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ON TREMATODES FROM WILD DUCKS IN RANGOON.

By B. S. Gogate.

(From the Biological Department, University of Rangoon.)

Two ducks were dissected. The first, *Anas poecilorhyncha* Forester 1781, contained only three specimens of *Echinostoma revolutum* (Froelich 1802) Looss 1899. The second, *Dendrocygna javanica* (Gmelin 1789), was more heavily parasitized containing both Trematodes and Nematodes. The Trematodes consisted of two genera of Echinostomes and one genus of Schistosomes. The former were obtained from the intestine and the latter from clotted blood in the body-cavity. As the bird reached the laboratory sometime after it was shot, a detailed examination of the blood could not be carried out.

I am indebted to Prof. F. J. Meggitt for his suggestions and criticism in the preparation of the manuscript.

***Echinostoma revolutum* (Froelich 1802) Looss 1899.**

The only feature in which the parasites differ from the description of Lühe (1909, p. 69) is the size. The biggest of them is only a little longer than the smallest mentioned in the description.

Host.—*Anas poecilorhyncha* Forester 1781.

Location.—Intestine.

Locality.—Rangoon.

***Paryphostomum testitrifolium*, sp. nov.**

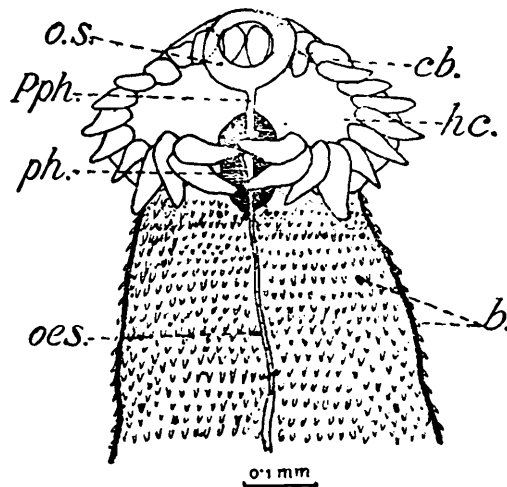
Description.—Body elongated, 3.5-5¹, armed with spines in front of ventral sucker, anterior end narrower than posterior. Maximum width (in region of testes) 0.555-0.952. Head collar strongly developed, with a single row of marginal spines, 27 in number, unbroken dorsally. Ventrally collar spines gathered into two “*end groups*” of 4 spines each.

Outermost spine of each end group 0.108-0.115 × 0.044-0.0479; other marginal spines 0.064-0.101 × 0.03-0.0324. Oral sucker subterminal, 0.115 × 0.128. Prepharynx small, 0.027 long. Pharynx globular, 0.135 × 0.093. Oesophagus approximately 0.464 long. Rami of intestine starting in front of the ventral sucker and running posteriorly nearly to posterior end of body. Ventral sucker very large, 0.547 × 0.539, enclosing a spacious cup-shaped cavity. Genital pore median anterior to ventral sucker, posterior to intestinal bifurcation.

Testes branched, trifoliate, each with two anterolateral and one postero-median branches, lying one behind the other in the median line in the hinder half of the body. Posterior testis larger than anterior.

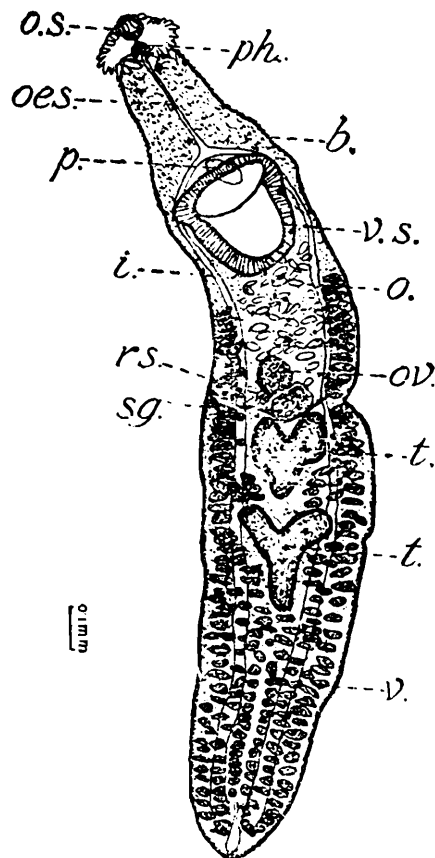
¹ All measurements are given in millimetres.

Cirrus-pouch moderately developed, 0.197×0.0945 , dorsal to ventral sucker and oblique to its axis.



TEXT-FIG. 1.—*Paryphostomum testitriifolium*, sp. nov.—Head region.¹

Ovary globular, 0.17×0.165 , situated slightly to one side of the median line of body, pretesticular, separated from anterior testis by the length of the shell gland complex. Latter prominent, bigger than ovary, 0.19×0.275 in median line of body. Receptaculum-seminis small,



TEXT-FIG. 2.—*Paryphostomum testitriifolium*, sp. nov.—Entire worm.

¹ ABBREVIATIONS USED IN TEXT-FIGURES.

b., body spines; cb., collar spines; hc., head collar; i., intestine; o., ova; oes., oesophagus; os., oral sucker; ov., ovary; p., cirrus-pouch; ph., pharynx; Pph., prepharynx; rs., receptaculum-seminis; sg., shell gland; t., testes; v.s., ventral sucker; v., vitelline glands.

approximately 0.055 diameter posterior to ovary. Vitellaria extending from behind the ventral sucker to the posterior end of body, extra and overcaecal and occasionally intercaecal in the ovarian and testicular regions, distinctly intercaecal in post-testicular region, filling the whole post-testicular part of body with loosely packed follicles. Transverse vitelline ducts running along anterior margin of anterior testis, opening into a small vitelline reservoir. Uterus short not much coiled, pre-testicular and intercaecal. Vagina passing dorsal to ventral sucker. Ova small, numerous, 0.0771×0.0409 .

Host.—*Dendrocygna javanica* (Gmelin 1789).

Location.—Intestine.

Locality.—Rangoon.

The genus *Paryphostomum* Dietz 1909, type-species *P. radiatum* (Dujardin 1845) Dietz 1909 from *Phalacrocorax carbo*, has been characterized by "the presence of a double row of collar spines." Edwards (1927) redescribed this type-species and amongst other minor differences, he found that the collar spines invariably occurred in a single dorsally unbroken row. In view of this observation, corroborated by those given above, either the original diagnosis is inaccurate in this respect or the constancy of the character is dubious; in either case no generic importance can be attached to it and the diagnosis should be altered to "Collar spines in a single or double dorsally unbroken row"

The presence of a double row of collar spines together with differences in the shape and disposition of the testes and cirrus sac, separate the present form from *P. segregatum* Dietz 1909 and *P. indicum* Bhalerao 1931.

It agrees with *P. radiatum* (Dujardin 1845) in the possession of a single row of collar spines, and the number constituting the row, but differs in (1) the ratio of its suckers; (2) the trifoliate nature of its testes; (3) the size and shape of the cirrus sac; and (4) the Anseriform host.

The differences being sufficient for the creation of a new species for which I propose the name *P. testitrifolium* in view of the trifoliate nature of its testes.

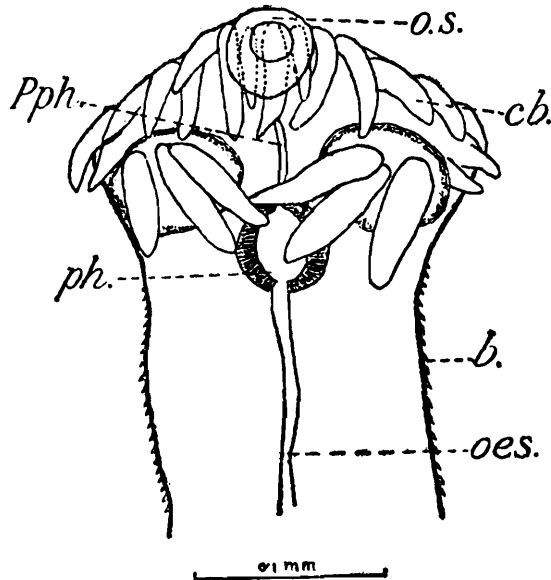
Key for the species of the genus *Paryphostomum* Dietz 1909—

- | | |
|---|-------------------------------------|
| 1. Collar spines in a single row . . . | 2. |
| Collar spines in a double row . . . | 4. |
| 2. Testes 4-5 lobed rosette-shaped . . . | <i>P. radiatum</i> (Dujardin 1845). |
| 3. Testes 3 lobed, two anterolateral and one postero-median lobe . . . | <i>P. testitrifolium</i> , sp. nov. |
| 4. Collar spines 27 in number, cirrus sac not extending behind ventral sucker . . . | <i>P. segregatum</i> Dietz 1909. |
| 5. Collar spines 42 in number, cirrus sac extending behind ventral sucker . . . | <i>P. indicum</i> Bhalerao 1931. |

***Petasiger minutissimus*, sp. nov.**

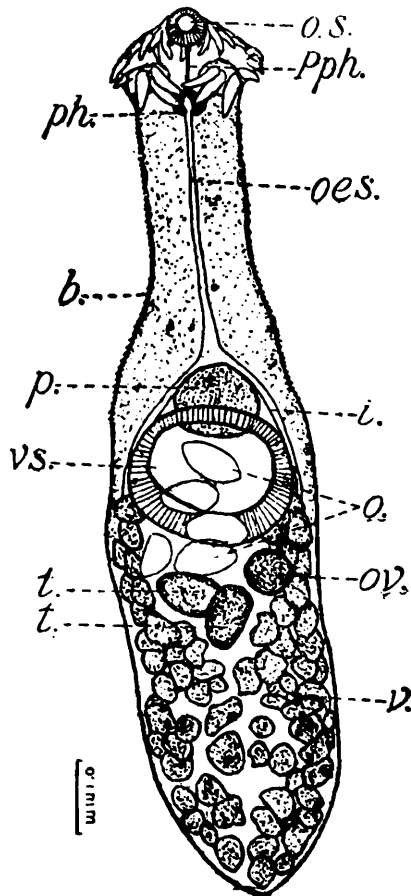
Description.—Body small, elongated, 0.984-1.338, anterior end narrower, with well-developed head collar bearing 23 collar spines, of which 17 spines are arranged in a single dorsally uninterrupted row, each spine $0.0368-0.0613 \times 0.01-0.0171$, the remaining 6 spines being in two ventral "end groups", each containing three spines, $0.0552-0.073 \times$

0.015-0.0225, borne on a very much raised portion of the collar. Maximum width of the body in region immediately behind ventral sucker—0.291-0.349. Body anterior to ventral sucker covered with spines. Oral sucker almost circular, 0.045-0.053. Prepharynx 0.05-0.06 long.



TEXT-FIG. 3.—*Petasiger minutissimus*, sp. nov.—Head region.

Pharynx globular, 0.0495-0.05. Oesophagus thin, 0.3-0.33 long. Intestinal caeca narrow, branching some distance in front of ventral sucker, from the posterior margin of the ventral sucker completely hidden under excessively developed vitelline follicles.



TEXT-FIG. 4.—*Petasiger minutissimus*, sp. nov.—Entire worm.

Ventral sucker prominent, central, broader than long, $0.1771-0.195 \times 0.198-0.226$. Genital pore anterior to ventral sucker, immediately ventral to intestinal bifurcation.

Testes oval, partly overlapping and with long axes almost at right angles to each other. Anterior testis a little behind posterior margin of ventral sucker, transverse to axis of body; posterior with long axis parallel to body. Cirrus-pouch broader than long, 0.113×0.121 , dorsal to ventral sucker, approximately half covered by anterior margin of ventral sucker, the other half lying between it and the intestinal bifurcation.

Ovary ovoid, $0.0633-0.064 \times 0.066$, close to ventral sucker, lateral, partly in zone of anterior testis, in some specimens, in others partly covered by posterior margin of the ventral sucker. Receptaculum seminis and shell gland obscured by the vitelline follicles. Vitelline follicles, in thick lateral bands in ovarian and testicular regions extending from level of posterior margin of ventral sucker to posterior end of body, and filling loosely median field also in post-testicular region leaving only a narrow median space.

Uterus short, pretesticular. Ova few, large, $0.0592-0.093 \times 0.0368-0.048$.

Host.—*Dendrocygna javanica* (Gmelin 1789).

Location.—Intestine.

Locality.—Rangoon.

Of the species of the genus *Petasiger*, Dietz 1909, the Burmese form most closely resembles *P. neocomense* Führmann 1928, with which it has in common the following characters :—

1. Single dorsally uninterrupted row of collar spines, with two *end groups* borne on a much raised portion on the ventral aspect.

2. Shape and the disposition of testes.

3. The position of the ovary.

It differs, however, in the following points :—

1. The total number of collar spines, and the number of spines constituting the *end groups*.

2. The distribution of the vitelline follicles.

3. The overlapping of the testes.

4. The size and shape of the cirrus-pouch.

5. The shape and size of the body and the Anseriform host.

The present form, therefore, constitutes a new species, for which I propose the name *P. minutissimus*, separating it from the other species of the genus by the characters given in the following key :—

- | | |
|---|--------------------------------------|
| 1. Collar spines in double row | 2. |
| Collar spines in single row . | 4. |
| 2. Spines 27 in number. Anterior end narrowed into a neck; cirrus-pouch round . | <i>P. excretus</i> Dietz 1909. |
| 3. Spines 19-21 in number. Anterior end not narrowed into a neck; cirrus-pouch elongated and oblique . | <i>P. pungens</i> (V. Linstow) 1893. |
| 4. Spines 27 in number. Cirrus-pouch elongated and parallel to the axis of the body. Posterior end more narrow. Vitelline follicles sparse and mostly lateral, not reaching posterior end . . . | <i>P. neocomense</i> Führmann 1928. |

5. Spines 19 in number. Anterior end narrowed into a neck and cirrus-pouch elongated and oblique. Posterior end more narrow. Vitelline glands not reaching posterior end, mostly lateral . *P. nitidus* Linton. 1928.
6. Spines 23 in number. Cirrus-pouch round. Posterior end rounded. Vitelline follicles filling median field in post-testicular region, reaching posterior end *P. minutissimus*, sp. nov.

Genus **Ornithobilharzia** Odhner 1912.

Ornithobilharzia sp.

Two immature male specimens were obtained from blood already clotting. Length 9.5, Breadth 0.488. Spines and tubercles present on the body. Oral sucker 0.196 in diameter. Ventral sucker pedunculated, 0.472×0.417 . Intestinal caeca long, running independently for most of their lengths, joining to form a common caecum approximately 0.52 from the posterior end. Testes approximately 70, circular, feebly developed. Cirrus-pouch rudiment posterior to ventral sucker. Gynacophoric canal well developed.

Host.—*Dendrocygna javanica* (Gmelin 1789).

Location.—Vascular system (?).

Locality.—Rangoon.

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A NEW SPECIES OF *XERIS* (HYMENOPTERA-SIRICIDAE) FROM THE HIMALAYAS.

By J. CHESTER BRADLEY, M.S., Ph.D., F.E.S., Cornell University,
Ithaca, New York.

Table of Palaearctic species of *Xeris*.

Vertex above ocelli smooth and polished, with only a few punctures along median line and in a sparse band above each eye; shoulders with a white stripe. Europe *spectrum*.

Vertex above ocelli densely punctate; the smooth polished area reduced to a spot on each side at summit; shoulders with only a white spot *himalayensis*, sp. nov.

***Xeris himalayensis*, sp. nov.**

♀ Head and antennae entirely black, except for small occipital spots. Thorax and abdomen entirely black, except for a yellow spot on cephalic aspect, extending slightly on to dorsal aspect of each shoulder and a pale area at base of sheaths of ovipositor. Wings hyaline, slightly stained yellowish, apical margins weakly clouded, costal cell dark brown. Front coxae black, the others brownish, rest of legs testaceous, the trochanters, knee-joints and hind femora somewhat paler.

Head densely granulate-punctate, smooth areas at summit of vertex; clypeus more coarsely sculptured than in *spectrum*, ridge on temples as in *spectrum*, but a row of punctures in front of it, another behind eyes, these connected below by transversely elongated punctures, all of which are absent in *spectrum*, temples behind ridge much more densely punctate than in *spectrum*. In other respects the structure not noticeably dissimilar from *spectrum*.

♂ Head black except for large occipital spots; thorax black except for lateral pronotal stripe not reaching to base of wings; abdomen reddish black, wings hyaline, with a trace of clouding at margins, and costal cell brown.

Head sculptured as in the female, the area on the temples in front of the ridge with more punctures.

Holotype, Female: Deoban, Chakrata Div., United Provinces, India; altitude 9,000 ft.; 17-18 June 1923, Dr. C. F. C. Beeson (United States National Museum, Catalogue No. 49312).

Allotype, Male: Deoban, June 6, 1923, Dr. S. K. Pillai (United States National Museum, Catalogue No. 49312).

A NEW GENUS OF BLOOD FLUKES OF THE FAMILY SPIRORCHIDAE, FROM THE TORTOISE, *HARDELLA THURGI* (GRAY).

By BIPIN BIHARI SINHA, M.Sc., Research Scholar, University of Lucknow.

The family Spirorchidae was erected by Stunkard (1921) to include the blood flukes from the turtles and originally contained only two genera—*Spirorchis* and *Hapalotrema*—which differ from each other in many features of their anatomy, and were placed in distinct sub-families, Spirorchinae and Hapalotreminae. The same year Stunkard had shown that *Spirorchis* MacCallum, 1918, and *Proparorchis* Ward, 1921, are synonymous thereby invalidating the family Proparorchidae as defined by the latter author. The bulk of the work on the family has been done by Stunkard, who in 1922 described two new genera, *Henotosoma* and *Hapalorhynchus*, one under each of the two sub-families, from North American turtles. The same author (1923), while reviewing the family Spirorchidae, described a new genus, *Haematotrema*, and several new species of the genus *Spirorchis*. Subsequently, he has considerably added to our knowledge of the family and has further described two new genera, *Vasotrema* and *Unicaecum*, from tortoises. Ejsmont (1927) added the genus, *Spirhapalum*, from the blood vessels of *Emys orbicularis* and erected the genus, *Diarmos-torchis* for *Spirorchis blandingi* of MacCallum (1926), owing to the position of the ovary between the testes. Thapar (1933) described a new genus *Tremarhynchus*, from an Indian tortoise, *Trionyx gangeticus* and considered it to be a connecting link between the two known genera of the sub-family Hapalotreminae Stunkard, 1921. Mehra (1933) described two species of a new genus, *Coeuritrema*, from Allahabad and further discussed the relationships of the families of the blood flukes. The present communication deals with an account of another new genus of blood flukes from India, collected from the larger blood vessels of a tortoise *Hardella thurgi* (Gray).

The work was undertaken at the suggestion of Dr. G. S. Thapar, to whom I am deeply indebted for constant guidance and the interest he has taken in my work. He made helpful suggestions in connection with the preparation of the paper for the press and also placed the use of his private library at my disposal.

***Gomtiotrema sanguina*, gen. et sp. nov.**

The parasite is a hermaphroditic distome, elongated and flattened in form (Text-fig. 1). It is widest in the region of the testes, gradually tapering towards the anterior end. The body is thin and transparent, 4.13 mm. in length and .41 mm. in greatest breadth. The body is covered over with a thin cuticle which is devoid of any hooks or spines. This cuticle is inturned at the oral sucker, the genital pore and the excretory pore.

The oral sucker is situated at the extreme anterior end of the body and is protrusible. It is oval in shape, about one-half protruding out at the anterior end. It is slightly larger than the ventral sucker, .125 mm. long by .075 mm. broad. The ventral sucker is circular and also protrusible. It is situated at about one-third the distance from the anterior end of the body, its diameter is .105 mm. The oral sucker

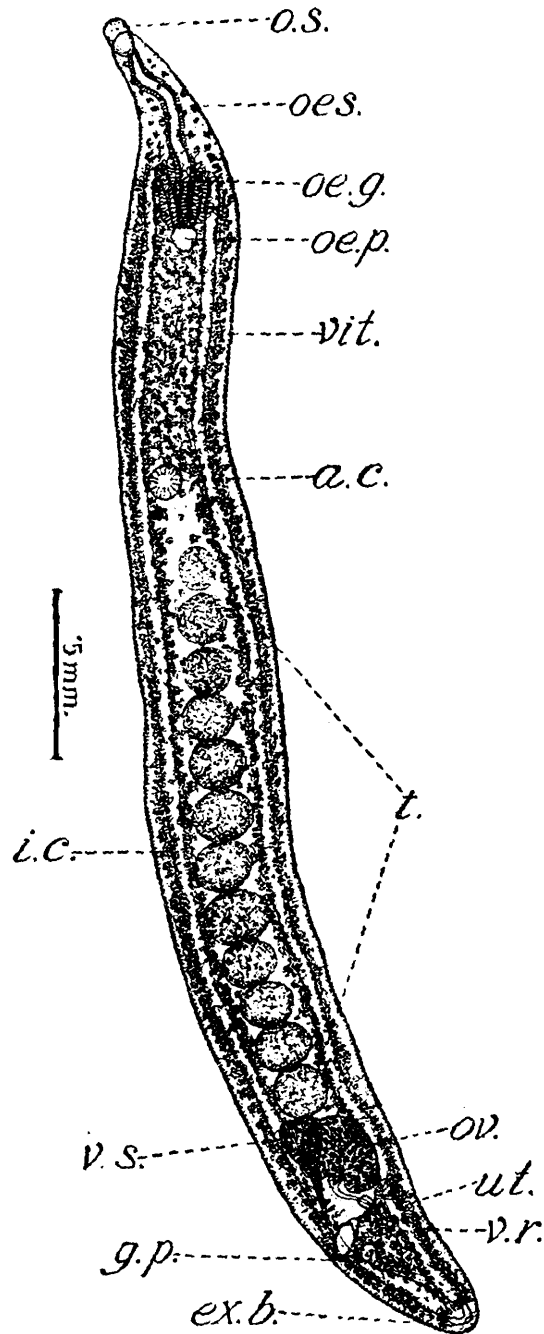


Fig. I.—*Gomtiotrema sanguina*, gen. et sp. nov. Dorsal view.

u. c. = acetabulum; *c. v. d.* = common vitelline duct; *e.* = egg; *ex. b.* = excretory bladder; *g. p.* = genital pore; *i. c.* = intestinal caeca; *l. c.* = Laurer's canal; *o. d.* = oviduct; *oes.* = oesophagus; *oe. g.* = oesophageal gland; *oe. p.* = oesophageal pouch; *oo.* = oötype; *o. s.* = oral sucker; *ov.* = ovary; *r. s.* = receptaculum seminis; *s. g.* = shell glands; *t.* = testes; *ut.* = uterus; *vit.* = vitellaria; *v. r.* = vitelline reservoir; *v. s.* = vesicula seminalis.

leads into a long oesophagus which follows a sinuous course to the point of its bifurcation into the intestinal caeca. It is .53 mm. long and is

surrounded by a layer of gland cells which form a compact glandular mass round the posterior one-fourth or so of the oesophagus. Posteriorly, the oesophagus is produced into a pocket-like structure that hangs freely in the parenchyma. The intestinal caeca arise in front of the median pocket from the oesophagus and run forwards anteriorly for a short distance and curve backwards, thereby forming an anterior loop at the point of their origin. The caeca run backwards almost parallel to the body wall and extend upto the posterior end of the body. Just before their termination posteriorly they bend inwards for a short distance and then run backwards; they are slender tubes of a more or less uniform diameter.

The excretory pore is situated at the posterior end of the body and is slightly dorsal in position. It leads into two elongated collecting ducts. These ducts pass forwards laterally to the ends of the intestinal caeca, where they narrow out to form the longitudinal ducts running dorsal to the caeca on either side of the body.

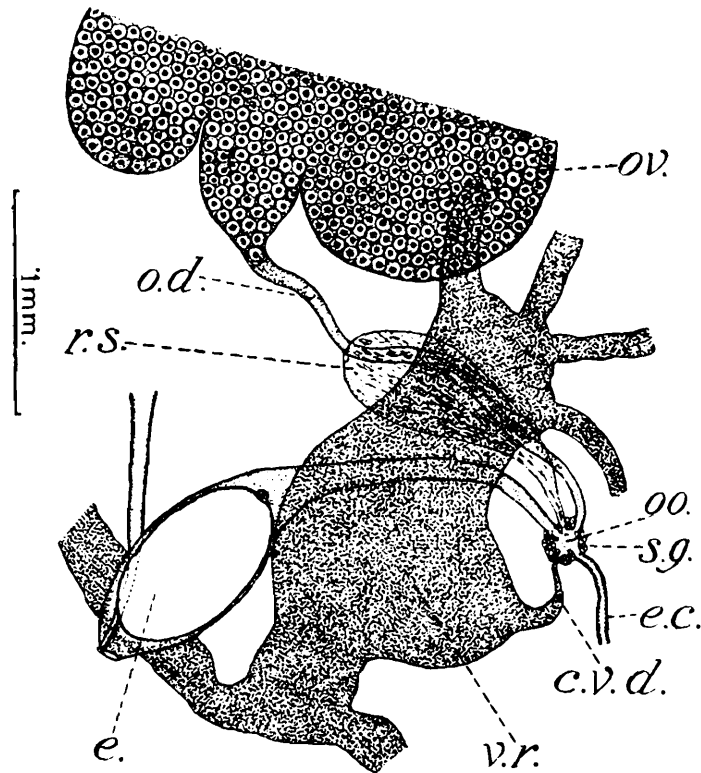


Fig. II.—Female genital organs of *Gomtiotrema sanguina*, gen. et sp. nov. Greatly enlarged. For explanation of lettering see fig. 1.

The female reproductive organs consist of a single dome-shaped ovary, trilobed posteriorly. It is situated .51 mm. in front of the posterior end of the body and is .25 mm. by .22 mm. in size. The oviduct arises from the middle lobe of the ovary at the posterior end and passes on the right side of the body. The oviduct after a short course (Text-fig. 2), receives the common vitelline duct from the vitelline reservoir and thus forms the oötype. The receptaculum seminis and the Laurer's canal also meet it at this point and the latter opens to the outside on the dorsal surface behind the region of the vitelline reservoir. The point of union of all these ducts is further marked by the presence of minute shell gland cells, arranged radially about the oötype.

The vitellaria are voluminous and well developed. They consist of masses of follicles on either side of the intestinal caeca, from the oral sucker to the posterior end of the body, but in front of the acetabulum and behind the vitelline reservoir they fill up all the spaces even between the caeca. Behind the genital pore, the ducts from the vitellaria unite together by transverse ducts to form the vitelline reservoir, from where the common vitelline duct takes its origin and opens at the oötype.

The uterus is short and arises from the oötype. It opens on the lateral side of the body at the genital pore situated outside the left intestinal caecum. A single large egg was found in the uterus, its dimensions are .088 mm. long by .050 mm. broad. It bears a knob-like projection at one end and is provided with a thick shell of a golden brown colour.

The male reproductive system is characteristic of the sub-family Spirorchinae. There are twelve testes, arranged in a linear series in the intercaecal space. The anterior two testes are separated from each other and also from the rest, but the remaining ten testes are joined end to end. They occupy a region 1.74 mm. in length, the anterior testis being at a distance of 1.58 mm. from the anterior end of the body. They are roughly oval to spherical in shape and vary in size. Beginning from the anterior testis, they are .12 mm. $\times$.11 mm., .15 mm. $\times$.15 mm., .14 mm. $\times$.14 mm., .14 mm. $\times$.16 mm., .16 mm. $\times$.166 mm., .15 mm. $\times$.166 mm., .15 mm. $\times$.166 mm., .16 mm. $\times$.19 mm., .125 mm. $\times$.16 mm., .127 mm. $\times$.155 mm., .13 mm. $\times$.16 mm., and .16 mm. $\times$.16 mm. respectively. The vesicula seminalis lies directly behind the posterior testis, touching the latter. It is widest anteriorly, and gradually tapers posteriorly to form a narrow ductus ejaculatorius. The latter opens at the genital pore besides the female opening, on the left side of the body at a distance of .45 mm. from the posterior end.

The new genus, *Gomtiotrema*, resembles *Spirorchis*, *Henotosoma* and *Haematotrema* in the general topography of the organs, but is distinguished by the presence of a ventral sucker, shape and number of the testes and the presence of the intestinal loop at the anterior end. From *Diarmos-torchis* it differs in the presence of the ventral sucker, the anterior intestinal loop and the relative position of the male and female genital organs. In the presence of the ventral sucker, it resembles the genera *Hapalotrema*, *Hapalorhynchus*, *Vasotrema*, *Spirhapalum*, *Tremarhynchus* and *Coeuritrema*, but differs from all these in the presence of twelve, entirely preovarial testes, the intestinal loop and the position of the genital pore. The only other genus of the family Spirorchidae is *Unicaecum* and from this, the new genus differs in the presence of both caeca, the presence of the ventral sucker, the position of the genital pore, the shape of the ovary and the anterior intestinal loop.

The diagnosis of the genus *Gomtiotrema* may be summarised thus :—

Hermaphroditic, blood-inhabiting distomes, with protrusible suckers ; no cuticular spines ; relatively large oesophagus ; a loop in the intestinal caeca at their origin from the oesophagus. Testes twelve, oval to spherical, preovarial, arranged in linear series, intercaecal ; vesicula seminalis continued into a narrow ejaculatory duct ; genital pore lateral and posterior. Ovary dome-shaped, trilobed posteriorly, anterior to the

genital pore ; vitellaria extensive ; receptaculum seminis and Laurer's canal present. Uterus short, with a single large egg, which is knobbed.

Host.—*Hardella thurgi* (Gray).

Locality.—Lucknow, River Gomti.

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REPORT ON A COLLECTION OF CESTODES FROM LUCKNOW (U. P., INDIA).

By L. N. JOHRI, *Department of Biology, University of Rangoon.*

INTRODUCTION.

The material described in this paper was mainly collected during the years 1928-1930 from Lucknow, either from neighbouring villages or from the local markets and from the Lucknow Zoological Garden. Attention was concentrated upon avian fauna though from time to time other hosts were also dissected. The investigation was mainly devoted to pigeons, and altogether some 200 birds from neighbouring localities were dissected. The present work on Cestodes was originally started under the guidance of Dr. G. S. Thapar, but owing to the lack of literature in Lucknow, permission was granted by Prof. K. N. Bahl to carry out the identifications at the University of Rangoon under the supervision of Prof. F. J. Meggitt, to whom I have great pleasure in expressing my indebtedness for the help afforded me, for the use of his extensive library and the loan of specimens from his collection. My sincere thanks are also due to Dr. G. S. Thapar for his help at Lucknow.

