I—Biology and Morphology of the Immature Stages of Mycetophilidae (*Diptera, Nematocera*)

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I—Introduction

The importance of larval characters in determining the affinities and systematic position of Diptera has been emphasized by Dufour, Brauer, Mik, Osten-Sacken, and Keilin. Osten-Sacken considered that the desideratum of dipterology was " to establish the natural character of each family in its larval form as well as the natural characters of at least the principal genera within each family during the same stage of existence ". As Edwards says, " The question as to whether the larval or adult characters are of greater value for classification has often been raised. In more than one case the larval characters have been shown to be more important (Culicidae, *Mycetobia*), and in some cases the classification of adults has been based on Secondary Characters, and only further examination revealed the characters of real taxonomic value ".

The position of *Mycetobia* provides a good example of the importance of larval characters. Winnertz and Johannsen included it in the Mycetophilidae. Keilin (1919, *a*), from a detailed larval study of *Mycetobia* and *Rhyphus*, concluded that they are closely related. Further investigations by Edwards based on adult characters confirmed Keilin's view that it should be transferred to the Rhyphidae.*

In our present state of knowledge, however, classification based on larval characters could not supersede classification by adults, as only a small proportion of the immature stages of insects is known in comparison to the number of adults. However, as Edwards points out, " Any attempt to base a classification on adults only without reference to the other stages is an unnatural proceeding and likely to

* It is interesting to note that in Packard's " Guide to the Study of Insects " and Sharp's " Insects ", Part II, the larva of *Mycetobia* is the only figure given to represent a Mycetophilid larva, though both these authorities admit its close resemblance to the larva of *Rhyphus*.

produce unnatural results, owing to the ease with which striking but really superficial characters can be confused with those of more fundamental importance from the point of view of phylogeny ".

In this paper forty-two species of larvae (two of which, *Ditomyia fasciata* and *Centrocnemis*, are excluded from the Mycetophilidae), belonging to six sub-families, are described. The plan adopted for each is to give a short account of its biology with description and figure of the whole larva, its mouth parts, and respiratory system.

A full account of the biology of the larva and pupa of *Brachypeza radiata*, together with a detailed description of both the external and internal anatomy, is first given. This is followed by a study of the external morphology of the remaining forty-one larvae in the order adopted by EDWARDS in his generic classification of the family. Finally, an appendix is added in which the internal parasites of some larvae are described, together with certain conclusions arrived at from the study of the larvae of Mycetophilidae.

II—HISTORICAL NOTES

The earliest description of a Mycetophilid larva we owe to REAUMUR (1740), a detailed and interesting account of the habits and transformations of *Ceroplatus reaumuri*. The larva is briefly described, but the mouth parts are neither described nor figured.

DE GEER (1776) described a Mycetophilid larva which he found in *Boletus luteus*. His excellent figure of the larva, showing the tracheal system and the well-developed antennae, leaves no room for doubt that he was dealing with a *Bolitophila*. Unfortunately, he failed to rear it, and a year later, finding a similar larva in the same fungus, naturally thought it was of the same species. This was probably not so, but the description is not adequate for the determination of the species. DE GEER's *Tipula fungorum* therefore, considered by BRAUER and OSTEN-SACKEN to belong to the *Mycetophilini*, cannot now be identified.

BOUCHÉ (1834) described and figured several Mycetophilid and Sciarine larvae. His account of the mouth parts of *Mycetophila signata* is of little value and the figures are incorrect.

DUFOUR (1839, *a*) divided the Mycetophilid larvae into *Antennatae* and *Non antennatae*, comprising the Bolitophilinae in his first division and the rest of the Mycetophilid larvae in the latter. This classification is incorrect since all the Mycetophilid larvae possess rudimentary antennae, with the exception of the sub-family Bolitophilinae, where the antennae are well developed. In another paper (1839, *b*) he described several Mycetophilid larvae belonging to the following genera—*Ceroplatus*, *Bolitophila*, *Sciara*, and *Sciophila* ; but though this paper is rich in biological and anatomical facts, his description of the mouth parts is incomplete.

In 1851, HEEGER described *Mycetophilia lunata*, *Sciara fuscipes*, and a *Bolitophila* which he mistook for *Limnobia platyptera*. The *Mycetophila* larva is figured as having nine pairs of spiracles on the first nine consecutive segments and the locomotory pads are shown on the dorsal instead of the ventral surface. The labrum, mandible, and maxilla of *Sciara* are drawn with care, but he overlooked the spiracles, and the labium is represented as occupying the whole area between the epicranial plates on the ventral surface of the head. In *Limnobia* (*Bolitophila*) the antennae and mouth parts are correctly described, except that he mistook the hypopharynx for the labium and figured a pair of mesothoracic spiracles. However, his descriptions and figures are an important contribution to the study of the larval mouth parts.

In 1861–3, OSTEN-SACKEN published his paper on " The Characters of the Larvae of Mycetophilidae ". This paper, besides summing up the work done previously, contains a comparative description of the external anatomy of the principal genera together with a brief account of what is known about the habits of each genus. The mouth parts are accurately described and figured (with the exception of the hypopharynx which he overlooked, and the labium to which he referred as " but little developed and I have not succeeded in elucidating its structure completely "). This paper was the most important publication on the Mycetophilid larvae at that period.

LABOULBÈNE (1863) and notably PERRIS (1870) described several Mycetophilid larvae. The former gave an account of *Sciara bigotti* but overlooked the antennae and eyes, and to the latter we owe several interesting biological and morphological accounts on *Sciarine*, *Sciophiline*, and a test-bearing larva, *Mycetophila scatophora*.

In his work on Dipterous larvae, BRAUER (1883) gave a summary of the most important references on Mycetophilidae up to 1883, together with a short account of the general characters of the larva. BELING (1886) described briefly twenty-four species of *Sciarine* larvae, but his account contains no figures and is therefore difficult to follow.

Concerning the internal anatomy of the Mycetophilid larvae, BERLESE (1889) described the internal changes occurring in the fatty tissues of *Mycetophila signata* during metamorphosis. HOLMGREN'S (1907) monograph on a test-bearing larva, *Mycetophila ancyliformans*, contains a detailed study of the internal anatomy of the larva and is profusely illustrated. The external anatomy is briefly dealt with, but according to EDWARDS the larva should be referred to the genus *Delopsis*.

SCHMITZ (1912) gave a detailed account of the biology and external morphology of *Polylepta leptogaster*. This paper raises several interesting points which will be discussed later.

MALLOCH (1917), in his " Preliminary classification of Diptera based upon larval and pupal characters ", described briefly several Mycetophilid larvae. The hypopharynx is not described and the figure given is inaccurate.

KEILIN (1919, *a*) was the first to suggest the separation of *Ditomyia* and *Symmerus* from the Mycetophilidae as a result of a detailed study of their larval and pupal characters.

An excellent account of the biology and morphology of two species of *Phronia* is given by STEENBERG (1924). The mouth parts of the larvae are described in detail and the figures are drawn with great care.

From a comparative study of the Mycetophilid larvae, SCHULZE (1924), apparently ignorant of KEILIN's work, came to a similar conclusion with regard to *Ditomyia*. The respiratory systems of *Ditomyia* and other Mycetophilid larvae are compared but the mouth parts are not described.

A comparative study of the head in several nematocerous larvae was made by BISCHOFF (1922). In a figure representing the ventral surface of a *Mycetophila* he mistook the chitinous ring supporting the pharynx for the hypopharynx.

The most important contributions to the study of the adults of Mycetophilidae together with a generic classification of the family are those of WINNERTZ (1863), DZIEDZICKI (1884–1910), LUNDSTRÖM (1906), JOHANNSEN (1909–12), LANDROCK (1911), and EDWARDS (1924).* In WINNERTZ's monograph on the Mycetophilidae, the larvae are inadequately described and no figures of them are given. EDWARDS's paper contains several biological observations on the larvae and pupae of Mycetophilidae. In his opinion. the family is subdivided into ten sub-families : Ditomyiinae, Bolitophilinae, Diadocidinae, Macrocerinae, Ceroplatinae, Lygistorhininae, Sciarinae, Manotinae, Sciophilinae, and Mycetophilinae.

III—*Brachypeza radiata* JENKINSON (Figs. 1–46)

Historical—Jenkinson (1901) was the first to record the adults of *Brachypeza radiata*, which he caught in his garden at Cambridge. EDWARDS (1924, *a*) reared the fly from larvae he found in a *Pleurotus* fungus. According to him, " the fly has not yet been found in the North of England or in Scotland, the most northerly record being King's Lynn ".

As no investigations on the immature stages of *B. radiata* have hitherto been recorded, and as they are easy to collect and rear, it was thought convenient to give a detailed study of the larva, taking it as representative of the family Mycetophilidae.

a. Biology of Larva and Pupa

The adults may be caught all the year round whenever fungi are available. The larvae are found in the fungus *Pleurotus*, which was obtained at the base of old standing elms at Kings Hedges near Cambridge and Grantchester in August, September, and November, 1929. I have not found them in any other situation than in this particular fungus.

Both sides of the fungus were covered with patches of eggs, while the interior was riddled by larvae in various stages of development. The fungus was placed in bell-jars, with a layer of moist sand at the bottom. In 22–27 days the adults emerged and were identified by Mr. F. W. EDWARDS.

Swarms of *B. radiata* were observed dancing round the fungus especially towards the evening. Copulation takes place in the air, the female later depositing its eggs

* For references to these papers the reader is referred to the paper by EDWARDS (1924/1925), 'Trans. Entom. Soc.,' London, p. 652.

in patches of 20–30 on the stem, the upper, and especially the lower surface of the fungus. Under laboratory conditions hatching took place in 48 hours. On leaving the egg, the larva penetrated within the fungus where it moulted ; prior to pupation the larvae left the fungus and showed positive tropism towards light. Finally the larvae penetrated just below the surface of the soil, spun barrel-shaped cocoons, and pupated.

The egg is oval, 0·5 mm. long and 0·2 mm. broad, white, opalescent owing to the chorion being raised into longitudinal rows of tubercles. Each tubercle, when examined in profile under high magnification (oc. II. obj. 5), is seen to consist of a short stalk carrying a round convex cap, thus resembling a small agaric fungus. The eggs of *B. radiata* are similar to those of *Mycetophila cingulum* (fig. 330, p. 88). The embryo lies straight in the egg and is shorter than it, so that one pole of the egg is more translucent than the other. Eclosion from the egg is effected by means of a curved chitinous tooth-like structure, situated in the middle of the frontal plate which may be seen beating against the chorion.

There are four larval stages, each lasting four to five days. The freshly-hatched larva has a small chitinized head and a body, free from hairs, composed of 12 apparent body segments. The head capsule and trophi of the first stage larva do not differ materially in structure from those of the fully grown larva which is described later. The respiratory system, on the other hand, is strikingly different in each instar and may be used in determining the stage to which the larva belongs.

The First Stage Larva is metapneustic, carrying a pair of small uniforous spiracles on the eighth abdominal segment. This is the only functional pair of spiracles present at this stage. From the main lateral trunks, however, short lateral branches pass outward in all the body segments except the second and twelfth but do not open to the surface.

The Second Stage Larva is propneustic, the larva being provided with a pair of minute prothoracic spiracles. The pair of abdominal spiracles of the first instar larva becomes non-functional and remains closed during the subsequent stages.

The Third Stage Larva is also propneustic, but the prothoracic spiracles are well developed, being provided with three oval spiracular openings and an external scar situated posterior to these openings.

The Fourth Stage Larva is peripneustic, bearing eight pairs of spiracles on the prothoracic and first seven abdominal segments. Prior to pupation, the fully grown larva penetrates just below the surface of the soil and spins a barrel-shaped papery cocoon, which is provided with a small circular opening at one end.

The pupa lies with the head towards the opening. It is 5 mm. long and 2·5 mm. broad across the thorax. The last larval skin is found attached to the last abdominal segment. The head is flat and pressed on the prothorax ; the antennae curve over the upper margin of the eye forming a semicircle. The larval eyes persist as deep pigmented spots lateral to the imaginal eyes. The legs are applied to thorax and venter ; the first pair extend backwards to the last abdominal segment, the second to the sixth, and third to the fourth abdominal segment. The wings extend to the anterior part of the fourth abdominal segment. The pupa is provided with eight pairs of small round sessile spiracles, one prothoracic and seven abdominal. After hatching from the pupa, the imago often remains quiescent for a day or two, but if the cocoon is touched the fly rushes out quickly and takes to wing.

b. External Morphology of Larva

The fully grown larva (fig. 1) is 12–14 mm. long and nearly cylindrical. It is creamy white in colour and has a small free chitinized head and a body composed of 12 apparent segments.

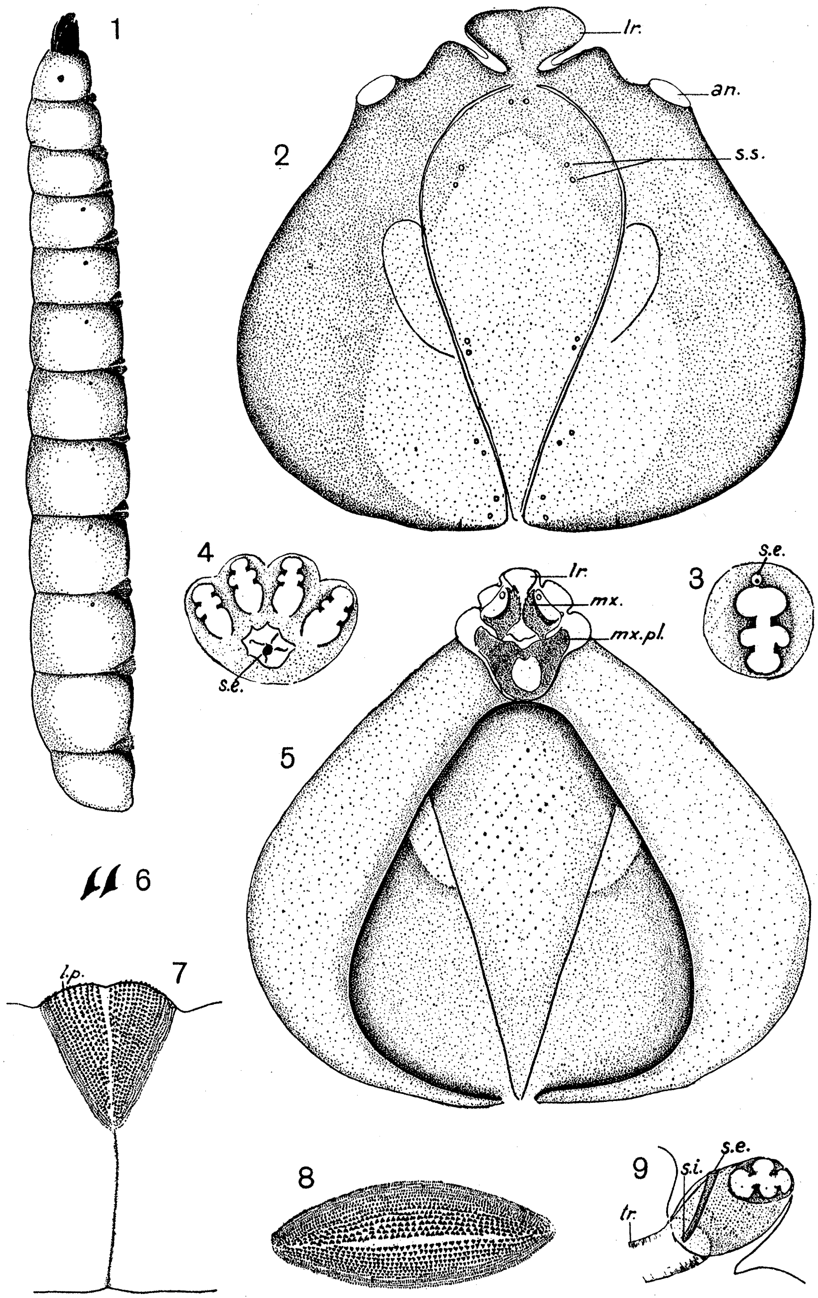
The head (fig. 2) is conical with a truncated apex. It is invested with a shining black chitinized capsule, and is completely free though it can be retracted into the first body segment up to the level of the antennae. The dorsal surface of the head (fig. 2) is protected by three plates ; one median and two lateral. The median plate (frontal or clypeal) tapers posteriorly to a point and is furnished with five pairs of small circular sensory pits (*s.s.*). The lateral plates (epicranial) curve round towards the ventral surface of the head and are joined at the mid ventral line (fig. 5), so that the cranium is of the closed type (VERHOEFF, post cranium clausum). Anteriorly each lateral plate carried a reduced antenna and a small pigmented eye.

The antenna (*an.*, fig. 12) is reduced to a convex transparent membrane similar to a watch-glass in shape and is supported by a strongly chitinized base and an annular chitinous band, outside which are found four minute papillae. In an oblique section each antenna (fig. 45) consists of a transparent chitinous membrane overlying a layer of elongated sensory epithelium, the proximal ends of which are connected to the antennal nerve.

The eye (*E.*, fig. 12) lies postero-lateral to the antenna and consists of a round transparent membrane overlying a layer of pigmented cells.

Viewed from the ventral surface, the head (fig. 5) is occupied by the large nearly-triangular occipital foramen, and a lozenge-shaped area consisting of the labrum (*lr.*), two maxillae (*mx.*), and two maxillary plates (*mx.pl.*). Anteriorly each lateral plate bears two tongue-shaped chitinous processes which articulate with the superior and inferior condyles of the mandible (fig. 12 ; *s.c.*, *i.c.*, fig. 14). These two processes enclose a semicircular transparent area through which the muscles operating the mandibles can be seen.

The labrum is a broad fleshy protuberance extending forward and downward to recurve within the mouth. It is supported along the posterior border by a semicircular chitinous frame, which is interrupted in the middle, and is provided with seven pairs of circular sensory papillae. On the ventral surface the labrum (fig. 10) is provided with rows of spinules and several chitinous hooks (*ep.p.*) and is supported by two lateral chitinous arms (*p.l.*) which articulate at right angles with the ends of the frame. Each arm carries a fan-shaped organ composed of 16–18 slightly chitinized hooks. In the living larva these arms move forward and backward and help in passing the food through the mouth. BISCHOFF (1922) and STEENBERG (1924) refer to these arms in the Mycetophilid larvae they examined as premandibles.



Brachypeza radiata Jenkinson

Fig. 1—Whole larva. × 8.
Fig. 2—Dorsal view of the head. × 120.
Fig. 3—Abdominal spiracle, dorsal view. × 320.
Fig. 4—Prothoracic spiracle, dorsal view. × 320.
Fig. 5—Ventral view of the head. × 120.
Fig. 6—Chitinous hooks of locomotory pad. × 320.
Fig. 7—Locomotory pad, side view. × 33.
Fig. 8—Locomotory pad. × 33.
Fig. 9—Abdominal spiracle. × 320.

The term premandible, however, presumes a homology which is extremely doubtful and should be abandoned.

GOETGHEBUER (1912) was the first to use the term premandible for two movable processes which arise from the ventral surface of the labrum in chironomid larvae. He considers these processes as belonging to the labrum, which according to him is enervated by the tritocerebrum. Moreover, he considers them as primary appendages of a cephalic segment.

The objections to the use of the term premandible are as follows :—

1. The term has already been used for the vestigial appendages of the tritocerebral segment in *Campodea* by UZEL. These appendages, however, are not homologous with the labral processes in *Chironomus*.

2. In sections these appendages in Mycetophilid larvae are solid and not hollow as in *Chironomus*.

3. The labrum in Dipterous larvae is enervated by the protocerebrum and not the tritocerebrum as GOETGHEBUER stated.

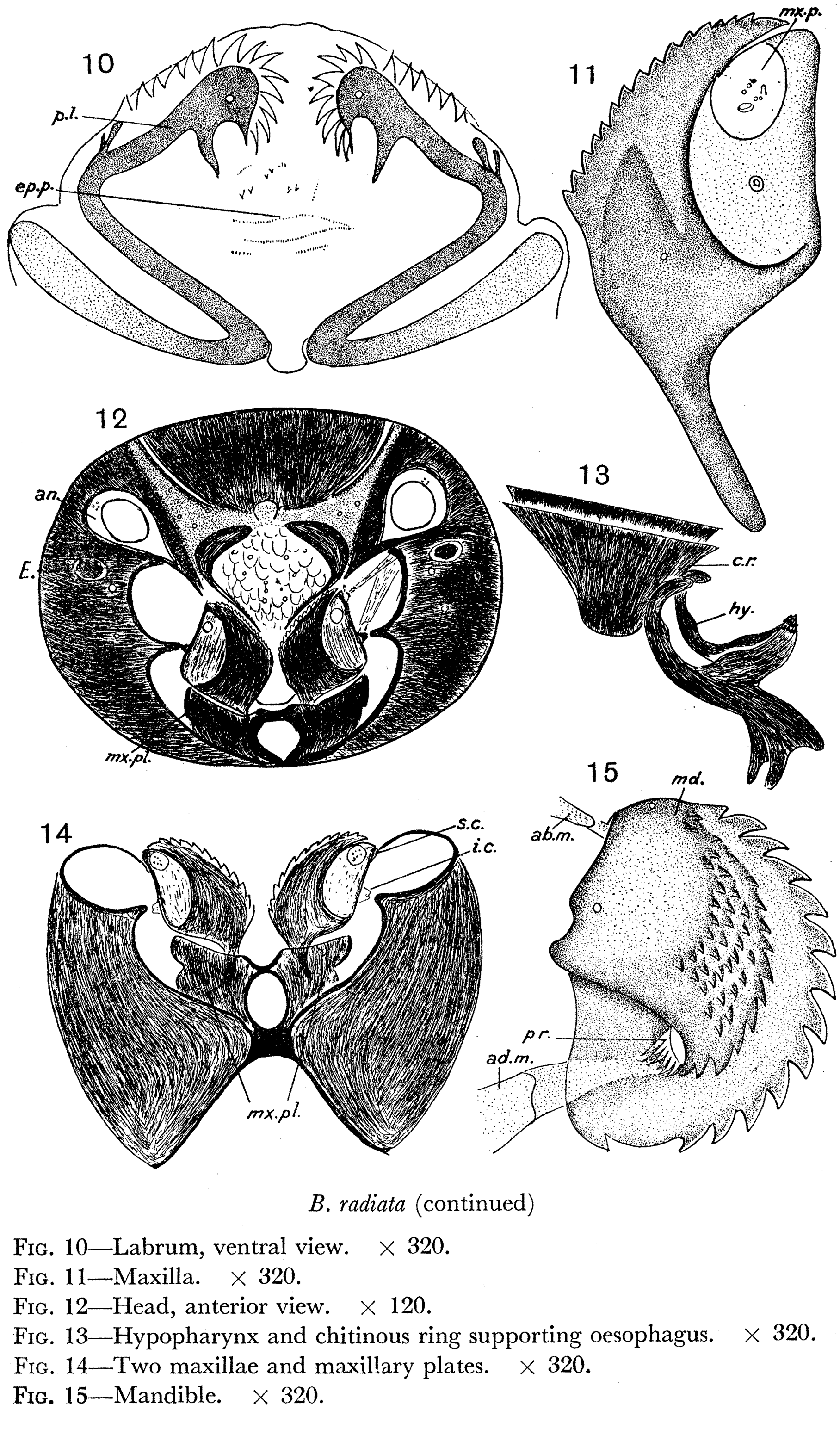
4. GOETGHEBUER's conclusion is based on morphological and not on embryological evidence.

SAUNDERS and PURI previously came to the conclusion with regard to the labral appendages of *Forcipomyia* (SAUNDERS, 1924) and *Simulium* (PURI, 1925) that they are secondary structures, and there is little doubt that in Mycetophilid larvae these lateral arms should be considered as localized thickening of labral chitin.

The cells lining the labrum when viewed in longitudinal section (fig. 37) are elongated, and are probably hypodermal cells, with several sensory cells leading to the dorsal papillae. HOLMGREN (1907), however, describes similar cells in *Mycetophila ancyliformans* as labral glands.

The mandible (fig. 15) is semicircular and consists of a convex dorsal and a larger flat ventral lamella, which are united along their inner borders. The mandible carries 14 strongly chitinized teeth, the last tooth being less chitinized than and opposed to the rest. The dorsal lamella is provided with a series of smaller denticles arranged in nearly parallel lines, and a small prostheca (*pr.*) at the inner basal angle. The prostheca in Mycetophilid larvae is a membranous structure with no articulation or muscle-attachment of any kind. HOLMGREN (1907), SCHMITZ (1912), and STEENBERG (1924) refer to the prostheca as " lacinia " in the mandibles of the larva they have described. Again such a nomenclature presumes a homology which is unproved and should be avoided.

The muscles operating the mandible are well developed and consist of an abductor and adductor muscle. The first takes its origin from the posterior and lateral side of the epicranial plate and consists of three bundles which converge towards the upper slender tendon which is inserted at the upper angle of the mandible. The adductor muscle arises from the dorsal and part of the ventral surface of the epicranial plate. The dorsal and ventral bundles converge towards the adductor tendon which is inserted at the inner basal angle, ventral to the prostheca (*ad.m.*, fig. 15).



B. radiata (continued)

FIG. 10—Labrum, ventral view. × 320.
FIG. 11—Maxilla. × 320.
FIG. 12—Head, anterior view. × 120.
FIG. 13—Hypopharynx and chitinous ring supporting oesophagus. × 320.
FIG. 14—Two maxillae and maxillary plates. × 320.
FIG. 15—Mandible. × 320.

The maxillae (fig. 11) lie ventral and parallel to the mandibles. Each maxilla consists of an inner and an outer lobe. The first (maxilla proper) is cultriform, carries 16 teeth along the inner border, and ends in a strongly chitinized rod-shaped process which lies dorsal to the maxillary plate (*mx.pl.*, fig. 14). The outer lobe (maxillary palp) is nearly semicircular and is provided anteriorly with an oval area (*mx.p.*) which is covered by transparent chitin, and bears seven small sensory papillae. Posterior to this area another circular papilla is present.

The maxillae are supported along their posterior borders by two quadrilateral plates—the maxillary plates—which are strongly chitinized and meet at the anterior and posterior angles, enclosing an oval area which is covered by transparent chitin. The term maxillary plates was first used by Holmgren (1907) and is retained here as a useful descriptive term.

The adductor muscle of the maxilla arises from the inferior surface of the cephalic capsule near the junction of the epicranial plates. It consists of several bundles which converge anteriorly, to be inserted to the rod-shaped process of the maxilla. The abductor muscle takes its origin from the lateral sides of the epicranial plate. It consists of several bundles which converge to a long, slender tendon, which is inserted to the lateral side of the maxilla.

The hypopharynx (*hy.*, fig. 13) consists of two irregular plates of chitin lying dorsal to the maxillae and at a nearly vertical plane to the ventral surface of the head. The two plates are joined at the mid-ventral line, forming a semicircle which supports the ventral surface of the mouth. Each plate is provided with a horizontal and a vertical process. The two horizontal processes are recurved like chamois-horns, and proceed backwards along the sides of the pharynx where they end by passing medially to a U-shaped chitinous plate (*c.r.*, fig. 13), which supports the pharynx. The vertical processes are boot-shaped, diverging proximally to enclose a triangular area which is covered by transparent chitin. The salivary duct opens at the base of this area between the proximal ends of the vertical processes.

The labium is reduced to a small, slightly chitinized plate situated between the proximal ends of the vertical processes of the hypopharynx. It supports the opening of the salivary duct along its ventral surface, and is provided with four minute papillae along its anterior border. The membranous area situated between the maxillary plates partly overlaps the labium along the ventral surface and probably corresponds to the submentum. The body consists of 12 apparent segments, the last of which carries a pair of membranous lobes on either side of the anus. On the ventral surface the body is furnished with 11 intersegmental lozenge-shaped projections (locomotory pads or pseudopodia). The first and last of these pads are less developed than the rest. Each pad (figs. 7, 8) is covered with 22–24 rows of chitinous hooks along the middle, and six to eight rows of spinules along the periphery. Each hook (fig. 6) consists of a broad base which is embedded in the cuticle and a free sharp end which in the anterior rows points towards the head and in the posterior rows towards the anus.

The body of the larva is free from hairs, scales, or spines, except for six groups of sensory hairs which are placed in direct relationship to the imaginal discs of the legs. Each group consists of four minute hairs of equal length. According to KEILIN, these groups of sensory hairs are present in all dipterous larvae and represent the sensory vestiges of the thoracic legs.

The fully grown larva carries eight pairs of functional spiracles on the prothoracic and first seven abdominal segments.

The prothoracic spiracle (fig. 4) is larger than the rest and situated at a slightly more dorsal level than the abdominal spiracles. Each spiracle is in the form of a nipple-like chitinous process projecting from the side of the body. In surface view the spiracular plate is perforated by four oval spiracular openings, the borders of which are strongly chitinized and send chitinous projections towards the lumen. The spiracular openings are covered by thin transparent membranes. The external scar (*s.e.*) lies posterior to the spiracular opening and consists of an irregular mass of chitin in the centre, from which chitinous threads radiate outwardly.

The abdominal spiracle (figs. 3 and 9) has only one opening leading to a cylindrical felt chamber, the lumen of which is filled with a fine reticulum of chitinous intima. The external scar (*s.e.*) is situated anterior to the spiracular opening. The position of the external scar, internal scar (*s.i.*), and spiracular cord is shown in fig. 9. In all Mycetophilid larvae the external scar in prothoracic spiracles is posterior to the spiracular opening, whereas in the abdominal spiracles the scar is anterior to the spiracular opening. Each spiracle is provided with a small spiracular gland consisting of several flask-shaped cells with intracellular ducts. I have not been able to trace the openings of these ducts.

c. Internal Anatomy of Larva

Integument—The integument of the larva consists of a chitinous cuticle and a layer of hypodermal cells resting on a basement membrane. The chitinous cuticle is flexible and colourless throughout, except in the head where it is thicker and dark brown in colour. In transverse section the cuticle is composed of an outer thin homogeneous layer—the epidermis—and an inner thicker laminated layer—the dermis. The staining reaction of these two layers is different. In Mann's Stain (Methyl-Blue-Eosin), the outer layer takes a reddish tinge (eosinophil); the inner is bluish (basophil). In sections stained with indigo-picro-carmine the outer layer of the cuticle is dark brown, the inner is mauve.

The hypodermis consists of a single layer of cells. In transverse section, the cells are nearly rectangular, the inner border is flat, the outer bulges slightly outwards. The cell partitions are not easily seen. The cytoplasm contains rounded black granules. The nucleus is ovoid and lies near the inner border of the cell ; the nuclear membrane is well defined and encloses several chromatic granules.

VIALLANES (1882) described a third layer of flattened cells adherent to the hypodermis in *Musca* and *Eristalis*, the sub-hypodermal cells. IMMS (1907) described a layer of sub-hypodermal cells in *Anopheles*. I have not been able to identify these cells in sections of *Brachypeza radiata*.

Muscular Attachment—It is undecided whether muscles are attached to the cuticle directly or indirectly through the hypodermic cell. In the direct mode of attachment it is difficult to explain what will happen to the muscular attachment during ecdysis, unless it is presumed that the muscle cells will secrete new fibrils to secure another attachment to the new skin—an unlikely function for them. The indirect mode of attachment is supported by the work of HENNEGUY (1906), PÉREZ (1910), and KEILIN (1917, *a*) who have shown that the muscle is attached by means of tonofibrils which are secreted by the hypodermal cells.

In sections of the larva of *Brachypeza radiata*, stained by Mann's Methyl-Blue-Eosin or indigo-picrocarmine, the muscular attachment is clearly seen to consist of a cone of fibrils (tonofibrils) which run through the dermis and end at the inner surface of the epidermis. These fibrils are devoid of any striation and show the same staining reactions as the dermis.

Fat Body—In the fully grown larva the fat forms a loose mass of lobes, with branching strands which occupy most of the space in the body cavity between the alimentary canal and the body wall.

In a longitudinal section (fig. 20) the outer mass of fat forms a cylinder which extends from the anterior to the posterior end of the larva. In transverse section (fig. 31) this cylinder is found to be interrupted in the region of the heart and ventral ganglia.

The fat cell is polygonal (fig. 41); the nucleus is ovoid and contains a knotted thread of chromatin and two or three eosinophil granules. The zone surrounding the nucleus stains deeply with eosin. The cytoplasm is vacuolated and, in osmic preparations, is full of fat droplets which increase in size towards the periphery of the cell. In addition to fat, the cytoplasm contains some albuminoid granules, the test for which may be made by heating a drop of Millon's reagent with the fat cells of a mature larva ; the albuminoid granules develop a red colour.

Oenocytes—In the larva of *Brachypeza radiata*, the oenocytes consist of seven paired groups of cells, situated below the hypodermis in the first seven abdominal segments, postero-medial to the abdominal spiracles. Each group consists of eight to ten cells arranged in a triangle, the apex of which is directed towards the spiracle. The cells are fixed in their positions by a network of tracheoles and fine protoplasmic prolongations which connect them together. Each cell is pear shaped, and surrounded by a delicate membrane. The cytoplasm stains deeply with haematoxylin ; the nucleus is spherical, about half the transverse diameter of the cell, and shows a well-defined deeply-staining nucleolus and several chromatin granules.

According to WHEELER, " the oenocytes originate by delamination or immigration from the ectoderm just caudal to the tracheal involutions and after their differentiation from the primitive ectoderm never divide, but gradually increase in size ".

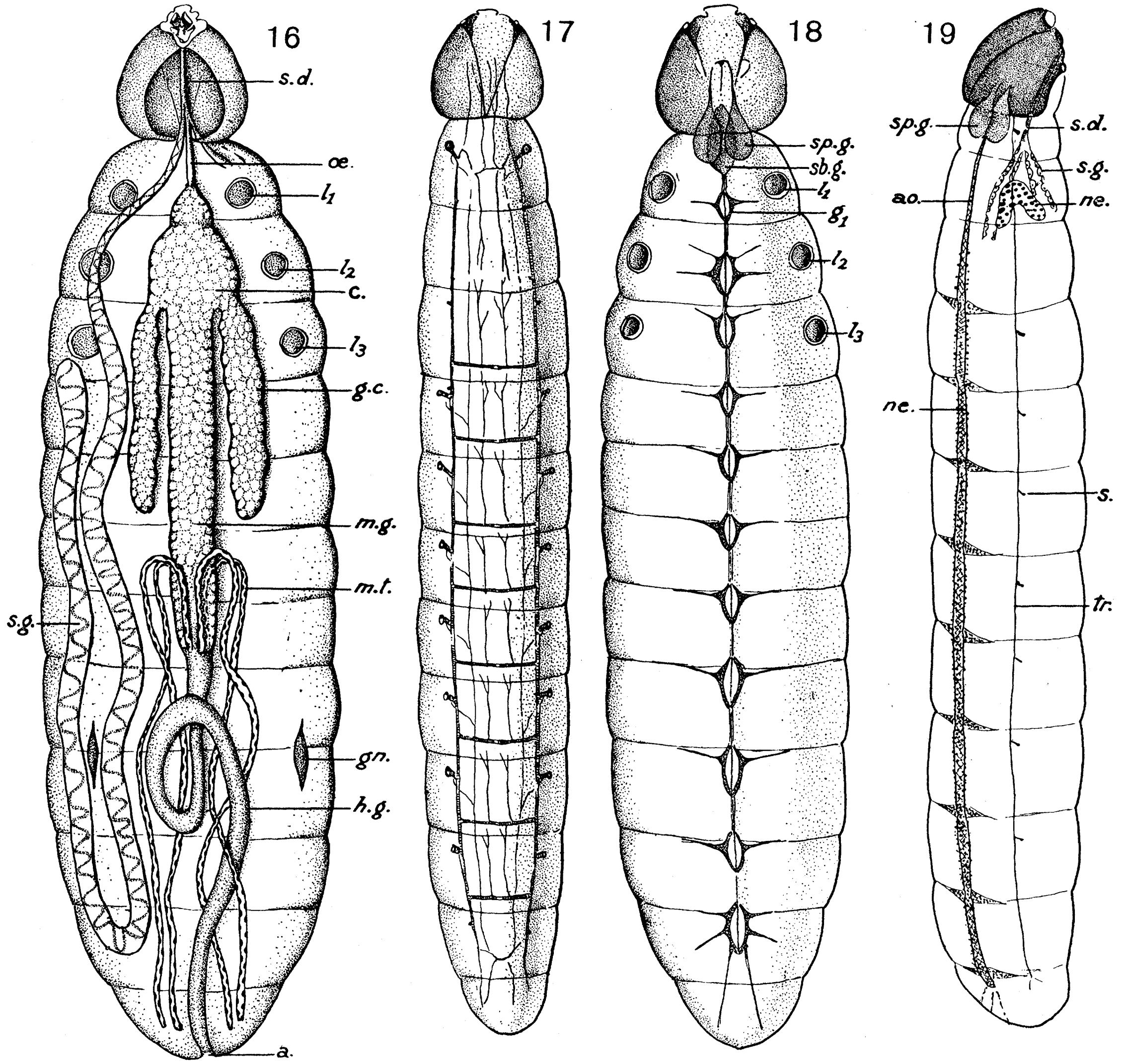
The function of oenocytes is not definitely known, though various suggestions have been made from a morphological study of the cells. Wielowiejski (1886) and Anglas (1901) regard them as secreting glands, but Pantel (1898) considers them as excretory in function. Glaser (1912) concludes from his biochemical investigations on the oenocytes of the Leopard Moth that they secrete oxidizing enzymes. So far no fat-splitting enzymes have been discovered.

Chordotonal Organs—On examining a living larva of *Brachypeza radiata* under high magnification, chordotonal organs were found on either side of the first eight abdominal segments. At the posterior end of the larva a dorsal and lateral chordotonal sensilla were also present. The eight abdominal pairs of chordotonal organs are similar to those described by Graber (1882) in the larvae of *Chironomus* and *Chaoborus*. The two terminal organs differ from the others in their position. They consist of a well-developed dorsal organ and a smaller lateral one. The dorsal chordotonal organ consists of a bundle of eight sensillae whose distal extremity is fixed to a thickened disk in the cuticula. A minute hair is situated in the vicinity of the disk. The bases of the sensillae are attached to the integument by a short fibrous ligament, while their proximal ends are connected by means of nerve fibres which join the eighth abdominal ganglion. The lateral chordotonal organ consists of two sensillae, the proximal ends of which are connected to the integument by a long fibrous ligament.

The function of such organs is not definitely known. Graber considered them as hearing organs. In Mycetophilid larvae it is more probable that such organs may coordinate the muscular movements. According to Imms, " they may be general vibration receptors which may either function in relation to muscular activity . . . or as receptors of vibration external to the insects ".

i *Digestive System*—The alimentary canal in *Brachypeza radiata* takes nearly a straight course and is slightly longer than the body of the larva on account of a single loop which is found in the hind-gut. The *fore-gut* begins at the mouth opening and ends at the junction of the oesophagus with the mid-gut. It is divided into pharynx and oesophagus. The *mouth cavity* (fig. 22) is formed by the labrum above, the mandibles and maxillae at the sides and the hypopharynx below. The *pharynx* (fig. 23) is supported along its ventral surface by a U-shaped chitinous piece (*c.r.*). The walls consist of a chitinous intima, a layer of epithelium and a semicircular muscular bundle which arches over the free ends of the chitinous support. Three pairs of muscles arise from the roof of the head capsule and are inserted into the dorsal surface of the pharynx (fig. 23, *m.d.ph*). The pharynx passes gradually into the oesophagus. The *oesophagus* is a straight, narrow muscular tube which is invaginated into the mid-gut and is then sharply reflected forwards to end at the beginning of the cardia, thus forming the oesophageal valve. At its anterior end the lumen of the oesophagus is crescent-like (fig. 21) ; but posterior to the cerebral lobes, the lumen becomes star-shaped (fig. 34) owing to the folding of the intima. In cross-section the epithelium is triangular (*ep.*, fig. 34) ; the cell partitions are not easily seen ; the protoplasm is granular towards the base, but the apex is clear. Well-developed circular muscles (*c.m.*, fig. 34) are present on the inside and some longitudinal fibres on the outside of the oesophageal wall.

In longitudinal section the oesophageal valve is composed of three layers: (1) the

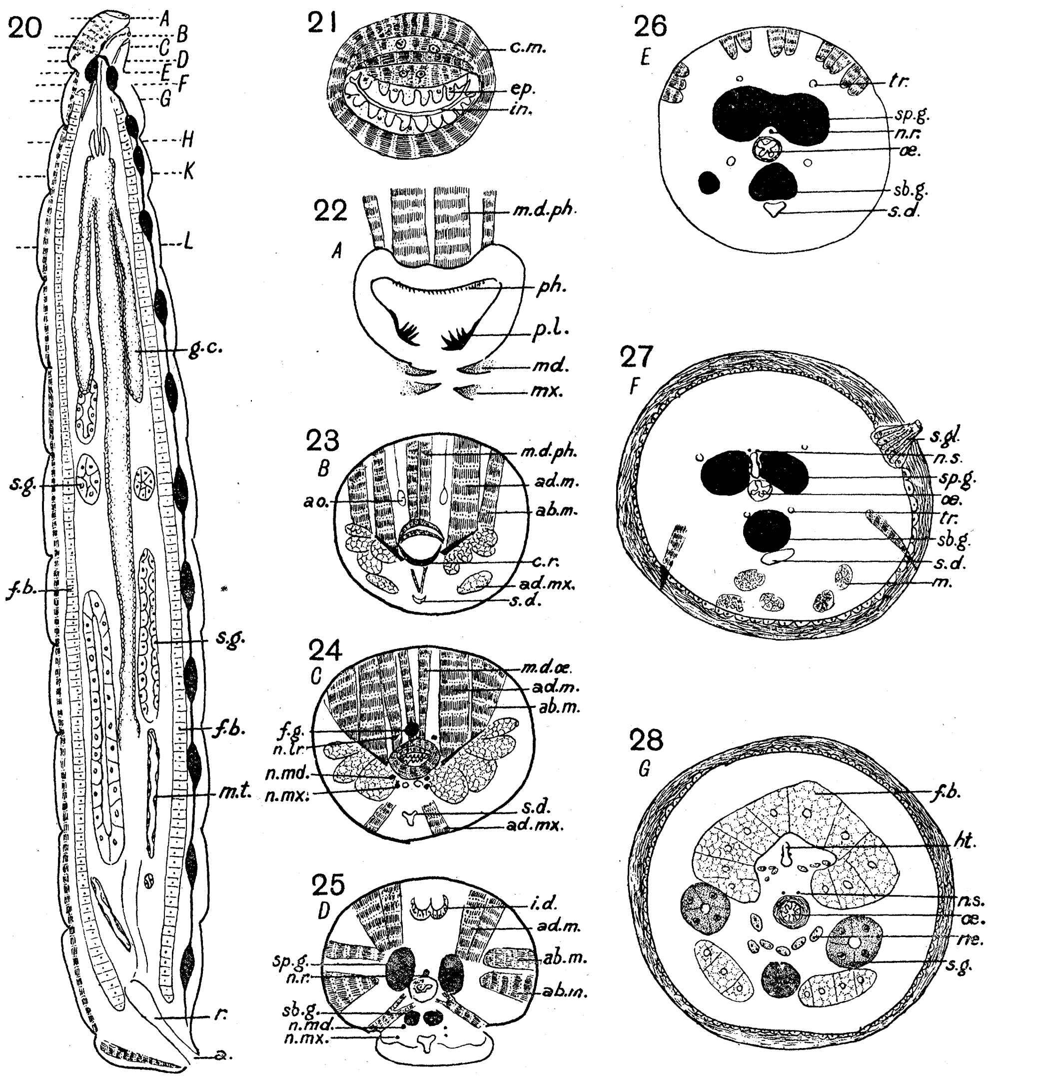


B. radiata (continued)

FIG. 16—A fully grown larva dissected to show the alimentary canal of the larva, the Malpighian tubules, the left salivary gland, and the imaginal disks of legs. × 12.
FIG. 17—Whole larva showing the respiratory system. × 12.
FIG. 18—Whole larva showing the nervous system. × 12.
FIG. 19—Whole larva showing the circulatory and nephric systems. × 12.

inner oesophageal layer with its musculature (*i.ep.*, fig. 32) ; (2) the outer reflected layer of the oesophagus (*o.ep.*) ; (3) the cells of the cardia (*c*). The same layers are shown in transverse section in fig. 35.

