaces. Exp. 16–18 mm.

subnebulosa (Stephens)

Frequents deciduous trees but more often is found by sweeping rank herbage such as beds of nettles. Distributed throughout the British Isles. C. iii-xi.

KEY TO SPECIES OF *Micromus* RAMBUR

- A single British species. *variegatus* (Fabricius)

Exp. 11–15 mm. The species is recognized by the narrow and elongate wing without a recurrent humeral veinlet at the base and only 3 branches to *Rs* (fig. 7, 7). In the hind wing the median and cubital veins are partly fused; more rarely, also in the fore wings; fore wings very transparent, with two rows of blackish spots centred over the inner and outer rows of gradate veins respectively.

Frequents long grass and rank herbage from which it may be swept at dusk. Widely distributed in Britain but not so far reported from Scotland. C. iv-xi.

KEY TO SPECIES OF *Nesomicromus* PERKINS

- 1 (2) Small species with wing expanse not exceeding 15 mm.; wings rounded at apices, tinted yellowish-brown and criss-crossed with fine darker lines, two of which follow the lines of the two series of gradate veins and a third runs parallel to them near the base of wing; some shorter streaks run from the posterior and outer borders of wing to meet the others at an acute angle near the wing apex; *Rs* with 4 branches (fig. 7, 9). *angulatus* (Stephens)

A very local species frequenting herbage and long grass below shrubs, especially young birch trees, into which they ascend and from which they may be swept just before and after dusk. Distributed widely throughout England, Ireland and south Scotland. V.L.R. v-ix.

- 2 (1) Larger species with wing expanse 15 mm. or over; wings more acute at apices and much paler coloured but with somewhat similar markings to *angulatus*, although broader and with an additional dark area at the ternal angle of the fore wings; *Rs* with 5 branches (fig. 7, 10). *paganus* (Linnaeus)

A more widely distributed and commoner insect than angulatus and easily recognized by its comparatively larger size and very characteristic markings. Found throughout the British Isles; frequents deciduous trees; appears to have a preference for elder bushes. C. but not often found in numbers. v-ix.

KEY TO SPECIES OF *Megalomus* RAMBUR

A single British species.....*hirtus* (Linnaeus)

Exp. 12-15 mm. A small but robustly built dark coloured species with broad, obtusely rounded apices to fore wings, costal area very broad especially towards base of wing; venation extraordinarily close and with 6 to 7 branches to *Rs* which all run closely parallel; the two gradate series of cross-veins forming strongly curved lines (fig. 10, 8).

Resting attitude highly characteristic, with head and antennae tucked under body. Almost exclusively attached to wood-sage growing on rocky exposed slopes; is easily obtained by sweeping in such situations. Scotland only, mainly on the eastern coasts. L.C. vi-ix.

KEY TO SPECIES OF *Drepanepteryx* LEACH

A single British species, which is the largest of the British Hemerobiids and is the only one with falcate wings (fig. 10, 2).....*phalaenoides* (Linnaeus)

Exp. 26-32 mm. General colour bright tawny with some dark fuscous markings. Wings markedly falcate, especially the fore wings, the outer border of which is very sinuous. Costal area very deep and strongly arched at its base; this area crowded with veinlets connected in the basal half of the wing by a series of horizontal veinlets; *Rs* with at least 10 branches running closely parallel; 3 complete series of gradate cross-veins.

Frequents deciduous trees of many kinds but mainly oak. Distributed sparingly in the north of England but more common in Scotland. (The Sussex record is open to doubt.) Frequents deep, well wooded valleys in Scotland and systematic beating of oaks on the slopes of such situations is the only way to secure this rare insect. L.R. v-x, September being the best month.

KEY TO SPECIES OF *Wesmaelius* KRUEGER

- 1 (2) Dark species with wings strongly reticulate with blackish markings, the veins speckled at even intervals with black arrow-head-shaped markings; the wing traversed by two well-defined oblique lines with two broken indistinct lines alternating. Figs. 9, 6 and 10, 5. Exp. 20-25 mm.

quadrifasciatus (Reuter)

Found only on coniferous trees, larch being the most frequented. The cocoon spun between pine needles and very conspicuous. Distinguished from other Hemerobiids by its large size and black, lace-like wings. C. v-viii.