INFECTION OF HOSTS.

A large number of the hosts dissected were pigeons. It was observed that infection was usually heavier in birds from slums and fed on a poor quantity of corn: wild forms from rural localities with but little chance of obtaining infected corn were either free from infection or not infected to the marked extent characteristic of those from the town. This indicates that the intermediate host is a weevil or some small arthropod present in corn. It is worth mention that in some cases the presence of large number of nematodes apparently prevents infection with cestodes. The degree of infection had marked effect upon the general health and vigour of the host, heavy infection resulting in extreme emaciation and weakness.¹ A careful examination of 20-30 pigeons kept in a cage showed that those heavily infected were listless and moped so much that no attempt was made to escape on the opening of the cage every morning and evening. One pigeon in particular would neither move nor mix freely with others; it was always found more or less at the same spot in the cage. A few gravid proglottides of *Raillietina* were found in the faeces. It died after a few days. Its intestine was so full of cestodes that the lumen was entirely obstructed. Even after their removal, deep furrow like streaks could be seen in the inner walls of the gut. Two tapeworms and a few incomplete strobilae were found free in the rectum.

¹ In this connection reference may be made to somewhat similar observations made by Mr. G. Sondhi (*Proc. 14th Ind. Sci. Cong.*, pp. 193, 194, 1927).

No helminths were obtained from *Tyto alba javanica*, *Megalornis* sp. and only one small cestode, *R. polychalix* Kotlan, 1920, from *Psittacula krameri manillensis*.

Order CYCLOPHYLLIDEA Carus.

Family ANOPLOCEPHALIDAE Cholodkovsky 1902.

Subfamily ANOPLOCEPHALINAE Führmann 1907.

Anoplocephala Blanchard 1848.

Anoplocephala magna (Abildgaard 1789).

Host :—*Equus zebra* Linn. 1758.

Locality.—Zoological Garden, Lucknow.

The table on p. 155 gives the differences between the present form and those described by Baer (1927, pp. 26, 27).

Killigrewia Meggitt 1927.

Killigrewia frivola Meggitt 1927.

Host :—*Columba livia intermedia*.

Length 198, breadth 5.5. Scolex 0.104 long and 0.28 in maximum diameter. Genital cloaca absent. Maximum length of cirrus sac 0.315. Vesicula seminalis 0.128×0.082 , present. Testes 113—154, usually 45-56, rarely, 82-89, poral; and usually 63-89, rarely 31, aporal. Otherwise agreeing with the description of Meggitt (1927, p. 316).

Killigrewia Meggitt 1927 has been regarded (Führmann 1932, p. 58) as a synonym of *Aporina* Führmann 1902. The two genera differ in the disposition of the testes, these organs being in two distinct lateral groups separated by the female glands in *Killigrewia* and in a continuous band across the proglottis in *Aporina*. The validity of these organs as a generic character is recognised in the Dilepidinae, Führmann 1907, and according to the diagnoses given by Führmann (1932, pp. 85-116) *Parorchites* Führmann 1932 (or *Anomotaenia* Cohn 1899) and *Parvirostrum* Führmann 1907, *Dilepis* Weinland 1834 and *Proorchida* Führmann 1907, and *Kowalewskiella* Baczynska 1914 and *Paricterotaenia* Führmann 1932 are separated only by this character. There appears, therefore, no reason for considering *Killigrewia* as a synonym of *Aporina*.

Moniezia Blanchard 1891.

Moniezia expansa (Rudolphi 1810).

Host :—Goat and Sheep.

Moniezia trigonophora Stiles and Hassal 1893.

Host :—Sheep.

Genital cloaca present 0.14 long and 0.135 in maximum breadth, otherwise agreeing with the description of Baer (1927, pp. 72-73).

CHART 1.

			Length.	Breadth.	Diameter of scolex.	Diameter of sucker.	Genital cloaca.	Cirrus sac (size).	Cirrus	Testes.	Receptaculum seminis.
<i>A. magna</i> (Abildgaard 1789)	.	.	350 ¹	25	3	1.2	Absen	1.4 × 0.01	Spiny	400—500	?
<i>A. magna</i> (present form)	.	.	157	11	6	2.6	Present	0.82-1.71 × 0.24	Without spines.	330—460	Very large

¹ All measurements in mm.

Subfamily THYSANOMINAE Fühmann, 1907.

Stilesia Railliet 1893.

Stilesia globipunctata (Rivolta 1874) Railliet 1893.

Host :—Sheep.

Maximum length 93 and maximum breadth 1.05. Testes 3-6 on each side. Cirrus sac $0.072-0.074 \times 0.027-0.041$.

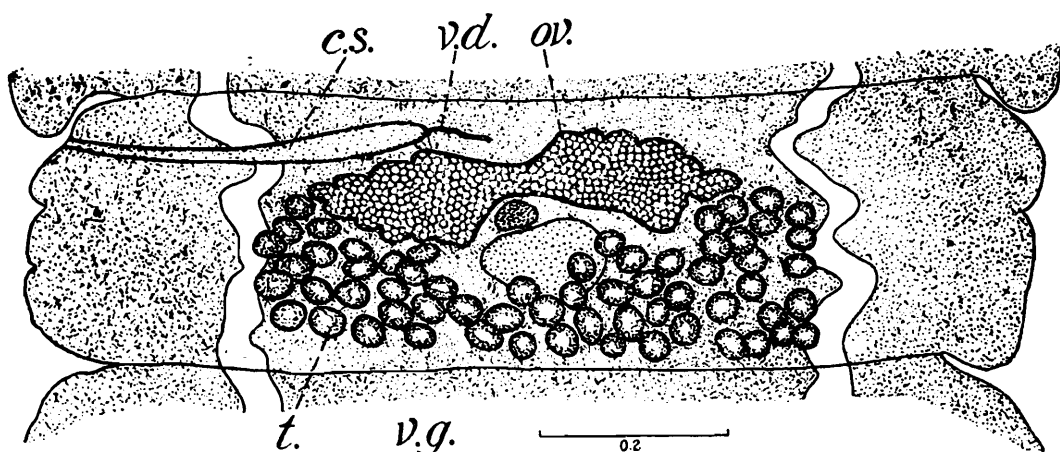
Subfamily LINSTOWIINAE Fühmann 1907.

Oochoristica Lühe 1898.

Oochoristica thapari, sp. nov.

Host :—*Calotes* sp.

Maximum length 21 and the maximum breadth 2. All segments broader than long. Scolex 0.305 diameter. Genital pore in anterior third of the proglottis margin, often approaching extreme anterior. Genital ducts passing in between longitudinal excretory vessels. Testes 48-62 (max. diameter of testis 0.033—0.04), closely surrounding ovary and vitelline gland posteriorly and laterally and limited between the longitudinal excretory vessels, though a portion of a few of the testes lies dorsally to the excretory vessels. Cirrus sac 0.36—0.49 extending well past longitudinal excretory vessels.



TEXT-FIG. 1.—*Oochoristica thapari*, sp. nov. Mature proglottis.

The number of testes and the relative and absolute size of the cirrus sac separate the present form from all others of this genus except *O. surinamensis* Cohn 1902, which closely approaches the present form in the size of cirrus sac. The new species in addition to the larger number of the testes is further characterised by the dorsal position of the genital ducts in relation to the longitudinal excretory vessels.

Family DAVAINIIDAE Fühmann 1907.

Subfamily DAVAINIINAE Braun 1900.

Cotugnia Diamare 1893.

Eighteen species of this genus have been recorded and are easily distinguishable except for *C. brotogerys* Meggitt 1915 and *C. digonopora*

(Pasquale 1890), *C. parva* Baer 1925 and *C. seni* Meggitt 1926. The first two only differ in the systematic position of the host and are otherwise similar; *C. brotogerys*, therefore, becomes a synonym of *C. digonopora*. *C. seni* differs from *C. parva* in the possession of a large receptaculum seminis, in the slightly smaller size of the rostellar hooks and the larger, absolute and relative, size of the cirrus sac, but with the present state of our knowledge of these forms it is not possible to be certain about their specific distinction.

***Cotugnia bahli*, sp. nov.**

Host :—*Turtur suratensis* Linn. 1788.

Maximum length 55 and greatest breadth 3.3 (gravid segment) and 2.4 (mature segment). Scolex 0.5 diameter. Rostellum 0.34 diameter. Rostellar hooks approximately 332, 0.0125–0.0135 and 0.0175 long. Genital pore in anterior half of the proglottis margin. Cirrus sac 0.215–0.223 long, extending to the longitudinal excretory vessels. Testes 69–74, in two groups, arranged as in *C. govinda* (described below) except that they extend lateral to excretory vessels.

Of the species of *Cotugnia* with the testes in two groups, *C. collini* Führmann 1909 is separated by its larger rostellar hooks, greater number of testes and larger cirrus sac; *C. inaequalis* Führmann 1909 by the smaller number of testes and a smaller cirrus sac, *C. polycantha* Führmann 1909 by the smaller rostellar hooks and greater number of testes, *C. noctua* (described below) by the much larger number of testes, *C. fleari* Meggitt 1927 by the smaller number of testes and a longer cirrus sac, and *C. govinda* by the extension of the testes within the excretory vessels.

***Cotugnia cuneata* var. *nervosa* Meggitt 1924.**

Host :—*Columba intermedia*.

This variety differs from var. *tenuis* in being much larger, the proglottis much broader, and in the development of strong musculature. Otherwise it agrees with the original description of the variety.

***Cotugnia cuneata* var. *tenuis* Meggitt 1924.**

Host :—*Columba intermedia*.

Rostellar hooks 416, 0.011–0.013 and 0.0155–0.018 long. Testes 65–75 in a continuous band. Other details comparable with the original description.

***Cotugnia digonopora* (Pasquale 1890).**

Host :—*Columba intermedia*.

Cirrus sac 0.32. Testes 128–158. Otherwise agreeing with Meggitt's description. Recorded from the Columbiformes for the first time.

***Cotugnia fila* Meggitt 1931.**

Host :—Duck.

Cotugnia fleari Meggitt 1927.

Host :—*Columba intermedia*.

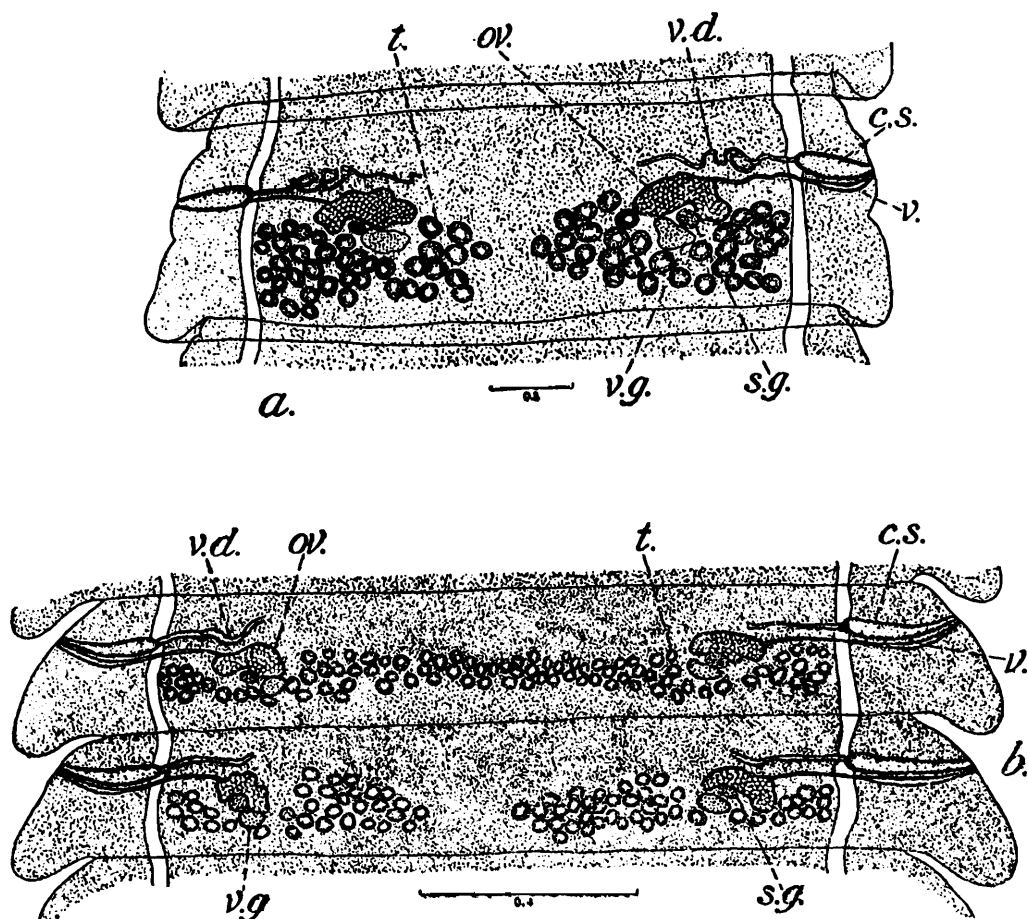
Length 53, breadth 1.5. Rostellar hooks approximately 308, 0.015 and 0.018 long. Cirrus sac 0.26 long extending to the longitudinal excretory vessel. Testes 46-57, in two clearly separated groups. These groups are not marked into poral and aporal groups. Receptaculum seminis present.

Cotugnia govinda, sp. nov.

Host :—*Milvus govinda*.

Locality :—Malhiabad, District Lucknow.

Maximum length 53.5 and greatest breadth 2. Scolex 0.565 diameter. Rostellum 0.25 diameter. Rostellar hooks 0.016 and 0.014 long, in two rows. Genital pore usually in anterior third of proglottis margin. In two proglottides female reproductive organs single, similar to those of *Raillietina* form. Cirrus sac 0.148-0.26 long, extending to or nearing to ventral longitudinal excretory vessel. Vas deferens partly straight and partly in convolutions. Testes in two clearly separated groups within



TEXT-FIG. 2.—a. *Cotugnia govinda*, sp. nov. Mature proglottis.

b. *Cotugnia intermedia*, sp. nov. Mature proglottis.

longitudinal excretory vessels: each group consists of 25-54, and again is subdivided into two, each postero-lateral to ovary; the two being joined by a chain of a few testes. Median medullary parenchyma free from testes. Gravid segments absent.

From *C. polycantha* Fühmann 1909, *C. inaequalis* Fühmann 1909. and *C. noctua* (described below) the present form is distinguished by the testes not extending lateral to excretory vessel. This is the first record of this genus from the Accipitriformes.

***Cotugnia inaequalis* Fühmann 1909.**

Host :—*Columba livia domestica*.

Cirrus sac 0.1-0.112, not reaching the ventral longitudinal excretory vessel. Testes approximately 57. Otherwise agreeing with the original details. First record from the Columbiformes.

***Cotugnia intermedia*, sp. nov.**

Host :—*Columba intermedia*.

Maximum length 48. Greatest breadth 3.2. Scolex 0.44-0.525 diameter. Rostellum armed with double circle of hooks, 0.012-0.017 long, arranged alternately. Genital pore in anterior half of proglottis margin. Cirrus sac 0.18-0.268 long, just reaching or just passing ventral longitudinal excretory vessel. Vas deferens partly straight and partly in coils. Testes 63-90, in some segments appearing in two distinct groups, while in others as a single broad band stretching from side to side of the proglottis; in either case mostly within longitudinal excretory vessel, rarely one or two outside. The anterior border of proglottis free from testes.

The size of the rostellar hooks and cirrus sac, together with the number of the testes, clearly separates the present species from others of the same genus except *C. fastigata* Meggitt 1920 which is distinguished by the larger number of testes and a larger cirrus sac, *C. inaequalis* Fühmann 1909 by its smaller cirrus sac; *C. polycantha* Fühmann 1909 by the smaller rostellar hooks, smaller cirrus sac and the larger number of the testes, and *C. fila* Meggitt 1931 by fewer testes. In addition, from all forms it is distinguished by the possession of testes in two groups or in a single continuous band in the same strobilous. This is the sole major character separating it from *C. cuneata* Meggitt 1924; and if it be of no specific value, the two species will have to be regarded as identical.

***Cotugnia januaria*, sp. nov.**

Host :—*Gallus domesticus*.

Length 3-11. Breadth 0.28-0.8. Scolex 0.55-0.85 diameter. Rostellum 0.28 in diameter, armed with a double circle of approximately 403 hooks, 0.006-0.007 and 0.005-0.006 long respectively. Genital pore at anterior extreme margin of proglottis. Cirrus sac 0.11-0.14 long extending to and often crossing longitudinal excretory vessel; vas deferens, a short uncoiled wide tube. Testes 18-35, a single broad band across proglottis posterior to ovary and extending a little beyond the longitudinal excretory vessel: anterior and most of posterior area of proglottis entirely free from testes. The gravid segments absent. Last few segments much smaller than preceding ones.

The present form is easily distinguished from the species of the same genus with the testes arranged in two distinct groups. *C. margereta*

Baer 1925, *C. seni* Meggitt 1926 and *C. fila* Meggitt 1931, by the larger rostellar hooks, large number of testes and larger cirrus sac.

***Cotugnia noctua*, sp. nov.**

Host :—*Columba intermedia*.

Length 51, maximum breadth 2. Scolex 0.51 diameter. Rostellum 0.225 diameter with double row of hooks, 0.012 and 0.018 long. Musculature with two layers of longitudinal muscles, the inner one the weaker and consisting of smaller and scattered muscular fibres. Transverse muscles not seen.

Genital pore in anterior half of proglottis margin. Genital cloaca poorly developed. Cirrus sac 0.176-0.2 long extending to ventral longitudinal excretory vessel. Coils of vas deferens few and small. Testes approximately 170-182, in two distinct groups, congregated round ovary on all sides and extending beyond ventral longitudinal excretory vessel. Gravid segments absent.

The possession of two distinct groups of testes in the present form distinguishes it from all the species of this genus with a single band of testes. *C. collini* Führmann 1909 is distinguished by the size of its rostellar hooks and cirrus sac. The smaller number of testes together with minor differences separates the remaining forms.

***Cotugnia parva* Baer 1925.**

Hosts :—*Corvus macrorhynchus* and *Columba intermedia*.

Rostellar hooks 378-396, 0.015-0.016 and 0.018-0.02 long. Cirrus sac 0.101-0.106 long and 0.04 maximum diameter. Testes approximately 32-41.

***Cotugnia polycantha* Führmann 1909.**

Host :—Pigeon.

Genital pore in anterior one-third of proglottis margin. Cirrus sac 0.168 to the ventral longitudinal excretory vessels. Testes, in two distinct groups, approximately 88.

***Raillietina* Führmann 1920.**

***Raillietina* (*Fuhrmanetta*) *echinobothridia* (Méglin 1880).**

Host :—Jungle-fowl.

Rostellar hooks approximately 239, 0.011 and 0.017 long. Testes 30-32. Egg-capsules approximately 80.

***Raillietina* (*Paroniella*) *reynoldsae* (Meggitt 1926).**

Host :—*Corvus splendens*.

Numerous small forms 0.9-2.0 long and 0.19-0.515 broad. Scolex 0.22 diameter rostellar hooks 144-167.

Raillietina (Paroniella) rangoonica (Subramanian 1928).

Host :—*Milvus govinda*.

Maximum length 98, maximum breadth 1.52. Scolex 0.27 diameter. Rostellar hooks 291. Acetabular hooks absent. Cirrus sac 0.11-0.16. Vas deferens greatly convoluted. Testes 23-37, of which 5-8 poral and the rest aporal; no testis either anterior or posterior to ovary. Ovary with small processes marked anteriorly, extends from centre of the proglottis to its anterior border, sometimes touching it. Egg-capsules lateral to longitudinal excretory vessels but leaving clear margins at the sides.

Raillietina (Raillietina) flabralis Meggitt 1927.

Host :—*Dichoceros bicornis bicornis*.

Raillietina (Raillietina) fuhrmanni (Southwell 1922).

Host :—*Crocopus chlorogaster*.

Length 18-50, breadth 0.46-1.05. Scolex 0.23 maximum diameter. Rostellum 0.14 diameter, hooks in two rows, each 0.023-0.029 and 0.024-0.033. Cirrus sac 0.114-0.172 long. Testes 8-15. Egg capsules approximately 30-60 per segment, each containing 4-9 eggs extending external to excretory vessel.

Raillietina (Raillietina) galeritae Skrjabin 1914.

Host :—A small black bird (unidentified).

Maximum length 67, greatest breadth 0.55. Scolex 0.236 diameter. Rostellar hooks 254, 0.014 and 0.0175 long. Suckers nearly spherical, 0.116 maximum diameter. Acetabular hooks 7-8 rows. Cirrus sac 0.11-0.142 × 0.045. Egg capsules more irregularly packed than described by Skrjabin and not extending external to excretory vessel.

Raillietina (Raillietina) macrocirrosa Führmann 1909.

Host :—*Francolinus* sp.

Maximum length 89-125, breadth 0.655-0.7. Scolex 0.32 diameter. Rostellum 0.165 diameter. Rostellar hooks 320, 0.014 and 0.017 long. Genital pore in anterior half of proglottis margin. Cirrus sac 0.06-0.087 long. Cirrus simple and unarmed. (Führmann's form possesses a muscular cirrus, also thick and very much coiled). Testes 28-30, lateral and posterior to ovary. Egg capsules imperfectly developed. First record from the Galliformes.

Raillietina (Raillietina) michaelsoni Baer 1925.

Host :—Pigeon.

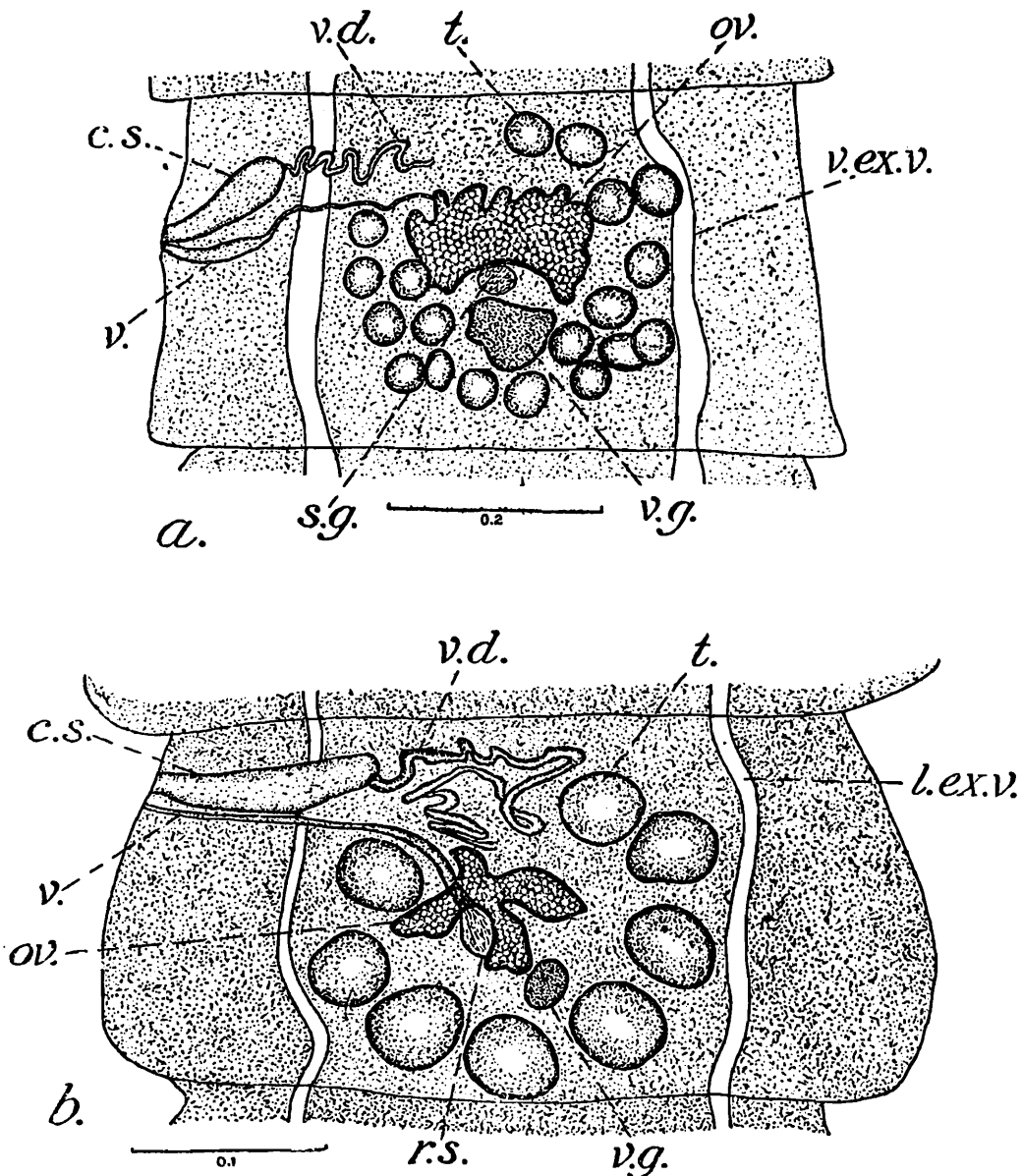
Maximum length 223, breadth 0.27. Scolex 0.26 diameter. Rostellar hooks 240-320, 0.014 and 0.0165 long. Testes 20-22, often 2-3 slightly

anterior to ovary on aporal side. Gravid segments absent. First record from the Columbiformes

***Raillietina (Raillietina) penetrans nova*, subsp. nov.**

Host :—Indian Mynah.

Maximum length 248, maximum breadth 0.67. Scolex 0.25 diameter. Rostellar hooks 154-184, 0.014 and 0.019 long. Acetabular hooks 4-5 rows. Musculature with two longitudinal muscular layers. Genital pore in anterior half of the proglottis margin. Genital cloaca very



TEXT-FIG. 5.—*a. Raillietina (Raillietina) penetrans nova*, subsp. nov. Mature proglottis.
b. Raillietina (Skrjabina) kakia, sp. inq. Mature proglottis.

shallow. Cirrus sac 0.125-0.134 long, not or nearly touching ventral longitudinal excretory vessel. Cirrus unarmed. Testes 16-19 lateral and posterior to ovary, with a few anterior aporally. Egg-capsules 35-58 extending beyond the ventral longitudinal excretory vessel, each containing 5-7 eggs.

The following chart gives the differences between the present form and *R. (Raillietina) penetrans* Baczynska 1914 :—

CHART 2.

	Host.	Length.	Breadth.	Acetabular hooks.	Proglottides.	Muscles.	Genital cloaca.	Cirrus sac.	Testes (arrange- ment).	Diameter of onchosphere.
<i>R. (Raillietina) pene- trans</i> Baczynska, 1914.	Galliformes .	30-40	1.5	14-15 rows	All broader than longer.	4 longi- tudinal layers.	Muscular canal.	With specially developed muscles.	Two lateral groups.	0.0104
<i>R. (Raillietina) pene- trans nova</i> , subsp. nov.	Passeriformes .	248	0.67 (mature segment). 0.62 (gravid segment).	4-5 rows	Gravid ones longer than broad.	2 longi- tudinal layers.	No muscular canal.	Without specially developed muscles.	Nearly surrounding the ovary.	0.047— 0.055

The differences as tabulated in the above chart distinguish the present form from *R. (Raillietina) penetrans* Baczynska 1914 but are not sufficient to justify the creation of a new species : it is, therefore, listed as a subspecies.

***Raillietina (Raillietina) polychalix* Kotlan 1920.**

Hosts :—*Columba livia domestica*, and *Psittacula krameri manillensis*.

Maximum length 273, maximum breadth 0.75. Scolex 0.26 diameter. Rostellar hooks 324, 0.011 and 0.014 long. Suckers armed with 6-7 rows of hooks ; the outermost with 0.006-0.007 long hooks, the size of hooks gradually diminishing towards the interior. Genital pore unilateral, in posterior half of the proglottis margin. Cirrus sac 0.125-0.13 long not reaching longitudinal excretory vessel. Vas deferens with numerous coils and surrounded by a large number of prostate cells. Testes 8-9. 30-40 egg-capsules extending laterally to longitudinal excretory vessels, each containing 6 eggs. The above description is of the forms from the Columbiformes : those from the Pisttacíformes differ in the following respects :—

Scolex 0.103 diameter. Rostellar hooks approximately 190, 0.0135 and 0.019 long. Testes 9-11. Cirrus sac 0.061 long. Egg-capsules 48.

These differences are not sufficient to justify the separation of the two forms

***Raillietina (Raillietina) tunetensis* Joyeux and Houdemer 1927.**

Host :—*Columba livia domesticata*.

Cirrus sac 0.085 long and not extending to ventral longitudinal excretory vessel. Egg-capsules extending lateral to longitudinal excretory vessel.

***Raillietina (Raillietina) volzi* Führmann 1905.**

Host :—*Columba livia domestica*.

Maximum length 313, maximum breadth 0.95. Scolex 0.235 maximum diameter. Rostellar hooks 182, 0.0135 and 0.016-0.0175 long. Suckers with 5-7 rows of hooks. Cirrus sac 0.133-0.17. Testes 30-32. 70-87 egg-capsules per segment, each egg-capsule contains 6-7 (usually 7) eggs. Otherwise agreeing with the original description. First record from the Columbiformes.

***Raillietina (Skrjabina) kakia*, sp. inq.**

Host :—*Corvus splendens*.

A single specimen without scolex. Length 5, maximum breadth 0.45. Genital pore in anterior quarter of the proglottis margin. Genital cloaca absent. Cirrus sac 0.085-0.123, extending beyond ventral longitudinal excretory vessel. Receptaculum seminis slightly developed. Testes 6-10, surrounding ovary laterally, posteriorly with a few anteriorly. Ovary trilobed : sometimes these lobes give out small processes and occupy nearly centre of proglottis. Egg-capsules numerous in each segment, not extending beyond longitudinal excretory vessels.

The smaller number of testes of the present species separates it from all other forms of this sub-genus except *S. magnicoronata* (Führmann 1908), *S. maroteli* (Neveu-Lemaire 1912), *S. oligacantha* (Führmann 1908) and *S. retusa* (Clerc 1903). From these the first is separated by the relative and the absolute lengths of the cirrus, together with the position of testes at the posterior end of the segment. *S. oligacantha* and *S. retusa* are not sufficiently described to distinguish them from the present form, while details of *S. maroteli* are not available in Rangoon. The present form is, therefore, listed as a sp. inq.

Raillietina sp.

Host :—*Gyps indicus*.