At the junction of the inner with the reflected layer of the oesophagus a blood sinus is present (*b.s.*, fig. 32). The outer layer of cells (*o.ep.*, fig. 33) are large and vacuolated ; the outer border is lined with chitin which bears several chitinous spines. The cell partitions show a fibrillar structure having the appearance of radial muscles



B. radiata (continued)

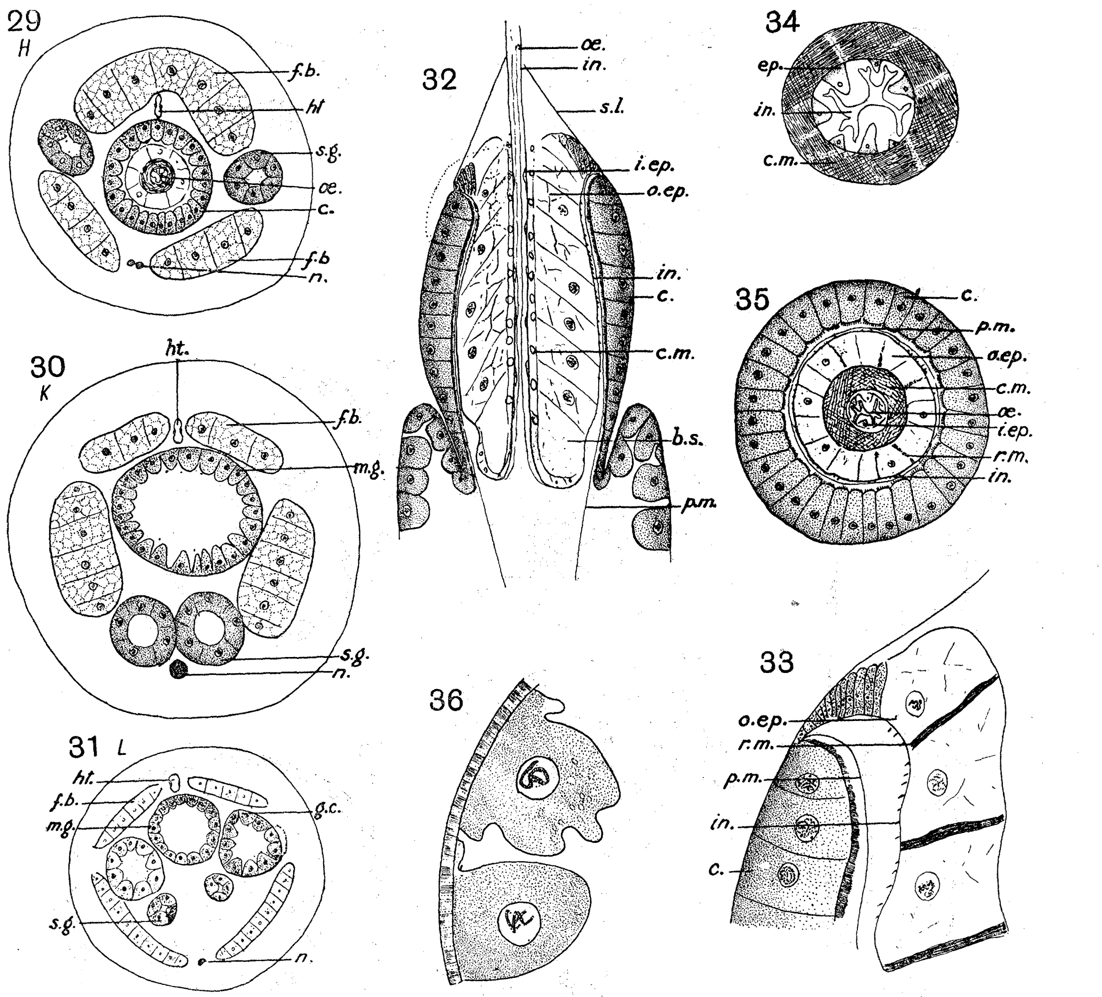
FIG. 20—Longitudinal section of larva. The dotted lines indicate the levels at which transverse sections were drawn. × 12.

FIG. 21—Oesophagus with its muscles, enlarged from fig. 24. × 185.

FIGS. 22–28—Transverse section of larva at levels A, × 185 ; B, × 54 ; C, × 54 ; D, × 54 ; E, × 54 ; F, × 54 ; G, × 54.

(*r.m.*) which arise from the muscular layer of the oesophagus. I have not been able, however, to detect any striation in them. At the junction of the reflected layer of the oesophagus with the cardia the cells become smaller and elongated (fig. 33).

The cardia (*c.*, fig. 32) is the portion of the mid-gut which encloses the oesophageal valve. It is lined with a layer of deeply staining columnar cells. From the anterior part of the cardia a cone of fibrous tissue with muscular strands stretches forwards to



B. radiata (continued)

FIGS. 29–31—Transverse section of larva at level H, × 54 ; K, × 54 ; L, × 54.
FIG. 32—Longitudinal section of oesophageal valve of the larva. × 120.
FIG. 33—Enlargement of the upper portion of oesophageal valve, indicated by dotted line in fig. 32. × 320.
FIG. 34—Oesophagus with its interlacing muscles. × 320.
FIG. 35—Transverse section near the middle of oesophageal valve. × 120.
FIG. 36—Two cells of the gastric caecum enlarged showing the circular muscle of the caecum. × 320.

the walls of the oesophagus (*s.l.*). The cells are striated along their inner border and each is provided with a spherical nucleus enclosing a long, convoluted, transversely striated band (fig. 46).

The peritrophic membrane* (*p.m.*, fig. 32) consists of a fluid secretion of the upper cells of the cardia, rolled out into a cylinder at the posterior end of the oesophageal valve, between the reflected layer of the oesophagus and the cardia. In the living larva the oesophageal valve has a limited range of forward and backward movements. The chitinous spines on the reflected layer of the oesophagus help to push the peritrophic membrane into the mid-gut.

The gastric caeca (*g.c.*, fig. 16) arise from the anterior portions of the mid-gut and extend backwards to the fifth body segment, being closely apposed to the mid-gut. The surface of these caeca is puckered and in the living larva they exhibit strong peristaltic movement. In cross-section the caeca are lined with tall, deeply staining columnar cells. The cytoplasm contains numerous secretory vacuoles which are discharged into the lumen (fig. 31). The inner border is striated, the outer rests on a basement membrane ; circular as well as a few longitudinal muscles are found on the outer side (fig. 36).

The function of these caeca consists probably in secreting digestive enzymes. In *Brachypeza radiata* the cells lining the caeca give off granular protrusions, which fill the lumen and are emptied by peristaltic movement at the anterior end of the mid-gut.

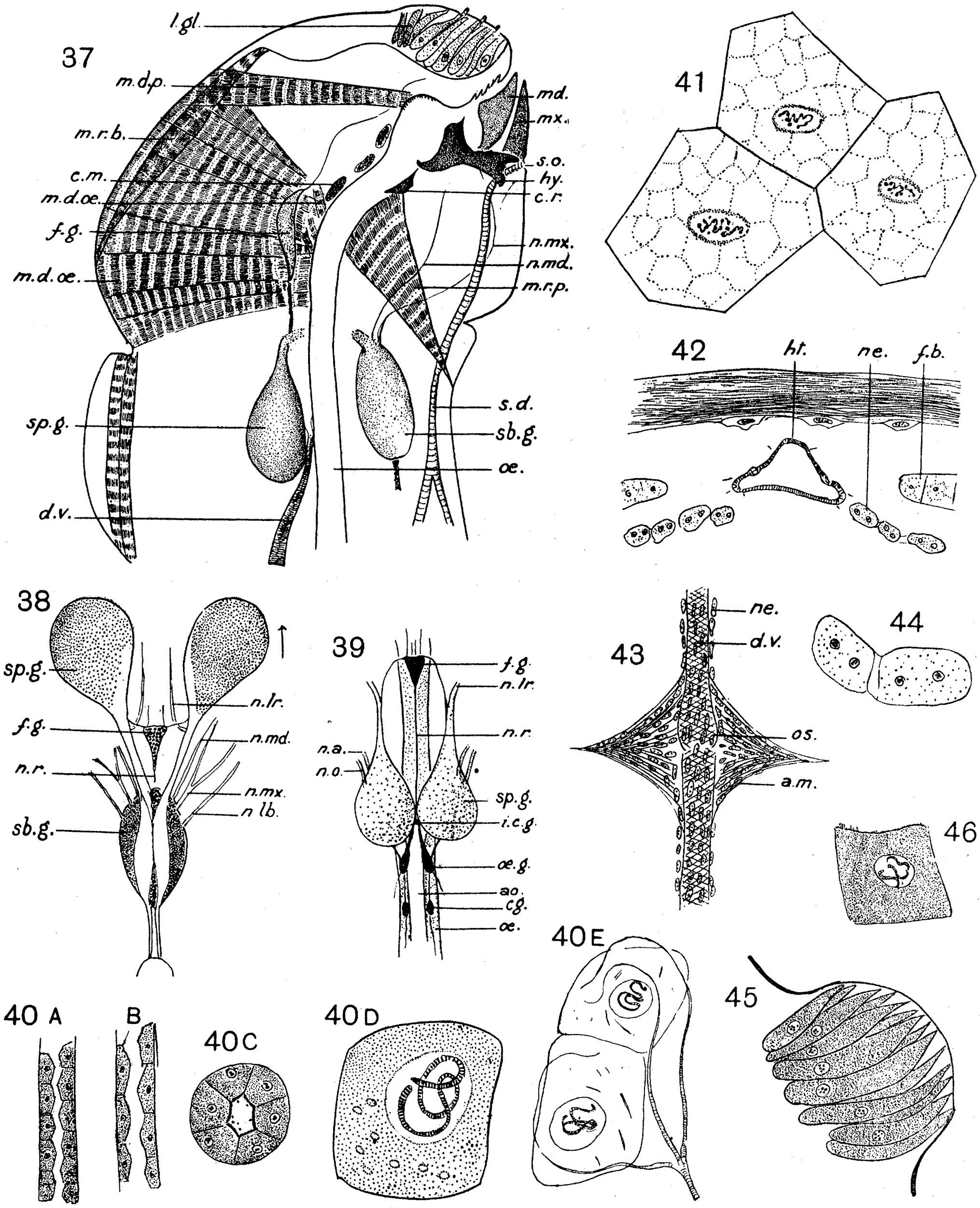
The stomach forms a straight tube which narrows slightly as it joins the hind-gut. At its anterior end it is lined by large cells whose cytoplasm contains several vacuoles. Towards the middle, the cells are somewhat flattened and in surface view appear to have two nuclei each. The muscular layer consists of an inner circular and an outer longitudinal bundle both poorly developed, except at the junction of the mid- with the hind-gut, where the circular muscles become strongly developed and form a sphincter. The four Malpighian tubules (*m.t.*, fig. 16) arise separately from the terminal part of the mid-gut, extending forwards and then backwards to surround the hind-gut. In cross-section the cells are distinct and bulge into the narrow lumen. The inner border of the cells is striated like the cells of the mid-gut.†

The hind-gut extends from the eighth to the twelfth body segment, forms one loop and opens at the anus. It is divided into a narrow ileum and a slightly wider rectum. The muscular layer is well developed and consists of annular muscles on the inside, and longitudinal muscles on the outside of the wall.

The salivary glands (*s.g.*, fig. 16) are in the form of two long, narrow convoluted tubes about two and a half times longer than the body of the larva. Anteriorly they unite to form a common duct, which is ringed like the trachea, and which opens to the exterior through an opening situated between the vertical processes of the hypopharynx (*s.o.*, fig. 37). In the anterior half the lining cells are columnar but gradually become flattened towards the posterior end (fig. 40, A and B). In cross-section the cytoplasm shows numerous vacuoles, the contents of which are discharged into the lumen (fig. 40, C). The nucleus of the salivary cell is spherical,

* The theories of the origin of the peritrophic membrane are discussed in VIGNON's paper (1901). WIGGLESWORTH (1930) described the press mechanism in several larvae.

† VAN GEHUCHTEN (1890) pointed out that the Malpighian tubes arise from the mid-gut and not the hind-gut in *Ptychoptera contaminata*. PANTEL (1898) found the same condition in *Thrixion halidayanum*.



B. radiata (continued)

FIG. 37—Head, sagittal section. × 36.

FIG. 38—Supra- and sub-oesophageal ganglion. The former is reflected forward. × 36.

FIG. 39—Sympathetic nervous system (dense black). × 36.

FIG. 40—A and B. Salivary gland, longitudinal section. × 92 ; C. Transverse section. × 160 ; D. Salivary gland cell showing the structure of the nucleus. × 540 ; E. Salivary gland cells showing intracellular tracheoles (Bielchomsky stain). × 480.

FIG. 41—Three fat cells. × 320.

FIG. 42—Transverse section showing heart and nephrocytes. × 120.

FIG. 43—A part of the dorsal vessel showing alary muscles, ostia, and nephrocytes. × 33.

FIG. 44—Two nephrocytes. × 324.

FIG. 45—Oblique section of the antenna of larva. × 320.

FIG. 46—Enlarged cell from the region of the cardia. × 320.

contains two or three nucleoli, and a long convoluted transversely striated cord (fig. 40, D). The salivary cells are profusely supplied with tracheoles (fig. 40, E).

ii *Respiratory System* (fig. 17)—In the larva respiration is carried out by means of the skin and a well-developed tracheal system. The integument is thin and the last abdominal segment is provided with four anal lobes, the walls of which are thin, transparent, and supplied by fine tracheoles. As has already been noted, the tracheal system varies with each larval instar. The fully grown larva is peripneustic, carrying eight pairs of functional spiracles on the prothorax and first seven abdominal segments, and two pairs of non-functional spiracles on the metathorax and eighth abdominal segment. The mesothorax and the last apparent segment are devoid of spiracles ; the first being supplied with air by tracheal branches from the pro- and metathorax, the second from the eighth abdominal segment.

The tracheal system consists of two main latero-dorsal longitudinal trunks extending from the prothoracic spiracle to the eleventh abdominal segment where they break up into fine branches forming a plexus in the region of the heart. The functional spiracles communicate with the main longitudinal trunks by means of short lateral tracheal branches. The non-functional spiracles are joined to the same trunks by means of stigmatic cords. From each of the lateral branches of the functional spiracle a tracheal branch arises which extends backwards and ventrally. These branches are connected by means of two latero-ventral longitudinal trunks. Each prothoracic spiracular trachea gives off a medial and a lateral branch which supply the brain and the structures inside the head capsule. The lateral branch extends anteriorly to the head capsule. The medial branches from each side bend backwards and are connected by a short transverse commissure. From the crest of the bend a small branch extends forwards. The two longitudinal trunks are connected by means of eight commissures situated at the posterior ends of the metathorax and the first seven abdominal segments and passing ventral to the dorsal vessel. At the mid-dorsal line their lumina are narrower and appear as if they were jointed. These areas represent the weak spots at which they break, to be withdrawn during ecdysis. Nine similar areas are present along each of the longitudinal trunks. From each commissure two fine branches pass forwards which subdivide into finer branches forming a sub-cuticular net of tracheoles. The dorsal vessel is supplied from tracheal branches that arise from the dorsal commissures and the two dorsal longitudinal trunks, the ventral chain of ganglia from the ventral longitudinal trunk. The viscera are supplied mainly from branches arising from the main dorsal longitudinal trunks but also from the ventral longitudinal trachea.

iii *Nervous System* (fig. 18)—For the study of the nervous system, freshly killed larvae were dissected in saline, to which a few drops of methylene blue were added. In this way some of the finer nervous branches were seen. Some of the dissected larvae were stained *in toto* in methylene blue and mounted in glycerine with good results. The nervous system was also dissected out and stained with haemalum.

The central nervous system consists of the *supra*-oesophageal, sub-oesophageal, and ventral chain of eleven ganglia. The *supra*-oesophageal ganglion (*sp.g.*, fig. 39) is bilobed. The two lobes are joined by a short transverse commissure and are connected to the sub-oesophageal ganglion by two thick crura cerebri. In the fully grown larva the lobes lie partly within and partly behind the head capsule.

Each lobe gives off the following branches :—

1. The labral nerve (*n.lr.*, fig. 39) which forms the stalk of the pyriform *supra*-oesophageal lobe. Distally it divides into two branches ; the medial branch joins the base of the triangular frontal ganglion (*f.g.*); the lateral branch extends to the labrum.
2. The antennal nerve (*n.a.*) which arises from the anterior third of the lobe and extends laterally as a thin branch to the base of the antenna.
3. The optic nerve (*n.o.*) which runs parallel and close to the antennal nerve and ends at the base of the larval eye.

The sub-oesophageal ganglion* (*sb.g.*, fig. 38) is ovoid, flattened dorso-ventrally, and lies beneath the *supra*-oesophageal ganglion. It gives off the following branches :—

1. The mandibular nerve (*n.md.*) which arises from the anterior end of the ganglion and divides distally into three delicate branches ; the uppermost branch supplies the adductor muscle, the middle extends between the two lamellae of the mandible, and the lower branch ends in the neighbourhood of the posterior condyle.
2. The maxillary nerve (*n.mx.*) which arises posterior to the mandibular nerve and soon divides into two slender branches. The medial branch supplies the adductor muscle, the lateral branch supplies the abductor muscle and probably also the maxillary palp.
3. The labial nerve (*n.lb.*) which arises posterior to the maxillary nerve and extends forwards as a thin branch. I have not been able to trace it to its termination.

The ventral chain (fig. 18) consists of 11 ganglia—three thoracic and eight abdominal. The first thoracic ganglion lies in the posterior part of the prothorax ; the second thoracic lies in the middle of the mesothorax, while the rest of the ganglia lie in the anterior part of their respective segments. The connectives between these ganglia are double throughout, but the nerves run so close to one another that they appear single to the naked eye. The first thoracic ganglion gives off a pair of lateral nerves which extend transversely and supply the muscles and imaginal disks of the prothoracic legs. The second thoracic and first seven abdominal ganglia give off two pairs of lateral nerves each. From the eighth abdominal ganglion three pairs of lateral nerves arise. The posterior pair extend straight backwards and supply the terminal abdominal segment.

* In fig. 38 the two lobes of the supra-oesophageal ganglion have been separated from one another and reflected forward.

iv *Sympathetic System* (in black, fig. 39)—As already stated, the two medial branches of the labral nerves extend forward and join the base of the triangular frontal ganglion (*f.g.*). The recurrent nerve (*n.r.*) arises from the apex of the frontal ganglion. It extends backwards along the dorsal surface of the oesophagus and joins a small infra-cerebral ganglion (*i.c.g.*). The latter gives off two divergent nerves which pass ventral to the aorta and terminate in a fusiform oesophageal ganglion (*oe.g.*). Each of the oesophageal ganglia gives off two nerves ; the first proceeds forwards and joins the ventral surface of the cerebral lobe ; the second extends backwards and joins a small cardiac ganglion (*c.g.*), which gives off several backward branches supplying the cardia and mid-gut.

v *Circulatory System*, *nephrocytes* (fig. 19)—The dorsal vessel or heart consists of a nearly cylindrical muscular tube, which is closed at the posterior end and open anteriorly. It arises at the posterior end of the eleventh body segment, extends forwards along the mid-dorsal line and ends as an open tube between the two cerebral lobes and the oesophagus.

The abdominal portion of the dorsal vessel consists of eight consecutive chambers, the last of which is slightly bulbous at the posterior border and is attached to the last abdominal segment by means of three fibrous strands. The other chambers (fig. 43) are narrower at the middle and wider at the ends. The chambers are separated from each other by paired ostioles (*os.*). Each ostiole is in the shape of a triangular slit, which is formed by the unfolding of two enlarged cells.

The thoracic portion of the dorsal vessel, known as the aorta, extends forwards as a narrow muscular tube which sinks ventrally and lies on the dorsal surface of the oesophagus and ends by passing between the cerebral lobes and the oesophagus (*d.v.*, fig. 37). I have not been able to trace the aorta beyond the transverse commissure which joins the two lobes and it probably ends here.

In transverse section the dorsal vessel (fig. 42) is triangular in shape and consists of two curved muscular cells which meet at the dorsal and ventral mid-lines. The nucleus bulges into the lumen. At the posterior region of the dorsal vessel the striated fibres take an oblique course ; anteriorly they run in a longitudinal direction.

In the abdomen the heart is supported by eight pairs of alary muscles. Each muscle (*a.m.*, fig. 43) takes its origin from the integument at the junction of two segments and spreads fan-wise, forming a network which supports the heart along the ventral surface. Besides the alary muscles, delicate fibrous strands pass from the dorsal surface of the heart to the integument.

Before reaching the cerebral lobes, the aorta is supported by a semicircular fibrous thickening along the ventral surface, the free ends of which extend forwards and are attached to the ventral surface of the cerebral lobes. From the dorsal surface of the aorta near its end, a slender fibrous thread extends forwards and dorsally to be inserted at the posterior margin of the head. This thread probably corresponds to PANTEL's " Gouttière susoesophagienne " which he described in the heart of *Thrixion halidayanum*.

vi *Nephrocytes*—To study the distribution of nephrocytes, ammonia-carmine was injected into the body cavity of several Mycetophilid larvae. Two hours after injection the nephrocytes could be distinguished as a dorsal pericardial and a ventral oesophageal group. An injected larva was cleared and mounted, while others were sectioned and counterstained with dilute haematoxylin. The pericardial nephrocytes (*ne.*, fig. 19) are numerous and extend along the dorsal vessel and alary muscles from the eighth abdominal segment to the posterior part of the metathorax. These are ovoid, the long axis lying in the same direction as the dorsal vessel, or for alary nephrocytes in the same direction as the alary fibres (*ne.*, fig. 43). The ventral group of nephrocytes consists of 35–40 cells which are found in the mesothorax ventral to the oesophagus and extending to the cardiac region of the midgut. This group corresponds to the " Guirlandenförmige Zellenstrang " described by WEISMANN in a cyclorrhaphous larva.

The nephrocytes (*ne.*, figs. 42, 44) are ovoid and connected together by fine fibrous strands. Each cell contains usually two vesicular nuclei, though in some cells only a single nucleus is present. The protoplasm is vacuolated and in injected specimens the carmine particles are distributed in the protoplasm, especially around the nucleus. Sometimes the nephrocytes become so overloaded with carmine that they break down, liberating their granules which are then taken up by the leucocytes. The function of these cells is probably excretory, as was shown by the work of KOWALEVSKY (1889), BRUNTZ (1903), and KEILIN (1917, *b*). HOLLANDE (1916), however, maintains that they are not excretory since they do not remove the by-products of metabolism, but absorb the albuminoid material of alimentary or autolytic origin and transform it into assimilable substance.

IV—FAMILY DITOMYIDAE KEILIN

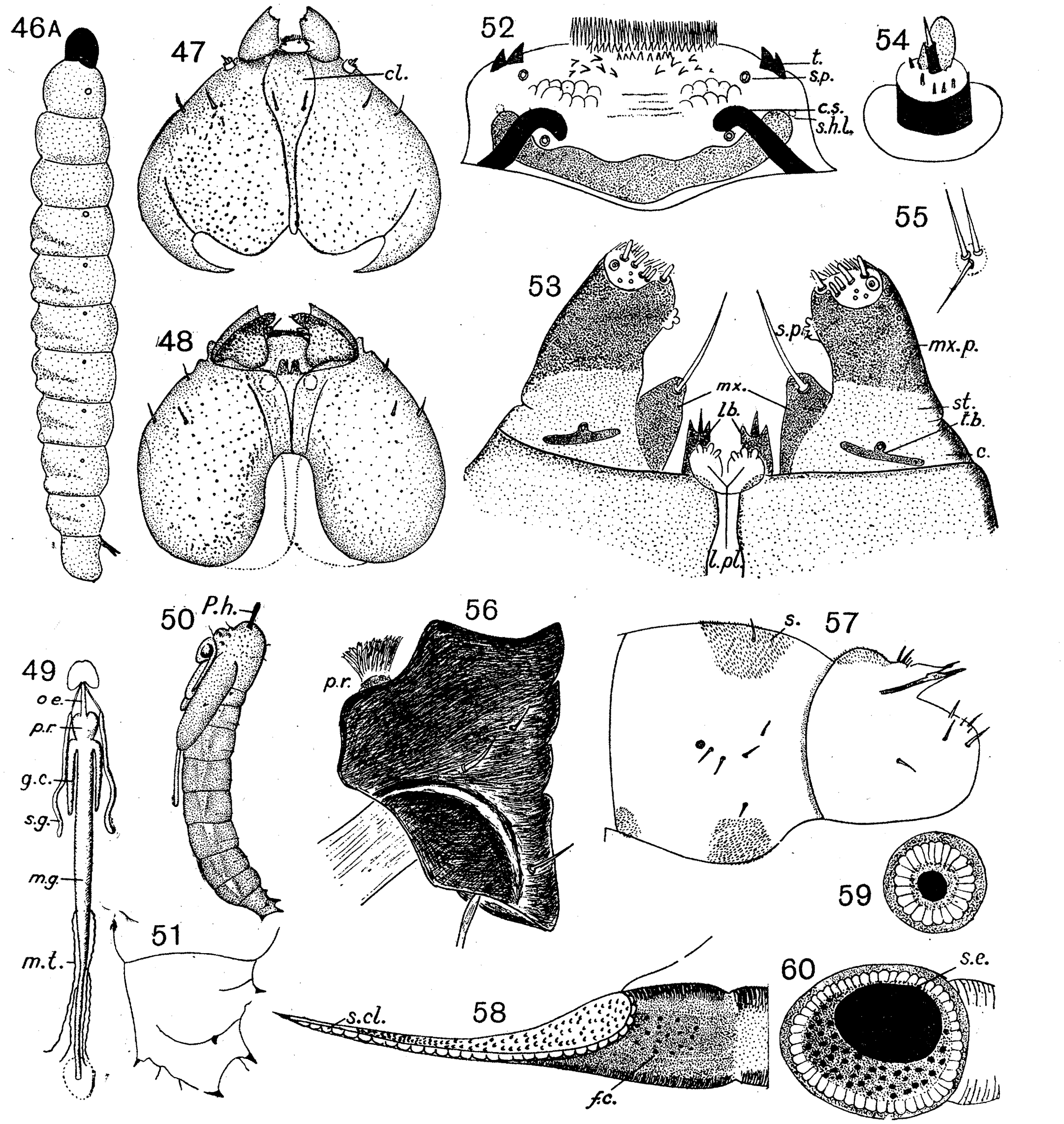
a. Ditomyia fasciata *Meigen*

Historical—The first observations on *Ditomyia fasciata* were made by MEIGEN (1818), who found an undeveloped young male in *Polyporus versicolor.* WINNERTZ (1863) found the larvae living in different polypori. The genus *Ditomyia* was included by him in the sub-family Mycetobinae and this position was ultimately accepted by JOHANNSEN (1910). MALLOCH (1917) suggested that *Ditomyia* and *Symmerus* should form a family by themselves but did not describe the larva of either. KEILIN (1919, *a*) gave a detailed description of the larvae and pupae of both *Ditomyia* and *Symmerus* and came to the conclusion that the family Ditomyidae must occupy among the Diptera, *Orthorrapha eucephala* of BRAUER, a position equally important with that of the Mycetophilidae, Bibionidae, Rhypidae, etc. SCHULZE (1924), apparently ignorant of KEILIN's work, came to a similar conclusion. According to EDWARDS (1924, *b*), this course is not justified from the point of view of adult morphology.

Biology and Morphology—The larvae live in *Polystictus versicolor*, growing on old beech-stumps. The last abdominal spiracle is often projected from the fungus.

Pupation takes place in the fungus without the formation of a cocoon. The larva (fig. 46*a*) is 9–10 mm. long, opaque white in colour. It consists of 11 body segments in addition to the head, with deep intersegmental grooves, which give it the appearance of a string of beads. The head (figs. 47 and 48) is invested with a dark brown chitinous capsule. The frontal plate is club-shaped, tapering posteriorly, and carries two sensory hairs. The epicranial plates curve round to the ventral surface and are there only separated by a narrow suture. They bear five hairs each ; two dorsal and three ventral. The antenna (fig. 54) consists of a basal chitinous segment which carries a bell-shaped sensory organ, one biarticulated and five smaller cylindrical papillae. The labrum (fig. 52) is transverse and supported by a broad band of chitin along its proximal margin and a chitinous arm (*c.s.*) on either side of the ventral surface. At the anterior margin there is a brush composed of bristles and sense organs. On each of its antero-lateral corners a bidentate chitinous process is present. The ventral surface is furnished with series of hooks, scales, and spinules. The dorsal surface carries two pairs of sensory papillae (*s.p.*) and a sensory hair (*s.h.l.*) on either side. The mandibles (fig. 56) are strongly chitinized. The outer margin is notched, while the inner carries three broad angulate teeth and a brush-like prostheca at the basal border. Each mandible bears three lateral sensory hairs. The maxillae (fig. 53) are more sensory than masticatory in function and their sclerites are fused together. The inner portion (*mx.*), the mala, which probably represents the fused galea and lacinia, is triangular in shape and carries a long sensory hair near the apex. The maxillary palps (*mx.p.*) are well developed and carry distally a circular area bearing sensory rods, circular papillae, and several setae. On the inner border each palp carries an indented sensory papilla (*s.p.*). The palp is supported by a broad transparent membrane which probably represents the fused stipes (*st.*), and cardo (*c.*). The latter is strengthened by a chitinous band (*t.b.*) carrying a sensory papilla. The labium (fig. 53) consists of two tridentate chitinous plates which are connected proximally. The labial palps (*l.pl.*) are subcircular and provided with three short papillae each.

Each *body-segment* carries on the dorsal surface a saddle-shaped area covered with short spinules (fig. 57) and two smaller areas on the ventral surface. In the pleural region five hairs are present in the vicinity of the spiracle. Six groups of hairs, each consisting of three sensory hairs (fig. 55) of equal length, are constantly present in direct connexion with the imaginal buds of the legs and represent their sensory vestiges. The larva is peripneustic, having one pair of prothoracic and eight pairs of abdominal spiracles. The prothoracic spiracle (fig. 60) is circular with the external scar (*s.c.*) situated eccentrically. Around the margin there is a circle of spiracular openings. The last abdominal spiracle (fig. 58) is drawn out into a spine-like process, with the spiracular openings on the periphery of an excavated area at the apex. The surface of the scar is studded with minute chitinous hooks. The other abdominal spiracles (fig. 59) are in essence similar to, but smaller than, the prothoracic spiracle, with the external scar in the centre.



Ditomyia fasciata Meigen

Fig. 46*a*—Whole larva. × 10.
Fig. 47—Dorsal view of head. × 120.
Fig. 48—Ventral view of head. × 120.
Fig. 49—Alimentary canal of larva (after Keilin). × 8.
Fig. 50—Pupa, lateral view (after Keilin). × 16.
Fig. 51—Posterior end of pupa (after Keilin). × 32.
Fig. 52—Labrum, ventral view. × 320.
Fig. 53—Maxillae and labium of larva. × 320.
Fig. 54—Atenna. × 320.
Fig. 55—Pleural sensory hairs. × 320.
Fig. 56—Mandible. × 185.
Fig. 57—Last two segments. × 54.
Fig. 58—Last abdominal spiracle. × 320.
Fig. 59—First abdominal spiracle. × 720.
Fig. 60—Prothoracic spiracle. × 540.

The alimentary canal (fig. 49) consists of a short pharynx, followed by a short oesophagus (*oe.*) which is invaginated within the proventriculus (*pr.*). The mid-gut is in the form of a straight tube, which gradually narrows as it joins the hind-gut. The junction is marked by four Malpighian tubules which arise separately and surround the hind-gut. Two gastric caeca (*g.c.*) arise from the anterior end of the mid-gut. The salivary glands (*s.g.*), unlike those of the Mycetophilidae, extend a short distance only beyond the gastric caeca.

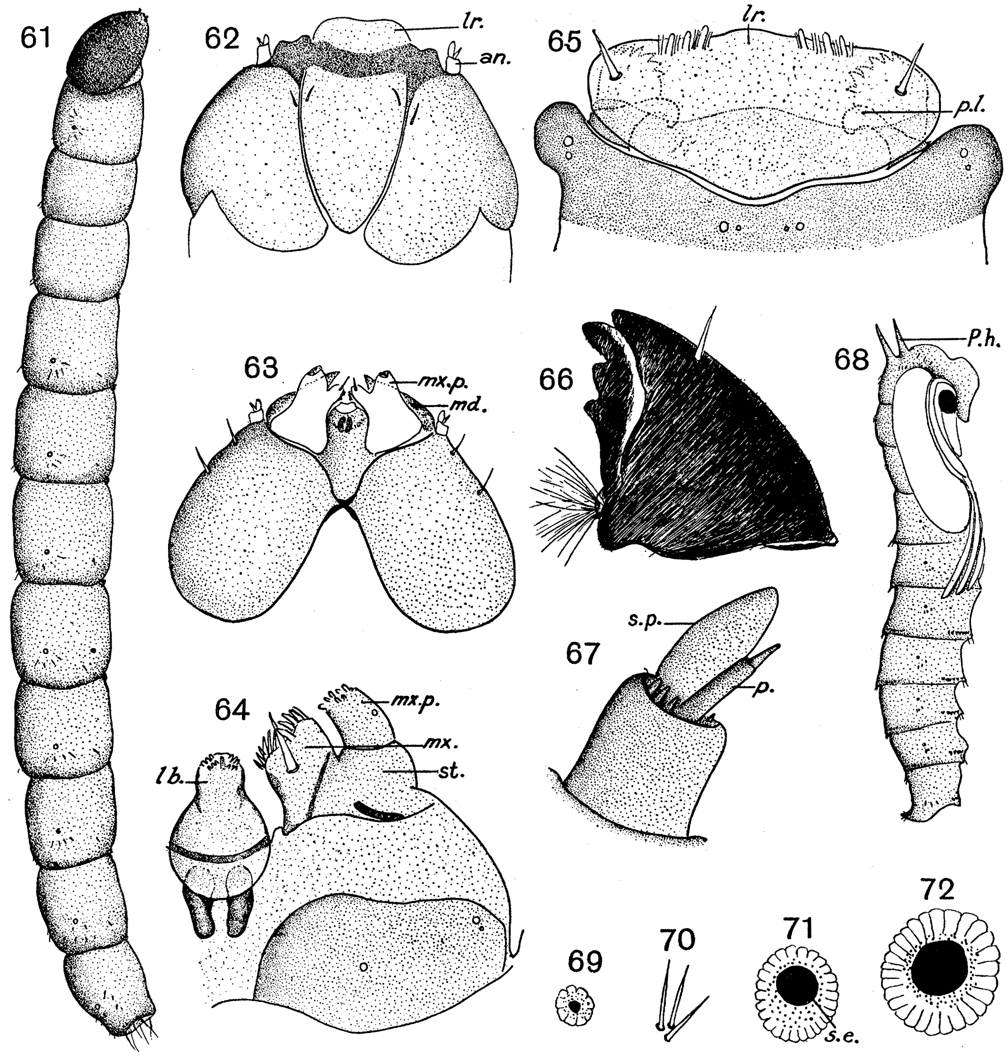
The pupa (figs. 50 and 51) is 3 mm. in length and is free from the larval skin. The thorax projects forwards and carries the respiratory horns (*P.h.*). Each abdominal segment bears a row of short spinules on the dorsal surface and the last segment five pairs of hooks curved dorsally (fig. 51).

b. Centrocnemis philippi *sp.*

The larva of *Centrocnemis* was found by Mr. Edwards on dead but rather hard logs at Puerto Blest, Lake Nahnel, Haupi, in the territory of Rio Negro, Argentine. He kindly gave me material consisting of one larva and several pupae.

Morphology—The larva of *Centrocnemis* (fig. 61) is 11 mm. long and has a light brown chitinized head and eleven body segments. The head (figs. 62, 63) is completely free. The frontal plate is shield-like and tapers posteriorly to a point. Its anterior third is more chitinized than the rest and carries a pair of sensory hairs. The lateral epicranial plates curve to the ventral surface of the head and there meet, so that the cranium is just closed. The antenna (fig. 67) consists of a basal cylindrical segment which carries sensory organs of three different shapes : (1) an elongated conical sensory papilla (*s.p.*) ; (2) a long biarticulated papilla ; and (3) four small cylindrical papillae. The labrum (fig. 65) is supported on the ventral surface by two curved chitinous plates (*p.l.*) to each of which is attached a membranous semi-circular area serrated on the inner margin. The posterior third of the dorsal surface is more chitinized than the rest. The anterior border carries two brushes consisting of several hairs and cylindrical sensory papillae and laterally a pair of sensory hairs. The mandible (fig. 66) is black and strongly chitinized. The inner border is cut into six teeth and carries a brush of setae at its basal corner. The outer border bears a sensory hair. The maxillary mala (*mx.*, fig. 64) is quadrilateral in shape and bears a long sensory hair on the ventral surface and a series of setae on the inner border. The palp (*mx.p.*) is furnished by a broad membranous area, the stipes (*st.*), which is fused with the cardo. The latter is strengthened by a chitinous band bearing two minute papillae. The labium (*lb.*) is flask-shaped and carries two rows of minute papillae. A pair of bean-shaped chitinized plates is found posterior and partly dorsal to the labium.

The body (fig. 61) is soft, creamy white, and carries several hairs along the dorsal and lateral surfaces, especially in the vicinity of the spiracles. Ventrally there are six groups, each consisting of three hairs (fig. 70) of equal length, situated on the



Centrocnemis sp. ?

Fig. 61—Whole larva. × 13.
Fig. 62—Head, dorsal surface. × 54.
Fig. 63—Head, ventral surface. × 54.
Fig. 64—Maxilla and labium. × 120.
Fig. 65—Labrum, dorsal surface. × 120.
Fig. 66—Mandible. × 120.
Fig. 67—Antenna. × 320.
Fig. 68—Pupa. × 16.
Fig. 69—First abdominal spiracle. × 185.
Fig. 70—Sensory hairs. × 320.
Fig. 71—Last abdominal spiracle. × 185.
Fig. 72—Prothoracic spiracle. × 182.

ventral surface of the thoracic segments. The last abdominal segment carries six long hairs along the posterior border, surrounding the anus.

The respiratory system is peripneustic and consists of a pair of prothoracic and eight pairs of abdominal spiracles along the sides of the fourth to the eleventh segments. The prothoracic spiracle (fig. 72) is circular and consists of a number of small trema surrounding a central core which represents the external scar. The abdominal spiracles (fig. 69) are of similar form to the prothoracic spiracles except that they are smaller. The last abdominal spiracles, unlike those of *Ditomyia,* are not elongated, but resemble the other abdominal spiracles, although they are larger (fig. 71).

The pupa (fig. 68) is brown and is completely free from the larval skin. The head is applied to the ventral surface. The prothorax is arched and carries a pair of respiratory horns (*P.h.*). The legs are applied to the body and lie in the same plane, reaching to the sixth body-segment. Each abdominal segment carries a row of small chitinous spinules on the ventral and dorsal surface, besides a few hairs in the vicinity of the spiracles.

Conclusion—It is evident from the study of the larva and pupa of *Centrocnemis* that it bears a close resemblance to *Ditomyia fasciata*, in the shape of the head, the structure of the mouth parts, the antennae, the shape and structure of the spiracles, and the number of the sensory vestiges of the legs ; and more so to *Symmerus* as described by KEILIN (1919, *a*). The larvae and pupae of *Ditomyia*, *Symmerus*, and *Centrocnemis* are entirely different from the rest of the Mycetophilidae in the structure of the mouth parts, antennae, cuticular armature, and respiratory system. The two genera, *Ditomyia* and *Symmerus*, must, according to KEILIN, " be re-united in a special family, the Ditomyidae, which itself must be completely separated from the family of the Mycetophilidae ". The larva and pupa of *Centrocnemis*, which to my knowledge are described here for the first time, should, on larval and pupal characters, also be included in the family Ditomyidae proposed by KEILIN. As to the relations of this new family, KEILIN states that " the larvae of Ditomyidae bear a closer resemblance to the larvae of Bibionidae than to those of any other Diptera, and more especially when we compare their labra, mandibles, maxillae, and the structure of the spiracles ".

V—SUB-FAMILY BOLITOPHILINAE WINNERTZ

Bolitophila MEIGEN

a. Historical and Biological Notes

GUÉRIN (1827) describes the larva of *Bolitophila cinerea* as having two anal stigmata situated between four movable lobes. From his description the larva belongs to the Tipulidae. DUFOUR (1839, *b*) gives a detailed account of *Bolitophila fusca* under its old name *Macrocera hybrida*. He classifies the Mycetophilid larvae into the *antennate* to which the Bolitophilinae belong and the *non antennate* which comprises the rest.

He gives a good description of the antenna and an excellent figure of the larva, showing well-developed antennae and a pair of prothoracic and seven pairs of abdominal spiracles. In 1853 HEEGER gave an account of a *Bolitophila* which he mistook for *Limnobia platyptera*. The antenna, labrum, and mandible are carefully drawn ; but the larva is represented with mesothoracic spiracle and the hypopharynx is mistaken for the labium. OSTEN-SACKEN (1862) compared the mouth parts of *Bolitophila* with those of other Mycetophilid larvae ; finally MALLOCH (1917) proposed to raise the Bolitophilinae to family rank. He described the antennae as two-jointed.

According to EDWARDS, the " larvae live inside soft textured fungi (Agarics or Boleti) growing on the ground ; in form they are rather short and stout and even under a hand lens can be readily distinguished from all other Mycetophilid larvae by the possession of distinct projecting antennae. Pupation takes place in the ground, the larvae burying themselves rather deeply and forming no cocoon. The pupae are active and wriggle to the surface from which they half project for the emergence of the adult, in this respect resembling Ditomyinae, but contrasting with the Ceroplatinae and higher Mycetophilidae ".

My own observations on the pupation of *Bolitophila* agree with EDWARDS's account and differ from those of OSTEN-SACKEN, who believes that the habits of the genus (*Bolitophila*) are like those of *Mycetophila*, the larva spinning a cocoon which remains on the surface of the ground.

