

ON PLANARIVORA INSIGNIS GEN. ET SP. N. (DIPTERA: MYCETOPHILIDAE), WHOSE LARVAL STAGES ARE PARASITIC IN LAND PLANARIANS

By

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(With one plate and 22 figures in the text.)

ABSTRACT

Planarivora insignis gen. et sp. n. is a Dipteron belonging to the family Mycetophilidae. The female is about 8.0 mm. long. The head and antennae are black, thorax and first abdominal segment reddish brown, the other abdominal segments black. The wings are fuscous and have a venation like that of *Ceroptilon* Rond. The three basal segments of the legs are reddish brown, tibiae and tarsi black. The male resembles the female but the thorax is black. The larval stages are parasitic in certain land planarians, namely *Geoplana tasmaniana* (Darwin), *Geoplana mortoni* Dendy and *Geoplana diemenensis* Dendy.

The adult flies emerge during January and February. The females lay their eggs in places where the land planarians occur. The first stage larva penetrates the body of the planarian by means of powerful mandibles and numerous hook-like spines situated at the front of the prothorax. Having entered the body of the planarian the larva grows very slowly during the period April to November. It then undergoes ecdysis giving rise to the second stage larva, which grows rapidly as it feeds on the internal organs of the planarian. Eventually the parasite kills its host, and bites its way out of the body. It then creeps into a crevice under a stone or in a rotten log and spins a frail meshwork of threads, in which it pupates. Pupation takes place towards the end of December and early in January. It lasts about eight days. Locality: Fern Tree, Mount Wellington, Tasmania.

INTRODUCTION

The little that is known concerning the Tasmanian Mycetophilidae appears mainly in the systematic studies of Skuse (1888), Ferguson (1925), Edwards (1929) and Tonnoir (1929). With regard to the biology of our local species nothing seems to have been recorded.

The larvae of most Mycetophilidae feed on fungi. In fact Landrock (1940) states: "Die Pilzmückenlarven sind ausnahmslos auf vegetabilische Kost angewiesen". In making this statement he appears to have been unaware of the work of Mansbridge (1933), who has shown that a carnivorous habit is present in at least three sub-families of fungus flies, namely, Ceroplatinae, Macrocerinae and Bolitophilinae. In some cases the larvae spin webs for capturing the small myriapods, insects &c., that form their prey. In the webs of certain species of *Platyura* and *Ceroplatus*

liquid droplets are suspended. These droplets have been shown by Biston (Mansbridge, 1933) to contain oxalic acid in sufficient strength to kill small insects coming into contact with it.

Planarivora insignis gen. et sp. n. described in the present paper is remarkable in having larvae that are parasitic in the body of certain terrestrial planarians, namely, *Geoplana tasmaniana* (Darwin), *Geoplana mortoni* Dendy and *Geoplana diemenensis* Dendy. Prior to pupation the larva kills and almost completely devours its host.

METHODS AND MATERIALS

Specimens of *Geoplana tasmaniana* (Darwin) were collected at Fern Tree, Mount Wellington, nearly every month of the year. They were brought to the laboratory and examined under a dissecting microscope. In infected specimens, that were not too heavily pigmented, it was often possible to see the dark head of the larva as the parasite moved about within the body of the planarian. In other cases it was necessary to dissect the planarian in order to determine whether or not it was parasitized.