Length 47, greatest breadth 0.2. Rostellar hooks approximately 300-357, 0.012 and 0.015-0.016 long. Acetabular hooks in 4-5 rows. Genital pore unilateral. Genital organs poorly developed and in an immature condition.

Family DILEPIDIDAE Führmann 1907.

Subfamily DIPYLIDIINAE Stiles 1896.

Dipylidium Leuckart 1863.

Dipylidium caninum (Linnaeus 1758).

Host :—Cats and dogs.

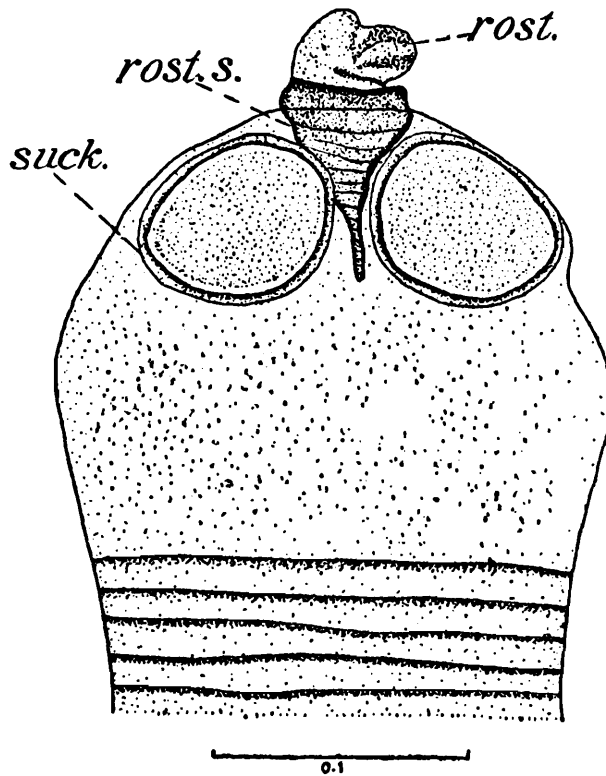
Eugonodaeum Beddard 1913.

Eugonodaeum ganjeum sp. nov.

Host :—*Acridotheres tristis*.

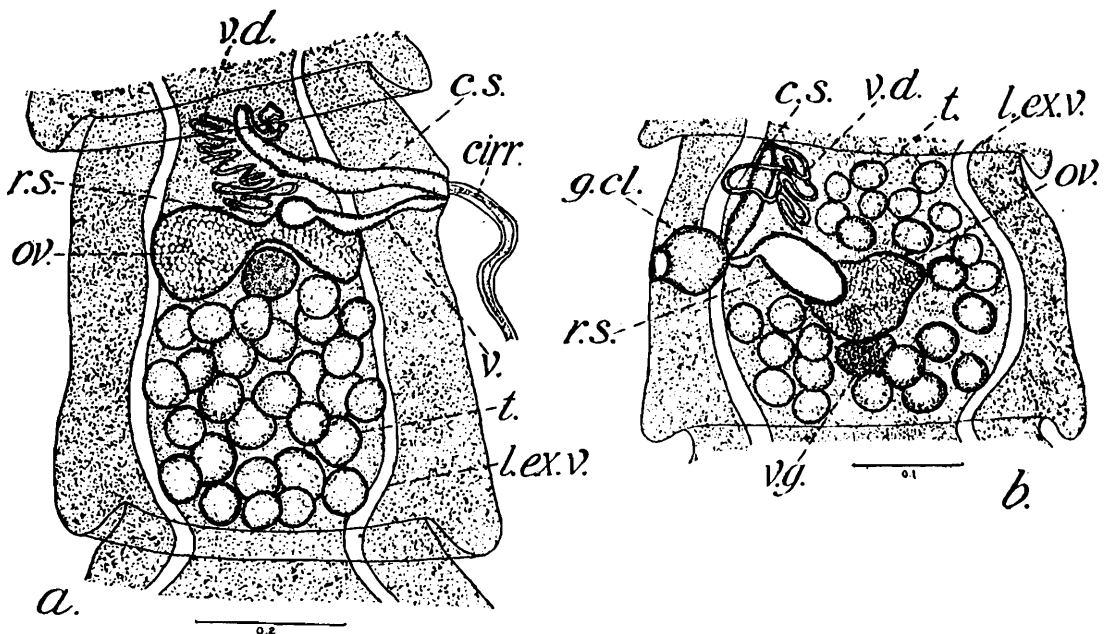
Length 31-35, maximum breadth 0.6 (mature segment) and 0.75 (gravid segment). Scolex globular slightly elongated, 0.178-0.185 in length and 0.225 maximum diameter. Rostellum ordinarily very small but seen protruding in the living specimen (it never extends so far as the length of the scolex). Rostellar hooks absent. A small rostellar pouch present, 0.78 long, not extending below the lower margin of the suckers. Suckers comparatively small, 0.083 maximum diameter, unarmed, situated at the anterior border of scolex. Genital pore irregularly alternates, in anterior fourth of the proglottis margin. Genital cloaca absent. Genital ducts pass between excretory vessels. Cirrus sac 0.315-0.366 × 0.027-0.042, crossing ventral longitudinal excretory vessel, obliquely directed towards anterior border of proglottis. Cirrus greatly elongated and protruded out of the proglottis (cirrus shown in diagram not complete, a part of it being damaged). Vas deferens greatly coiled. Testes 27-40, posterior to ovary, and do not extend beyond ventral longitudinal excretory vessel, though a portion of some actually lies dorsally to the excretory vessel. Ovary in immature segments compact, in mature ones distinctly bilobed and extends from one longitudinal excretory vessel to the other. Uterus persistent, whole mounts and

transverse sections through gravid proglottis show that the egg-capsules are formed inside the uterus, which later expands to allow the egg-capsules



TEXT-FIG. 6.—*Eugonodaeum ganjeum*, sp. nov. Scolex.

to become thickly crowded and extend beyond the ventral longitudinal excretory vessels.



TEXT-FIG. 7.—a. *Eugonodaeum ganjeum*, sp. nov. Mature proglottis.

b. *Eugonodaeum testifrontosa*, sp. nov. Mature proglottis.

The present form may be included in either of the genera *Eugonodaeum* Beddard 1913 or *Uncinaria* Skrjabin 1914. Originally these were separated by the possession of the unilateral genital pores in the former and of alternating genital pores and chitinous cirral hairs and spines of the latter. So far, including the new forms in the present paper, six species have been recorded.

CHART 3.

No.	Species.	Host.	Distribution.	Scolex.		Cirral hairs.	Genital pores.	Genital cloaca.	Genital ducts.	Cirrus sac (size).	Testes.
				Rostellum.	Rost. hooks.						
1	<i>Eugonodaeum oedcnemi</i> Beddard 1913.	Charadriiformes	New World	Present	Absent	Absent	Unilateral	Present	Between	Large	few
2	<i>Unciunia trichocirrosa</i> Skrjabin 1914.	Accipitriformes	Paraguay	Present	Absent	Present	Alternate	Present	?	0.11	30—35
3	<i>U. sudanea</i> Woodland 1928.	Galliformes	Sudan	Absent	Absent	Absent	Alternate	Present	Between	0.34—0.41	30—35
4	<i>U. acapillicirrosa</i> Moghe 1933.	Anseriformes	Nagpur, India.	Present	Absent	Absent	Alternate	Present	Between	0.19×0.057	60
5	<i>Eugonodaeum ganjeum</i> , sp. nov.	Passeriformes	Lucknow, India.	Present	Absent	Absent	Alternate	Absent	Between	0.315—0.366	27—40
6	<i>E. testifrontosa</i> , sp. nov.	Charadriiformes	Lucknow, India.	?	?	Absent	Alternate	Present	Between	0.085—0.14	25—30

From the above table it will be seen that the cirral hairs have only once been found, *i.e.*, by the original investigator, and are absent in the other five forms. Apart from this, the only character separating the genera is the position of the genital pores, a character by itself not usually regarded as of generic rank (*e.g.*, *Raillietina*). Until the presence of cirral hairs is substantiated or until the hitherto undescribed female organs show any difference it is advisable to regard the genus *Unciunia* as a synonym of *Eugonodaeum*.

In the above table the differences between the present form and the previously described species are also tabulated.

***Eugonodaeum testifrontosa*, sp. nov.**

Host :—*Gallinago coelestis*.

Greatest length 8, greatest breadth 0.4. Scolex absent. Genital pore irregularly alternating, slightly anterior to centre of the proglottis margin. Genital cloaca 0.07 deep $\times$ 0.064 maximum breadth, crossing ventral longitudinal excretory vessel. Cirrus sac 0.085-0.14 $\times$ 0.023, running more or less parallel with longitudinal excretory vessels, and nearly touching anterior border of the proglottis. Vas deferens greatly coiled. Testes 25-30, almost filling the proglottis excepting the anterior poral area mainly occupied by cirrus sac, vas deferens, and receptaculum seminis. Ovary in centre of proglottis, compact. Vagina comparatively short opening into genital cloaca just posterior to cirrus sac. Receptaculum seminis large. Uterus persistent, greatly comparable to the previous form excepting that the capsules are limited between the ventral longitudinal excretory vessels. Maximum diameter of egg 0.027.

Unilateral genital pores together with the large size of the cirrus sac and the few testes are enough to distinguish the new species from *Eugonodaeum oedicorni* Beddard 1913. The previous species *E. ganjeum* and *U. sudanea* Woodland 1928 differ in the larger size of the cirrus sac and the disposition of the genital organs : cirrus sac in the present case is nearly parallel with the longitudinal excretory vessels, and the testes are anterior to the ovary. The typical disposition of the cirrus sac, together with its small size and the absence of the hair cluster with the chitinous spine at its base, clearly distinguish the present form from *U. trichocirrosa* Skrjabin 1914. It is also separated from *U. acapillicirrosa* Moghe 1933 by the disposition of the testes and the cirrus sac together with the smaller number of the former.

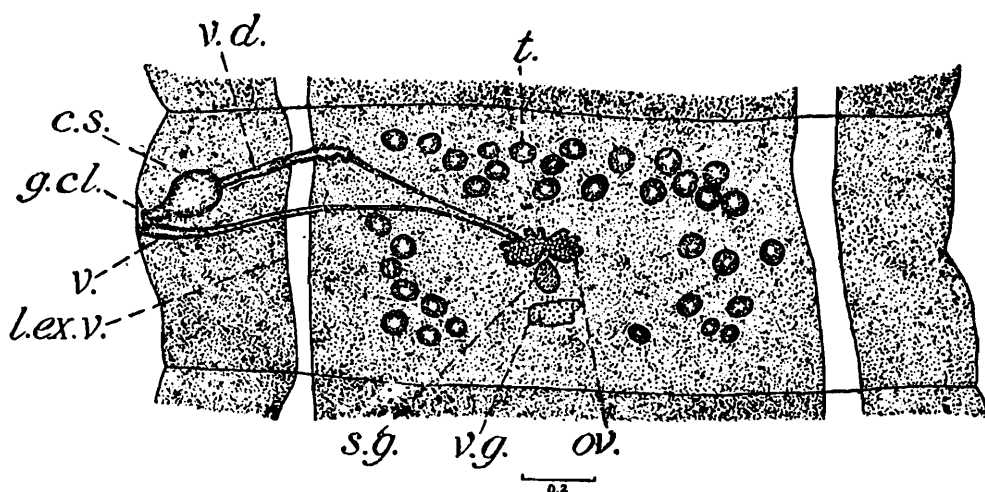
Subfamily DILEPIDINAE Führmann 1907.

***Gidhaia indica*, gen. et sp. nov.**

Host :—*Gyps indicus*.

Maximum length 206, maximum breadth 5. Scolex absent. Segmentation distinct. Genital cloaca present. Genital pore irregularly alternates, in anterior half of proglottis margin. Cirrus sac very small, flask-shaped 0.206 $\times$ 0.125 not extending to ventral longitudinal excretory vessel but well separated from it. Often a small external vesicula seminalis present. Genital ducts pass dorsal to longitudinal excretory vessels. Testes 32-40, anterior to female genital organs stretching

from one longitudinal excretory vessel to the other, poral and aporal groups, and also sometimes a few posterior to female genital organs. Receptaculum seminis absent. Ovary nearly in the centre of the proglottis or slightly poral. Small sac-like structures often appear on either side of shell gland and show the early development of uterus later on it is transversely elongated with lateral extremities sub-divided.



TEXT-FIG. 8.—*Gidhaia indica*, gen. et sp. nov.. Mature proglottis.

The present form differs from *Parvirostrum magnisomum* Southwell 1930 by its smaller number of testes, larger size of cirrus sac and the absence of the receptaculum seminis.

The characters given above clearly indicate that the present form must be included in the *Dilepidinae*. From the genera of this subfamily with alternating genital pores such as *Angularella* Strand 1925 synonym *Angularia* Clerc 1906, *Parvirostrum* Fühmann 1907, *Paricterotaenia* Fühmann 1932, and *Laterorchites* Fühmann 1932, it is distinguished by the location of the testes anterior to ovary, from *Bancroftiella* Johnston 1911 and *Kowalewskiella* Baczyńska 1914 by the course of the genital ducts and the presence of the testes lateral to the female genital organs, from *Cyclustera* Fühmann 1901 by the irregularly alternating position of the genital pores and the absence of the ring-like uterus, from *Parorchites* Fühmann 1932 (genital ducts passing dorsal to longitudinal excretory vessel) by the presence of the testes anterior to ovary and from *Liga* Weinland 1857, by the lateral disposition of testes and the absence of the tubular prolongations from eggs. It is, therefore, essential to create for it a new genus for which I propose the name *Gidhaia* with the present species as the type and with the following diagnosis:—

Dilepidinae; Genital pores irregularly alternate. Genital canals pass dorsally to longitudinal excretory vessels. Testes in two groups, poral and aporal, anteriorly to the female organs connected by several rows and with a few testes posterior to them. Female genital organs slightly poral or in centre of proglottis. Uterus transversely elongated, with lateral extremities greatly sub-divided. Adults in birds.

Type-species.—*Gidhaia indica*, sp. nov.

As in *Parvirostrum* Fühmann 1908, the testes are never anterior to the ovary (Fühmann 1932, p. 112). *Parvirostrum magnisomum* Southwell 1930 can not be included in that genus: its characters, on the contrary place it in *Gidhaia*.

It should, however, be mentioned that genus *Taufkia* Woodland 1928 retains its validity and cannot in any way be considered as a synonym of *Parvirostrum* as has been suggested by Southwell (1930, p. 167).

Family HYMENOLEPIDIDAE Führmann 1907

Subfamily HYMENOLEPIDINAE Perrier 1897

Diploposthe Jacobi 1896.

Diploposthe laevis (Bloch 1782) Jacobi 1896.

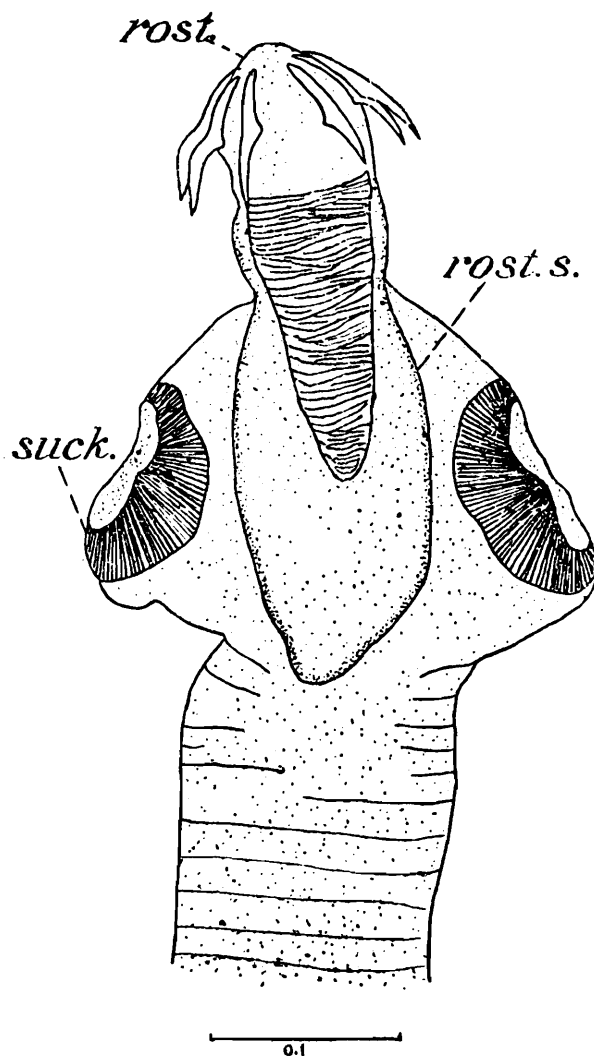
Host :—Duck.

Maximum length 166, maximum breadth 5.5. Genital pore slightly posterior to middle of the proglottis margin. Cirrus sac 0.658×0.11 extending to longitudinal excretory vessels. Testes three.

Hymenolepis Weinland 1858.

Hymenolepis clausa Linstow 1906.

Host :—*Columba intermedia*.



TEXT-FIG. 9.—*Hymenolepis clausa* Linstow. Scolex.

Rostellor hooks 0.068-0.084 long. Cirrus sac comparatively longer (0.272), extending half the breadth of the proglottis. Otherwise agreeing with the original description.

Hymenolepis furcata (Stieda 1862).

Host :—*Crocidura* sp.

Maximum length 3, maximum breadth 0.19. Scolex more or less rectangular, maximum breadth 0.24, and minimum breadth 0.17. Rostellar hooks 36, 0.016-0.018 long. Genital pore in anterior half of the proglottis margin. Cirrus sac 0.029-0.04, extending to ventral longitudinal excretory vessel. Of the two aporal testes, one internal and anterior to the other. Ovary small, poral mostly between cirrus sac and anterior testis.

The present form is placed in this species provisionally pending an investigation of the cestodes of *Crocidura*.

Hymenolepis multihamata Meggitt 1927.

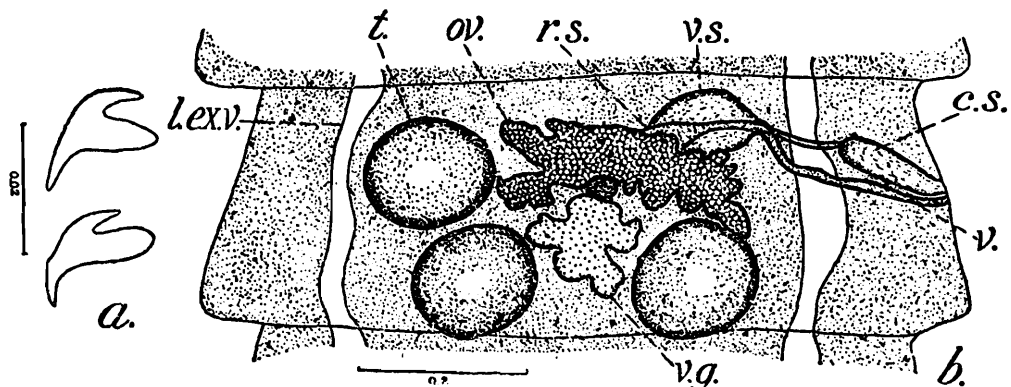
Host :—*Milvus govinda*.

Length 1.68, maximum breadth 0.27. Scolex 0.19 diameter. Rostellum 0.09 in diameter. Rostellar hooks 10, 0.114 and 0.075-0.087. Genital pore in anterior third of the proglottis margin. Cirrus sac 0.13-0.133 in mature segments, crossing longitudinal excretory vessels. Cirral spines absent.

Hymenolepis planestici Mayhew 1925.

Host :—*Acridotheres tristis*.

Length 175, greatest breadth 1.525. Scolex 0.31 diameter. Rostellum 0.08 diameter. Rostellar hooks 6, 0.017-0.02 long. Cirrus sac 0.125-0.135 long, extending to ventral longitudinal excretory vessel. Vas deferens short, narrow, ending in an external vesicula seminalis.



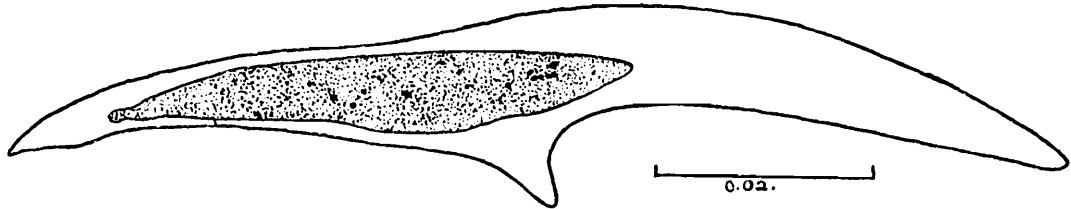
TEXT-FIG. 10.—*Hymenolepis planestici* Mayhew. a. Rostellar hooks. b. Mature proglottis.

Receptaculum seminis often present but poorly developed. Genital atrium absent. Testes 0.16 in maximum diameter. Vitelline gland with 4-5 distinct lobes.

The Lucknow form differs from the original description (Mayhew 1925, p. 73) in the smaller number of rostellar hooks, slightly smaller relative size of cirrus sac and the lobed vitelline gland. These differences, however, do not appear sufficient to justify the creation of a new species.

Hymenolepis rugosa birmanica* Meggitt 1924.Host* :—*Columba intermedia*.

Rostellar hooks 0·087-0·097 long. Cirrus sac 0·166 long, slightly exceeding half the breadth of the segment. Testes, variable in arrange-



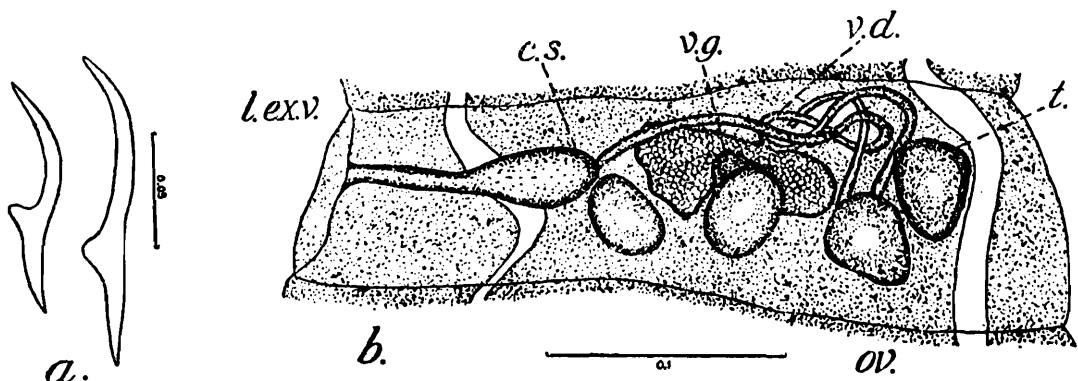
TEXT-FIG. 11.—*Hymenolepis rugosa birmanica* Meggitt. Rostellar hook.

ment, usually in a transverse row towards the posterior margin of the proglottis.

H. serrata Fühmann, 1906 greatly resembles *H. rugosa* Clerc, 1906. It differs only in the shape of hooks and the slightly smaller relative size of the cirrus sac, and specific identity of the two species appears to be clearly indicated.

Oligorchis* Fühmann 1906.**Oligorchis hierticos*, sp. nov.***Host* :—*Milvus govinda*.*Locality*.—Kakori, District Lucknow.

Maximum length 6·5, maximum breadth 0·45. Scolex 0·375-0·39 diameter. Rostellum 0·13 diameter, armed with approximately 16-18 hooks, 0·083-0·1 and 0·113-0·19 long. Suckers spherical, 0·11-0·14 diameter. Segments much broader than long. Genital pore unilateral, in anterior third of the proglottis margin. Genital ducts pass dorsal to the longitudinal excretory vessels. Musculature with two layers of longitudinal muscles, the bundles in the inner layer being feebly developed and lined internally by transverse muscles. Cirrus sac 0·065-0·125, crossing and extending a little beyond the ventral longitudinal excretory



TEXT-FIG. 12.—*Oligorchis hierticos*, sp. nov. *a.* Big and small rostellar hooks. *b.* Mature proglottis.

vessels. Cirrus well developed and spiny. Both seminal vesicles absent. Vas deferens specially developed, its coils usually extending to the aporal testis, sometimes beyond it. Testes, one aporal and anterior to the others, which are in a transverse row (posterior and lateral to ovary) : in more

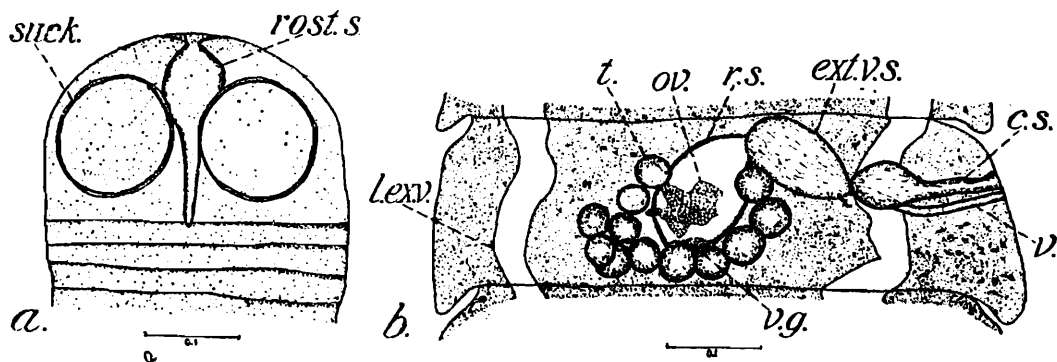
posterior segments all form a single row in contact with the posterior border of the proglottis. Uterus divided longitudinally into usually right and left sacs, often with a (comparatively much smaller) third between the two, containing 116-150 eggs.

From the present species, *Oligorchis paucitesticulatus* Fühmann 1913 may be distinguished by the large number of testes, *O. yorkei* (Kotlan 1923) by the difference in number, size, shape and arrangement of the rostellar hooks while *O. toxometra* Joyeux and Baer 1928 and *O. strangulatus* Fühmann 1909 are distinguished by the smaller size of the rostellar hooks, and their different shapes. Assuming the author's description to be accurate, *O. longivaginosus* Mayhew 1925 is to be distinguished by a characteristic division of the ovary into 4-6 knob-like lobes, a specially long vagina and the arrangement of the rostellar hooks in a single row and their uniform size.

***Pseudoligorchis magnireceptaculata*, gen. et sp. nov.**

Host :—Bat.

Maximum length 76, maximum breadth 0.718 (gravid segment) and 0.638 (maximum width of the mature proglottis). In some strobilae, last but third or fourth segment gets reduced in width and the succeeding ones show further reduction till the last proglottis is reduced to 0.38 breadth. Scolex 0.318 maximum diameter. Rostellar sac embedded in the scolex, 0.067 diameter and 0.2 long. Rostellar hooks absent (the specimen were thoroughly examined in living state before fixation and the rostellar hooks were found completely absent). Genital pore unilateral, slightly anterior to middle of the proglottis margin. Genital cloaca absent. Genital ducts pass between the dorsal and ventral longitudinal excretory vessels. Cirrus sac 0.14-0.16 × 0.053, extending to ventral longitudinal excretory vessel, containing a fairly well developed external vesicula seminalis. Testes 8-12 in between the longitudinal excretory vessels and surrounding the ovary laterally and posteriorly, their number is usually greater on the aporal than on the poral side. Ovary with small irregular processes, in the middle of the proglottis. Receptaculum seminis large. Uterus an irregularly lobed sac, occupying the segment except the slight margin at the lateral sides.



TEXT-FIG. 13.—*Pseudoligorchis magnireceptaculata*, gen. et sp. nov. a. Scolex; b. Mature proglottis.

From the characters given, it is obvious that the above form must belong to Hymenolepidinae. Of the genera of this subfamily it is

clearly separated from *Aploparaksis* Clerc 1903, *Diorchis* Clerc 1903, *Hymenolepis* Weinland 1858 and *Oligorchis* Fühmann 1906, by the number of testes, from *Diplogynia* Baer 1925 and *Diploposthe* Jacobi 1896 by its unilateral genital pores, from *Chitenolepis* Baylis 1923 (also from a mammal and with an unarmed rostellum) by the course of the genital ducts, lateral disposition of testes and the absence of the remarkably thickened outer shell of egg, from *Drepanidotaenia* Railliet 1892 by the lateral disposition of testes and the central position of ovary (never aporal), and from *Echinocotyle* Blanchard 1891 and *Hymenofimbria* Skrjabin 1914 by the absence of a sacculus accessorius and also of more than two longitudinal excretory vessels (as compared to the latter genus only).

I propose the name *Pseudoligorchis* for the new genus with the following diagnosis :—

Hymenolepidinae; Scolex with an? unarmed rostellum. Genital pore unilateral. Genital ducts pass between the longitudinal excretory vessels. Testes numerous (more than four) posterior and lateral to female glands. External vesicula seminalis present. Uterus an irregularly lobed sac.

Type-species.—*Pseudoligorchis magnireceptaculata*, sp. nov.

Including the form *Oligorchis hierticos* described above altogether seven species of *Oligorchis* Fühmann 1906 have been recorded, all of which possess four testes except *O. paucitesticulatus* Fühmann 1913, which has 7-11. Mayhew (1925, p. 37) is of the opinion that the presence of external and internal vesicula seminalis is comparatively unimportant and would therefore remove the species from Hymenolepididae. However, when the constancy of that organ in Hymenolepididae is considered, to dismiss it arbitrarily is unjustified and the writer is of the same opinion as Fühmann, i.e., that the form belongs to Hymenolepidinae. The constancy of the testes in that subfamily is a character on which the genera are founded, and there is no more reason for altering the diagnosis of the genus *Oligorchis* to 4-11 testes so as to include *O. paucitesticulatus*, than to alter it to 3-11 testes so as to include the genus *Hymenolepis* Weinland 1858: excluding the species under discussion, the number of testes in both the genera is equally constant. *O. paucitesticulatus* is, therefore, transferred to the new genus *Pseudoligorchis*.

Family TAENIIDAE Ludwig 1886.

Taenia Linnaeus, 1758.

Taenia saginata Goeze, 1782.

Host :—Man.

Taenia hydatigena Pallas 1766.

Host :—*Capra hircus*.

Multiceps multiceps (Leske 1780) Hall 1910.

Host :—*Ovis aries*.