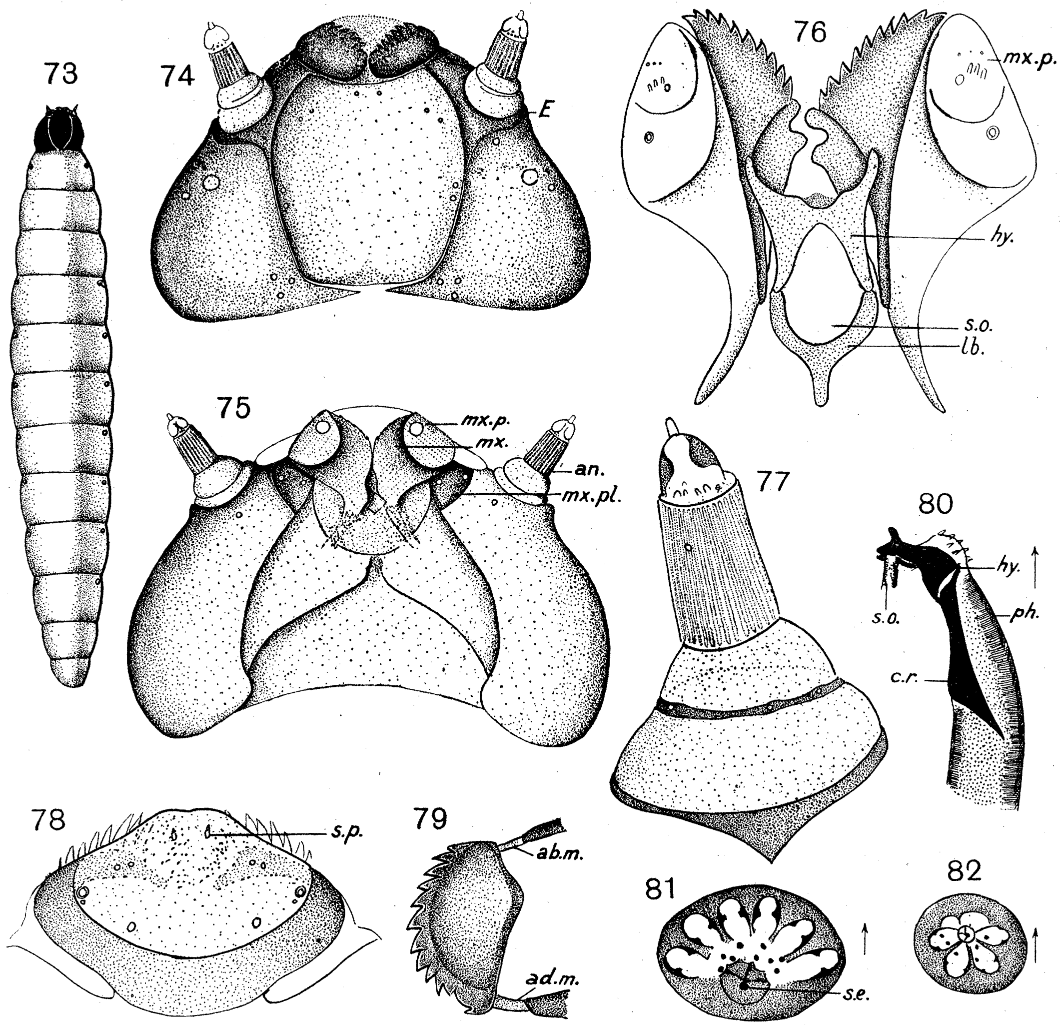
The larvae of Bolitophilinae are almost alike in the shape of their heads and bodies except that the last abdominal segment offers some characters which may be useful in separating the various species.

The antennae and trophi of the members of this sub-family are similar to those of *Bolitophila saundersi* which is more fully described than the others. There are, however, some variations in the number of papillae on the antennae and labra, and the number of teeth borne by the mandibles and maxillae of the various species, in addition to slight modifications in the position of the external scar and the number of spiracular openings in the prothoracic and abdominal spiracles. A brief description is given of these variations alone.

b. Bolitophila saundersi *Curtis*

The larva (fig. 73) is found in the fungus *Hypoloma fasciculare*. It is stout, broad in the middle, and attenuate at both ends. It is 5·5 mm. long, and consists of a well-chitinized head and twelve body segments.

The head (figs. 74, 75) is trapezoidal, narrow at the anterior border and broad at the posterior margin. The frontal plate is broad anteriorly and the sides, unlike all other Mycetophilid larvae, do not converge to a point on the posterior border. It bears five pairs of sensory pits. The lateral epicranial plates curve downward to the ventral surface of the head, where they join two triangular chitinous plates. These meet at their inner angles. The antenna (fig. 77) is supported by a well-chitinized base and consists of three segments. The first joint is a white, fleshy truncated cone, slightly constricted in the middle where a chitinous band, furnished



Bolitophila saundersi CURTIS

FIG. 73—Whole larva. × 13.
FIG. 74—Dorsal view of head. × 120.
FIG. 75—Ventral view of head. × 120.
FIG. 76—Two maxillae and hypopharynx. × 320.
FIG. 77—Antenna. × 320.
FIG. 78—Dorsal view of labrum. × 320.
FIG. 79—Mandible. × 185.
FIG. 80—Hypopharynx and chitinous ring supporting pharynx. × 320.
FIG. 81—Prothoracic spiracle. × 540.
FIG. 82—Abdominal spiracle. × 540.

with three sensory papillae, forms an additional support. The second joint is a strongly chitinized cylinder bearing a small sensory papilla ; the third is bell-shaped with chitinized folded edges, and carries a cylindrical papilla distally and five small papillae at the base. Malloch describes the antenna as two-jointed in *Bolitophila*. The terminal joint may have been broken in his specimen. The eyes (*E.*, fig. 74) are postero-lateral to the antennae and consist of two small, transparent convex areas overlying a layer of pigmented cells. Dufour must have overlooked them, for he says he found no trace of eyes. The labrum (fig. 78) is smaller comparatively than that of other Mycetophilid larvae. It is supported by a well-developed horny and semicircular frame along the posterior margin and bears six sensory papillae (*s.p.*) on the dorsal surface. The free ends of the frame articulate with two chitinized arms, each carrying a fan-shaped organ consisting of twelve blade-like teeth, the movement of which helps to direct the food particles to the mouth opening. The mandible (fig. 79) is semicircular in shape with the inner border cut into twelve teeth, the last of which is less chitinized than, and opposed to, the rest. I could not find a prostheca in the mandibles of *Bolitophila* that I examined. The inner cultriform lobe of the maxilla (fig. 76) bears twelve teeth, of which the last two are rounded and more chitinized than the rest. Posterior to the last tooth the inner border is heavily chitinized and ends in a rod which lies dorsal to a semicircular membranous area situated between the two maxillary plates. The outer lobe which forms the maxillary palp carries distally a circular area covered with membranous chitin and furnished with three cylindrical and four circular sensory papillae. The maxillary plate (*mx.pl.*, fig. 75) is quadrilateral in shape and carries two sensory hairs. The hypopharynx (*hy.*, figs. 76, 80) is similar to that of *Brachypeza radiata*. The labium (*lb.*, fig. 76) is semicircular in shape with a spur-like median process. The lateral ends meet the terminal parts of the vertical processes of the hypopharynx, to enclose the opening of the salivary duct.

The body (fig. 73) of the larva is shorter and stouter than that of other Mycetophilidae. The skin is free from hairs and spines, except for ten intersegmental locomotory pads, and six groups of sensory hairs, each group consisting of four minute hairs of equal length, representing sensory vestiges of the legs. The locomotory pads are situated on the ventral surface, between each of the segments of the body. The first and last pads are poorly developed, and consist of a double row of small chitinous hooks in the middle and four to six irregular rows of spinules along the periphery. The intermediate pads have a double row of hooks with ten to twelve rows of spinules. The last abdominal segment (fig. 104) is furnished with a ring of chitin on the ventral surface enclosing the anus, which consists of a vertical slit and occasionally is prolapsed through the ring.

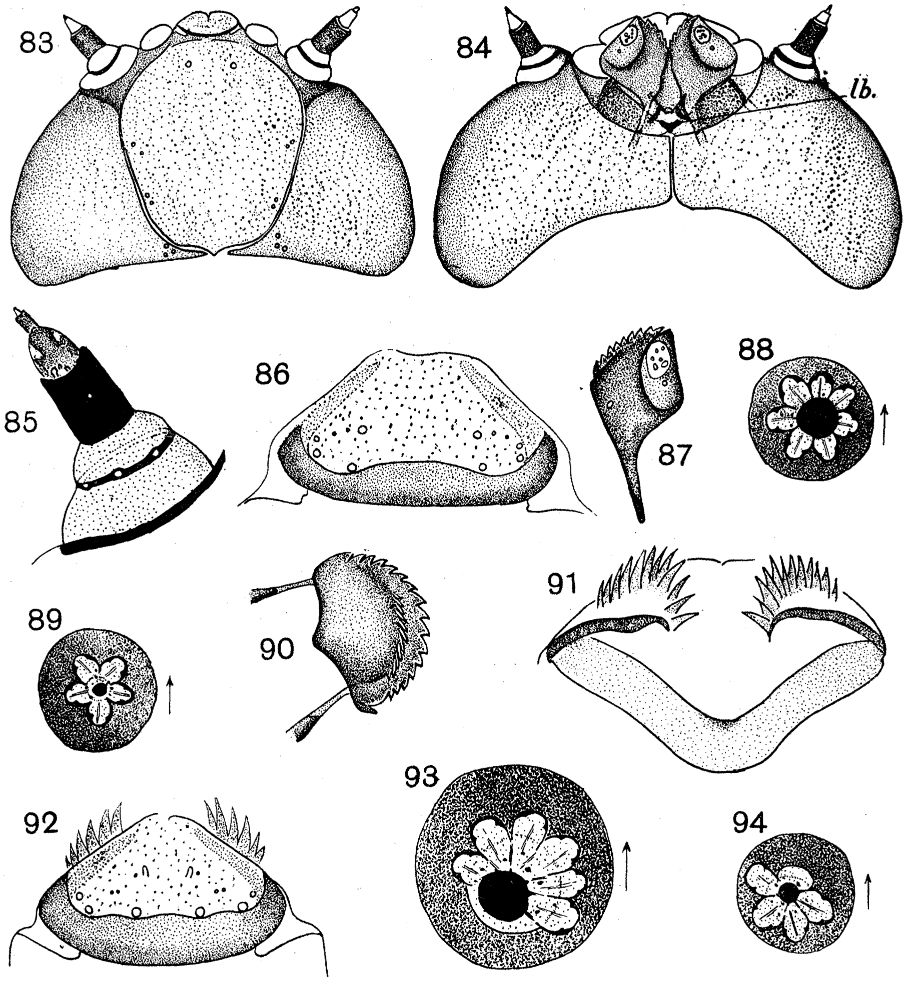
The prothoracic spiracle (fig. 81) is in the form of a chitinous nipple-like projection. The distal surface consists of a chitinous plate with six oval spiracular openings, the edges of which are thickened and show two small projections towards the lumen. The openings are covered with a thin transparent membrane, having longitudinal slits for the passage of air. The external scale (*s.e.*) is situated posterior to the spiracular openings.

Of the abdominal spiracles borne on the first seven abdominal segments, each carries four spiracular openings situated posterior to the external scar (fig. 82).

c. B. pseudohybrida *Landrock*

The larvae are found in *Tricholoma nudum* and some species of *Russula*. They are short, measuring 6 mm. in length.

The antenna (fig. 85) consists of three segments, the terminal being provided with three small papillae at the base. The labrum (fig. 86) shows six pairs of sensory



Bolitophila pseudohybrida Landrock ; *B. glabrata* Loew

Fig. 83—Dorsal view of head. × 120.
Fig. 84—Ventral view of head. × 120.
Fig. 85—Antenna. × 320.
Fig. 86—Dorsal view of labrum. × 320.
Fig. 87—Maxilla. × 185.
Fig. 88—Prothoracic spiracle. × 540.
Fig. 89—Abdominal spiracles. × 540.
Fig. 90—Mandible. × 185.
Fig. 91—Labrum, ventral surface. × 320.
Fig. 92—Labrum of *Bolitophila glabrata*, dorsal view. × 320.
Fig. 93—Prothoracic spiracle of *B. glabrata*. × 540.
Fig. 94—Abdominal spiracle of *B. glabrata*. × 540.

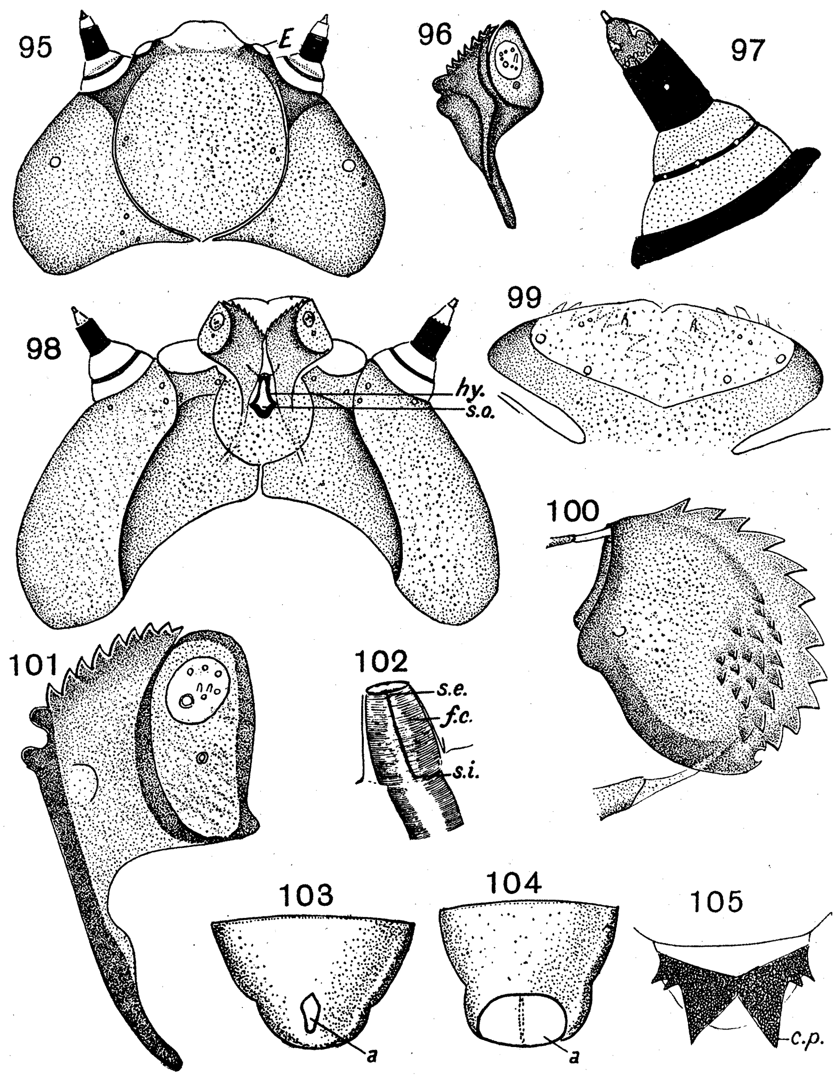
papillae on the dorsal surface. The mandible (fig. 90) carries seventeen teeth along the inner border and a second row of smaller teeth on the superior lamella. The maxilla (fig. 87) has nine teeth, the last of which is more rounded and more heavily chitinized than the rest. The maxillary palp bears six circular papillae. The labium (*lb.*, fig. 84) is a semicircular plate of chitin with a median chitinous extension. The two lateral ends meet the free terminal portions of the vertical processes of the hypopharynx and enclose the salivary duct. The prothoracic spiracles (fig. 88) are provided with seven spiracular openings, the external scar being in the centre. Each abdominal spiracle (fig. 89) has five openings distributed around the external scar. The last abdominal segment (fig. 103) shows a lozenge-shaped chitinized area surrounding the subventral anus.

d. B. glabrata *Loew*

The larva is found in the stem of the fungus *Clytocybe nebularis*. The antenna (fig. 97) carries seven small sensory papillae on the base of the terminal segment. The labrum (fig. 92) is provided with seven pairs of sensory papillae varying in size and shape. The mandible is similar to that of *B. saundersi*. The maxilla (fig. 96) bears ten teeth, of which the last two are rounded and strongly chitinized. The prothoracic spiracle (fig. 93) has six to seven spiracular openings, the external scar being eccentric and situated posterior to the spiracular openings. The abdominal spiracle (fig. 94) carries four spiracular openings lying behind the external scar. The last abdominal segment (fig. 105) bears a plate of chitin on the dorsal surface, showing two broad triangular teeth in the middle and two smaller teeth on either side. This character serves to separate this species from the others.

e. B. cinerea *Meigen*

The larva is found in *Hypholoma velutinum*. The antenna carries six small papillae at the base of the terminal segment. The labrum (fig. 99) is supported by a broad chitinized frame and bears five pairs of dorsal papillae. The mandible (fig. 100) is provided with twelve teeth along the inner border and a series of smaller teeth on the dorsal lamella. The maxilla (fig. 101) is heavily chitinized and ends in a chitinous rod which lies dorsal to a semicircular membrane connecting the two maxillary plates (fig. 98). It bears eleven teeth along the inner border. The labium is reduced to a semicircular plate of chitin supporting the salivary opening (*s.o.*). The prothoracic spiracle is provided with five spiracular openings. The external scar is posterior to the openings. The abdominal spiracle is a nipple-like chitinous projection, the distal surface showing four oval spiracular openings situated posterior to the external scar. Fig. 102 is a side view of such a spiracle showing the external scar (*s.e.*), the internal scar (*s.i.*), and the scar filament (*s.f.*), representing the collapsed tube through which the trachea of the previous instar has been drawn out.



B. glabrata (continued) *and B. cinerea* MEIGEN

FIG. 95—Head of *Bolitophila glabrata*, dorsal view. × 120.
FIG. 96—Maxilla. × 185.
FIG. 97—Antenna. × 320.
FIG. 98—Head of *Bolitophila cinerea*, ventral surface. × 185.
FIG. 99—Labrum of *B. cinerea*, dorsal surface. × 320.
FIG. 100—Mandible. × 320.
FIG. 101—Maxilla. × 320.
FIG. 102—Abdominal spiracle. × 320.
FIG. 103—Last abdominal segment of *B. pseudohybrida*. × 54.
FIG. 104—Last abdominal segment of *B. saundersi*. × 54.
FIG. 105—Last abdominal segment of *B. glabrata*, dorsal surface. × 54.

VI—Sub-family Diadocidinae Winnertz

Diadocidia Ruthe

a. Diadocidia ferruginosa *Meigen*

Biology—The larvae are found on damp barkless branches of trees lying on the ground. They live in dry silken tubes about 20 mm. long and 0·5 mm. in diameter.

The late Dr. D. Sharp gave an interesting account of the mode of life of this larva in a letter to Dr. D. Keilin, from which the following extracts are taken :—" The tubes are very delicate and flatten and collapse except in the part the larva may happen to be in. They are not perfect or elaborate structures and are more or less broken at the extremities. It is difficult to find any mode of construction other than the emission by the larva of sheets of silken slime adhering to the wood by dampness and close apposition and moreover by side threads of silk. The tubes I feel sure are not properly a construction at all. Many Mycetophilid larvae are covered with slimy silk they are constantly emitting. The matter emitted by *Diadocidia* appears to be of a more silky and less slimy nature than usual, and I imagine that to this fact and to the adhesion to the wood and possibly to some peculiarity in the integument of the larva the tubular form taken by its emitted matter is due."

" The larva frequently rests in the anterior part of the tube and protrudes its small head, moving it from side to side and touching the wood but making no movement that looks like the prehension of food. When alarmed it will dart rapidly along the tube as already stated, but usually its movement is a deliberate glide made apparently without any effort. The posterior part of the body is sometimes apparently exerted from the tube and when again withdrawn it leaves a prolongation of the smear behind it. It is in fact always covered with the slime or silk and it looks as if this were extruded from the posterior part of the body. I believe, however, this is not the case, but that it comes from the mouth and that the posterior part of the body is constantly as it were drowned in this sludge. This point is of importance in connexion with the absence of breathing organs in the abdominal region."

" Notwithstanding the larval breadth being almost that of the tube, the larva experiences no difficulty in turning itself in the other direction by doubling up. When the larva is full grown it advances to one extremity of the tube and forms outside it a curious little mass of silken matter so irregularly formed that it is scarcely entitled to be called a cocoon ; in this it turns to a pupa and if so fortunate as to escape being eaten by some of its numerous predacious neighbours, emerges in a few days. In the case of our specimens indoors this was in the latter part of October."

" When taken out of its tube the larva is a small soft almost colourless creature with a small pale yellow head, having a few black marks on this. The segmentation is obscure but there are apparently thirteen segments in addition to the head."

My observation on the living larva of *Diadocidia* agrees with Dr. Sharp's description except that I make the body segments to be twelve instead of thirteen. I have succeeded in rearing two adults out of the six living larvae obtained. The larvae were parasitized by small nematodes which were found in the body cavity of the larvae near the junction of the mid-gut with the hind-gut. I counted six such nematodes in one larva.

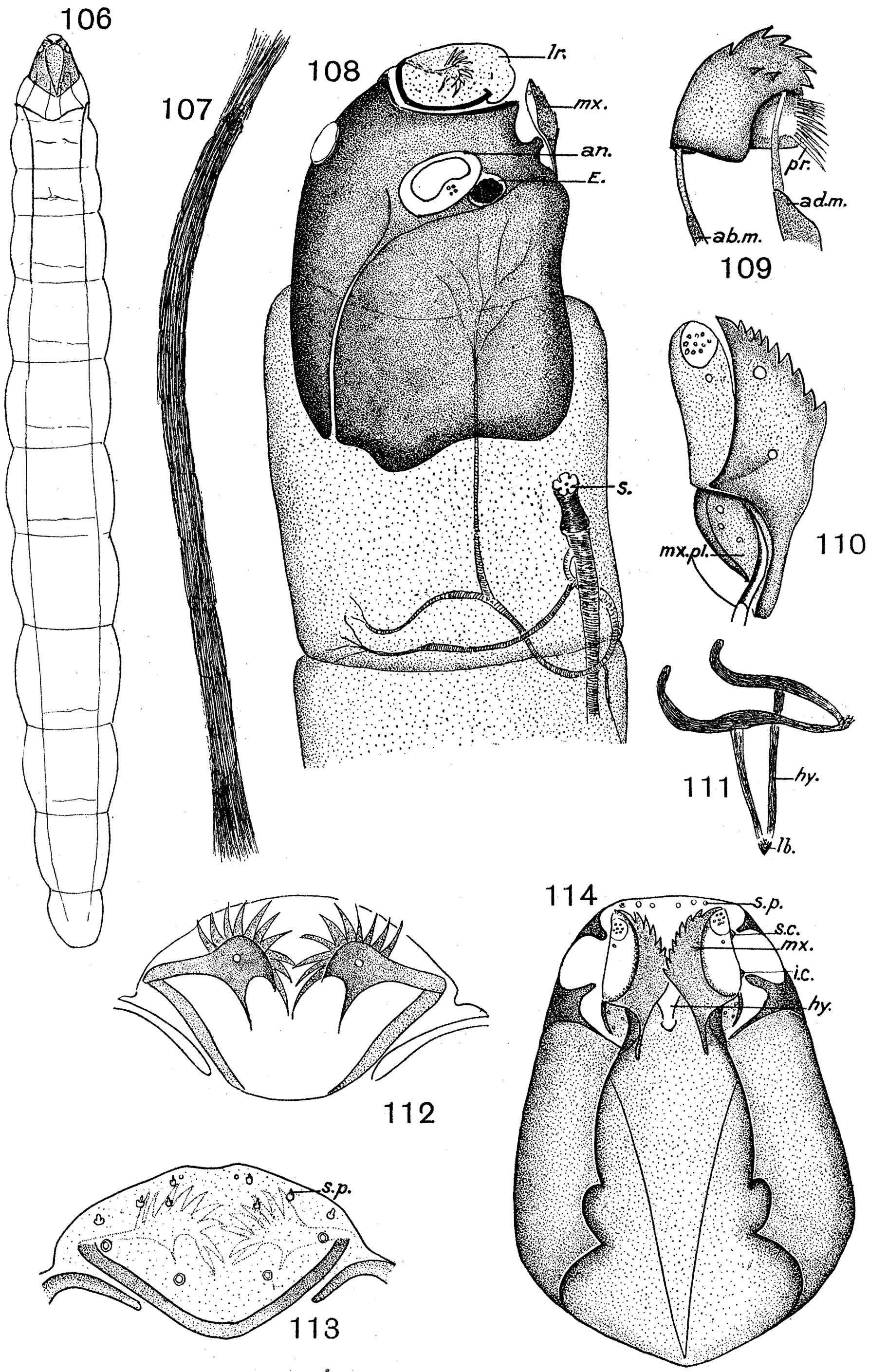
Morphology—The larva (figs. 106, 107) is slender, about 15 mm. long. The integument is polished and free from hairs and spines except for the six groups of sensory hairs representing the sensory vestiges of the legs.

The head (figs. 108, 114) is elongated, invested with a light brown chitinous capsule, and usually partly retracted in the prothoracic segment. The frontal plate is triangular in shape and tapers posteriorly to a point. The lateral epicranial plates curve to the ventral surface of the head and are separated by a transparent membrane. Anteriorly each plate sends out two chitinized tongue-shaped processes which articulate with the superior and inferior condyles of the mandibles (*s.c.*, *i.c.*, fig. 114).

The antenna (*an.*, fig. 108) is reduced to a convex transparent membrane similar to a watch-glass, and supported by a chitinized base and a band of chitin, outside which are found four small sensory papillae. The eye (*E.*, fig. 108) lies latero-ventral to the antenna and consists of a transparent membrane covering a layer of pigmented cells. The labrum (figs. 112, 113) is supported by a chitinous frame along the posterior borders, and carries seven pairs of dorsal papillae (*s.p.*). The lateral ends of the frame articulate with two chitinous arms which lie ventral to the labrum. Each arm is provided with a fan-shaped organ, composed of several curved teeth.

The mandible (fig. 109) is small and consists of a dorsal and a central lamella. The former is the smaller and bears a prostheca (*pr.*) along its inner basal border, in addition to two dorsal teeth. The inner margin is provided with seven teeth, the last of which is less chitinized than and opposed to the rest. The inner lobe of the maxilla (fig. 110) carries nine teeth, and the outer lobe, which represents the maxillary palp, is provided with a circular area covered with a transparent membrane bearing ten minute papillae. The maxillary plates (*mx.pl.*) are widely separated, fusiform in shape, and provided with three hairs each. The hypopharynx is composed of a chitinous skeleton and lies mainly dorsal to the maxillae. The skeleton consists of two vertical rods, the proximal part of which is seen between the two maxillae (*hy.*, fig. 114). Anteriorly, these rods diverge, passing dorsal to the maxillae, and finally articulate with two horn-shaped horizontal processes of the hypopharynx which meet in the mid-ventral line. In fig. 111, the hypopharynx and labium are dissected out and shown from the side. The curved parts of the horizontal processes embrace the sides of the pharynx. The labium (*lb.*, fig. 111) is reduced to a small semicircular plate, which articulates with the free ends of the vertical processes of the hypopharynx, and supports the opening of the salivary duct.

The respiratory system of *Diadocidia* is of special interest as the larva is propneustic with the tracheal trunks well defined only in the anterior four body segments (fig. 106). The prothoracic spiracle (*s.*, fig. 108) consists of five small spiracular openings arranged round the central external scar. These openings lead to a cylindrical felt chamber, the lumen of which is traversed by several chitinous threads.



Diadocidia ferruginosa Meigen

Fig. 106—Whole larva, showing respiratory system. × 8.
Fig. 107—Larva in its silken tube. × 6.
Fig. 108—Side view of head and first thoracic segment. × 120.
Fig. 109—Mandible. × 320.
Fig. 110—Maxilla. × 320.
Fig. 111—Hypopharynx. × 320.
Fig. 112—Labrum, ventral surface. × 320.
Fig. 113—Labrum, dorsal surface. × 320.
Fig. 114—Head, ventral surface. × 120.

With the exception of this species, *Ceroplatus* and *Polylepta leptogaster*, all Mycetophilid larvae are peripneustic. *Ceroplatus* is apneustic and the last propneustic. In all these forms with reduced tracheal system, the integument is very thin and moist, the larvae living in a very humid atmosphere inside hygroscopic slimy tubes. These factors will enhance skin respiration and it is probable that the reduction in the number of spiracles is a secondary adaptation to such conditions.

VII—Sub-family Ceroplatinae Winnertz

Ceroplatus Bosc

a. Ceroplatus lineatus *Fabricius*

It was Bosc (1792) who first erected the genus *Ceroplatus* for a rare fly he reared from a larva he found in the vicinity of Paris. Réaumur (1740) gave an interesting account of the biology and metamorphosis of *Ceroplatus reaumuri* under the specific name *tipuloides*. Dufour (1839, *a*) described five species of *Ceroplatus*, and gave a detailed account of *Ceroplatus tipuloides*. His description of the mouth parts and his figures are, however, not very accurate. Wahlberg (1848) gave an account of the phosphorescence of the larva and pupa ; the latter, he said, " shines through the cocoon as through a lantern ". Hudson (1891), Wheeler and Williams (1915), and Edwards (1924, *a*) gave a short description of the New Zealand "glow worm", the adult of which was described as *Bolitophila luminosa* by Skuse (1890). The genus *Arachnocampa* was subsequently erected for this species by Edwards. The larva of *A. luminosa* is totally unlike *Bolitophila* but closely resembles *Ceroplatus*.*

Biology—The larva of *C. lineatus* is found on bark-growing fungi such as *Auricularia mesenterica*. It lives under a transparent tent made of ribbons of saliva. This tent is hygroscopic and the larva is thus found in a humid atmosphere which helps its cutaneous respiration. In making this tent, the salivary secretion is poured out on the fungus, the larva then raises its head and glides forward till the four small lobes at the posterior end are brought into contact with the salivary secretion. These lobes act as a trowel, shaping the saliva into ribbons. They also help to fix the posterior end of the larva to its substratum. Before pupation it retires to a crevice and secretes a web around itself, hardly to be called a cocoon.

Ceroplatus sesioides was shown to be luminous in its larval and pupal stages by Wahlberg. The larvae live gregariously beneath a glutinous web. Wahlberg found the whole body of the larva to be luminous. According to Wheeler and Williams, " Photogenesis in this species as in certain Chironomidae, may be due to the presence of phosphorescent bacteria ".

* Edwards has recently (1933–4) given reasons founded upon the larval characters for including *Arachnocampa* in the sub-family Ceroplatinae.

In the New Zealand "glow-worm" the structure of the luminous organs, according to WHEELER and WILLIAMS, consists of "the dilated tips of the four Malpighian tubules which appear as the four curved luminous rods and therefore constitute the photogenic organ".

I have never found the larva or pupa of *Ceroplatus lineatus* to be luminous, though I looked for such a phenomenon on several nights.

The food of this larva has baffled many investigators. NORRIS (1894), HUDSON (1926), and WHEELER stated definitely that the larva subsists on insects; while RÉAUMUR, DUFOUR, PERRIS, and EDWARDS stated that the European species of *Ceroplatus* feed on fungus spores. I have examined many larvae by transparency and found their alimentary canal to be full of fungus spores. The question, however, requires more extended observations than I was able to carry out, as the larvae may feed on fungus spores as well as on small flies.*

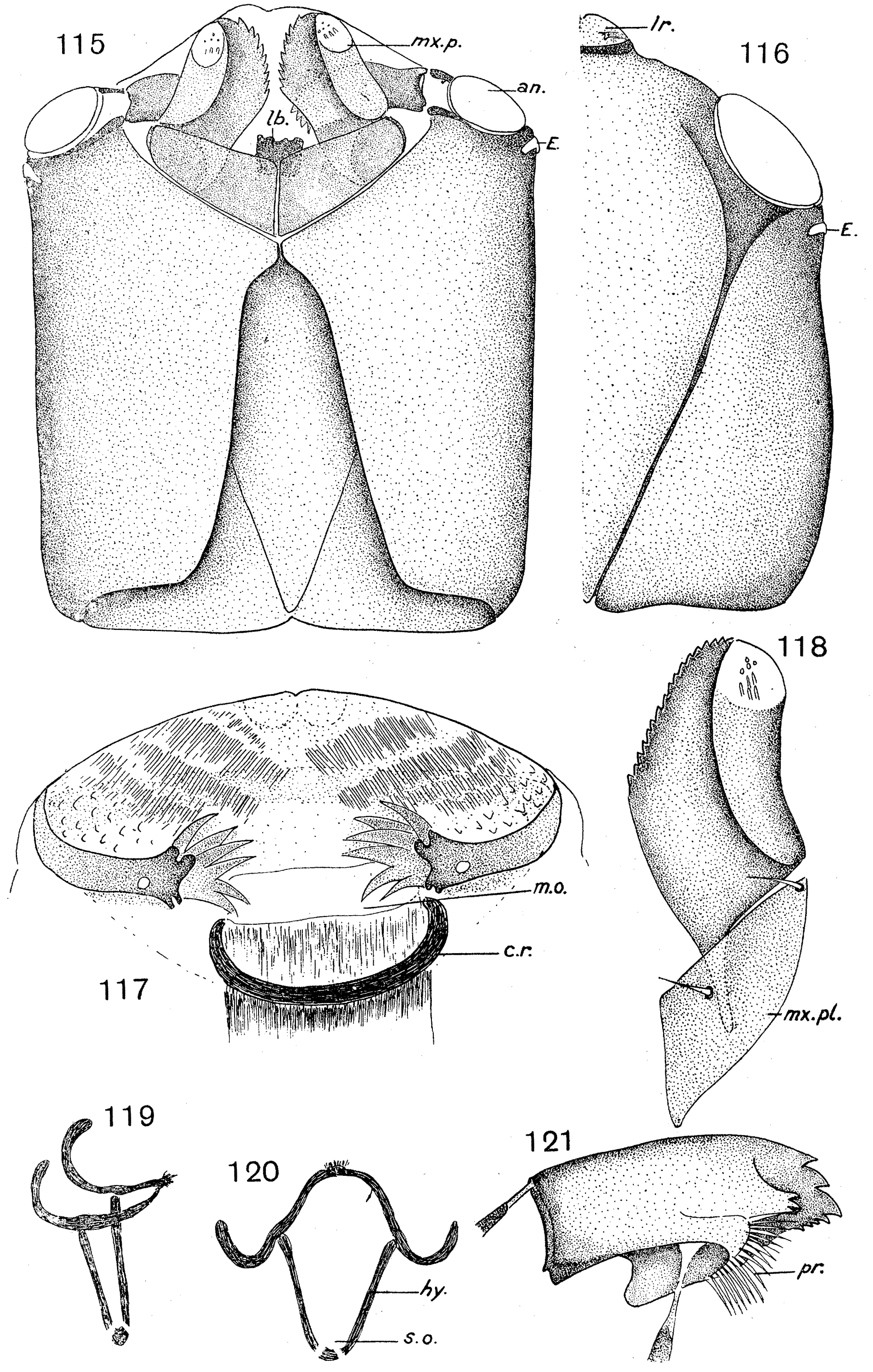
Morphology—The larva is 24 mm. long and 3 mm. wide. It is more like a small annelid worm than a dipterous larva, or, as DUFOUR said, "Elle est larve de diptère par sa partie antérieure, et annelide par le rest du corps".

The head (figs. 115, 116) is square. The sides of the frons converge to a point posteriorly. The lateral epicranial plates curve to the underside of the head and meet anteriorly, leaving between their edges a triangular space covered by a transparent membrane. The antenna (*an.*, fig. 115) consists of a convex transparent membrane, like a watch-glass in shape, and is supported by a chitinous ring. The eyes (*E.*, figs. 115, 116) are small vestigial structures situated posterior to the antennae and are composed of a transparent membrane overlying a layer of pigmented cells. The labrum (fig. 117) is small compared with the other mycetophilid larvae. It is supported by a well-developed chitinous frame which joins the clypeus anteriorly. Two well-developed chitinous arms, each carrying a fan-shaped organ, articulate at right angles to the chitinous frame. The fan-shaped organ is composed of six teeth. Four pairs of small circular sensory papillae are present on the dorsal surface.

The mandible (fig. 121) is rectangular in shape. It carries seven teeth along its inner border, of which the upper three are more developed than the rest. A set of three teeth is also present on the superior lamella.

The maxilla (fig. 118) carries seventeen small teeth along its inner border. Posteriorly it ends in a chitinized rod which lies dorsal to the maxillary plate (*mx.pl.*). The maxillary plate (*mx.pl.*) is well developed and consists of a triangular plate of chitin. It carries two sensory hairs on its upper border. The two maxillary plates meet at the mid-ventral line. The hypopharynx (figs. 119, 120) is similar to that

* Since the above was written an important paper on the biology of Ceroplatinae and Macrocerinae has been published by MANSBRIDGE (1933). He shows that the larvae of *Platyura* spp. and *Apemon* are predacious, while *Ceroplatus* and *Macrocera* are partly carnivorous. The droplets of fluid in the webs of *Platyura* and *Ceroplatus* were found to contain oxalic acid of strength sufficient to kill other insects coming into contact with it, though the larvae of the former, at least, proved to be immune. He, too, was unable to detect luminosity in the larvae dealt with.



Ceroplatus lineatus F.

FIG. 115—Head, ventral view. × 120.
FIG. 116—Dorsal view of left half of head. × 120.
FIG. 117—Labrum, ventral view. × 320.
FIG. 118—Maxilla. × 185.
FIG. 119—Side view of hypopharynx. × 185.
FIG. 120—Dorsal view of hypopharynx. × 185.
FIG. 121—Mandible. × 185.

of *Diadocidia*. A small semicircular membrane, covered with sensory hairs, is present at the junction of the horizontal processes. The labium (*lb*., fig. 115) consists of a small quadrilateral plate of chitin, situated between the free ends of the vertical processes of the hypopharynx and supports the opening of the salivary duct. Four small sensory papillae are present at the anterior border of the labium.

The body of the larva is composed of eleven segments in addition to the head. Its ventral surface is flat, while the dorsal surface is convex. The first four body-segments are quite distinct from the rest. They are rectangular in shape and of equal length. Unlike the other segments, they possess little pigment. The other segments of the body are difficult to make out, especially in preserved material, owing to the presence of circular bands of pigment, but in the living larva the segmentation is more clearly seen.

The fifth segment possesses six circular pigmented bands alternating with bands free from pigment. The sixth to the tenth body-segments are equal in length and have seven bands of pigment each. The eleventh segment tapers posteriorly and has seven bands of pigment. It ends in four conical lobes, two dorsal and two ventral, of variable size according to their stage of turgescence. The body is free from hairs and locomotory pads. The integument is very thin and shining. The larva is apneustic.

VIII—Sub-family Sciarinae Winnertz

Sciara

The literature on the Sciarinae is more extensive than that of any other sub-family of the Mycetophilidae owing to the fact that all the Mycetophilidae which have any economic importance belong to this sub-family. The larvae of many species have been recorded as root pests on various potted plants, young wheat, orchids, peas, lettuces, cucumbers, and tomatoes.

Bouché (1834) described the larva and pupa of *Sciara vitripennis* and three other species of *Sciara*. His description and figures of the mouth parts are inaccurate and he mistook the number of spiracles. Dufour (1834), Laboulbéne (1863), and Perris (1871) described several species of *Sciara*, but added little to the existing knowledge of their morphology.

Heeger (1851) gave a detailed description of the larva and pupa of *Sciara fuscipes*. His figures of the labrum, mandible, and maxilla are drawn with great care, but he failed to detect the hypopharynx, and regarded the spiracles as missing. Beling (1886) gave short descriptions of twenty-four species of larvae and pupae of *Sciara* but not a single figure. Guercio (1905) described the metamorphosis of *Sciara analis*. Malloch (1917) gave a short description of *Sciara prolifica*, and finally Thomas (1930) gave a detailed description of *S. nitidicollis*.

The damage done to the roots of plants by Sciarine larvae has been noted by Curtis (1860), Coquillet (1895), Johannsen (1910), Edwards and Williams (1917), Hungerford (1916), and Speyer (1922). All these papers give an account of the damage done to the plant attacked, but only deal with the morphology of the larvae in general terms.

Biology.—The larvae of the Sciarinae are found in various situations such as fungi, decaying wood, roots of potted plants, grass, moss, and birds' nests. Pupation takes place in a slight papery cocoon, and adults emerge by breaking the tops of the cocoons.

The migratory habit of *Sciara militaris* has been the subject of papers by GUERIN-MÉNEVILLE (1846), BELING (1883), and MIK (1883). At the time of migration the larvae, known as the army worm (Heerwurm), form a procession said to be sometimes forty to a hundred feet long, five to six inches wide and an inch in depth, and to consist of millions of larvae sticking closely together and gliding along like a serpent. Such processions have been observed in the woods in Germany, Sweden, Russia, and the United States. The object of these migrations is not known, for, as OSTEN-SACKEN pointed out, "that the larvae do not migrate in search of food, can be inferred from the fact that they appear to be full-grown when they form these processions".

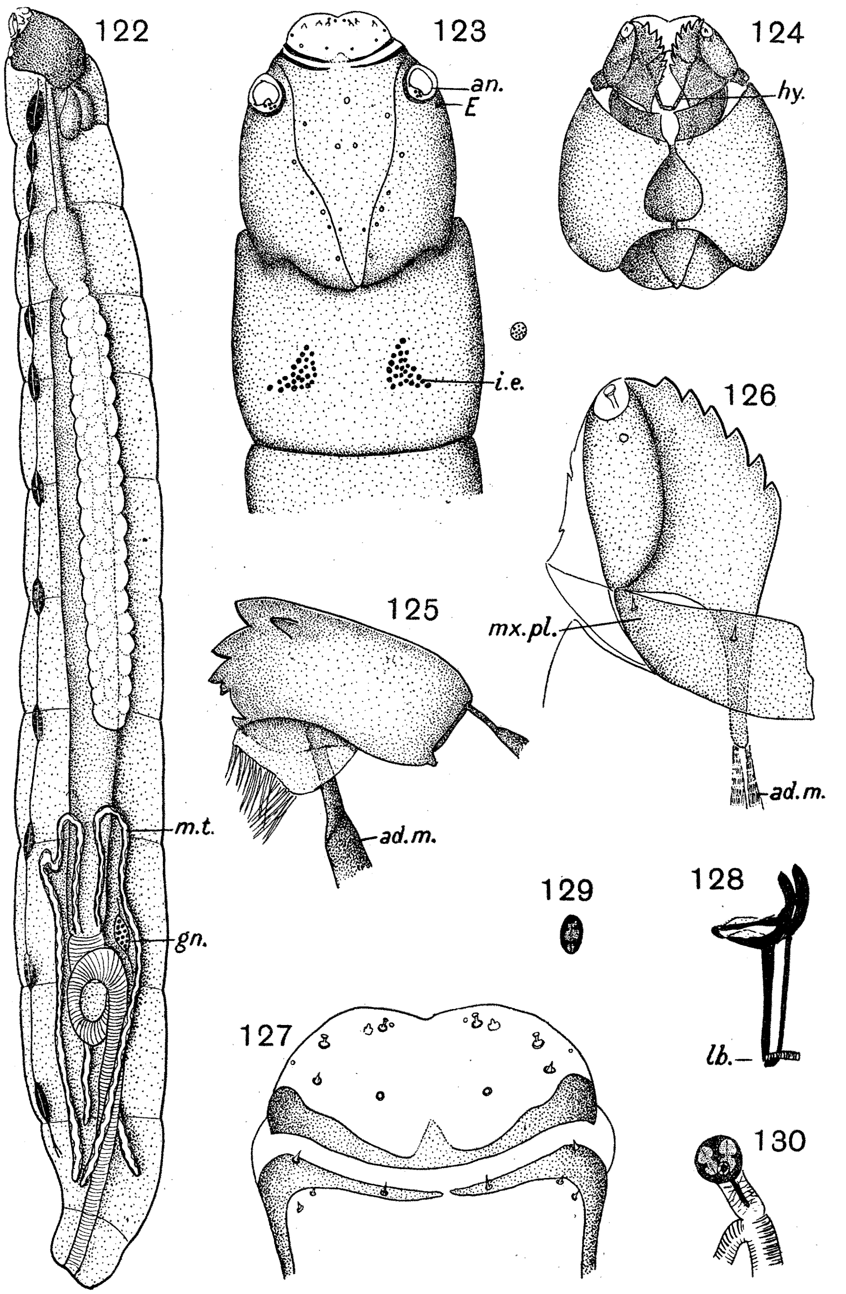
WINNERTZ believed he had found galls produced on the leaves of young lime-trees by *Sc. tilicola*, but the correctness of this identification was doubted by MIK and OSTEN-SACKEN.