- 2 (1) Pale species, wings of a dull pale ochreous with indistinct markings of somewhat similar pattern to *quadrifasciatus*. Fig. 9, 4 and 5. Exp. 20-25 mm.

concinus (Stephens)

Confined to coniferous trees with a strong preference for Scots pine. Distribution similar to the last but perhaps less often seen on account of its more cryptic colouring and the greater extent of pine as compared with larch. L.C. vi-viii.

Family CHRYSOPIDAE

KEY TO GENERA

Moderate sized insects of green or yellow colouring; venation of wings green or green and partly black; discoidal (median) cell (*Mc* of figs. 11 and 13) triangular; the vein running from the apex of this cell in a straight line to terminate on most posterior one of the *distal* gradate series of cross-veins (fig. 13, *d* to *f*).....*Chrysopa* Leach (p. 32)

Rather larger insects than the last, coloured reddish-brown; venation brown or ochreous; discoidal cell an elongate quadrangle; the vein running from its antero-external angle markedly zigzagged and terminating on the most posterior of the *proximal* gradate series of cross-veins (fig. 11, 9)

Nathanica Navas (p. 34)

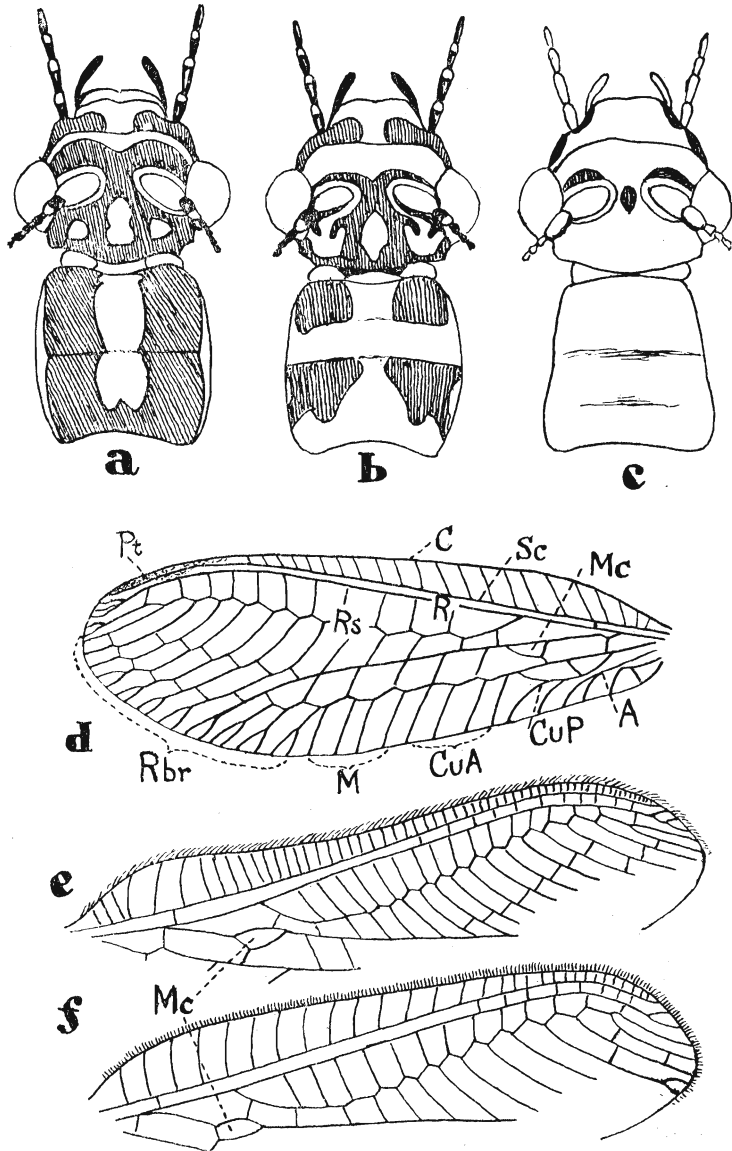


FIG. 13.—*Chrysopa* spp. Heads of: (a) *dorsalis* Burmeister; (b) *perla* (L.); (c) *septempunctata* Wesmael. Wings of: (d) *carnea* Stephens; (e) *flava* (Scopoli); (f) *ciliata* Wesmael. Notation: A, anal vein; C, costa; M, median vein and branches; Mc, Median or discoidal cell; R, radius; Rs, radial sector; Rbr, branches of radius; CuA, anterior cubitus; CuP, posterior cubitus; Pt, pterostigma; Sc, subcosta.