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REFERENCE LETTERS FOR THE TEXT FIGURES.

c. s. = cirrus sac ; *cirr.* = cirrus ; *ext. v. s.* = external vesicula seminalis ; *g. cl.* = genital cloaca ; *l. ex. v.* = longitudinal excretory vessel ; *mus. p.* = muscular pad ; *ov.* = ovary ; *r. h.* = rostellar hooks ; *r. s.* = receptaculum seminis ; *rost.* = rostellum ; *rost. s.* = rostellar sac ; *s. g.* = shell gland ; *suck.* = sucker ; *t.* = testis ; *v.* = vagina ; *v. d.* = vas deferens ; *v. ex. v.* = ventral excretory vessel ; *v. g.* = viteline gland ; *v. s.* = vesicula seminalis.

A FURTHER NOTE ON THE STYLE SACS OF GASTROPODS.

By R. V SESHAIYA, *Annamalai University, Annamalainagar, S. India.*

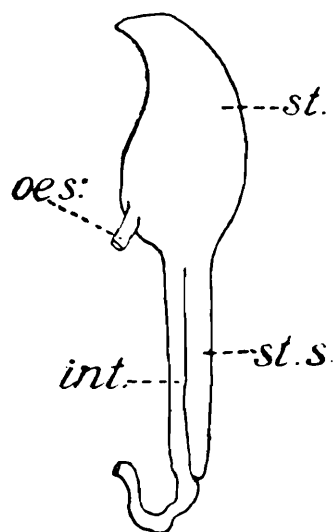
Yonge (9) recently compiled a list of forty one Gastropod genera, in which the style sac is known to occur. From this list *Ampullaria* has to be omitted, since Bouvier's record of a style sac in this genus has not been confirmed, particularly by the investigations of Prashad (5) who considers that the caecum in the Ampullariidae is not a style sac.

The present note records the presence of a style sac in five more genera, viz., (i) *Septaria* (ii) *Cyclotopsis* (iii) *Stomatodon* (iv) *Acrostoma* (v) *Tiara*. With the inclusion of these, the number of the Gastropod genera possessing a style sac comes to forty five, omitting *Ampullaria*.

In determining the presence of a style sac in the case of very limited preserved material one should look for two decisive features, the gastric shield and the epithelium of the style sac. In the case of the genera dealt with in this note, the material available for study was mostly limited and I have been guided by the above two features in arriving at my conclusions.

In the family Neritidae, a style sac was recorded by Lenssen in *Neritina*. Bourne (1) who described the anatomy of *Septaria* made no mention of a style sac in it. He found the stomach of *Septaria* to consist of a dilated oesophageal and a narrower pyloric moiety, but did not explain the relation of the latter to the intestine. He remarked however, about the presence of a thickened epithelial ridge, the "crete stomacale," in the stomach resembling the condition found in Gastropods with a crystalline style.

The shape of the stomach of *Septaria borbonica*, figured by Bourne (1) differs from that of *Septaria dravidica*¹ as will be seen from text-



TEXT-FIG. 1.—The stomach of *Septaria dravidica*.

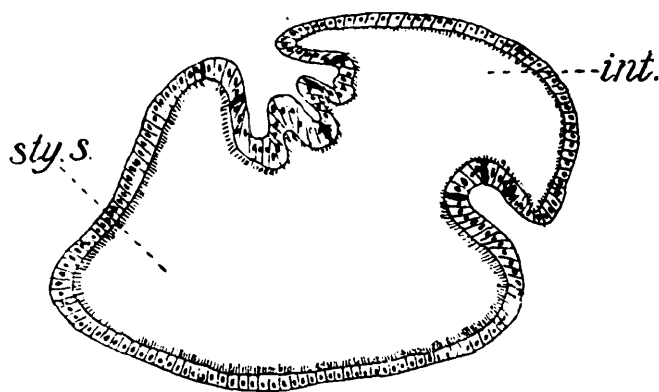
int. intestine in communication with the style sac ; oes. oesophagus ; st. posterior or gastric part of the stomach ; st. s. style sac.

fig. 1. In *Septaria dravidica* the stomach is about 7 mm. of which the wider gastric portion is about 3 mm. and the narrower cylindrical part, about 4 mm. The gastric part is more than twice as broad as the pyloric portion. The latter consists of the style sac and intestine, which can be made out externally by the two longitudinal grooves separating them on the dorsal and ventral surfaces. In a transverse section, the style sac and the first part of the intestine are seen to be in "wide and open communication," being incompletely separated by the two typhlosoles. The style sac is twice as broad as the intestine. Its epithelium, which is thicker than that of the intestine, shows the usual features. The cells in the intestinal part are shorter and the cilia also are shorter. The minor typhlosole is a simple projection, whereas the major typhlosole is broad and shows

¹ *Septaria dravidica* Prashad, from Porto Novo, South India.

two grooves. Gland cells are especially abundant in the major typhlosole.

The style sac communicates by its entire length with the intestine. A gastric shield is present in the posterior chamber of the stomach and



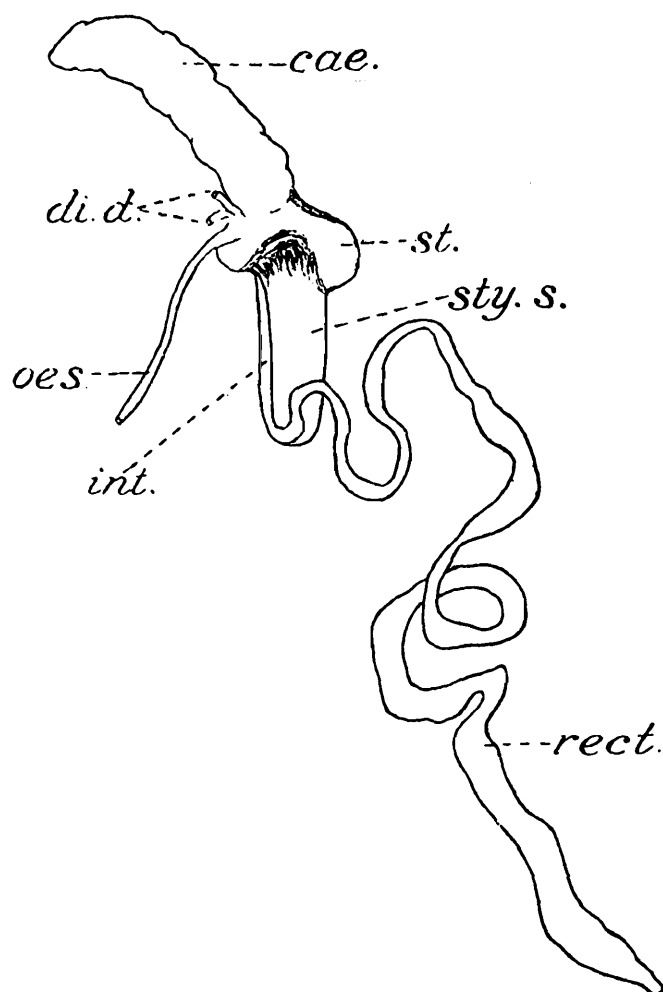
TEXT-FIG. 2.—Transverse section through the anterior part of the stomach (style sac and intestine) of *Septaria dravidica*. A few gland-cells are represented. Lettering as in fig. 1.

has the appearance of the “crete stomacale” described by Bourne (1) in *Septaria borbonica*.

The only terrestrial genus in which the style sac has been recorded till now is *Pomatias* (= *Cyclostoma*). Garnault's (2) observation recording the presence of a style sac in it was confirmed by Yonge (9). I find that *Cyclotopsis* also possesses a style and style sac. The stomach of *Cyclotopsis* differs to some extent in shape from that of *Pomatias*. It may be considered to comprise of three portions, a posterior caecum corresponding to the “cul-de-sac” of the stomach in *Pomatias*, a middle gastric portion and an anterior cylindrical part. The latter is what Garnault (2) termed the “intestine conoide” in *Pomatias*. He considered it as a part of the intestine. In *Cyclotopsis* it is composed of the first part of the intestine and the style sac, and may, therefore, be considered as the pyloric extension of the stomach, as in the case of the other genera possessing a style sac. The two parts, the intestinal and the stylar, can be made out externally. The intestinal part is whitish, narrow, and runs alongside of the wider greyish style sac. The pyloric part of the intestine is continued into the ‘cylindrical part.’ The presence of the intestinal and stylar portions was not described by Garnault (2) in the case of the “intestine conoide” of *Pomatias*.

In a transverse section of the anterior chamber or “intestine conoide”, the style sac is seen as a wide circular chamber communicating with the small intestinal portion on one side. The communication between the style sac and intestine, which is wide in the upper part of the style sac, but narrower in the lower part, is bounded by the two typhlosoles. The typhlosoles present the features recorded in the other genera possessing a style sac. Gland cells are conspicuous on them, as also in the intestinal part of the anterior chamber. The style sac communicates by its entire length with the intestine. The epithelium of the style sac shows the usual characteristic features. The style, as made out in transverse

sections, consists of co-axial layers with a central core showing food particles consisting of vegetable matter. The animal is herbivorous, and in the laboratory was fed on bananas and moistened filter paper.



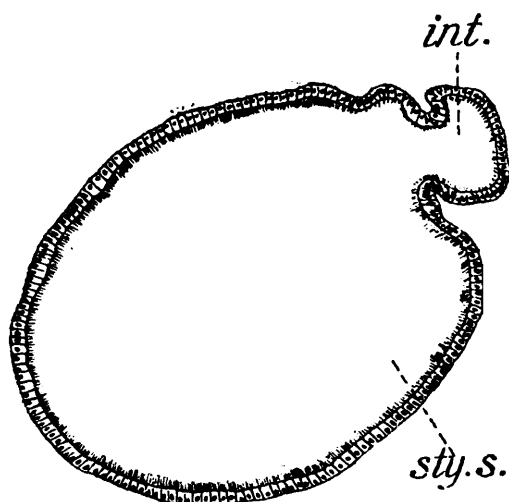
TEXT-FIG. 3.—A partial dissection of the alimentary canal of *Cyclotopsis subdiscoidea*.
cae. caecum of the stomach; *di. d.* ducts of the digestive gland;
int. intestine in communication with the style sac; *oes.* oesophagus;
rect. rectum; *st.* stomach; *sty. s.* style sac.

Sections through the middle chamber of the stomach showed the thickened cuticle in the form of a gastric shield. The cavity is usually filled with a large quantity of hard vegetable matter, and for sectioning, the chamber had to be slit open and cleaned of its food contents before clearing and embedding.

The style sacs of *Acrostoma*, *Tiara*, *Stomatodon* are of the type found in the other Melaniidae.

In this connection it may be pointed out that the structure of the style sac within the limits of a family is strikingly uniform. The only exception appears to be *Lithoglyphus* in which a style sac separate from the intestine was recorded by Von Ihering in 1885. I think it needs reinvestigation, as in other known members of the Hydrobiidae the style sac has a restricted communication with the intestine. As was pointed out by Yonge (9), the style sac cannot be of any taxonomic significance, but is correlated with the nutritional demands of the animal. As to the uniformity of structure within a family, it may be said that

the species of a family having a common structural potentiality can develop in response to their nutritional needs a common type of style sac.



TEXT-FIG. 4.—Transverse section through the anterior part of the stomach (style sac and intestine) of *Cyclotopsis subdiscoidea*. Lettering as in fig. 3.

Another point that may be referred to in this connection is the classification of the style sacs. More emphasis seems to have been laid by some authors on the width of the communication between the style sac and intestine, rather than on the length, as seen from the use of the expression "wide and open communication." The style sac, as in *Turritella*, may have a wide communication with the intestine and at the same time the communication may be *restricted*, extending only to a part of the length of the style sac. It seems better, therefore, to avoid the expression "wide and open communication" in the classification of the style sacs and use only the terms "free communication, restricted communication, and separate style sac" as Yonge (9) has done. The classification of the style sacs of Gastropods, as given by Mackintosh (4), may be re-stated as follows:—

Stage I.—(a) Style lying in the intestine or

(b) Style sac communicating by its entire length with the intestine.

Stage II.—Style sac communicating by part of its length. The communication may be wide as in *Turritella* or narrow as in *Mysorella*.

Stage III.—Style sac communicating by a small fraction of its length or quite separate.

In conclusion I have pleasure in expressing my best thanks to Dr. Bains Prashad for sending me some of the references and the specimens of Melaniidae referred to in this note, and for the identification of *Septaria dravidica*.

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ANATOMY OF *PALUDOMUS TANSCHAURICA* (GMELIN).

By R. V SESHAIYA, *Annamalai University, Annamalaiagar, S. India.*

INTRODUCTION.

The family Melaniidae, as usually constituted, consists of diverse forms whose anatomical relationships are imperfectly known. Moore (17) in his studies of the Molluscs of the Great African lakes described the anatomy of archaic forms like *Nassopsis* and *Bythoceros*. In the monographs of Bouvier (8), Bernard (7) and Perrier (20), anatomical accounts of particular systems of organs of some of the Melaniidae are referred to. Of no typical member of the family, however, whether foreign or Indian, a complete anatomical account has so far been published. For the Indian forms the only references available are the contributions by Annandale (2, 3) and Rao (26), and relate only to the radular or conchological features.

For the genus *Paludomus*, Ramanan (25) described briefly the habits of *P. tanschaurica*, and Annandale (2) figured the radula of *P. obesa* and commented on the distribution of the genus in India. The present paper gives a complete account of the anatomy of *P. tanschaurica*.

The genus *Paludomus* occurs in Ceylon, India, Malay Peninsula and Borneo. Preston (24) records thirty five species from the Indian Empire. *Paludomus tanschaurica* is found generally in clear, slow moving, shallow streams with a sandy bottom. The animals usually come towards the water-edge of the stream and extend the anterior part of the body out of water. The animals feel quite at home out of water for some length of time, and even crawl about outside water. When placed in a basin of water in the laboratory, they invariably climb the sides of the vessel and come to the water-edge with the anterior part of the body extended out of the shell, and some even crawl out of the water and lie outside. Fully grown specimens are met with in abundance usually in November and December. The shells in the adult specimens are usually found coated with encrustations of mud and algae and are then not easily distinguished from the surrounding algae that may be present in the water around them. In the hot season, when the stream dries up, the animals burrow into the mud. In the laboratory, specimens that had been kept outside water for two months easily revived when placed in water.

Ramanan (25) states that the species is 'oviparous' and I believe it is so, as I have not come across any evidence of vivipary in the animal.

THE ANIMAL.

The body of the animal, which consists of two and a half whorls, shows the usual divisions of the Gastropod body, head, foot and visceral mass. The head, foot and the mantle edge with its processes can be protruded out of the shell. When the animal actively moves about in water, the mantle processes are fully extended into the water and project forwards, but do not rest on the upper surface of the shell as in the

case of *Melanoides*. When the animal is out of water, the tips of the mantle processes project a little beyond the shell.

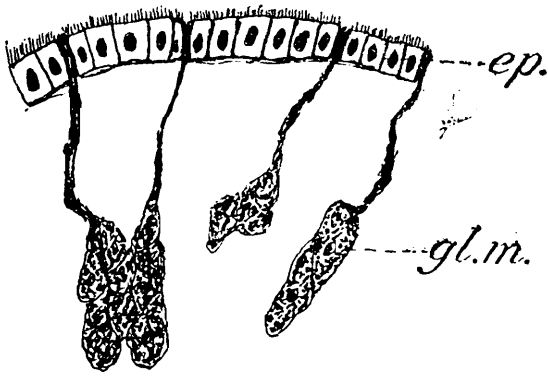
In the male the first and the second whorls have an orange brown colour, due to the presence of the testis on the dorsal and right lateral aspects. In the female specimens, the corresponding whorls are occupied by the ovary which is grey with interspersed yellow patches. On the convex side of the lower part of the second whorl the stomach is conspicuous. At the lower or anterior end of the penultimate whorl, to the left, is the pericardium, and behind it, the termination of the style sac is noticed as a circular translucent spot surrounded by glistening white connective tissue. Commencing at the apex of the body and extending to the right, and then alongside of the style sac, is the renal organ which is yellowish white in colour.

The mantle varies in colouration in the different parts. In the adult male the right side of the mantle enclosing the lower part of the genital duct is of an orange brown colour, while in the female the corresponding region is greyish white to creamy white in colour due to the conspicuous lower part of the oviduct. The mantle over the ctenidial region has a bluish-green appearance and the dorsal part of the stomach region also shows the same colour.

The Head.—The head projects forwards as the partly contractile snout, which, in the fully extended condition, measures about 3 mm. The head and snout are dark brown in colour with interspersed yellow spots arranged in transverse rows. The oral aperture is vertical and slit-like and situated at the anterior end of the snout. The tentacles measure about 6 mm. when fully extended, and are cylindrical and tapering at the tips. They bear the eyes on the outer side on slight lateral prominences. The tentacles are of the same colour as the snout.

The snout, in cross-section, is roughly semicircular in outline. The integument over the snout and the head consists on the outside of a layer of columnar cells with deep staining cytoplasm and round nuclei. The cytoplasm towards the distal ends of the cells is densely filled with brown pigment. Beneath the outer epithelium is a thick layer of transverse muscle fibres containing connective tissue between them. Underneath the transverse fibres are longitudinal fibres. On the sides of the head the longitudinal fibres are not confined to the lower part of the head but are present higher up also. Below the longitudinal fibres a few transverse fibres are again present. These different muscles bring about the elongation and contraction of the snout. The tentacle is covered by a columnar epithelium with unicellular mucous glands between the epithelial cells. The cells contain pigment and are similar to those found in the integument of the snout. The central part of the tentacle shows a more densely arranged connective tissue than that in the peripheral part lying under the epithelium, and contains several lacunae. The tentacular nerve and the tentacular blood vessel are seen in the centre. Underneath the general epithelium are circular muscles, and then come longitudinal muscles. Muscle fibres running across the tentacle from one side to the other are also present. The connective tissue cells are heavily pigmented like the epithelial cells.

The Foot.—The foot in its fully expanded condition measures about 12 mm. by 8 mm., and is somewhat triangular in shape, but owing to its contractility, it often assumes an oblong or quadrate shape. On the ventral surface, near the anterior margin it shows a shallow transverse groove. The sole is of a light grey colour with interspersed yellow spots. The central region of the foot is of lighter hue than the peripheral. The operculum is carried by the foot dorsally about its middle, and the shell rests on the operculum when the animal is in progression. The foot, in its general structure is in no way specially modified. It is covered by columnar epithelium, which on the ventral surface is ciliated, while the main mass of the foot is composed of connective tissue and muscles, including longitudinal, transverse and vertical or dorso-ventral fibres. In the region of the anterior groove the cilia are longer. The pedal gland which is well developed is situated beneath the ventral epithelium and is composed of ovoid masses of gland cells with oval nuclei and long



TEXT-FIG. 1.—The pedal gland-masses. *e. p.* ventral ciliated epithelium of the foot; *gl. m.* mass of gland cells.

necks opening on the ventral surface. Each gland mass has the appearance of a multicellular gland of the saccular type, but is really a compact collection of unicellular gland cells. The narrow necks of the cells, as they develop and press forward to the epithelium, simulate the appearance of ducts. Anterior to the groove are more deeply staining, roundish cells with round nuclei and with their cell-details usually obliterated by

the deep stain which they take up. As the cells develop they come up to open into the groove.

The columellar muscle does not call for any remarks. A pseudo-epipodial flap forming a siphon, as in forms like *Viviparus*, *Pila* and *Mysorella*, is not present in *Paludomus*; but, the right side of the mantle opposite the terminations of the rectum and genital duct is produced into a short broad triangular spout-like structure.

THE MANTLE AND MANTLE CAVITY.

The mantle has the usual relationship to other organs and is better developed dorsally. Ventrally it unites with the foot leaving free a narrow fringe of about 0.5 mm.

The anterior part of the mantle is of interest in several respects. Immediately anterior to the termination of the ctenidium a vein runs transversely. This is the circum-pallial vessel or vena circularis. When the mantle is examined fresh, there is seen a heavily pigmented area in front of this vessel, extending for a distance of about 0.8 mm., and beyond it is a broad greyish white area appearing to be slightly thicker than the rest of the mantle edge. This corresponds in position to the supramarginal ridge of forms like *Viviparus*. Anterior to this greyish band, lies the free edge of the mantle or the mantle margin. The mantle

margin is ciliated and is about 0.2 mm. in width and slightly translucent in appearance in the living animal. In the position corresponding to the supramarginal ridge is a shallow groove, the supramarginal groove, but as will be shown later on, the differentiation of the mantle into a supramarginal ridge with a supramarginal groove in front of it, as seen in the Viviparidae, Ampullariidae and many other groups, is not properly discernible in the case of *Paludomus*. Blood vessels are seen ramifying in the pigmented area and communicating with the circum-pallial vessel.

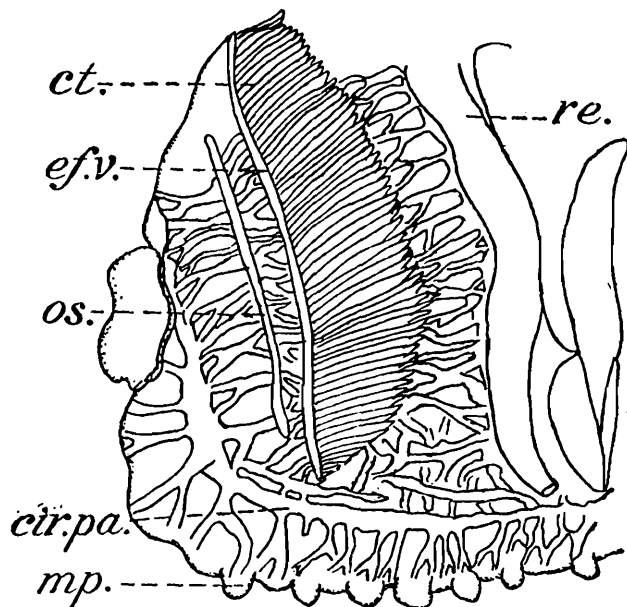
The most conspicuous feature of the mantle is the presence of the mantle processes. In very young specimens nine to twelve may be noticed, and in the adult specimens there are usually fifteen to twenty but the number sometimes goes up to twenty-three. The processes on the right side are usually closer to one another than those of the left side. They are of more or less uniform size unlike those of *Melanoides*. In the absence of grooves communicating with the supramarginal groove they differ from those of the Viviparidae. They differ also from the mantle processes of *Turritella*, which are grooved dorsally and are arranged in two rows.

In *Paludomus* the processes arise from the ventral surface of the mantle edge, and are, generally speaking, finger-like in outline. In the contracted condition they measure about 0.2 to 0.3 mm. and appear as oval structures with their long axes parallel to the mantle margin and are attached by stalk-like bases. When fully extended, they assume a more or less lanceolate shape. Observed in the living condition under the microscope, the mantle processes show a pellucid, peripheral portion and a densely pigmented central part. The pigment is light yellow in colour, seen by incident light under the binocular dissecting microscope. It is not uniformly dense in all processes; in some a few splashes are seen, sometimes none, while in others very dense lumps may be seen. The pigment is usually continuous with that of the basal part of the processes and that in the mantle also, but in some it may be discontinuous. Sometimes similar pigment is noticed in the mantle between the processes. Under high power the pigment appears in the form of a network of granules.

The Circulation in the Mantle.—The circum-pallial vessel receives small veins anterior to it. Posteriorly also there is a network of vessels communicating with it, and here and there are small veins having a course somewhat parallel to the circum-pallial vessel and communicating with it. Sinuses are present in the mantle processes also and they communicate with the circum-pallial vessel. Further details are dealt with under the circulatory system.

Histology of the Mantle processes.—In a vertical section passing through the mantle and the mantle process, the mantle process is seen as an anteroventral prolongation of the mantle. Its epithelium is continuous on the one hand with the epithelium of the ventral surface, and on the other with the epithelium of the mantle margin. It is composed of narrow columnar cells with prominent, elliptic to oval nuclei showing granular chromatin. The cells, especially towards the sides and the base, are ciliated. The distal ends of these cells show fine

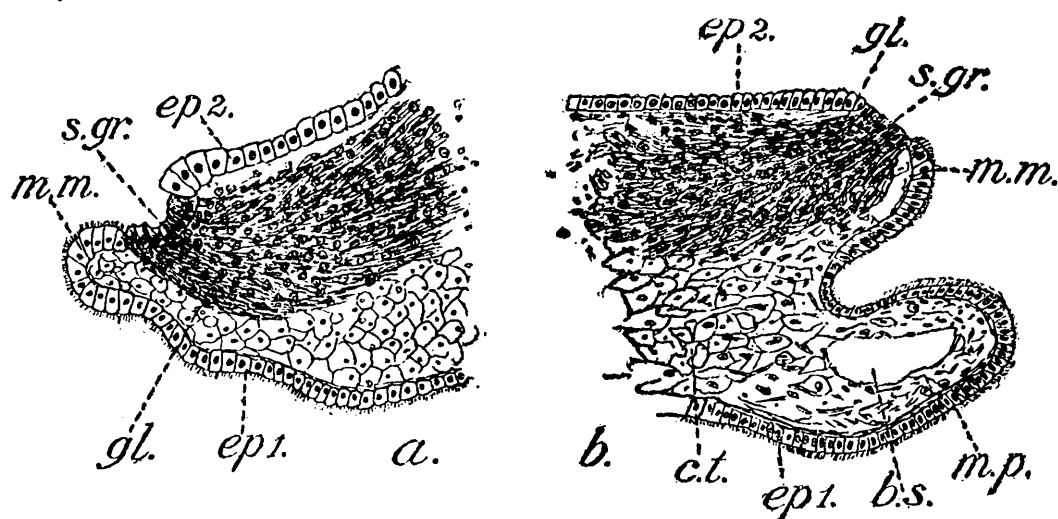
granules. Between the epithelial cells a few unicellular gland cells are seen. Each gland cell has a long narrow neck opening on the surface and a round swollen base containing an oval nucleus. The gland cells appear to be the same as those of the ventral epithelium of the mantle edge, and stain homogeneously. The thickness of the mantle process is composed of connective tissue and one or more sinuses. The pigment which is conspicuous in the living condition is not seen in sections.



TEXT-FIG. 2.—Circulation in the mantle. *cir. pa.* circum-pallial vessel; *ct.* ctenidium; *ef. v.* efferent ctenidial vein; *mp.* mantle process; *os.* osphradium; *re.* rectum.

The Histology of the Mantle.—The inner surface of the mantle in the anterior region is composed of columnar ciliated cells, among which are found unicellular mucous glands. The upper surface which is considered responsible for the secretion of the nacreous layer is composed of cubical or shortly columnar cells with large or rather oval nuclei. The anterior part of the mantle comprising of the mantle margin and the region of the supramarginal groove, in very young specimens differs to some extent from that of adult specimens. In the former, behind the mantle margin, there is a distinct groove and the epithelium behind it is slightly raised, being composed of cells a little taller than those of the remaining part of the outer epithelium of the mantle. The cells in the supramarginal groove are columnar and slightly compressed with large round, basally placed nuclei. They are similar to the outer epithelial cells of the mantle. Situated in the connective tissue of the mantle and extending a little backwards under the outer epithelium is the shell gland which is composed of elongate cells with large round nuclei containing granular chromatin. Generally, in the different families (Viviparidae, Ampullariidae) similar gland cells open behind the groove on the supramarginal ridge, but in *Paludomus* they distinctly open into the supramarginal groove. As in *Pila* and *Viviparus*, the gland consists of a mass of cells having narrow necks which reach out to the groove but are shorter than those in the Viviparidae.

In adult specimens, the region of the groove is very shallow and is not clearly seen. Its position is indicated usually by the break in the



TEXT-FIG. 3.—*a.* Section through the mantle edge of an young specimen. *ep*₁. inner epithelium of the mantle; *ep*₂. outer epithelium; *gl.* shell gland; *m.m.* mantle margin; *mp.* mantle process; *s. gr.* supra marginal groove.
b. Section through the mantle edge and mantle process of an adult. *b. s.* blood sinus; *c. t.* connective tissue; *ep*₁. inner epithelium of the mantle; *ep*₂. outer epithelium of the mantle; *gl.* shell gland; *m. m.* mantle margin; *m.p.* mantle process; *s. gr.* region of the supra-marginal groove.

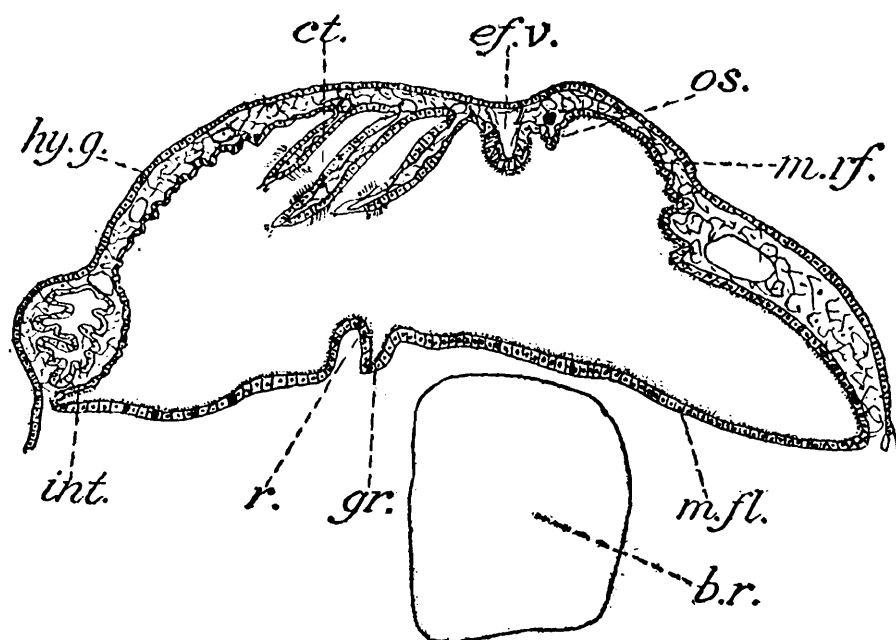
continuity of the dorsal epithelium and sometimes by a slight depression. Into this region the fibre-like necks of the shell glands open. The cells of the supramarginal groove, as seen in young specimens, are hardly distinguishable in the adult. In a large series of sections of the mantle edges of the adult examined by me, I found the shell gland present in a more or less well developed condition. The region immediately in front of the supramarginal groove is the mantle margin and consists of ciliated columnar cells.

The thickness of the mantle is composed of connective tissue, blood vessels and muscle fibres. The latter consists of longitudinal fibres beneath the epithelium, transverse muscle fibres and a few fibres running across the thickness of the mantle. The connective tissue cells are large and irregularly round and some of them contain calcareous concretions.