The inclusion of *Sciara* among the Mycetophilidae has been questioned by ENDERLEIN, who, in 1911, pointed out the difference in the form of the adult eyes of the Sciarinae from the Mycetophilinae and their close resemblance to the eyes of the Lestremiinae. He proposed, therefore, to unite Sciarinae with the Lestremiinae into one family, the Sciaridae. This grouping is not supported by a study of the larvae of Sciarinae, which closely resemble the larvae of Mycetophilinae in the mouth parts, number of spiracles, and shape of the head. KIEFFER, has also pointed out that the larvae of Lestremiinae resemble those of other Cecidomyiidae and should be included with them. Moreover, according to EDWARDS, "the Sciarinae, like the Mycetophilidae, always possess well-developed tibial spurs, while the Lestremiinae, like the Cecidomyiinae, have none". The shape of the eyes "is not a character of fundamental importance, and as the Sciarinae present no other striking and constant points of difference from the Mycetophilinae or Sciophilinae they must be treated as a sub-family of Mycetophilidae". This view is well supported from a study of the larvae of Sciarinae and Mycetophilinae.

a. Sciara auripila *Winnertz*

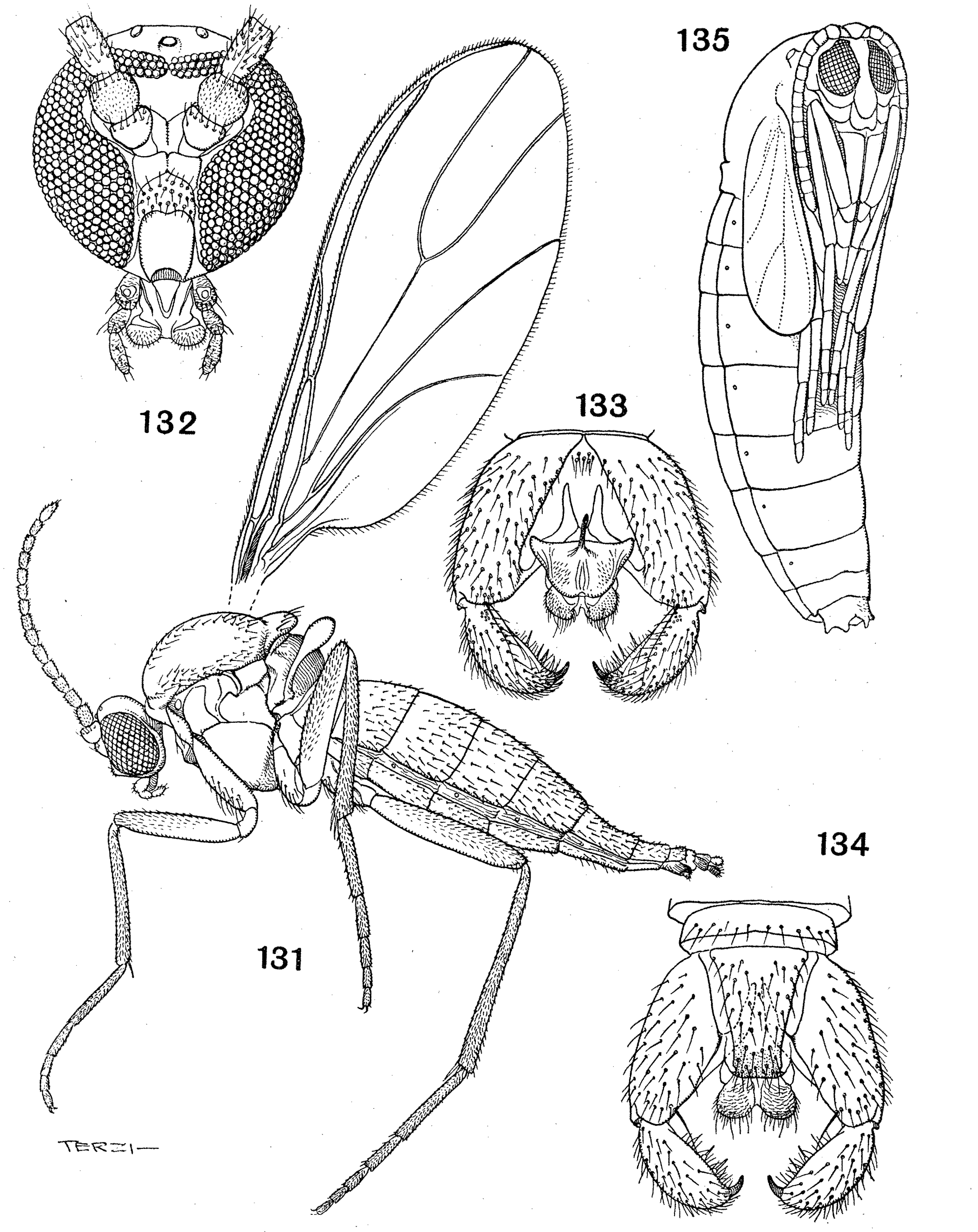
The larva lives on rotten wood covered with fungus. It measures 11–12 mm. in length, and has a black shining head and 12 abdominal segments. Pupation takes place within a papery cocoon which is found in a crevice of the wood.

The head of the larva (figs. 123 and 124) is subquadrate. The frontal plate is broadest at the level of the antennae. The lateral sutures take an undulating course and meet posteriorly. The epicranial plates curve to the ventral surface of the head and meet at two points, enclosing a triangular membranous area. The posterior



Sciara auripila WINNERTZ

FIG. 122—Whole larva, showing internal anatomy by transparency. × 10.
FIG. 123—Head and first thoracic segment. × 120.
FIG. 124—Head, ventral surface. × 120.
FIG. 125—Mandible. × 185.
FIG. 126—Maxilla. × 185.
FIG. 127—Labrum, dorsal surface. × 185.
FIG. 128—Hypopharynx, side view. × 185.
FIG. 129—Abdominal spiracle. × 540.
FIG. 130—Prothoracic spiracle. × 540.



Sciara auripila WINNERTZ (continued)

FIG. 131—Adult female. × 54.
FIG. 132—Head, front view. × 120.
FIG. 133—Male genitalia (ventral view). × 120.
FIG. 134—Male genitalia (dorsal view). × 120.
FIG. 135—Pupa. × 22.

margin of the head shows two lateral concavities. The antenna (*an.*, fig. 123) is supported by a strongly chitinized base and a circular band of chitin outside which are found four minute papillae. The larval eye (*E.*, fig. 123) consists of a pigmented layer of cells covered by a transparent membrane. In the fully mature larva, the imaginal eye (*i.e.*, fig. 123), consisting of a triangular spotted area, is found beneath the cuticle of the prothorax. Each spot consists of several granules. During pupation, the imaginal eyes move forward and overlap the larval eyes which persist as deeply pigmented spots. The labrum (fig. 127) is supported by a chitinized frame along the posterior border. Dorsally it is provided with seven pairs of sensory papillae of various shapes. The mandible (fig. 125) bears five teeth, the last of which is less chitinized than and opposed to the rest. The superior lamella carries one tooth and a well-developed prostheca situated at the inner basal angle. The maxilla (fig. 126) carries seven teeth and ends in a chitinized rod which serves for the insertion of the adductor muscle (*ad.m.*). The maxillary palp supports a transparent serrated membrane and has at the apex a circular area which carries one peg-shaped sensory papilla. The maxillary plate is quadrilateral and bears two sensory hairs. The hypopharynx (fig. 128) consists of two horizontal and two vertical processes. The latter are seen between the inner borders of the maxillae (*hy.*, fig. 124). Anteriorly, they lie dorsal to the maxillae and end by articulating with the horn-shaped horizontal processes. The labium (*lb.*, fig. 128) is situated between the vertical processes of the hypopharynx and supports the opening of the salivary gland.

The larva is provided with eight pairs of spiracles, situated in the prothorax and the first seven abdominal segments. The prothoracic spiracle (fig. 130) is biforous. The spiracular openings lead into a felt chamber which communicates with the trachea. The external scar is situated posterior to the openings. The abdominal spiracle is uniforous (fig. 129). The external scar is anterior to the spiracular opening.

The alimentary canal (fig. 122) can be seen by transparency in a larva cleared in cedarwood oil. The short pharynx is followed by the oesophagus, which is invaginated within the proventriculus. The mid-gut is in the form of a straight cylindrical tube extending from the second to the seventh body segment. Anteriorly the mid-gut communicates with two gastric caeca which are closely applied to its sides. Each caecum extends from the third to the seventh abdominal segment. Its surface is puckered by reason of the presence of circular and longitudinal muscles. The hind-gut extends from the ninth segment, makes one loop, and opens at the anus. The four malpighian tubes (*m.t.*) arise separately from the end of the mid-gut, extend a little forwards and then backwards, surrounding the hind-gut. The salivary glands (not shown in fig. 122) are tubular and extend a short distance behind the posterior end of the mid-gut. Anteriorly they join a common duct, which opens between the vertical processes of the hypopharynx. The nervous system is shown in fig. 122. It consists of supraoesophageal and suboesophageal ganglia, and a ventral chain of eleven ganglia. The supraoesophageal ganglia are joined to the suboesophageal by means of two lateral crura cerebri. The gonads (*gn.*, fig. 122) are fusiform and consist of a cluster of large rounded cells.

The pupa (fig. 133) is 4 mm. in length. The head is flat and apposed to the prothorax. The antennae curve over the upper margin of the eye and extend to the metathorax. The wings extend to the third abdominal segment. The three pairs of legs are almost on the same level, extending to the fourth abdominal segment.

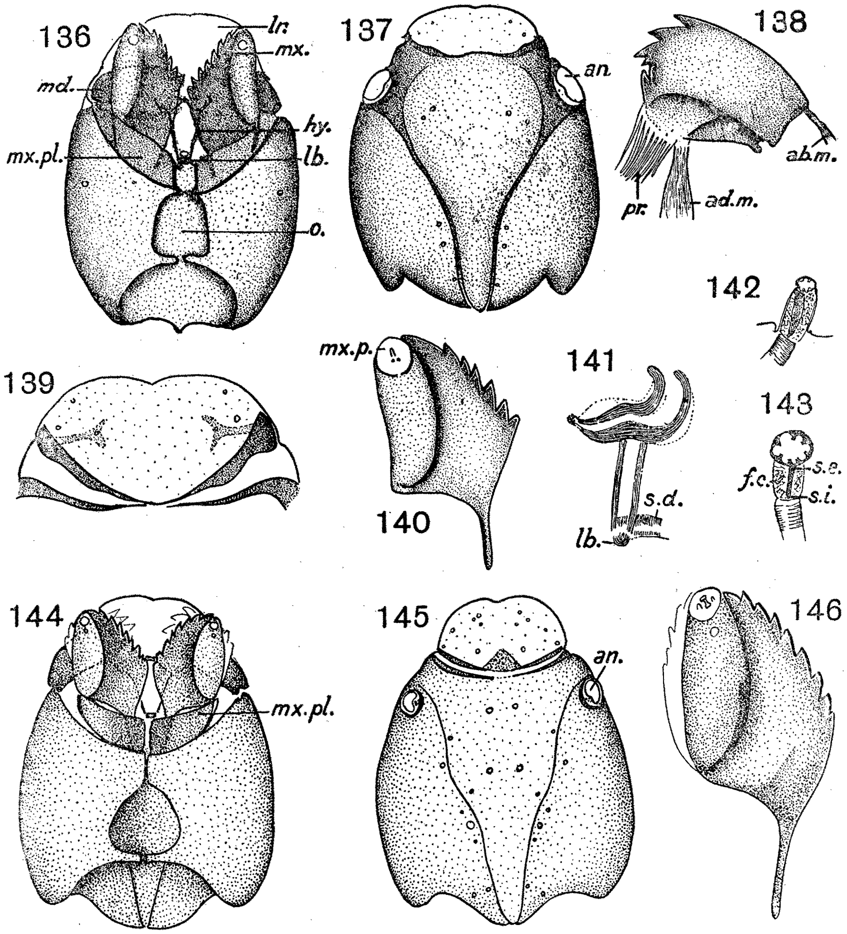
The external morphology of the adult fly and the male and female genitalia are shown in figs. 131, 132, and 134, respectively.

b. S. semialata *Edwards*

Morphology—The full grown larva is 10 mm. long, yellowish in colour, and shows a double row of yellowish granules on the dorsal surface of the last seven abdominal segments. The body is more slender than that of the Mycetophilinae and consists of 12 segments in addition to the head.

The head (figs. 136, 137) is quadrate and jet black in colour. The frons is pyriform, with the stalk directed posteriorly, and carries two pairs of minute sensory papillae. The epicranial plates curve to the ventral surface of the head where they almost meet at two points, being separated only by two narrow bands of chitin enclosing an oblong area (*o.*, fig. 136) covered with transparent chitin. The antennae (*an.*, fig. 137) are reduced to circular areas covered by transparent chitin. Each is supported by a well-chitinized base and a ring of chitin, outside which are found four minute papillae. The eyes are posterior to the antennae and consist of a thin chitinous membrane, overlying a layer of dark violet pigmented cells. The labrum (fig. 139) is supported by a chitinized frame, which is narrow in the middle and increases in breadth towards the sides. It carries two pairs of sensory papillae on the dorsal surface. Two arms of chitin articulate at right angles with the ends of the frame and are shown by transparency in the figure. The mandible (fig. 138) is rectangular in shape. The inner border is cut into five teeth, the last of which is less chitinized than and opposed to the rest. A well-developed prostheca (*pr.*) joins the superior lamella at the inner basal corner of the mandible. The maxilla (fig. 140) consists of an inner broad lobe which carries seven teeth and ends in a chitinous rod which lies dorsal to the maxillary plate. The maxillary palp shows a circular area anteriorly (*mx. p.*) covered with transparent membrane and carrying a small cylindrical sensory papilla. The maxillary plates (*mx.pl.*, fig. 136) are rectangular in shape, and enclose between them an oval area covered with transparent chitin. The hypopharynx (*hy.*, figs. 136, and 141) is of the usual form. The horizontal processes, however, in this species support a semicircular membranous area, which carries several sensory papillae. The curved parts of these processes pass medial to a chitinous U-shaped trough (not represented in the figure) which supports the ventral and lateral sides of the pharynx. The labium (*lb.*, figs. 136, 141) consists of a small rectangular piece of chitin which articulates with the free ends of the vertical processes of the hypopharynx and supports the opening of the salivary duct.

The body of the larva is slender and bears nine double rows of small spines situated on the ventral surface of the last nine intersegmental areas. The rest of the body is free from hairs except for the six groups, each group consisting of four small hairs of equal length, representing the sensory vestiges of the legs.



Sciara semialata Edwards ; *and S. fenestralis* Zetterstedt

Fig. 136—Head of *S. semialata*, ventral view. × 120.
Fig. 137—Head of *S. semialata*, dorsal view. × 120.
Fig. 138—Mandible of *Sciara semialata*. × 185.
Fig. 139—Labrum of *S. semialata*, dorsal surface. × 185.
Fig. 140—Maxilla of *S, semialata*. × 185.
Fig. 141—Hypopharynx of *S. semialata*, side view. × 185.
Fig. 142—Abdominal spiracle. × 540.
Fig. 143—Thoracic spiracle. × 540.
Fig. 144—Head of *S. fenestralis*, ventral view. × 120.
Fig. 145—Head of *S. fenestralis*, dorsal view. × 120.
Fig. 146—Maxilla of *S. fenestralis*. × 185.

The respiratory system consists of eight pairs of spiracles situated along the sides of the larva. The prothoracic spiracle (fig. 143) is slightly more dorsal than the rest and shows a circular spiracular opening with a number of chitinous projections into the lumen. This leads to a felt chamber (*f.c.*) which shows several chitinous threads within the lumen. The external scar (*s.e.*) is situated posteriorly to the spiracular opening. The abdominal spiracle (fig. 142) has a small oval spiracular opening. The external scar is anterior to the opening.

The pupa of *Sciara* is similar to that of *Brachypeza radiata* already described. It differs, however, by having longer antennae, extending to the apices of the wings. The fore, mid, and hind legs are shorter, the hind legs extending only a little beyond the apices of the wings. The prothoracic spiracles are pedunculate and assume the shape of small horns.

c. S. fenestralis *Zetterstedt*

Sciara fenestralis ZETTERSTEDT was at one time determined as *S. nitidicollis* MEIGEN, and a detailed description of its larva under the latter name was given by THOMAS (1930). A redescription of the adult, with synonymy, has been given by LENGENDORF (1930).

Sciara fenestralis was bred from larvae found in narcissus bulbs, sent by Mr. F. R. PETHERBRIDGE of the School of Agriculture, Cambridge. The larvae caused considerable damage to the bulbs.

The adults are found all the year round. The female lays its eggs in the soil and the roots of narcissus. Eclosion is effected by means of a small peg-shaped egg-burster situated at the posterior third of the frontal plate. The larva passes through four instars. In the first instar it is metapneustic ; in the second and third it is propneustic, while in the fourth it is peripneustic.

Pupation takes place within a papery cocoon and the image works its way out through a split along the dorsal surface of the pupal skin. The whole life cycle takes 30–35 days.

The mature larva measures 8 to 10 mm., and has a black glossy head and 12 abdominal segments.

The head (figs. 144 and 145) is subquadrate with arcuate sides. The frontal plate is provided with four pairs of small sensory pits. It is broadest at the level of the antennae and tapers posteriorly. The lateral sutures take an undulating course and meet posteriorly. The epicranial plates almost meet at two points, enclosing between them a triangular membranous area. Posteriorly, the dorsal margin of the head shows two lateral emarginations. The antenna (*an.*, fig. 145) is supported at the base by a strongly chitinized band of chitin, between which and an inner circular bar are four sensory papillae. The labrum (figs. 147, 149) is supported by a strongly chitinized frame, the ends of which articulate with two arms (*pl.*, fig. 149). Each arm supports a fan-shaped organ consisting of several hooks and spinules. On the dorsal surface, the labrum is provided with seven pairs of sensory papillae of different shapes. The mandible (fig. 148) bears five teeth, the last of which is less chitinized and is opposed to the rest. The superior lamella carries one tooth and a prostheca along the inner basal angle. The inner lobe of the maxilla (fig. 146) bears nine teeth and ends in a strongly chitinized rod, to which the adductor muscle is attached. The outer lobe has a circular area at its distal end which carries three sensory papillae. The lateral border supports a transparent serrated sheath. The maxillary plates (*mx.pl.*, fig. 144) are triangular and meet along the mid-ventral line. The hypopharynx (fig. 152) is of the usual form. The horizontal processes join at the mid-ventral line and support a small membrane studded with minute papillae. The labium (*lb.*, fig. 152) is a rectangular chitinous plate situated between the vertical processes of the hypopharynx. It supports the opening of the salivary duct on its ventral side.

The prothoracic spiracle (fig. 151) is biforous, with the external scar posterior to the spiracular opening. The abdominal spiracle (fig. 150) is uniforous, with the scar anterior to the opening.

THOMAS (1930) describes the first instar larva of *Sciara nitidicollis* as propneustic. In all Mycetophilid larvae the first instar is metapneustic and it is probable that THOMAS overlooked this stage in his account. It is also doubtful whether what he describes as the mandibular glands are really such. KEILIN (1913, *a*) discovered them in an unidentified Sciarine larva, but I have failed to find them in any larva of this sub-family. THOMAS's description appears to refer to the fat body.

The labium is reduced in all mycetophilid larva. THOMAS's description and figure of the labium include both hypopharynx and labium proper.

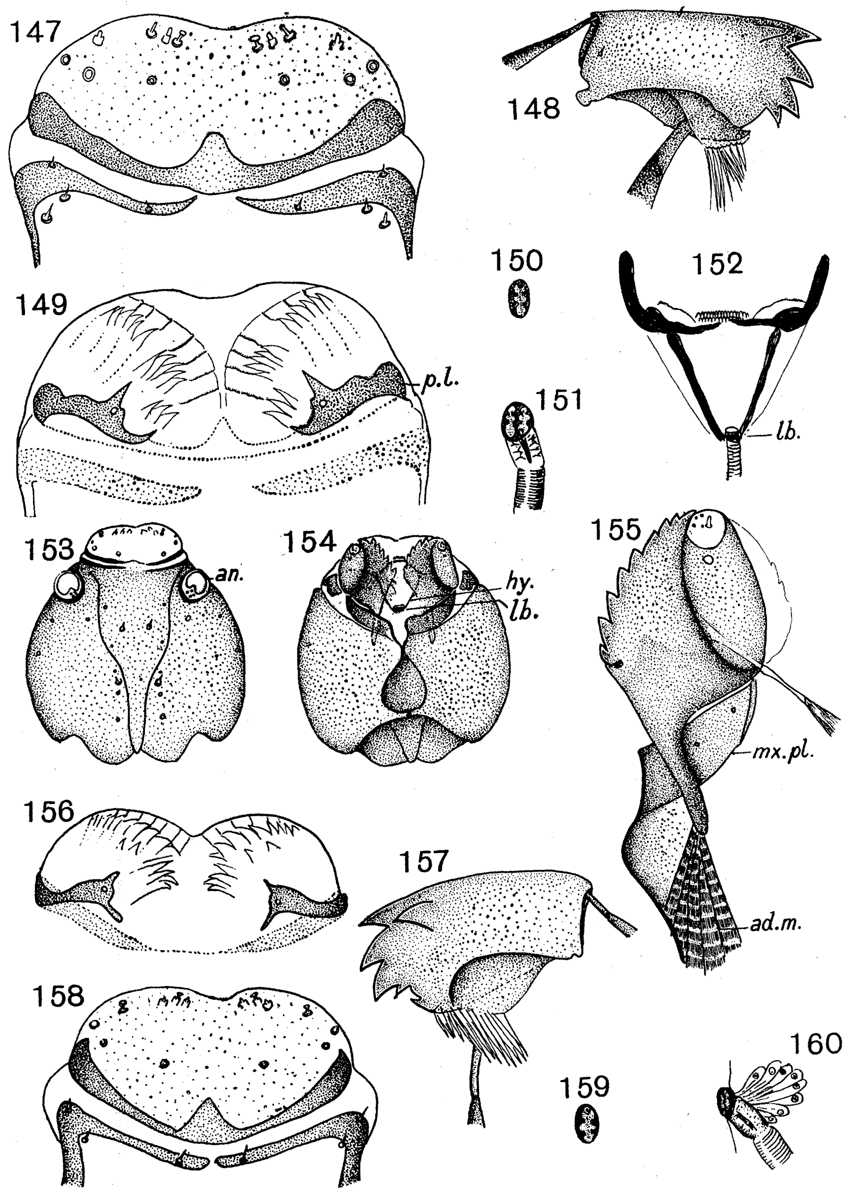
d. Plastosciara *Berg*

Plastosciara perniciosa *Edwards*

The larva is found feeding on the roots and stems of cucumbers, causing considerable damage at times. The adults are found in greenhouses.

The larva is small, measuring 5 to 6 mm. It has a black head and 12 body segments.

The head (figs. 153, 154) is subglobular. The frontal plate carries a pair of sensory hairs and four sensory pits. The sides of the plate take an undulating course and join posteriorly. On the ventral surface the lateral epicranial plates almost meet at two points, as in *S. fenestralis*. Dorsally the posterior border of the head shows two lateral emarginations. The antenna (*an.*, fig. 153) is also much like that of *S. fenestralis*. The labrum (figs. 156, 158) is provided with seven pairs of papillae, four of which resemble collar studs, the rest being circular. The mandible (fig. 157) closely resembles that of *S. fenestralis*. The maxillary palp (fig. 155) is provided with one rod-shaped and four circular papillae. Laterally the palp supports a transparent serrated membrane. The maxillary plate is triangular and bears two sensory hairs. The hypopharynx (*hy.*, fig. 154) supports a small membrane, carrying several papillae. The labium (*lb.*, fig. 154) consists of a rectangular plate, supporting the opening of the salivary gland. The prothoracic spiracle (fig. 160) is biforous, and provided with a spiracular gland composed of elongated cells. The abdominal spiracle (fig. 159) is uniforous.



S. fenestralis and *Plastosciara perniciosa* EDWARDS

FIG. 147—Labrum of *S. fenestralis*, dorsal surface. × 185.
FIG. 148—Mandible of *S. fenestralis*. × 185.
FIG. 149—Labrum of *S. fenestralis*, ventral surface. × 185.
FIG. 150—Abdominal spiracle. × 540.
FIG. 151—Prothoracic spiracle. × 540.
FIG. 152—Hypopharynx, front view. × 185.
FIG. 153—Head of *P. perniciosa*, dorsal surface. × 120.
FIG. 154—Head of *P. perniciosa*, ventral surface. × 120.
FIG. 155—Maxilla of *P. perniciosa*. × 185.
FIG. 156—Labrum of *P. perniciosa*, ventral surface. × 185.
FIG. 157—Mandible of *P. perniciosa*. × 185.
FIG. 158—Labrum of *P. perniciosa*, dorsal surface. × 185.
FIG. 159—Abdominal spiracle. × 540.
FIG. 160—Prothoracic spiracle. × 540.

IX—Sub-family Sciophilinae (Winnertz) Edwards

The larvae of this sub-family are found under the surface of bark-growing fungi. They live within delicate tubes of saliva. When taken out of their tubes they are soft, free from locomotory pads, and more slender than the larvae of other sub-families. As a rule no cocoon is formed, the pupa being merely suspended by a few threads. The whole life cycle from egg to adult lasts three to four weeks.

Eleven species belonging to ten genera are described in the following order :—(1) *Mycomyia marginata* ; (2) *M. wankowiczii* ; (3) *Leptomorphus walkeri* ; (4) *Polylepta leptogaster* ; (5) *Sciophila* ; (6) *Monoclana rufilatera* ; (7) *Apoliphthisa subincana* ; (8) *Leia bimaculata* ; (9) *Tegragoneura sylvatica* ; (10) *Boletina* sp. ; (11) *Docosia fumosa*.

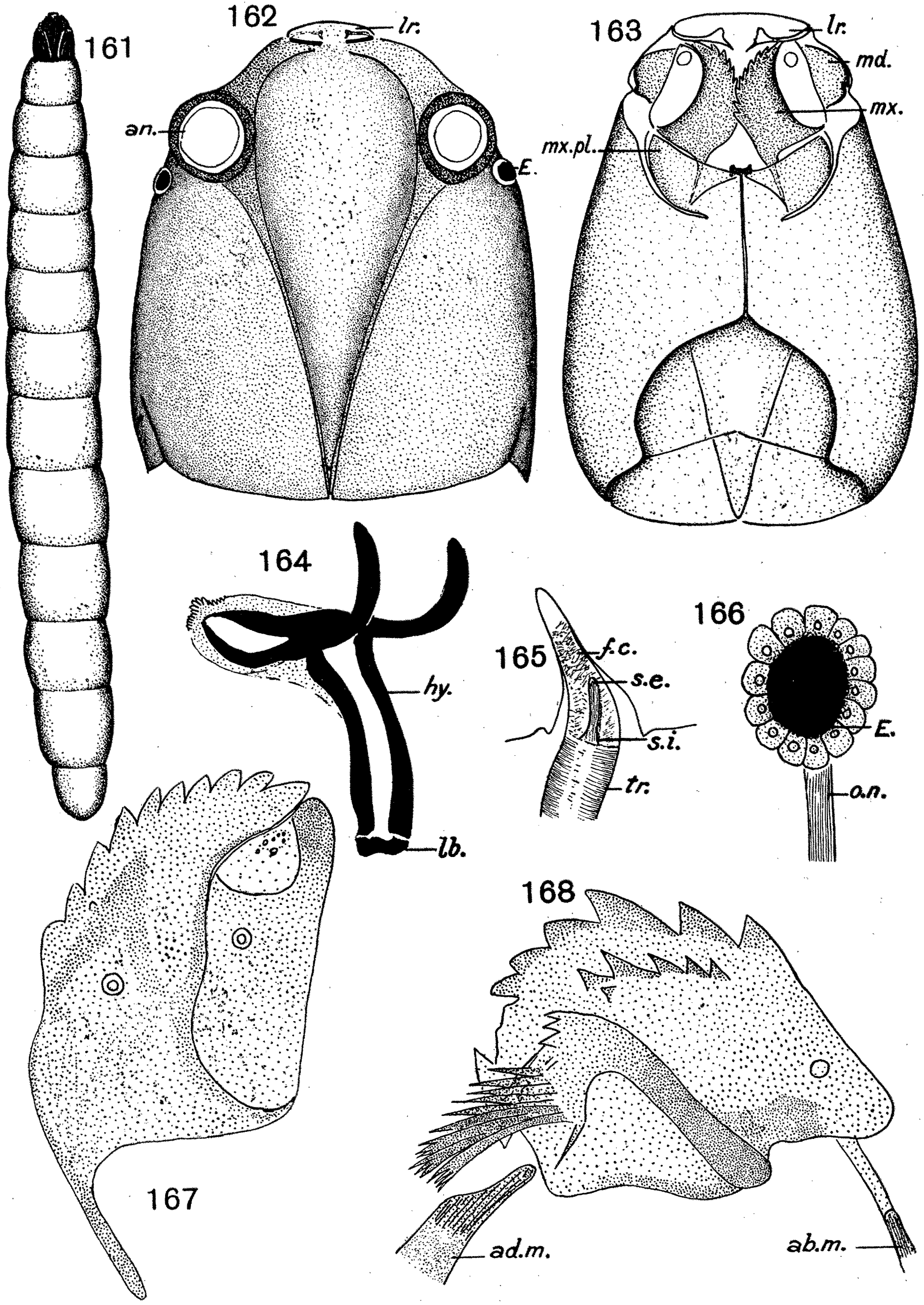
a. Mycomyia marginata *Meigen* Mycomyia *Rondani* (= Sciophila *Winnertz*)

The only description of a *Mycomyia* is that of Malloch (1917) who gave a brief description of *M. brevivittata*. The ventral surface of the head and left mandible are figured.

The larva is found under bark covered with *Poria vaporaria*. It lives in an elongated slimy tube, twice as long as the larva itself. The tube is moored to the bark by means of fine lateral threads. The larva glides backwards and forwards inside the tube and at times turns on itself by sliding the head against the body. No cocoon is formed, the pupa being merely suspended by a few threads. The removal of these threads is fatal to the pupa. They probably conduct the moisture from the bark to the pupa and thus help to maintain it in an optimum condition of humidity.

Morphology—The larva (fig. 161) is 16–18 mm. long, and is creamy white in colour, slender, broader at the middle and attenuated at both ends. The integument is thin, soft, and shining. It has 12 body segments.

The head (figs. 162, 163) is elongated. The frontal plate is triangular and tapers posteriorly to a point. The lateral epicranial plates meet along the mid-ventral suture. The antenna (*an.*, fig. 162) is supported by a strongly chitinized base and a circular band of chitin, between which are found four minute papillae. It is covered by a transparent membrane which resembles a watch glass in shape. The larval eye (*E.*, figs. 162, 166) consists of a transparent membranous area overlying a layer of pigmented cells. The optic nerve ends at the proximal extremity of these cells. The labrum is supported by a chitinized frame and carries on the dorsal surface eight pairs of sensory papillae. The mandibles (fig. 168) are well developed and bear seven teeth along the inner border. The superior lamella is furnished with a second row of smaller teeth and a prostheca. The maxilla (fig. 167) is broad. The inner lobe carries ten teeth and ends in a short chitinous rod. The outer lobe or palp is provided with a circular area covered with thin chitin and bearing seven small papillae. The hypopharynx (figs. 163, 164) supports a semicircular membrane



Mycomyia marginata MEIGEN

FIG. 161—Whole larva. × 6.
FIG. 162—Dorsal surface of head. × 120.
FIG. 163—Ventral surface of head. × 120.
FIG. 164—Hypopharynx, side view. × 320.
FIG. 165—Prothoracic spiracle. × 540.
FIG. 166—Larval eye. × 320.
FIG. 167—Maxilla. × 320.
FIG. 168—Mandible. × 320.

furnished with several minute papillae. The labium (*lb.*, fig. 164) consists of a rectangular plate which supports the opening of the salivary duct. There are eight pairs of spiracles, one prothoracic and seven abdominal, situated on the sides of the first seven abdominal segments. The prothoracic spiracle (fig. 165) consists of a chitinous nipple-like structure, which is provided with a single spiracular opening leading to a felt chamber (*f.c.*). The lumen of the felt chamber is filled with a fine reticulum of chitinous intima. The external and internal scars are shown in their relative position in fig. 165. The former is situated posterior to the spiracular opening. The abdominal spiracles are smaller in size. The external scars are anterior to the spiracular openings.

b. Mycomyia wankowiczii *Dziedzicki*

The larva is found on fallen branches, covered with a whitish fungus, on which the larva feeds.

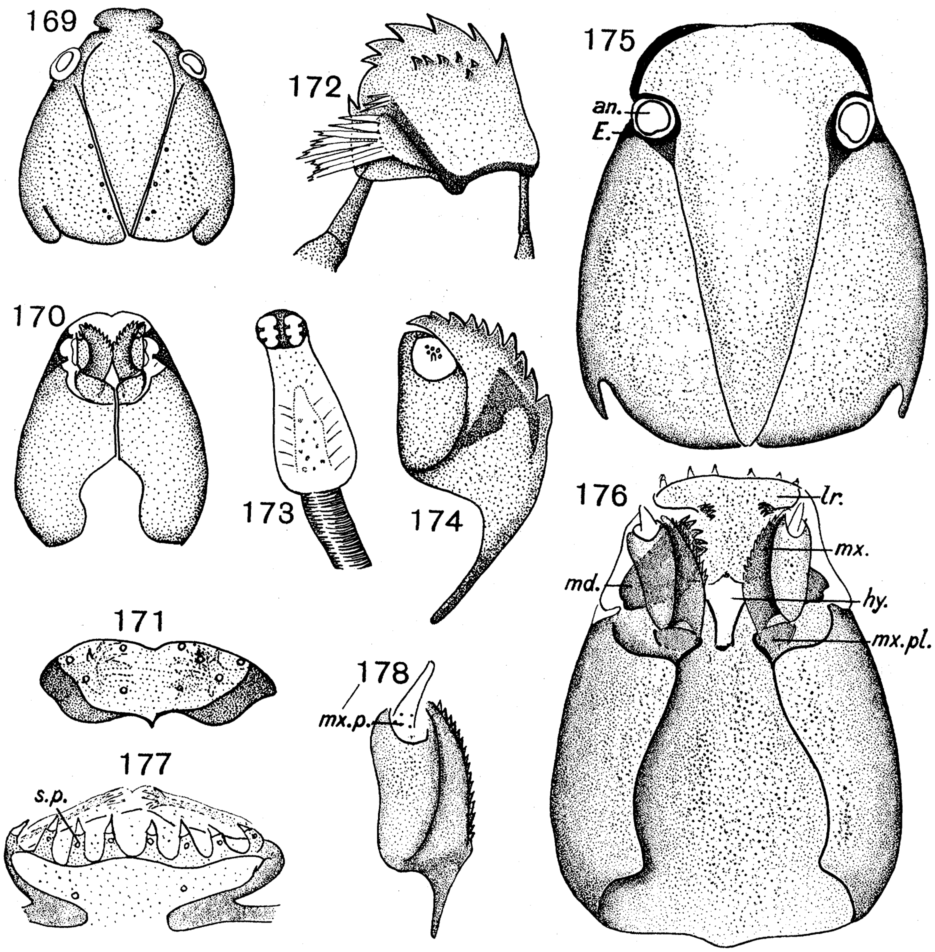
The head (figs. 169, 170) is triangular, the posterior border showing two dorsal emarginations. The lateral epicranial plates meet along the middle third of the mid-ventral line. The labrum (fig. 171) carries five pairs of sensory papillae. The mandible (fig. 172) is quadrate and bears seven teeth along the medial border, the last of which is less chitinized and opposed to the rest. The superior lamella carries six smaller teeth and a well-developed prostheca. The molar portion of the maxilla (fig. 174) is provided with ten teeth. The maxillary palp carries one conical and five circular papillae. The prothoracic spiracle is biforous ; the abdominal is uniforous.

c. Leptomorphus *Curtis*

Leptomorphus walkeri *Curtis*

Biology—The larva feeds on *Poria vaporaria*, which covers fallen branches of trees. It forms there a tube of mucilage in which it lives. The last larval skin remains attached to the pupa which, like some leptidopterous pupae, may be found suspended by threads to the lid of the breeding box. The whole life-cycle from egg to adult takes 22 to 25 days. The pupal stage lasts about a week and the flies emerged in my breeding boxes throughout September and October. It is likely that there may be two generations in the year.

The movements of this larva are very characteristic. It glides with the greatest ease and even with rapidity over the uneven and scaly fungoid growth covering the bark. In doing so, it is assisted by the very fine and numerous silken threads, which it is constantly emitting and fastening to the surface, so that they form, as it were, bridges over the depressions and inequalities. The anterior segments are extremely mobile, the first three segments constantly vibrating from side to side, while the anterior portion of the small head knocks against the fine walls of the pits of the *Poria*. It cannot be seen to take any food, but may possibly detach some microscopic food particles as it knocks its mouth against the fungus. It moves backwards and forwards with equal facility in the tube of mucilage formed by its salivary excretion. Sometimes it turns by reversing its head and then gliding along its own back. When full-grown, the larva attaches itself by the tail to the surface of the fungus by means of a bunch of threads and then changes to a pupa unprotected by any cocoon.



Mycomyia wankowiczii Dziedzicki and *Leptomorphus walkeri* Curtis

Fig. 169—Head of *M. wankowiczii*, dorsal view. × 54.
Fig. 170—Head of *M. wankowiczii*, ventral view. × 54.
Fig. 171—Labrum of *M. wankowiczii*, dorsal view. × 320.
Fig. 172—Mandible of *M. wankowiczii*. × 320.
Fig. 173—Prothoracic spiracle of *M. wankowiczii*. × 540.
Fig. 174—Maxilla. × 320.
Fig. 175—Head of *L. walkeri*, dorsal surface. × 120.
Fig. 176—Head of *L. walkeri*, ventral surface. × 120.
Fig. 177—Labrum of *L. walkeri*, dorsal surface. × 185.
Fig. 178—Maxilla of *L. walkeri*. × 185.

Morphology—The larva measures 15 mm. in length and has a free head and twelve body segments. The integument is polished, shining, and marked with delicate irregular fuscous marks, some of which coalesce so as to form pairs of small spots, one or two pairs on each segment. These marks are subject to much variation but they are absent on the first and last segments.

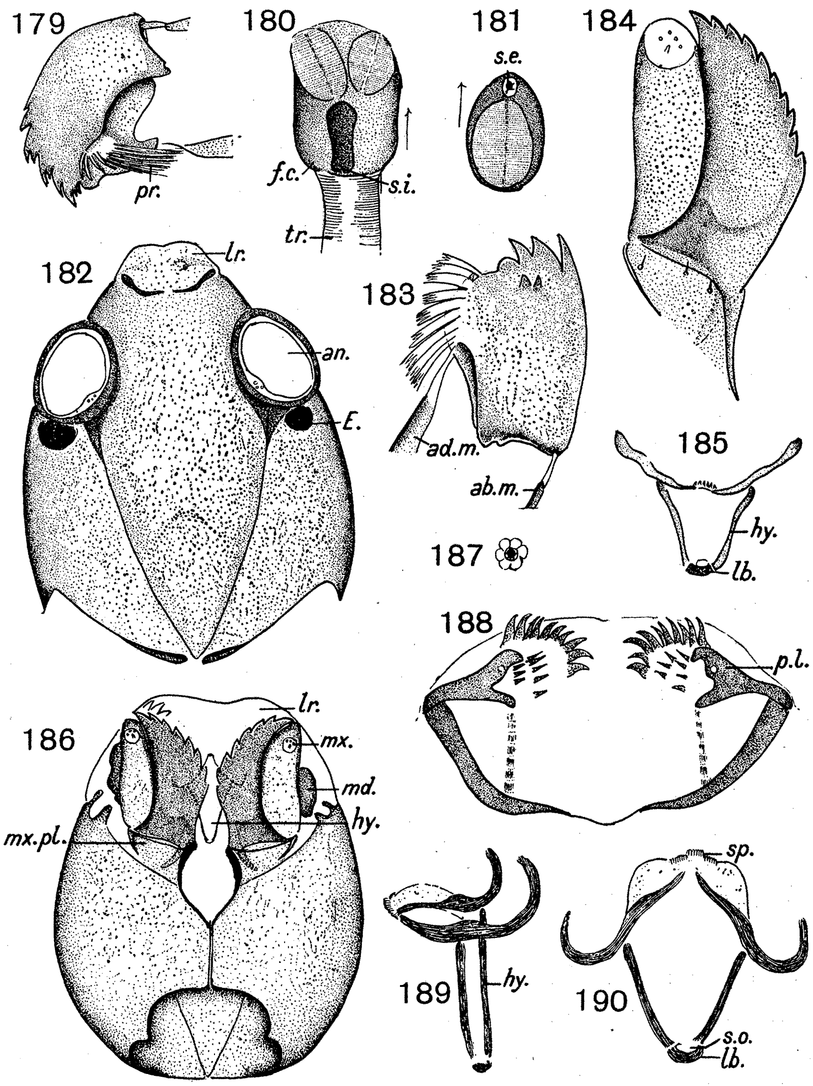
The head (figs. 175, 176) is elongated. The frontal plate is triangular and tapers posteriorly to a point. The epicranial plates are joined together only by a transparent soft membrane so that the cranium is not chitinized on the ventral surface. The dorsal posterior margin of the head shows two marked lateral emarginations. The antenna (*an.*, fig. 175) is very similar to those already described. The eyes (*E.*, fig. 175) are deeply pigmented and situated postero-laterally to the antennae. The labrum (fig. 177) is supported posteriorly by a chitinous frame which is interrupted in the middle. Each end of the frame articulates with an arm of chitin, which passes ventral to the labrum and carries a fan-shaped organ. The labrum carries seven well-developed sensory papillae (*s.p.*), each consisting of a basal cylindrical part and a terminal conical papilla. This is the only larva in which the dorsal papillae are well developed. The dorsal surface of the labrum is strengthened by a band of chitin which runs anterior to the bases of the papillae. The mandible (fig. 179) articulates with the epicranial plate by means of two tongue-shaped chitinous projections seen on the ventral surface of the head. It is almost rectangular in shape and carries along its inner convex margin six teeth, of which the third, fourth, and sixth bear additional denticles. It consists of two lamellae which unite along the inner toothed border. The dorsal lamella is smaller than the ventral and carries a prostheca (*pr.*) at its inner basal corner. The maxilla (fig. 178) consists of an inner narrow cultriform lobe, bearing sixteen small teeth, and an outer lobe, the maxillary palp, which shows a circular area anteriorly covered with transparent membrane, and carrying four small papillae and one elongated conical papilla (*mx.p.*). The maxillary plates (*mx.pl.*, fig. 176) are small quadrate, chitinized areas separated by a transparent membrane. The hypopharynx (*hy.*, fig. 176, 185) supports a semicircular membrane whose free border is fringed with small sensory hairs.

