DISTRIBUTION, HOSTS AND HABITS OF THE INDIAN SERPHOIDEA AND BETHYLOIDEA.

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CONTENTS.

Introduction.

For controlling insect pests by the agency of their natural enemies, parasites and predators, it is essential that the habits, biology and seasonal occurrence of the natural enemies of potential importance are fully known. Consolidated accounts, including such information about various groups of parasites are useful not only to India but to other countries also, where the pests are the same or belong to allied species or genera.

In an earlier paper (1940) we published all the information available about the hosts, distribution and biological features of the parasitic species of the group Chalcidoidea, especially those represented in the Imperial Pusa Collection in the laboratory of the Imperial Entomologist at New Delhi. The present paper similarly deals with the Indian Serphoidea and Bethyloidea, two other important groups of Parasitic Hymenoptera.

The superfamily Serphoidea has been designated by several previous workers like Ashmead and Morley as Proctotrupoidea, after the genus *Proctotrupes* Latreille. But according to the International Rules of Zoological Nomenclature, the names of families and subfamilies are based on that of the oldest genus of the group. Kieffer (1914) pointed out that *Serphus* Schrank was described in 1780, sixteen years before Latreille's description of *Proctotrupes* appeared and therefore, the latter is synonymous with *Serphus*. *Serphus* thus being the oldest genus of the group, the correct name for the superfamily should be Serphoidea, which is adopted in the present paper.

The Serphoidea, though comparatively smaller than the Chalcidoidea, are perhaps of greater economic interest in that, unlike the latter, all the species comprising them are parasitic. The group has, however, been very much neglected by workers both in India and abroad, and hardly 3,000 species are known from the whole world, of which hardly one hundred have been recorded from India.

The Serphoidea are very closely related to the Chalcidoidea, from which they can easily be distinguished by the relative positions of the tegulae and pronotum, which touch each other in the Serphoidea. The superfamily, as at present recognised, comprises the following five families (*vide* Mani, 1941) :—

1. Scelionidae (=Scelionidae *s. str.* Ashmead + Platygasteridae Först.).
2. Calliceratidae (=Ceraphronidae Haliday).
3. Diapriidae (=Diapriidae *s. str.* Haliday + Belytidae Först.).
4. Serphidae (=Proctotrupidae Latr.=Serphidae *s. str.* Kieff. + Heloridae Först.).
5. Pelecinidae.

A systematic catalogue of the Oriental Serphoidea, with keys to families, subfamilies, genera and species, has recently been published by Mani (1941).

The Bethyloidea comprise the following four families :—

1. Anteonidae (=Dryinidae Haliday, *partim*).
2. Embolemidae (=Dryinidae Haliday, *partim*).
3. Bethylidae.
4. Sclerogibbidae.

There is a considerable amount of diversity of opinion with regard to the limits and exact relationships of the Bethyloidea and the Serphoidea. Some authors, like Kieffer (1914), regarded the Bethylids as part of the Serphoidea, while others (Ashmead, 1900) included them in the Vespoidea. The Bethylids, however, seem to be quite distinct from them both in several essential characters and are, therefore, treated as belonging to a distinct superfamily, *viz.*, Bethyloidea, in this paper a course adopted by Brues and Melander (1932).

About 50 species of Bethylids are known from India so far and the life-histories and habits of most of them have yet to be thoroughly worked out, but whatever information is available is summarized in the following pages.

Superfamily SERPHOIDEA.

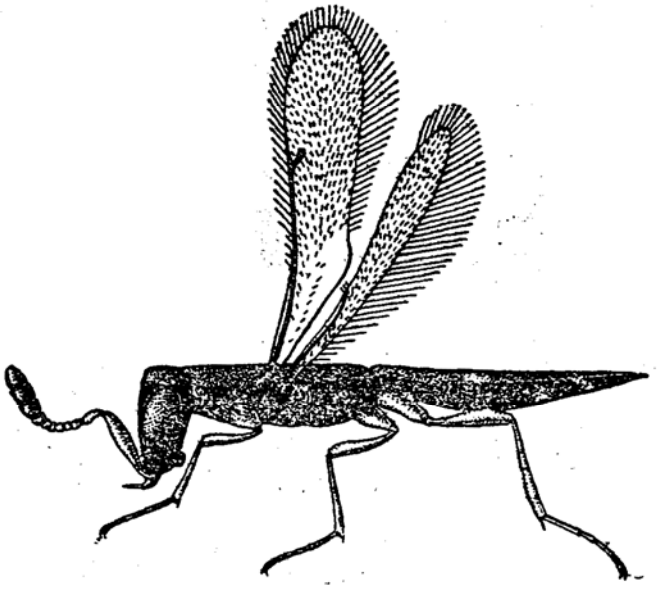
Family SCELIONIDAE.

Subfamily *TELENOMINAE.*

Nardo cumaeus Nixon.

1938. *Nardo cumaeus*, Nixon, *Ann. Mag. Nat. Hist.* (11) I, p. 279.

There are several examples of this species in the Imperial Pusa Collection[1] bred by Mr. Lakshmanan from the eggs of *Macropes excavatus* Distant (Rhynchota) at Delhi. The



TEXT-FIG. 1.—*Nardo cumaeus* Nixon, ♀ : ×75.

species was originally described from specimens bred from the same host at Lyallpur (Punjab). Subsequently (Mani, 1939) it was also bred from the eggs of this host at Karnal (Punjab) and Delhi.

[1] The insect collection in the Laboratory of the Imperial Entomologist, Imperial Research Institute, New Delhi, is known as "Imperial Pusa Collection".

N. cumaeus has a greatly flattened body. It is reported to be an important parasite of *Macropes excavatus*, which is a pest of sugarcane in Delhi, Sind and the Punjab. In the latter place the percentage of parasitism often rises up to 62·2 in November. At Delhi the percentage of parasitism ranges between 43·5 and 73·7 during November-February, and at this locality no less than three generations were noticed between November 1938 and March 1939.

Nardo phaeax Nixon.

1938. *Nardo phaeax*, Nixon, *Ann. Mag. Nat. Hist.* (11), I, p. 283.

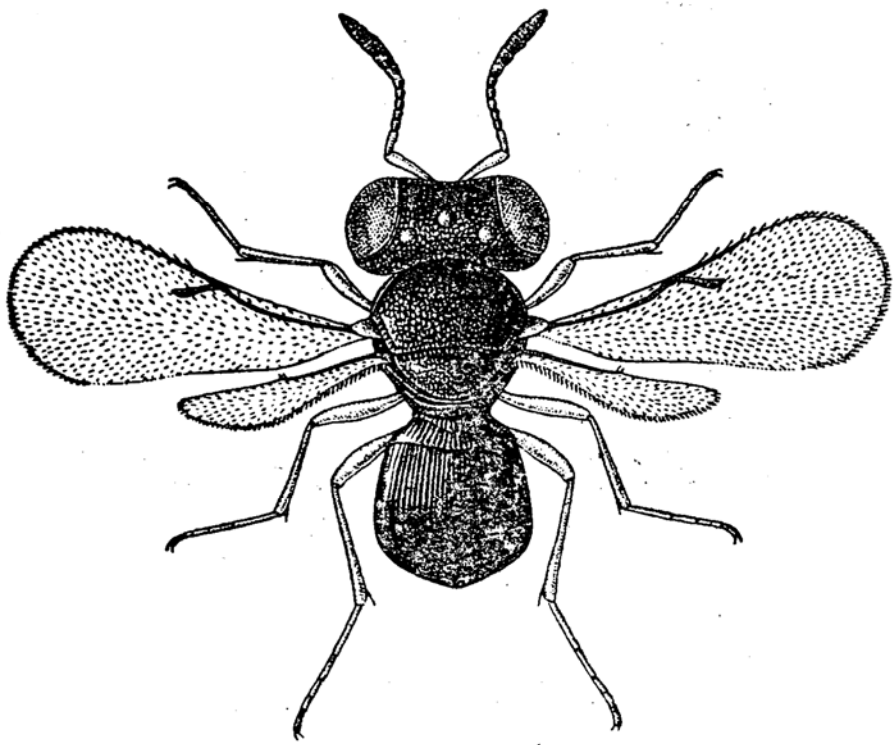
There are numerous specimens of this species in the Imperial Pusa Collection, bred by Mr. Lakshmanan from the eggs of *Macropes excavatus* Distant at Karnal (Punjab) along with *Nardo cumaeus* Nixon recorded above. The species was originally described from specimens bred from the same host at Lyallpur. Mani (1939) recently recorded it on the same host from Karnal. It has also since been bred from this host at Delhi.

This parasite and *N. cumaeus* occur side by side and together parasitise the eggs of *Macropes excavatus*. The percentage of parasitism was 62·3 in February 1939 at Delhi.

Telenomus anwari Mani.

1939. *Telenomus anwari*, Mani, *Ind. J. Ent.* I, (1-2), p. 94.

There are numerous specimens of this species in the Imperial Pusa Collection, bred by Mr. M. S. Anwar from the eggs of a Pentatomid bug on sugarcane leaf at Delhi in 1938-1939.



TEXT-FIG. 2.—*Telenomus anwari* Mani, ♀: ×32.

There are also several other specimens of the species bred by Dr. E. S. Narayanan from the eggs of a Pentatomid on sugarcane leaf at Pusa in 1935-1936, and labelled provisionally as *Microphanurus* sp.

Telenomus beneficiens (Zehntner) Nixon.

1896. *Ceraphron beneficiens*, Zehntner, *Archif voor de Java Suikerindustrie* IV, p. 487.
1937. *Telenomus beneficiens*, Nixon, *Ann. Mag. Nat. Hist.*, (10) XX, p. 465 (redescription).

This species was originally described as *Ceraphron beneficiens* by Zehntner, from specimens bred from the eggs of *Diatraea venosata* (Walk.)[1] and *Grapholitha schistaceana* Snell. in Java (Krüger, 1899). Later on, Dodd (1914) also bred the species from the same hosts in Java and included it under the genus *Phanurus* Thomson. Recently, Nixon (1937) and Mani (1939) independently considered the parasite to be a species of the genus *Telenomus* Haliday.

In the Imperial Pusa Collection there are numerous specimens of this species bred from the eggs of *Diatraea venosata* (Walk.) at Pusa, Delhi, Karnal (Punjab), Coimbatore and Mysore. It has also been bred from the eggs of *Scirpophaga nivella* (Fabr.) in the United Provinces, Delhi, Mysore, Coimbatore and the Punjab. This is reported to parasitise the eggs of several other Lepidopterous hosts, such as *Chilo simplex* Butler, *Schoenobius incertellus* Walk. *Sesamia* sp., *Argyria sticticraspis* (Hamps.), etc., in Formosa, Japan, Hawaii, Java, Malaya and Mauritius. But it appears to us that this is a specific parasite of *Diatraea venosata* only, and the forms from other hosts belong probably to distinct species. A form bred from the eggs of *Scirpophaga* spp. in India and Formosa belongs to *Telenomus beneficiens* var. *elongatus* Ishida (Mani, 1941).

The species is perhaps the most important egg-parasite of *Diatraea venosata* (Walk.) in India. It is also very common in Delhi on *Argyria sticticraspis* (Hamps.). The parasitised eggs of this latter host are easily recognised in the field by their brown colour.

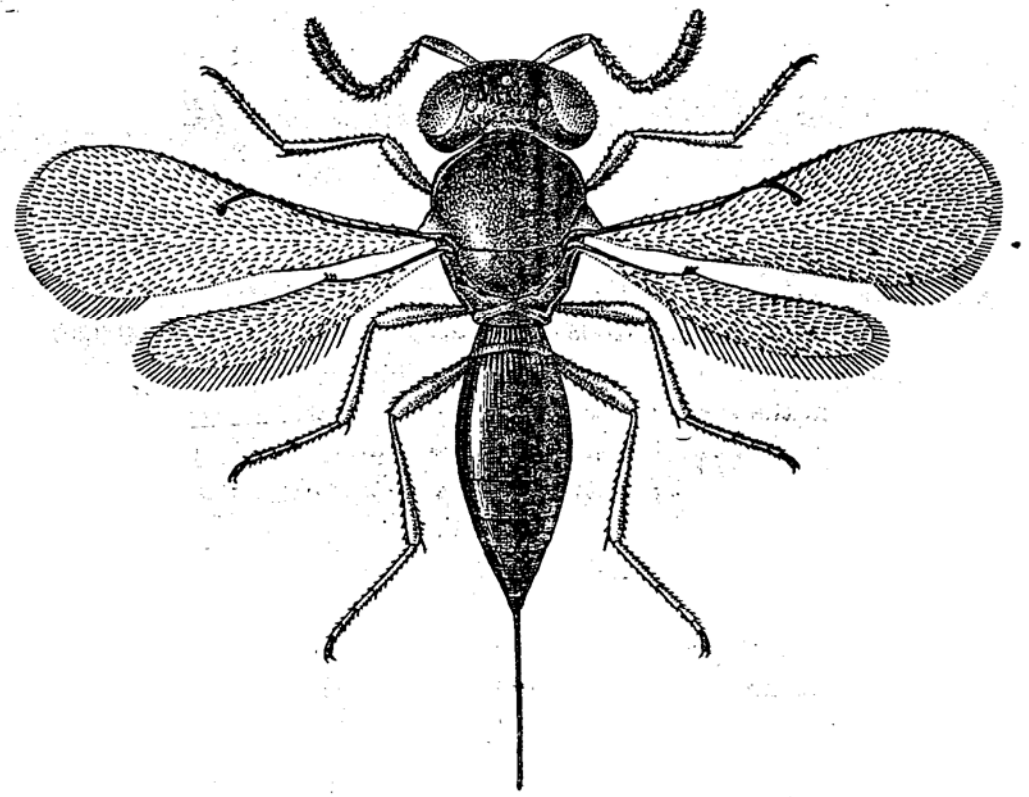
The adult parasites, especially the females, are strongly attracted to light. The females start egg-laying immediately after emergence. Parthenogensis is common. The female usually confines its attention to a single egg-cluster of the host and oviposits at the rate of one egg for each minute. It is interesting to note that only those eggs of the host which are less than three or four days old are selected for oviposition by the parasite. The egg-laying capacity of the parasite is about 70—270 eggs for one female.