KEY TO SPECIES OF *Chrysopa* LEACH

- 1 (8) Bluish-green species marked more or less with black; pedicel of antennae marked with black.
- 2 (3) Subcosta of fore wings black as well as many cross-veins and junctions of longitudinal veins. Fig. 13, a. Exp. 25-34 mm. **dorsalis** (Burmeister)
Confined exclusively to coniferous woods. Ova laid singly; larva naked. South and east counties of England. L. vi-viii.
- 3 (2) Subcosta of fore wings green.
- 4 (5) Head, thorax and abdomen strongly marked with black; many cross-veins black. Wings short and broad with apices rounded (figs. 11, 8 and 13, b). Exp. 22-32 mm. **perla** (Linnaeus)
Frequents the undergrowth and saplings in deciduous woods, often in small colonies. Ova laid in groups but not on a common stalk; larva naked. Throughout Wales and England only. C. v-viii.
- 5 (4) Head, thorax and abdomen with restricted black markings.
- 6 (7) Claws simple; dark green species with short, broad wings with obtuse apices. Exp. 22-25 mm. **abbreviata** Curtis
Confined to sand-dunes along the coasts of England on marram grass. Ova laid singly; larva naked. L.R. vi-vii.
- 7 (6) Claws dilated at base; intense green species with wings shaped similarly to last species. Exp. 25-30 mm. **phyllochroma** Wesmael
Frequents lush vegetation usually in open situations. Ova laid singly; larva naked. England only. N.C. vi-viii.
- 8 (1) Pale green, yellow or carneous coloured species: pedicel of antennae coloured similarly to the scape.
- 9 (10) Costal space of fore wing narrowing abruptly shortly after base of wing (fig. 13, e); large species. Exp. 30-50 mm. **flava** (Scopoli)
Deciduous woods, especially oak. Ova laid in numbers on a common stalk (fig. 14, k); larva naked. Throughout the British Isles. C. v-viii.
- 10 (9) Costal space of fore wing narrowing gradually apicalwards (fig. 13, d and f).
- 11 (12) Apex of the median (discoidal) cell not extending as far as the first cross-vein connecting *Rs* with *M* (fig. 13, d, *Mc*); pale green or carneous species. Exp. 25-30 mm. **carnea** Stephens
Occurs in multiple situations, deciduous woods or even entering houses to hibernate. Changes from pale green to carneous during hibernation. Ova laid singly; larva naked. Throughout the British Isles. V.C. i-xii.
- 12 (11) Apex of median (discoidal) cell extending beyond the first cross-vein connecting *Rs* with *M* (fig. 13, e and f).
- 13 (16) A conspicuous black spot between the bases of antennae.
- 14 (15) A black point at base of costa of fore wing; palpi ringed with black; bright green species, abdomen black beneath (var. *prasina* has the venter wholly green beneath). Exp. 25-35 mm. **ventralis** Curtis
Found in coniferous and deciduous woods alike, also in coppices of sallow and hazel, often in great numbers. Ova laid singly; larvae concealing themselves under a coat of debris. Found throughout the British Isles. V.C. v-ix.
- 15 (14) No black point at base of costa of fore wing; seven black points on face (fig. 13, c); a large, very green species. Exp. 30-40 mm. **septempunctata** Wesmael
Frequents gardens and deciduous woods, often in undergrowth. Ova laid in groups but not on a common stalk (fig. 14, i); larva naked. C. v-viii. England only, especially in the south.
- 16 (13) No black spot between the bases of antennae.
- 17 (18) Scape of antennae elongate, twice as long as broad; head unmarked. Exp. 35-45 mm. **vittata** Wesmael
Found in deciduous woods, especially of oak and hazel. Larva naked. Widely distributed throughout the British Isles; C., in the south; M.C., elsewhere. v-viii.
- 18 (17) Scape of antennae short, only about as long as broad.
- 19 (20) Setiferous hairs lining costal border of wings erect, perpendicular to costa (fig. 13, f); subgenital plate much prolonged; very pale species. Exp. 20-30 mm. **ciliata** Wesmael
Found in the same habitats as the last and with a similar distribution; ova laid singly in small groups; larva coats itself with debris. C. iv-x.