The larva is peripneustic, bearing eight pairs of spiracles, on the prothoracic and first seven abdominal segments. The prothoracic spiracle (fig. 180) is biforous, with the external scar situated posterior to the spiracular openings. The abdominal spiracle (fig. 181) has one opening, situated posterior to the external scar (*s.e.*).

d. Speolepta *Edwards*

Speolepta leptogaster *Winnertz*

Schmitz (1912) gives a detailed account of *S. leptogaster*. The figures are drawn with great care and he discusses the atrophy of the larval eyes in relation to troglophilic habit, as well as the development of accessory eyes in the adults from two small crescent-shaped pigmented areas at the sides of the mid-dorsal line in the prothorax of the larva. Cheetham (1920) found the larva and pupa of *Polylepta* in a cave in Yorkshire and gives a brief description of the pupa.



Leptomorphus walkeri (continued) and *Speolepta leptogaster* WINNERTZ

FIG. 179—Mandible of *Leptomorphus walkeri*. × 185.
FIG. 180—Prothoracic spiracle of *Leptomorphus walkeri*. × 540.
FIG. 181—Abdominal spiracle of *Leptomorphus walkeri*. × 540.
FIG. 182—Head of *Speolepta leptogaster*, dorsal surface. × 185.
FIG. 183—Mandible of *S. leptogaster*, ventral surface. × 320.
FIG. 184—Maxilla of *S. leptogaster*. × 320.
FIG. 185—Hypopharynx of *Leptomorphus walkeri*. × 320.
FIG. 186—Head of *S. leptogaster*, ventral surface. × 185.
FIG. 187—Prothoracic spiracle of *S. leptogaster*. × 540.
FIG. 188—Labrum of *S. leptogaster*, ventral surface. × 320.
FIG. 189—Hypopharynx of *S. leptogaster*, side view. × 320.
FIG. 190—Hypopharynx of *S. leptogaster*, ventral view. × 320.

The larvae are found on the walls of dark damp caves. They live in a slimy tube of saliva. The pupae, according to CHEETHAM, are found hanging free and head downwards, with the empty larval skins attached to their hind end.

Morphology—The larva is a slender, worm-like creature, 15 mm. long, broadest in the middle and attenuated at both ends. The integument is soft, polished, and free from hairs, except for six groups of sensory hairs representing the vestiges of the legs.

The head (figs. 182, 186) is elongated, subconical in shape, widest at the middle and narrow anteriorly. The frontal plate attains its maximum width at the posterior border of the antennae and tapers posteriorly to a point. The lateral epicranial plates curve and meet along the posterior third of the mid-ventral line. Anteriorly each plate sends out two chitinous tongue-shaped projections which articulate with the superior and inferior condyles of the mandible. The antenna (*an.*, fig. 182) is convex and has papillae between the two supporting chitinous bands. The eyes (*E.*, fig. 182) are situated posterior to the antennae. Each eye consists of a transparent membrane overlying a layer of pigmented cells. The labrum (fig. 188) is fleshy and encased in a chitinous frame which is attenuated at the middle. The dorsal surface carries six pairs of sensory papillae of different shapes. The mandible (fig. 183) is provided on the inner border with five teeth, the last of which is less chitinized and opposed to the rest. The superior lamella bears two smaller teeth and a well-developed prostheca, consisting of several flat hairs with ciliated free margins.

The inner cultriform lobe of the maxilla (fig. 184) bears ten teeth on the inner margin and ends in a short chitinous rod. The outer lobe shows a circular area anteriorly covered with transparent chitin and bearing one cylindrical and four circular papillae. The maxillary plates (*mx.pl.*, fig. 186) are quadrilateral in shape with strongly chitinized borders. The two inner borders meet posteriorly and enclose a transparent membranous area situated posterior to the labium. Each maxillary plate bears three sensory hairs. The greater part of the hypopharynx lies dorsal to the maxillae. The horizontal processes meet in the mid-ventral line and support a semicircular membrane whose free border carries several sensory papillae (*s.p.*, fig. 190).

The labium (*lb.*, fig. 190) is reduced to a small semicircular chitinous plate. The respiratory system is identical with that of *Diadocidia*. The larva is propneustic and the two longitudinal tracheal trunks, according to SCHMITZ, are only well developed in the anterior three segments. The prothoracic spiracle (fig. 187) is provided with six small spiracular openings surrounding the external scar.

According to SCHMITZ, the larva is divided into four regions : (1) head, (2) three thoracic segments, (3) seven distinct abdominal segments, (4) three indistinct terminal segments. I have only preserved material of this larva and it is difficult to be certain of the number of segments. It is, however, unlikely that the larva should have thirteen segments, while closely allied forms have only twelve, the typical number in the Mycetophilidae.

Schmitz failed to see the six groups of sensory hairs, which are placed in direct relationship to the imaginal discs of the legs and which have been described by Keilin in several families of Diptera. I have found them to be constant in all Mycetophilid larvae, including *S. leptogaster*. Every group consists of four small sensory hairs of equal length. They are so minute as to require a high magnification (oil immersion lens)—a fact that may account for Schmitz having overlooked them.

The labium and hypopharynx are described together in Schmitz's paper. The labium is said to be rudimentary and completely hidden within the head. The description of the hypopharynx and the figures given agree with mine, except that the membrane supported by the anterior portion of the horizontal processes is considered as forming part of the labium. I consider this structure as entirely belonging to the hypopharynx. The labium may be seen from the ventral surface of the head as a semicircular chitinous plate, articulating with the free ends of the vertical processes of the hypopharynx and supporting the opening of the salivary duct.

Respiratory System—According to Schmitz, the integument in *Speolepta* is so thin that respiration in the larva is mainly cutaneous. Trachae are, however, found in the head and first three body segments. Schmitz believes that he has found not only a functional pair of prothoracic spiracles but also a non-functional pair on the mesothorax.

Respiration is entirely cutaneous in the Ceroplatinae, which have an extremely thin cuticle. *Diadocidia*, like *Speolepta*, has the respiratory system developed only at the anterior end of the larva, the prothoracic spiracles alone being functional. But neither in *Diadocidia* nor in any other Mycetophilid larva have I found any trace of a non-functional spiracle in the mesothorax. It seems likely that Schmitz has seen the non-functional spiracles of the metathorax, which are present in all Mycetophilid larvae.

e. Sciophila *sp.* ?

Sciophila *Miegen*

(= Lasiosoma *Winnertz*)

De Geer (1776) described what he called the larva of *Tipula seticornis*, but this Perris suggests may have been a *Sciophila* or a *Leia*.

Van Roser (1834) and Bremi (1846) described larvae believed by them to be a species of *Sciophila*. According to Osten-Sacken, however, it is probable that both these authors were dealing with species of *Mycetophila*.

Dufour (1841), Perris (1849), and Osten-Sacken described various species of *Sciophila*. Dufour described *Sciophila striata* as having no mandible and no palps, and the spiracles as consisting of nine pairs. Perris (1870) gives an excellent account of *Sciophila striata* which agrees with that of Osten-Sacken.

I found the larvae in *Polyporus giganteus*, in association with other Mycetophilid larvae. I failed to rear them, but have no doubt that they belonged to the genus

Sciophila, for when examined under the binocular the larvae shot out a pair of antenniform processes from the front of the head. These processes when fully extended were about as long as the head itself. On dissection these structures proved to be the well-developed maxillary palps, a feature of *Sciophila* larvae, which were first described and figured by OSTEN-SACKEN.

The larva lives within a delicate tube of mucilage. Pupation takes place in a slight dry silken cocoon placed in a crevice in the fungus.

Morphology—The larva (fig. 191) is 15 mm. long, slender, and tapered at both ends.

The head (figs. 192, 197) is light brown, elongated, narrow anteriorly and broad posteriorly. The frontal plate is broad at the level of the antennae and tapers posteriorly to a point. The lateral epicranial plates meet ventrally along the mid-ventral line. The dorsal border of the occipital foramen shows no emargination. The antenna (*an.*, fig. 197) has two minute sensory papillae situated between the two chitinous bands. The eyes (*E.*) are posterior to the antennae, opaque, and black. The mandible (fig. 195) is quadrilateral in shape ; its inner border bears seven teeth, the last of which is less chitinized than and opposed to the rest. The prostheca (*pr.*) overlies the last tooth and joins the superior lamella at the inner basal corner of the mandible. The inner lobe of the maxilla (fig. 194) is narrow and curved. It carries 17 small teeth along its inner border, and ends in a chitinous rod. The outer lobe is broad and shows a circular area, through which the elongated subuliform maxillary palp (*mx.p.*) is shot out. The maxillary plates (*mx.pl.*, fig. 192) are triangular in shape and meet in the mid-ventral line. The hypopharynx (fig. 193) consists of the usual horizontal processes and vertical rods. The curved part of the horizontal processes, however, passes medially to a trough-shaped chitinized plate (*c.r.*) which supports the ventral and lateral sides of the pharynx.

The labium (*lb.*, figs. 192, 193) is reduced to a small plate of chitin.

The body is free from hairs and locomotory pads, except for the six groups of sensory hairs which represent the vestiges of the legs. The integument is polished and shining. The thoracic segments are marked by circular black bands (fig. 191) which under a high magnification are found to consist each of a number of spots of pigment.

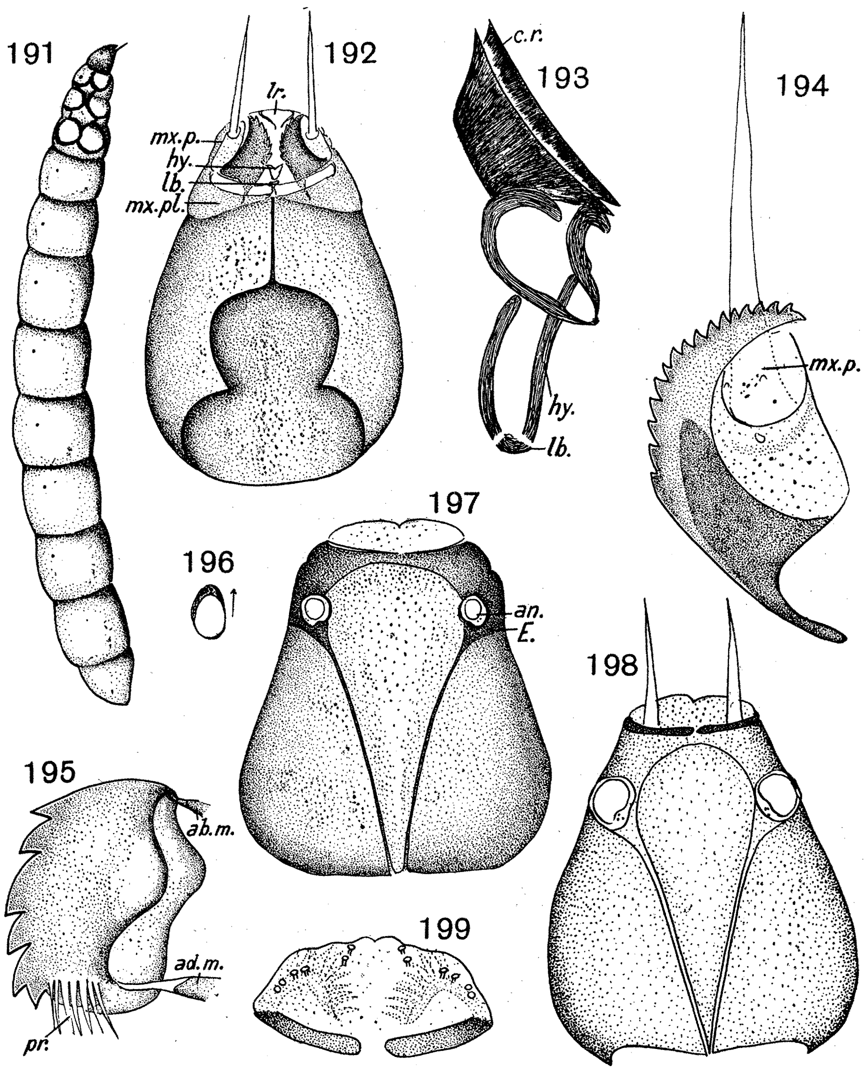
The larva has eight pairs of small spiracles ; one prothoracic, which is biforous, with the external scar posterior to the spiracular openings, and seven abdominal, situated on the sides of the first seven abdominal segments. The abdominal spiracle (fig. 196) is uniforous with the external scar anterior to the opening.

f. Monoclona *Mik*

Monoclona rufilatera *Walker*

The larva measures 12 to 15 mm. and is found on rotten wood attacked by fungus. It lives within a tube of mucilage about twice its own length. Pupation takes place within a dry silken cocoon placed in a crevice of the wood.

The head (figs. 198, 200) is elongated, narrow anteriorly and broad posteriorly. The frontal plate is broadest at the level of the antennae and tapers posteriorly to a point. The lateral epicranial plates meet along the middle third of the mid-ventral line, then separate and meet again posteriorly, enclosing an oval area covered with transparent chitin. Anteriorly, each plate has two small chitinized processes which



Sciophila sp. and *Monoclona rufilatera* WALKER

FIG. 191—Larva of *Sciophila*. × 6.
FIG. 192—Head of *Sciophila*, ventral surface. × 120.
FIG. 193—Hypopharynx of *Sciophila*. × 320.
FIG. 194—Maxilla of *Sciophila*. × 320.
FIG. 195—Mandible of *Sciophila*. × 320.
FIG. 196—Abdominal spiracle of *Sciophila*. × 540.
FIG. 197—Head of *Sciophila*, dorsal surface. × 120.
FIG. 198—Head of *Monoclona rufilatera*. × 120.
FIG. 199—Labrum of *Monoclona rufilatera*, dorsal surface. × 320.

articulate with the superior and inferior condyles of the mandibles. The antenna bears three sensory papillae between the supporting bands of chitin. The labrum (fig. 199) is transverse and carries six pairs of sensory papillae, four of which are rod-shaped and the rest circular. The mandible (fig. 201) is quadrate and carries seven teeth. The prostheca overlies the last tooth, which is less chitinized than the rest. The maxillary mala (fig. 202) is curved and carries sixteen teeth. It ends in a short chitinized rod which lies dorsal to the maxillary plate and serves for the attachment of the adductor muscle. The maxillary palp is provided anteriorly with a circular membranous area, through which the elongated sensory process is shot out. When fully extended, the process is about half the length of the larva. The maxillary plate is triangular, the sides being curved. It carries two sensory hairs. The hypopharynx and labium are similar to those of *Sciophila*.

The larva is provided with eight pairs of spiracles ; one prothoracic and seven abdominal. The thoracic spiracle (fig. 203) is biforous, the external scar being posterior to the spiracular openings. The abdominal spiracle (fig. 204) is uniforous. The spiracular opening leads into a felt chamber.

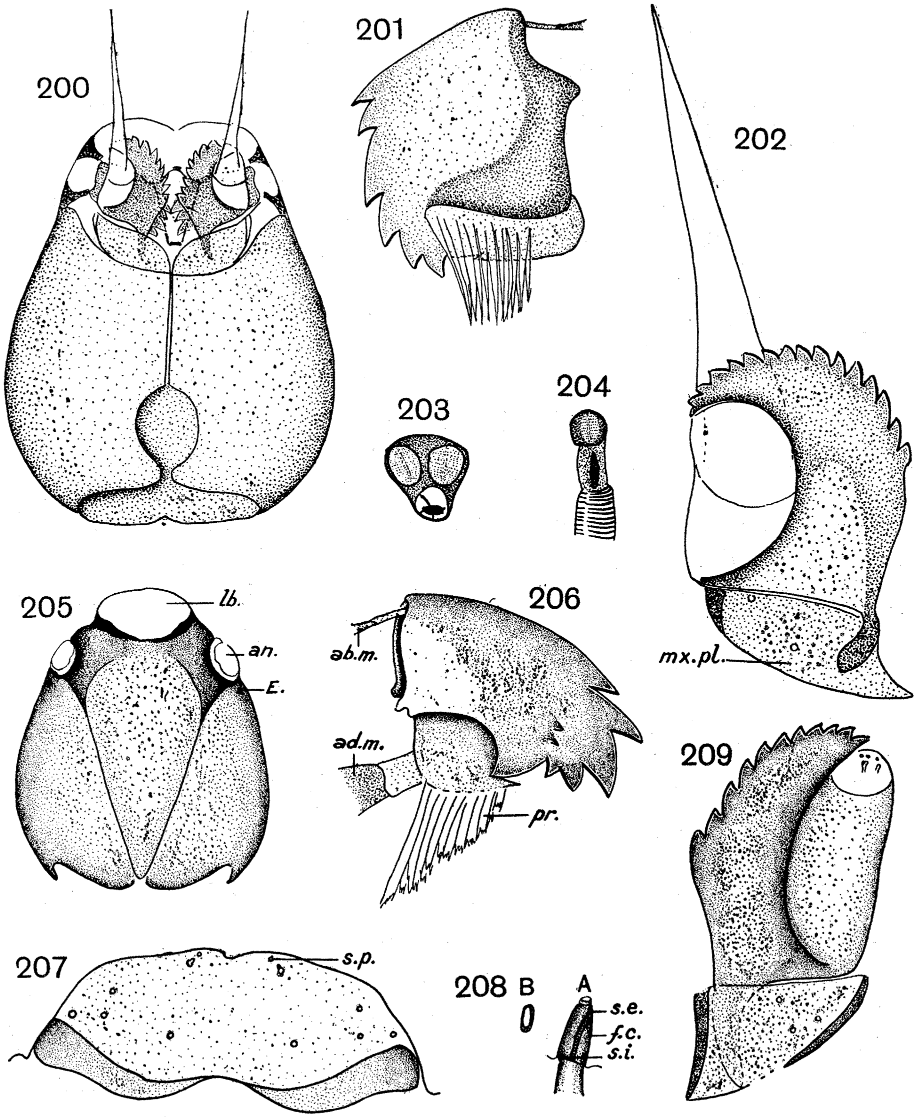
g. Apoliphthisa *Grzegarzk*

Apoliphthisa subincana *Curtis*

The larva feeds on *Poria vaporaria* growing on oak bark. It spins a tube of mucilage, within which it glides with ease. The tube is anchored to the fungus by means of several strands of saliva. The pupa is short, stout, and suspended by a few threads of saliva, but no definite cocoon is formed. The mode of progression is similar to that of *Leptomorphus*.

Morphology—The larva is 16 mm. long. It is slender, creamy white in colour, broadest in the middle and gradually tapering at both ends. The integument is shining and free from hairs and spines, except for the six groups of sensory hairs representing the vestiges of the legs.

The head (fig. 205) is invested with a dark brown chitinous capsule. The frontal plate is triangular in shape, widest at the level of the antennae and tapering gradually to a point at the dorsal margin of the occipital foramen. The epicranial plates on the ventral surface are separated by a transparent membrane. The posterior border of the occipital foramen shows two lateral emarginations on the dorsal surface. The antenna (*an.*, fig. 205) is convex, and supported by a strongly chitinized base, and a ring of chitin. The eyes (*E.*, fig. 205) consist of two small pigmented areas situated postero-laterally to the antennae. The labrum (fig. 207) is transverse, about twice as broad as long. Its chitinous frame is thin at the middle and broadens gradually towards the sides. It carries six pairs of small dorsal sensory papillae (*s.p.*). The mandible (fig. 206) carries on the inner border six teeth of various sizes, the last of which is less chitinized than and opposed to the rest. The superior lamella bears two smaller dorsal teeth and a well-developed prostheca, consisting of several flat



Monoclona (continued) and *Apoliphthisa subincana* CURTIS

FIG. 200—Head of *M. rufilatera*, ventral view. × 120.
FIG. 201—Mandible of *M. rufilatera*. × 320.
FIG. 202—Maxilla of *M. rufilatera*. × 320.
FIG. 203—Prothoracic spiracle. × 540.
FIG. 204—Abdominal spiracle. × 540.
FIG. 205—Head of *A. subincana*, dorsal surface. × 120.
FIG. 206—Mandible of *A. subincana*. × 320.
FIG. 207—Labrum of *A. subincana*, dorsal surface. × 320.
FIG. 208—A. Prothoracic spiracle. B. Abdominal spiracle. × 540.
FIG. 209—Maxilla. × 320.

hairs with ciliated margins. The inner cultriform lobe of the maxilla (fig. 209) carries eleven teeth. The maxillary palp carries two cylindrical and three circular sensory papillae. The maxillary plates are triangular in shape, each bearing three sensory hairs. The hypopharynx is similar to that of *Sciophila*. The labium is provided with two pairs of minute papillae.

There are eight pairs of spiracles ; one prothoracic and seven abdominal, the latter borne on the sides of the fourth to the tenth segments. The prothoracic spiracle (fig. 208, A) is a slender nipple-like chitinous projection provided with two small oval openings situated posterior to the external scar. The abdominal spiracle (fig. 208, B) is uniforous.

h. Leia *Meigen*

Leia bimaculata *Meigen*

(= Glaphyraptera *Winnertz*)

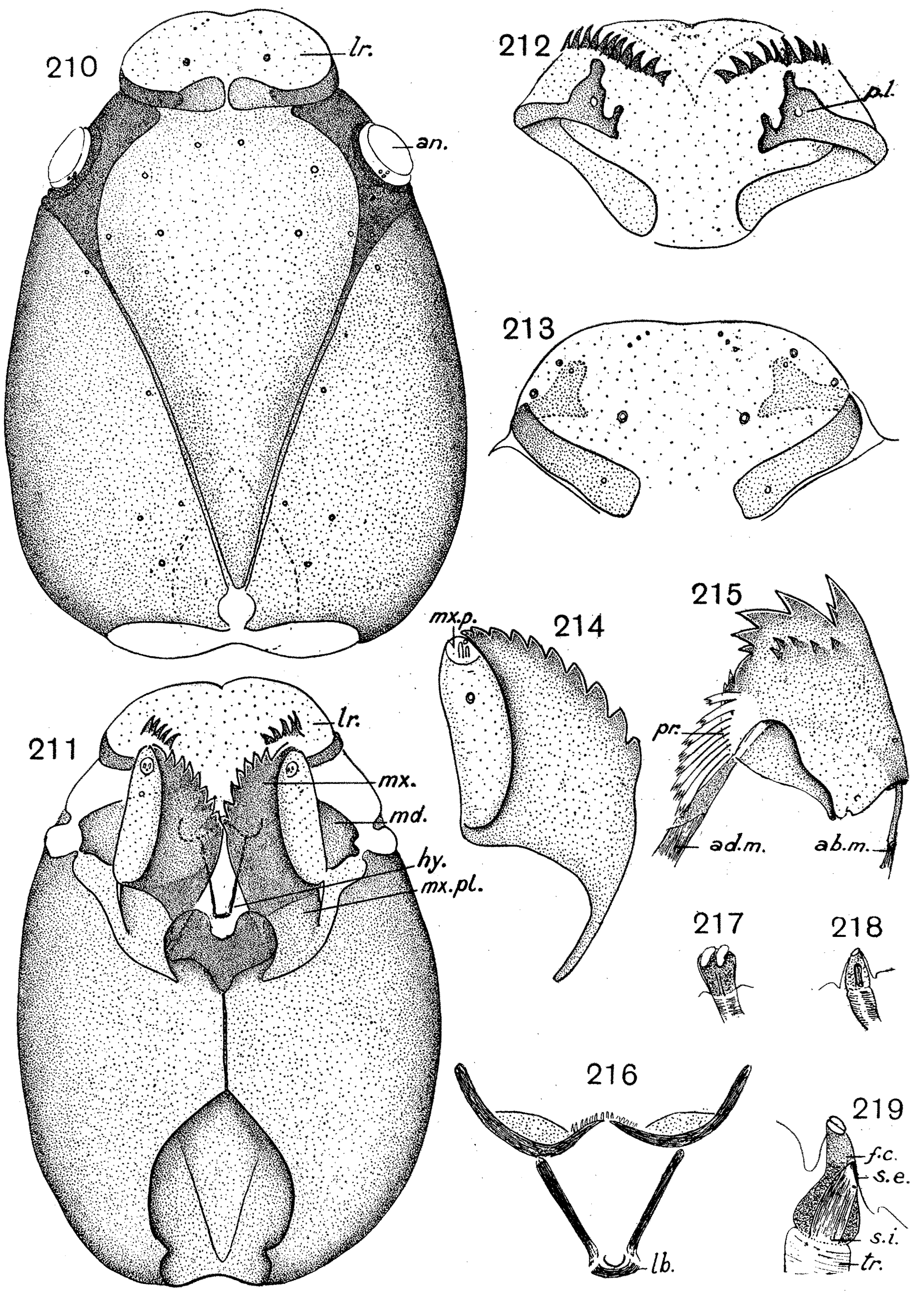
Van Roser (1834) merely described *Leia fasciola* as " A transparent smooth and slimy larva living in a delicate web on the surface of tree fungi ". Osten-Saken (1861–3) found a full-grown white larva, living in a similar web, and believed it was a *Leia* as " several specimens of the perfect insect of this genus were concealed under the same bark in the vicinity of the larvae ". Weiss (1919) gave a short description of the larva and pupa of *Leia bivittata*. The mouth-parts of the larva are not described and no figures are given.

The larvae feed on decaying specimens of *Russula nigricans*. Fresh samples of this fungus also harboured *Mycetophila guttata*. No definite cocoon is formed and the pupa is only suspended by a network of fine threads.

The larva lives in a tube of mucilage which is about twice as long as itself. The part of the tube not occupied by the larva looks like a flat slimy ribbon and has been mistaken for such by some observers. That it is a tube and not a flat ribbon can be easily proved by touching the head of the larva with a needle, when the collapsed portion of the tube becomes filled as the larva changes its position. The latter is able to turn by sliding its head back against the body. As it moves forwards it stretches its head beyond the end of the tube and vibrates from side to side, at the same time knocking its head against the fungus. In doing so a drop of saliva is emitted and this is pulled out into a thread as the larva raises its head. The operation is repcated several times till a close meshwork is formed, becoming later an extension of the tube beneath which the larva moves. The tube is moored to its position by several lateral threads.

Morphology—The larva is 18 mm. long. The integument is polished, shining, free from hairs and spines, except for the six groups of hairs representing the sensory vestiges of the legs. It is a slender larva, broadest a little behind the middle and attenuated at both ends.

The head (figs. 210, 211) is black, elongated, narrow anteriorly and broad posteriorly. The frontal plate is triangular, attaining its maximum width at the



Leia bimaculata Meigen

Fig. 210—Head, dorsal surface. × 120.
Fig. 211—Head, ventral surface. × 120.
Fig. 212—Labrum, ventral surface. × 320.
Fig. 213—Labrum, dorsal surface. × 320.
Fig. 214—Maxilla. × 320.
Fig. 215—Mandible. × 320.
Fig. 216—Hypopharynx, ventral view. × 320.
Fig. 217—Prothoracic spiracle. × 540.
Fig. 218—Abdominal spiracle, side view. × 540.
Fig. 219—Prothoracic spiracle, side view. × 540.

level of the antennae and tapering posteriorly to a point. It bears four pairs of sensory pits. The lateral epicranial plates meet along the middle third of the head between the oral opening and occipital foramen. Anteriorly each plate has two tongue-shaped chitinous processes which articulate with the condyles of the mandible (fig. 211). On the dorsal surface, the lateral plates are furnished with several sensory pits. The posterior border of the head is almost straight. The antenna (*an.*, fig. 210) has three small circular papillae between the supporting chitinous bands. The labrum (figs. 212, 213) is supported by a semicircular chitinous frame which is interrupted in the middle. The labrum bears seven pairs of small sensory papillae on the dorsal surface (fig. 213). The mandible (fig. 215) is polygonal, the inner border bearing five sharp teeth. The first and fourth tooth each carry an additional denticle. The superior lamella bears a row of five smaller teeth and a well-developed prostheca (*pr.*).

The lobe of the maxilla (fig. 214) bears ten small teeth. The maxillary palp is narrow and has a circular area anteriorly, covered with transparent chitin, and bearing two cylindrical papillae and a small circular sensory one (*mx.p.*). The maxillary plates (*mx.pl.*, fig. 211) are quadrilateral in shape and separated by a cordiform chitinous plate. The hypopharynx (*hy.*, figs. 211, 216) supports a small membrane carrying several papillae. The labium (*lb.*, fig. 216) is reduced to a semicircular chitinized plate.

The larva is provided with eight pairs of spiracles ; one prothoracic and seven abdominal, the latter borne on the sides of the fourth to the tenth body segments. The prothoracic spiracle (figs. 217, 219) has two oval openings which lead to a felt chamber. The external scar is posterior to the spiracular openings. The abdominal spiracle is uniforous, with the opening situated behind the external scar (fig. 218).

i. Tetragoneura *Winnertz*

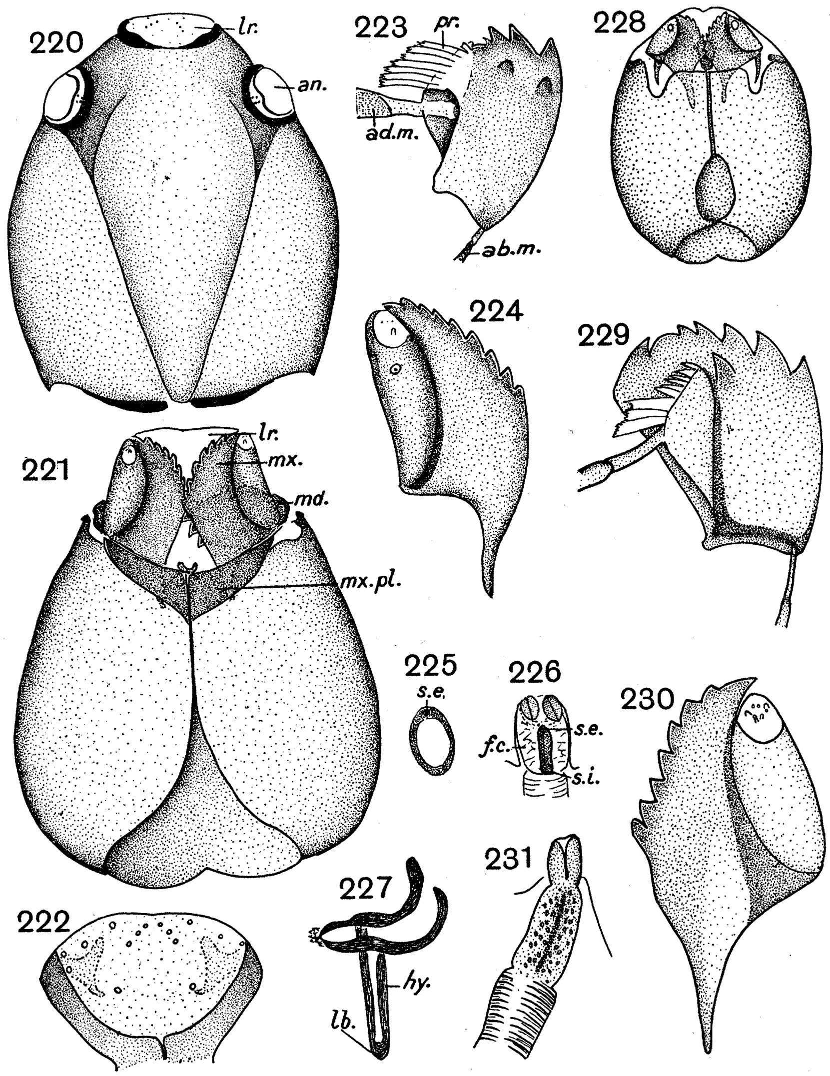
Tetragoneura sylvatica *Curtis*

The larva lives on small fallen branches covered with *Poria vaporaria*. It forms a slimy tube from its salivary secretion in which it glides with ease. Pupation takes place in a slight cocoon of meshwork.

Morphology—The larva is white and 18 mm. long when fully extended. It is slender, broadest a little behind the middle and attenuated at each extremity. The integument is very shiny and the segmentation is not very distinct. The terminal segment is small and carries the anus in the form of a small subventral vertical slit.

The head (figs. 220, 221) is elongated, broad at the middle and narrow anteriorly. The frontal plate tapers posteriorly to a point. The lateral epicranial plates meet ventrally along the middle third of the head and then diverge to form the borders of the occipital foramen.

The antenna (*an.*, fig. 220) bears four small papillae between the supporting chitinous bands. The labrum (fig. 222) is supported by a semicircular chitinous



Tetragoneura sylvatica CURTIS and *Boletina* sp. ?

FIG. 220—Head of *Tetragoneura*, dorsal surface. × 120.
FIG. 221—Head of *Tetragoneura*, ventral surface. × 120.
FIG. 222—Labrum of *Tetragoneura*, dorsal surface. × 185
FIG. 223—Mandible of *Tetragoneura*, dorsal surface. × 185.
FIG. 224—Maxilla of *Tetragoneura*. × 185.
FIG. 225—Abdominal spiracle of *Tetragoneura*. × 540.
FIG. 226—Prothoracic spiracle of *Tetragoneura*. × 540.
FIG. 227—Hypopharynx of *Tetragoneura*, side view. × 185
FIG. 228—Head of *Boletina*, ventral surface. × 120.
FIG. 229—Mandible of *Boletina*. × 185.
FIG. 230—Maxilla of *Boletina*. × 185.
FIG. 231—Prothoracic spiracle. × 540.

frame along the posterior border. On the dorsal surface, it carries seven pairs of small sensory papillae. The mandible (fig. 223) is polygonal, its inner border being furnished with five sharp teeth and a well-developed prostheca (*pr.*). The inner lobe of the maxilla (fig. 224) carries nine teeth. The maxillary palp, or outer lobe of the maxilla, is narrow and bears one cylindrical and three minute papillae anteriorly. The maxillary plates (*mx.pl.*, fig. 221) are triangular in shape and meet along the mid-ventral line. The horizontal processes of the hypopharynx (fig. 227) meet in the mid-ventral line and carry a small membrane covered with sensory hairs. The labium (*lb.*, fig. 227) is reduced to a small semicircular chitinous plate.

The body of the larva is smooth, moist, and free from hairs and spinules, except for the six groups of sensory hairs which represent the sensory vestiges of the legs.

The prothoracic spiracle (fig. 226) bears two oval spiracular openings which are each covered by a transparent membrane, having a longitudinal slit for the passage of air. These openings lead to a felt chamber presenting a reticulum of chitinous intima. The external scar is situated posterior to the spiracular openings. The abdominal spiracle (fig. 225) is uniforous with the external scar (*s.e.*) anterior to the spiracular opening.

k. Boletina *Staeger*

Boletina *sp.* ?

The larva measures 10–12 mm., and is found in rotten wood covered with fungus.

The head (fig. 228) is oval and black. The frontal plate is broadest at the level of the antenna and tapers posteriorly to a point. The lateral epicranial plates meet along the middle third of the head, then separate and meet again at the occiput, thus enclosing an oval area, which is covered with transparent chitin.

The labrum is transverse and carries six pairs of sensory papillae. The mandible (fig. 229) carries six teeth. The superior lamella is provided with one tooth and a well-developed prostheca. The maxilla (fig. 230) is provided with eight teeth and ends in a short chitinized rod. The maxillary palp carries seven sensory papillae, four of which are rod-shaped and the rest circular. The hypopharynx is of the slender sciarine type. The labium consists of a small rectangular chitinous plate.

The prothoracic spiracle (fig. 231) is biforous ; the spiracular openings lead into an elongated felt chamber, the lumen of which is filled with chitinous threads. The abdominal spiracles are uniforous.

l. Docosia *Winnertz*

Docosia fumosa *Edwards*

Biology—The larva *D. fumosa* lives in birds' nests. Mr. H. Hamm was the first to make this interesting discovery and reared the larva to adult-stage more than once. Since then Mr. F. W. Edwards has reared it from several thrushes' and hedge-sparrows' nests at Letchworth. Mr. Hamm has kindly sent me a thrush's nest in which *Docosia* larvae were found embedded in the walls. The first attempt to rear these larvae failed, but in another batch sent to me I succeeded in rearing two male adults. Pupation takes place in a dense tough cocoon to which particles of dirt are attached. Unlike the other Sciophilinae, which live within a slimy tube, the larvae of *Docosia fumosa* are free and saprophagous, like some members of the Sciarinae.

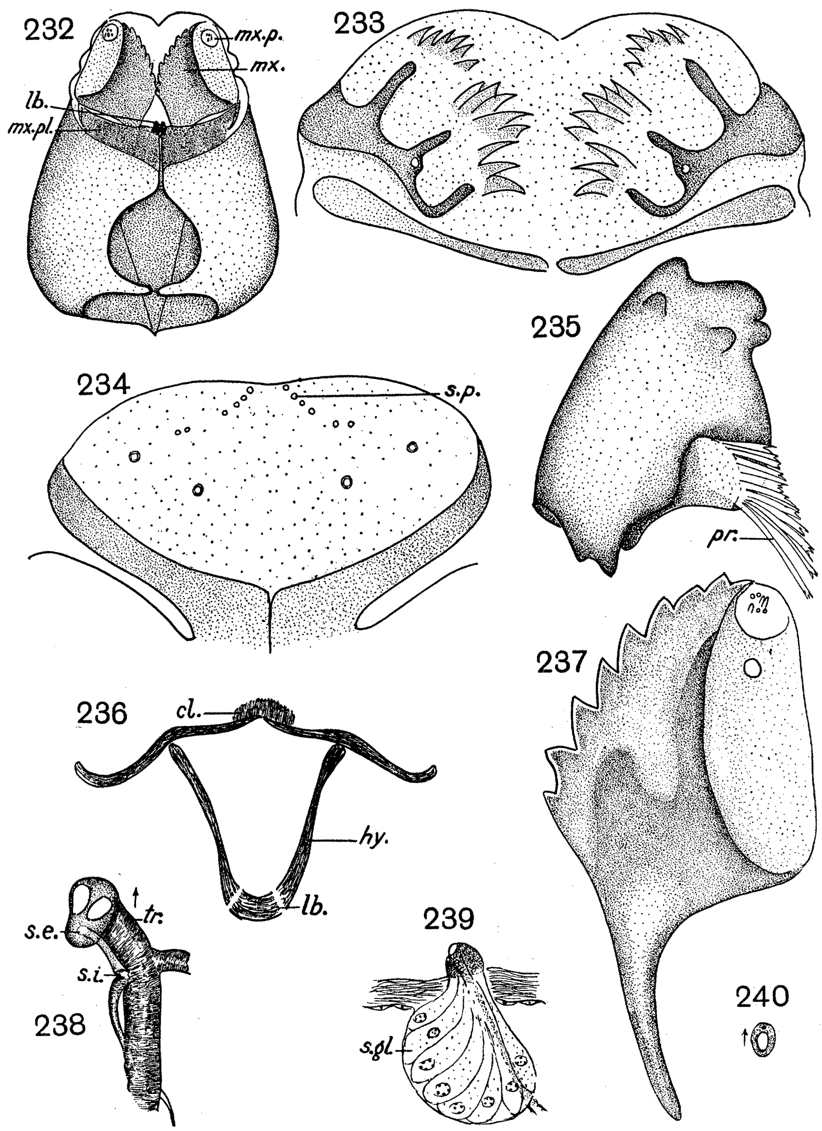
The adults of this genus, according to EDWARDS, "are small black insects, in life much resembling species of *Sciara*. They also resemble *Tetragoneura* in appearance and habits, but are sharply differentiated by the position of the lateral ocelli close to the eye-margins, as well as by the longer vein R_1. They might easily be confused with the genus *Trichonta* of the Mycetophilinae, which has a rather similar venation, but the microtrichia of the wings and tibia are quite irregularly arranged, and on this account I have included *Docosia* in the Sciophilinae. There are no anepisternal bristles, another clear point of distinction from *Trichonta*. I believe this genus is not distantly related to *Tetragoneura*. On larval characters, however, *Docosia* is more closely related to the Sciarinae than the Sciophilinae".

Morphology—The larva is 10 mm. long and is stouter and shorter than the rest of the Sciophilinae. It is yellowish in colour and the integument is not so thin as that of *Polylepta* or *Leptomorphous*.

The head (fig. 232) is elongated, narrow anteriorly and broad posteriorly. The frontal plate tapers to a point posteriorly on the dorsal surface. The lateral epicranial plates meet along the mid-ventral line by means of two chitinous bands and enclose a circular area covered with transparent chitin. The labrum (figs. 233–234) carries eight pairs of small circular papillae on the dorsal surface. The chitinous arms (fig. 233) on the ventral surface are well developed and each shows three chitinous projections to which are attached several hooks arranged in a fan-like manner. The mandible (fig. 235) is polygonal, and bears three rounded teeth, of which the middle is the largest. The superior lamella carries two smaller dorsal teeth, and a prostheca (*pr.*) along the inner basal angle. The inner lobe of the maxilla (fig. 237) is broad and bears nine well-developed teeth. The outer lobe or maxillary palp has a circular area anteriorly which is covered by transparent chitin and carries three cylindrical and four small circular papillae. The maxillary plates (*mx.pl.*, fig. 232) are triangular in shape and meet along the mid-ventral line. The horizontal processes of the hypopharynx (*hy.*, fig. 236) support a semicircular membrane, covered with sensory hairs. The labium (*lb.*, fig. 236) is reduced to a small plate of chitin.

The prothoracic spiracle (fig. 238) is biforous, with the external scar (*s.e.*) posterior to the spiracular openings. The seven pairs of abdominal spiracles are situated on the first seven abdominal segments. Each spiracle (fig. 239) is furnished with a single oval spiracular opening, situated posterior to the external scar. The spiracular gland (*s.gl.*) is shown in the figure and consists of several flask-shaped cells with intracellular ducts. I could not trace the openings of these ducts.