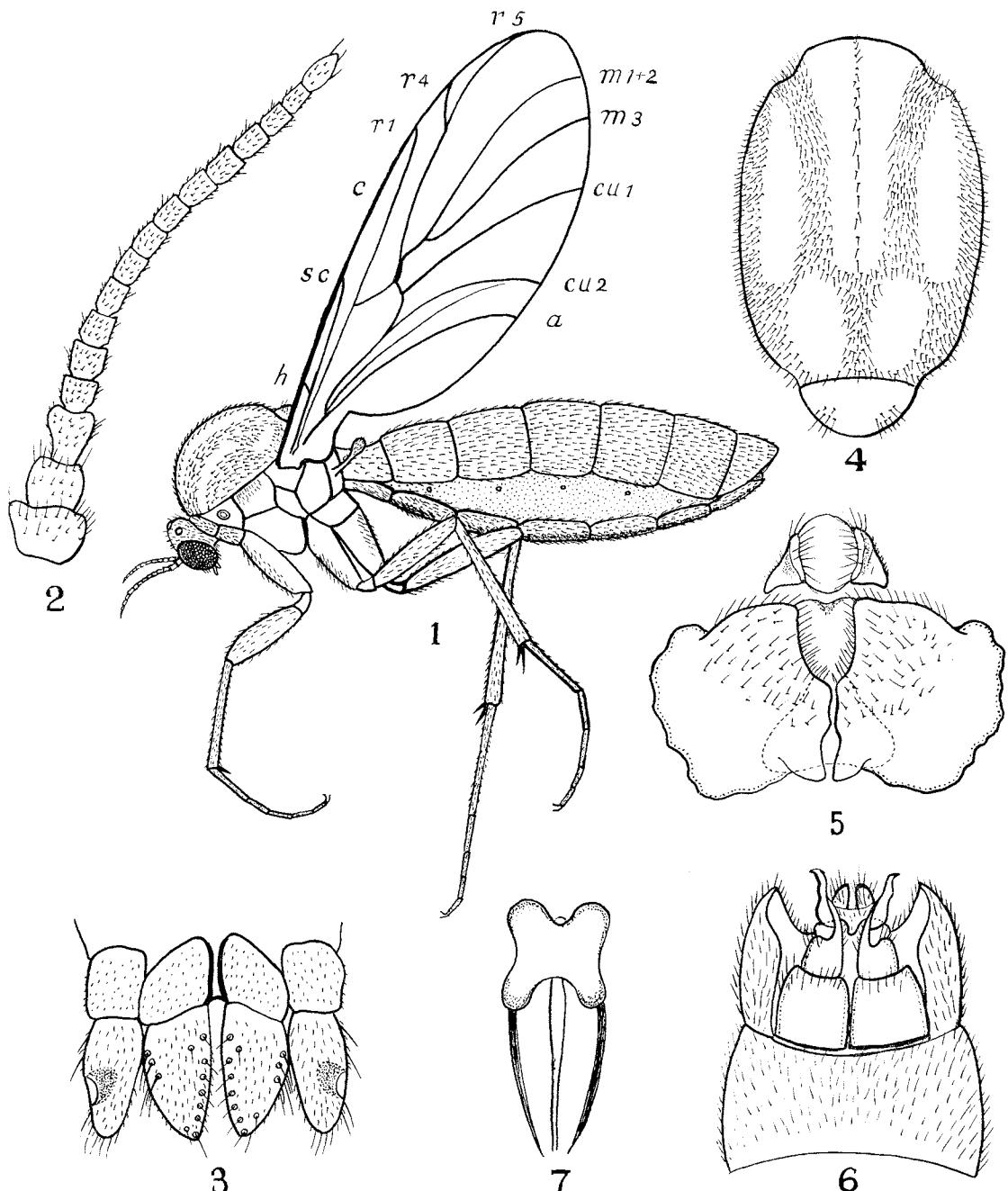
Some infected specimens of the planarian were kept amongst moss and rotten wood in small vivaria until the mycetophilid larva emerged and pupated. A number of adults were bred from pupae thus obtained and also from pupae collected in the field.

Adults of both sexes were kept together in vivaria containing moss, ferns, rotten wood &c., brought from the natural habitat. Non-infected specimens of *Geoplana tasmaniana* were also placed amongst the materials in the vivaria. It was thought that under these conditions males and females of the mycetophilid might mate, but no mating was observed to occur.

The features of adults and larvae were studied in both living and preserved specimens. Whole mounts of dissected parts were prepared for examination under the microscope. Some of the larvae were fixed in Bouin's fluid and cut in serial sections at a thickness of 10 micra. The sections were stained with Ehrlich's haematoxylin and eosin.

Family: MYCETOPHILIDAE
Sub-family: Ceroplatinae
Genus: PLANARIVORA gen. n.

Face broad. Compound eyes oval. Three ocelli in a curved line. Antennae short, with 2 + 14



Planarivora insignis sp. n.

Imago

FIG. 1.—Female showing wing venation.
FIG. 2.—Antenna.

FIG. 3.—Palpi and proboscis.

FIG. 4.—Mesonotum from above.

FIG. 5.—Ovipositor and anal segment of female from below.

FIG. 6.—Hypopygium and anal segment of male from below.

FIG. 7.—Aedeagus from above.

segments; flagellum rounded and tapering. Proboscis short and withdrawn. Palpi straight and two segmented; basal segment distinct, apical segment thickened and having a large concave sensory pit. Wings clothed with microtrichia; a few longer setae on the veins and in the anal region. Venation like that of *Cerotelion*, r_4 ending in costa beyond the apex of r_1 . Pleurotergites bare. Middle and hind tibiae slightly enlarged from base to apex. First tarsal segment of hind legs not thickened. Abdomen with seven complete segments in female, eight in male. Larva apodous, peripneustic and parasitic in land planarians. Genotype: *Planarivora insignis* sp. n.