The duration of life of the adult female is usually short in the laboratory, never exceeding two days under dry atmospheric conditions. When fed with honey solution, the adult female lives for about 15 days, the maximum life under such a condition being 29 days in spring. The females usually live much longer than the males. The sex-ratio is about one male to nine females. When a large number of host eggs are available for parasitisation, the progeny usually consists entirely of females.

The importance of this parasite in the control of the Lepidopterous borers of sugarcane is due probably to two factors: (1) the great preponderance of females over males and (2) the high fecundity of the female. At Delhi the species parasitises the eggs of *Scirpophaga nivella* usually to such a great extent that during March-April, very few host eggs hatch out in nature. In the Punjab, the percentage of parasitisation of this host varies from 17·8 in March, 51·0 in April to 55·0 in August-September. The total period of life-cycle ranges between 21 and 24 days in March, 9 and 14 days in June-July and 8 and 13 days in July-August and the parasite is capable of passing through ten to twelve generations a year if host-eggs are available. At Pusa (Bihar), Pruthi (1937) found the parasitisation to increase

[1] *Diatraea venosata* (Walk.) is *D. striatalis* Snell. of the older authors, under which name Zehntner recorded the host of *T. beneficiens*.

from 3 to 15 per cent. between March and April. The percentage of parasitisation in the field usually varies from 70 to 90.



TEXT-FIG. 3.—*Telenomus beneficiens* (Zehnt.) Nixon, ♀: ×48.

This species was bred in large numbers in the laboratory and liberated in the field for the control of *Diatraea venosata* and *Argyria sticticraspis* in Mysore but the results are not known.

The following is a summary of the information available about this parasite in other countries :

De Charmoy (1915), studying this parasite (under the name *Prophanurus beneficiens*) on the hosts *Diatraea venosata* and *Sesamia vuteria*[1] in Mauritius, found that the pre-imaginal period was 15 days in the field. The high percentage of parasitisation of *Diatraea venosata* by this species in Java (72·4 per cent.) is believed by Ishida (1914) to be due to the great preponderance of females over males ; he found 96 per cent. of females in " sampling test collection " under the field conditions. On the host *Chilo simplex*, Kuwana (1922) reported that the parasite passed through 11-12 generations in a year in Japan, the winter being passed in the adult stage. The number of eggs laid varied between 50 in spring and 100 in summer. The duration of life of the adult female fed with honey solution was over 30 days. Working with the same hosts in Japan, Okada and Maki (1934) found that the parasite had 8 to 9 generations in a year. Maximum emergence of parasites was found to occur between 5 and 7 A.M., the males emerging somewhat earlier than the females. Sex-ratio was two females to one male. Eggs laid at the beginning or at the end of the oviposition period mostly gave rise to males. Copulation

[1] *Sesamia vuteria* is *Sesamia nonagriodes* of older authors.

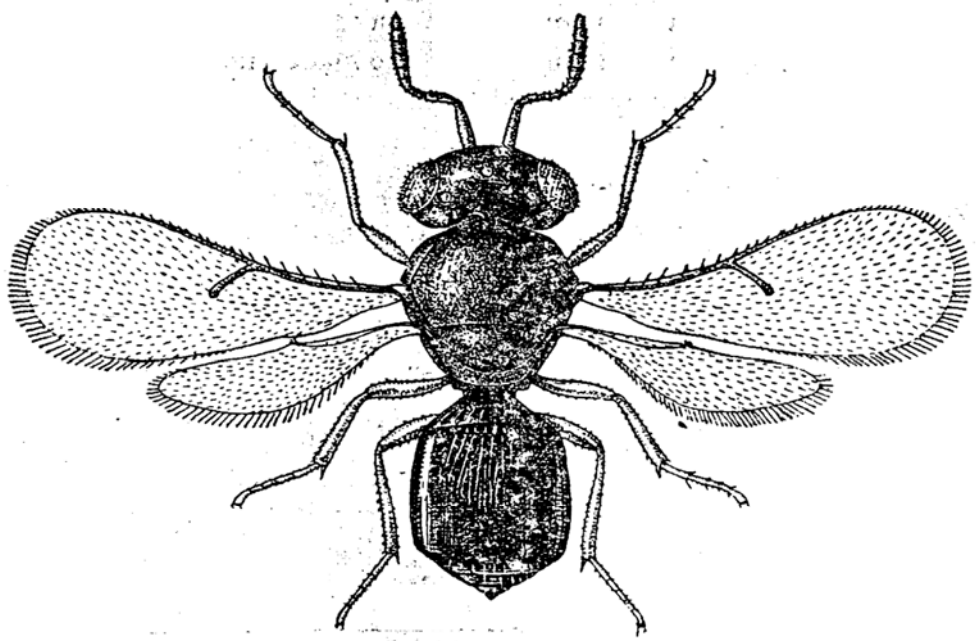
was observed near the host egg-cluster. The males are polygynous. More eggs were usually laid on the day of emergence than on any subsequent day. The number of adult progeny of a single female varied from 45 to 275, with an average of 143. The duration of life of the adult female was 15-16 days, with a maximum of over 30 days in summer. Optimum conditions of development for the parasite were found to be 25°-30°C., and a relative humidity of 75-80 per cent. The immersion in water of the parasitised host eggs for five days at 20°C. and for three days at 30°C. did not in any way adversely affect the viability of the young parasites inside.

The form *Telenomus beneficiens* var. *elongatus* Ishida was reported (Hazelhoff, 1929) to be a parasite on the eggs of *Scirpophaga intacta* in Java between October 1927 and June 1928; before January 1928 the parasitisation was 64·2 per cent., but only 37·3 per cent. afterwards. In August 1928, 45·0 per cent. of the host population were parasitised. The corresponding figures in the case of *Diatraea venosata* were 78·6 per cent. and 87·5 per cent. Van Dillewijn (1933) has recorded an interesting periodicity in the population densities of the parasite and its host *Scirpophaga intacta* in Java; this periodicity is believed to be due to the influence of parasitism. When the chief flight of the moths occurs, the parasite is scarce in the field, so that the first brood of host eggs practically escapes parasitisation. The larvae hatching from these eggs give rise to the second generation of moths after two months. By this time the parasite has considerably increased in numbers and the eggs laid by the second generation moths are heavily parasitised, the parasites breeding rapidly and maturing in about 10 days.

Telenomus colemani Crawford.

1920. *Telenomus colemani*, Crawford, *Proc. U. S. Nat. Mus.* XLII, p. 2.

In the Imperial Pusa Collection there are a few specimens of this parasite bred at Mysore from the eggs of *Dolycoris indicus* Stål. (Pentatomidae).

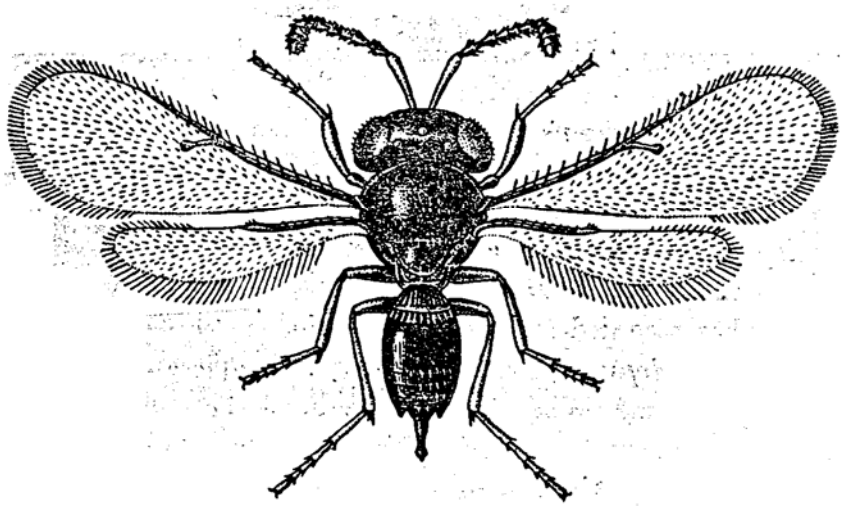


TEXT FIG. 4.—*Telenomus colemani* Crawford, ♀: ×50.

Telenomus javensis Dodd.

1914. *Telenomus javensis*, Dodd, *Arch. Naturgesch.* LXXX (A. 5), p. 163.

This species was originally described as an egg-parasite of a Tineid moth on sugarcane leaf in Java. Ahmad (1939) bred it from the eggs of the amaranthus weevil *Lixus* (*Hypolixus*) *truncatulus* (Fabr.) at Pusa (Bihar).



TEXT-FIG. 5.—*Telenomus javensis* Dodd, ♂.

Telenomus latisulcus Crawford.[1]

Ramakrishna (1927) recorded this species as parasitic on the eggs of *Coptosoma cribraria* (Fabr.) (Pentatomidae) at Coimbatore ; he also later on collected some specimens of *Telenomus*, which he believes to belong to this species, from the brood-cells of a species of *Xylocopa* in Mysore.

Telenomus mesillae (Cockerell).

1897. *Hadronotus mesillae*, Cockerell, *Canad. Ent.* XXIX, p. 25.

This species was recorded by Gahan (1932) as an egg parasite of *Pentatoma ligata* Say, *P. sayi* Stål and *Euschistus servus* Say in New Mexico and California.

Mani (1936, 1941) provisionally referred to this species a series of specimens in the Indian Museum, Calcutta, labelled as having been bred by Major Sage from the eggs of a Pentatomid bug at Pareshnath, Bengal.

Telenomus proditor Nixon.

1937. *Telenomus proditor*, Nixon, *Ann. Mag. Nat. Hist.* (10) XX, p. 456.

This species was described from specimens bred by Mr. S. N. Chatterjee from the eggs an unidentified moth on *Gmelina arborea* and from the eggs of *Eupterote undata* at Dehra Dun.

Telenomus scirpophagae Ashmead (in lit.).

Several specimens of a species of *Telenomus* bred from the eggs of *Scirpophaga auriflua* at Pusa were sent to Ashmead for identification by Lefroy in 1905. In a letter dated the 21st of September 1905 to Lefroy, Ashmead wrote that he had identified the specimens as belonging to a new species, which he proposed to describe under the name *Telenomus*

[1] Reference to the original description of this species cannot be traced in the literature available in this country.

scirpophagae. We are unable to trace this name in the literature ; we do not also find any named specimens of the species in the Imperial Pusa Collection. The species is probably identical with *T. beneficiens* var. *elongatus* described above or with *T. dignoides* Nix. described from the same host from Java.

Telenomus usipetes Nixon.

1938. *Telenomus usipetes,* Nixon, *Ann. Mag. Nat. Hist.* (11) I, p. 584.

This species was described from specimens bred from the eggs of *Hapalia machaeralis* (Walk.) and *Hyblaea puera* (Cram.) from Insein, Pyinmana and North Toungoo in Burma. Garthwaite and Desai (1939) have published an account of the biology of this parasite, along with a figure of the adult female. According to them, the parasitised host-eggs are easily recognised four or five days after parasitisation by their dark yellow colour. The total life-cycle is completed in a period, varying from 8 to 12 days in summer and 14 to 15 days in winter. The duration of life of the adult is on the average about six days, the maximum being 31 days. Copulation occurs soon after the emergence of the adults. Only one egg is laid in each host-egg, the oviposition occupying about 12 minutes. The percentage of parasitisation of the eggs is 12 in the case of *Hapalia machaeralis* and 1 in the case of *Hyblaea puera.*

Aholcus adenyus Nixon.