As to the function of the mantle processes, it is certain that they do not mould the sculpture of the shell as in the Viviparidae, the structure between the two being quite different. Further in *Paludomus* the processes are not embryonic structures as in many Viviparidae, but increase in size and number as the animal grows. In '*Melania*,' Benson (6) states that the processes clasp the right lip of the shell while the animal is crawling, and thus perhaps occasion the transverse furrows observable on the shell. In *Paludomus*, as seen already, the processes are more uniform and do not clasp the shell in the same manner as in *Melania*. But in the living animal they project beyond the shell and are turned up against the edge of the shell. If at all they can have any share in the formation of the sculpture of the shell, it can only be that, by frequent pressing against the edge of the shell as it is secreted, they

cause the lines seen on the shell, which, when examined under the lens, appear to consist of a series of minute elevations; but there is no exact correspondence between the mantle processes and the spiral lines which are about fourteen, the three central ones being prominent. The presence of definite sinuses in the processes in communication with the circumpallial vessel would show that the processes may function to some extent as accessory respiratory organs.

The Mantle cavity and the Pallial complex.—The floor of the mantle cavity shows on the right side a low ridge bounding on one side a slight depression or groove and extending from the apex of the mantle cavity to the region below the right tentacle. This ridge and groove are present in both the sexes and have no connection with the reproductive system like the genital grooves of the type which Moore (16)



TEXT-FIG. 4.—The mantle cavity (diagrammatic). *b. r.* buccal region; *ct.* ctenidium; *ef. v.* efferent ctenidial vein; *gr.* groove on the mantle floor; *hy. g.* mucous gland; *int.* intestine; *m. fl.* mantle floor; *m. rf.* roof of the mantle cavity; *os.* osphradium; *r.* ridge on the mantle floor.

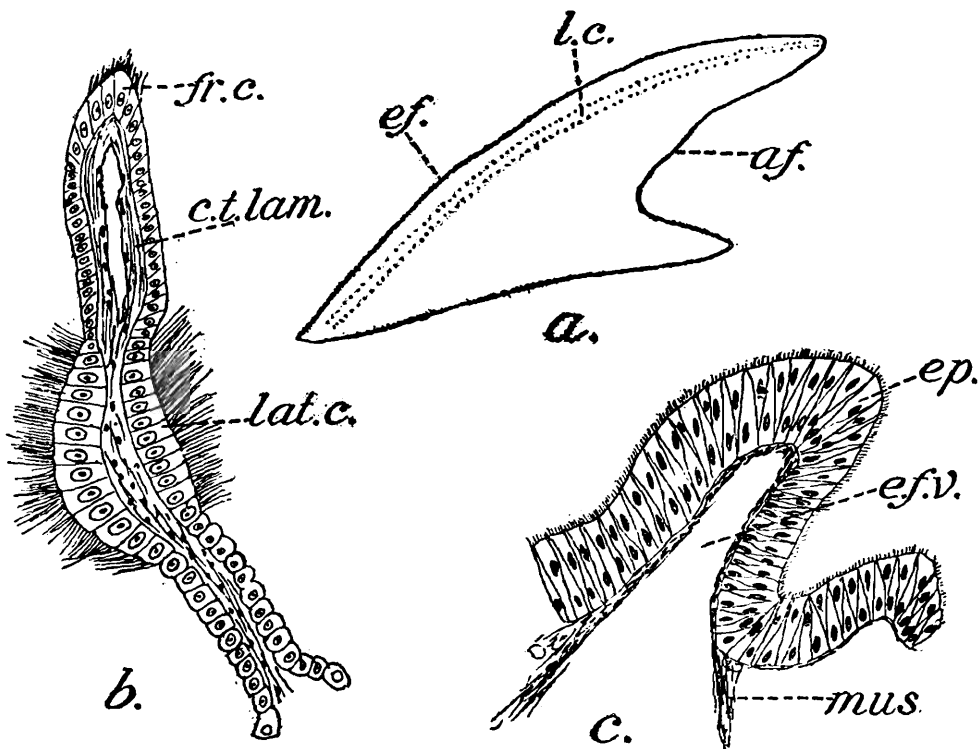
described in some of the Melaniidae. The position of the ridge and groove is similar to that of the food groove noticed by Yonge (33) in forms with ciliary feeding mechanism, but, as will be shown later on, there is no ciliary feeding in *Paludomus*. Sections through this region show the ridge to be a small, simple elevation of the mantle floor. In conjunction with the special ciliated epithelium at the base of the ctenidium, which will be described below, this ridge and groove may play some role in directing the water currents in the mantle cavity.

The pallial complex, as usual, consists of the osphradium, the ctenidium, the hypobranchial gland, and the lower part of the genital gland.

The osphradium is situated on the left side of the mantle cavity and is in the form of a simple, narrow ridge of more or less uniform width, and measuring about 3 mm.

The ctenidium is monopectinate and measures about 10 mm. It consists of about 200 lamellae. The lamellae in the middle region of the ctenidium are, as usual, of greater width than those towards either end of the ctenidium. Each lamella is attached to the roof of the mantle by its base and has a concave afferent side. The efferent side is longer than the base and measures about 2.4 mm., while the base measures only 1.8 mm. The region of specially well-developed cilia *i.e.* of the lateral cells is parallel to the efferent side.

A ctenidial leaflet is composed of a double layer of epithelium enclosing a blood space and a connective tissue lamella. In the latter, nuclei and muscle fibres are seen. At the apex of the leaflet the frontal cells are shortly columnar and ciliated, with large round nuclei. These gra-



TEXT-FIG. 5.—*a.* A single lamella of the ctenidium. *af.* afferent side; *ef.* efferent side; *l. c.* region of lateral ciliated cells.

b. Section through a single ctenidial lamella. *c. t. lam.* connective tissue lamella; *fr. c.* frontal ciliated cells; *lat. c.* lateral ciliated cells.

c. The mantle epithelium over the efferent ctenidial vein. *ef. v.* efferent ctenidial vein; *ep.* ciliated and glandular epithelium; *mus.* muscles.

dually pass down into the next part of ctenidium composed of shorter cells enclosing the efferent blood space. Below this is the region of the lateral cells with well-developed cilia. The cells are tall and columnar with large oval nuclei and the cilia are as long as the cells. The rest of the ctenidium is lined uniformly by somewhat cylindrical cells having among them ovoid gland cells.

The epithelium over the efferent ctenidial vessel is high and consists of columnar ciliated cells with rather distally placed nuclei. Between them are narrow gland cells with basally placed nuclei, and granular cytoplasm. Beneath the epithelium, longitudinal muscles and vertical muscles passing to the mantle roof are present. The contraction of these muscles probably helps the flow of blood. As to the function of the

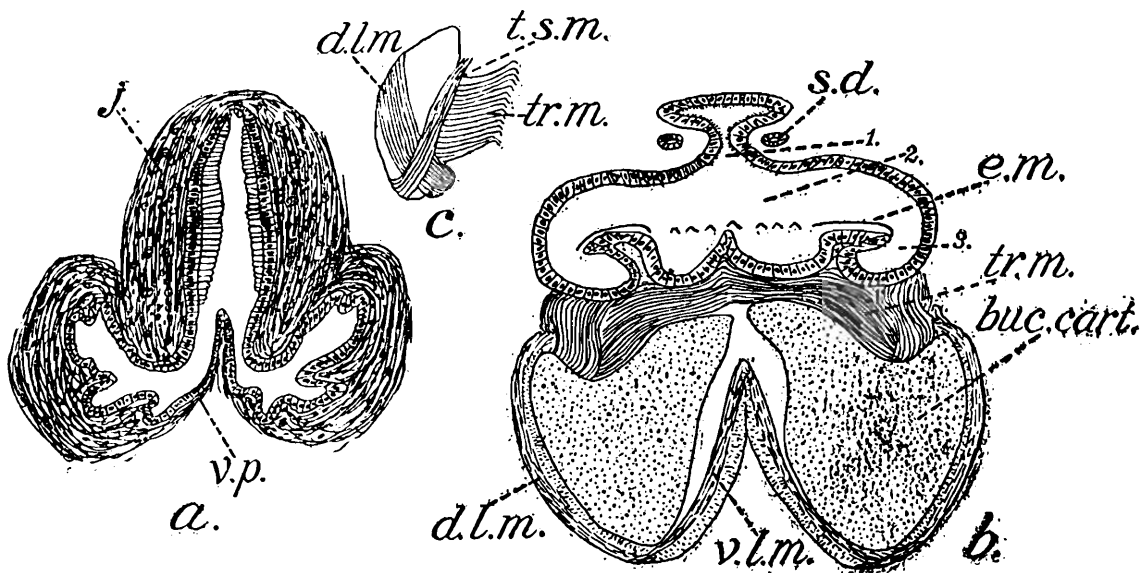
epithelium, it may be serviceable in directing the flow of the incurrent water. The mantle epithelium between the rectum and the ctenidium shows slight transverse folds and constitutes the mucous or hypobranchial gland. In this region the gland cells are numerous and globose and the depth of the staining they take depends on the amount of secretion in the cells. Between the mucous cells are columnar epithelial cells.

The general inner epithelium of the mantle is composed of short columnar ciliated cells with unicellular mucous glands between them. The gland cells are goblet shaped and differ from those of the hypobranchial gland in being of smaller size.

THE DIGESTIVE SYSTEM.

The food of the animal consists of diatoms and filamentous algae like *Spirogyra*. The feeding is by the radular mechanism.

The mouth is in the form of a vertical slit placed at the end of the snout. Bounding the mouth on either side there is an oval greyish coloured area which is smooth and cushion-like. The mouth is lined by columnar cells with oval nuclei and leads into the oral cavity or vestibule.



TEXT-FIG. 6.—a. Section through the region of the jaw. j. jaw; v. p. process of the ventral epithelium.

b. Transverse section of the buccal mass. 1. 2. 3 The three portions of the buccal cavity; buc. cart. buccal cartilages; d. l. m. dorsolateral muscles; e. m. elastic membrane; s. d. salivary ducts; tr. m. transverse muscle connecting the buccal cartilages; v. l. m. ventro-lateral muscles.

c. Dissection to show the muscles of the buccal cartilages. d. l. m. dorso-lateral muscles; t. s. m. tensor superior muscle; tr. m. transverse muscle connecting the cartilages.

The oral cavity is surrounded by circular muscle fibres with connective tissue between them. The connective tissue is of the type found in the oral region of other Taenioglossates and which Bregenzer (9) termed labial cartilages in *Bythinella*. Muscle fibres run from the oral region to the dorsal and lateral regions of the snout. The appearance of the oral cavity as seen in section differs in the different parts. A little behind the mouth, the "vestibule" is seen to comprise of a central cavity produced into a dorso-median diverticulum and two ventro-lateral diverticula

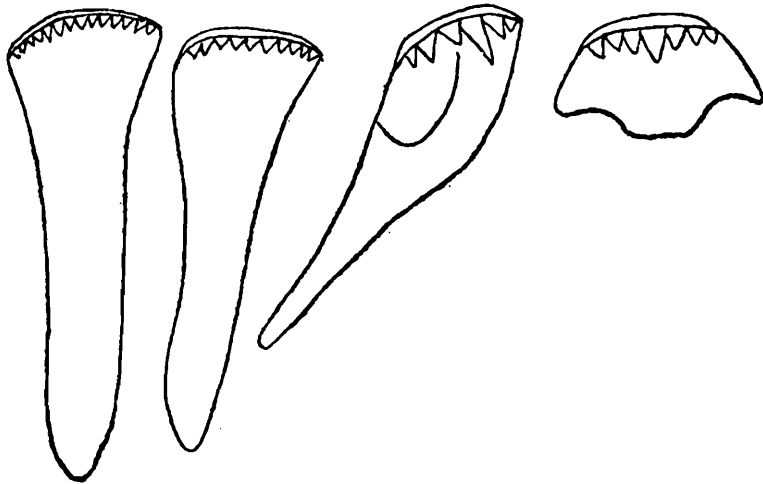
which are separated by a conical projection of the floor of the vestibule. A little further behind, about the commencement of the jaws, the ventro-lateral prolongations become reduced, while the conical projection of the floor assumes a dagger-shaped form in transverse section. The dorso-median chamber becomes prominent and its epithelium develops on its inner edge thick, cuticular plates which are continued into the jaws behind. The cells underlying the cuticular plates are columnar with elliptic nuclei, and show brown granules towards their free ends. In the region of the jaws the elevation on the floor of the cavity becomes still more pronounced and assumes a villus-shaped structure projecting half way into the dorsal diverticulum and the central cavity is drawn out laterally on either side. The jaws appear in transverse sections as chitinous rods in continuation of the underlying cells and are as long as the cells. Behind the jaws, the dorsal cavity becomes shorter and the oral cavity passes into the buccal cavity. In this region one can distinguish (i) a short median or dorsal unpaired cavity which is the continuation of the dorsal diverticulum of the oral cavity. Its roof shows two small lateral prolongations and its epithelium is ciliated throughout. (ii) The central cavity which has lateral expansions is flattened over the cartilages. (iii) In the posterior part of the buccal mass the ventro-lateral expansions of the buccal cavity dip beside the buccal cartilages. The floor of the central cavity shows two lateral elevations, one on either side, which are directed inwards and over which the elastic membrane is spread. The dorsolateral epithelium of the central cavity is composed of columnar cells with gland cells between them.

The buccal mass is pyriform and measures about 2 mm. Dorsally several fine strands of muscles arise from the anterior part of the oral tube and run to the dorsum of the snout. Some of these are median and others lateral. The anterior dorso-lateral muscles are represented by slightly thicker strands that arise laterally from the buccal mass about the region of the jaws. The posterior dorso-laterals are represented by two thick white strands arising from the sides of the buccal mass and several thread-like muscles arising more dorsally. The sphincter muscle, as usual, is developed in the anterior region of the buccal mass. The retractors of the buccal mass are club-shaped and arise laterally in the posterior part of the buccal mass about the level of the hind ends of the buccal cartilages. Ventrally a pair of ventro-median protractors are present arising at the hind end of the oral tube. A little behind these, the depressors of the radula arise and run down towards the region of the pedal ganglia.

The buccal cartilages are two in number, and viewed from the ventral surface, appear roughly oval in outline, but owing to a dorso-lateral depression in the anterior part, they appear as V-shaped structures in transverse sections of the anterior part. In the posterior part, the cartilages overlap each other partially. The structure of the cartilage is of the usual type, being composed of irregularly polygonal cells with faintly-staining, homogeneous ground substance, and with round deep staining nuclei situated close to the cell limits. The cell limits are distinctly stained. Towards the peripheral part of the cartilages the cells are small, and some of them possess two nuclei.

As for the muscles of the buccal cartilages, the condition presented by *Paludomus* differs from what has been described in forms like *Pila*, *Mysorella*, *Bythinella* and *Paludestrina*. Amaudrut (1) did not include the Melaniidae in his studies of the anterior part of the digestive tube of the gastropods. In a dissection of the buccal mass from the dorsal surface, after removing the superficial muscles, the radula and the elastic membrane, the buccal cartilages will be seen. Passing obliquely on the dorso-lateral surface of each cartilage is a band of muscle which runs forwards and inwards, and is attached to the elastic membrane. This corresponds to the tensor superior muscle. Underneath it is an oblique muscle, the dorso-lateral, running forwards and outwards from the posterior end of the cartilage. Posteriorly these muscles turn round to become continuous with those seen on the ventral surface, the ventro-lateral muscles. The ventral muscles run forwards on the inner surface of the cartilage. The transverse muscle connecting the two cartilages is a broad muscle arising from the dorso-lateral concavity of one cartilage and runs to that of the other and is therefore dorsal in position, though ventral to the dorsal muscles described above. In forms like *Pila* the muscle connecting the two cartilages is ventral in position.

The radula measures about 2.75 mm. It has the typical Taenioglossid formula 2. 1. 1. 1. 2 and bears about 130 transverse rows of teeth. The central tooth has a trapezoid outline, the anterior edge measuring 0.06 mm. and the posterior 0.09 mm., while the length in the antero-posterior axis is about 0.05 mm. The anterior margin, which is slightly reflexed downwards, bears one pointed conical, central denticle and three, sometimes four, smaller denticles on either side. The central denticle is stouter and more conspicuous than the lateral ones. The base of the



TEXT-FIG. 7.—The teeth of the radula showing the central, lateral and two marginals of one side.

central tooth is not straight but protrudes in the middle. The lateral tooth consists of a quadrilateral portion with its base prolonged on one side. The cutting edge bears one large denticle and three or more smaller denticles on either side. The outer and inner marginals are more or less similar, being somewhat spathulate in shape. The inner marginal bears ten small conical denticles. The outer marginal is slightly narrower than the inner marginal and bears twelve to sixteen denticles, sometimes even more.

In *Paludomus obesa*, the radula of which was figured by Annandale (2), the marginals have fewer denticles. The radula of *Paludomus tanschaurica* bears a closer resemblance to that of *Melania tuberculata*, the figure of which also was given by Annandale (2), in the marginals having small uniform denticles. The radula of *Paludomus* differs from that of *Acrostoma* in which the radular teeth are relatively shorter with fewer and blunt denticles. It differs also from that of *Nassopsis*, and less so from that of *Bythoceros* in which the shape of the central is different and the lateral has a shorter prolongation than in *Paludomus*.

The salivary glands are two long tubular and somewhat coiled structures. In preserved specimens they are usually found to extend as far as the region of the supra-intestinal ganglion. They lie close pressed to the sides of the oesophagus and in the region of the cerebral commissure lie under it. As they reach the buccal mass, the salivary glands pass into the salivary ducts which are narrower than the glands, and which taper towards their openings into the buccal cavity. The two ducts open on the dorsal surface into the buccal cavity, one on either side, about the middle of the buccal mass. The histological structure of the salivary glands of *Paludomus* agrees with that of Hydrobiidae, in having gland cells with support cells between them.

The oesophagus, on leaving the buccal mass, descends down to pass through the cerebral commissure, and is about 9 mm. long. The oesophageal epithelium has the usual histological features and is longitudinally folded. It has an investment of muscle fibres on the outside.

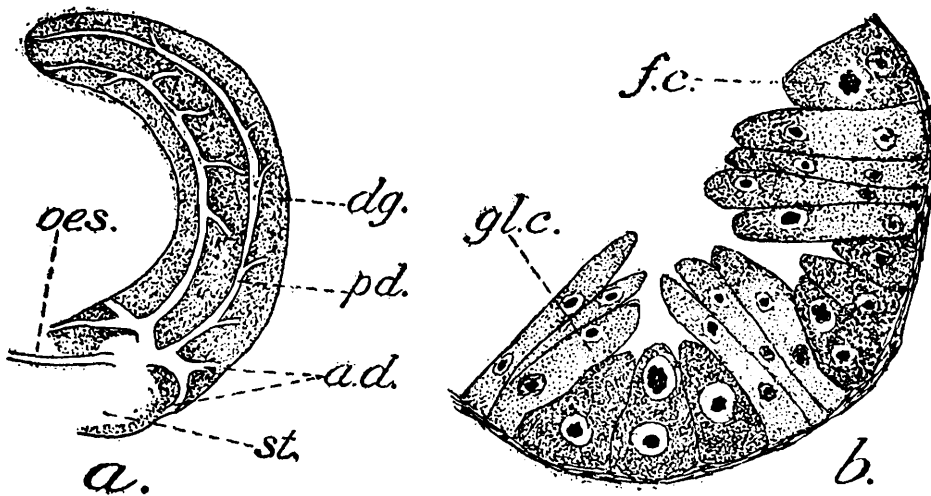
The oesophagus and the style sac are surrounded by a dense coating of a glistening-white connective tissue which shows effervescence on the addition of a drop of acid. The tissue consists of irregularly polygonal cells with feebly staining cytoplasm and deep-staining laterally placed nuclei. Some of the cells are large and possess calcareous concretions. When these are dissolved out as in the course of ordinary acid fixation, the cells appear full of lacunae with thick walls.

The first part of the intestine has a well formed dorsal typhlosole besides finger-shaped processes. It has an investment of longitudinal and circular muscles. The rectum is much wider than the upper part of the intestine and its walls are thrown into prominent, longitudinal folds. A characteristic feature of the rectal epithelium is the abundance of goblet-shaped gland cells. After osmic fixation followed by iron haematoxylin, the cells show spherical basal nuclei and rows of dark spherical granules in the distal part. With ordinary stains the gland cells become deeply stained.

The disposition of the digestive gland has been described elsewhere. It consists of branched tubules or diverticula, from which small ducts arise. Those from the posterior part unite to form two long ducts running more or less parallel to each other from the apex of the body to the stomach. The main ducts from the anterior part are shorter and each posterior duct is joined by the anterior, so that there are ultimately two openings of the digestive gland into the stomach.

The tubules of the digestive gland, in cross section are roughly circular in outline and are bound together by connective tissue containing blood vessels. The tubules are composed of cells, which, by their

staining reaction and size, appear to be of two distinct kinds, the ferment cells and the gland cells. The ferment cells are ovoid, shorter, stouter



TEXT-FIG. 8.—*a.* The ducts of the digestive gland. *a. d.* anterior ducts ; *d. g.* digestive gland ; *oes.* oesophagus ; *p. d.* posterior ducts ; *st.* stomach.
b. Portion of a transverse section of the digestive gland. *f. c.* ferment cells ; *gl. c.* gland cells.

and crowded between the gland cells, and do not usually reach the cavity of the tubule. They are deep-staining and have a cytoplasm showing a vacuolated appearance in osmic fixed material followed by staining in iron haematoxylin ; the nucleus is spherical with a distinct nucleolus and is placed in the lower part of the cell. The gland cells are greyish and have a granular structure, the granules being abundant towards the free ends. They are cylindrical in shape, narrower and longer than the ferment cells and the nuclei are smaller. Both kinds of cells often show a large vacuole in the distal part. In the ferment cell the vacuole, when present, contains a number of small spherical bodies crowded together and dark brown in colour. In the gland cell the vacuole contains bodies which are light greyish brown and often in a state of disintegration or digestion. In some specimens especially in those infected with Trematode parasites, the cells of the digestive gland were found to be practically of uniform appearance, being of the type of the ferment cells. The nucleus, in almost all the cells, consisted of a clump of chromosomes and mitotic phases could be observed. Yonge (32) has shown that in Lamellibranchs the ferment cells are really the earlier stages of the gland cells and that they undergo division in the tubules. The same seems to be the case with the digestive gland of *Paludomus*.

THE CIRCULATORY SYSTEM.

The position of the pericardium has already been described. It is a triangular cavity bounded by the apex of the mantle cavity, the kidney and the style sac. There are no pericardial glands. The heart consists of a single conical ventricle and a somewhat oval auricle. The ventricle is thick and muscular, the muscles running from the base to the apex, from side to side, and obliquely as well as from back

to front. It has consequently a spongy appearance with a much diminished cavity. The auricle, as usual, is thin walled and less muscular and has a wider cavity. The muscles arising from the base of the ventricle are disposed to form a kind of valvular arrangement allowing blood to pass from the auricle to the ventricle but not the other way. The ventricle gives rise to a short truncus arteriosus which divides into an anterior artery and a posterior or visceral artery. At the base of the truncus arteriosus also, the muscle fibres are disposed to form a kind of valvular arrangement. The anterior aorta, after giving off a small artery, soon after its origin, passes forward to supply the anterior part of the body and the foot. In its course it lies dorsal to the oesophagus, and anteriorly it gives off a branch to the foot, while the main branch passes beneath the radula to the buccal mass. The pedal artery runs dorsal to the pedal ganglion. The visceral artery runs on the dorsal side of the style sac, and proceeding further, gives off a branch to the digestive gland and another to the genital organ.

The venous system consists of a system of lacunae and is difficult to trace satisfactorily. The following appears to be the general course of the venous circulation. The genital gland and the digestive gland are situated in sinuses and the venous blood from the posterior parts of the body passes into the posterior sinus. Anteriorly the oesophagus and the anterior part of the alimentary canal lie in a sinus. The sinuses in the tentacles have been referred to already. The pedal sinuses run ventral to the pedal ganglia. The sinuses from the anterior parts of the body all unite into the anterior sinus. The anterior and the posterior sinuses unite ventral to the stomach to form the abdominal sinus. From the abdominal sinus some of the blood flows into the kidney from which a distinct renal vein passes to the base of the auricle into which it opens. The blood from the upper part of the intestine also passes through the abdominal sinus into the kidney.

The remaining part of the blood flows into the rectal sinus. The genital duct has under it a sinus into which also, some blood from the ventral or abdominal sinus seems to flow. From this sinus the blood flows into the rectal sinus surrounding the lower part of the intestine and the rectum. From the rectal sinus the blood flows along the roof of the mantle cavity into the ctenidial lamellae by a number of ramifications and from the ctenidium into the efferent ctenidial vessel. The efferent ctenidial vessel opens into the auricle at its base.

The pallial circulation, as stated already, is interesting. Bernard (7) did not study the Melaniidae, and of the forms he studied, *Natica* resembles *Paludomus* in the possession of a circum-pallial vessel but in other respects *Paludomus* is different. An examination of the fresh mantle or one fixed in formaline will show the distribution of the vessels. Arising from the lower part of the rectal region of the mantle is the circum-pallial vessel whose course has been described already. A number of sinuses are connected with it both in front and behind. Some of those in front communicate, as has been described above, with the sinuses in the mantle processes. The vena circularis or circum-pallial vessel runs to the left side and turns up where a number of sinuses from the left side of the body open into it. In this region a network of sinuses

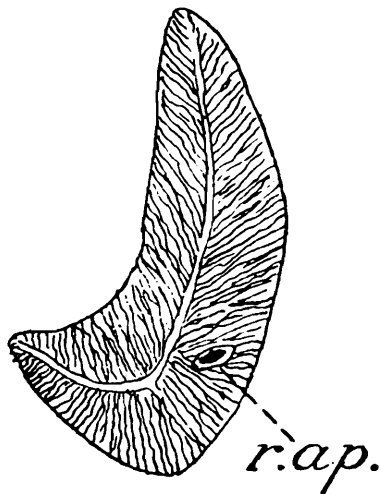
can be seen connecting the vena circularis with the efferent ctenidial vessel. Thus the blood from the circum-pallial vessel flows into the efferent ctenidial vessel. The appearance of this part of the pallial circulation is like that seen in the case of the Pulmonates. The habit of *Paludomus* in coming to the water's edge and keeping the anterior part of the body out of water is probably correlated, to some extent, with these peculiarities of circulation.

Several parts of the body, as noticed before, have a bluish green appearance and in the course of dehydration of fixed material, the alcohol is turned bluish-green, probably due to the presence of haemocyanin in the blood.

THE KIDNEY.

Perrier (20) made a passing reference to the kidney of *Melania* and said that it is a simple sac-like structure with its cavity obliterated by septa.

The renal organ of *Paludomus* is greyish or whitish yellow in the living condition. It is situated at the apex of the body whorl. Starting from the apex of the body whorl in front of the anterior end of the style sac, it passes up on the right side of the style sac as far as the posterior chamber of the stomach. Its anterior end projecting into the mantle cavity is roughly triangular in shape. The total length of the kidney is about 4 to 5 mm. and its greatest width is 2 mm., while in the narrow part extending alongside of the style sac it measures 1 mm.



TEXT-FIG. 9.—The kidney viewed from the ventral surface. *r. ap.* renal aperture.

The renal aperture into the mantle cavity is situated quite at the apex of the mantle cavity, more posteriorly than is usually the case. It is placed on the right side, on the ventro-lateral aspect of the ascending part of the kidney, close to the intestine. It is slit-like, and elliptic in outline. The pericardial aperture is much smaller than the pallial

aperture and is placed on the pericardial aspect of the kidney. The intestine is placed dorsal to the kidney and is pushed down into it. In sections, this gives the appearance of the intestine being almost surrounded by the kidney.

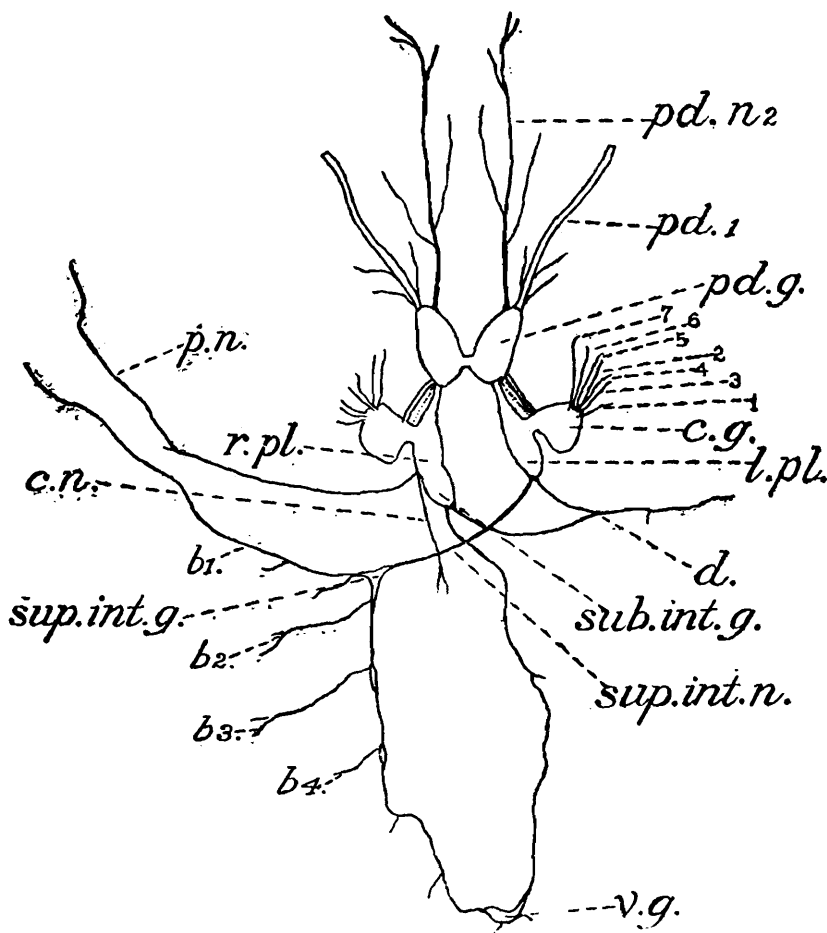
Internally the cavity of the kidney is traversed by numerous transverse septa. In a transverse section, the posterior part of the kidney lying between the style sac and the intestine appears roughly triangular in outline with the base being dorsal and the apex being near to the style sac. Running from the dorsal wall to the ventral are lamellae between which are blood spaces. Each lamella is composed of a double layer of renal epithelium enclosing a blood space. The renal cells are cubical with a homogeneous cytoplasm and usually vacuolated in the distal part. The nuclei are round and possess distinct, round nucleoli. In some of the cells, the nuclei are not seen.