The new genus *Planarivora* is close to *Ceroplatus* Bosc and *Cerotelion* Rond but differs from them in the form of the antennae, palpi and genitalia of the adult and also in the larva being peripneustic and parasitic.

Planarivora insignis sp. n.

Female (Text-fig. 1).

Length (without antennae) 8.0 mm.

Colour: Head and antennae black. Thorax and first abdominal segment reddish brown. Second to seventh abdominal segments with black tergites and sternites. Coxae, trochanters and femora of legs reddish brown; tibiae and tarsi black. Tibial spurs black. Wings fuscous.

Head small, broad and directed forwards and downwards. Compound eyes oval and well separated. Three ocelli in a curved row. Surface of head and compound eyes finely pubescent. Antennae short, about 1.03 mm. long, with 2 + 14 segments. The flagellum rounded and tapering slightly towards the apex. It is clothed with short fine hairs (Text-fig. 2). Palpi short, straight and two-segmented. The distal segment is enlarged, pubescent and furnished with a few bristles. It has a large concave sensory organ on its outer side (Text-fig. 3). The proboscis is short and withdrawn.

Thorax high and strongly arched due to the pronounced convexity of the mesonotum (Text-fig. 1). Pronotum small, pubescent and partly concealed beneath the front of the mesonotum. Its anterior and posterior divisions are separated by a groove. The surface of the mesonotum exhibits pubescent and hairless regions as shown in Text-fig. 4. Scutellum small and almost semicircular with a few hairs on each side. Postnotum steep, slightly arched and smooth. In the pleural region the anepisternite has a few short hairs on its upper part immediately behind the spiracle. The other pleura are smooth and bare.

Wings: Length 6.2 mm., greatest width 2.3 mm. Surface clothed with microtrichia and a few scattered macrotrichia especially in the anal region. The margin and veins also bear small setae. The venation (Text-fig. 1) resembles that of *Cerotelion*. The costa extends to the apex of the wing. A small humeral vein is present. The sub-costa opens into the costa at about one third of the wing length from the base. The radius has three branches r_1 , r_4 and r_5 . The first branch r_1 opens into the costa at slightly more than two thirds of the wing length from the base. The branch r_4 enters a

short distance beyond the apex of r_1 . The branch r_5 , which is more than twice the length of r_4 , enters the costa a little before the apex. The basal stalk of the media is pale and indistinct, the vein appearing to arise from cu_1 and to fuse for a short distance with the radial sector, before dividing into two branches $m_1 + 2$ and m_3 . The cubitus forms two branches cu_1 and cu_2 . The anal vein a is complete and extends to the posterior margin of the wing. Between a and cu_2 the wing forms a fold. An axillary vein is lacking. The halteres measures 0.86 mm. long. The rounded apex is finely pubescent and the stalk has a few longer setae.

Legs: The measurements of the segments in mm. are as follows:—

	Leg 1	Leg 2	Leg 3
Coxa	0.91	0.91	0.97
Trochanter	0.28	0.28	0.28
Femur	1.14	1.65	1.83
Tibia	1.31	2.00	2.46
Tarsus	1.94	2.74	2.97
Total	5.58	7.58	8.51

The coxae are elongate, those of the third pair of legs being nearly half the length of the femora. The anterior coxae are pubescent for their full length in front, the middle coxae on the apical half in front, and the hind coxae lightly pubescent on the outer side. Tibiae are slightly and uniformly expanded towards the apex. The second and third pairs are furnished with a dorsal, an inner and an outer row of very short setulae amongst the general pubescence. There is a single ventral spur at the apex of the first tibiae and a pair of ventral spurs at the apex of the second and third tibiae. The tarsi are five segmented, the basal segment being longer than the others. They are clothed with fine hairs and short bristles. The tarsal claws are somewhat straight and have about five small teeth.

Abdomen is about 6.5 mm. long and has seven complete segments. In the non-gravid female it is somewhat dorso-ventrally compressed. In the gravid female it is fusiform, narrowed in front and behind. The tergites and sternites are clothed with short recumbent hairs. The pleural membrane is transparent. There is a pair of spiracles on each of the seven complete abdominal segments. The genitalia (Text-fig. 5) are partly telescoped within the seventh abdominal segment. The ovispawner, which is short, appears to be formed from the sternite of the eighth segment, which is divided into two setose concave plates situated one on each side of the genital aperture. The tergite of the segment is lacking. Concealed between the concave plates is a delicate irregular ring of chitin surrounding the gonopore. This may represent a very much reduced ninth segment. The anal segment, which projects slightly above the genital aperture, has a pair of setose lateral plates or paraprocts.