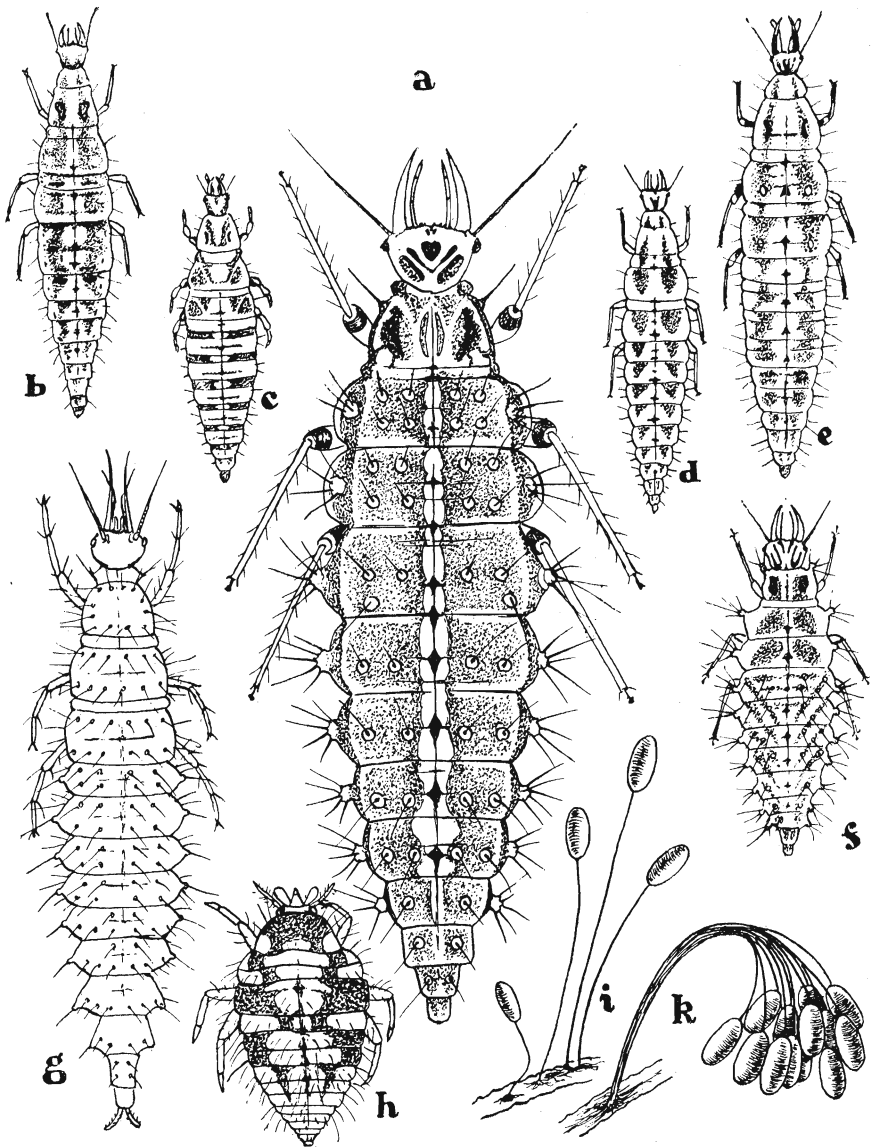


FIG. 14.—Larvae of: (a) *Nathanica capitata* (Fab.); (b) *Kimminsia nervosa* (Fab.); (c) *Sympherobius pygmaeus* (Rambur); (d) *Hemerobius humulinus* L.; (e) *Wesmalius quadrifasciatus* (Reuter); (f) *Chrysopa albolineata* Killington; (g) *Osmylus fulvicephalus* (Scopoli); (h) *Semidalis aleyrodiformis* (Stephens). (i) ova of *Chrysopa septempunctata* Wesmael; (k) the same of *C. flava* (Scopoli).