The blood spaces in the lamellae communicate with the abdominal sinus surrounding the upper part of the intestine. The renal vein leaves the kidney ventrally in the anterior part. A blood-gland is absent.

The renal opening into the mantle cavity is lined by ciliated and gland cells and beneath the epithelium a well developed layer of muscles is seen. The reno-pericardial passage is lined by ciliated cells.

THE NERVOUS SYSTEM.

In the family Melaniidae, Bouvier (8) studied the nervous system of *Melania*, *Faunus* and *Melanopsis*. The study of the nervous system of *Paludomus* shows that it comes very close to that of *Melania* in all important features.



TEXT-FIG. 10.—The nervous system. 1 to 7. cerebral nerves; b_1 . anterior branchial nerve; b_2 , b_3 , b_4 , branchial nerves; $c. g.$ cerebral ganglion; $c. n.$ columellar nerve; $d.$ dialyneury; $l. pl.$ left pleural ganglion; $p. n.$ pallial nerve; $pd. g.$ pedal ganglion; $pd_1 n.$, $pd_2 n.$ dorsal and ventral pedal nerves; $r. p.$ right pleural ganglion; $sub. int. g.$ sub-intestinal ganglion; $sup. int. g.$ supra-intestinal ganglion; $sup. int. n.$ supra-intestinal nerve; $v. g.$ visceral ganglion.

The cerebral ganglia have a thick investment of connective tissue which has to be removed carefully in exposing them. They are oval in shape and their broad inner ends are united by a very short broad commissure. Each cerebral ganglion gives rise to seven nerves besides the nerve to the statocyst. The number, mode of origin and distribution of these nerves differs to some extent from what was described by Bouvier (8) for *Melania*.

(i) Arising dorsally from the outer lateral surface of the cerebral ganglion is a short slender nerve which proceeds to the side of the snout in front of the posterior retractor of the buccal mass. Bouvier (8) does not mention any such nerve in the case of any of the species of *Melania*. (ii) Anterior to this, arising dorsally from the anterior border of the cerebral ganglion, is a slender nerve, which, running forwards, divides into two branches and finally proceeds to the integument of the snout, in front of the tentacle. (iii) and (iv) Slightly posterior to the above nerve, arise the tentacular and ocular nerves which run more or less parallel to each other. The tentacular nerve is thicker than the ocular nerve and after passing into the tentacle, gives off a branch. (v) Slightly ventral to these, arises what may be called the proboscidian nerve which runs forward and divides into two branches proceeding to the dorsal part of the oral region. (vi) The next one is the labial nerve proceeding to the oral region. (vii) The ventral-most or innermost one is the buccal nerve which is well developed and fairly long. It gives off a labial nerve while the main nerve enters the buccal mass in front, and after giving off a small nerve to the anterior part of the buccal mass, runs backwards under the superficial muscles of the buccal mass and arrives in the buccal ganglion. The buccal ganglia are oval with their narrow ends connected by a fairly long commissure, and situated ventrally one on either side of the posterior part of the buccal mass. Each buccal ganglion gives off two nerves. The arrangement of the buccal connective is similar to the condition obtaining in *Melania* and *Cerithium*. (viii) The nerve of the statocyst arises close to and inside of the origin of the cerebro-pedal connective. It is free throughout its course and runs between the cerebro-pedal and pleuro-pedal connectives.

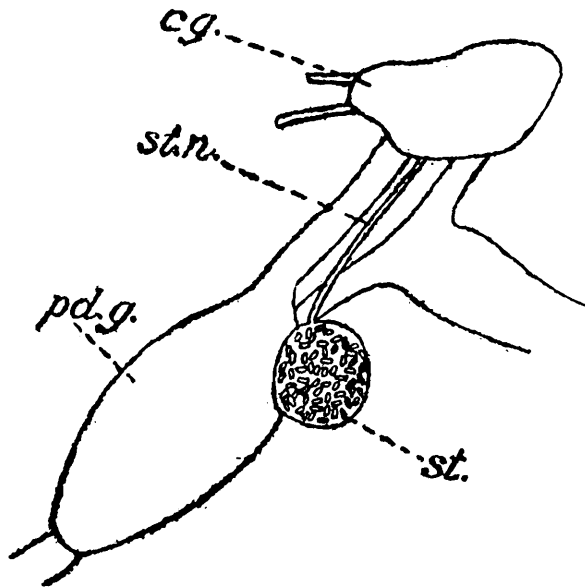
In the arrangement of the lateral centres *Paludomus* shows very close resemblance to *Melania*. The pleural ganglia are approximated to the cerebral, being connected to them by very short connectives, unlike the condition seen in *Melanopsis*. The right pleural ganglion is a somewhat spindle-shaped ganglion which gives rise to the supra-intestinal nerve and the right pallial nerve. The supra-intestinal nerve is a thick nerve which proceeds to the supra-intestinal ganglion. The left pleural ganglion is oval in shape and gives rise to two nerves (a) the left pallial nerve which proceeds to the anterior part of the mantle and (b) a slender nerve which runs down to the columellar muscle.

The sub-intestinal ganglion is in contact with the left pleural. Besides the right visceral nerve, it gives off a pallial nerve which proceeds to the right and joins the right pallial nerve from the right pleural ganglion, thus presenting a dialyneurous condition. The common nerve thus formed passes into the mantle on the right side and after giving off a branch proceeds to the genito-rectal region. This anastomosis differs from that seen in *Melania costata* and *M. tuberculata* in being much shorter and approaches the condition described for *M. amarula*. In fact, the anastomosis can be seen on opening the animal without much dissection.

The right visceral nerve has a slightly wavy course and in its course gives off one nerve. The supra-intestinal ganglion is triangular in outline and gives rise to two chief nerves, the 'anterior branchial' nerve

and the left visceral nerve. Close to its origin the anterior branchial nerve gives a fine branchial nerve and further on another slender nerve. After passing into the mantle it turns forwards and a fine nerve from the left pallial nerve runs towards this, but I have not been able to observe any anastomosis. The left visceral nerve is thinner than the right one and gives off three branchial nerves, the first one arising from it close to its origin from the supra-intestinal. Usually two small ganglia are seen in the course of the left visceral nerve. The visceral ganglion is slightly curved and situated close to the region of the renal aperture. It gives off two nerves one of which proceeds to the kidney.

The pedal ganglia are somewhat elongate and oval in shape and longer than the cerebral ganglia. The pleuro-pedal and the cerebro-pedal connectives are of moderate length, being much shorter than those of *Melanopsis* and slightly shorter than those of *Melania costata*. The two pedal ganglia are connected by a short narrow commissure situated in the upper part. The pleuro-pedal connectives are thicker than the cerebro-pedal. The pedal ganglia are produced into two thick ventral pedal cords which run to the posterior part of the foot. Close to its origin each pedal cord gives rise to two nerves, one on either side, and another nerve arises on the outer side a little further on. Arising dorsally and towards the inside of each pedal ganglion a thinner cord arises and runs parallel to its fellow. Each of these dorsal cords gives off a number of nerves but does not anastomose with its fellow. From the outer, lateral surface of each ganglion arises a short nerve to the sides of the foot. The pleuro-pedal cord close to its junction with the pedal ganglion, gives off laterally a short nerve.



TEXT-FIG. 11.—The statocyst and its nerve. *c. g.* cerebral ganglion; *pd. g.* pedal ganglion; *st.* statocyst with statoliths; *st. n.* nerve of the statocyst.

The statocysts are spherical and are situated in the upper part of the ventral surface of the pedal ganglion. The course of the nerve to the statocyst has already been described. The statocyst is spherical being about 0.3 mm. in diameter and is filled with numerous more or less oblong statocysts, the sides of which are slightly convex. The number

of statoliths varies in the family Melaniidae, as stated by Bouvier (8). In *Melania tuberculata*, *M. costata* and *M. amarula* according to Bouvier (8) the statocyst contains a single, round statolith. In *M. asperata* the statoliths are said to be numerous and so is the case with *Melanopsis*. In *Nassopsis* and *Bythoceros* also, the statocysts contain numerous statoliths. The statocyst in *Paludomus* is surrounded by connective tissue. Immediately outside the epithelium of the statocyst is a layer of muscle fibres. The epithelium consists of short cubical cells with large nuclei. Cilia could not be made out ; however, some of the cells appeared to have short processes.

The structure of the eye is of the usual type and does not call for any remarks. The tentacles have already been described.

The general shape and position of the osphradium have been described already. The osphradium is placed over a nerve and consists of (i) sensory cells, (ii) gland cells and (iii) ciliated cells. The sensory cells are columnar and possess oval nuclei. The gland cells are of the usual type and found between the sensory cells. The ciliated cells are found towards the base of the osphradium on the lateral edges.

It now remains to consider whether the nervous system of *Paludomus* shows any relationship at all to that of the African Melaniidae described by Moore (17). There is practically no resemblance to the archaic condition seen in *Nassopsis*. As for *Bythoceros*, *Paludomus* shows some resemblance in the disposition of the cerebral ganglia, in the dialynerous condition and in the approximation of the left pleural and the sub-intestinal ganglia. But the pleuro-pedal and the cerebro-pedal are shorter in *Paludomus* and the recurrent part of the buccal nerve passing to the buccal ganglion at the posterior end of the buccal mass is longer than in *Bythoceros*.

THE REPRODUCTIVE SYSTEM.

The reproductive system of *Paludomus* is peculiar among the Melaniidae and differs from what has been described in the other genera *Melania*, *Bythoceros*, *Nassopsis* and *Faunus*.

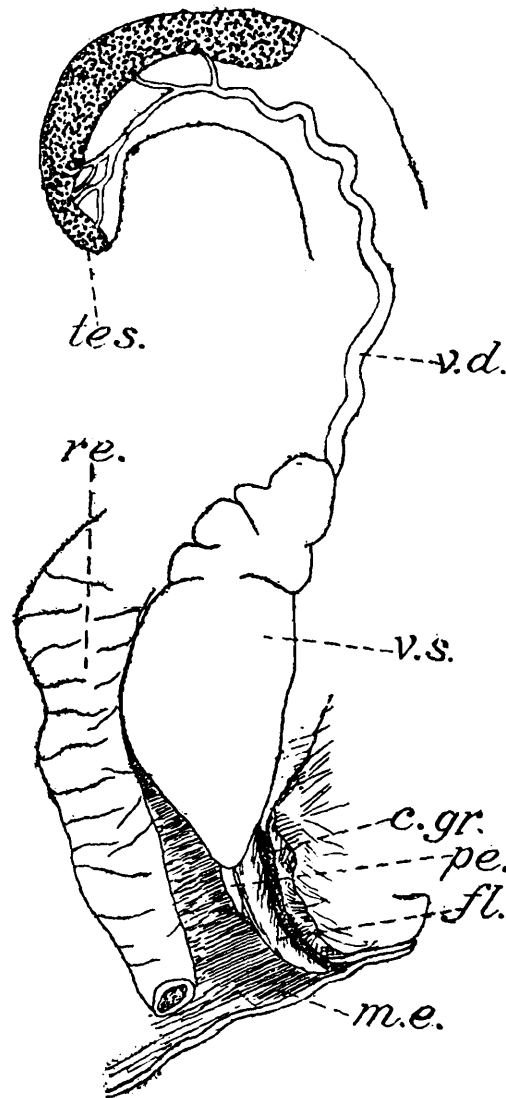
The animal is dioecious, but except for the slightly larger size of the body-whorl in the female, there is nothing to mark the sexes externally.

The Male Reproductive System.—The male reproductive system consists of the testis, the vas deferens, an enlargement of the vas deferens and the penis.

The testis is of an orange colour and occupies the dorsal and right lateral aspects of the first and second whorls of the animal and overlies the digestive gland. Anteriorly it extends very nearly to the posterior end of the stomach. It measures about 7 mm. in length and consists of tubular follicles. From these a few chief ducts arise and lead into the vas deferens which runs on the columellar side of the apical whorls. In its lower part which lies below the stomach, the duct becomes stouter and somewhat coiled.

On reaching the mantle cavity, the vas deferens presents an enlargement which may be termed the seminal vesicle. It opens anteriorly by a slit-like aperture which is bounded on one side by a flap extending beyond the genital duct for about 2 mm., i.e., as far as the anal region

The area bounded by the flap is in continuation of the genital aperture and represents the vestigial, ciliated groove present in the reproductive

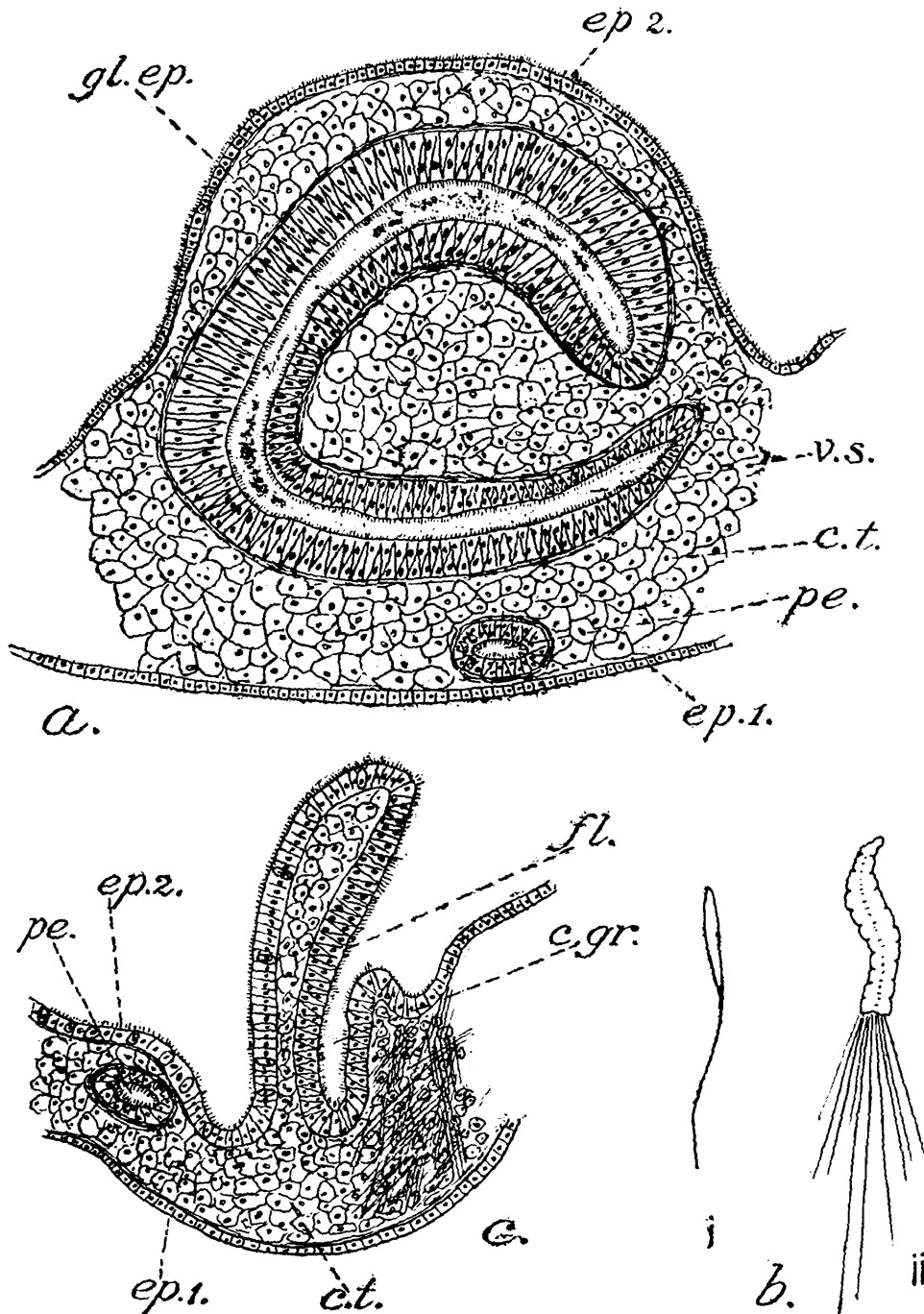


TEXT-FIG. 12.—Male reproductive system. *c. gr.* ciliated groove; *fl.* flap bounding the ciliated groove; *m. c.* mantle edge; *pe.* penis; *re.* rectum; *tes.* testis; *v. d.* vas deferens; *v. s.* seminal vesicle.

systems of the less specialised forms. The flap arises from the ventro-lateral edge of the enlargement of the vas deferens, or seminal vesicle. In the enlargement of the vas deferens two parts can be made out externally, an upper or posterior, triangular and comparatively thin-walled part measuring about 2 or 3 mm. and a lower thick walled portion about 4 mm. in length. From the posterior part of this enlargement of the vas deferens a long and slender tubular structure, the penis, arises, and after passing on it for some length, runs forward in the connective tissue of the mantle and lies on the rectal side of the genital duct. It tapers at its free end and measures about 4 to 5 mm.

The cavity of this lower part of the vas deferens is rendered crescentic in section owing to its wall being pushed in on one side. In the presence of this curious copulatory organ *Paludomus* differs from the other Melaniidae. Bouvier (8) states that he did not observe a penis in the Melaniidae studied by him, although Fischer had mentioned the presence

of a penis at the back of the tentacles. In *Bythoceros* the male genital duct is enlarged, but not like that seen in *Paludomus*, and the penis is absent. In *Nassopsis* the genital duct is simple and shows no modification in the mantle cavity. In the possession of the penis besides the genital aperture, *Paludomus* resembles *Typhobias*, but in the latter the penis is developed from the mantle and is muscular, according to Moore (15).



TEXT-FIG. 13.—a. Section of the male reproductive system through the seminal vesicle and penis. c. t. connective tissue; ep₁, ep₂. outer and inner epithelium of the mantle; gl. ep. glandular and ciliated epithelium of the seminal vesicle; pe. penis; v. s. seminal vesicle.

b. (i) eupyrene sperms; (ii) oligopyrene sperms.

c. Section through the male reproductive system in the region of the groove and flap. c. gr. ciliated groove; c. t. connective tissue; ep₁, outer epithelium of the mantle; ep₂, inner epithelium of the mantle; fl. flap; pe. penis.

The sperms are of two kinds, eupyrene and oligopyrene. The eupyrene sperms measure about 14μ exclusive of the tail which measures about 26μ . The oligopyrene sperms measure about 20μ and bear a tuft of cilia, about ten in number and measuring about 40μ . The oligopyrene, when examined alive in fresh smear preparations, wriggle about.

The testis is covered by a single layer of cubical epithelium similar to and continuous with the general body epithelium. The investing epithelium consists of cubical cells with large oval nuclei. Beneath the epithelium are muscle fibres running transversely and underneath them lies connective tissue with blood spaces. The tubules of the testis lie in this connective tissue by which they are separated from one another. The tubules have a thin investment of connective tissue and their walls are composed of a protoplasmic layer in which nuclei of the sperm mother cells or spermatocytes are found. The spermatocytes develop into spermatogonia that project into the cavity of the tubule.

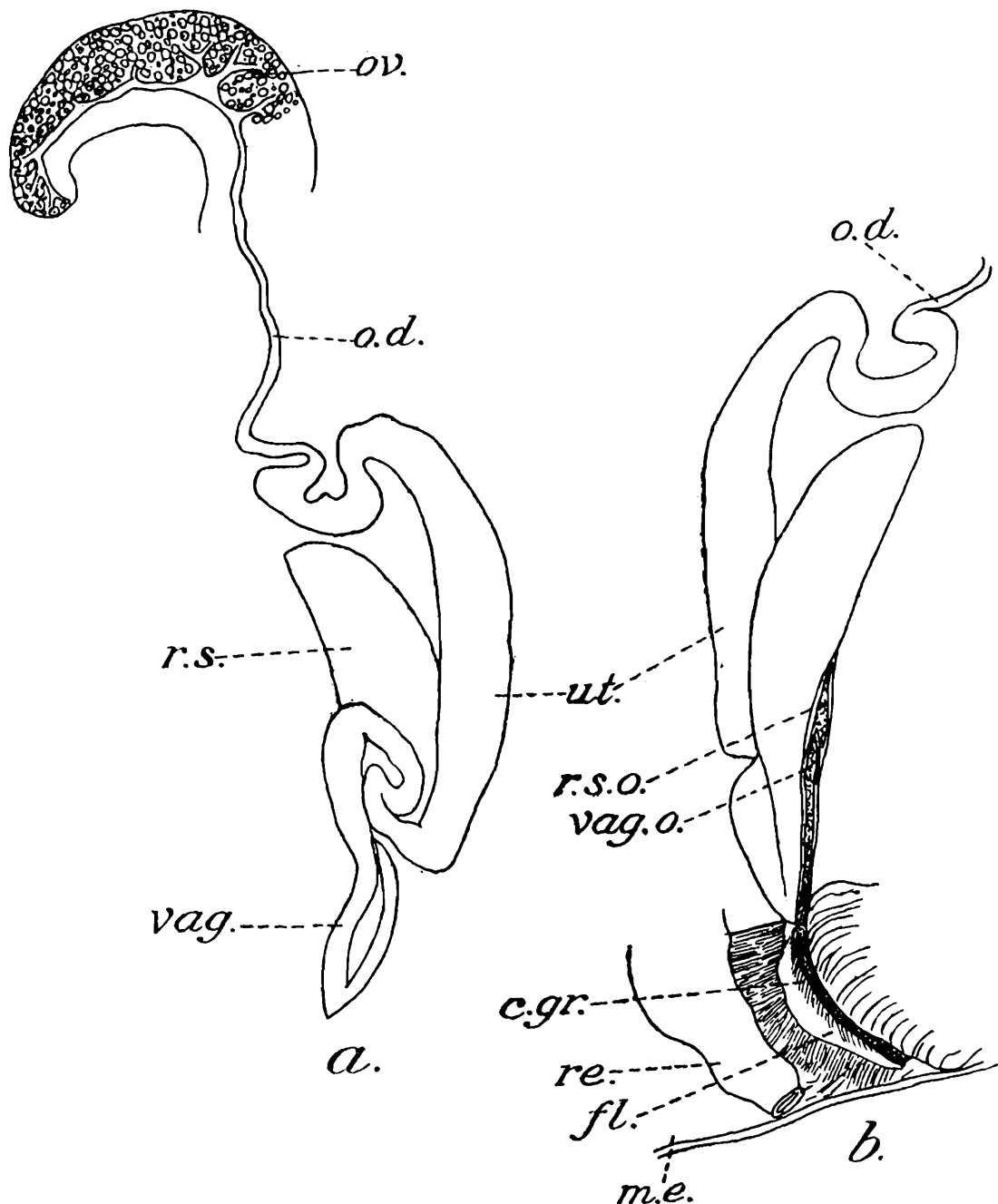
The vas deferens has an epithelium composed of cubical, ciliated cells, and is surrounded by muscle fibres.

The swollen part of the vas deferens or seminal vesicle lying in the mantle cavity has a thick investment of connective tissue in common with that surrounding the penis. The cavity of this enlargement is narrow and, as already pointed out, crescentic in section. The walls are thick and covered on the outside by muscle fibres. In transverse section the whole structure appears C-shaped and the narrow cavity is lined by ciliated and glandular epithelium. Owing to the presence of two kinds of cells, gland cells and ciliated cells, the nuclei appear at two different levels. The ciliated cells are narrow and possess oval nuclei which are rather distally placed, whereas the gland cells have basally placed nuclei. The penis, in transverse section, appears elliptic in outline. Its cavity is merely a narrow continuation of that of the enlargement of the vas deferens, and its histological structure is the same. The groove also is lined by ciliated and glandular epithelium continuous with that of the seminal vesicle. The flap guarding the groove is lined on the side facing the groove by glandular and ciliated epithelium continuous with that of the groove. The outer side is composed of epithelium continuous with that of the inner surface of the mantle.

The Female Reproductive System.—The female reproductive system consists of (i) the ovary (ii) the oviduct (iii) the uterus (iv) the vagina (v) the receptaculum seminis and (vi) as in the male, a flap guarding on one side a ciliated furrow.

The ovary occupies a position corresponding to that of the testis in the male. The colour of the ripe ovary is grey with interspersed yellowish, circular patches. The ovary is a racemose structure consisting of much branched tubular follicles, from which small tubules arise and lead into about seven or eight larger ducts which finally join the oviduct. The lower or the anteriormost duct is stouter than the others and receives four smaller branches. The oviduct runs on the columellar side of the digestive gland and the stomach, and on entering the mantle cavity, enlarges into the thick walled uterus. The oviduct is about 4 or 5 mm. long and yellowish in colour. The lower part of the female genital duct

lying in the mantle cavity is peculiar. The uterus in its lower part turns up to take a sharp bend and after once more becoming doubled on itself

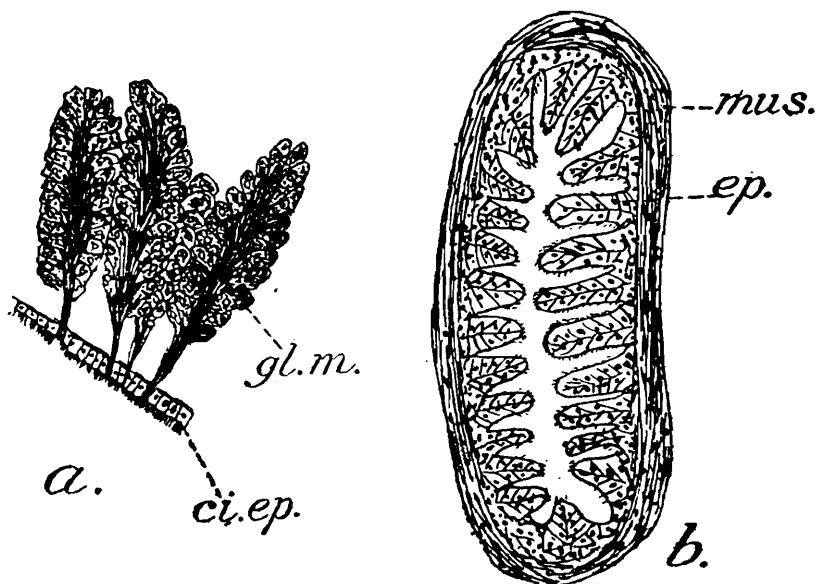


TEXT-FIG. 14.—*a.* Dorsal and *b.* ventral views of the female reproductive system. *c. gr.* ciliated groove; *fl.* flap; *m. e.* mantle edge; *o. d.* oviduct; *ov.* ovary; *re.* rectum; *r. s.* receptaculum seminis; *r. s. o.* opening of the receptaculum seminis; *ut.* uterus; *vag.* vagina; *vag. o.* vaginal opening.

passes into the vagina. The vagina is oval in outline. Lying in the same plane as the uterus and vagina, there is a roughly triangular thin walled sac which appears to be a receptaculum seminis and not a brood pouch. The internal structure and the absence of any traces of embryos in the numerous specimens examined by me lead me to consider this sac a receptaculum seminis. The receptaculum seminis and the vagina open into a kind of furrow guarded by a flap extending, as in the male, for a length of about 2 mm. in front of the vagina. The flap extends from

the surface of the vagina and is continuous with the spermatheca also. The uterus is about 5 or 6 mm. in length and has thick glandular walls. The walls of the vagina and the uterus develop a creamy-white colour in mature specimens, which is seen conspicuously on the outer surface of the mantle.

The ovary is covered by a thin epithelium which is a continuation of the general body epithelium and underneath this there is connective tissue. The follicles which are roughly oval in section consist of a thin germinal epithelium from which ova in different stages of growth project into the cavity of the follicle. The ripe oogonia are found filled with yolk. The oviduct is lined by columnar ciliated cells. The cavity of the uterus also is lined by columnar ciliated cells. The thickness of the uterine wall in the upper part is composed of elongate saccular gland masses composed of groups of cells with ill defined cell-limits and round nuclei. These glands open between the epithelial cells into the cavity of the uterus. In the lower part of the uterus and the vagina, the walls, as already stated, have a creamy white colour, and the histological structure, though really the same as that of the upper part of the uterus presents often a different appearance. The cavity is roughly U-shaped. One limb of the U-shaped cavity develops in its walls, on either side, glandular tissue similar to that seen in the upper part of the uterus, but deep staining and with cell details obliterated. The gland masses open by narrow necks between the ciliated cells. Each gland mass consists of gland cells arranged round a central lumen and appearing like saccular glands opening into the uterine cavity between the epithelial



TEXT-FIG. 15.—*a.* The gland-masses of the vaginal wall. *ci. ep.* ciliated epithelium; *gl. m.* gland mass.
b. Section through the receptaculum seminis. *ep.* epithelium; *mus.* muscle.

cells. The other limb of the cavity is usually not invested with glandular tissue. This condition is similar to what I described in *Mysorella*. The inner side of the flap, and the groove are lined by an epithelium continuous with that of the vagina.

The receptaculum seminis, has a characteristic appearance in section. It has an investment of muscle fibres and its epithelium is thrown into finger shaped processes and is composed of columnar, glandular and ciliated cells, with basally placed nuclei, and with cytoplasm staining light pink with eosin. The ciliated cells seem to become transformed into the gland cells by the loss of the cilia. A brood pouch, as described for *Melania*, is not found in *Paludomus*. I examined a very large number of specimens in the different seasons of the year and no trace of 'vivipary' could be found. The species seems to be oviparous as Ramanan (25) has recorded.

The above account of *Paludomus* will show that its reproductive system is unlike that of any other genus in the Melaniidae, so far as is known to us. *Paludomus* has to be considered as a specialised form. The open groove present in the less specialised forms like *Melania episcopalpis* as described by Moore (16) is indicated in *Paludomus* by the very short furrow, guarded by a flap extending anteriorly for a distance of 2 mm. from the genital aperture.

Summary and Conclusion.

1. The complete anatomy of *Paludomus tanschaurica* is described.
2. The foot possesses a well developed pedal gland.
3. The structure of the mantle and the mantle processes is described.
4. The mantle processes, which are present, do not have the same function as those in the Viviparidae. No function is definitely assigned to them, but the presence of the sinuses would show that they may subserve as accessory respiratory organs.
5. The shell secreting region of the mantle differs from that of the Viviparidae in one respect. The shell gland does not open on a supra-marginal ridge but into the supramarginal groove which is found fairly well developed only in young animals.
6. The mantle floor shows a low ridge on the right side bounding a shallow groove and running from the apex of the mantle cavity to the right tentacle. The epithelium over the efferent ctenidial vessel is peculiar in being high and composed of well developed gland cells and ciliated cells. The ridge and this epithelium may be useful in directing the currents of water.
7. The buccal cartilages are connected *dorsally* by a broad transverse band of muscle.
8. The radula resembles in the nature of its marginals that of *Melanoides tuberculata*.
9. The salivary glands are fairly long, coiled, simple tubular structures.
10. The digestive gland shows two types of cells, the gland cells and the ferment cells, according to their staining reaction. The ferment cells undergo division in the tubules, and in some specimens, especially in those infected with parasites, all the cells of the digestive diverticula are uniformly made of ferment cells. It is quite probable that, as in Lamellibranchs, the ferment cells represent a stage in the development of the gland cells.