Male.

Length (without antennae) 8.8 mm.

Colour is somewhat darker than that of the female, the whole thorax being black. The femora and tibiae are reddish brown but the other segments of the legs are black.

The form and clothing of the antennae, head, palpi, thorax, wings and legs much the same as in the female.

Abdomen is about 6.5 mm. long and has eight complete segments. It is somewhat dorso-ventrally compressed. A small accessory sclerite is situated between the first and second sternites. The ninth segment has a tergite, which is emarginate posteriorly and produced downward on each side partially enclosing the genitalia. The ninth sternite is divided mesially into two parts, each of which gives rise posteriorly to a twisted hook-shaped gonapophysis (Text-fig. 6). If the tergite is removed the aedeagus is seen. It has a pair of rounded lobes, one on each side of the genital aperture. In front it is connected to two long curved apodemes, which extend into the eighth segment (Text-fig. 7). The anal segment has a small sternite and a pair of paraprocts. Each of the eight complete abdominal segments has a pair of spiracles.

Locality: Fern Tree, Mount Wellington, Tasmania. January, 1962.

Immature stages.

The egg is slightly ovoid and measures 0.34 x 0.29 mm. It has a brownish chorion.

First larval stage (Text-fig. 8) is about 1.25 mm. long. It has a well developed head, a thorax of three segments and an abdomen of nine. The head is brown and well chitinized. The rest of the body is soft and creamy white, the internal organs being visible through the transparent body wall.

The head (Text-figs. 9 and 10) is about 0.180 mm. long and 0.126 mm. wide at the antennae. It narrows slightly towards the posterior and the epicranium is emarginate behind. The frons appears to be fused with the lateral epicranial plates, which curve to the ventral side of the head. The lower edges of the plates almost meet in front behind the maxillae, but posteriorly the edges diverge and then converge again leaving between them an elongate pyriform space, where the chitin is thin and transparent. Each antenna has the form of an oval convex transparent membrane surrounded by a chitinous ring. Close below the ring is a small ocellus. On the dorsal side of the head between the antennae is a thick, strongly chitinized transverse bar, above which is a row of four sensory organs. Two other sensory organs are situated on the dorsal surface of the head, one on each side in line with the posterior edge of the antenna. The labrum (Text-fig. 11) is almost semicircular and is provided with three pairs of sensory organs. The mandibles (Text-fig. 12) are large, well curved and powerful. The maxillae (Text-fig. 13) and palp are transparent leaf-like structures. The maxilla has two teeth on its inner margin. A circular sensory organ with four papillae is situated near the apex of the palp.