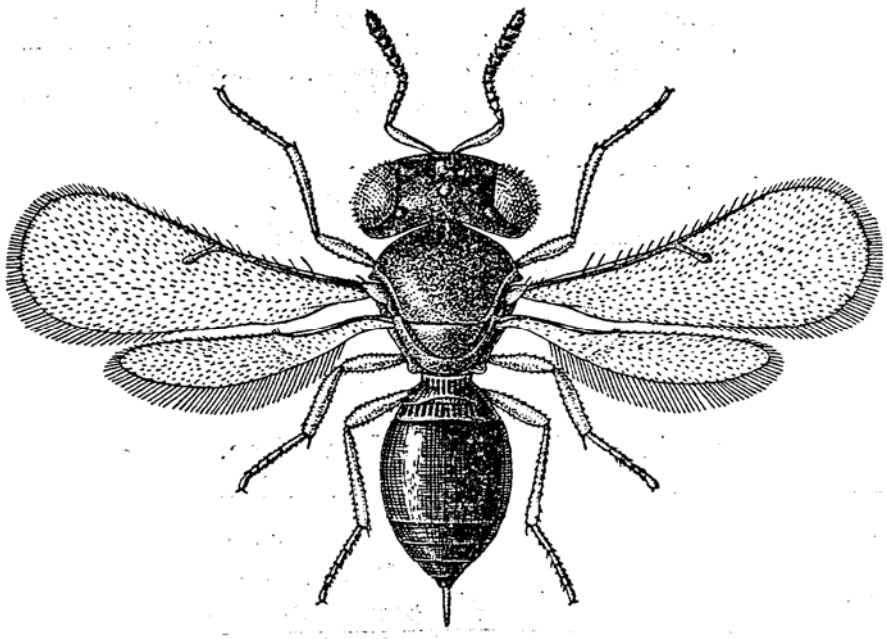
1937. *Telenomus* (*Aholcus*) *adenyus,* Nixon, *Ann. Mag. Nat. Hist.* (10) XX, p. 122.

This species was described as having been bred from the eggs of a " Lepidopterous insect " on Lima beans at Peradeniya (Ceylon).

Aholcus euproctiscidis Mani.

1939. *Aholcus euproctiscidis,* Mani, *Ind. J. Ent.* I, (1-2), p. 95.

In the Imperial Pusa Collection there are numerous specimens of this parasite bred by Mr. B. B. Bose from the eggs of *Euproctis lunata* (Walk.) (Lymantriadae) at Delhi (Imperial Pusa Insectary cage slip No. 3003).



TEXT-FIG. 6.—*Aholcus euproctiscidis* Mani, ♀: ×42.

At Delhi, the pre-imaginal period of the parasite is about eight to nine days in August-September. Before emergence of the parasite, the host-eggs first turn light brown and ultimately black. Twenty-nine eggs in a cluster of thirty-three were parasitised. As, however, only a few egg-clusters are attacked in the field, the percentage of parasitisation is not high.

Aholcus molochrus Nixon.

1937. *Telenomus (Aholcus) molorchus*, Nixon, *Ann. Mag. Nat. Hist.*, (10) XX, p. 117.

This species was recorded by Nixon as having been bred from the eggs of *Lenodora vittata* at Pusselawa (Ceylon).

Microphanurus barrowi (Dodd).

1920. *Telenomus barrowi*, Dodd, *Trans. Ent. Soc.* 1919, p. 356.

This species was described as having been bred from the eggs of a Sphingid moth at Dalhousie (Punjab).

Microphanurus seychellensis (Kieffer).

1910. *Telenomus seychellensis*, Kieffer, *Bull. Soc. Ent. Fr.*, p. 294.

This species was originally described by Kieffer from the Seychelles Islands. Later, Nixon (1938) recorded it from Passera (Ceylon) and from Abyssinia to the Cape in Africa.

It parasitises the eggs of *Cantheconidia robusta* (Dist.), *Antestia orbitalis* Westw., *Antestia orbitalis* var. *lineaticollis* Stål and *Agonoscelis pubescens* Thunb.[1] Cherian & Brahmachari (1941) recorded it on *C. furcellata* from S. India.

Microphanurus striaticeps Dodd.

This species was recorded by Nixon (1935, 1938) as parasitic on the eggs of a Pentatomid bug laid on brinjal leaf at Lyallpur (Punjab) and on the eggs of *Acanthomia brevirostris* Stål (Rhynchota) in Nyasaland, Nigeria and the Cape (Africa).

Microphanurus sulmo Nixon.

1938. *Microphanurus sulmo*, Nixon, *Ann. Mag. Nat. Hist.* (11) II, p. 126.

This species was described by Nixon as having been bred from the eggs of *Cantheconidia robusta* (Dist.) at Talwakelle (Ceylon).

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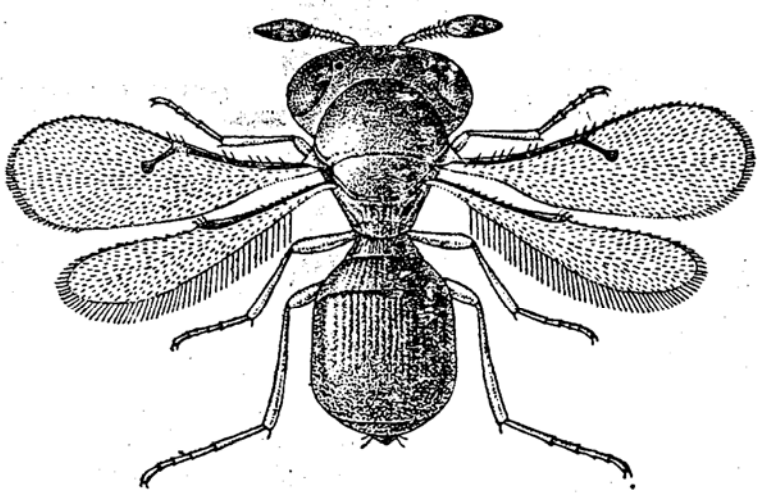
[1] *Antestia orbitalis=A. variegata* Thunb., and *Agonoscelis pubescens=A. versicolor* of older authors.

Subfamily *BAEINAE*.

Dissacolus lakshmani Mani.

1939. *Dissacolus lakshmani*, Mani, *Ind. J. Ent.* I, (1-2), p. 96.

In the Imperial Pusa Collection there are numerous specimens of this species, bred by Mr. Lakshmanan from the egg-masses of an unidentified spider attached to sugarcane leaf at Delhi.



TEXT-FIG. 7.—*Dissacolus lakshmani* Mani, ♀: ×48.

Aneurobaeus apterus (Bugn. & Popoff).

1910. *Baeus apterus*, Bugnion and Popoff, *Rev. Suisse Zool.* XVIII, p. 729.

This species was reported to have been bred from the eggs of the aquatic spider *Argiope aetherea* Walk. in Ceylon. The total pre-imaginal period is about 12 or 13 days. It also parasitises the eggs of another species of spider, *viz.*, *Argiope catenulata* Dol., in Ceylon.

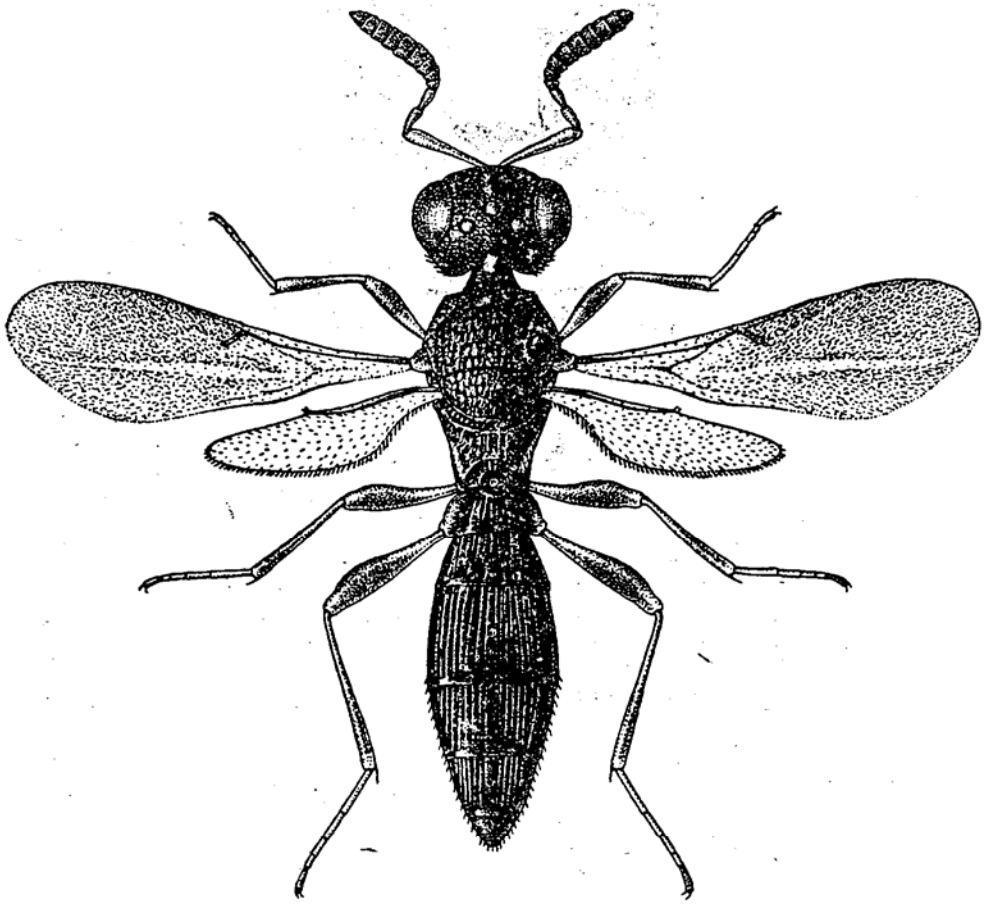
The female is apterous, while the male has well-developed wings. The adult female is capable of jumping. Both the sexes are black in colour and measure about 0·8 mm in length, but the female is usually a little smaller than the male. Kieffer (1926) in describing the habits of this species observed as below: "Larve einzeln in den Eiern einer Spinnenart, die ihr Gewebe in wagerechter Richtung, zwischen 2 etwa 3 m voneinander entfernten Baumstämmen, bei einer Höhe von 1-1½ m angebracht hatte und deren zahlreiche Eier (über 150) nicht, wie üblich, zu einer Kugel vereinigt, sondern in einer Ebene in regelmäßigen Linien gruppiert und von einem grauen Gespinst umgeben waren. Das Ei des Parasiten ist im Verhältnis zum Ei der Spinne, das es zum großen Teil ausfüllt, als sehr groß zu bezeichnen ..... Parasitiert auch in Eiern von *Argiope*

catenulata Dol., deren Gewebe an Wasserpflanzen befestigt und über der Oberfläche des Wassers ausgebreitet ist ".

Subfamily *Scelioninae*.

Scelio sp.

A species of *Scelio* was bred from the eggs of *Atractomorpha crenulata* Fab. at Pusa. The Imperial Pusa Collection contains numerous specimens of the species (Imperial Pusa Insectary, Cage slip No. 1227).

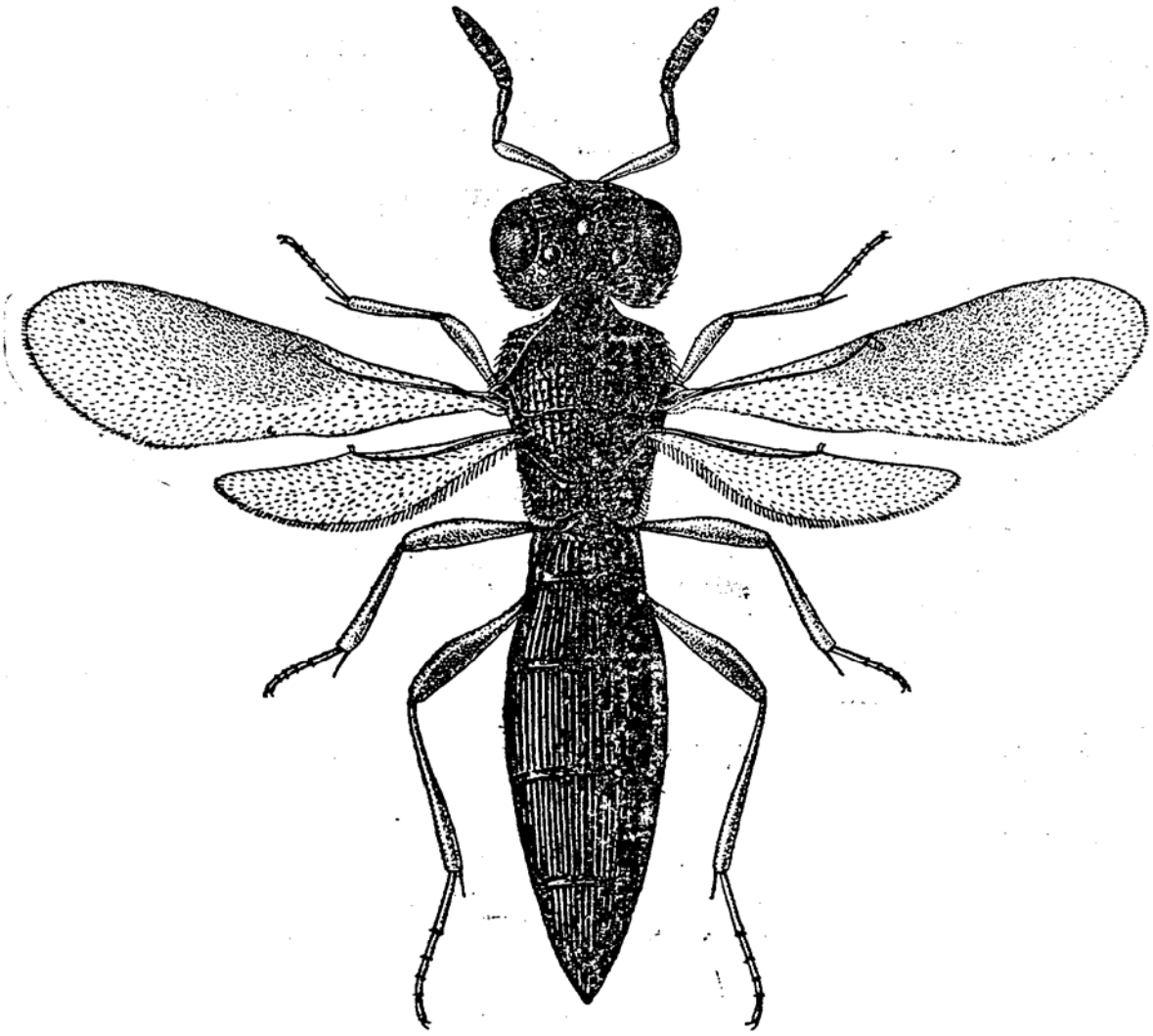


Text-fig. 8.—*Scelio* sp. ♀ : ×20.