The larva of *Docosia fumosa* differs from the Mycetophilinae (including *Trichonta*) in the absence of well-developed locomotory pads, in the structure of the mandible



Docosia fumosa Edwards

Fig. 232—Head of *Docosia fumosa*, ventral surface. × 120.
Fig. 233—Labrum, ventral surface. × 320.
Fig. 234—Labrum, dorsal surface. × 320.
Fig. 235—Mandible. × 320.
Fig. 236—Hypopharynx, dorsal surface. × 320.
Fig. 237—Maxilla. × 320.
Fig. 238—Prothoracic spiracle. × 540.
Fig. 239—Abdominal spiracle, side view. × 540.
Fig. 240—Abdominal spiracle. × 540.

and hypopharynx, as well as in the mode of living. The Mycetophilinae are saprophagous. In the Mycetophilinae the mandibles are semicircular in shape and carry from nine to fourteen teeth on the inner border. In *Docosia fumosa* they are polygonal in shape and bear three blunt teeth. The hypopharynx in the Mycetophilinae is a comparatively massive structure consisting of two horizontal plates of chitin and two vertical boot-shaped processes which join the horizontal plates at their distal extremity. In *Docosia*, the hypopharynx (fig. 236) is a slender structure consisting merely of two horizontal and two narrow vertical rods.

The genus *Docosia* is included in the Sciophilinae by EDWARDS, who says that it is not distantly related to *Tetragoneura*.

On larval characters, however, *Docosia fumosa* shows a closer relationship to the Sciarinae than the Sciophilinae, especially in the shape of the head and trophi (*cf. Sciara semialata* with *Docosia*). Moreover, the larva of Docosia is saprophagous (another point of similarity with the Sciarinae) and does not live in a tube of saliva like the rest of the Sciophilinae.

X—SUB-FAMILY MYCETOPHILINAE (WINNERTZ) EDWARDS

The sub-family Mycetophilinae includes more genera and species than any other of the Mycetophilidae, the Sciarinae and the Sciophilinae coming next.

According to EDWARDS, the Mycetophilinae are divided into two groups or tribes, the *Exechini* and the *Mycetophilini*. The larvae belonging to these two tribes may be easily separated by examining the locomotory pads, which are well developed in the *Mycetophilini* and poorly developed in the *Exechini* (not absent, as indicated by JOHANNSEN and EDWARDS). There are, however, some exceptions to this rule, *i.e.*, *Brachypeza radiata* is included in the *Exechini* by EDWARDS though the locomotory pads are well developed in the larva.

Nine species belonging to seven genera are described here and whenever more than one species belonging to a single genus are described, one is taken as a type and is described in greater detail than the others. The main points can be seen at a glance by referring to the figures. A detailed account of the biology, external and internal anatomy of *B. radiata*, has already been given.

a. Exechia *Winnertz*

Exechia fusca *Meigen* (fungorum *Auct.*)

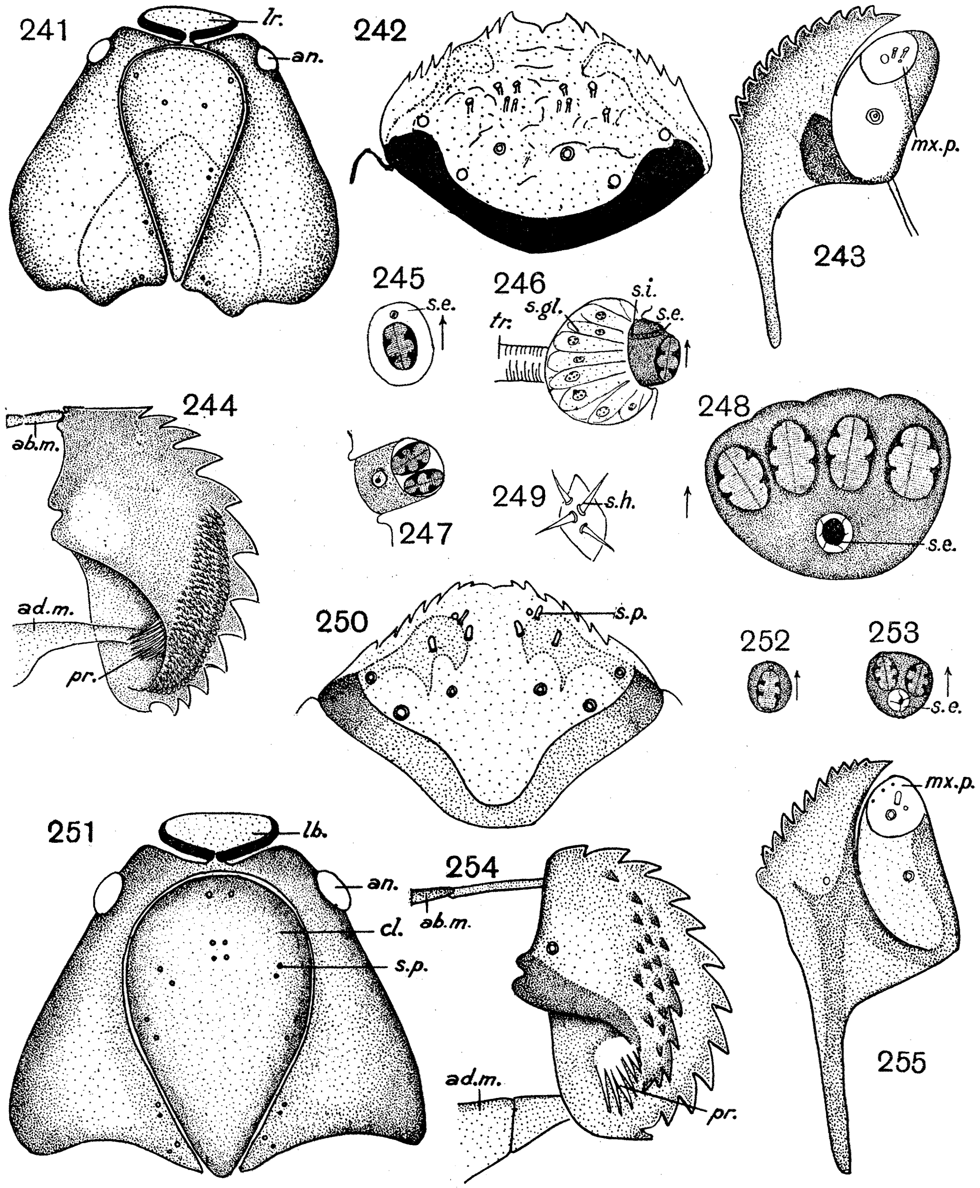
DE GEER (1776) gives a description of a Mycetophilid larva, which OSTEN-SACKEN related to the genus *Mycetophila*, and BRAUER to *Exechia fungorum*. In DE GEER'S figure, the larva is represented with distinct projecting antennae composed of three segments, and is therefore undoubtedly a *Bolitophila*. PASTEJRIK (1908) described *Exechia contaminata* and MALLOCH (1917) gave a short account of *Exechia nativa*. The larva is said to have well-developed locomotory pads.

Biology—The larvae are usually found in the stalk of small ground fungi. Pupation takes place just below the surface of the ground, within a thin cocoon. The life cycle lasts between three and four weeks, the fly appearing in my breeding box in October and November. It is certain that there is more than one generation in a year as the flies are found throughout the year, and I have reared the fly twice between September and December.

Morphology—The larva is 9–10 mm. long, and is shorter and broader than the Sciophiline larvae. It is broadest in the middle and attenuated at both ends.

The head (fig. 241) is black, trapezoidal, narrow anteriorly and broad posteriorly. The posterior margin shows two shallow lateral emarginations, separated from a central concavity by blunt chitinous projections. The frontal plate carries four pairs of small sensory pits. It is broad and rounded anteriorly and tapers to a point posteriorly. The lateral epicranial plates meet on the ventral surface of the head, posterior to the maxillary plates, so that the cranium is closed. The antenna (*an.*, fig. 241) bears 5–6 minute sensory papillae. The eyes lie postero-laterally to the antennae. The labrum (fig. 242) is supported by a semicircular chitinized frame along the posterior border. On the dorsal surface, it is furnished with eight pairs of sensory papillae, five cylindrical and three circular. The mandible (fig. 244) carries thirteen teeth along its inner border. The dorsal lamella bears seven to eight rows of smaller teeth, and a small prostheca along the inner basal angle. The inner cultriform lobe of the maxilla (fig. 243) bears twelve small teeth. The outer lobe has a circular area anteriorly covered with transparent chitin and carries two cylindrical and one circular sensory papilla. Posterior to that area, another circular papilla is found. The maxillary plates are triangular in shape with curved inner and outer borders. The inner angles meet anteriorly at the mid-ventral line, while the inner sides are separated by a semicircular transparent membrane. The hypopharynx is similar to that of *Brachypeza radiata* already described. Each horizontal plate has a boot-shaped process which lies on one side of the salivary opening. The labium is a semicircular chitinous plate lying ventral to the inner angles of the maxillary plates, posterior to the hypopharynx. It is partly hidden on the ventral surface by the semicircular membrane separating the maxillary plates. The anterior border carries two pairs of minute sensory papillae and supports the opening of the salivary duct.

The body is soft and creamy white. The integument is thin and free from hairs except for the usual six groups representing the sensory vestiges of the legs. Each of these consists of four sensory hairs (fig. 249) of equal length. There are ten intersegmental locomotory pads which are poorly developed. The first lies at the anterior border of the third segment and consists of three to four rows of minute spinulae which are only visible under high magnification. The other nine pads are better developed, situated along the third to the eleventh intersegments. Each pad consists of a double row of hooks surrounded by six to eight rows of spinules.



Exechia fusca Meigen and *Exechia dorsalis* Staeger

Fig. 241—Head of *E. fusca*, dorsal surface. × 120.
Fig. 242—Labrum of *E. fusca*, dorsal surface. × 320.
Fig. 243—Maxilla of *E. fusca*. × 320.
Fig. 244—Mandible of *E. fusca*. × 320.
Fig. 245—Abdominal spiracle of *E. fusca*. × 540.
Fig. 246—Abdominal spiracle of *E. fusca*, side view. × 540.
Fig. 247—Last abdominal spiracle of *E. fusca*. × 540.
Fig. 248—Prothoracic spiracle of *E. fusca*. × 540.
Fig. 249—Sensory hairs of *E. fusca*. × 540.
Fig. 250—Labrum of *E. dorsalis*, dorsal surface. × 320.
Fig. 251—Head of *E. dorsalis*, dorsal surface. × 120.
Fig. 252—Abdominal spiracle of *E. dorsalis*. × 540.
Fig. 253—Prothoracic spiracle of *E. dorsalis*. × 540.
Fig. 254—Mandible of *E. dorsalis*. × 320.
Fig. 255—Maxilla of *E. dorsalis*. × 320.

The prothoracic spiracle (fig. 248) consists of a chitinous nipple-like projection. The spiracular plate shows three and sometimes four oval-shaped openings, the borders of which are thickened and send short chitinous projections towards the lumen. The spiracular openings are covered with transparent membranes having longitudinal clefts for the passage of air. These clefts are very difficult to see. The external scar (*s.e.*) consists of a chitinous plug with radiating chitinous threads. It lies posterior to the spiracular openings.

The seven abdominal spiracles (figs. 245, 246, 247) are smaller and have one spiracular opening. In one case the last abdominal pair of spiracles were dissimilar, the spiracle on the left side uniforous while that on the right was biforous (fig. 247). A similar condition was once found in the last abdominal pair of spiracles in *Phronia strenua*. The spiracular gland (*s.gl.*, fig. 246) consists of a bunch of elongated flask-shaped cells, each cell having an intracellular duct. I could not detect the opening of the terminal duct on the spiracular plate, and it is likely that these ducts open into the lumen of the spiracles. The function of such glands is probably to secrete an oily substance which will prevent the wetting of the spiracles.

b. E. dorsalis *Staeger*

The larva is found in various species of *Boletus*. The head (fig. 251) is trapezoidal in shape. The frontal plate carries seven pairs of sensory pits. The epicranial plates show two shallow concavities along the posterior border.

The labrum (fig. 250) is furnished with seven pairs of sensory papillae, three cylindrical and four circular. The chitinous frame shows a depression at the middle. The mandible (fig. 254) carries twelve teeth along the inner border. The dorsal lamella bears three rows of smaller teeth and a prostheca (*pr.*) at the inner basal angle. The maxilla (fig. 255) bears thirteen teeth, the last of which is more rounded than the others. The maxillary palp carries one cylindrical and five small circular papillae. The hypopharynx and labium are similar to those of *Exechia fusca*.

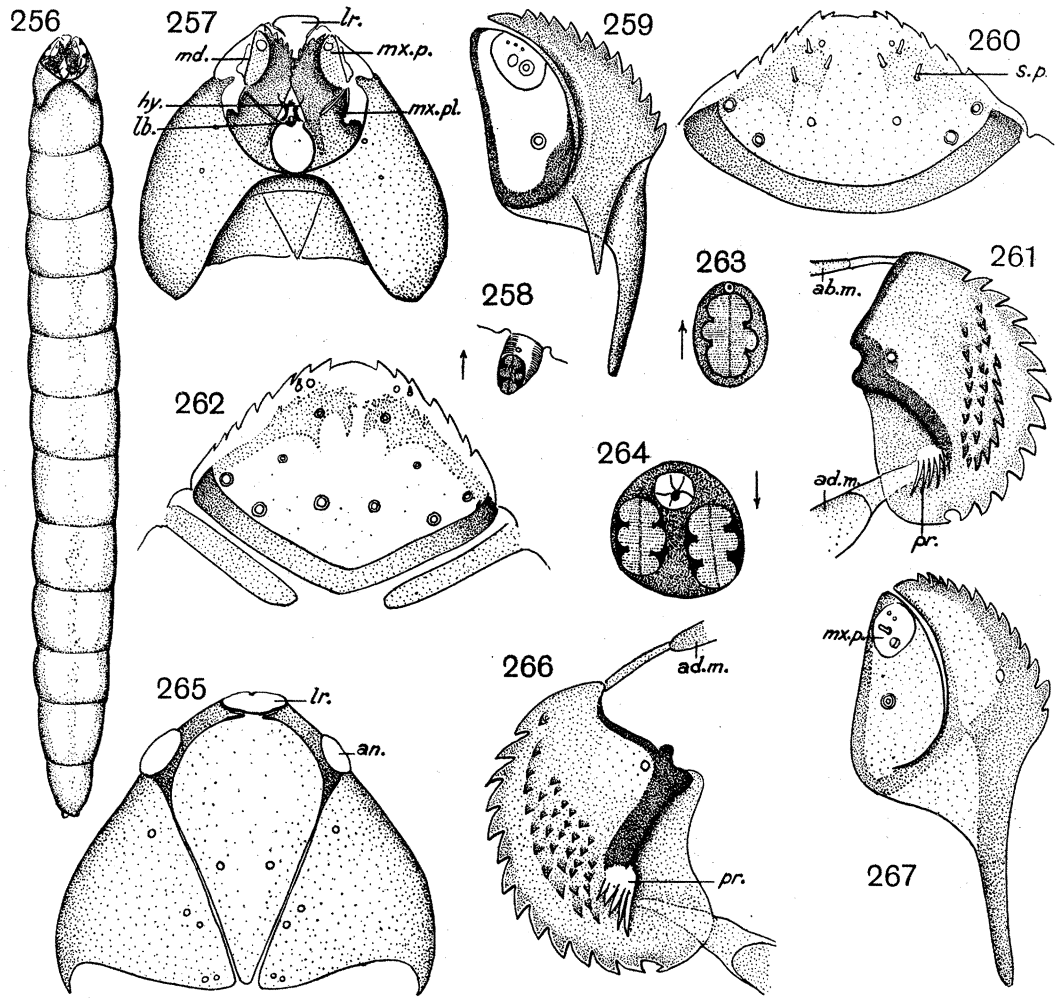
The prothoracic spiracle is biforous (fig. 253), the abdominal spiracles uniforous (fig. 252).

c. E. separata *Lundström*

The larva (fig. 256) is 7–8 mm. long and lives in *Boletus bovinus*. On the ventral surface it is furnished with ten intersegmental locomotory pads similar to those of *Exechia fusca*.

The head (fig. 257) is dark brown and cordiform. The lateral epicranial plates are united through a narrow strip of chitin, situated posterior to a membranous oval area separating the two maxillary plates. Anteriorly each plate has two tongue-shaped chitinous projections which articulate with the condyles of the mandible. The labrum (fig. 260) is furnished with seven pairs of sensory papillae, three pairs of which are cylindrical and the rest circular. The mandible (fig. 261) carries 13 teeth along its inner border. The dorsal lamella bears three rows of smaller teeth and a prostheca (*pr.*). The maxilla (fig. 259) has 13 teeth along the inner border.

The maxillary palp carries five circular sensory papillae. The maxillary plates (*mx.pl.*, fig. 257) are quadrilateral in shape, the inner and outer borders being



Exechia separata Lundström and *E. indecisa* Walker

Fig. 256—Larva of *E. separata*. × 12.
Fig. 257—Head of *E. separata*, ventral surface. × 120.
Fig. 258—Abdominal spiracle of *E. separata*. × 540.
Fig. 259—Maxilla of *E. separata*. × 320.
Fig. 260—Labrum of *E. separata*, dorsal surface. × 320.
Fig. 261—Mandible of *E. separata*. × 320.
Fig. 262—Labrum of *E. indecisa*. × 320.
Fig. 263—Abdominal spiracle of *E. indecisa*. × 540.
Fig. 264—Prothoracic spiracle of *E. indecisa*. × 540.
Fig. 265—Head of *E. indecisa*, dorsal surface. × 540.
Fig. 266—Mandible of *E. indecisa*, dorsal surface. × 320.
Fig. 267—Maxilla of *E. indecisa*. × 320.

strongly chitinized. They are separated by an oval membranous area which partly covers the labium on the ventral surface. The hypopharynx is similar to that of

Exechia fusca. The labium (*lb.*, fig. 257) is reduced to a small rectangular chitinous plate situated between the two maxillary plates. The anterior border supports the opening of the salivary duct and carries two pairs of minute sensory papillae.

The prothoracic spiracle is biforous, the abdominal (fig. 258) is uniforous.

d. E. indecisa *Walker*

The larva lives in *Boletus bovinus* in association with *Exechia separata*. It is 7–8 mm. long.

The head (fig. 265) is similar to that of *E. separata*. The posterior border of the dorsal surface shows two lateral emarginations.

On the dorsal surface the labrum is furnished with seven pairs of circular papillae (fig. 262). The mandible (fig. 266) carries 14 teeth on inner border and four rows of smaller teeth on the dorsal lamella. The inner cultriform lobe of the maxilla (fig. 267) has 13 teeth. The maxillary palp is furnished with one cylindrical and three circular papillae. The prothoracic spiracle (fig. 264) is biforous. The abdominal spiracle (fig. 263) is uniforous.

e. Rhymosia

Rhymosia domestica *Meigen*

The larva of *R. domestica* is found in the stalks of *Tricholoma nudum* and *Clytocybe infundibuliformis*. The pupa is enclosed in a papery cocoon.

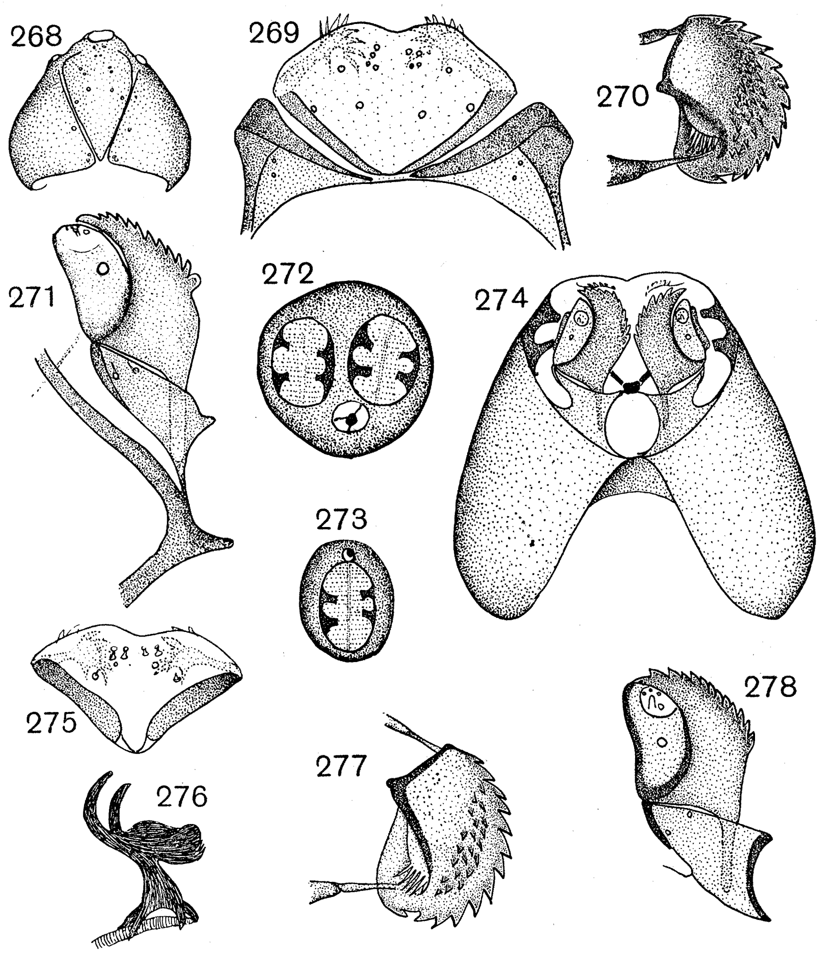
The head (fig. 268) is triangular in shape with rounded angles. The frontal plate bears six pairs of sensory pits. On the dorsal surface, the labrum carries seven pairs of circular sensory papillae (fig. 269). The mandible (fig. 270) is semicircular, the inner border having fourteen teeth, the last of which is less chitinized than and opposed to the rest. The superior lamella is provided with three to four rows of smaller teeth and a prostheca. The maxilla (fig. 271) bears twelve teeth. The maxillary palp carries one conical and three circular papillae. The hypopharynx (fig. 276) sends out on each side a boot-shaped chitinized plate which embraces the salivary duct. The labium consists of a rectangular plate of chitin situated between the boot-shaped plates.

The prothoracic spiracle (fig. 272) is biforous, the abdominal spiracle uniforous (fig. 273).

f. R. gracilipes *Dziedzicki*

The larvae of *R. gracilipes* are found in the stalks of the fungi *Russula* and *Amanita*.

The lateral *epicranial plates* (fig. 274) meet at two points ventrally, enclosing an oval area covered with transparent chitin. Anteriorly each plate sends out two tongue-shaped processes which articulate with the superior and inferior condyles of the mandible. The labrum (fig. 275) carries four pairs of sensory papillae, of which three are like collar-studs in shape and the other is circular. The mandible (fig. 277) bears thirteen teeth along the median border. The superior lamella is provided with three rows of smaller teeth and a prostheca. The maxilla (fig. 278) carries thirteen teeth. The maxillary plate is triangular and bears two sensory hairs. The maxillary palp is provided with one conical and four circular papillae.



Rhymosia domestica MEIGEN and *R. gracilipes* DZIEDZICKI

FIG. 268—Head of *R. domestica*, dorsal surface. × 120.
FIG. 269—Labrum of *R. domestica*, dorsal surface. × 320.
FIG. 270—Mandible of *R. domestica*. × 320.
FIG. 271—Maxilla of *R. domestica*. × 320.
FIG. 272—Prothoracic spiracle of *R. domestica*. × 540.
FIG. 273—Abdominal spiracle of *R. domestica*. × 540.
FIG. 274—Head of *R. gracilipes*, ventral surface. × 120.
FIG. 275—Labrum of *R. gracilipes*, dorsal surface. × 320.
FIG. 276—Hypopharynx of *R. gracilipes*, side view. × 320.
FIG. 277—Mandible of *R. gracilipes*. × 320.
FIG. 278—Maxilla of *R. gracilipes*. × 320.

The labium (fig. 274) is rectangular and situated between the vertical processes of the hypopharynx.

The prothoracic and abdominal spiracles are similar to those of *R. domestica*.

g. Genus Cordyla *Meigen*

The genus *Cordyla* was first established by MEIGEN.

According to DUFOUR, RÉAUMUR (1738, fig. 10, Plate XIII) gives an excellent figure of the larva of *Cordyla crassipalpa*, which clearly shows eight pairs of spiracles and ventral locomotory pads. From his figure and caption, he probably mistook a gastric caecum, which exhibits marked peristaltic movements, for the dorsal vessel. DUFOUR (1839, *a*) described and figured what he believed to be *Cordyla crassipalpa*, but OSTEN-SACKEN (1861–3) believed the larva to have been that of *Mycetophila*.

PASTEJRIK (1905) and VIMMER (1909) described *Cordyla fusca*. The latter's figure of the respiratory system is inaccurate.

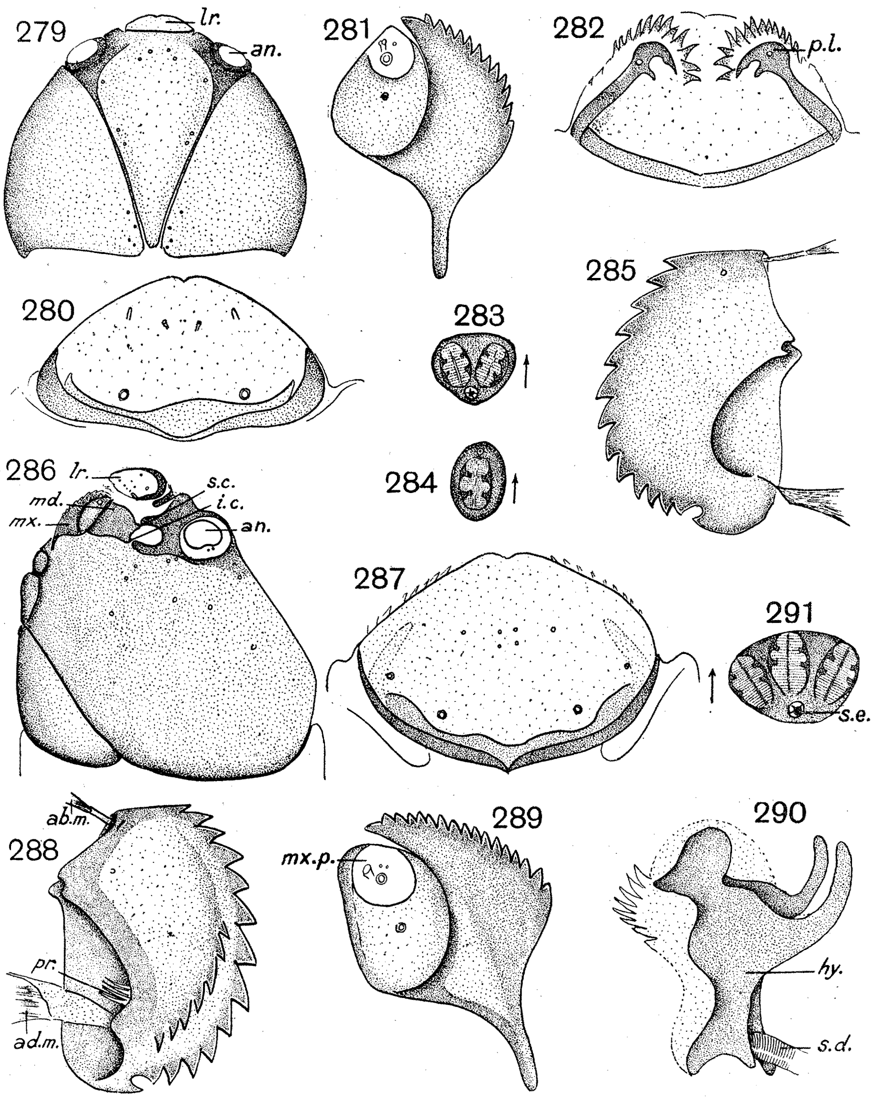
h. Cordyla brevicornis *Staeger*

The larva lives in a variety of fungi such as *Boletus edulis*, *Amanita rubescens*, and *Russula chloroides*. It usually attacks the stem. Pupation takes place usually in a dense cocoon at a depth of a centimetre from the surface of the soil. Few pupae are found in the fungus.

Morphology—The larva is 7 mm. long. The head (fig. 279) is black and subconical in shape. The frontal plate tapers posteriorly to a point and carries five pairs of sensory pits. The lateral epicranial plates meet on the ventral surface, being joined together by a narrow chitinous bar situated posterior to an oval-shaped area, which is present between the two maxillary plates. The antenna (*an.*, fig. 279) carries four minute papillae between the two supporting bands of chitin. On the dorsal surface the labrum (figs. 280, 282) is furnished with two cylindrical and one circular pair of sensory papillae. The mandible (fig. 285) is semicircular in shape and carries fourteen teeth along the inner border.

The maxilla (fig. 281) is broad. The inner lobe carries thirteen teeth and ends in a comparatively short chitinized rod. The maxillary palp shows one cylindrical and two circular papillae. The maxillary plates are triangular in shape and separated by an oval area covered with transparent chitin. The hypopharynx is similar to that of *Brachypeza radiata*. The labium consists of a small rectangular chitinous plate, situated between the two maxillary plates. The body of the larva is free from hairs except for the six groups representing the sensory vestiges of the legs. Each group consists of four hairs of equal length. On the ventral surface the body is provided with nine intersegmental locomotory pads, the first and second body segments being free from such pads. Each pad consists of two rows of chitinous hooks surrounded by three to four rows of spinules.

The prothoracic spiracle (fig. 283) has two oval spiracular openings, the borders of which are thickened and show four small projections towards the lumen. The external scar (*s.e.*) is posterior to the openings. Each of the seven abdominal spiracles is uniforous with the external scar situated anteriorly (fig. 284).



Cordyla brevicornis STAEGER and *C. flaviceps* STAEGER

FIG. 279—Head of *C. brevicornis*. × 120.
FIG. 280—Labrum of *C. brevicornis*, dorsal surface. × 320.
FIG. 281—Maxilla of *C. brevicornis*. × 320.
FIG. 282—Labrum of *C. brevicornis*, ventral surface. × 320.
FIG. 283—Prothoracic spiracle of *C. brevicornis*. × 540.
FIG. 284—Abdominal spiracle of *C. brevicornis*. × 540.
FIG. 285—Mandible of *C. brevicornis*. × 320.
FIG. 286—Head of *C. flaviceps*, lateral view. × 120.
FIG. 287—Labrum of *C. flaviceps*. × 320.
FIG. 288—Mandible of *C. flaviceps*. × 320.
FIG. 289—Maxilla of *C. flaviceps*. × 320.
FIG. 290—Hypopharynx of *C. flaviceps*. × 320.
FIG. 291—Prothoracic spiracle of *C. flaviceps*. × 540.

i. C. flaviceps *Staeger*

The larva lives in various species of *Russula*. It spins a dense cocoon prior to pupation which takes place just below the surface of the ground.

Morphology—The larva is 5·5 mm. long and has a black chitinous head. Each epicranial plate sends out two tongue-shaped chitinous processes to articulate with the two condyles of the mandibles (*s.c.; i.c.*, fig. 286). The labrum (fig. 287) is provided on the dorsal surface with five pairs of sensory papillae. The mandible (fig. 288) carries fourteen teeth on the inner border. The dorsal lamella bears one row of smaller teeth, and a prostheca (*pr.*). The inner lobe of the maxilla has seventeen teeth. The maxillary palp is broad and bears one cylindrical and three circular papillae. The hypopharynx is represented from the side in fig. 290. It consists of two irregular chitinous plates which join at the mid-ventral line. Each plate has a vertical boot-shaped process, which passes along the side of the salivary duct (*s.d.*).

The prothoracic spiracle (fig. 291) is usually biforous, although in one specimen three openings were found. The abdominal spiracle is uniforous.

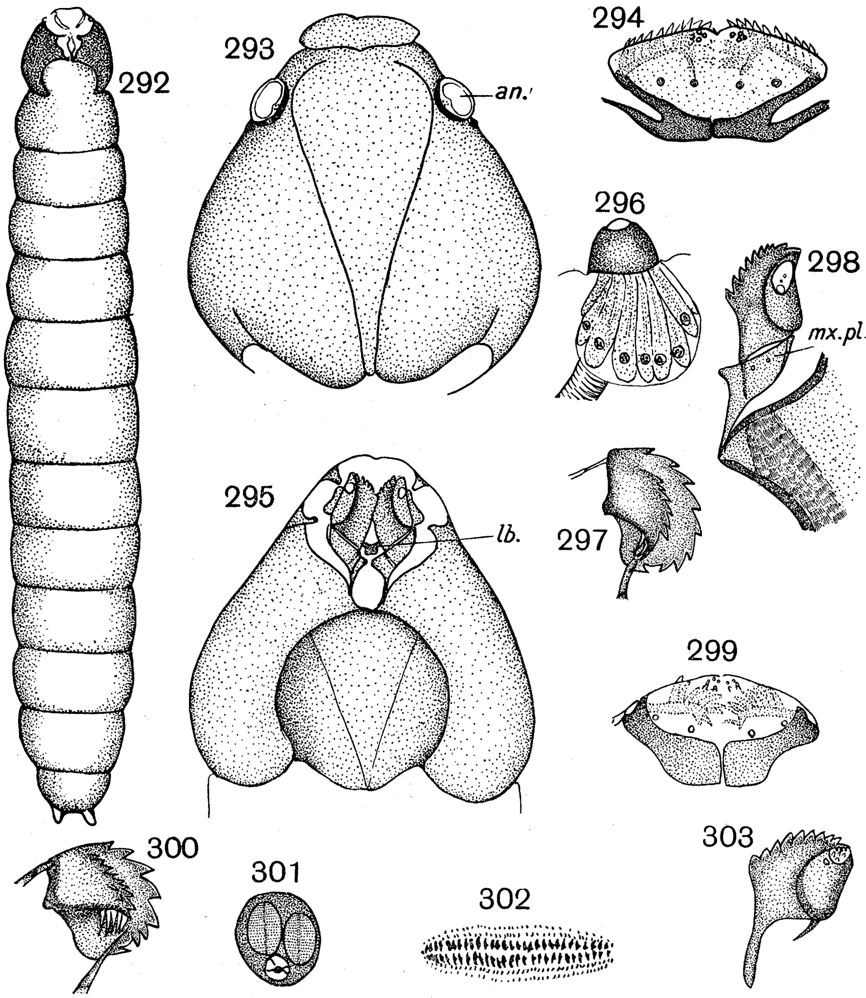
k. Trichonta *Winnertz*

Trichonta falcata *Lundström*

The larvae of *Trichonta* are found on bark-growing fungi. According to EDWARDS, some of the larvae feed within the substance of the fungus, others upon the surface, the latter being always covered by a sheet of dry mucilage which is coextensive with the larva's feeding ground and is enlarged as the larva grows. Excrement accumulates under this sheet and forms a protective covering. In both cases pupation takes place in a light silken cocoon.

Trichonta falcata is found on *Stereum hirsutum*. The larva (fig. 292) is 8 mm. long, and has a black chitinized head and 12 body segments, the last of which is provided with two conical papillae. The ventral surface bears ten intersegmental locomotory pads, the first and last of which are weakly developed. Each of the other pads (fig. 302) consists of two rows of chitinized hooks and four rows of spinules.

The head (figs. 293, 295) is cordiform. The frontal plate is broadest at the level of the antennae and tapers posteriorly to a point. The epicranial plates meet at two points, enclosing an oval area covered with transparent chitin. The antenna (*an.*, fig. 293) bears four minute sensory papillae. Eyes are present. The labrum (fig. 294) is supported by a chitinized frame along the posterior border, and carries six pairs of circular papillae dorsally. The mandible (fig. 297) is provided with nine teeth, while the superior lamella carries a row of smaller teeth and a small prostheca. The maxilla (fig. 298) carries 10 teeth. The maxillary palp is provided with three circular sensory papillae. The maxillary plate (*mx.pl.*) is triangular in shape with arcuate sides. The hypopharynx is of the massive mycetophiline type. It consists of two horn-shaped horizontal processes, which join at the mid-ventral line, and two boot-shaped vertical processes. The labium (*lb.*, fig. 295) is quadrilateral in shape, situated between the vertical processes of the hypopharynx. The prothoracic



Trichonta falcata LUNDSTRÖM and *T. vitta* MEIGEN

FIG. 292—Whole larva of *T. falcata*. × 12.
FIG. 293—Head of *T. falcata*, dorsal surface. × 120.
FIG. 294—Labrum of *T. falcata*, dorsal surface. × 320.
FIG. 295—Head of *T. falcata*, ventral surface. × 120.
FIG. 296—Abdominal spiracle of *T. falcata*, side view. × 540.
FIG. 297—Mandible of *T. falcata*. × 320.
FIG. 298—Maxilla of *T. falcata*. × 320.
FIG. 299—Labrum of *T. vitta*, dorsal surface. × 320.
FIG. 300—Mandible of *T. vitta*. × 320.
FIG. 301—Prothoracic spiracle of *T. vitta*. × 540.
FIG. 302—Chitinous hooks of locomotory pads. × 120.
FIG. 303—Maxilla of *T. vitta*. × 320.

spiracle is biforous. Each abdominal spiracle (fig. 296) is uniforous and is provided with a spiracular gland consisting of several elongated flask-shaped cells.

l. Trichonta vitta *Meigen*

This is the commonest species of *Trichonta*. The larvae are found in *Poria vaporaria*, their presence being easily detected by the brownish discolouration they leave on the surface of the fungus.

The labrum (fig. 299) is supported by a well-developed chitinized frame, and the dorsal surface is provided with two pairs of conical and four pairs of circular papillae. The mandible (fig. 300) is provided with eight teeth. The superior lamella carries eleven smaller teeth and a prostheca. The maxilla (fig. 303) carries ten teeth and its palp is provided with seven small papillae.

The prothoracic spiracle (fig. 301) is biforous, the abdominal spiracle uniforous.

m. Genus Phronia *Winnertz*

A larva similar to *Phronia* was first described by BREMI (1846) under the name *Sciophila cellaria*. PERRIS (1849) gave an interesting account of a test bearing larva, *Mycetophila scatophora*. He also bred an ichneumonid parasite from the larva. HOLMGREN (1907) gives a detailed account of the biology, the external and the internal anatomy of the larva. KNAB and VAN ZWALUMENBERG (1918) give a short account of *Mycetophila merdigera*, but did not describe the mouth-parts of the larva. According to EDWARDS, the larvae described by PERRIS, HOLMGREN, and KNAB should be referred to the genus *Delopsis*.

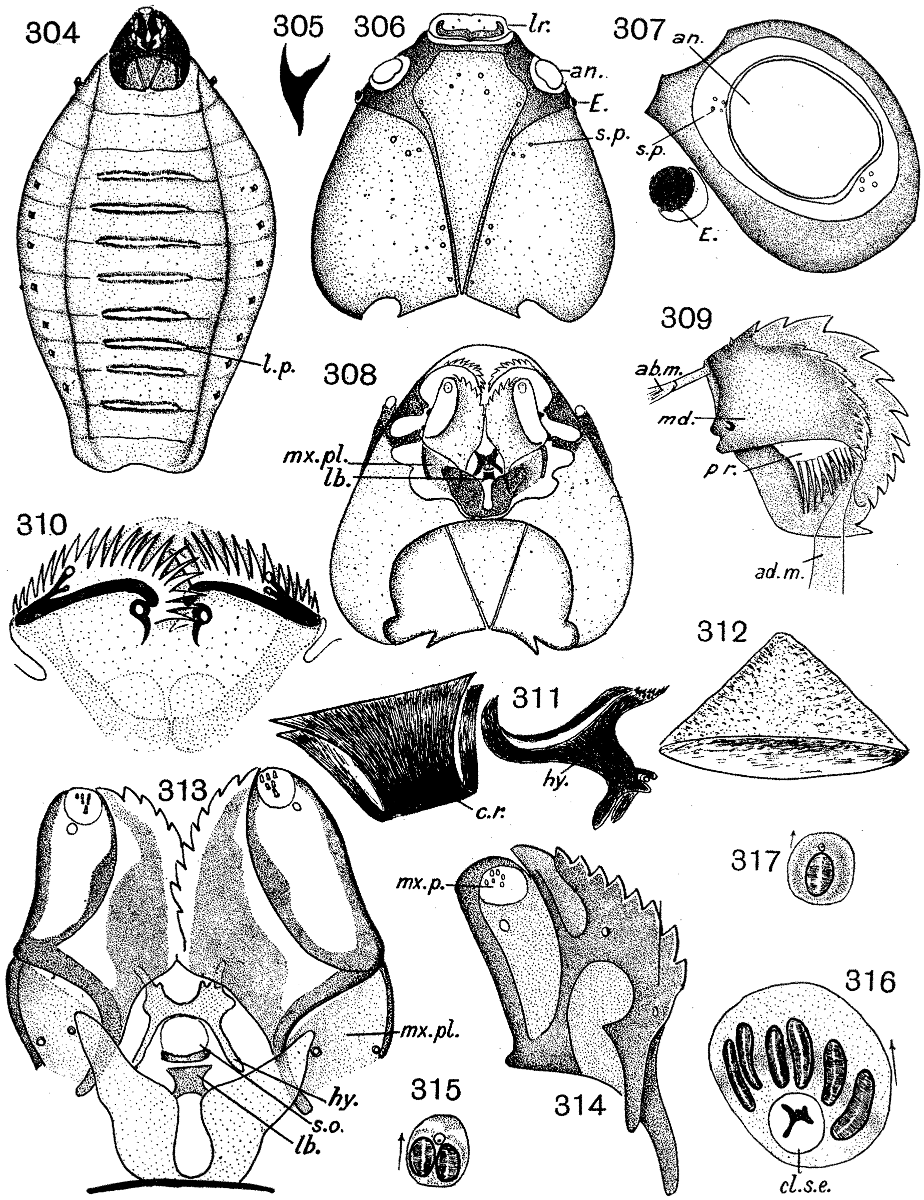
Finally STEENBERG (1924) gave an excellent account of the biology and external morphology of *Phronia strenua* and *P. Johannae*. The mouth-parts of the larvae are described in detail and the figures are drawn with great care.

n. Phronia strenua *Winnertz*

Biology—The larva lives on sodden, fallen, and barkless branches. It feeds on moulds, and bears a hard black conical case (fig. 312) made from its own excrement. Before pupation, it leaves this test, retires to a crevice in the wood, and spins a light silky cocoon.

Morphology—The larva (fig. 304) is slug-like in shape, having a flat ventral and convex dorsal surface. It is 5 mm. long, and 2 mm. wide across the middle.