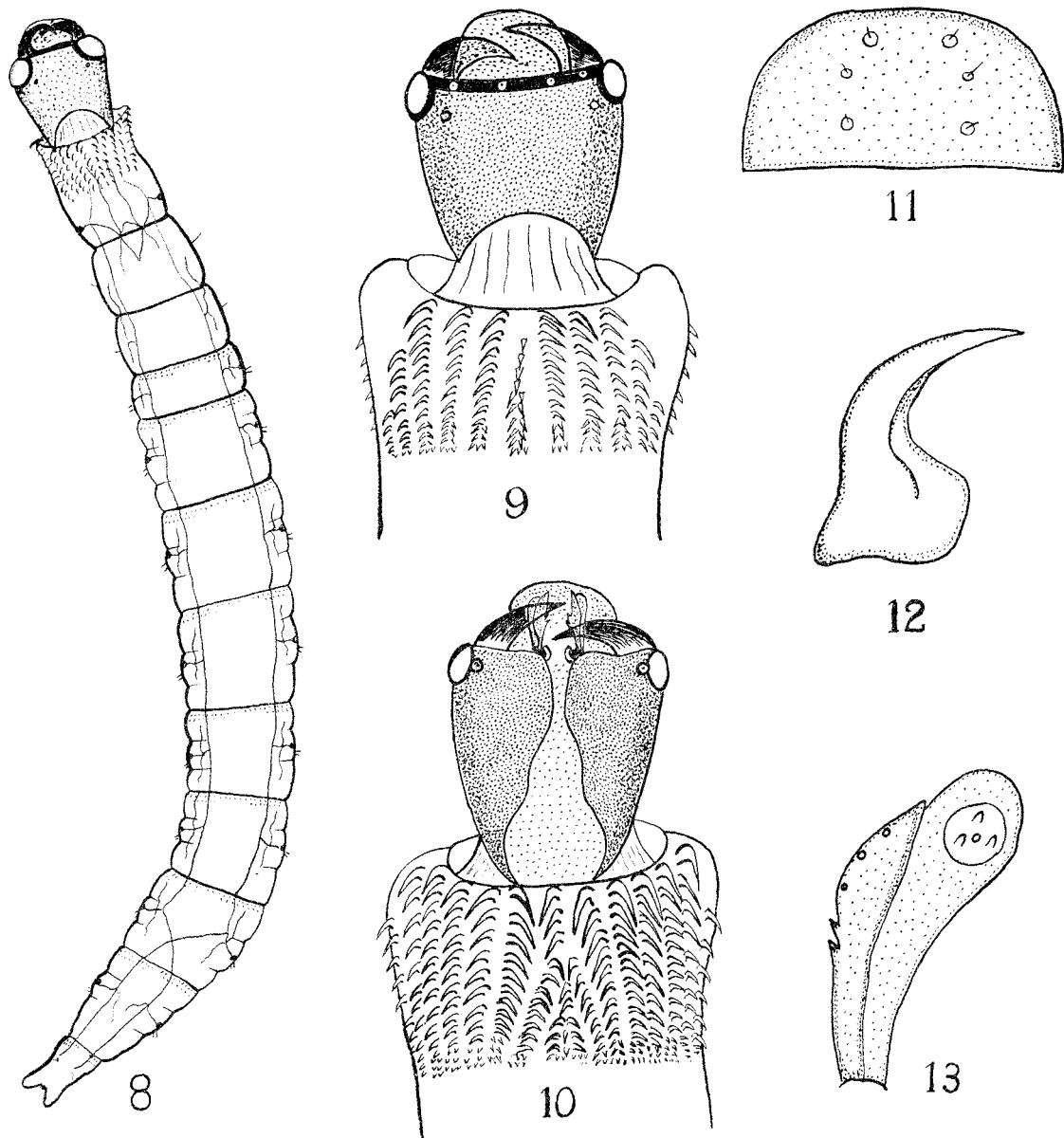
The front of the prothorax forms an introvert, which enables the head to be completely withdrawn. The introvert is armed with numerous hook-shaped spines arranged in longitudinal rows. There are about 10 rows above and 15 below. The longest rows have about twelve spines. The lateral and median rows are shorter than the others and have a smaller number of spines. In each row the spines decrease in size posteriorly and become more numerous. When the head is extended the spines point backwards, but when the head is withdrawn the spines are also withdrawn and then point forwards inside the introvert. A narrow space on each side of the introvert is devoid of spines. A pair of spiracles open laterally in the posterior third of the prothorax.

On the ventral side at the front of the mesothorax and metathorax are further small hook-like spines arranged in short longitudinal rows, having about five spines in the longest rows. Spines are absent from the dorsal side of the two segments.

The abdomen tapers posteriorly. All the abdominal segments except the first and last are transversely wrinkled. The first seven possess a pair of spiracles. Close behind each spiracle are two small setulae. The main trunks of the tracheal system seen from the dorsal side are shown in Text-fig. 8. Round the anterior of each segment of the abdomen is a more or less complete double row of minute spinules. The last abdominal segment is divided posteriorly into two lobes.

Second larval stage (Text-fig. 14) is about 11.7 mm. long and 1.14 mm. in greatest width. However, when full-fed it may measure 17.1 mm. long and 2.0 mm. in greatest width. It has a head, three thoracic segments and nine abdominal segments. In general appearance it is vermiform and somewhat narrowed in front and behind. The colour is creamy white and the body-wall transparent.

The head (Text-fig. 15) is small and rounded, being about 0.57 mm. in diameter. The greater part of the cranial capsule is pale soft and transparent. Only the edges of the plates appear more or less strongly chitinized. The lateral epicranial plates curve ventrally, their lower edges converging behind the maxillary plates and strongly diverging posteriorly. The antenna has the form of a convex transparent membrane surrounded by a dark ring of chitin. A small ocellus lies close behind the antenna. The labrum (Text-figs. 16 and 17) is somewhat semicircular. On its dorsal surface are twelve sensory organs arranged in two groups of six. The anterior margin and part of the lower surface are furnished with a number of small pointed processes. Fan-shaped organs are absent but the ventral surface of the labrum has a median V-shaped structure and a pair of pointed lateral processes, which converge towards the median structure. The mandible (Text-fig. 18) is not lamelliform but strong and stout. Its outer margin forms a well rounded ventrolateral angle. The inner margin is armed at the apex with seven teeth (Text-fig. 19). Attached to the inner side is a prostheca having seven pointed processes. The maxilla (Text-fig. 20) is leaf-like and has twelve teeth along its inner margin. The palp is soft and membranous. It has a sensory organ in the middle



Planarivora insignis sp. n.