Scelio hieropglyphi Timberlake.

1932. *Scelio hieropglyphi*, Timberlake, *Proc. Hawaii. Ent. Soc.* VIII, p. 157.

In the Imperial Pusa Collection there are a few specimens of this species, bred from the eggs of *Hieroglyphus banian* Fabr., laid in paddy fields at Coimbatore.



TEXT-FIG. 9.—*Scelio hieroglyphi* Timberlake, ♀: ×18.

Scelio oxyae Timberlake.

1932. *Scelio oxyae*, Timberlake, *Proc. Hawaii. Ent. Soc.* VIII, p. 158.

In the Imperial Pusa Collection there are a few specimens of this species, bred from the eggs of *Oxya velox* Fabr. at Coimbatore. The total life-cycle of the parasite occupies about 45 days during December-January and about 20-25 days in April.

S. pembertoni Timb. and *S. serdangensis* Timb. (1932), two other species parasitic on the eggs of *Oxya velox* in Hawaii, were introduced in 1933 into Malaya against this grasshopper, but the results are not known.

Lepidoscelio viatrix Brues.

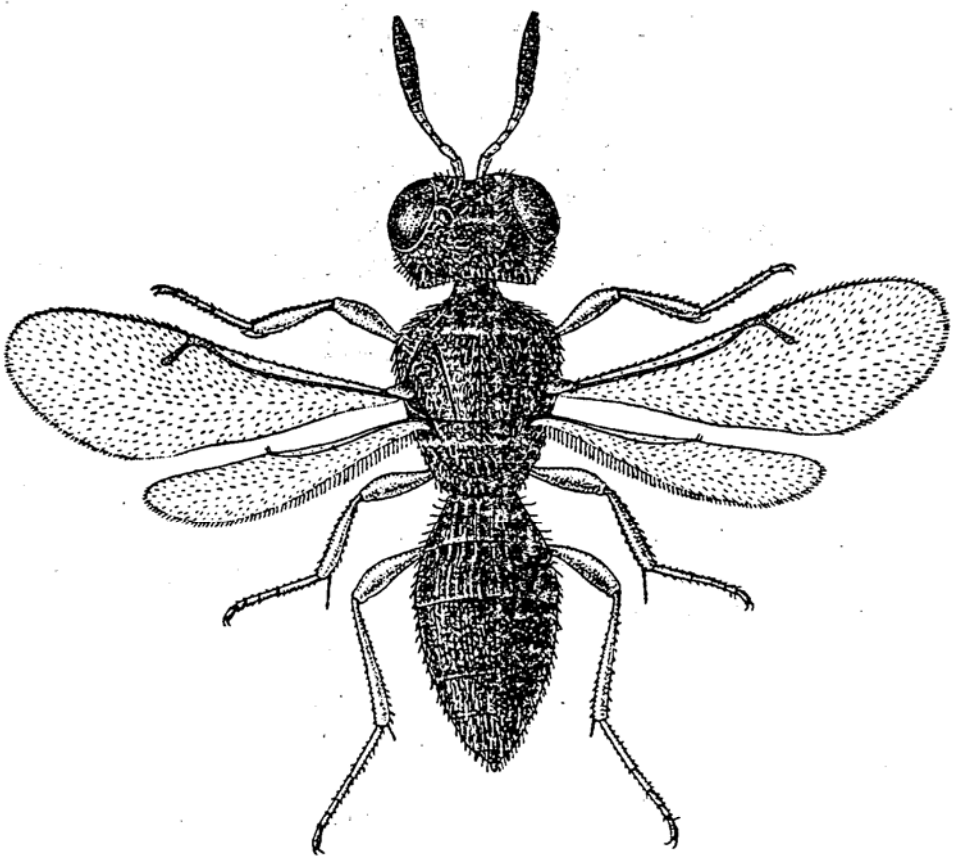
1917. *Lepidoscelio viatrix*, Brues, *Proc. Nat. Acad. Sci. Washington* III, p. 139.

This species was described from specimens bred from the eggs of the "Deccan grasshopper," *Colemania sphenarioides* Bot., in South India.

Hoploteleia gravelyi Mani.

1936. *Hoploteleia gravelyi*, Mani, *Rec. Ind. Mus.* XXXVIII, p. 469.

The species was originally described from specimens bred from the eggs of an unidentified " long-horned " grass-hopper at Madras.



TEXT-FIG. 10.—*Hoploteleia gravelyi* Mani, ♀; ×14.

In the Imperial Pusa Collection there are several specimens of this species bred from the eggs of an unknown grass-hopper on sugarcane at Cuttack and Coimbatore.

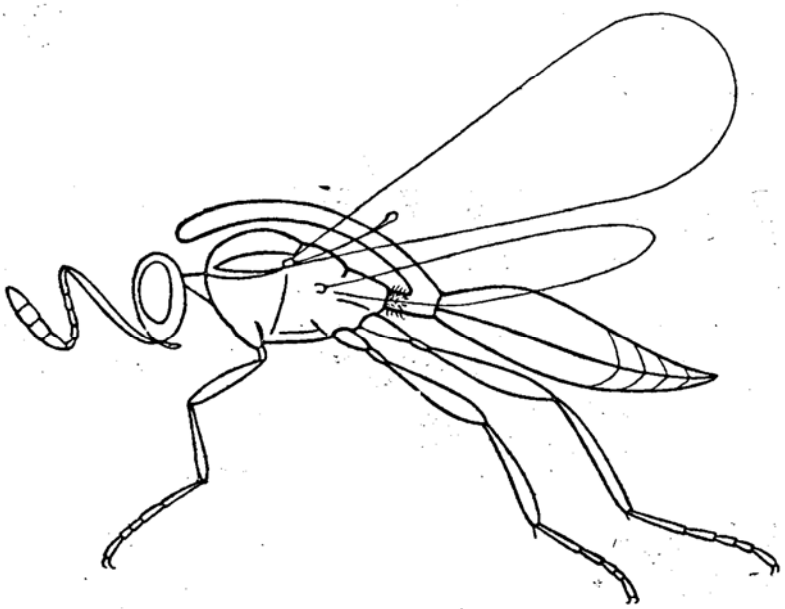
Subfamily *PLATYGASTERINAE.*

Inostemma indica Mani.

1941. *Inostemma indica*, Mani, *Cat. Ind. Ins.* XXVI, p. 32.

This species was bred by Mr. M. S. Mani from the larvae of the gall-midge, *Neolasioptera cephalandrae* Mani at Tanjore, South India. The total pre-imaginal period was thirteen days in August, 1931 at Tanjore.

This is the first species of the genus *Inostemma* Haliday to be recorded from India and is remarkable in that the petiole of the abdomen bears a long style-like process containing the extraordinarily long ovipositor, turned forwards on the thorax.



TEXT-FIG. 11.—*Inostemma indica* Mani, ♀: ×50.

Anectadius bengalensis Kieffer.

1905. *Anectadius bengalensis*, Kieffer, *Ann. Soc. Sci. Bruxelles* XXIX, p. 189.

This species was described from specimens bred from "the midge larvae, producing galls" on *Artemisia* at Kurseong, Eastern Himalayas.

Anectadius striolatus Kieffer.

1905. *Anectadius striolatus*, Kieffer, *Ann. Soc. Sci. Bruxelles* XXIX, p. 187.

This species was described from specimens bred from the larvae of the gall-midge *Lasioptera textor* Kieffer, at Kurseong, Eastern Himalayas.

Amitus aleurolobi Mani.

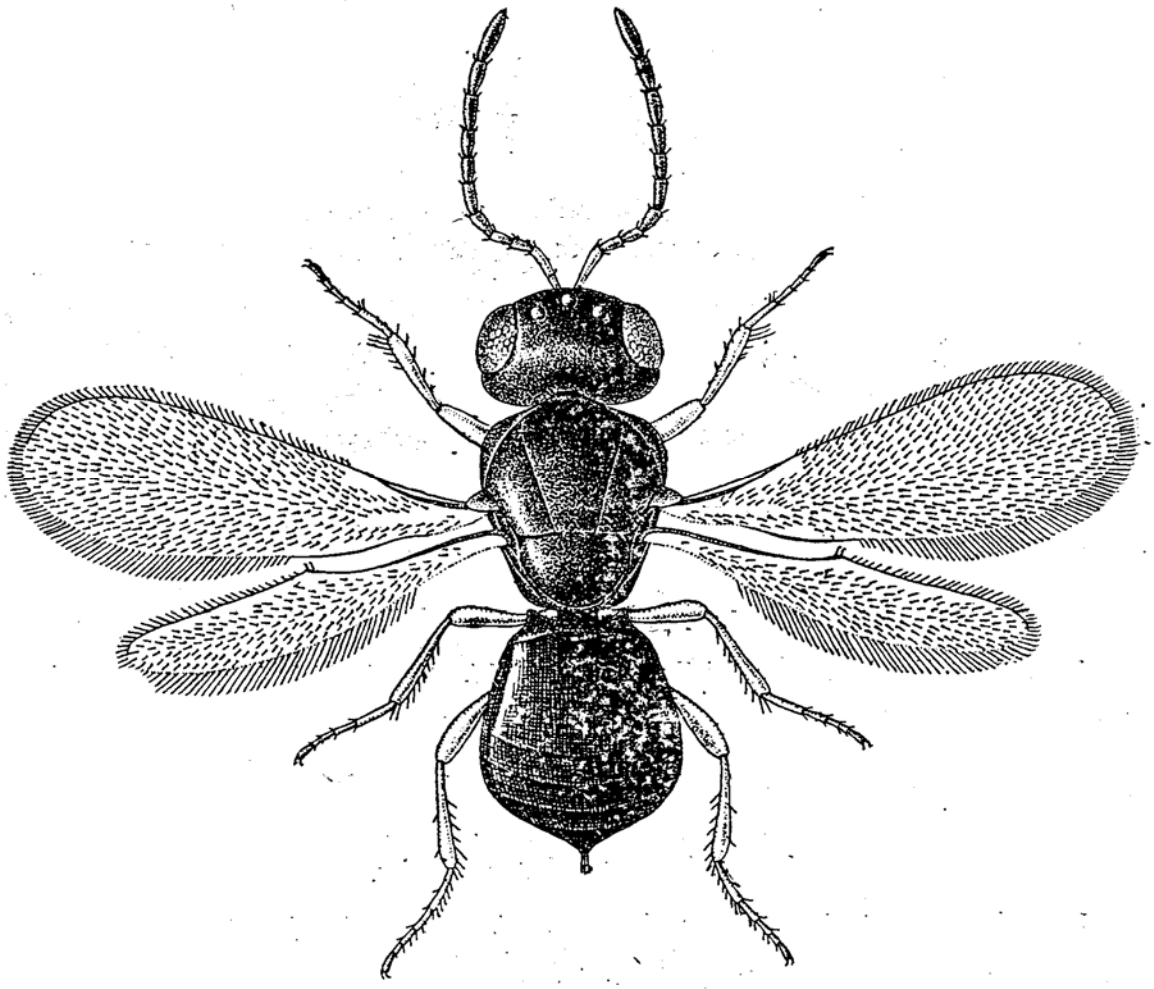
1939. *Amitus aleurolobi*, Mani, *Ind. J. Ent.* I, (1-2), p. 97.

In the Imperial Pusa Collection there are numerous specimens of this species bred by Mr. M. Ahmad from the nymphs of *Aleurolobus barodensis* (Maskell) at Majhautia and Pusa (Bihar).

In association with the Chalcids *Cardiogaster secundus* Mani and *Encarsia* spp., this species heavily parasitises the last instar nymphs of *Aleurolobus barodensis* on sugarcane at Pusa. The percentage of parasitisation by this species alone reached 92·04 in the middle of December 1918. This species is, indeed, more abundant at Pusa than the others in December. As many as six parasites emerge from a single puparium of the host.

The genus *Amitus*, along with one or two other closely related genera has peculiar habits for the subfamily Platygasterinae in parasitising Aleurodids; all the other genera are parasitic in gall-midges.