- 20 (19) Setiferous hairs lining costal border of wings sloping strongly towards apex of wing; subgenital plate not prolonged.
- 21 (22) Fore wing with a black point at base of costa (as in *ventralis*); sides of face marked with ferruginous or fuscous; first costal cross-vein black in part or whole. Exp. 24-32 mm. **flavifrons** Brauer
Chiefly in coniferous woods or on deciduous trees near them; ova laid on a common stalk, often in bunches; larva conceals itself beneath debris attached to its hairs. Widely distributed throughout the British Isles save Scotland. N.C. v-ix.
- 22 (21) Fore wing without a black point at base of costa; face without lateral ferruginous or fuscous markings; first costal cross-vein not marked with black; very pale species. Exp. 20-30 mm. **albolineata** Killington
Frequents deciduous trees with preference for saplings and associated undergrowth; ova laid singly on edge of leaf; larva coats itself with debris. Widely distributed throughout the British Isles. N.C. v-ix.

KEY TO SPECIES OF *Nathanica* NAVAS

- 1 (2) Large species; head a bright orange; a pale yellow longitudinal stripe running on mid-dorsum of prothorax and thorax; claws of tarsus expanded at base. Exp. 40-48 mm. (Discoidal cell of fore wing quadrilateral; 2 series of gradate veinlets forming lines concave to one another; median vein ending distally on the most posterior gradate veinlet of the inner series; cubitus ending on that of outer series; venation, apart from costa and bases of subcosta and other main veins, which are greenish, dark reddish-brown (fig. 11, 9).) **fulviceps** (Stephens)
Confined to oaks, keeping to the upper branches and so rarely seen. A mass emergence takes place when numbers may be found under oaks clinging to grass stems. R. England only. vi-viii.
- 2 (1) Smaller species with wing expanse under 40 mm.; head bright ferruginous; no pale stripe on prothorax and thorax; claws of tarsus simple, no basal expansion. Exp. 30-36 mm. (Wings broader and shorter than in *fulviceps*, otherwise venation and colour similar.) **capitata** (Fabricius)
A mass emergence takes place under conifers as in the case of fulviceps. Shows a preference for coniferous trees, especially Scots pine, but may be found anywhere resting on palings or trunks of trees or even adventitiously when beating for other species of Neuroptera. More widely distributed, in Scotland as well as England. Not so far reported from Ireland. N.C. v-viii.

GLOSSARY OF TERMS AND ABBREVIATIONS EMPLOYED IN THE TEXT

- Abd.*: abdomen.
- Acuminate*: coming to a needle-like point.
- Anal*: end of abdomen.
- Anal field*: posterobasal area of the wings included by the anal veins.
- Anal plate*: two laterodorsal plates into which the tergite of the tenth abdominal segment is divided (figs. 8, 9).
- Anal vein*: the most posterior of the longitudinal veins of the wings.
- Antennae*: slender pair of sensory organs borne on the dorsum of the head between the eyes, made up of a scape, pedicel and numerous segments forming a thread-like flagellum.
- Aphides*: small homopterous insects belonging to the family Aphidae and commonly known as "Green-fly".
- Apical*: the part of a segment of any organ furthest removed from the thorax.
- Bilobate*: divided into two lobes by a notch.
- C.*: the costa or anterior border of wing. "Common" when used as an abbreviation for the occurrence of species.
- Cerci*: filamentous and usually segmented appendages of the tenth abdominal segment.
- Clypeus*: the sclerite on the front of the head between the frons above and the labrum below, the latter attached to it.
- Cordate*: heart-shaped.
- Costa*: anterior border of wing (fig. 3, C).
- Costal space*: space between the costa and subcostal veins.
- Coxae*: basal segments of the leg.

Crepuscular : becoming active at dusk.

Cubitus : cubital vein or veins situated between the median and anal veins (fig. 3, *CuA*).

Discoidal cells : conspicuous enclosed spaces in the median area of the wings. Cells in the discal area of wings.

Dorsum : the upper surface or back of any organ.