The small chitinous head (figs. 306, 308) is usually retracted into the prothorax to the level of the antennae. It is triangular in shape with rounded angles. The frontal plate is broadest at the level of the antennae and tapers posteriorly to a point. It carries three pairs of sensory pits. The epicranial plates unite posterior to the maxillary plates (*mx.pl.*, fig. 308). Anteriorly they send out two tongue-shaped chitinous projections which articulate with the condyles of the mandibles. The posterior margin of each plate is notched. The antenna (*an.*, fig. 307) bears four minute papillae (*s.p.*). The eyes (*E.*, fig. 307) are situated postero-lateral to the antennae. On the dorsal surface, the labrum is furnished with five pairs of sensory papillae. The mandible (fig. 309) is semicircular in shape and bears twelve teeth



Phronia strenua Winnertz

Fig. 304—Whole larva, ventral surface. × 12.
Fig. 305—Enlarged chitinous hook of locomotory pad. × 320.
Fig. 306—Head, dorsal surface. × 120.
Fig. 307—Antenna and larval eye. × 320.
Fig. 308—Head, ventral surface. × 320.
Fig. 309—Mandible. × 320.
Fig. 310—Labrum, ventral surface. × 320.
Fig. 311—Hypopharynx and chitinous ring supporting pharynx. × 320.
Fig. 312—Test of larva. × 320.
Fig. 313—Two maxillae, hypopharynx and labrum. × 320.
Fig. 314—Maxilla. × 320.
Fig. 315—Abnormal abdominal spiracle. × 320.
Fig. 316—Prothoracic spiracle. × 320.
Fig. 317—Abdominal spiracle. × 320.

along the inner border, while the dorsal lamella carries two rows of smaller teeth and a well-developed prostheca (*pr.*).

The inner lobe of the maxilla (fig. 314) is provided with nine teeth. The outer lobe is provided with six small sensory papillae (*mx.p.*, fig. 314). The maxillary plates (*mx.pl.*, fig. 313) are lozenge-shaped chitinous areas which meet posteriorly at the mid-ventral line. The outer borders are strongly chitinized, the inner borders being separated anteriorly by a narrow transparent membrane. Each plate carries two sensory hairs.

The hypopharynx (*hy.*, figs. 311, 313) consists of two irregular plates of chitin, which are joined at the mid-ventral line between the inner borders of the two maxillae (fig. 313). Following this junction posteriorly, they end in two curved horn-like chitinous processes which pass along the sides of the pharynx (fig. 311). Anteriorly they send out two boot-shaped chitinous processes which embrace the opening of the salivary duct. The pharynx is supported by a chitinous plate (*c.r.*) curved like a U, the anterior borders of which pass laterally to the horn-shaped processes (fig. 311).

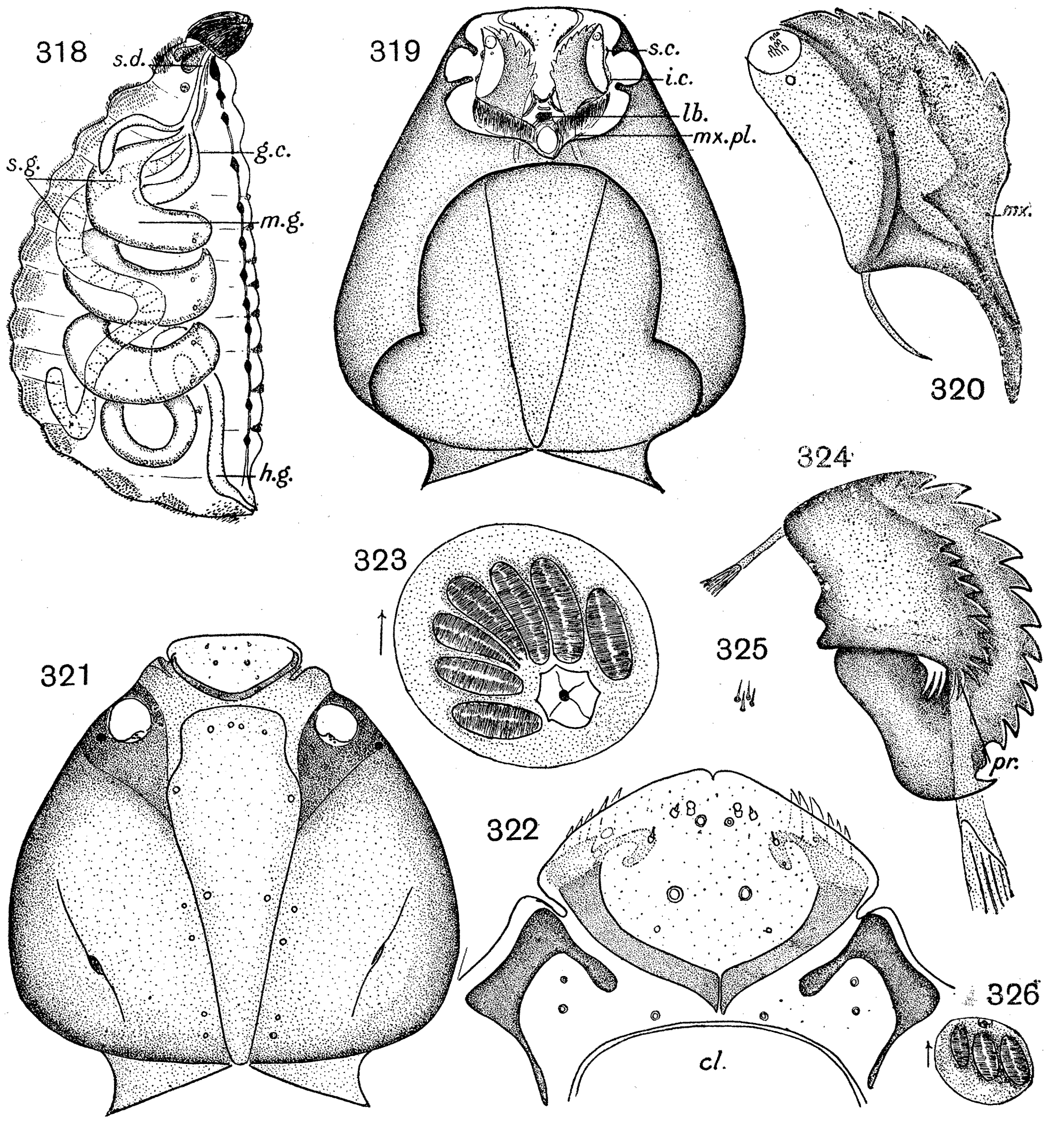
The labium (*lb.*, fig. 313) is reduced to a small quadrate chitinous plate situated between the two maxillary plates and supporting the ventral surface of the salivary opening (*s.o.*).

The body of the larva is free from hairs and spinules except for six groups of sensory hairs, and eight intersegmental locomotory pads. Each of the former consists of four sensory hairs of equal length, and represents the sensory vestiges of a leg. The locomotory pads (*l.p.*, fig. 304) consist of a double row of chitinous hooks surrounded by five to six rows of spinulae. Each hook (fig. 305) consists of a broad base embedded in the skin and a free curved sharp end. The prothoracic spiracle (fig. 316) has six longitudinal spiracular openings situated anterior to the external scar (*cl.s.e.*). The seven pairs of abdominal spiracles (fig. 317) are uniforous. In one case the last abdominal pair was abnormal, the spiracle on the right side being biforous (fig. 315), while that on the left was uniforous like the rest (fig. 317). A similar abnormality has been encountered in *Exechia guttiventris*.

o. Phronia annulata *Winnertz*

The larvae live on damp and mouldy fallen branches. Unlike *P. strenua*, they do not carry excremental tests on their backs. The larva (fig. 318) is larger than *P. strenua*, and the body is covered with spinules along the dorsal surface and in the vicinity of the spiracles. The pronotum carries a tuft of hair on the dorsal surface.

The head (fig. 321) is wider than that of *P. strenua* and is usually retracted into the prothoracic segment. The lateral epicranial plates are provided with two triangular chitinous expansions along the posterior margin, and two chitinous thickenings along the sides for the attachment of muscles. The frontal plate carries four pairs of sensory pits. On the ventral surface the two epicranial plates are united in a narrow chitinous bar situated posterior to a membranous area, which separates the two



Phronia annulata WINNERTZ

FIG. 318—Side view of larva, showing internal anatomy. × 12.
FIG. 319—Head, ventral surface. × 120.
FIG. 320—Maxilla. × 320.
FIG. 321—Head, dorsal surface. × 120.
FIG. 322—Labrum, dorsal surface. × 540.
FIG. 323—Prothoracic spiracle. × 540.
FIG. 324—Mandible. × 540.
FIG. 325—Thoracic sensory hairs. × 540.
FIG. 326—Abdominal spiracle. × 540.

maxillary plates (*mx.pl.*, fig. 319). The labrum (fig. 322) carries six pairs of sensory papillae of different shapes. The mandible (fig. 324) is provided with twelve teeth along its inner border. The dorsal lamella carries a row of smaller teeth and a small prostheca at the inner basal angle. The inner lobe of the maxilla is cut into eight teeth (fig. 320). The maxillary palp bears nine rod-shaped papillae. The maxillary plates (*mx.pl.*, fig. 319) are rectangular in shape, and separated anteriorly by an oval membranous area. The hypopharynx is similar to that of *P. strenua.* The labium (*lb.*, fig. 319) is reduced to a quadrilateral chitinous plate which lies between the vertical processes of the hypopharynx. It supports the opening of the salivary duct.

The prothoracic spiracle is well developed (fig. 323). The spiracular plate is perforated by seven oval openings situated anterior to the external scar. The abdominal spiracle has three openings which are posterior to the external scar (fig. 326).

The larva of *Phronia annulata* differs from that of *P. strenua* in having a larger head, better developed prothoracic and abdominal spiracles, and a different number of the papillae and teeth borne on its labrum, mandibles, and maxillae. Moreover, it is easily distinguished from *P. strenua* by having the dorsal surface covered with spinules and by not carrying an excremental test. The two species of *Phronia* described are unlike all other Mycetophilid larvae in the shape of their body, which is slug-like. This is probably a secondary adaptation to their environment, for the larvae live on fallen branches which are liable to become dry. As all Mycetophilid larvae require a saturated atmosphere for respiration, the body of *Phronia* is shortened to enable the larva to withstand adverse conditions, thus exposing less cuticular surface and so preventing excessive evaporation. That this shortening is a secondary adaptation is supported by the fact that the alimentary canal, which is straight in all other Mycetophilid larvae, is coiled on itself in *Phronia* (fig. 318). Moreover, *Phronia annulata* is provided with spinulae on the dorsal surface and short hairs in the vicinity of the spiracles—a unique condition in Mycetophilid larvae and possibly an adaptation to reduce surface evaporation. *Phronia strenua* carries an excremental test which may serve a similar purpose. In both species skin respiration is reduced, but spiracular respiration is increased, as evidenced by the well-developed spiracles. Holmgren described hypodermal glands in *M. ancyliformans.* The function of such glands is probably to cover the body with an oily secretion and thus reduce surface evaporation.

p. Genus Mycetophila *Meigen*

Mycetophila *Meigen* (Fungivora *Meigen* 1800)

Historical—Osten-Sacken and Brauer gave lists of the literature on *Mycetophila* larvae up to 1883, the outstanding work being that of Dufour (1839, *b*) who described five species. In 1902 Berlese gave an account of the internal changes in the fatty tissue of *M. signata.* Holmgren (1907) described a test bearing lava, *M. ancyliformans,* and dealt with its biology, external and internal anatomy. Knab and Zwalumenberg (1918) gave a short account of *Mycetophila medrigera.* The mouth-parts are not described. The larvae described by HOLMGREN and KNAB are unlike any of the species belonging to Genus *Mycetophila*. They resemble the larvae of *Phronia*, but according to EDWARDS they should be referred to the genus *Delopsis*.

Biology—According to EDWARDS, " the larvae live in the interior of fungi, some species attacking many different kinds, others being restricted to a single fungus-host. They may be found either in terrestrial or lignicolous fungi, though the same species will usually occur only in one of these classes of host. A distinct cocoon is always formed, which may be placed either in the ground or in the fungus, if this is of a species which will not decay too readily. Some of the species which pupate within the fungus have very interesting arrangements for the escape of the imago, either a lobster-pot-like arrangement of stiff threads or a thin papery cap being formed at the front end of the tough cocoon. The cocoon of these species which pupate in or at the surface if the ground is generally of slighter texture and without any special arrangements for emergence. As often occurs in other genera of this family, the imagos after hatching from the pupa often remain quiescent in the cocoon for quite a long time ".

q. Mycetophila cingulum *Meigen*

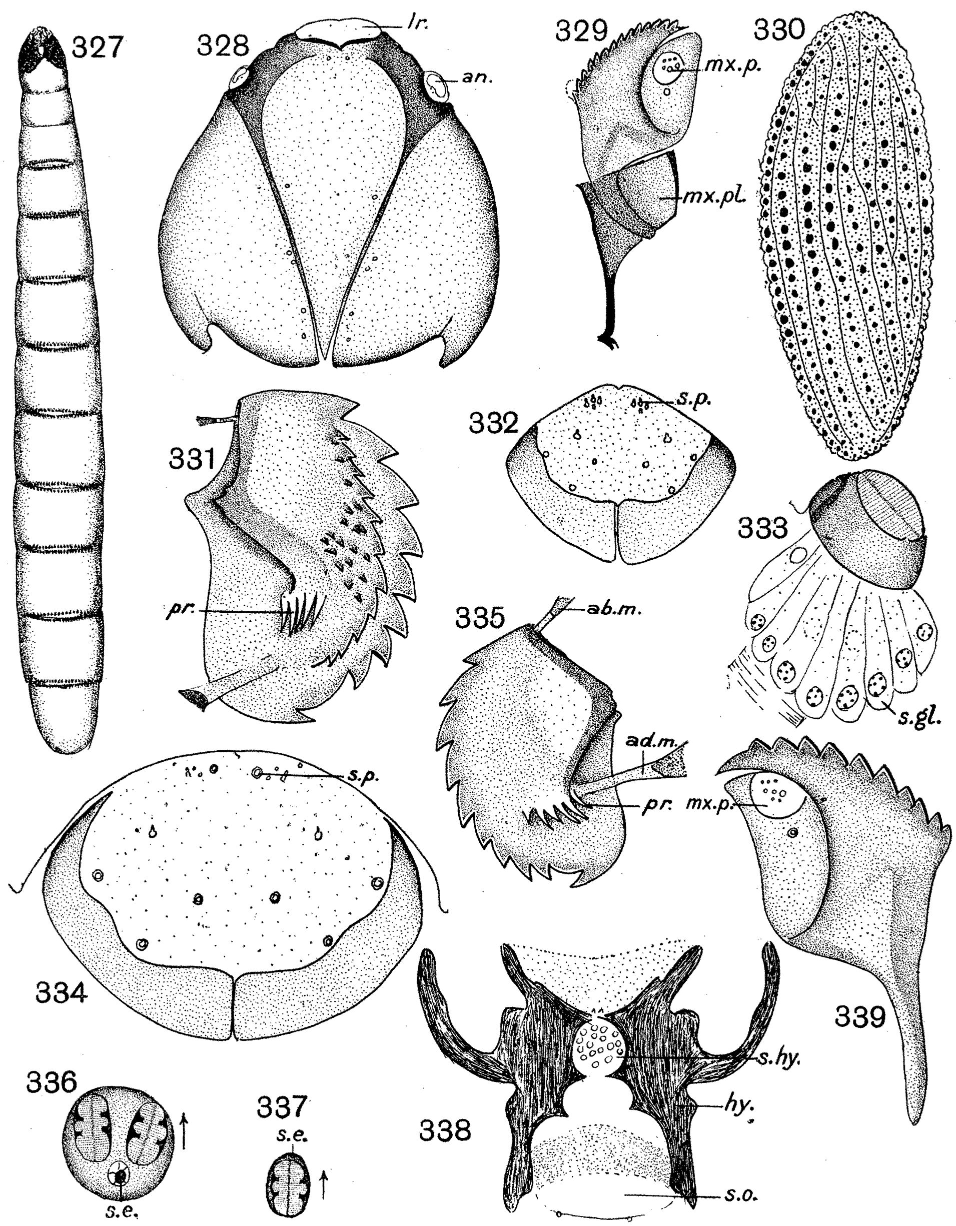
The larva lives exclusively on *Polyporus squamosa*. The female lays its eggs on the underside of the fungus. These (fig. 330) are exactly similar to those of *Brachypeza radiata*.

The larva passes through four instars. In the last instar, the body of the larva is curved in the shape of a U and it buries itself beneath the surface of the ground where it spins a slight cocoon. The last exuvia is usually found attached to the terminal segment of the pupa.

The mature larva (fig. 327) is 8 mm. long, and is broadest a little behind the middle and attenuated at both ends. The integument is thin and free from hairs, except for six groups of sensory hairs and nine intersegmental locomotory pads. The former consist of four sensory hairs each situated in the position of legs. Each locomotory pad consists of double rows of chitinous hooks surrounded by three to four rows of spinules.

The head (fig. 328) is cordiform. The frontal plate tapers posteriorly to a point and carries three pairs of sensory pits. The lateral epicranial plates are united ventrally to the maxillary plates. The posterior border shows two emarginations. The antenna (*an.*, fig. 328) bears six minute papillae. Two pigmented eyes are present.

The labrum (fig. 332) is supported by a semicircular chitinous frame along the posterior border and carries eight pairs of sensory papillae of different shapes. The mandible (fig. 331) is semicircular in shape and provided with nine teeth along its inner border. The superior lamella bears four rows of smaller teeth, and a small prostheca (*pr.*). The inner lobe of the maxilla (fig. 329) carries 15 small teeth and ends in a curved chitinous rod. The outer lobe bears six circular papillae. The maxillary plates are quadrilateral in shape, the borders composed of thickened



Mycetophila cingulum MEIGEN and *M. forcipata* LUNDSTRÖM

FIG. 327—Whole larva of *M. cingulum*. × 12.
FIG. 328—Head of *M. cingulum*, dorsal view. × 54.
FIG. 329—Maxilla of *M. cingulum*. × 185.
FIG. 330—Egg of *M. cingulum*. × 320.
FIG. 331—Mandible of *M. cingulum*. × 320.
FIG. 332—Labrum of *M. cingulum*, dorsal view. × 185.
FIG. 333—Abdominal spiracle of *M. cingulum*, side view. × 540.
FIG. 334—Labrum of *M. forcipata*, dorsal view. × 320.
FIG. 335—Mandible of *M. forcipata*. × 320.
FIG. 336—Prothoracic spiracle of *M. forcipata*. × 540.
FIG. 337—Abdominal spiracle of *M. forcipata*. × 540.
FIG. 338—Hypopharynx, ventral view of *M. forcipata*. × 320.
FIG. 339—Maxilla of *M. forcipata*. × 320.

chitin. They are separated by an oval area covered with transparent chitin. The hypopharynx is similar to that of *Brachypeza radiata*. The labium is reduced to a small rectangular plate, the anterior border of which bears four minute papillae.

The prothoracic spiracle is biforous ; the seven abdominal spiracles (fig. 333) are uniforous.

r. M. forcipata *Lundström*

The larva lives in *Polyporus betulinus*. Pupation takes place under the surface of the ground in a dense oval cocoon.

The larva is 7 mm. long. The head is cordiform, the posterior border showing two lateral emarginations. The labrum (fig. 334) is supported by a well-developed crescent-shaped chitinous frame along its posterior border and carries seven pairs of dorsal papillae. The mandible (fig. 335) is provided with ten teeth along its inner border. The superior lamella bears a prostheca (*pr.*) along its inner basal angle. The inner lobe of the maxilla (fig. 339) is curved and carries eleven teeth. The maxillary palp is provided with eight minute papillae.

The hypopharynx is flattened and is represented from its dorsal (oral) aspect in fig. 338. It consists of two irregular chitinous plates which join in the mid-ventral line. At their junction they enclose a circular transparent area which carries several sensory hairs, the bases of which are shown. Each plate sends a boot-shaped chitinous process to the lateral side of the salivary opening (*s.o.*). The labium consists of a small rectangular chitinous plate which supports the ventral surface of the salivary opening.

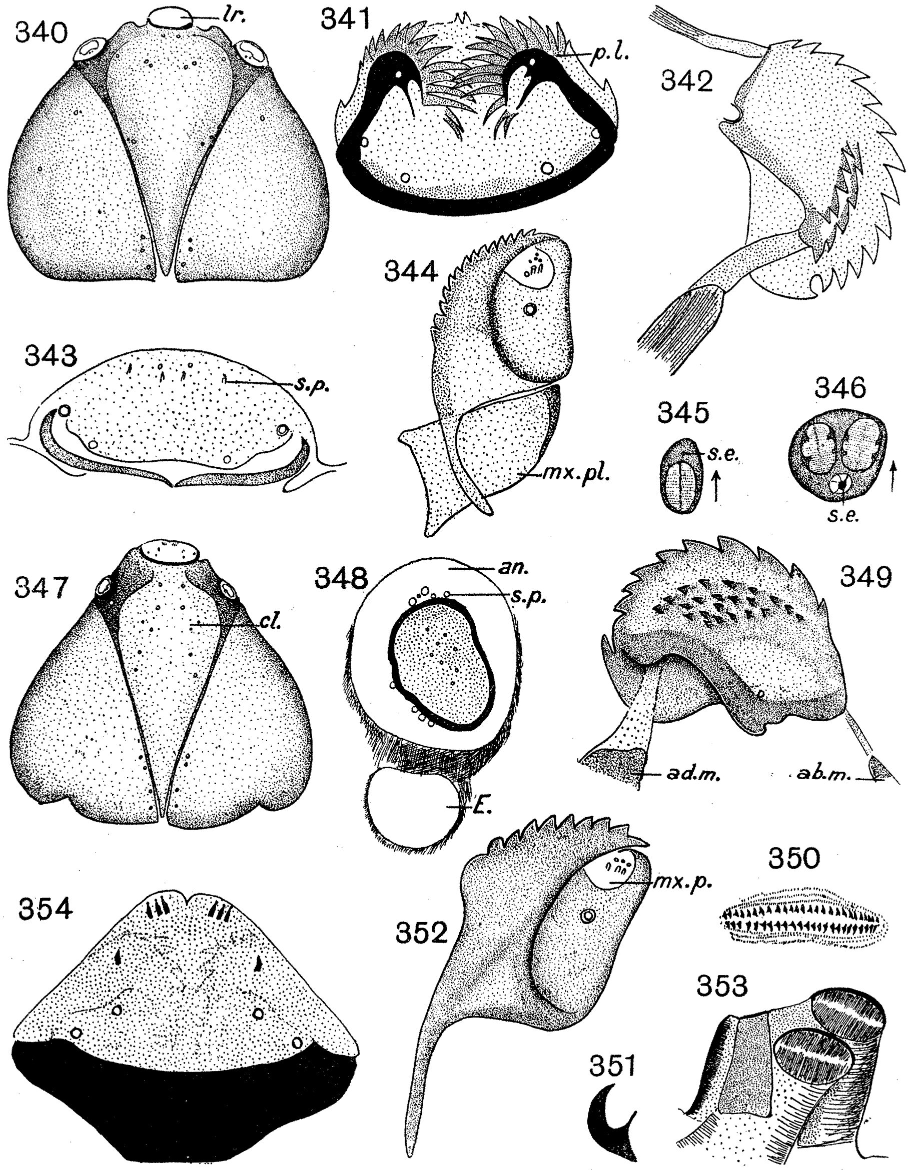
The prothoracic spiracle (fig. 336) is biforous ; the external scar (*s.e.*) is situated posterior to the spiracular opening. The abdominal spiracle (fig. 337) is uniforous.

s. M. luctuosa *Meigen*

The larva is found in *Paxillus involutus* in company with *M. marginata*. It forms a slight cocoon, and pupates just under the surface of the ground.

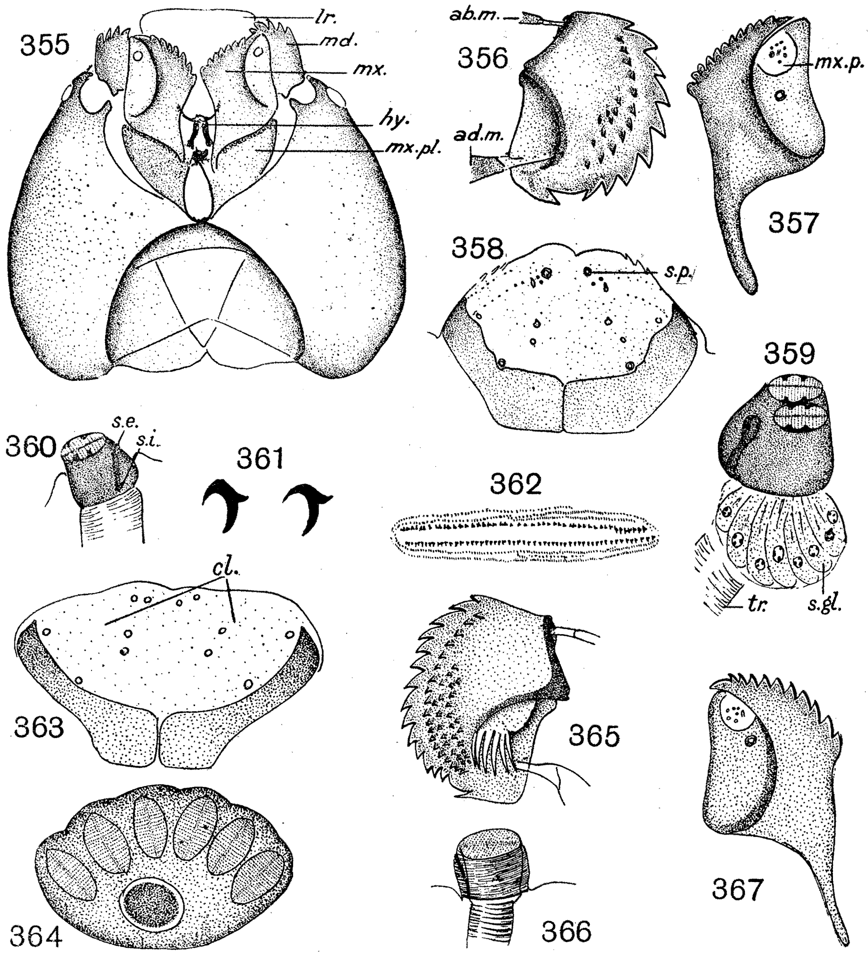
The larva is 7 mm. long. The frontal plate tapers posteriorly to a point and carries six pairs of sensory pits (fig. 340). The epicranial plates unite ventrally to a triangular area situated between the two maxillary plates. Anteriorly each plate sends out two tongue-shaped chitinous processes which articulate with the condyles of the mandibles. The antenna is supported by a chitinized base and an irregular band of chitin, between which are found nine minute papillae. The labrum (figs. 341, 343) carries five pairs of sensory papillae. The mandible (fig. 342) bears 14 teeth along the inner border and two rows of smaller teeth on the superior lamella. The maxilla (fig. 344) carries 14 small teeth. The maxillary palp is broad and bears seven sensory papillae. The maxillary plates (*mx.pl.*) are triangular in shape and separated by a triangular area which is covered with transparent chitin. The labium is a small chitinous plate, situated partly anterior to the triangular area which separates the two maxillary plates.

The prothoracic spiracle (fig. 346) is biforous, the abdominal uniforous (fig. 345).



Mycetophila luctuosa Meigen and *M. ornata* Stephens

Fig. 340—Head of *M. luctuosa*, dorsal surface. × 120.
Fig. 341—Labrum of *M. luctuosa*, ventral surface. × 320.
Fig. 342—Mandible of *M. luctuosa*. × 320.
Fig. 343—Labrum of *M. luctuosa*, dorsal surface. × 320.
Fig. 344—Maxilla of *M. luctuosa*. × 320.
Fig. 345—Abdominal spiracle of *M. luctuosa*. × 540.
Fig. 346—Prothoracic spiracle of *M. luctuosa*. × 540.
Fig. 347—Head of *M. ornata*, dorsal surface. × 120.
Fig. 348—Antenna and larval eye of *M. ornata*. × 320.
Fig. 349—Mandible of *M. ornata*. × 320.
Fig. 350—Locomotory pad of *M. ornata*. × 54.
Fig. 351—Chitinous hook of locomotory pad of *M. ornata*. × 185.
Fig. 352—Maxilla of *M. ornata*. × 320.
Fig. 353—Prothoracic spiracle of *M. ornata*. × 540.
Fig. 354—Labrum of *M. ornata*, dorsal view. × 540.



Mycetophila guttata DZIEDZICKI and *M.* (*punctata* MEIGEN) *fungorum* DE GEER

FIG. 355—Head of *M. guttata*, ventral surface. × 120.
FIG. 356—Mandible of *M. guttata*. × 185.
FIG. 357—Maxilla of *M. guttata*. × 185.
FIG. 358—Labrum of *M. guttata*, dorsal surface. × 185.
FIG. 359—Prothoracic spiracle of *M. guttata*, side view. × 540.
FIG. 360—Abdominal spiracle of *M. guttata*, side view. × 540.
FIG. 361—Chitinous hooks of locomotory pad of *M. guttata*. ×320.
FIG. 362—Locomotory pad of *M. guttata*. × 33.
FIG. 363—Labrum of *M. fungorum*, dorsal surface. × 185.
FIG. 364—Prothoracic spiracle of *M. fungorum*. × 540.
FIG. 365—Mandible of *M. fungorum*. × 185.
FIG. 366—Abdominal spiracle of *M. fungorum*. × 540.
FIG. 367—Maxilla of *M. fungorum*. × 185.

t. M. ornata *Stephens*

The larva is found in *Polysticus versicolor* and *Polyporus giganteus*. Before pupation it spins a dense cocoon with an open network at the head. Pupation takes place within the fungus.

The head (fig. 347) is cordiform ; the frontal plate carries six pairs of minute sensory pits. The antenna (*an.*, fig. 348) is supported by the usual two chitinous bands between which are found nine sensory papillae (*s.p.*). The eye (*E.*, fig. 348) is situated postero-laterally to the antenna. The labrum (fig. 354) is provided with four rod-shaped and two circular sensory papillae. The mandible (fig. 349) carries ten teeth on the inner border and three to four rows of smaller teeth on the superior lamella. The maxilla (fig. 352) bears ten teeth. The maxillary palp is provided with three cylindrical and three circular sensory papillae.

The prothoracic spiracle (fig. 353) is biforous, the abdominal uniforous. The body of the larva is furnished with nine intersegmental locomotory pads, the first being situated between the metathorax and first abdominal segment. Each pad (fig. 350) consists of a double row of chitinous hooks surrounded by three rows of spinules.

u. M. guttata *Dziedzicki*

The larva lives in *Russula nigricans*. According to Edwards, " The cocoons are of tough texture except for a very neat papery cap in front. They are placed in the fungus a little way from the surface, and before pupation the larva cuts a nearly circular hole in the skin of the fungus to ensure safe emergence ".

The head (fig. 355) is subglobular. The lateral epicranial plates meet ventrally posterior to an oval area situated between the two maxillary plates. The labrum (fig. 358) is supported by a well-developed chitinized frame along the posterior border. It carries eight pairs of sensory papillae. The mandible (fig. 356) bears twelve teeth along the inner border and three rows of smaller teeth on the superior lamella. The inner lobe of the maxilla (fig. 357) is provided with twelve teeth. The outer lobe has a circular area anteriorly which bears eight small papillae. The maxillary plates (*mx.pl.*, fig. 355) are triangular in shape and separated by an oval area which is covered with transparent chitin. The labium is situated partly anterior to the oval area.

The prothoracic spiracle (fig. 359) consists of a small truncated conical projection of chitin, which is perforated by two oval spiracular openings. The spiracular gland (*s.gl.*) consists of several elongated cells supported by a basement membrane. The larva has nine intersegmental locomotory pads on the ventral surface. Each pad (fig. 362) consists of a double row of hooks, surrounded by three interrupted rows of spinules on either side. Each hook (fig. 361) consists of a wide base which is embedded in the skin and a sharp curved point. The free ends of the hooks of the anterior row point towards the head, those of the posterior row towards the anus.

v. M. (punctata *Meigen*) fungorum *De Geer*

The larva is commonly found in *Armillaria mellea* and many other ground fungi such as *Boletus edulis*, *Russula chloroides*, and *Hypholoma fasciculare*. Prior to pupation, it leaves the fungus and penetrates below the surface of the ground where it spins a papery cocoon.

The larva is 8 mm. long. The head is brown and it is thus easy to separate this from the other species whose heads are jet black. The labrum (fig. 363) is supported by a well-developed chitinized frame and carries seven pairs of dorsal papillae. The mandible (fig. 365) is provided with 15 teeth along its inner border. The superior lamella bears a well-developed prostheca and three to four rows of smaller teeth. The maxilla (fig. 367) carries eleven teeth. The maxillary palp bears seven sensory papillae.

The labium consists of a small chitinized plate situated between the vertical processes of the hypopharynx.

The prothoracic spiracle (fig. 364) is well developed, being provided with six oval spiracular openings.

The abdominal spiracle (fig. 366) is uniforous.

XI—List of Parasites of Mycetophilid Larvae

The following is a list of parasites found in Mycetophilid larvae :—

	Parasite	Host	Author
Protozoa	*Nosema* sp.	*Sciara analis*	Guercio (1905)
	Crithidia sp. ?	*Sciara* sp.	Madwar
	Schnedieria caudata	*Sc. nitidicollis*	Leger (1892)
Helminthes	*Nematode* (larval stage)	*Diadocidia ferruginosa*	Madwar
	*Atractonema gibbosum**	*Sciara* sp.	Keilin
	Aproctonema entomophagum†	*Sc. pullula*	Keilin
Insecta (Hymenoptera) Ichneumonidae	*Hemiteles gracilis*	*Sciara analis*	Guercio
	Orthocentrus protervus Holmgr.	*Scipphila hirta* Mg.	Roman (1923)
	Aniseres lubricus Foerst	*Phronia strenua* Winn.	,,
	Proclitus edwardsi Roman	*Brachypeza radiata* Jenk.	,,
	Proclitus paganus Hal.†	*Bolitophila glabrata* Lw.	,,
	Symplicis breviuscula Roman	*Diadocidia ferruginosa* Mg.	,,
	Entypoma robustum Foerst	*Dynastoma fuscicorne* Mg.	,,
	Aperileptus albipalpus Gu.	*Mycetophila forcipata* Lundst.	,,
	Plectiscus sodalis Foerst	*Mycetophila lineola* Mg.	,,
	Plectisus tenuicornis Foerst	*Apoliphthisa subincana* Curt.	,,
Braconidae	*Aspilota* sp.	*Cordyla brevicornis*	Roman
Proctotrupidae	*Proctrotrupes aculeator*	*Mycetophila nigra*	Morley
	P. gravidator	*Bolitoph. fusca*	,,
	P. devagator	*Scioph. linn.*	,,
	P. ater	*Mycetophila punctata*	,,
Diptera	*Tachinid* sp. ?	*Sciara* sp. ?	Thompson

* *Atractonema gibbosum* was first described by Leukart from a Cedidomyid larva. Keilin found it in a *Sciara* larva (*unpublished work*).

† Since the above was written, an important paper on the morphology and life history of *Aproctonema entomophagum* has been published by Keilin and Robinson (1933).

XII—Crithidia ? Parasitic on Sciarine Larvae

The hind-gut of a Sciarine larva contained numerous flagellates. These were examined in a hanging drop preparation. They moved with great rapidity and remained alive for 30 hours.

Morphology—The body is $20 \times 2 \mu$. The posterior end is blunt, the anterior pointed and furnished with a flagellum about twice as long as the body. The trophonucleus is oval and is situated in the middle of the body. The kinetonucleus is rod-shaped and placed midway between the trophonucleus and anterior end of the body. Both nuclei could be seen in the living animal. The flagellum arises in the neighbourhood of the kinetonucleus. The presence of an undulating membrane was not ascertained, so it is possible that the flagellates may belong to the genus *Herpetomonas*.

Dividing forms could be seen splitting longitudinally, beginning at the anterior end. The flagellum of the daughter flagellate is shorter than that of the parent and in consequence the two flagellates hang together until the shorter flagellum has grown long enough to work against the other flagellum and so effect separation.

XIII—*Proclitus edwardsi* Roman. Ichneumonid Parasite of *Brachypeza radiata* Jenkinson

The Ichneumonid, *Proclitus edwardsi* was bred by Edwards (1924, *a*) from its host *Brachypeza radiata*. Edwards suggested that the high degree of parasitism to which the larvae are subject may account for the relative scarcity of adult flies of *Brachypeza* compared to the abundance of the larvae. Hamm and I have each since bred this parasite from the same host.

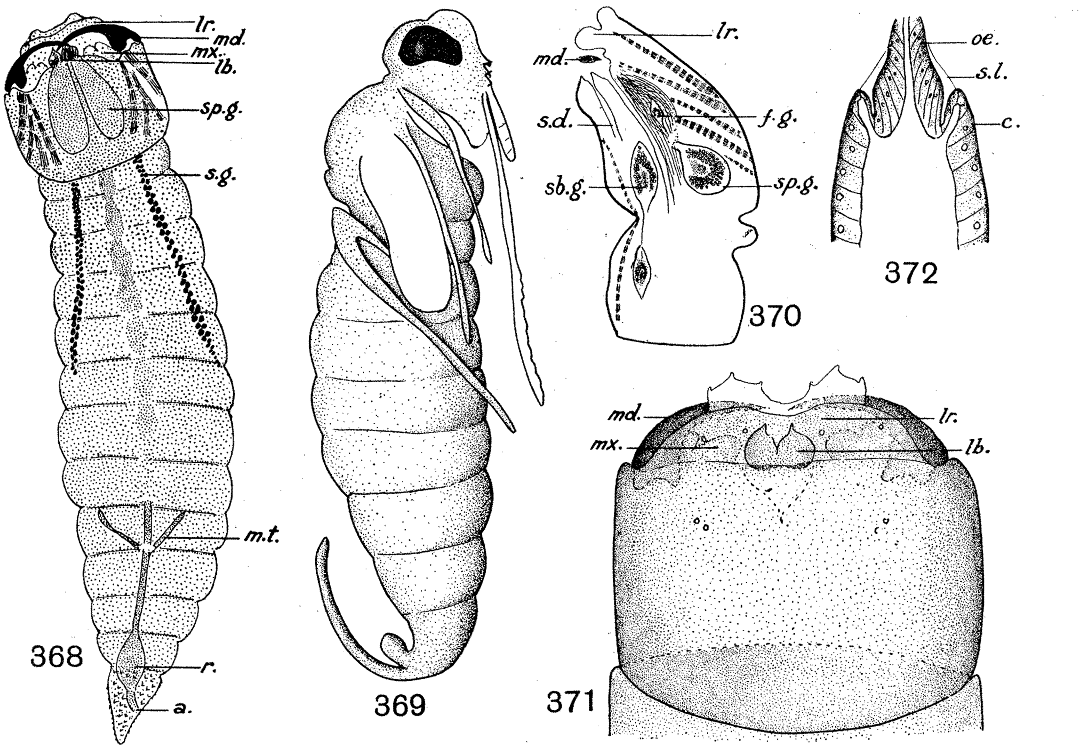
Brachypeza radiata bred from material collected at Kings Hedges, Cambridge, Gamlingay, and Barton Mills were free from parasites. In September, 1929, however, eight larvae out of ten from Grantchester were found to be parasitized. On the 30th September, hymenopterous parasites began to appear amongst the remaining material and these were identified as *Proclitus edwardsi* by the late Dr. Waterston.

Usually one parasite only was found in the host, but in a few cases two or three were present. In such cases one parasite was alive and the others were dead. Artificial infection failed.

Morphology—The parasites are found in the body cavity of the host, in the posterior third. They were dissected out, examined alive, and stained *in toto* in dilute haemalum. Longitudinal sections of parasitized larvae were prepared to study the internal anatomy of the parasite.

The larva (fig. 368) is creamy white, fusiform, broadest a little behind the middle and tapering posteriorly to a point. The cuticle is studded with numerous minute papillae. The larva has a free well-defined head and thirteen body segments.

The head (figs. 368, 371) is quadrate, light brown in colour. The dorsal surface is convex and bears six groups of sensory pits. A pair of small circular papillae are present at the base of each mandible. The ventral surface is flat. The labrum (*lr.*, fig. 371) consists of a transparent semicircular membrane. The anterior border



Proclitus edwardsi Roman

Fig. 368—Larva of *P. edwardsi.* × 72.
Fig. 369—Pupa of *P. edwardsi.* × 33.
Fig. 370—Saggital section of head of *P. edwardsi.* × 120.
Fig. 371—Head of *P. edwardsi,* dorsal surface. × 120.
Fig. 372—Oesophageal valve. × 120.

has two triangular expansions, each carrying three sensory papillae. Posterior to these expansions four circular papillae are present. The mandibles (*md.*, figs. 368, 371) are smooth, sickle-shaped, strongly chitinized structures. The two free pointed ends overlap when the mandibles are fully adducted. The adductor and abductor muscles are shown by transparency in fig. 368. The maxillae (*mx.*, fig. 371) consist of two transparent lobes, which are difficult to see, situated on the inner sides of the mandible. The anterior free border is notched. The labium (*lb.*, figs. 368, 371) is triangular in shape, bifid at its anterior border. The periphery is more chitinized than the centre. In fig. 371 it is shown by transparency through the membranous labrum.

The body segments are clearly defined ; the terminal segment differs from the rest in being triangular and covered with small chitinous spinules.

The pupa (fig. 369) is found within the host's cocoon and exhibits a wide range of movements when free. The frontal surface of the head is inclined obliquely downwards. The thorax is arched and the abdomen tapers posteriorly. The antenna curves over the anterior margin of the eye and extends backwards to the fourth body segment. It consists of 19 segments. The maxillary palp consists of five segments of unequal length. The abdomen is composed of eight visible segments, the last of which is provided with a pair of lateral lobes which curve backwards. The terebra is folded back over the dorsal surface of the abdomen and extends upwards to the sixth abdominal segment.

Internal Anatomy of the Larva—The alimentary canal takes a straight course from the mouth-opening to the anus. The fore-gut extends to the mesothorax where it is invaginated into the mid-gut to form the cardiac valve (fig. 372). The pharynx (fig. 370) is a muscular organ and gives attachment to three sets of muscles, namely :—dorso-ventral, longitudinal, and transverse. The first are present in the mid-sagittal plane and are inserted in the head capsule along the sides of the mid-dorsal line. They act as dilators of the pharynx. The latter two interdigitate with each other and act as constrictors. The mid-gut meets the hind-gut at the posterior border of the ninth body segment. It is uncertain whether or not there is communication between them. The two Malpighian tubules open at the beginning of the hind-gut, which takes a straight course and opens on the dorsal surface of the terminal segment (fig. 368). Before its termination it widens to form a rectal ampulla (*r.*, fig. 368).

The two salivary glands (*s.g.*, fig. 368) extend backwards as two straight tubes to the fifth body segment. Anteriorly they join a common duct which opens dorsal to the labium (*s.d.*, fig. 370).

The central nervous system consists of a supra-oesophageal, a sub-oesophageal, and a chain of eleven ventral ganglia, of which the last is the largest and probably consists of three fused ganglia.

I could not find any spiracles.

XIV—Comparative Morphology of Mycetophilid Larvae

Body Form—The Mycetophilid larvae are nearly cylindrical, but broadest a little posterior to the middle and somewhat attenuated at both ends. They vary in length, the Bolitophilinae being short, stumpy and 5–6 mm. in length, the Diadocidinae and Sciophilinae slender, elongated, and about 15–18 mm. long. The Mycetophilinae and Sciarinae are of medium length, 10–12 mm. *Ceroplatus* is worm-like, 20–25 mm. long, with the anterior four body-segments well defined, while the rest are masked by secondary folds of the skin. *Phronia* is an aberrant in form, having flat ventral and convex dorsal surface.