The species *Amitus aleurolobi* was figured by Misra (1919) but he wrongly called it a Chalcidid ; his figure is also inaccurate in several other respects and a correct figure of the parasite is appended hereto.



TEXT-FIG. 12.—*Amitus aleurolobi* Mani, ♀ : ×64.

Platygaster oryzae Cameron.

1891. *Platygarter oryzae*, Cameron, *Mem. Manchester Lit. Philos. Soc.* (4), IV, p. 182.

This species is a widely distributed larval parasite of the paddy silver-shoot gall-midge *Pachydiplosis oryzae* Mani, in South India, Central Provinces, Bengal and Burma. Parasitisation is often high but the parasite is not of much use, as the damage by the midge larvae is already over before the parasites kill the larvae. The parasite, if found in large numbers, serves, however, to reduce the density of population of the midges in the next generation and thus may indirectly minimise the damage to the succeeding crop.

Platygaster tibialis Kieffer.

1905. *Platygaster tibialis*, Kieffer, *Ann. Soc. Sci. Bruxelles* XXIX, p. 191.

This species was described by Kieffer as having been bred from the larvae of the gall-midge, *Lasioptera textor* Kieffer, at Kurseong, Eastern Himalayas.

Polygnotus sp.

Ramakrishna (1927) recorded a species of *Polygnotus* to be parasitic on the larvae of *Pachydiplosis oryzae* Mani at Tanjore in South India.

Family CALLICERATIDAE.

Subfamily *CALLICERATINAE.*

Calliceras athanasii (Girault).

The original description of this species, which is attributed to Girault by Ramakrishna (1920, 1927), cannot be traced in the literature available in this country.

Ramakrishna (*op. cit.*) recorded it as a parasite of *Plusia agramma* Guen. at Coimbatore.

Calliceras manilae (Ashmead).

1904. *Ceraphron manilae*, Ashmead, *Proc. U. S. Nat. Mus.* XXVIII, p. 135.

This species was originally described by Ashmead from the Philippine Islands.

Ferrière (1933) recorded it as having been bred from *Apanteles machaeralis* at Dehra Dun.

He also recorded it from Java, where, however, the host is not known.

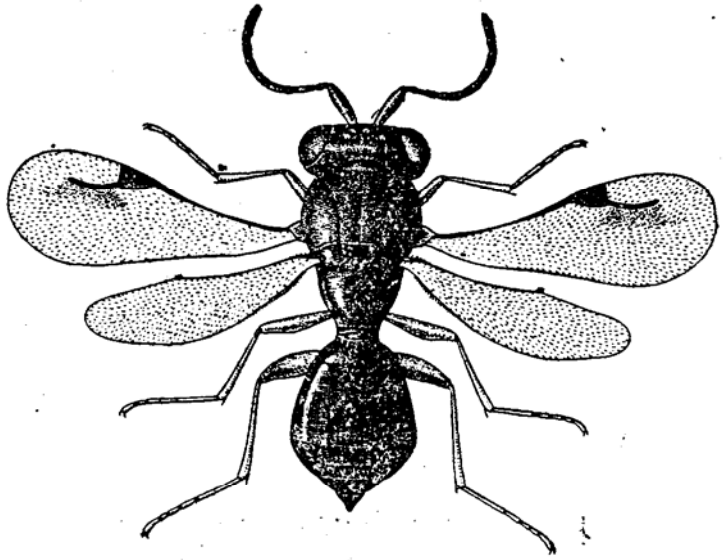
Subfamily *MEGASPILINAE.*

Lygocerus rufipes (Thomson).

1858. *Ceraphron rufipes*, Thomson, *Öfv. Kongl. Vet.-Akad. Förhand.* XV, p. 293.

1914. *Lygocerus rufipes*, Kieffer, *Das Tierreich* XLII, p. 153.

Mani (1941) recently recorded this species as a parasite of *Chrysopa* sp. from Jullunder (Punjab). It was originally described from Sweden; in France it attacks *Aphis euonymi*. The parasite has since been bred at Delhi from the nymphs of *Chrysopa virgestes* (?), a predator on aphids, *Pyrilla* spp., etc. The parasite attacks the host, while the latter is in the prepupal stage inside its cocoon. Six or seven eggs are usually laid on each host. The parasite completes its development entirely inside the host cocoon and emerges as adult in about a fort-



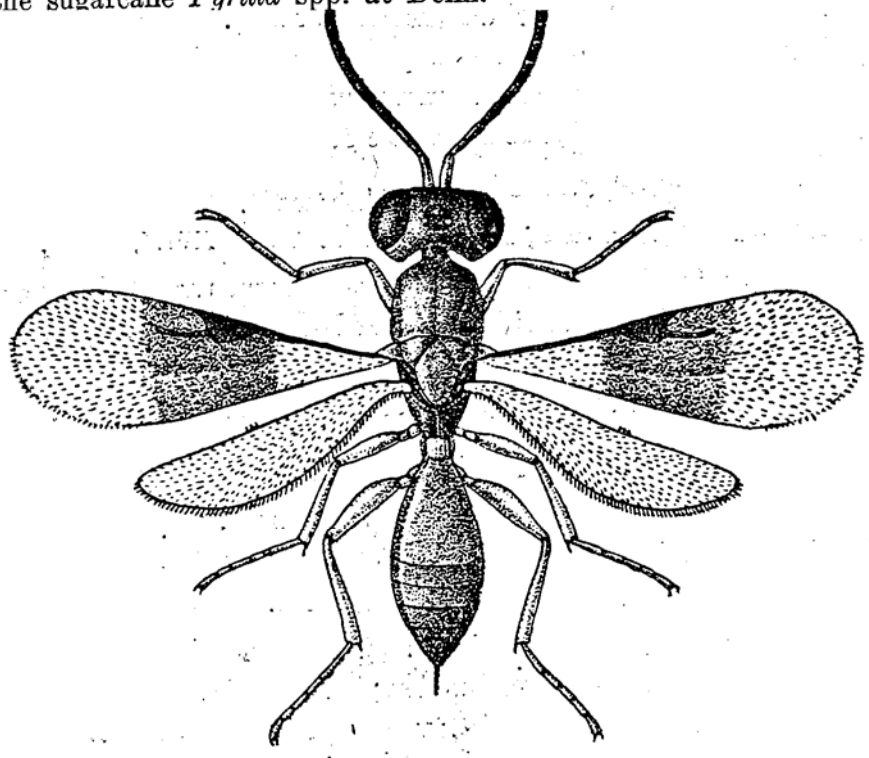
TEXT-FIG. 13.—*Lygocerus rufipes* (Thomson), ♀: 9. (reproduced from *Ind. Journ. Ent.* III, p. 27).

night, during summer, after oviposition. Although five or six adults emerge from the cocoon of a host, only a single exit hole is seen on the cocoon.

Atritomellus indicus Mani.

1939. *Atritomellus indicus*, Mani, *Ind. J. Ent.* I (1-2), p. 98.

The Imperial Pusa Collection contains a few specimens of this species, bred by Mr. M. S. Anwar from the nymphs of *Nimboa basipunctata* Withycombe (Neuroptera), which is a predator on the sugarcane *Pyrilla* spp. at Delhi.



TEXT-FIG. 14.—*Atritomellus indicus* Mani, ♀: ×30.

The parasitisation of the prepupal stage of the useful predator is very high and often almost all the nymphs collected from the field have been found parasitised. The parasites appear to be most numerous during March. As many as six parasites have been found to emerge from a single individual nymph of the host. The pre-imaginal period is about fifteen days during March-April at Delhi. The parasite begins to increase in number from end of January; by the end of March it practically exterminates the predator.

Family SERPHIDAE.

Subfamily *SERPHINAE*.

Serphus gravidator (Linnaeus).

1758. *Ichneumon gravidator*, Linnaeus, *Syst. Nat.* (10) I, p. 565.

This species occurs all over Europe, where about eight different varieties are recognised. The variety *Serphus gravidator gravidator* (Linn.) was once observed among the ants, *Formica sanguinea* in Europe; but Kieffer (1914) records it to be a parasite of *Boletophila fusca* in Europe.

Gardner (1929) has recently recorded another variety of this species, *viz.*, *Serphus gravidator partipes* Dodd, as having been bred as an endoparasite of the larvae of the beetle, *Nebria cameroni* Andrews (Carabidae), at Dehra Dun. According to him, the parasitic larvae emerge from the host-larvae at the anal extremity of the latter and then pupate on the body of the host. The pupal period is believed to be about ten days at Dehra Dun.

Serphus sp.

A species of *Serphus* was recorded by Jardine (1918) as parasitic on the tea Tortrix *Homona cofearia* Nietn. in Ceylon.

Superfamily BETHYLOIDEA.

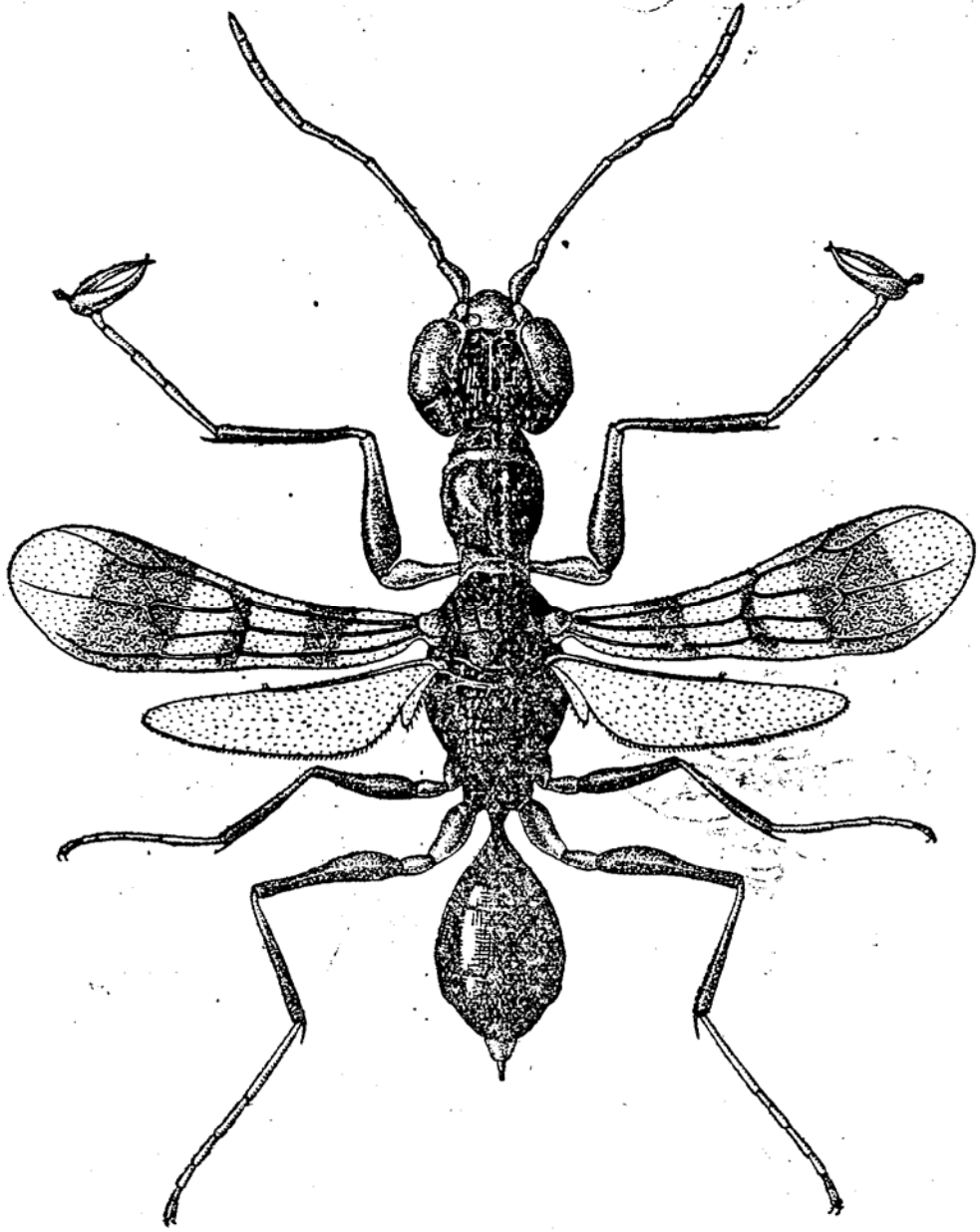
Family ANTEONIDAE.

Subfamily *LESTODRYININAE.*

Lestodryinus pyrillae Kieffer.