First larval stage.

FIG. 8.—Larva from above showing main tracheal tubes.
FIG. 9.—Head and introvert from above.

FIG. 10.—Head and introvert from below.

FIG. 11.—Labrum from above.

FIG. 12.—Mandible.

FIG. 13.—Maxilla and palp.

of its distal half. The maxillary plate is somewhat triangular. The hypopharynx (Text-fig. 21) consists of two vertical rods and a pair of horn-like horizontal processes. The vertical rods meet ventrally in a U-shaped bend round the opening of the salivary duct. Below the bend is a rudimentary plate representing the labium.

Between the head and prothorax is a short introvert, which turns inward when the head is withdrawn. This region is furnished with minute spinules, which are quite unlike the large hook-shaped spines of the first stage larva. Two spiracles are situated, one on each side, in the posterior half of the prothorax. On the ventral side of the three thoracic segments the imaginal disks of the three pairs of legs may be seen. All the thoracic and abdominal segments have transverse rows of minute spinules on the anterior margin, the spinules being more numerous ventrally than dorsally.

The second to the eighth abdominal segments have a number of transverse wrinkles or annuli. A pair of spiracles is present on each of the abdominal segments except the last. The body of the larva appears to be quite devoid of setae. The last segment ends in a pair of lobes, one on each side of the anus.

The larva has a large crop and a pair of gastric caeca. Four Malpighian tubules arise at the posterior end of the midgut. The salivary glands are long, tubular and convoluted. The tracheal system is peripneustic.

This second larval stage of *Planarivora insignis* has some features in common with the larva of *Ceroplatus lineatus* Fabricius described by Madwar (1937). The form of the antennae, maxillae, hypopharynx and labium is much the same in the two species. They also agree in having a body that is free from hairs. They differ, however, in the shape of the head, the structure of the mandibles and labrum and in the segmentation of the body. Moreover, the larva of *Ceroplatus lineatus* is said to be apneustic and free-living, whilst that of *Planarivora insignis* is peripneustic and parasitic.

The pupa (Text-fig. 22) measures 7.14 mm. long. The head is 0.97 mm. wide. The thorax and abdomen both 1.71 mm. wide. The antennae curve back over the eyes and reach the mesothorax. The wings and legs extend along the ventral surface of the body. The first pair of legs and the wings reach the third abdominal segment, the second pair of legs the fifth segment and the third pair of legs the sixth segment. On the first seven abdominal segments are two small conical projections, one on each side, marking the position of the tracheal spiracles. The sternite of the ninth segment has a deep median cleft on the posterior margin.