11. The pallial circulation in the anterior part of the mantle is interesting in the presence of a circumpallial vessel receiving a ramification of vessels in front of, as well as behind it, and communicating on the left side with the efferent ctenidial vessel.

12. The renal organ is a simple sac-like organ with its cavity traversed by transverse septa.

13. The nervous system resembles in general that of *Melania* in being dialyneurous, in the approximation of the sub-intestinal ganglion to the left pleural and in the nature of the buccal nerves.

The general tendency in *Paludomus* is towards greater concentration. The statocyst contains numerous statoliths unlike the statocysts of *Melania tuberculata*, *M. amarula*, which, according to Bouvier (8) have a single statolith.

14. The reproductive system does not resemble that of any other Melaniid described so far. The male reproductive system is interesting in having (a) an enlargement or seminal vesicle in the mantle cavity, (b) a slit-like aperture and (c) a flagellum-like penis. The sperms are of two types, eupyrene and oligopyrene. The female reproductive system possesses a uterus and vagina with glandular walls and a receptaculum seminis. There is no brood pouch as in *Melanoides*. In both sexes there is a short furrow of about 2 mm. guarded by a flap leading from the genital aperture to the mantle edge. This is the vestigial form of the ciliated groove found in the less specialised types of reproductive system.

15. The animals withstand dessication in the laboratory for over two months.

This account of *Paludomus tanschaurica* will show that its resemblances are to *Melania* especially forms like *Melanoides tuberculata* and *Melania amarula*. The resemblances are chiefly with reference to the nervous system. With regard to the reproductive system *Paludomus* stands by itself and shows features of specialisation in both sexes in the development of accessory structures.

In conclusion I have to express my best thanks to Dr. Bains Prashad for encouragement and the interest he has taken in the progress of my work.

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NOTES ON THE BIONOMICS OF *TROCHUS NILOTICUS* LINN.¹

3. SUR UN COPÉPODE PARASITE DE *Trochus niloticus*.

Par THÉODORE MONOD, Docteur ès-sciences, *Museum National d'Histoire Naturelle, Paris*.

***Panaietis incamerata* Stebbing 1900.**

1900. *Panaietis incamerata*, Stebbing, *Wiley's Zoological Results*, V, pp. 666, 667, pl. lxx, fig. E.

1932. *Panaietis incamerata*, Monod et Dollfus, *Ann. Parasitol.* X, p. 157, fig. 17 A.

Localité.—3 ♂, 21 ♀. dans la cavité buccale et l'oesophage d'un gastéropode, *Trochus niloticus* Linné, à Port Blair, Iles Andamans, Septembre 1932—Mars 1933. Ces spécimens m'ont été très obligeamment communiqués par Mr. Robert Gurney, auquel ils avaient été envoyés par le Dr. Bains Prashad, de l'Indian Museum. Je remercie vivement Mr. Robert Gurney de m'avoir ainsi permis l'étude d'une espèce intéressante et mal connue ainsi que le Dr. Bains Prashad pour l'hospitalité qu'il a bien voulu accorder à cette note dans les *Records of the Indian Museum*.²

Habitat.—L'unique exemplaire (♀) dont avait disposé Stebbing provenait de la cavité palléale d'un gastéropode indéterminé de *Panaieti*, Archipel de la Louisiade. La redécouverte de l'espèce aux Iles Andamans permet de donner une deuxième localité et de préciser l'identité de l'hôte, ou peut-être de l'un des hôtes seulement.

Remarques sur le genre Panaietis.—Sur la foi des documents publiés, très sommaires puisque les pièces buccales de *Panaietis* ne sont pratiquement ni décrites ni figurées par Stebbing, nous avons, R. Ph. Dollfus et moi, avoué récemment "l'impression" (1932, p. 156) que *Panaietis* Stebbing 1900 et *Conchocheres* G. O. Sars 1918 étaient synonymes. L'examen des spécimens andamans de *Panaietis incamerata* infirme notre supposition et nous oblige à restituer le genre *Panaietis*, dont la ♀ porte des maxillipèdes développés, à la famille des Lichomolgidae, tandis que *Conchocheres*, à ♀ sans maxillipèdes, demeure dans la famille des Clausiidae.³

¹ The second Note of this Series was published in *Rec. Ind. Mus.*, XXXVI, pp. 1—4 (1934).

² 15 spécimens (14 ♀, 1 ♂) ont été retournés à l'Indian Museum, 1 ♀ a été déposée au British Museum (Nat. Hist.), 1 ♀ chez Mr. Robert Gurney et 7 exemplaires (5 ♀, 2 ♂) ont été conservés à Paris.

³ Cette famille, très mal définie, n'est peut-être pas une groupe naturel. Si l'absence de maxillipède chez la ♀ n'est qu'un caractère générique, et si *Myicola* peut vraiment trouver place, comme le veut Wilson (1932, p. 346), dans les Lichomolgidae, il n'est pas invraisemblable que *Clausia* et *Conchocheres* ne puissent au jour en faire autant et qu'il faille—le jour où ces genres seront mieux connus considérer *Conchocheres* Pelseneer, et même *Strongylopleura* Pelseneer et *Ischnurella* Pelseneer comme des Lichomolgidae, vaste groupe sans doute infiniment plus polymorphe et plus difficile à définir qu'on ne l'a cru jusqu'à présent, alors qu'on n'avait affaire qu'aux genres typiques, plus ou moins cyclopoïdes. J'ajoute que le rapprochement de *Conchocheres* et de *Mytilicola-Tricicola* (Monod et Dollfus, 1932, p. 154) ne saurait être que provisoire et ne survivrait pas, bien entendu, à une absorption des Clausiidae (*sensu* G. O. Sars) par les Lichomolgidae.

Stebbing avait, à très juste titre (1900, p. 666) reconnu que son genre *Panaietis* était voisin d'*Anthessius* Della Valle et de *Paranthessius* Claus.

Remarques sur Panaietis incamerata.—La diagnose originale et les figures qui l'accompagnent étant incomplètes, parfois erronées, et ne concernant d'ailleurs qu'un des sexes, il m'a semblé utile de donner quelques dessins précis et une description sommaire de l'espèce.

Taille : 7 (♂) à 9 (♀) millimètres. *Corps* allongé, étroit, vermiforme légèrement dilaté dans la région céphalique, environ 5 fois plus long que

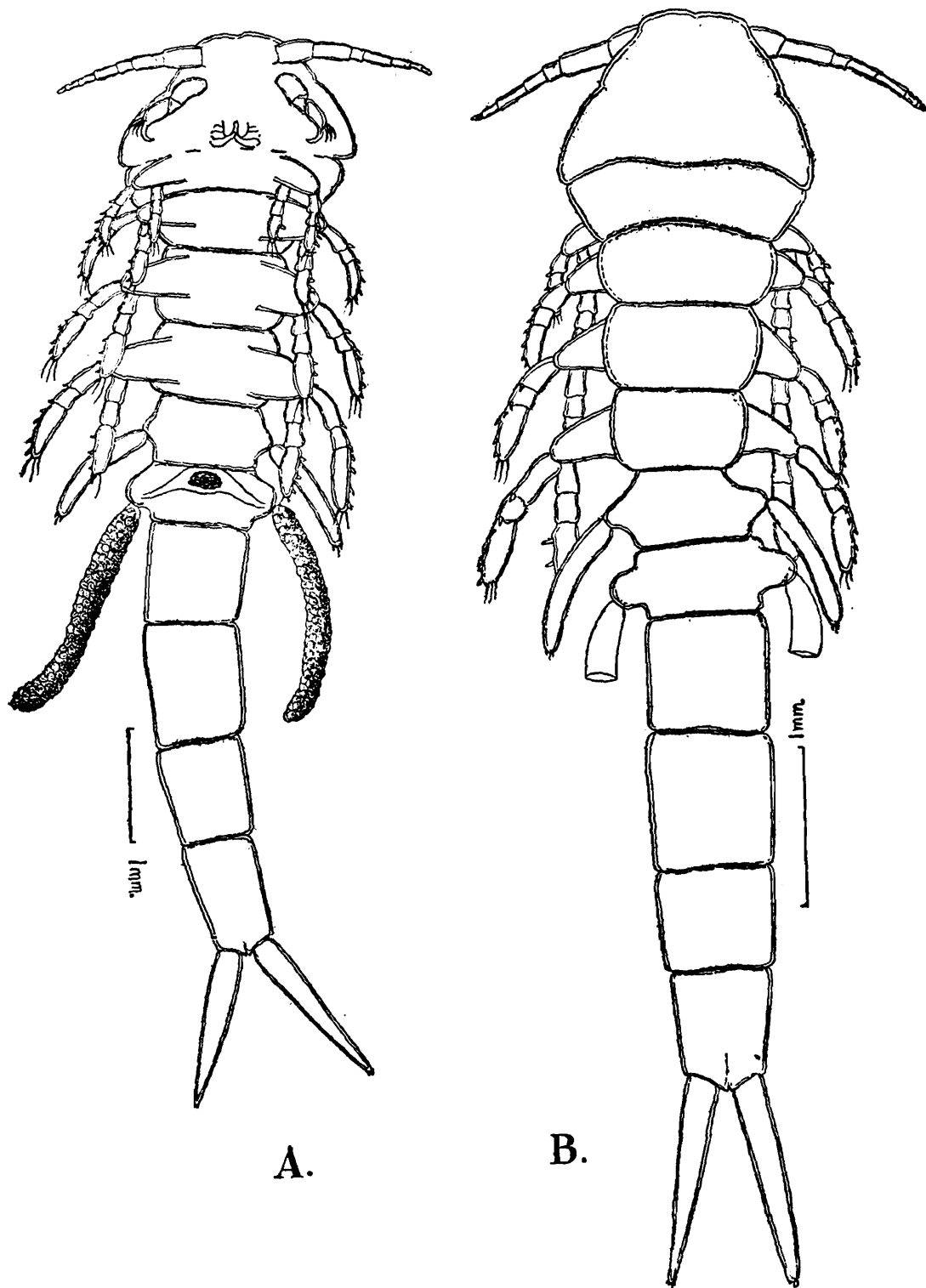


FIG. 1.—*Panaietis incamerata* Stebbing, A. B. ♀, ♀.

large (largeur maxima au bord postérieur de céphalon). Céphalon très court (env. 9 fois dans la longueur totale), notablement plus large que long, largement arrondi au bord frontal, à bord latéraux convexes, à bord postérieur subdroit. *Thorax* (env. $3\frac{1}{2}$ dans la long. tot.) à 5 somites pédigères libres, de largeurs décroissantes de I à IV, à bords latéraux légèrement et régulièrement convexes; V avec une saillie latérale marquée (insertion de la 5^e patte). *Abdomen* long ($\frac{3}{5}$ de la long. tot. environ), très étroit, 5-articulé dans les 2 sexes; somites II-V à bords rectilignes, sensiblement parallèles, sauf au V où les bords latéraux convergent un peu rostro-caudalement; segment génital ♀ très court, avec des lobes

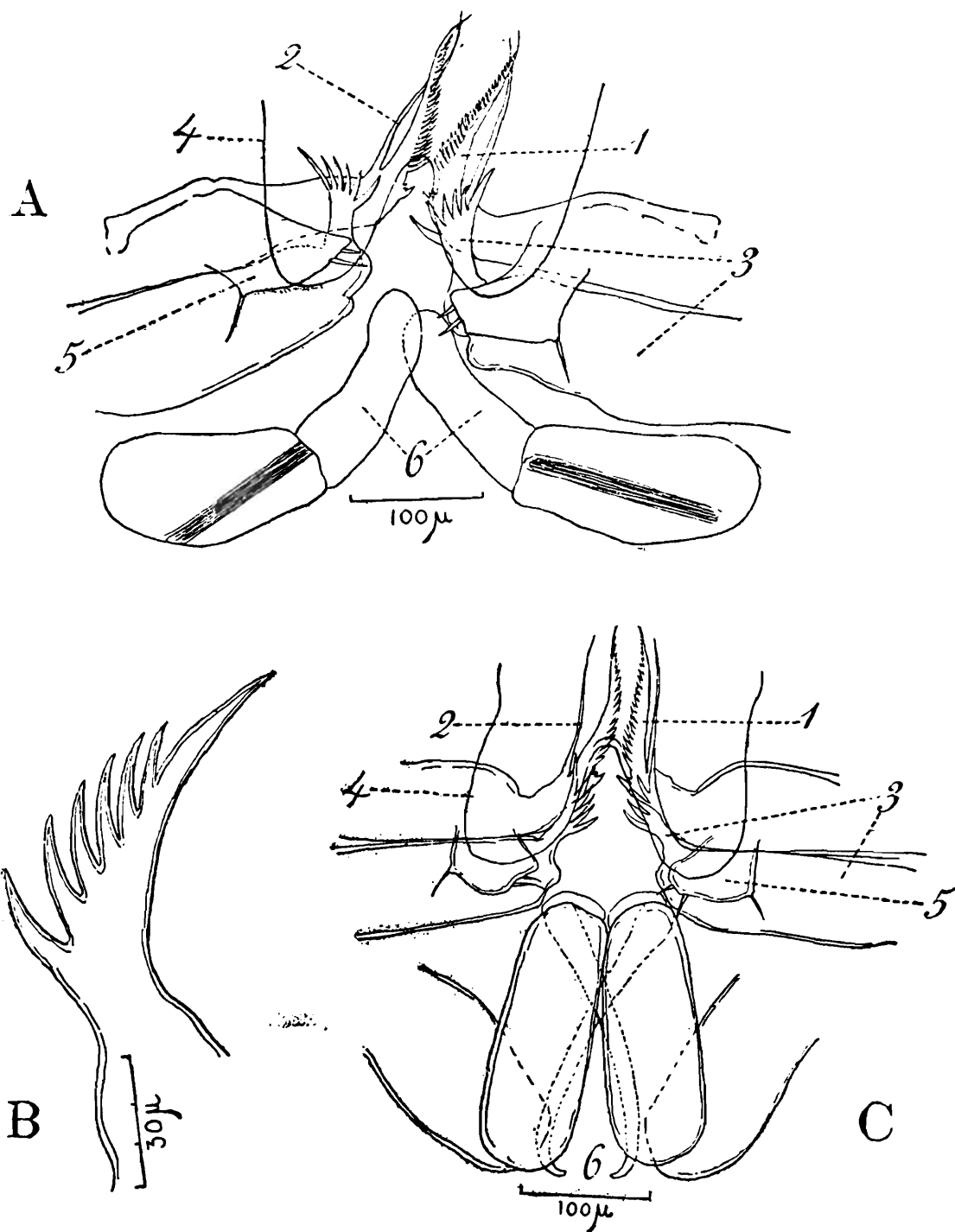


FIG. 2.—*Panzietis incamerata* Stebbing. A. ♀, pièces buccales; B. apex maxillaire; C. ♂, pièces buccales, 1. division interne et principale de l'apex mandibulaire; 2. division externe et accessoire de cet apex; 3. maxille; 4. labrum; 5. maxillule; 6. maxillipèdes.

latéraux hémisphériques¹ très saillants, le même segment proportionnellement plus long chez le ♂, à bords latéraux simplement convexes, avec 2 sétules aux angles caudo-latéraux, branches furcales longues (env. 1/6 de la long. tot.) simples, digitiformes, 6-7 fois plus longues que larges, terminées en pointe obtuse portant 4 sétules. Antennules normales, 7-articulées, sétigères. Antennes 3-articulées², trapues.

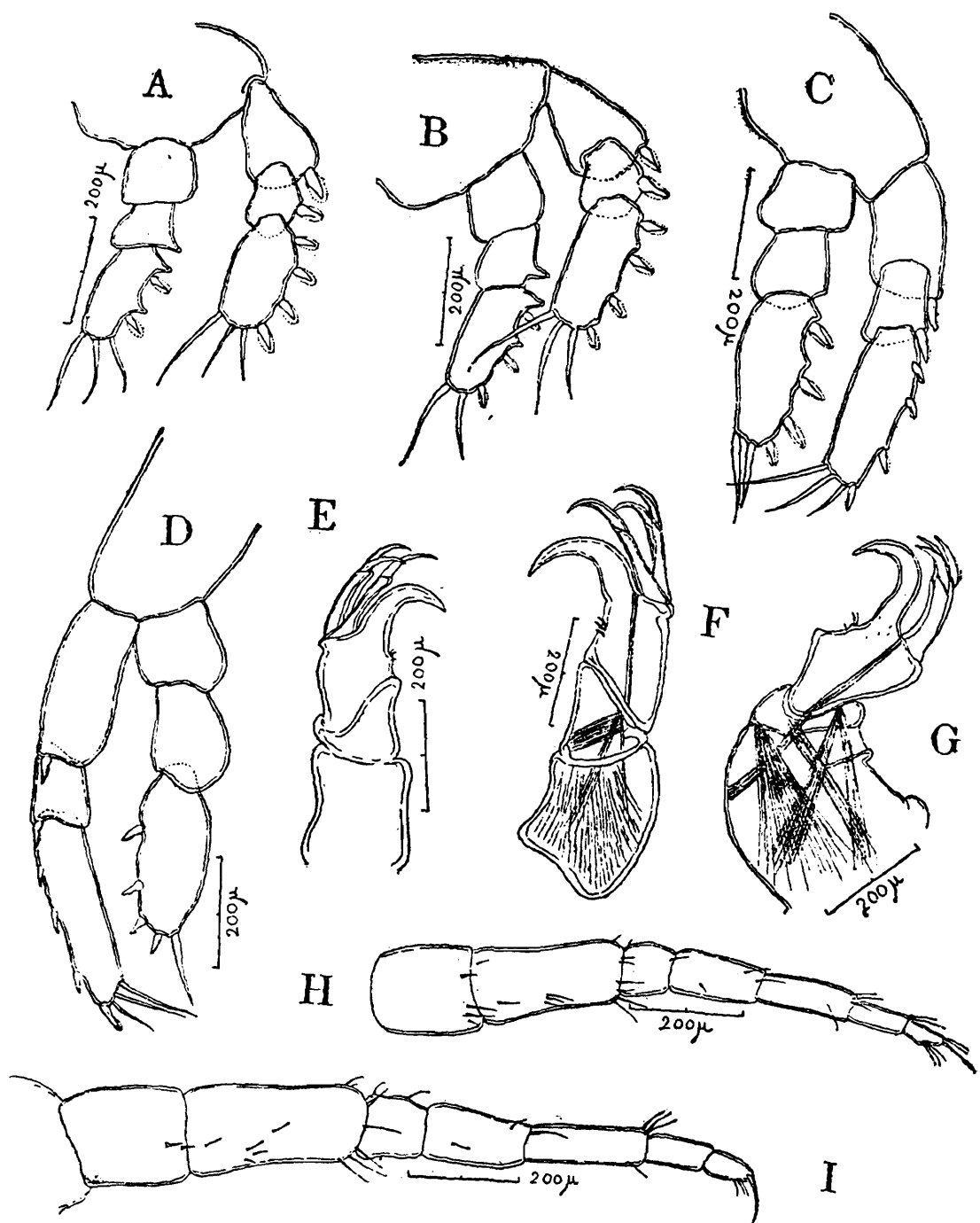


FIG. 3.—*Panaietis incamerata* Stebbing. ♂, A-D. pattes thoraciques i-v; E. antenne ♂; F. antenne ♀; G. antenne ♂; H. antennule ♂; I. antennule ♀.

¹ C'est par erreur que Stebbing (1900, p. 666) considère les saillies latérales du segment génital comme appartenant à la base d'un très long "premier" somite abdominal.

² Stebbing se trompe en donnant l'antenne comme 2-articulée (1900, p. 666, pl. lxx, fig. E ai, où le "muscle" est en réalité une limite articulaire) et Wilson, reproduisant cette erreur, place *Panaietis* (entrée 2/71 de la *Key to the genera of the suborder Cyclopoida* 1932, p. 583) dans les genres à antenne 2-articulée.

préhensiles ; 3^e- article portant 3 très petites sétules internes, une très puissante griffe et, extérieurement à celle-ci, 3 griffes beaucoup plus grêles. *Labrum* profondément bilobé, à lobes entiers et inermes. *Mandibule* bifide, étant terminée par une lame pectinée effilée et un flagelle accessoire, paraissant inermes et aussi long que la lame principale ; quelques denticules plus forts à la base de la partie régulièrement pectinée de celle-ci. *Maxillule* trapézoïdale, portant 3 sétules (1+2). *Maxille* terminée par un processus robuste portant 6-7 fortes épines. *Maxillipède* apparemment 2-articulé et inermes (chez la ♀, 3-articulé, et préhensile, avec un long dactyle falciforme portant 2 sétules à la base, chez le ♂).

Pattes thoraciques 1-IV à 2 rames 3-articulées ; chétotaxie (les épines sont des épines à frange et les soies sont glabres) : I, exopodite : art. 1, 1 épine ext., art. 2, 1 épine ext., art. 3, 4 épines ext. + 3 soies apicales ; endopodite : art. 1, inermes, art. 2, inermes, art. 3, 2 épines ext. + 3 soies apicales. II, exopodite : art. 1, 1 épine ext., art. 2, 1 épine ext., art. 3, 4 épines ext. + 3 soies apicales ; endopodite : art. 1, inermes, art. 2, inermes, art. 3, 3 épines ext. + 2 soies apicales. III, exopodite : art. 1, 1 épine ext., art. 2, 1 épine ext., art. 3, 4 épines ext. + 2 soies apicales. IV, exopodite : art. 1, 1 épines ext., art. 2, 1 épine ext., art. 3, 4 épines ext. 3 soies apicales ; endopodite : art. 1, inermes, art. 2, inermes, art. 3, 4 épines ext. 1 soie apicale. Les seuls différences entre le ♂ et la ♀ concernent les pattes I et II qui ont, chez le ♂, 3 protubérances coniques supplémentaires au bord externe de l'endopodite (1 à l'article 2, 2 à l'article 3). *Patte thoracique* V grêle, cylindroïde, étroite, env. 6-7 fois plus longue que large, légèrement arquée et entièrement glabre, à l'exception de l'apex, muni de 2 spinules et d'une sétule. *Sacs ovigères*, en cordons

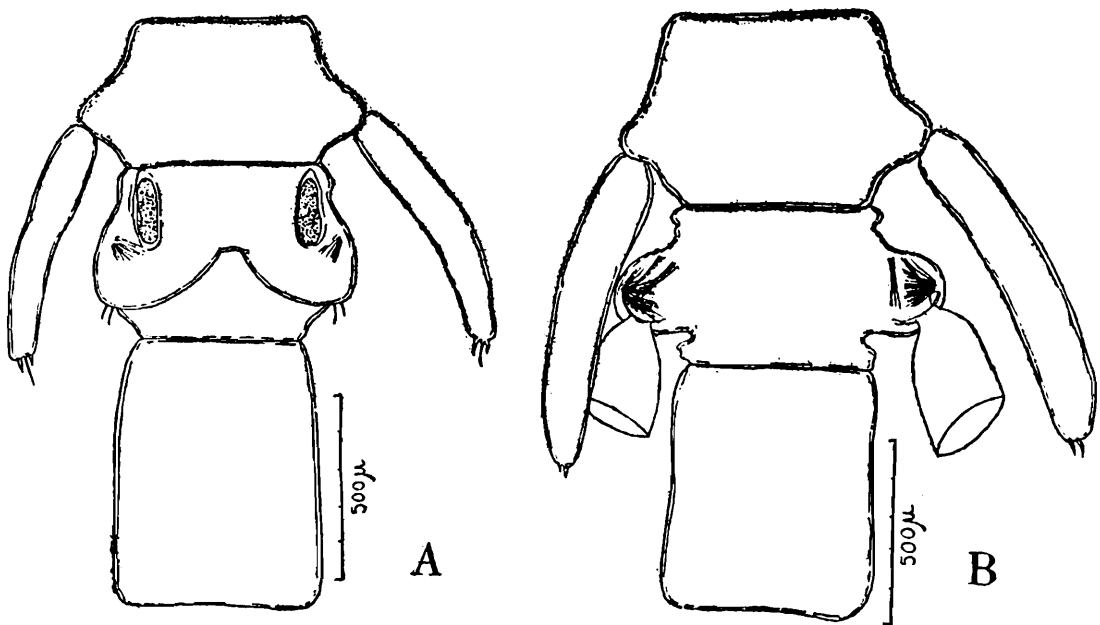


FIG. 4.—*Panaietis incamerata* Stebbing. A. ♂ 5^e somite thoracique, segment génital et 2^e somite abdominal ; B. ♀, *id.*

grêles, à oeufs multisériés, plus ou moins longs, pouvant atteindre presque l'extrémité caudale mais ne semblant jamais la dépasser.

Anatomie interne : réceptacle séminal ovalaire ou globuleux, allongé transversalement, ne dépassant pas, ou à peine, en avant, la limite du

segment génital; ovaire céphalique, paraissant entièrement double; oviductes pénétrant parfois dans la base des pattes.

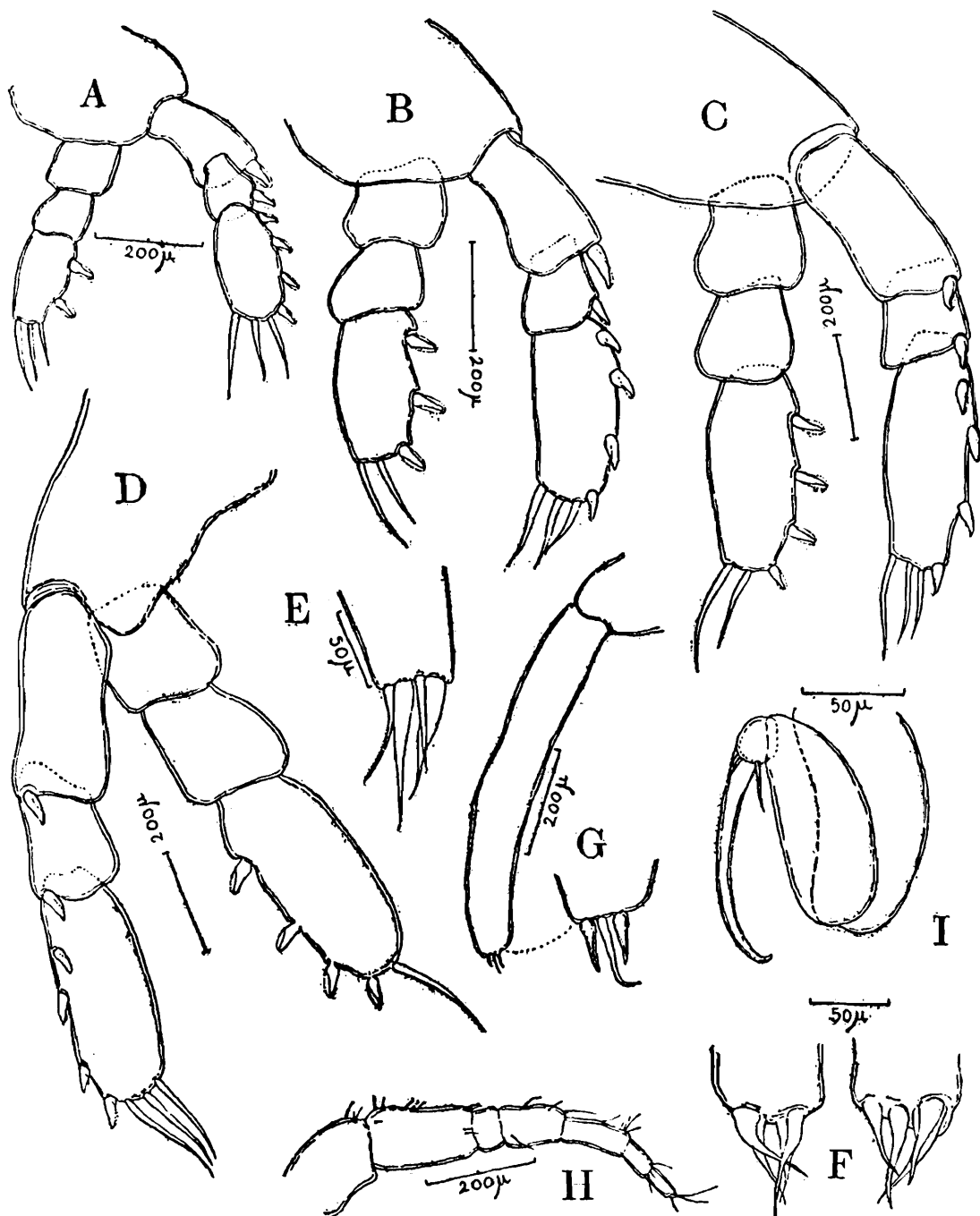


FIG. 5.—*Panaietis incamerata* Stebbing. A-D. ♀, pattes thoraciques i-v; E, F. id., extrémités de branches furcales; G. 5^e patte thoracique ♂; H. antennule ♀ juv.; I. maxillipède ♂.

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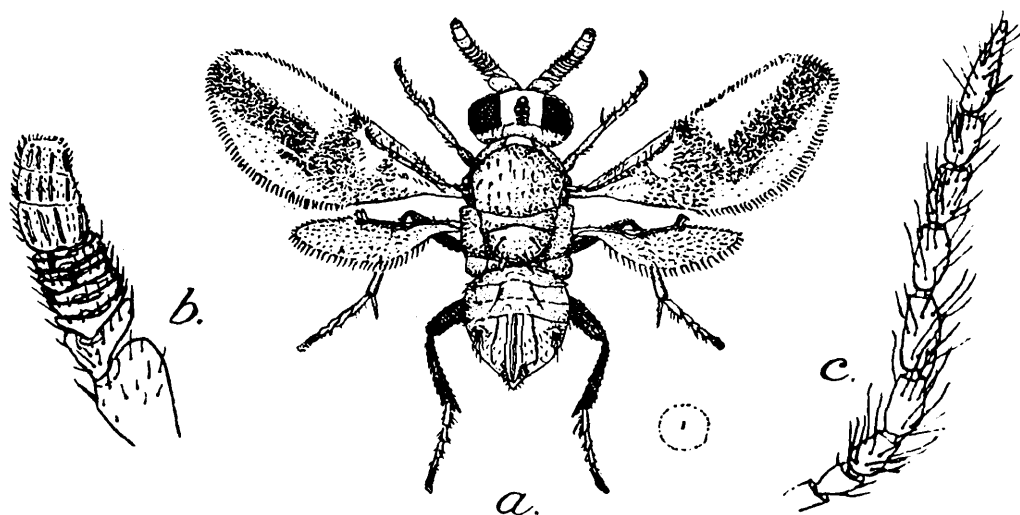
FIRST RECORD OF THE CHALCID GENUS *COMPERIELLA* HOWARD FROM INDIA WITH A DESCRIPTION OF A NEW SPECIES.