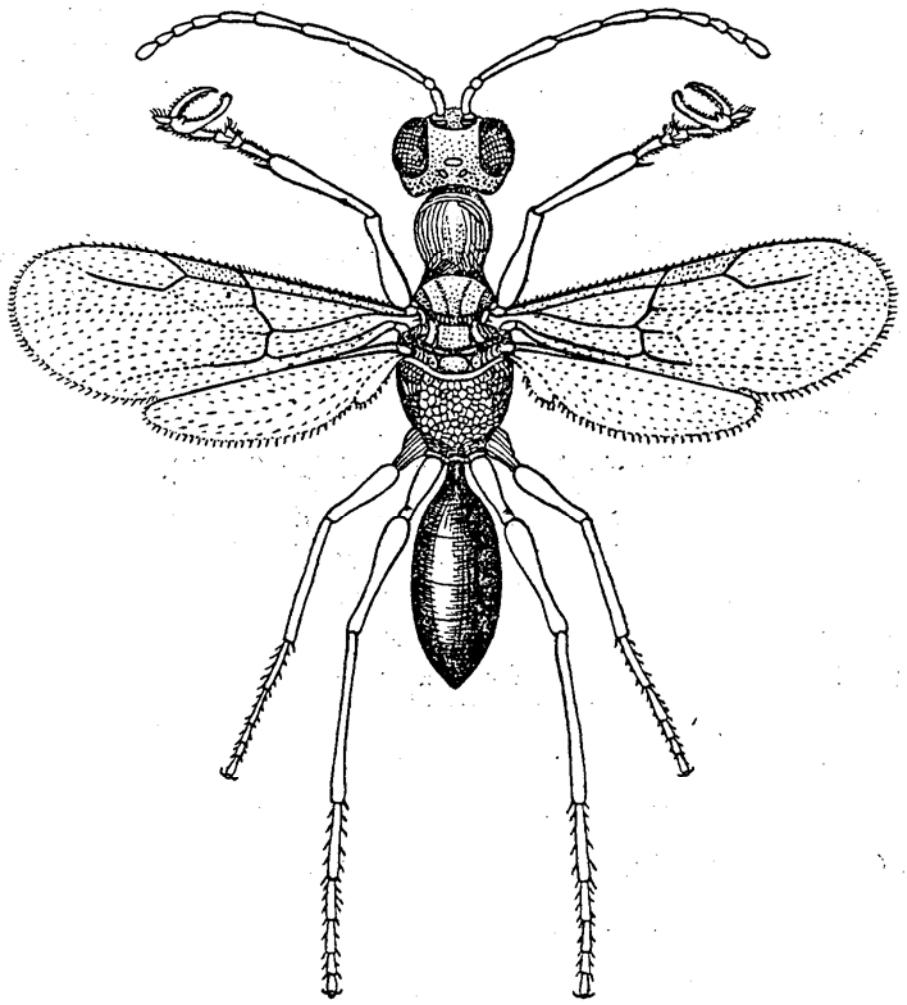
1911. *Lestodryinus pyrillae*, Kieffer, *Bull. Soc. Hist. Nat. Metz.* XXVII, p. 108.

In the Imperial Pusa Collection there are numerous specimens of this species bred from the nymphs of *Pyrilla* spp. at Pusa and Delhi.



TEXT-FIG. 15.—*Lestodryinus pyrillae* Kieffer, ♀: ×16.

The full-grown larva is about 4·5—4·6 mm. long and 1·5 mm. thick, pale white in colour, pointed anteriorly and with four small hairs medially. The cocoon is composed of thin, white



TEXT-FIG. 17.—*Chlorodryinus pallidus* Perkins, ♀: ×16.

silken threads exuded by the full-grown larva and measures about 9·0 mm. long. It encloses within it another smaller cocoon about 4·5 mm. long, within which pupation takes place. The cocoons of males are usually smaller than those of females. The male pupa turns black and the female pupa turns brown before the emergence of the adult. The female pupa measures about 3·2 mm. long.

Before emergence, the adult squirms about in the pupa and bites a hole just in front of its mouth. This hole is widened gradually and the adult comes out through it. Immediately after emergence, the adults fly away.

The total pre-pupal and pupal periods at Pusa in December-January are 10 days and 30 days respectively.

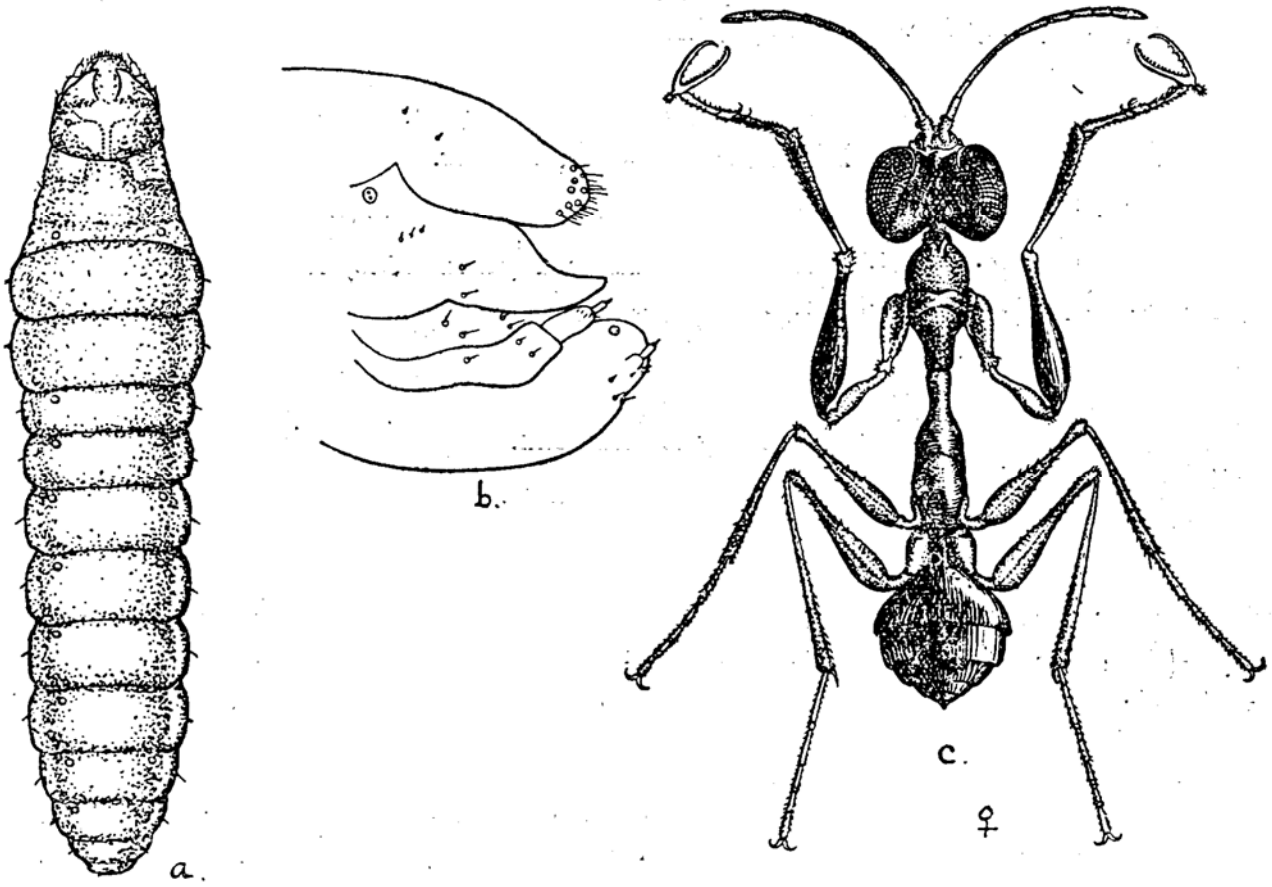
The adults of *Pyrilla* are never parasitised. Hyperparasitism by two species of Chalcidids (Encyrtids) is very heavy.

Subfamily *GONATOPIDINAE.*

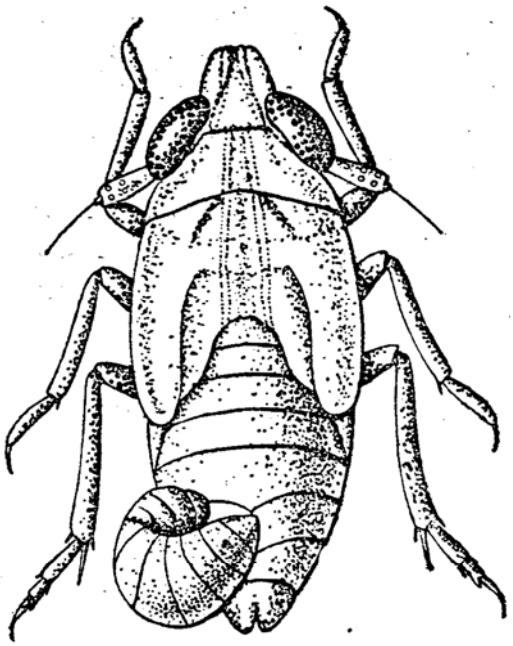
Pseudogonatopus sogatea Rohwer.

1920. *Pseudogonatopus sogatea*, Rohwer, *Proc. U. S. Nat. Mus.* LVII, p. 160.

This species was described from specimens bred (Misra, 1920) from the nymphs of the Delphacid paddy leaf-hoppers, *Sogata pusana* Dist., *S. distincta* Dist. and *S. pallescens* Dist. at Pusa.



TEXT-FIG. 18.—*Pseudogonatopus sogatea* Rohwer: ×16.



TEXT-FIG. 19.—Nymph of *Sogata* sp. with a larva of *Pseudogonatopus sogatea* Rohwer on the abdomen: ×30.

Haplogonatopus orientalis Rohwer.

1920. *Haplogonatopus orientalis*, Rohwer, *Proc. U. S. Nat. Mus.* LVII, p. 159.

This species was described from specimens bred from the nymphs (Misra, 1920) of *Sogata* spp. on paddy leaves at Janjgir, Bilaspur (Orissa).

Digonatopus lucidus Rohwer.

1920. *Digonatopus lucidus*, Rohwer, *Proc. U. S. Nat. Mus.* LVII, p. 159.

This species was described from specimens bred (Misra, 1920) from the nymphs of *Nephotettix bipunctatus* (Fabr.) at Pusa.

Family BETHYLIDAE.

Subfamily *BETHYLINAE.*

Bethylus distigma Motschulsky.

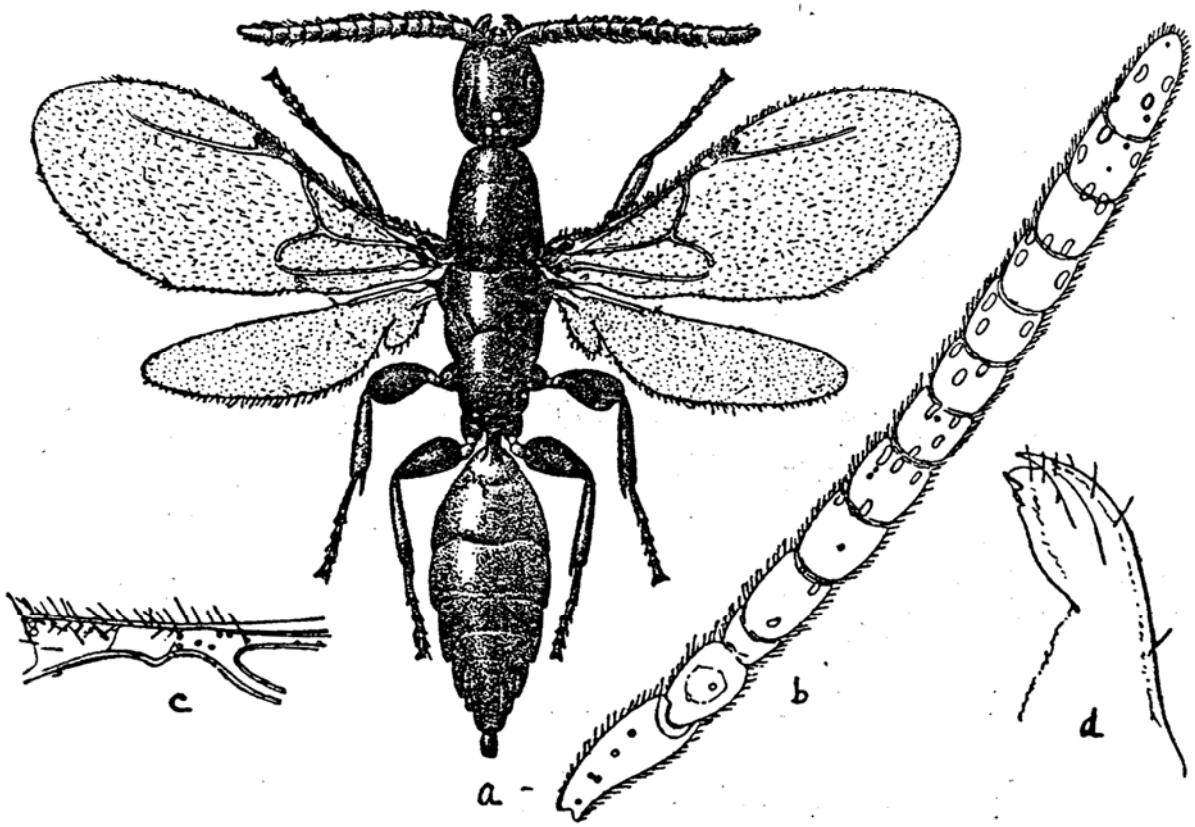
1863. *Bethylus distigma*, Motschulsky, *Bull. Soc. Imp. Nat. Moscou* XXXVI (2), p. 27.