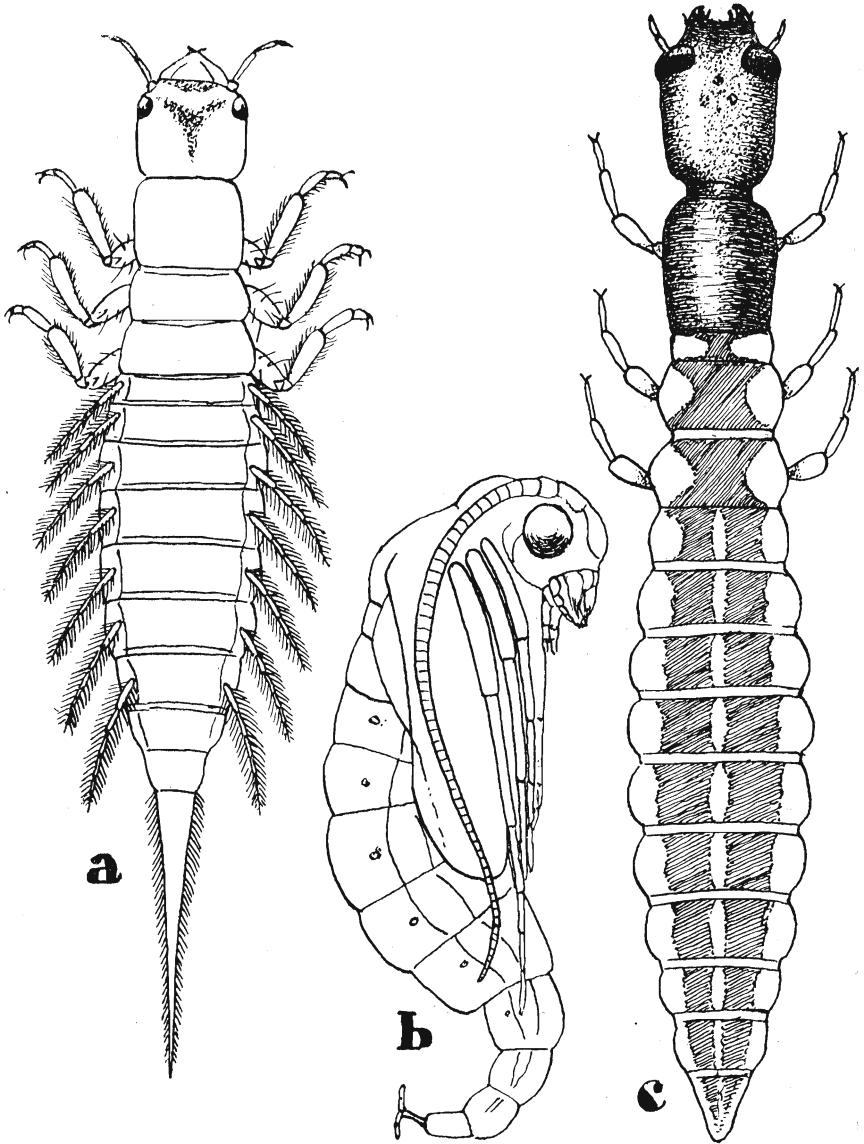


FIG. 15. (a) Larva of *Sialis lutaria* L. ; (b) pupa of *Panorpa germanica* L. ; (c) larva of *Raphidia maculicollis* Stephens.