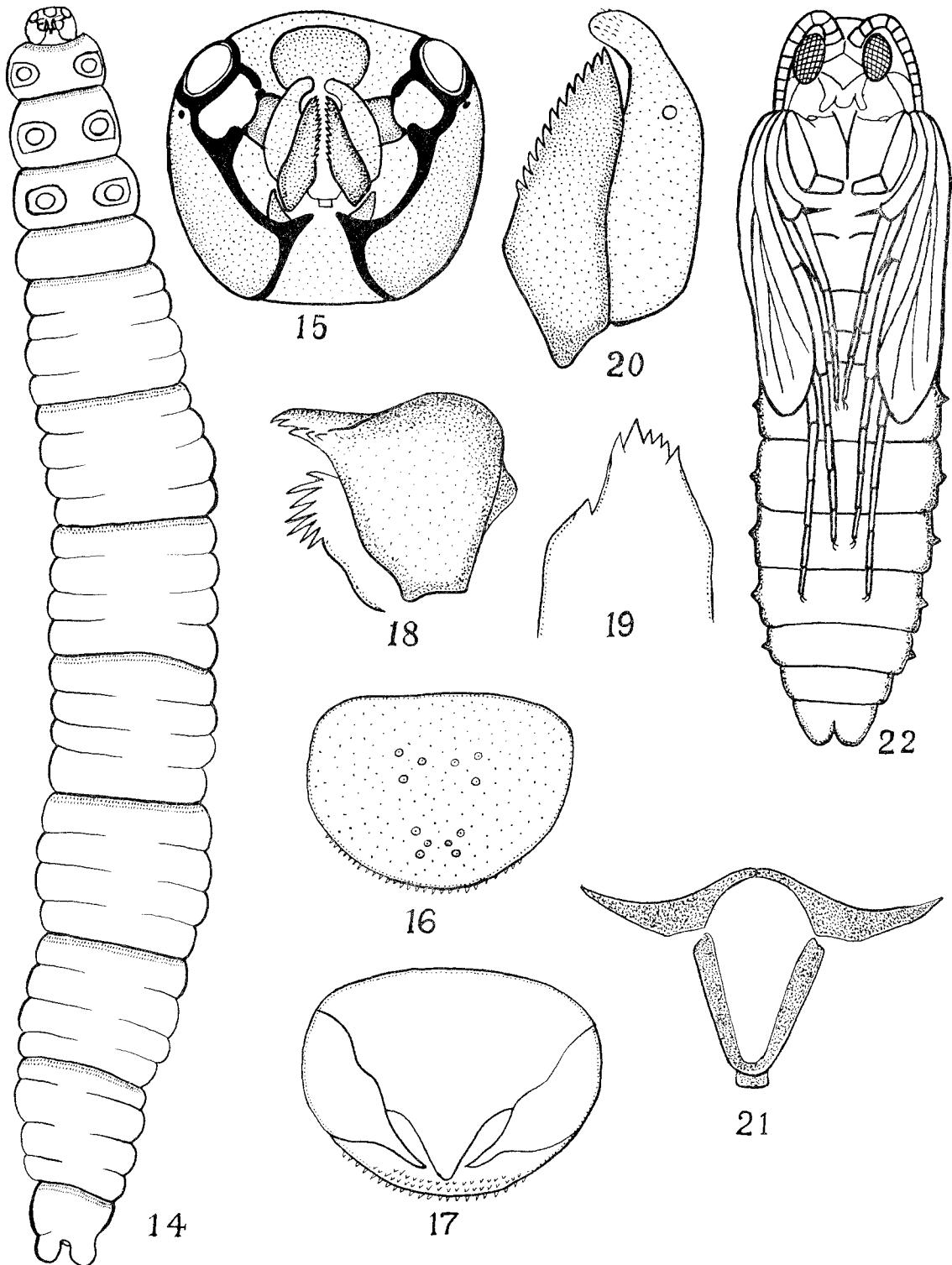
Biology of *Planarivora insignis*.

Adults first appear about the middle of January. When the female emerges from the pupa the whole of her abdomen is already distended with eggs, which are visible through the transparent pleural membrane. In the case of one specimen that was dissected 683 eggs were counted.

In vivaria where non-infected specimens of *Geoplana tasmaniana* (Pl. 1, fig. 1) were kept together with adults of *Planarivora insignis*, it was found that the females of the mycetophilid laid their eggs about two or three days after emerging from the pupa. The eggs were deposited singly and scattered about near the moss under which the land planarians were concealed. Unfortunately the eggs failed to develop and hence the exact duration of the incubation period is not known. However, under natural conditions at Fern Tree, Mount Wellington, land planarians were found to be infected with the first stage larva towards the end of April. At the beginning of May larvae of only 1.25-2.28 mm. length were collected by dissection from specimens of *Geoplana tasmaniana*. One such larva removed on 1st May, 1962, was washed free from the copious slime of the planarian and then placed on the dorsal surface of another non-infected specimen of *Geoplana tasmaniana*. The larva began to penetrate the planarian immediately, using its powerful mandibles and hook-like spines to pierce the body-wall. In about eight minutes it had reached the interior of its host. The planarian reacted by ceasing to creep, flattening the body and then raising the lateral margins so that the dorsal surface was concave. It remained thus for about 20 minutes, making only feeble movements with its anterior end. It then began to move about normally. No wound was visible where the small larva had entered.

During the year 1962 one hundred and eighteen specimens of *Geoplana tasmaniana* were collected at Fern Tree. Of these 33 were found to be infected with the larva of *Planarivora insignis*. In 31 of the infected specimens only a single larva was present in each, but in the remaining two planarians two larvae occurred in each. Before they were preserved nearly all the larvae were measured and it was found that during the greater part of the year, April to November, the first stage larva grows very slowly, reaching a maximum length of about 4.0 mm. During this time it does not seem to cause much harm to its host. If the planarian is not too heavily pigmented, the larva may be seen through the body wall. Towards the end of the year there is apparently very rapid growth (see Table I). Thus six larvae collected in December measured from 6.9 mm. to 9.0 mm. in length. They were all second stage larvae. In each case the exuviae of the corresponding first stage larva were found within the body of the planarian. The head capsules of the exuviae measured in diameter 132, 132, 133, 126, 135 and 129 micra respectively.