This species was originally described from specimens collected at Mt. Nuwara Elliya in Ceylon.

Under the name *Goniozus montanus* Kieff. (which is a synonym of *Bethylus distigma*), Beeson and Chatterjee (1939) have recorded this species to be an ectoparasite of the caterpillars of *Agrotera basinotata* Hamps., *Chalcidoptera straminalis* Guen., *Hyblaea puera* Cram. *Lygropia quaternalis* Zell. and *Sylepta* (?) *crotonalis* in Nilambur in South India, and Dehra Dun (U. P.). Chatterjee (1941) described the biology of this species on the caterpillars of *Cacoecia* sp. at Allahabad ; he also briefly described the immature stages of the parasite. The female parasite exhibits a remarkable degree of ' mutterliche Bewachung ' (Lengerken, 1939) : After paralysing the host caterpillar and laying its eggs on it, the female *Bethylus* guards the place and remains so until all her eggs have hatched out. On forcibly removing her and confining her with another host caterpillar, she lays more eggs only on rare occasions. At the time of standing guard and before ovipositing, the female punctures the host at several places and feeds on the exudation therefrom. According to Chatterjee (*op. cit.*), the total life-cycle is about 11 days at Allahabad. A single host-caterpillar is often parasitised by as many as nine larvae of this species. Pupation is said to take place in a chocolate-brown coloured cocoon. The parasite was introduced into Burma from South India for the control of the above-mentioned defoliators and is reported to have successfully become established.

Bethylus sp.

Fletcher and Misra (1919) have recorded a species of *Bethylus* (?) as parasitic on the pink bollworm of cotton, *Platyedra gossypiella* (Saunders) in Cawnpur. Three specimens of the parasite emerged from the larva between July and October.



TEXT-FIG. 20.—*Bethylus* sp.

a. Adult ♀: ×38; b. Antenna of ♀; c. Marginal vein; d. Right mandible. (reproduced from *Rep. Proc. Third Ent. Meet. Pusa* II, pl. lxxix, p. 447).

Trissomalus fulvicornis Rohwer.

Ramakrishna (1927) recorded this species as parasitic on the caterpillar of *Argyroploce illepida* Butler at Mysore. The original description of this species is not traced in the literature available in this country.

Goniozus indicus Ashmead.

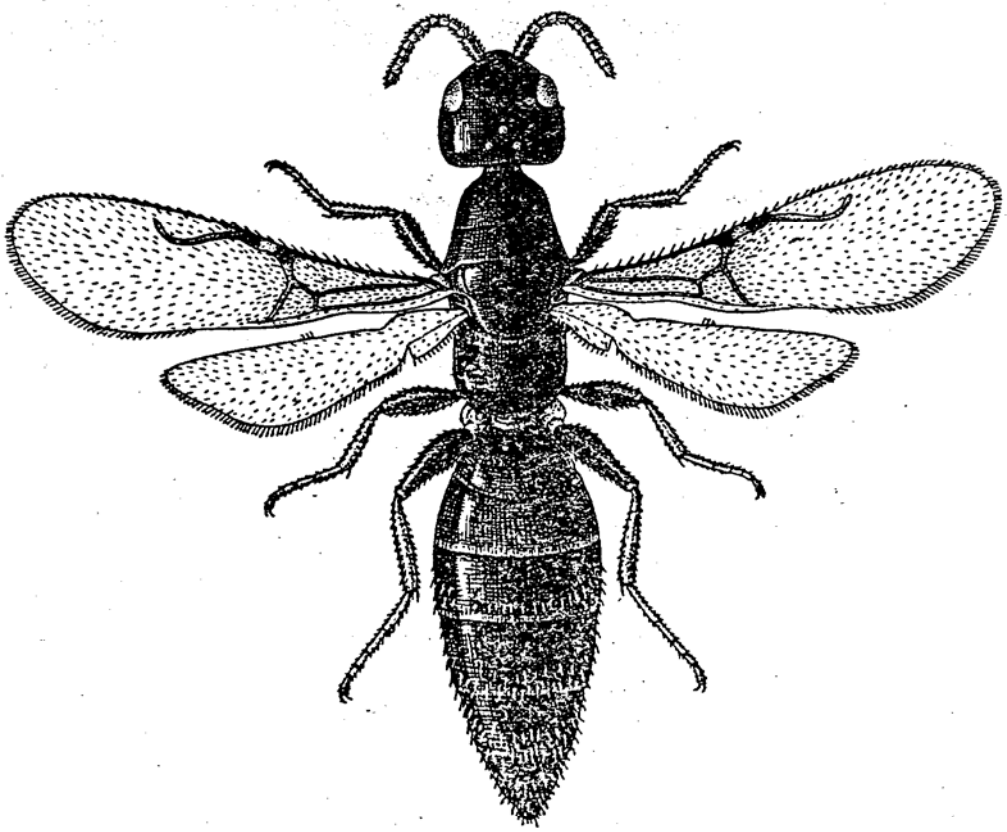
1903. *Goniozus indicus*, Ashmead, *Indian Mus. Notes* VI, p. 2.

1940. *Goniozus indicus*, Muesebeck, *Proc. Ent. Soc. Washington* XLII (6) : p. 121.

Five female specimens bred from the larvae of *Scirpophaga auriflua* by L. de Niceville at Champaran (Bihar) were described by Ashmead (*loc. cit.*) as *Goniozus indicus*. On the assumption that Ashmead never published a description of *Goniozus indicus*, Muesebeck (*loc. cit.*) has recently described it as new, retaining, however, the name proposed by Ashmead. We have discovered Ashmead's original description of the species (*loc. cit.*), which is valid under the International Rules of Zoological Nomenclature, and thus takes precedence over that of Muesebeck. We have already attempted to draw Dr. Muesebeck's attention to this, but owing to the uncertainties of communication due to the war, it may be long before he publishes a correction. We, therefore, take this opportunity of re-instating Ashmead's *G. indicus*, with a view to avoiding confusion likely to be caused by Muesebeck's name finding its way into literature.

In the Imperial Pusa Collection there are numerous specimens of this species bred by Dr. E. S. Narayanan from the larvae of *Emmalocera depressella* Swinh. at Pusa.

At Pusa, the parasite appears in the field in appreciable numbers (percentage of parasitisation 10) in winter only, when the larvae of *Emmalocera depressella* are full-grown and have already done the damage to sugarcane. It does not, therefore, appear to be of much



TEXT-FIG. 21.—*Goniozus indicus* Ashmead, ♀: ×16.

practical use in controlling the root-borer of sugarcane, *Emmalocera depressella*. The parasite has also been bred at Delhi from the larvae of *Scirpophaga* spp. and *Emmalocera depressella*.

Goniozus indicus was recorded by Reh (1925) from the Oriental Region on *Scirpophaga auriflua* Zell., *S. intacta* Snell., *S. monostigma* Zell. and *S. chrysorrhoea* Zell. Muesebeck (*loc. cit.*) has also recorded this species as having been bred from the larvae of *Chilo* sp. on *cholam* by Mr. P. Israel and from the larvae of *Diatraea venosata* by " C. K. S. Collector" at Coimbatore. Recently we received for identification two specimens of this species bred by Mr. M. C. Cherian from the larvae of *Scirpophaga* sp. at Coimbatore.

Goniozus cuttockensis recently described by Lal (1939) from specimens bred by Mr. M. Ahmad from the " burrows of the stem-borer of sugarcane " at Cuttack, is conspecific with *Goniozus indicus* Ashmead, and should, thus, be considered a synonym.

GENERAL REMARKS ON THE BIOLOGY OF SERPHOIDEA AND BETHYLOIDEA.

No comprehensive account of the biology of the Serphoidea or the Bethyloidea is available. In the following pages an attempt is made to bring together the very much scattered and fragmentary information regarding the biological features of these groups, in the hope that this may serve as a basis for further work in future.

SERPHOIDEA.

The Serphoidea are parasites, mostly on the eggs, but occasionally on the larvae, nymphs or pupae of other insects. Several of the species are hyperparasites and attack the eggs or larvae of parasitic Chalcids, Ichneumonids or other Serphids ; a few species are also inquilines. They occur in all parts of the world but more abundantly in tropical countries. Though practically all orders of insects are parasitised by the members of this group, Coleoptera, Lepidoptera, Rhynchota and Diptera are the most common orders attacked by them.

The adults, which usually feed on the juices of plants, are active flyers, and especially the females are strongly attracted to light. The range of flight, however, is not very great and does in no case exceed a few yards. The Scelionid, *Tiphodytes gerriphagus* (Marchal) (Kieffer, 1926) from France, uses its wings not only for flying but also as oars for swimming under the water, where it lays its eggs on the eggs of its aquatic host, *Gerris* sp. (Hemiptera). Kieffer (*loc. cit.*) very vividly describes the habits of this species : "Nach Marchal schreitet dieses Tier auf den Pflanzen innerhalb des Wassers mit derselben Leichtigkeit wie auszerhalb des Wassers ; es schwimmt nach allen Richtungen, auch nach unten, durch regelmäszige Schläge mit den Flügeln."

The duration of life of the adults is usually short under natural conditions, but when fed with honey or sugar solution in the laboratory, may extend up to one to two months, depending upon the conditions of temperature and humidity. Females usually predominate in numbers and also live longer than the males. Copulation usually takes place near the host eggs or near the place of emergence of the adult parasites. Parthenogenesis is common.

The phenomena of both primary and secondary parasitism are met with in this group. A very advanced type of parasitism has been recorded by Rabaud (1922) and Chopard (1923) in the species, *Rileia manticida* Kieffer (Scelionidae), parasitic on the oothecae of *Mantis religiosa* Linn. in France. On emergence, the adult parasite searches for and settles down upon the body of an adult mantid. It then loses its wings and becomes thenceforward an ectoparasite on the mantid. The female parasite which thus settles down upon an adult female mantid, gradually makes its way to the posterior part of the body of its host, in order to lay its eggs in the frothy mass of the ootheca, before the latter dries and hardens. Where the mantid happens to be a male, the parasite transfers itself to the female at the time of copulation of the host (Bischoff, 1927).

In the majority of cases there are specific hosts, and all members of the family, subfamily or genera always parasitise the same group of insects. Most species of the subfamily Telenominae, for instance, attack the eggs of Lepidoptera or Rhynchota. *Telenomus beneficiens* (Zehnt.) Nix., *T. spodopterae* Dodd, *T. vandergooti* Dodd, etc., are common examples of species parasitising the eggs of Lepidoptera. Several other species like *Telenomus anwari* Mani, *T. colemani* Crawf., etc., on the other hand, attack the eggs of Rhynchota. Some species, e.g., *T. tabanivorus* (Ashmead) in America, are parasitic on the eggs of *Tabanus* spp. (Diptera). Most species have only one host but several instances are also known of a species attacking the eggs of two or more insects. *T. beneficiens*, for instance, has been recorded from the eggs of *Diatraea venosata*, *Chilo* spp., *Scirpophaga* spp., *Schoenobius incertellus*, etc. *T. mesillae* likewise is known to be parasitic on the eggs of several species of Pentatomid bugs, such as, *Pentatoma ligata*, *P. sayi*, *Euschistus servus*, etc.

The majority of the subfamily Baeinae, for example, the genera *Baeus*, *Psilocolus*, *Dissacolus*, *Acolus*, etc., are specific egg-parasites of Araneida (Arachnida). We have so far only one species, viz., *Dissacolus lakshmani* Mani, of this subfamily bred from the eggs of a spider on sugarcane leaf, reported from India. Some species like those of the genus *Aphanomerus*, are parasitic on the eggs of Fulgoridae. A species, *Tetrabaeus americanus* (Brues) is reported by Brues (1908) to have been bred from the cocoons of a species of *Crabro* (Crabronidae : Hymenoptera) from the United States. *Aneurobaeus apterus* (Bugn. & Popoff) from Ceylon (Kieffer, 1926) is remarkable in that the female, which is apterous, is aquatic in its habits and parasitises the eggs of the spiders, *Argiope aetherea* Walck. and *A. catenulata* Dol. (Argiopidae : Araneida), which are laid on the submerged branches of various species of water plants. Another species, *Thoron metallicus* (Curtis) (Kieffer, 1926), is also known to occur on aquatic weeds or moss, possibly as a parasite of some aquatic Arachnid.

The hosts of the subfamily Teleasinae are, however, very little known. Several species are known to attack the eggs of Carabidae and Scolytidae in Europe. Two species have also been bred as parasites on the gall-midge, *Rhabdophaga rosaria* (H. Loew) in Europe. *Hoplogyron* (*Hoplogyron*) *myrmecobius* Kieffer and *Paragyron myrmecophilus* Kieff. from England are guests in the nests of *Lasius fuliginosus* (Formicoidea). No species of the Teleasinae has so far been recorded from India.