- Endopterygota* : insects in which the wings develop in the larval and prepupal stages.
Epistome : see *clypeus*.
Eruciform : shaped like a caterpillar ; grub-like.
Exp. : expanse.
Exserted : thrust out when ready for employment.
Falcate : curved like a sickle. Curved shape of apex of wings (fig. 10, 2).
Femur : the thigh or third segment of the leg.
Filiform : thread-like.
Flagellum : see *antennae*.
Fuscous : dingy brown.
F.w. : fore wing.
Gonocoxite : basal segment of a gonapophysis.
Gonapophyses : appendages enclosing the genital opening.
Gradate : step-like arrangement of cross-veins (fig. 3, *Gr*).
Holometabola : insects in which there is a true pupal or resting stage.
H.w. : hind wing.
Hypandrium : a plate covering in the male genitalia below (fig. 6).
Hypognathous : having mouth-parts situated below the head.
Infuscated : clouded with brown.
Instar : a stage of larval life between two ecdyses or changes of skin.
Johnston's organ : a minute organ situated on the second segment of the antennae and believed to be auditorial in function.
L. : local.
Labium : lower lip.
Labrum : upper lip.
L.C. : locally common.
Ligula : portion of labium immediately anterior to the mentum or chin (= a little tongue).
Macropterous : having two pairs of fully developed wings.
Macrotrichia : long hair-like bristles on the veins and borders of wings.
Malpighian tubes : organs of excretion in insects. In the Neuroptera six are modified to form silk-secreting glands.
Mandible : upper jaws.
Maxilla : lower jaws.
Median vein : a main vein of the wings running posterior to the radius and its branches (fig. 3, *M*).
Medius : see *Median vein*.
Mesothorax : the second segment of the thorax, which carries the second pair of legs and fore wings.
Metathorax : the third segment of the thorax, carrying the hind legs and wings.
Micropterous : having only one pair (the fore wings) of fully developed wings (fig. 7, 6).
Micropyle : a small cap on one pole of the egg through which the spermatozoa enter and from which the young larva usually escapes.
Microtrichia : short fine hairs found on the wing membrane.
Moniliform : like a string of beads.
N.U.C. : not uncommon.
Ocelli : three single faceted accessory eyes arranged in a triangle on the vertex of the head.
Ovate : oval.
Palps : sensitive segmented organs attached to the maxillae employed as feelers when feeding.
Pectinate : comb-like ; with numerous parallel branches.
Pedicel : the second segment of the antennae.
Prepupa : a stage between the last instar of the larva and the pupa, usually of short duration.
Prothorax : the first and smallest segment of the thorax, giving attachment to the first pair of legs, and forming a long neck in the case of the Snake-flies.
Pterostigma : an opaque chitinous cell on the costal border near the apex of the wings.
R. : rare.
Radial sector : main branch of the radius (fig. 3, *Rs*).
Radius : the longitudinal vein (*Ri*) running from base of wing to its apex immediately posterior to the subcostal vein (fig. 3, *Ri*).
Recurrent humeral vein : basal costal veinlet of the Hemerobiidae, which curves back towards the base of the wing (fig. 3, *Rhv*).

- Reniform* : kidney-shaped.
Rostrum : a beak.
Rs : see *Radial sector* (fig. 3, *Rs*).
Saltatorial : having the power of jumping.
Sc. : subcosta, which see.
Scope : basal segment of antennae.
Sclerites : a separate chitinized portion of the skin or exoskeleton.
Scutellum : a small division of the dorsum of the mesothorax lying posterior to the scutum.
Scutum : main division of the dorsum of the mesothorax.
Serrate : saw-like.
Setae : hair-like bristles.
Setiferous : bristly.
Setose : bristled or spined.
Spinaret : an organ for spinning silk and constructing the cocoon, situated at the anus of Neuropterous larvae.
Spiracle : breathing organs, apertures of the tracheal system, situated on the sides of the thorax and first eight segments of the abdomen.
Sternite : separate chitinized plates of the exoskeleton situated on the ventral aspect of thorax and abdomen.
Subcosta : a main longitudinal vein running from base of wing to or near its apex immediately below the costa (fig. 3, *Sc*).
Subfalcate : partially sickle-shape.
Sulcus : grooves indicating the division between sclerites or former sutures ; the soft membrane between two segments.
Tarsus : end or distal segment of the leg, usually 3-segmented.
Tergites : separate chitinized plates of the exoskeleton situated on the dorsal aspect of thorax and abdomen.
Terminal twigging : the bifurcation of the main veins into two terminal branches or twigs at the wing borders, highly characteristic of the Neuroptera (figs. 10 and 11).
Testaceous : dull brick-red in colour.
Tibia : fourth segment of the leg ; the shin.
Trichobothria : a group of sensory organs, probably auditory in function, numbering from 6 to 50, clustered on an oval dome-like structure on the upper aspect of each anal plate (or lateral tergites of the tenth segment) (figs. 8 and 9, *trb.*).
Trichosors : minute wart-like tubercles mounting two or three bristles situated along the wing borders and alternating with the terminal branches of veins (fig. 3, *t*).
Truncate : squared, obtuse at end.
Ventral : under surface of abdomen.
Vestigial : remains of ; degenerate in character.

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(For further references, Killington's Monograph, cited above, should be consulted.)

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