The second stage larva feeds voraciously and infected planarians are often found with small wounds in the body-wall. These wounds may serve to allow the rapidly growing larva more ready access to air, or they may be merely lesions caused by its feeding. The rapid destruction of its internal organs soon results in the planarian becoming less active and finally ceasing to move about. The larva now bites its way out of its host (Pl. 1, figs. 2 and 3). It then continues to feed until little of the planarian remains.



Planarivora insignis sp. n.
Second larval stage and pupa.

FIG. 14.—Larva from below.
FIG. 15.—Head of larva from below.
FIG. 16.—Labrum of larva from above.

FIG. 17.—Labrum of larva from below.
FIG. 18.—Mandible and prostheca of larva.
FIG. 19.—Apex of mandible of larva.

FIG. 20.—Maxilla and palp of larva.
FIG. 21.—Hypopharynx and labium of larva from below.
FIG. 22.—Pupa from below.

TABLE 1.

Number of specimens of *Geoplana tasmaniana* examined during the year 1962 and the number and size of the larvae of *Planarivora insignis* found.

Month	<i>Geoplana tasmaniana</i> Examined	<i>Geoplana tasmaniana</i> Infected	<i>Planarivora insignis</i> Larvae found	Lengths (mm.)
Jan.	...	...	...	...
Feb.	16	0	...	...
Mar.	8	0	...	...
Apr.	...	...	...	...
May	39	8	8	1.25-3.0
Jun.	3	2	2	not re- corded.
July	8	4	6	1.90-2.70
Aug.	...	...	...	...
Sep.	14	5	5	2.85-3.14
Oct.	11	7	7	2.85-3.30
Nov.	8	1	1	4.0
Dec.	11	6	6	6.9-9.0
Total	118	33	35	

When full-fed the larva creeps into a crevice under a moss-covered stone or in a rotten log and there spins a frail mesh-work of threads (Pl. 1, fig. 4). A specimen kept under observation in the laboratory commenced spinning on 3rd January, 1962 and finished on 8th January, 1962. The threads are spun from the opening of the salivary duct and the larva raises the anterior part of its body, moving its head from side to side and up and down as it searches for points to which the threads may be attached. When spinning, some of the threads are fixed to the larva's own body in order to suspend it. Many of the threads support clear liquid droplets. Tests show that the droplets contain oxalic acid.

A few hours after completing the frail mesh-work of threads which serves as a delicate cocoon, the larva defaecates and at the same time expels its Malpighian tubules. It then undergoes ecdysis

disclosing the pupa. The larval exuviae remain adhering to the posterior end of the pupa. Pupation lasts about eight days. When the imago emerges from the pupal exuviae, it does not immediately move away. Usually it rests by the cast off skin in the mesh-work of threads for two or three days before taking flight.

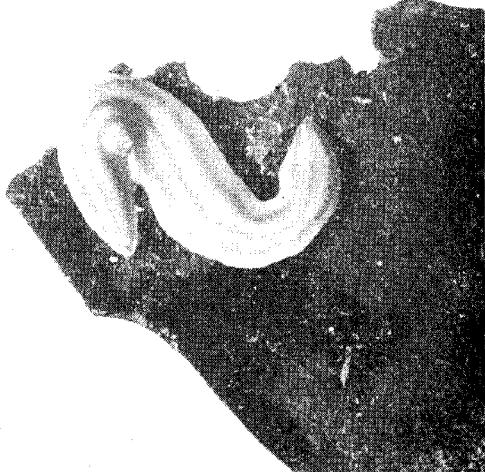
In addition to parasitising *Geoplana tasmaniana* (Darwin), the larvae of *Planarivora insignis* are also sometimes found in *Geoplana mortoni* Dendy and *Geoplana diemenensis* Dendy, which occur at the same locality.

ACKNOWLEDGEMENTS

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1



2



3

4

FIG. 3.—*Geoplana tasmaniana* with the larva of *Planarivora insignis* fully emerged and feeding on the body of its host. X 2.

FIG. 4.—The larva of *Planarivora insignis* spinning a frail mesh-work of threads in which to pupate. X 1.



PLATE 1.—

FIG. 1.—*Geoplana tasmaniana* resting on a fallen leaf. X 2.
FIG. 2.—*Geoplana tasmaniana* with two lesions in the dorsal surface through which the larva of *Planarivora insignis* is emerging. X 2.

F.P.8.