The subfamily Scelioninae are usually parasitic on the eggs of Orthoptera, especially the families Acrididae, Locustidae and Mantidae. *Scelio uvarovi* Obglobin, for instance, is an egg-parasite of *Locusta migratoria* phase *danica* in Ukraine and Central Russia (Obglobin, 1927 ; Predtechenskii, 1928). *Scelio nikoloskyi* Obglobin (1927) is another egg-parasite of *L. migratoria* in the Russian Turkestan. From Madagascar it is reported (Ferrière, 1930) that the eggs of *L. migratoria migratorioides* are parasitised by another species, viz., *Scelio zolotarevskyi* Ferr. The genera *Hadronotus* and *Hadronotoides* are, however, of exceptional habits and resemble the Telenominae in parasitising the eggs mostly of Rhynchota and in the case of one species of a Lepidoptera. Brues (1930) observed the species, *Paridiris nigricornis* (Brues) and *Ceratoteleia marlatti* (Ashmead) living in the compound nests of *Myrmica* sp. and *Leptothorax* sp. (Formicoidea) in the United States.

The biology of the subfamily Platygasterinae is better known than that of the Telenominae (Kieffer, 1926). But for one or two exceptions, all the Platygasterinae are parasitic on the eggs or the larvae of gall-midges (Itonididae : Diptera). *Platygaster oryzae* Cam. and *Polygnotus* sp. are two well known parasites of the paddy silver-shoot gall-midge, *Pachydiplosis oryzae* Mani, in India, Burma and Malaya. *Polygnotus vernalis* Myers is an important parasite of the notorious wheat pest of America, viz., *Mayetiola destructor* (Say) (Hessian-fly). Three species of the genus *Amitus*, whose hosts only are known so far, are parasitic on the nymphs of Aleurodids. *Amitus minervae* Silvestri (1911) is parasitic on *Aleurodes olivinus* Silv. in Sicily and *Amitus aleurodinis* Haldemann (1850) on *Aleurodes corni* Hald. and *A. forbii* Ashm. in the United States. A recently described species, *Amitus aleurolobi* Mani (1939), is a parasite on the nymphs of the sugarcane whitefly, *Aleurolobus barodensis* (Mask.) in India.

The rare records of the Platygasterinae attacking Aphids or Cynipids, are doubtful ; *Platygaster aphidis* Ashm., for instance, is reported to have been bred from a species of *Aphis*

on *Chenopodium album* in New York. According to Ashmead (1893), however, this species is probably a parasite of an unknown gall-midge, which is predaceous on the *Chenopodium* aphid. The same is probably true of *Fahringeria synergorum* Kieff., reported by Kieffer (1921) as having been bred from galls of Cynipids. One or two species, like *Platygaster myrmecobia* Kieff. and *P. pygmaea* Kieffer (1913), are reported to be guests respectively in the nests of *Formica rufa* and *F. rufibarbis* (Formicoidea) in Luxemburg.

The mode of parasitism in the Platygasterinae differs from that of the other subfamilies of the Scelionidae in some important respects. For instance, in the case of most of the Scelionidae, the parasite develops entirely within the eggs of the host and always kills the host embryo. But in this subfamily the parasite spends only a part of its pre-imaginal life in the eggs of its host. The host embryo is not killed but is allowed to develop and the host larva hatch out, containing within it the parasitic larva. In the larval stage of the host the development of the parasite takes place rather very rapidly and ultimately the parasite emerges, killing the host larva.

The eggs of the Telenominae are usually elongated and stalked, while those of the Platygasterinae are variable. The shape and size of the eggs of Platygasterids depend, to a very great extent, upon the host eggs ; the eggs of some of them are elongate and stalked but in others short and without stalk. According to Marchal (1906), the eggs of *Synopeas rhanis* (F. Walk.) (parasitic on the gall-midges, *Perrisia ulmariae* Bremi and *P. urticae* Perris in France and Belgium) are oval, with a short stalk at the posterior end and a long one (three times as long as the egg itself) at the anterior end. Those of *Trichacis remulus* (F. Walk.) (parasitic on *Maytiola destructor* in France and England) are elongate-oval, narrowed at the two ends and with a very short stalk at the cephalic end, while the tail end has a whip-like projection (Marchal, 1906). In the case of the European *Inostemma piricola* Kieff., parasitic on the larvae of the pear gall-midge, *Contarinia pirivora* Riley, the eggs are fusiform, with a very long stalk at the cephalic end and a short process at the caudal end (Kieffer, 1926).

The position of the parasitic larva within the host larva differs very much in different species. In the case of *Synopeas rhanis* the parasitic larva lies free in the body cavity of the host ; the larva of *Platygaster minutula* (Dalla Torre), on the other hand, lives in the stomach of its victim, *Mayetiola destructor* ; while *Trichacis remulus* forms cysts in the ventral nerve cord of the same host (Kieffer, 1926).

There are generally at least three larval stages. The first stage larva resembles the members of the Copepod genus *Cyclops* and is therefore called a " Cyclopoid " larva. The second stage larva, called the " secondary larva, " is roundish and shows no external segmentation but internally eight transverse bundles of muscles can be seen. The third stage larva is distinguished from the secondary larva by the presence of external segmentation. For a detailed account of biology of *Platygaster*, reference may be made to Marchal (1906).

Very little is known about the biology of the family Calliceratidae. The larvae of the members of this family are mostly primary or secondary endoparasites on Coccidae, Aphididae, larvae of Itonididae, Muscidae and Syrphidae. Numerous species have also been met with in the nests of different species of ants, where they are apparently parasitic on the larvae of myrmecophilous insects. The following species are common examples occurring in ant nests : *Calliceras luteipes* (Kieff.) occurs in the colony of *Solenopsis fugax* in Holland,

C. myrmicarum (Kieff.) in the colony of *Myrmica* sp. in England and *C. testaceipes* (Kieff.) in the colonies either of *Lasius fulvus* or *Formica rufa*, according to the season in Holland (Kieffer, 1926).

In the genus *Lygocerus* we meet with primary parasitism of aphids as well as of aphidivorous Neuroptera and Diptera like the Syrphidae and hyperparasitism of the Braconid, *Aphidius*, which is itself a primary parasite of various species of aphids. The biology of this genus was studied by Haviland (1920), who observed three larval instars.

Ratzeburg (1844) has recorded several species, like *Calliceras vitripennis* (Ratzb.) and *C. unispinosa* (Ratzb.), which he believes are parasitic on the larvae of weevils boring in the branches of pine trees in Germany. He has also observed that larvae of the Scolytidae, Bombycidae, Tortricidae and Teneidae are parasitised by members of this family. *Calliceras clavata* (Ratzb.) is recorded as having been bred from the larva of the gall-midge, *Rhabdophaga rosaria* H. Loew, in Germany. A recently described Indian species, *Atritomellus indicus* Mani (1939), is a parasite of *Nimboa basipunctata* Withycombe (Neuroptera), which is a predator on the eggs of *Pyrilla* spp. (Fulgoridae : Rhynchota).

In the family Calliceratidae the eggs are white, nearly two or three times as long as thick, slightly constricted at both ends or subcylindrical and provided with a short stumpy stalk at one end. Accounts of the larval and pupal stages are not yet available.

Our knowledge of the biology of the Serphidae is also equally fragmentary. Very few forms have been studied in detail in this respect, but the majority of the species so far studied are parasitic on the larvae of Mycetophilidae, Muscidae or Phoridae among the Diptera, and Carabidae, Staphylinidae and Coccinellidae among the Coleoptera. (Kieffer, 1914) reported that *Phaenoserphus viator viator* (Haliday) was bred in England and Belgium from the larvae of *Nebria brevicollis* F. (Coleoptera) and was also met with in the nest of *Lasius niger* (Formicoidea) in Germany. Several other species are also known to occur in the nests of various other species of ants. Kieffer (1926) recorded that Newman found twenty-one larvae of *Phaenoserphus calcar* (Haliday) ectoparasitic on a single individual of the Myriapod, *Lithobius forficatus* ; the parasitic larvae were found attached to the ventral side of the host by their cephalic ends. Eastham (1929) published a short list of the Coleopterous hosts of the European species of this family.

In the Serphidae the eggs are almost cylindrical, elongated and have a whip-like prolongation at one end. Eastham (*op. cit.*) studied the life-history and the post-embryonic development of *Phaenoserphus viator* (Haliday), which is an endoparasite (in addition to the hosts already mentioned above) on the larva of *Pterostichus niger* (Carabidae) in England. He found four larval instars. The first instar larva is without tracheae, is incompletely segmented and bears seven pairs of prolegs. Later instars are apodous and in them the tracheae develop gradually but become functional only in the fourth instar. Before pupation, the parasitic larvae, numbering as many as forty-five per host larva, emerge, attach themselves to the outside of the host and pupate without spinning a cocoon.

The members of the subfamily Helorinae of the Serphidae are known to be parasitic on the larvae of Chrysopidae (Neuroptera).

Most of the insects parasitised by the Diapriidae are pests of agricultural or forest plants and the family is, therefore, of great economic importance. For example, *Galesus silvestrii* Kieff., an important parasite of the notorious Mediterranean fruit-fly, *Ceratitis capitata*

Wied., in Nigeria, Gold Coast and French Guinea, belongs to this family. From tropical Africa this parasite was successfully introduced into Italy and Hawaii for the control of the fruit-fly. *Galesus silvestrii* Kieff. parasitises several other fruit-flies also, as for example, *Ceratitis anonae* Graham, *C. nigerrima* Bezzi and *C. giffardi* Bezzi in the Hawaii, and according to Silvestri (1913) *Dacus oleae* Rossi, *D. bipartitis* Graham and *Ceratitis colae* in Italy.

Most of the species, the life-histories of which are known so far, are endoparasites on the larvae or the pupae of Diptera. A few species are, however, known to attack the larvae of Coleoptera or Lepidoptera. Numerous species are also guests in the nests of ants, where probably they are parasitic on the larvae or pupae of various myrmecophilous insects.

The post-embryonic development of only a few forms has been studied so far. According to the observations of Silvestri (*op. cit.*), the females of *Galesus silvestrii* search for the puparia of *Ceratitis capitata* in the soil and lay their eggs singly in each puparium. The total pre-imaginal period of the parasite is about twenty-five days in the tropical Africa, thirty days in Honolulu (Hawaii) and twenty-five to thirty days in Italy. The eggs are white, elliptic and broader at the cephalic than at the caudal end. The full-grown larva measures about 3·25 mm. long.

Most of the species of the subfamily Belytinae are parasitic on larvae of fungivorous Diptera.

BETHYLOIDEA.

In their larval stage all the members of the superfamily Bethyloidea are parasites on other insects. The Anteonidae attack Homoptera ; only two species are recorded as parasitic on Lepidoptera, but both these records require confirmation. The peculiar predatory fore-legs of the adult females of the subfamily Aphelopinae are employed in capturing the hosts such as the active Cicadidae and Jassidae, for parasitisation. The fore-femora are swollen and club-shaped and the terminal tarsal segment is armed with two great pincer-claw-like processes, which while at rest lie back, sometimes even reaching the base of the tarsus itself. The true claws are very small and inconspicuous. The proximal pincer-like process of the terminal tarsal segment bears a series of comb-like teeth or setae, which are supposed to be sensory structures. With the help of one of these pincer claws the female holds the host by the neck, and with the other pincer the saltatorial hind legs of the victim are temporarily disabled. Species having the characteristic comb-like process on the proximal pincer of the terminal tarsal segment usually parasitise the Cicadidae and Fulgoridae, while those without such a structure attack the Jassidae. On a victim being securely caught and held tight, oviposition commences. The female takes about a minute or so in depositing her eggs on one individual of the host, after which the latter is set free. The parasitised host nymph, on being thus liberated, jumps about, feeds and behaves apparently normally, without exhibiting any outward sign of the effects of parasitism for a time. After, however, four to eight days, there appears on the parasitised nymph a conspicuous bag-like or gall-like cyst, called a " thylacium ", containing within it the parasitic grub. The position of this cyst on the host nymph varies in different genera. In some cases, *e.g.*, *Echthrodelphus*, *Paradryinus*, *Neodryinus* and *Thaumatodryinus*, this cyst appears on the dorsal side of the abdomen under the wings, in others, for instance, as in *Anteon*, on the ventral side of abdomen ; and on rare occasions both on the dorsal and lateral sides as in *Pseudogonatopus*. Very rarely more than one cyst is seen on the same individual of the host. The cyst is usually

oval or wedge-shaped and more or less laterally compressed. As the parasitic larva develops inside the cyst, the host becomes gradually more and more sluggish, stops feeding and ultimately dies. The parasite pupates in a cocoon either on the leaf of the food-plant of its host or in the soil. The adult parasite also feeds on the juices of its larval host.

The Bethylidae are mostly parasitic on lepidopterous and coleopterous larvae. It is still not clear whether the Bethylids, while parasitising, actually kill or only paralyse their victim. Bridwell (1920) studied the biology of a species of *Epyris*, which passes its larval period as a parasite of Tenebrionid larvae. The genus *Goniozus* usually attacks the caterpillars of Lepidoptera. Numerous species are also known to be parasitic on myrmecophilous insects. Several species live inside plant galls as parasites on the gall-forming insects, while others are found in tunnels in wood, where they attack the larvae of wood-boring insects. A few forms have also been observed living on fungi. Furthermore, one genus, viz., *Harpogocryptus*, resembles the Anteonidae in parasitising the nymphs of Homoptera.

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MGIPC—M—III-8-10—9-9-42—350.