The ventral locomotory pads vary in the extent of their development. They are well developed in the Mycetophilinae and to a less extent in the Bolitophilinae. Each pad consists of a double row of hooks surrounded by several rows of spinules. In the Sciarinae they are represented by rows of spinules. In Diadocidinae, Ceroplatinae, and Sciophilinae they are absent.

The integument is soft and moist in all Mycetophilid larvae. It is very thin in Ceroplatinae, Diadocidinae, and Sciophilinae, but comparatively thicker in Mycetophilinae and Bolitophilinae.

Body Segments—In all Mycetophilid larvae, the body consists of twelve apparent segments, the last of which is provided with anal lobes. In *Ceroplatus*, I found only eleven segments, though in this larva the body segmentations are so masked by secondary folds of the skin that they are difficult to make out. In *Polylepta* (Schmitz, 1912), *Diadocidia* (Sharp, 1918), and *Mycetophila ancyliformans* (Holmgren, 1907) the larvae are said to possess thirteen body segments, the last of these being reduced. Probably the anal lobes, which are well developed in *Diadocidia* and *Polylepta*, were counted by these authorities as a definite segment.

From a study of the respiratory system in Dipterous and other holometabolous larvae, which shows a striking metameric arrangement, Keilin (1924) considers the general and maximum number of true segments in all holometabolous larvae to be eleven (in addition to the head).

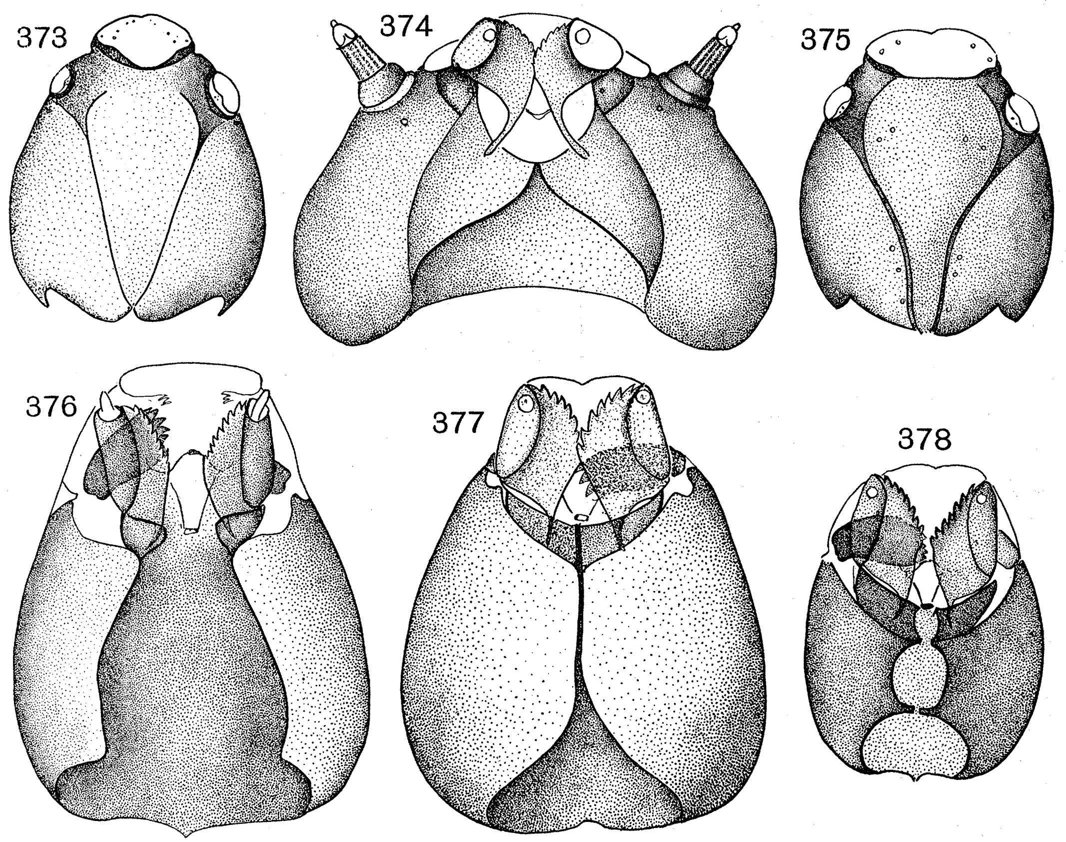
On Keilin's hypothesis the Mycetophilid larvae possess eleven true segments, the last of which is double.

In the larvae of *Bibio* (Morris, 1917), *Scatopse* (Morris, 1918), *Anopheles* (Imms, 1907–8), *Chironomus* (Miall and Hammond, 1900), the body is described as consisting of twelve segments. For lack of embryological evidence, I have not been able to decide whether the last abdominal segment in Mycetophilid larvae is a true metamere or merely a subdivision of the penultimate segment, and I have therefore considered the body of Mycetophilid larvae as consisting of twelve apparent segments.

The Head—The head in Bolitophilinae (fig. 374) is trapezoidal, narrow anteriorly, broad and rounded posteriorly. Dorsally the lateral epicranial sutures are curved, and do not meet posteriorly. In *Diadocidia* (fig. 114) and the Sciophilinae (figs. 376, 377) the head is elongated ; the epicranial sutures are straight and meet at a point on the posterior margin. The Sciarinae (fig. 375) have a rectangular head with arcuate sides ; the epicranial sutures take an undulating course and meet posteriorly. The head in *Ceroplatus* (fig. 115) is almost square, with parallel sides ; in the Mycetophilinae it is cordiform (fig. 328).

On the ventral surface the cranium is either closed (fig. 377) (*i.e.*, the epicranial plates meet at the mid-ventral line), or not closed (*i.e.*, the epicranial plates are separated), as in all the Mycetophilidae except *Diadocidia* and *Leptomorphus*. This closure may be effected through the meeting of the epicranial plates at one point as in the Mycetophilinae and Ceroplatinae (fig. 115) ; at two points, as in the *Sciarine* (fig. 378) ; or along the mid-ventral line (fig. 377), as in *Sciophila* and *Mycomyia*. The antennae are rudimentary in all Mycetophilid larvae except the Bolitophilinae. In the latter (fig. 374) each consists of three segments and it is probable that this represents the generalized type of this organ and that specialization took place by reduction.

I found eyes in all my specimens, and it is probable that they occur in all



Comparative morphology of the head in Mycetophilidae

FIG. 373—Head of *Apolophthisa subincana*. × 120.
FIG. 374—Head of *Bolitophila saundersi*. × 120.
FIG. 375—Head of *Sciara semialata*, dorsal view. × 120.
FIG. 376—Head of *Leptomorphus walkeri*. × 120.
FIG. 377—Head of *Tetragoneura sylvatica*. × 120.
FIG. 378—Head of *Sciara semialata*, ventral view. × 120.

Mycetophilid larvae as small pellucid or opaque spots which are easily missed. I found them in *Sciara*, though according to DUFOUR they are absent in that genus.

Trophi—The labrum is supported by a chitinized frame in all Mycetophilid larvae. This frame is well developed in the Bolitophilinae (fig. 380), but is thinner and depressed in the middle in the Sciarinae (fig. 379), and separated in *Leptomorphus*

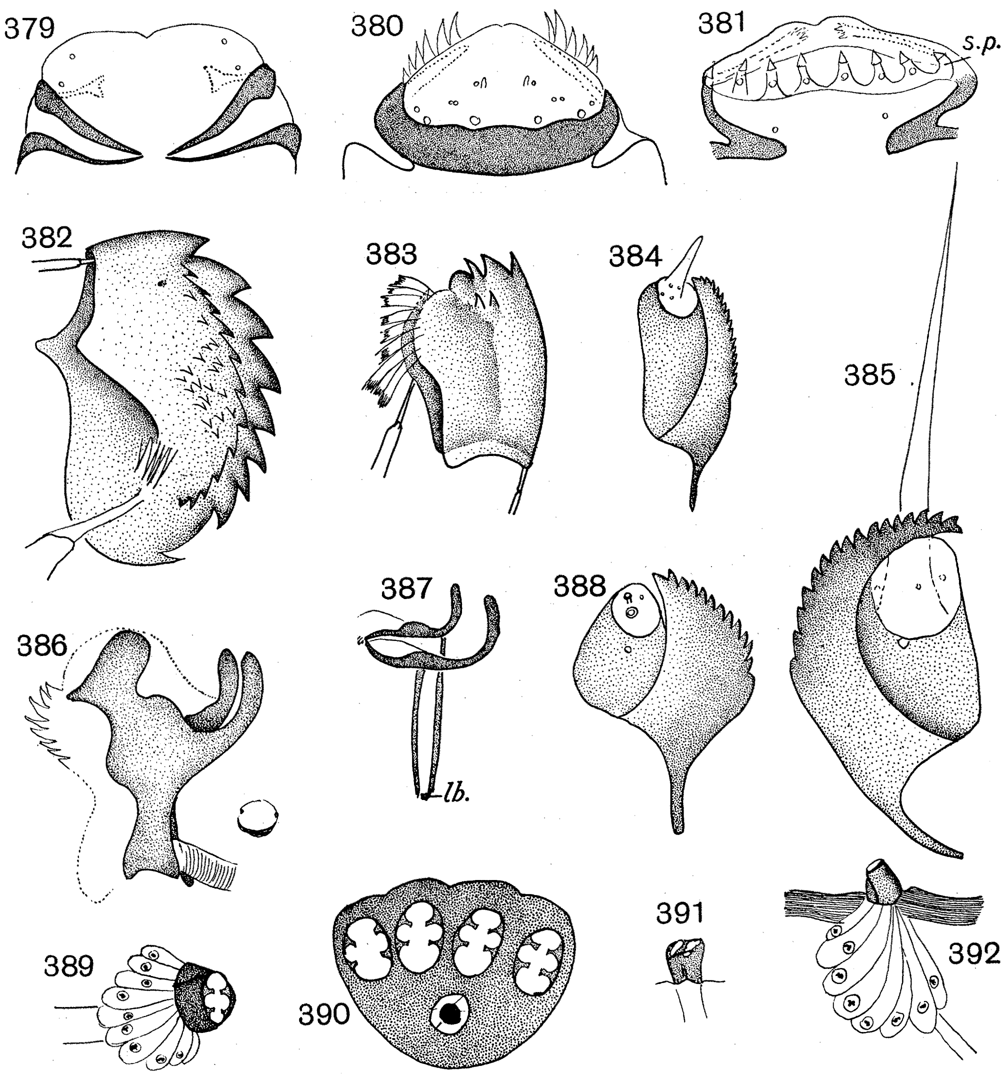


FIG. 379—Labrum of *Sciara semialata*. × 185.
FIG. 380—Labrum of *Bolitophila glabrata*. × 320.
FIG. 381—Labrum of *Leptomorphus walkeri*. × 185.
FIG. 382—Mandible of *Mycetophila cingulum*. × 320.
FIG. 383—Mandible of *Polylepta leptogaster*. × 320.
FIG. 384—Maxilla of *Leptomorphus walkeri*. × 320.
FIG. 385—Maxilla of *Sciophila*. × 320.
FIG. 386—Hypopharynx of *Cordyla brevicornis*. × 320.
FIG. 387—Hypopharynx of *Polylepta leptogaster*. × 320.
FIG. 388—Maxilla of *Cordyla brevicornis*. × 320.
FIG. 389—Abdominal spiracle of *Exechia guttiventris*. × 540.
FIG. 390—Prothoracic spiracle of *E. guttiventris*. × 540.
FIG. 391—Prothoracic spiracle of *Leia bimaculata*. × 540.
FIG. 392—Abdominal spiracle of *Leia bimaculata*. × 540.

(fig. 381). The sensory papillae are of two shapes, cylindrical or circular. They attain their maximum development in *Leptomorphus walkeri* (*s.p.*, fig. 381). The mandibles are of two types. The semicircular form bearing numerous teeth (10–14) present in the Mycetophilinae and Bolitophilinae (fig. 382), and the quadrate form (fig. 383), carrying 5–7 teeth, found in the other sub-families. The only exception I found is that of *Mycomyia marginata* (Sciophilinae) where the mandible (fig. 168) is of the former type.

The maxillae—In the Bolitophilinae the inner border is strongly chitinized and bears 10–11 teeth. The Sciophilinae (fig. 385) have a much curved inner lobe carrying 14–16 teeth, while the Sciarinae have only 6–7 teeth.

In all Mycetophilid larvae the sensory part of the maxillary palp consists of a flat membranous area carrying a few papillae (fig. 388). In *Sciophila* (fig. 385) this area is elongated into a membranous cone which can be shot out and retracted by the larva, while in *Leptomorphus* (fig. 384) it attains an intermediate development between that of *Sciophila* and the rest of the Mycetophilidae.

The maxillary plates vary in shape. They may be triangular and meeting along the mid-ventral line (fig. 377) as in *Ceroplatus*, *Leia*, and *Tetragoneura* ; or quadrate and meeting at one point (fig. 378), as in *Sciara* and the Mycetophilinae ; or separated by a membranous area (fig. 376), as in *Leptomorphus* and *Sciophila*.

The hypopharynx is of two types ; the slender and the massive type. The first type (fig. 387) consists of two horizontal and two vertical rods. It is found in all the larvae except those belonging to the Mycetophilinae and Bolitophilinae. The second type (fig. 386) consists of two irregular chitinous plates, each provided with a vertical boot-shaped process. This character is constant and enables us to separate the larvae of Mycetophilinae and Bolitophilinae from those of all the other sub-families. The labium is reduced to a small chitinous plate situated at the base of the hypopharynx between its two vertical processes. The labium supports the opening of the salivary gland along its ventral surface. Its shape varies, being semicircular with a median process in the Bolitophilinae, quadrate in the Mycetophilinae, and rectangular in the other sub-families.

Alimentary system—The alimentary canal takes a nearly straight course from the mouth opening to the anus. It is slightly longer than the body of the larva on account of the loop formed by the hind-gut. In *Phronia*, however, the alimentary canal forms three loops on account of the shortening of the body of the larva (fig. 318). The anus is sub-ventral in all Mycetophilid larvae except *Ceroplatus*, where it is terminal.

XV—Comparison of Some Internal Organs with Those of Related Larvae

The anterior portion of the mid-gut is provided with two long lateral caeca of equal length, which run backwards and are closely apposed to the mid-gut. The external surface is puckered. The puckering is due to the circular constrictor muscles which are present in Mycetophilid larvae. These muscles are absent in the caeca of Bibionidae (MORRIS, 1917) and those of *Anopheles* (IMMS, 1907–8).

The size and number of these caeca vary among nematocerous larvae. They may be absent as in *Psychoda* (DELL) or numerous (eight or more) as in *Anopheles* (IMMS, 1907–8) and *Chironomus* (MIALL and HAMMOND, 1900). In general, however, where they are few in number they are well developed, as in the Mycetophilidae and Ditomyidae, whereas when numerous they are reduced in size, as in *Ptychoptera* and *Chironomus*.

In families closely related to the Mycetophilidae, the number of these caeca varies even in the same family. In *Ditomyia* there are two caeca ; three in *Bibio hortulans* (KEILIN, 1919, *b*) ; four (three anterior and one posterior) in *B. johannis* (MORRIS, 1917, *b*) ; four (two anterior and two posterior) in *Scatopse notata* (KEILIN, 1919, *b*).

The *Malpighian tubes* are four in number in all Mycetophilid larvae. They are of equal length and arise separately from the terminal portion of the mid-gut. In *Ceroplatus*, according to DUFOUR (1839, *a*), the four tubes arise by two common ducts at the junction of the mid- with the hind-gut. In *Bibio johannis*, *B. marci*, *Ditomyia fasciata*, and *Scatopse notata* the same number is present. In the former two they arise from a common duct.

The *two salivary glands* are well developed in all Mycetophilid larvae, being about $2\frac{1}{2}$ times the length of the body. In *Ditomyia fasciata* and *Bibio johannis* they are less developed and do not exceed half the length of the body.

The central *nervous system* of all Mycetophilid larvae is of the so-called primitive type, *i.e.*, it is not centralized, as in the higher dipterous larvae. It consists of a supra-oesophageal, a sub-oesophageal, three thoracic, and eight abdominal ganglia, extending to their respective segments. The connectives between these ganglia are double throughout. In most Nematocerous larvae the connectives run so close to each other as to appear single, though in reality they are always double.

In the larvae of related families, such as the Ditomyidae, Bibionidae, and Scatopsidae, the same number of ganglia are present as in Mycetophilid larvae.

The central nervous system of *Anopheles maculipennis* closely resembles that of Mycetophilid larvae. According to IMMS, " In the eighth segment the ganglion is larger than those of the preceding segments, it is somewhat triangular in form, and it gives off pairs of nerves which supply both the eighth and last segments. It is therefore to be regarded as a fusion of the primitive ganglia of those segments ". In *Simulium* and *Chironomus* the same number of ganglia is present as in Mycetophilid larvae. In the first, according to PURI (1925), " the last three abdominal ganglia are fused together in the sixth segment to form a compound ganglion which shows its three component parts even externally ". In *Chironomus dorsalis* the last two abdominal ganglia are close together (MIALL and HAMMOND, 1900).

An extended nervous system consisting of a ventral chain of eleven ganglia (three thoracic and eight abdominal) is frequently found in the larvae of *Nematocera* (tribe Eucephala) in contrast to the centralized nervous system which is present in the larvae of Cyclorrhapha.

XVI—Development of the Eye in Mycetophilid Larvae

Schmitz (1912) considers that the mature larva has three different pairs of eyes, namely :—(1) the larval eyes (Nebenaugen), which are found posterior to the antennae and which are absent in the pupa and imago ; (2) rudimentary eyes (rudimentäre Augen) which lie beneath the skin of the first thoracic segment on either side of the mid-dorsal line and which are said to develop into the accessory eyes of the adult ; (3) rudiments of the imaginal eyes (Hauptaugen) which lie lateral to the rudimentary eyes and later develop into the compound eyes of the imago.

The disappearance of the larval eye in the imago and the development of the rudimentary eye of the larva into the accessory eye of the imago are not supported by the work of Zavrel (1907) or Keilin (1913, *a*), who maintain that the larval eyes persist and become the accessory eyes of the imago.

Zavrel (1907), who made a comparative study of the eyes in the larvae and pupae of Diptera, clearly shows in his figures (1, 2, 5, 9, 11, p. 247) that the larval eyes (Nebenaugen) persist in the pupa. These larval eyes may be doubled or trebled.

Keilin (1913, *a*) found that the larval eyes persist in *Belgica antarctica* and become the accessory eye of the imago. In fact, he concluded his discussion on the development of the accessory eye in *Belgica* by saying "Je pense que chez tous les insectes à métamorphose complète dont la larve possède des yeux simples, ces yeux persistent chez l'imago. Ils peuvent être plus ou moins déplacés et masqués par les yeux imaginaux qui gagnent en surface".

I have never found the rudimentary eyes described by Schmitz in any of the Mycetophilid larvae, though in many cases I found the elements of the ommatidia of the compound eyes (Hauptaugen) in mature larvae, in the form of two conspicuous, fusiform, pigmented areas on either side of the mid-dorsal line in the prothoracic segment.

In the pupa the accessory eye (which is the persisting larval eye) is found as a deeply pigmented spot below the imaginal compound eye, which as it travels forwards and gains in size completely masks the accessory eye (larval eye) in the imago.

XVII—Respiratory Adaptations

The larvae of Mycetophilidae are found in wet media. When exposed to a dry atmosphere they die in 30–40 minutes. Humidity, therefore, is essential for their life.

All the mature larvae of Mycetophilidae are peripneustic except *Ceroplatus*, *Diadocidia*, and *Speolepta*. The former is apneustic, the latter two are propneustic. In *Ceroplatus*, the tracheal system is well developed but functional spiracles are absent. The body of this larva is elongated and provided with four protrusible anal lobes, the skin is thrown into numerous folds which increase its surface, the integument is thin and richly supplied with a sub-cuticular net of tracheoles and the larva lives under a hygroscopic tent of saliva. These facts seem to indicate that the conditions for cutaneous respiration are specially favourable.

In *Diadocidia* and *Speolepta*, the conditions for cutaneous respiration are also favourable, the larvae being slender, elongated, and provided with anal lobes. The integument also is thin and the larvae live in slimy hygroscopic tubes. The absence of abdominal spiracles may be due to an arrest of their development owing to the favourable conditions in which they live. The presence, on the other hand, of a pair of prothoracic spiracles supplying the head, the pro- and mesothoracic segments may assist the less active cuticular respiration of the chitinized head with its actively growing imaginal discs. Moreover, the larvae often protrude their heads beyond the limits of their slimy tubes for feeding and the thoracic region of their bodies may thus be exposed to a less saturated atmosphere.

In the Bolitophilinae and Mycetophilinae, on the other hand, the larvae are liable to be exposed to a less humid atmosphere, especially prior to pupation, when they leave the fungus. Here we find a tendency for reduction of the skin surface, the larvae being short and curved during that period. The spiracles are well developed.

An interesting case of surface reduction is seen in *Phronia*. The larvae live under fallen branches and are liable to be exposed to a dry atmosphere. The body is shortened, the dorsal surface is either covered by an excremental test as in *Phronia strenua*, or with spinules as in *P. annulata* (fig. 318). The spiracles, however, are well developed.

In general, then, when the conditions for cuticular respiration are favourable (such as in larvae living in hygroscopic tubes), the spiracles are found to be reduced either in size, as in the Sciophilinae (*cf.* figs. 391, 392, with figs. 389, 390), or in number, as in *Diadocidia* and *Speolepta*, or else to be absent as in *Ceroplatus*. The skin surface, on the other hand, is increased. Where the larvae are liable to be exposed to a dry atmosphere, the skin surface is reduced, and the spiracles are well developed, as in the Bolitophilinae and Mycetophilinae.

In Mycetophilid larvae, the peripneustic system is to be considered as primary, the apneustic and propneustic as being derived from the peripneustic. This hypothesis is supported by the presence of ten pairs of *non-functional spiracles* in the apneustic form (*Ceroplatus*) and nine pairs of similar, and one pair of functional spiracles in the propneustic forms (*Diadocidia* and *Speolepta*), occupying the same place as the eight pairs of functional spiracles and two pairs of non-functional spiracles (metathoracic and eighth abdominal) which are present in all Mycetophilid larvae.

The larvae of Ditomyidae, Scatopsidae, and Bibionidae are peripneustic. The first and second carry nine pairs of spiracles, the third carries ten pairs. In all these forms, however, the last abdominal spiracles are more developed than the rest, showing a tendency to the metapneustic condition. The larvae of Mycetophilidae, on the other hand, show a tendency to become propneustic—a very rare condition in nematocerous larvae. Evidence in support of this statement is afforded by the following facts :—

1. The prothoracic spiracles are first developed in the second stage larva and persist in subsequent stages. The abdominal spiracles, on the other hand, are only developed in the fourth stage larva.

2. The prothoracic are better developed than the abdominal spiracles in all Mycetophilid larvae without exception, consisting of 2–7 spiracular openings, whereas the abdominal spiracles consist of a single opening.

3. In *Speolepta* and *Diadocidia*, the larvae have become propneustic.

XVIII—Locomotion

All dipterous larvae are apodous, but various provisional means have been adopted for locomotion or fixation. Among the Nematocera the larvae may be provided with ventral pseudopods distributed on one or more of the body segments (*i.e.*, *Simulium*, *Chironomus*, *Dixa*, *Dicranota*, etc.); with ventral suckers (*Blepharocera*); or with leaping power (*Cecidomyia*). In some larvae, the mandibles may be adapted for locomotion (*Mycetobia*).

Among the Mycetophilidae, the Bolitophilinae, and the Mycetophilinae possess locomotory pads. Moreover, they exhibit a leaping power analogous to that of Cecidomyid larvae. This is effected by the larva bringing its anal segment against the posterior margin of the head, so forming a loop perpendicular to the surface on which it rests and then, by suddenly releasing that tension, the larva projects itself into the air.

The Sciophilinae live in slimy tubes, where there is little friction. The larva exhibits a gliding movement and no locomotory pads are present. *Ceroplatus* moves in a serpentine manner and is also devoid of locomotory pads.

Keilin (1915, *b*) considers that larvae of Diptera which have once lost their legs in the process of evolution, through a change in their mode of life, never regain homologous structures, even though their old manner of life may be resumed. In accordance with this theory, such locomotory organs (pseudopods and suckers) as are found in Mycetophilid larvae are to be considered as neoformations of an adaptive nature and not as true appendages.

XIX—Observations on Pupation

Keilin (1915, *a*) discusses the modes of pupation among the Orthorrhapha, and classifies them into three groups:

(1) Pupa free—this is the commonest condition.
(2) Pupa enclosed in a cocoon, as in *Mycetophila blanda*, certain aphidivorous Cecidomyidae, Simulidae, certain Chironomidae, etc.
(3) Pupa enclosed in larval skin, as in all Stratiomyidae, Scatopsinae, etc.

The great majority of Mycetophilid larvae pupate in the ground. A few, however, pupate in the fungus on which they have fed, as *Mycetophila guttata*, and in most of the Sciophilinae the pupa hangs freely, being suspended by a few salivary threads.

The pupae may be free, as in the Bolitophilinae ; or enclosed in a dense cocoon, as in the Mycetophilinae ; or merely enclosed in a meshwork of salivary threads which can hardly be called a cocoon, as in Diadocidinae and some Sciophilinae.

XX—Systematic Position of the Family

Many classifications of the Nematocera have been proposed from time to time. Most of these have been based on adult characters. Brauer's classification, however, is based on larval characters, and Edwards takes into consideration both larval and adult characters.

Concerning the relationship of the Mycetophilidae to other families, Edwards regards them as being nearest to the Bibionidae and Cecidomyidae and possibly, though certainly less closely, related to the Anisopodidae.

The larvae of Mycetophilidae agree with those of Ditomyidae, Bibionidae, and Scatopsidae in possessing a free chitinized head, 12 apparent body segments, and a peripneustic respiratory system. They differ, however, in the structure of the mouth parts, cuticular armature, and number of spiracles.

The larvae and pupae of *Ditomyia*, *Symmerus*, and *Centrocnemis* closely resemble one another and are here joined together to form the family Ditomyidae, which is completely separated from the Mycetophilidae. On adult characters, on the other hand, *Ditomyia*, *Symmerus*, and *Centrocnemis* are still included in the Mycetophilidae. It is probable that the Ditomyidae may be found to occupy an intermediate position between the Mycetophilidae and Bibionidae.

XXI—Larval Key

1. Antenna well developed, composed of three segments .	Bolitophilinae
Antenna rudimentary, composed of one segment . .	2
2. Larva free ; locomotory pads present	3
Larva enclosed in a slimy tube ; pads absent	4
3. Epicranial plates meeting at one point on ventral surface ; locomotory pads well developed	Mycetophilinae
Epicranial plates meeting at two points, locomotory pads rudimentary	Sciarinae
4. Larva without spiracles, vermiform	Ceroplatinae
Larva with spiracles, not vermiform	5
5. Larva peripneustic	Sciophilinae (*Pars maj.*)
Larva propneustic	6
6. Epicranial plates meeting on ventral surface	Sciophilinae (*Pars min.*) (*Speolepta*)
Epicranial plates not meeting on ventral surface . . .	Diadocidinae

I am greatly indebted to Professor D. Keilin for the suggestion and plan of the work and also for the helpful criticism and ready counsel in all matters relating to the morphology and physiology of Dipterous larvae. I am also indebted to Dr. F. W. Edwards of the British Museum for his generous supply of material and identification of specimens. I am grateful to Messrs. G. Mansbridge (Slough), A. Hamm (Oxford), and F. Wilson (Farnham Royal) for supplying me with some material, and to Mr. A. W. Rymer Roberts for revising my manuscript for the press.

XXII—Summary

From this study of Mycetophilid larvae it is clear that certain definite characters are common to all the representatives of the family.

The *head* is free, strongly chitinized, and has no tentorial rods. The *antenna* is usually reduced to a single flattened *non-chitinized* segment, carrying a few minute sensory papillae. In the Bolitophilinae only it is better developed, consisting of three segments. The labrum is fleshy and supported by a chitinous frame which articulates with two movable arms, each carrying a fan-shaped organ. The *mandible* is lamelliform, toothed along its inner border, and carries a prostheca at the inner basal angle except in *Bolitophila*. The *maxilla* consists of an inner cultriform and an outer oval lobe. The former is serrated along the inner margin and ends in a chitinous bar which lies dorsal to the maxillary plate ; the latter is provided with a circular membranous area, carrying several papillae. The hypopharynx consists of two curved horizontal processes which join in the mid-ventral line, and two vertical processes, which join the horizontal processes. The labium is reduced to a small chitinous plate situated at the base of the hypopharynx, supporting the opening of the salivary gland.

The body is soft ; the integument thin and free from hairs except for the six groups of sensory hairs, which are situated in direct relationship to the imaginal discs of the legs. Each group consists of four minute hairs of equal length. Most of the larvae are peripneustic with eight pairs of spiracles borne on the prothoracic and first seven abdominal segments. The few exceptions to this rule, represented by *Ceroplatus* (appeustic), *Diadocidia*, and *Speolepta* (propneustic), can be explained as being due to secondary adaptation. In all Mycetophilid larvae the salivary glands are well developed, being longer than the body of the larva. The alimentary canal takes a straight course except in *Phronia* (fig. 318). From the anterior part of the mid-gut, two lateral caeca arise, which run backwards and are closely apposed to the mid-gut.

These characters are sufficient to separate the larvae of Mycetophilidae from those of all the other *Nematocera*. The community of type in Mycetophilid larvae is so marked that the course adopted by Malloch in according family rank to the Bolitophilinae, Mycetophilinae, Sciarine, etc., is in my view unjustifiable.

XXIII—Key to Lettering

a., anus.
ab.m., abductor muscle.
ad.m., adductor muscle of mandible.
ad.mx., adductor muscle of maxilla.
a.m., alary muscle.
an., antenna.
ao., aorta.

b.s., blood sinus.

c., cardia.
C., cardo.
c.g., cardiac ganglion.
cl., clypeus.
c.m., circular muscle.
c.p., chitinous plate.
c.r., chitinous ring supporting pharynx.
c.s., chitinous support of labrum.

d.v., dorsal vessel.

E., eye.
ep., epithelium.
ep.p., epipharyngeal processes.

f.b., fat body.
f.c., felt chamber.
f.g., frontal ganglion.

g_1, first ganglion.
g.c., gastric caecum.
gn., gonad.

h.g., hind gut.
ht., heart.
hy., hypopharynx.

i.c.g., infra-cerebral ganglion.
i.c., inferior condyle of mandible.
i.d., imaginal disk.
i.e., imaginal eye
i.ep., inner fold of oesophagus.
in., chitinous intima.

l_1, l_2, l_3, imaginal disks of legs.
lb., labium.
l.gl., labral gland cells.
l.p., locomotory pad.
lr., labrum.

m., muscle.
md., mandible.
m.d.oe., dilator muscle of oesophagus.
m.d.ph., dilator muscle of pharynx.
m.g., midgut.
m.o., mouth opening.
m.r.b., retractor buccal muscle.
m.r.p., retractor muscle of pharynx.
m.t., malphigian tubules.
mx., maxilla.
mx.p., maxillary palp.
mx.pl., maxillary plate.

n., ventral nerve cord.
n.a., nerve to the antenna.
ne., nephrocytes.
n.lb., nerve to the labium.
n.lr., nerve to the labrum.
n.md., nerve to the mandible.
n.mx., nerve to the maxilla.
n.r., recurrent nerve.
n.s., stomogastric nerve.

o., transparent chitin.
oe., oesophagus.
oe.g., oesophageal ganglion.
o.ep., outer fold of the oesophagus.
o.n., optic nerve.
os., ostia.

P.h., respiratory horns.
ph., pharynx.
p.l., chitinous fan-like plate.
p.m., peritrophic membrane.
pr., prostheca.
pr., proventriculus.

r., rectum.
r.m., radial muscle.

s., spiracle.
sb.g., sub-oesophageal ganglion.
s.c., superior condyle.
s.d., salivary duct.
s.e., extrenal scar.
s.f., scar filament.
s.g., salivary gland.
s.gl., spiracular gland.
s.h., sensory hairs, indicating the remains of the thoracic legs.
s.h.l., sensory hairs of labrum.
s.hy., sensory hairs of hypopharynx.
s.i., internal scar.
s.l., suspensory ligament.

s.o., opening of salivary duct.
s.p., sensory process.
sp.g., supra-oesophageal ganglion.
s.s., sensory pit.
st., stipes.
t., chitinous teeth.
t.b., chitinous band.
tr., trachea.
w_1, w_2, imaginal disks of the wings.

XXIV—References

Osten-Sacken and Brauer gave a list of references relating to the Mycetophilid larvae, the latter bringing the important references up to 1883.

Anglas, J. (1901). 'Bull. sci. Fr. Belg.,' vol. **34**, p. 363.
Beling, Th. (1883). 'Naturwissenschaften,' vol. **56**, p. 253.
—— (1886). 'Wien. ent. Ztg.,' pp. 11–14, 71–74, 93–96, 129–134.
Berlese, A. (1889). 'Riv. Pat. Veget. Firenze,' vol. **8**.
—— (1899). 'Riv. Pat. Veget. Firenze,' vol. **18**, pp. 86–92.
Bischoff, W. (1922). 'Arch. Naturgesch.,' vol. **88**, pp. 981–984.
Bosc (1792). 'Ann. Soc. Hist. Nat. Paris,' vol. **1**, p. 42.
Bouché, P. F. (1834). "Naturgeschichte der Insecten," Berlin, Nicolaï.
Brauer, F. (1883). 'Denkschr. Akad. Wiss. Wien,' vol. **47**, p. 1.
Bremi, J. J. W. (1846). 'Isis,' vol. **3**, pp. 164–175.
Bruntz, L. (1903). 'Arch. Biol. Paris,' vol. **20**, pp. 217–422.
Cheetham, C. (1920). 'Naturalist,' vol. **45**, p. 189.
Coquillett, D. W. (1895). "Insect Life," vol. **8**, pp. 406–408.
Curtis, J. (1860). "Farm Insects," London, p. 460.
De Geer, J. (1776). 'Mem.,' vol. **6**, p. 361.
Dufour, L. (1839, *a*). 'Ann. Sci. nat.,' vol. **11**, p. 193.
—— (1839, *b*). 'Ann. Sci. nat.,' vol. **12**, pp. 5–60.
—— (1841). 'Mem. Soc. Lille,' vol. **1**, pp. 201–207.
Edwards, F. W. (1919). 'Ann. Mag. Nat. Hist.,' (9), vol. **3**, pp. 372–376.
—— (1924, *a*). 'Ann. Mag. Nat. Hist.,' (9), vol. **14**, p. 175.
—— (1924, *b*). 'Trans. Ent. Soc. Lond.,' p. 582.
—— (1933–34). 'Proc. Linn. Soc. Lond.,' p. 3.
Edwards, F. W., and Williams, C. B. (1917). 'Ann. appl. Biol.,' vol. **2**, pp. 258-262.
Enderlein, G. (1911). 'Arch. Naturgesch.' and Suppl., pp. 116–207.
Gehuchten, Van (1890). 'La cellule,' vol. **6**, pp. 185–289.
Glaser, R. W. (1912). 'Biol. Bull. Wood's Hole,' vol. **23**, pp. 213–222.
Goetghebuer, M. (1912). 'Mem. Acad. R. Belg.' (*a*), vol. **3**, pp. 1–26.
Gräber, V. (1882). 'Arch. mikr. Anat.,' vol. **20**, p. 506.
Guérin, — (1827). 'Ann. Sci. nat.,' vol. **10**, pp. 399–411.
Guérin-Méneville, F. E. (1846). 'Rev. Zool.,' vol. **9**, pp. 14–18.
Heeger, E. (1851). 'S.B. Akad. Wiss. Wien,' vol. **7**, p. 394, Pl. XI.
—— (1853). 'S.B. Akad. Wiss. Wien,' vol. **11**, pp. 27–34.
Henneguy, F. (1906). 'C.R. Ass. Anat.,' 8e Réunion. Bordeaux, pp. 133–140.

HOLLANDE, C. H. (1916). 'Arch. Zool. exp. gén.,' vol. **55**, pp. 62–74.
HOLMGREN, N. (1907). 'Z. wiss. Zool.,' vol. 88, pp. 1–77 (contains a list of literature).
HUDSON, G. V. (1891). 'Trans. N.Z. Inst.,' vol. **23**, pp. 43–49.
—— (1926). 'Ann. Mag. Nat. Hist.' (9), vol. **18**, pp. 667–670.
HUNGERFORD, H. B. (1916). 'J. econ. Ent.,' vol. **9**, pp. 538–549.
IMMS, A. D. (1907–8). 'J. Hyg. Camb.,' vol. **7**, pp. 291–318; 'Parasitology,' vol. **1**, pp. 103–133.
JENKINSON, F. (1901–8). 'Ent. mon. Mag.,' vol. **44**, pp. 132–133.
JOHANNSEN, O. A. (1909–1912). 'Bull. Me. agric. Exp. Sta.,' Nos. 172, 180, 195, 200.
KEILIN, D. (1913, *a*). "Diptera." 'Deuxième Expédition Antarctique Française,' commandé par le Dr. J. Charcot (1908–10), pp. 217–231.
—— (1913, *b*). 'Arch. Zool. exp. gén.,' vol. **52**, pp. 1–8.
—— (1915, *a*). 'Bull. sci. Fr. Belg.,' vol. **49**, pp. 15–198, Pls. I–XVI.
—— (1915, *b*). 'Bull. Soc. zool. Fr.,' vol. **11**, pp. 38–43.
—— (1917, *a*). 'Parasitology,' vol. **9**, pp. 325–450.
—— (1917, *b*). 'C.R. Acad. Sci. Paris,' vol. **165**, p. 339.
—— (1919, *a*). 'Ann. Mag. Nat. His.,' vol. **3**, pp. 33–41.
—— (1919, *b*). 'Ent. mon. Mag.,' vol. **5**, pp. 92–96.
—— (1924). 'Bull. Soc. ent. Fr.,' pp. 125–128.
KEILIN, D., and ROBINSON, V. C. (1933). 'Parasitology,' vol. **25**, pp. 285–294.
KNAB and VAN ZWALUWENBERG (1918). 'Ent. News,' vol. **29**, pp. 138–142.
KOWALEWSKY (1889). 'Biol. Zbl.,' vol. **9**, p. 33.
LABOULBÈNE, A. (1863). 'Ann. Soc. ent. Fr.,' vol. **3**, pp. 105–110.
LANDROCK (1911). 'Wien. Ent. Ztg.,' vol. **30**, pp. 161–167.
LÉGER, L. (1892). "Recherches sur les Gregarines." 'Theses. Poitiers,' p. 153.
LUNDSTRÖM, C. (1906) 'Acta Soc. Fauna Flora fenn.,' vol. **29**, No. 7.
MALLOCH, J. R. (1917). 'Bull. Illinois Lab. Nat. Hist.,' vol. **12**.
MANSBRIDGE, G. H. (1933). 'Trans. R. Ent. Soc.,' vol. **81**, p. 75.
MEIGEN (1818). 'Europ. Zweifl. I.,' p. 223.
MIALL, L. C., and HAMMOND, A. R. (1900). "The structure and life history of the Harlequin fly, *Chironomus dorsalis*," 'Clarendon Press,' Oxford.
MIK, J. (1895). 'Wien. Ent. Ztg.,' vol. **14**, p. 133.
MORLEY, C. (1920). 'Entomologist,' vol. **53**, pp. 83–89.
MORRIS, H. M. (1917). 'Ann. appl. Biol.,' vol. **4**, pp. 91–108.
MORRIS, H. M. (1918). 'Ann. appl. Biol.,' vol. **5**, pp. 102–111.
NORRIS, A. (1894). 'Ent. mon. Mag.,' vol. **2**, p. 202.
OSTEN-SACKEN, C. (1861–63). 'Proc. Ent. Soc. Philad.,' vol. **3**, pp. 105–130.
PANTEL, J. (1898). 'La Cellule,' vol. **15**, pp. 7–290.
PASTEJRIK, J. (1908). "Exechia contaminata?", 'Acta Soc. ent. Bohem. (Čsl.),' pp. 27–31.
PÉREZ, CH. (1910). 'Arch. Zool. exp. gén.,' vol. **4**, p. 217.
PERRIS, ED. (1849). 'Ann. Soc. ent. Fr.,' vol. **7**, p. 331.

Perris, Ed. (1870). 'Ann. Soc. ent. Fr.,' vol. **4** (10), pp. 154–162.
Puri, I. M. (1925). 'Parasitology,' vol. **17**, pp. 295–369.
Réaumur (1738). 'Memoires pour servir à l'histoire des Insectes,' vol. **4**, p. 191.
—— (1740). *Ibid.*, vol. **5**, p. 23.
Roman, A. (1923). 'Ent. mon. Mag.,' vol. **59**, pp. 71–76.
Roser, von C. L. F. (1834). 'Correspondenzbl. Landwirtsch. ver. in Würtemburg, Stuttgart,' vol. **8**, p. 19.
Schmitz, H. (1912). 'Jaarb. Natuurh. Genoot. Limburg,' pp. 65–96.
Schulze, R. (1924). 'Zool. Jb. Abt. 1 (Syst.),' vol. **48**, pp. 433–462.
Sharp, D. (1918). "Insects," Part II. Macmillan & Co. "The Cambridge Natural History," London.
Skuse, F. A. A. (1890). 'Proc. Linn. Soc. N.S.W.' (2) v., p. 678.
Speyer, E. R. (1922). 'Bull. ent. Res.,' vol. **13**, pp. 255–259.
Steenberg, C. M. (1924). 'Vidensk. Medd. naturh. Foren. Kbh.,' vol. **78**, pp. 1–49.
Thomas, I. (1930). 'Proc. zool. Soc. Lond.,' Part 4, pp. 1009–1026.
Viallanes, H. (1882). 'Ann. Sci. Nat. (Zool.),' vol. **14**, 65, pp. 1–348.
Vignon, P. (1901). 'Arch. Zool. exp. gén.,' vol. **9**, pp. 372–692.
Vimmer, A. (1909). 'Acta Soc. ent. Bohem. (Čsl.),' pp. 148–153.
Wahlberg, (1849). 'Stett. ent. Ztg.,' pp. 120–123.
Weiss, H. (1919). 'Psyche,' vol. **26**, pp. 80–82.
Wheeler, W. M., and Williams, F. X. (1915). 'Psyche,' vol. **22**, pp. 36–43.
Wielowiejski, H. R. (1886). 'Z. wiss. Zool.,' vol. **43**, p. 512.
Wigglesworth, V. B. (1930). 'Quart. J. Micr. Sci.,' vol. **73**, pp. 593–616.
Winnertz, J. (1863). 'Verh. zool.-bot. Ges. Wien,' vol. **13**, pp. 637–964.
Zavrel, J. (1907). 'Zool. Anz.,' vol. **31**, No. 8, pp. 247–255.