By T. V. RAMAKRISHNA AYYAR, B.A., Ph.D., Madras Agricultural Department, Coimbatore.

The genus *Comperiella* was established by L. O. Howard (3) in 1906 to include an extremely interesting Chalcid wasp collected by the famous parasite hunter George Compere from China, with *C. bifasciata* as the type-species. Since then three more species of this genus have been described: *C. pia* from Australia by Girault in 1915, *C. cerapterocera* by Mercet from Spain in 1921 and *C. unifasciata* by Ishi from Japan in 1925. The genus has not been recorded from India so far. A couple of years ago, while engaged in bionomic and systematic studies on South Indian scale-insects and their parasites, the author came across a wasp bred from a diaspine scale-insect which on examination was provisionally regarded as a *Comperiella*. For want of time and sufficient material at the time further examination of the insect was left in abeyance though a record of it was included in the author's bulletin (1) on Coccidae in 1930. Recently the study was taken up on further material becoming available and on comparison with the description of the three previously recorded forms the Indian form was found to belong to a new species; this was confirmed by an authority on the group, Mr. H. Compere of California, who recently visited Coimbatore. The species is described below under the name *C. indica*, sp. nov.

Comperiella indica, sp. nov.

Female (text-fig. a) length from head to tip of abdomen 1.034 mm.; including the wing which extends behind body 1.43 mm. General



Comperiella indica sp. nov.

- a. Complete insect, female, seen from above.
- b. Antenna of female.
- c. Antenna of male.

colour light to dark brown. Eyes dark; funicular joints of antennae and dorsolateral region of base of abdomen deep brown. In certain lights the frontovertex between the eyes shows a shining creamy colour with a narrow, long brown streak over the ocellar region behind; the median region of the pronotum shows a similar shining patch and the mesoscutum is iridescent with a greenish metallic colour. Ocelli with some reddish pigment. Legs—in the two front pairs of legs, femora, extreme basal region and the narrow margins of tibiae concolorous with body, greater portion of tibiae, spur and all tarsal joints except last of a whitish yellow colour. Femora and tibiae of hind legs and last tarsal joint uniform deep dark brown; only basal tarsal joints whitish yellow. Wings hyaline. There is only one conspicuous brownish fascia in the fore-wings arising near the middle of the wing and extending to the wing apex; there is a slight indication of a rudimentary lower fascia just at the base of upper divided by a narrow indistinct hyaline region. Head broader than long. Eyes large, ocelli forming an acute-angled triangle; surface of ocellar region beautifully polygonal. Antennae well developed. In most other features this species resembles the geno-type *C. bifasciata*, H.

Male—smaller than female, a little less than 1 mm. long. The antennae of male (text-fig. c) are quite different in structure from those of the female (text-fig. b); the funicular joints are long and fringed with long curved hairs. Abdomen short, smaller than thorax. Wings without any brownish fascia as in female.

Described from half a dozen females and from males bred as parasites from the tamarind scale *Aspidiotus tamarindi* G. on the Coimbatore farm. This scale is often a serious pest of tamarind—the foliage and occasionally the fruits being completely covered with colonies of this scale and *Aspidiotus orientalis* N.

Type ♀ in the collections of the Zoological Survey of India (Indian Museum), Calcutta, No. 869/H 3.

The main differences between this Indian species and the previously recorded forms are shown in the following key as a supplement to the table published by Compere (2):—

- | | |
|---|-------------------------------|
| 1. Fore-wings of female with two divergent brownish fasciae. | |
| a. Colour dark bluish black | <i>C. bifasciata</i> Howard. |
| b. Colour blue | <i>C. ceraptocera</i> Mercet. |
| c. Colour dark brownish to metallic green | <i>C. pia</i> Girault. |
| 2. Fore-wings of female with two parallel brownish fasciae | <i>C. unifasciata</i> Ishi. |
| 3. Fore-wings of female with only one brownish fascia; colour light to dark brown | <i>C. indica</i> , sp. nov. |

The striking difference between these species is to be found in the infuscation of the fore-wing.

All the known species are natives of the Eastern Hemisphere and the majority are from the Oriental region. It is not unlikely that further studies may lead to the discovery of other species in this region.

As a beneficial insect *C. bifasciata* H. was transported from Japan and China into California in 1922 as biological control against citrus-scales of the genus *Chrysomphalus*.

LITERATURE.

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SEVEN NEW SPECIES OF INDIAN BETHYLIDAE (HYMENOPTERA).

By C. F. W. MUESEBECK, *Bureau of Entomology, United States Department of Agriculture.*

Recently the Bureau of Entomology of the United States Department of Agriculture received for identification a small number of Indian Bethylidae from Dr. T. V. Ramakrishna Ayyar, Government Entomologist at Coimbatore, India. Several undescribed species were included, and since Dr. Ayyar has requested names for use in economic studies, descriptions of the new species have been prepared and are given below. The types are deposited in the United States National Museum, while the paratypes, where available are in the Indian Museum, Calcutta.

The drawings of the two text-figures were prepared by Miss Eleanor A. Carlin of the Bureau of Entomology, United States Department of Agriculture.

***Pristobethylus indicus*, sp. nov.**

(Fig. 1).

Apparently very similar to *serricollis* (Westwood), an African species, but differing in having only the anterior half of the pronotal margin scalloped, and in the more nearly hyaline wings. From *semiserratus* Kieffer, another African species, which the new species resembles in the character of the pronotal margin, it may be distinguished by the head being broadly emarginate behind, by the situation of the lateral ocelli at the posterior margin of the head, by the shorter mandibles, and by the shorter mesoscutum.

Female.—Length 5.5 mm. Head flattened, at least as broad as long, the posterior margin broadly excavated, the posterior lateral angles with three blunt closely-placed teeth; malar space wanting; distance from eye to posterior margin of head more than half the eye length; mandible about as long as eye, the outer margin weakly scalloped; clypeus very small and partly concealed by the bases of antennae; dorsal surface of head very delicately and minutely reticulate, with a few large punctures and long, erect, scattered hairs anteriorly; ventral surface also with long erect hairs; ocellocular line at least one and one half times as long as postocellar line; occiput with abundant long hairs; antennae 13-segmented, a little longer than head; scape large, flattened, with conspicuous spines on its dorsal surface, especially along the margin; pedicel longer than broad, at least as long as second segment of flagellum, a little emarginate above; first segment of flagellum the shortest, not as long as broad; the following subequal, about as long as broad, except the apical segment, which is a little longer than broad.

Thorax strongly depressed, in the region of tegulae about as broad as head, with numerous long erect hairs on the pleura and sternum; pronotum very large, at least as long as broad, its anterior margin, and

the lateral margins half way to the tegulae, conspicuously elevated and scalloped, its dorsal surface minutely reticulate like the head, with

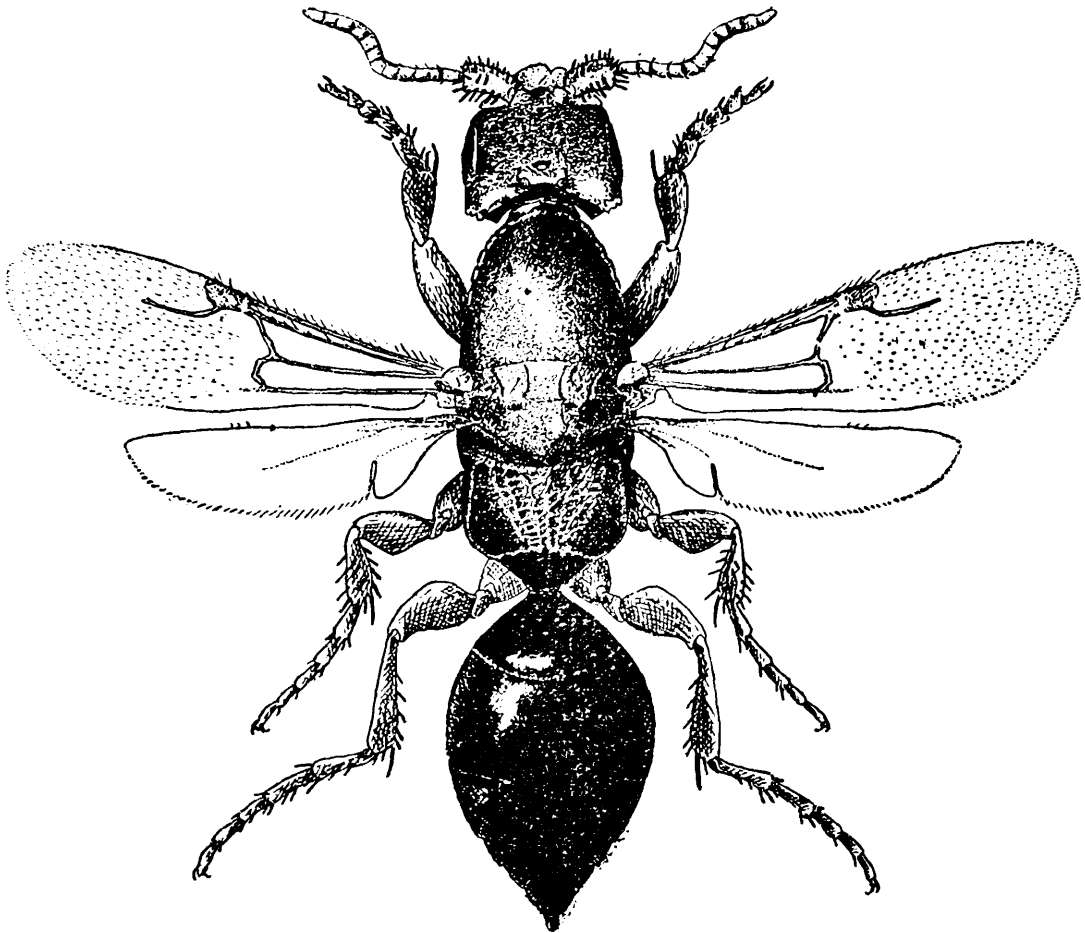


FIG. 1. Female of *Pristobethylus indicus*, sp. nov.

six or eight large scattered punctures on anterior half; mesoscutum not more than one-third as long as pronotum, also minutely reticulate, and with four shallow longitudinal furrows, the median pair posteriorly broadening and deepening into elongate foveae which attain posterior margin of mesoscutum; scutellum gently convex, sculptured like pronotum, and with two widely separated circular foveae at base; dorsal face of propodeum carinately margined on sides and behind, with three longitudinal carinae medially, the median one complete, the other two not quite attaining posterior margin, the area between them crossed by numerous transverse ridges which are intersected by an irregular raised longitudinal line about midway between the median carina and each of the lateral carinae; area between lateral carinae and lateral margins of propodeum very delicately transversely aciculate; posterior face of propodeum abruptly declivous, with a complete median carina, surface very delicately obliquely lineolated; metapleurum closely longitudinally aciculate; anterior coxae at least as large as posterior pair, convex beneath; middle and posterior coxae ventrally flattened; all femora short, with long, erect, scattered hairs, anterior pair longest, middle pair shortest, only about two-thirds as broad as long; middle tibia thickly covered with strong spines on outer side; posterior tibia with a few similar spines toward apex; anterior tarsus rather short,

segments broadening apically and two or three basal segments armed with well developed spines beneath; middle and posterior tarsi slender, with several long spines at the apex of each segment; anterior wing with a very short fringe on outer margin; basal half of wing almost entirely glabrous, apical half closely hairy; median and submedian cells closed; stigma slightly longer than broad; radius strongly curved near base, a little longer than basal vein.

Abdomen shorter than thorax, at its widest point slightly broader than thorax, surface mostly minutely reticulate or lineolate; second tergite larger than any of the following.

Black; mandibles, palpi, clypeus, and antennae ferruginous; tegulae brownish yellow; wings subhyaline; legs brownish red; coxae more or less piceous to blackish; the apical two or three abdominal segments reddish.

Type-locality.—Chaughat, Malabar; India.

Type.—U. S. N. M. No. 50137; *Paratype* No. $\frac{870}{H_3}$ in the collection of the Zoological Survey of India (Indian Museum), Calcutta.

Described from two females collected May 29 and May 31, 1931, respectively, the latter the type.

***Perisierola nephantidis*, sp. nov.**

This species resembles *emigrata* Rohwer but differs in the relatively shorter and broader first discoidal cell, in having the dorsal face of propodeum weakly margined posteriorly toward the sides, in the coarser sculpture of the propodeum and metapleurum, the relatively broader head, and the somewhat paler legs.

Female.—Length about 3 mm. Head not distinctly longer than broad, its dorsal surface finely coriaceous with numerous small but distinct, well-separated punctures; clypeus with a prominent median longitudinal carina which extends caudad to a point about one-third the distance from antennae to median ocellus; eyes broad, narrowed posteriorly, hardly one and one half times as long as broad and shorter than distance between them; ocellular line at least one and one half times as long as postocellar line; distance from eye to posterior margin of head about half the eye length; antennae about as long as head, scape nearly twice as long as broad, somewhat flattened; remainder of antenna much more slender than scape; pedicel about as long as broad, subequal to basal segments of flagellum; none of flagellar segments except the last distinctly longer than broad.

Thorax slightly narrower than head; pronotum at least one and one half times as long as mesoscutum, finely coriaceous and with some scattered very weak punctures; mesoscutum more than twice as broad as long, with distinct, though delicate, lateral longitudinal grooves, and sculptured like pronotum except that the punctures are as distinct as those of the head; disc of scutellum rather flat, broader at base than long, separated from mesoscutum by a fine grooved line, its surface very delicately reticulate with a few scattered distinct punctures and a small oblique fovea on each side at the base; dorsal face of propodeum uniformly very closely punctate and opaque except for a narrow smooth

and polished strip down the middle; the delicate apical transverse carina broadly obliterated medially; posterior face of propodeum strongly declivous, flat, shallowly reticulate; mesopleurum delicately minutely reticulate; metapleurum very finely, longitudinally wrinkled and opaque; stigma longer than broad, broadening toward apex, much larger than prostigma; basal vein broken distinctly above middle.

Abdomen about as long as thorax and at least as broad, narrowed rather abruptly at base and gradually toward apex, entirely smooth and shining.

Black; mandibles black; antennae entirely brownish yellow; wings hyaline; stigma and prostigma brown; veins yellowish; anterior coxae and femora piceous, the latter paler at apices, middle and posterior coxae more or less piceous, their femora pale brown; all tibiae and tarsi brownish yellow.

Male.—Essentially like the female, except that the mandibles are yellow.

Type locality.—Coimbatore, India.

Type.—U. S. N. M. No. 50138, *Paratype* No. $\frac{871}{H3}$ in the collection of the Zoological Survey of India (Indian Museum), Calcutta.

Host.—The Xyloryctid moth *Nephantis serinopa*.

Described from ten females and one male. The allotype and three paratypes are from the type locality; three paratypes are from Salem; one is from Dharmapuri; one from Tirupatur, and one from Calicut.

Apparently this is the species the life history and habits of which have been discussed by Ramachandra Rao and Cherian¹ under the name *Parasierola* sp.

***Perisierola mellipes*, sp. nov.**

This species also closely resembles *emigrata* Rohwer but may be distinguished readily by its entirely yellow legs and mandibles, elongate eyes, and the presence of a well-developed transverse carina defining posterior margin of dorsal face of propodeum.

Female.—Length 2.2 mm. Head hardly longer than broad; clypeus somewhat compressed and produced anteriorly, its median keel extending back a short distance beyond antennae; surface of head finely coriaceous, with scattered distinct punctures; eyes twice as long as broad, about as long as distance between them and narrowing somewhat anteriorly; posterior margin of head carinate; distance from eyes to posterior margin of head less than half the eye length; antennae as long as head; scape slightly compressed, hardly twice as long as broad and only a little broader than flagellum; pedicel subequal to basal flagellar segments and about as long as broad.

Thorax hardly narrower than head; pronotum and mesonotum delicately coriaceous; mesoscutum on posterior half and scutellum with a few scattered punctures; lateral grooves of mesoscutum distinct; scutellum not broader at base than long; dorsal face of propodeum very finely closely punctate except for a slightly elevated polished strip down the middle; posterior face of propodeum strongly declivous,

¹ *Year Book, Madras Dept. Agric.*, pp. 11-22 (1927).

reticulate; mesopleurum indistinctly reticulate, shining; metapleurum closely very shallowly punctate; stigma longer than broad, broadening toward apex, much larger than prostigma; basal vein broken at about middle; median and submedian cells glabrous toward apex; radius not much more than twice as long as stigma, very slightly curved; posterior femur two and one half times as long as broad.

Abdomen about as long as thorax, narrowing strongly from middle to apex, smooth and shining except for a little faint reticulation at bases of second, third, and fourth tergites.

Black; mandibles, antennae, and all legs entirely, honey yellow; wings hyaline; stigma and prostigma brown.

Type locality.—Coimbatore, India.

Type.—U. S. N. M. No. 50139, *Paratype* No. $\frac{872}{H3}$ in the collection of the Zoological Survey of India (Indian Museum), Calcutta.

Two female specimens bred from an unknown host on 'margosa' March 15, 1932.

Key to the Indo-Australian species of *Perisierola*.

1. Wings distinctly infumated; pterostigma not longer and hardly broader than prostigma; radius sharply angled near apex; propodeum delicately reticulate medially . . . 1. *angulata* Muesebeck.
- Wings hyaline; pterostigma much longer and broader than prostigma; radius not sharply angled; propodeum polished medially . . . 2.
2. Dorsal face of propodeum margined at apex by a distinct complete transverse carina, and elevated keel-like down the middle; eyes twice as long as their greatest breadth; mandibles, and the legs entirely, yellow; basal vein broken at about the middle . . . 2. *mellipes*, sp. nov.
- Dorsal face of propodeum not margined at apex or the carina only weakly developed toward the sides, and the median longitudinal line not elevated keel-like; eyes definitely less than twice as long as broad; mandibles usually black, sometimes yellow in male; legs usually more or less piceous or blackish . . . 3.
3. Basal vein broken at or above upper third; first discoidal cell twice as long as broad; median polished area of propodeum extending upon the posterior face; metapleurum delicately reticulate and shining; all femora completely blackish; mandibles black in both sexes . . . 3. *emigrata* Rohwer.
- Basal vein broken definitely below upper third; first discoidal cell not twice as long as broad; median polished area of propodeum not extending upon posterior face; apices of anterior femora and the middle and posterior femora yellowish brown; mandibles yellow in male . . . 4. *nephantidis*, sp. nov.

***Parasierola quadrifoveata*, sp. nov.**

(Fig. 2).

Apparently distinguishable from all described species of this genus by the presence of four foveae at base of scutellum and by the unusually small discoidal cell.

Female.—Length 4.5 mm. Head large, as broad as long, dorsal surface strongly coriaceous and opaque, with numerous shallow, well-

separated, umbilicate punctures; clypeus triangularly produced both anteriorly and posteriorly, a little compressed and with a prominent median longitudinal carina which extends caudad nearly to a point opposite the middle of the eyes; eyes much shorter than the distance between them and hardly twice as long as the distance from eyes to posterior margin of head; lateral ocelli removed by about the diameter of one of them from posterior margin of head; postocellar line only slightly longer than diameter of an ocellus and about one-third the ocellocular line; antennae slightly longer than head; scape cylindrical, weakly curved, more than twice as long as thick; pedicel a little less than half as long as scape, much longer than thick and about as long as first segment of flagellum; basal four flagellar segments slightly longer than the others, but all segments distinctly longer than thick.

Thorax much narrower than head; pronotum a little longer than mesoscutum, finely coriaceous and opaque with scattered long erect hairs; mesoscutum twice as broad as long, sculptured like pronotum and with lateral longitudinal grooved lines; the transverse impression

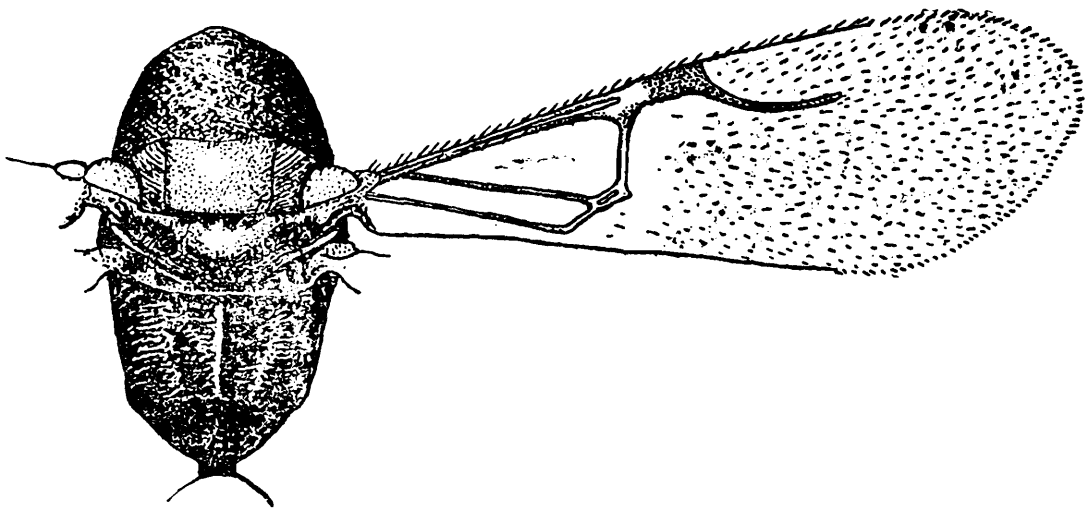


FIG. 2. Thorax of *Parasierola quadrifoveata*, sp. nov.

across base of scutellum divided into four well-marked foveae; disc of scutellum a little more finely coriaceous than mesoscutum; dorsal face of propodeum more than half as long as broad, with a very prominent, complete, median longitudinal carina, and on each side, midway between this carina and the lateral margin, a very weak longitudinal raised line curving slightly inward toward apex and merely representing the outer margin of a shallowly impressed and weakly rugose area; surface between this area and lateral margin finely transversely striate or lineolate; posterior face of propodeum separated from dorsal face by a complete well-developed carina, and very delicately reticulate; stigma much longer than broad, truncate at apex; prostigma very small; radius gently curved, a little more than twice as long as stigma, its apex a little farther from apex of wing than from stigma; basal vein broken at about its lower third; first discoidal cell minute; median and submedian cells very sparsely hairy; posterior metatarsus as long as tarsal segments 2 to 5 combined.

Abdomen slightly longer than thorax, entirely smooth and polished. Black ; mandibles, antennae, and all legs including coxae testaceous; wings hyaline ; stigma brown.

Type locality.—Bellary, Madras, India.

Type.—U. S. N. M. No. 50140.

Described from a single specimen reared August 28, 1928, from a cocoon taken on betel leaf.

***Pristocera areolata*, sp. nov.**

In Kieffer's key¹ to the species of *Pristocera* this species runs to *gaullei* Kieffer. It is readily distinguished from that species, however, by its quadridentate mandibles, by having the first flagellar segment nearly four times as long as the pedicel, and by the smoother pronotum and propodeum.

Male.—Length 6 mm. Head slightly longer than broad, its dorsal surface convex, shining, with abundant erect hairs, strongly punctate, the punctures well separated, the interstices polished ; eyes bare ; level of upper eye margins about on a line with anterior margin of a median ocellus ; ocelli separated from each other by only slightly more than the diameter of one of them ; lateral ocelli about three times the length of ocellular line from occipital carina ; mandibles very strongly broadened apically, quadridentate, all the teeth large, the outer tooth the largest ; apices of teeth in an oblique line ; anterior margin of clypeus truncate ; antennae about twice as long as head, slender, tapering to the apex ; scape cylindrical, rather strongly curved, about three times as long as thick ; pedicel a little broader than long ; flagellar segments elongate, the first nearly as long as scape, the basal four almost as thick as the scape, the following becoming rapidly more slender.

Thorax at tegulae about as wide as head ; pronotum with a low transverse ridge separating the broad smooth apical third from the anterior part which is weakly transversely roughened ; mesoscutum nearly as long as pronotum, smooth, with only a few weak punctures, and with four complete distinctly impressed grooves, the middle pair a little farther from each other than from the lateral grooves ; a transverse furrow at base of scutellum ; scutellum flat, polished, with a few punctures at sides ; dorsal face of propodeum as long as broad at apex, weakly carinately margined at sides and apex, and with a complete median longitudinal carina and a more or less irregular, weaker, oblique carina from near each basal lateral angle toward apex of median carina ; a few transverse rugae between median and oblique lateral carinae, and four irregular polished areas at base ; posterior face of propodeum convex, nearly smooth on the middle, rugose punctate laterally ; side of pronotum smooth and polished ; mesopleurum punctate, the punctures large, the interstices polished ; a narrow distinct longitudinal groove above middle of mesopleurum ; metapleurum finely longitudinally aciculate ; stigma three times as long as broad, its lower margin gently curved ; radius arising from very slightly behind middle of stigma, more than twice as long as stigma, postmarginal vein a little more than

¹ *Das Tierreich*, Lief. 41, p. 454 (1914).

half as long as stigma, first brachial cell very poorly defined ; legs slender ; tarsal claws with two teeth within.

Abdomen a little shorter than thorax, depressed, smooth and polished, the second and third tergites subequal ; the first and second tergites practically glabrous, the third sparsely hairy, the following thickly so.

Black ; mandibles reddish, black at base and the teeth blackish ; antennae ferruginous ; tegulae brownish yellow ; wings hyaline ; stigma and veins brown, all coxae blackish ; femora more or less piceous ; tibiae and tarsi yellowish brown.

Type locality.—Coimbatore, India.

Type.—U. S. N. M. No. 50141.

A single specimen collected November 18, 1926.

Epyris politiceps, sp. nov.

In Kieffer's key¹ this species runs best to *pilosipes* Kieffer, but disagrees with the description of that species especially in having the head and pronotum very minutely punctate, the apex of the mandible oblique with the lower margin produced into an acute tooth, and the mesonotum not half as long as pronotum.

Male.—Length 5 mm. Head about as broad as long, nearly round as seen from above, dorsal surface smooth and polished but with numerous minute setiferous punctures, the hairs long, abundant, and suberect ; underside of head polished, clypeus very short, its anterior margin a little produced medially ; the median keel of clypeus not extending back upon frons ; eyes not twice as long as broad, shorter than the distance between them ; frons with a fine impressed median line anteriorly ; distance from eyes to posterior margin of head more than half the eye length ; ocelli large ; distance between the median ocellus and one of the lateral ocelli about equal to the diameter of an ocellus ; postocellar line less than twice the diameter of an ocellus ; ocellocular line twice as long as postocellar line ; lateral ocelli removed by one and one half times the diameter of one of them from the carinate posterior margin of the head ; antennae twice as long as head ; scape hardly thicker than flagellum, about twice as long as thick, pedicel a little broader than long ; first segment of flagellum barely longer than pedicel, not as long as broad, second and following flagellar segments more than twice as long as the first, subequal.

Thorax in the region of the tegulae about as broad as head, fully twice as long as broad, pronotum delicately coriaceous, with rather abundant long hairs like the head ; mesoscutum not distinctly half as long as pronotum, similarly sculptured, the lateral grooves sharply impressed and extending nearly to the extreme base ; disc of scutellum at least as long as mesoscutum, similarly sculptured and provided with a large and deep fovea on each side at base ; these foveae separated by less than twice the diameter of one of them ; propodeum with dorsal face carinately margined on the sides and behind, the middle third provided with five complete longitudinal carinae which converge slightly caudad, the narrow strips between them traversed by numerous low

¹ *Das Tierreich*, Lief. 41, p. 309, (1914).

transverse rugae; the area between lateral margin of propodeum and the most latera of the five carinae closely aciculate; posterior face of propodeum closely transversely aciculate and with a complete median longitudinal carina; mesopleurum finely coriaceous; metapleurum longitudinally aciculate; stigma more than twice as long as broad, radius originating from beyond the middle of stigma, not evenly curved; postmarginal vein distinct, nearly one-third as long as stigma; femora stout, the anterior pair slightly larger than posterior pair, the middle pair very small; tarsal claws cleft; middle tibia with a few scattered spines on its outer side.

Abdomen shorter than thorax, acute as apex; first and second tergites completely polished and nearly glabrous, the following with abundant suberect hairs.

Black; mandibles, antennae, palpi, and tegulae pale ferruginous; wings subhyaline; stigma and veins brown; legs piceous; tarsi paler; fourth abdominal segment on the sides, and the following entirely, red.

Type locality.—Mysore, India, 1,100 ft. elevation.

Type.—U. S. N. M. No. 50142.

Described from a single male specimen collected April 28, 1918.

***Epyris coriaceus* sp. nov.**

This species runs to *caffrarius* Kieffer in Kieffer's key, but may be distinguished by its coriaceous, opaque, and more uniformly punctate pronotum, by only three of the five longitudinal carinae of propodeum being complete, and by the ferruginous antennae.

Female.—Length 5 mm. Head slightly longer than broad, delicately coriaceous with numerous, but well-separated, distinct punctures; mandibles broadening slightly to the apex, where they are bluntly bidentate, the teeth about equal; eyes less than one and one half times as long as broad and only about a fourth longer than the distance from eyes to posterior margin of head; ocelli small, in an equilateral triangle; postocellar line less than twice the diameter of an ocellus and little more than one-third as long as ocellular line; scape more than twice as long as broad, somewhat flattened, much broader than flagellum, at least as long as pedicel and the basal two flagellar segments combined; pedicel and first flagellar segment subequal, hardly as long as broad and somewhat shorter and narrower than any of the following segments.

Thorax narrower than head; pronotum sculptured like head except that punctation is more widely spaced medially; mesoscutum not more than half as long as pronotum, with four longitudinal furrows; the lateral pair extending from the posterior margin not quite to the base; the median pair complete, slightly sinuate, very delicate cephalad but broadening into elongate foveae before posterior margin; disc of scutellum finely coriaceous, with two circular foveae at base separated by more than twice the diameter of one of them; dorsal face of propodeum sharply margined on the sides and behind, transversely aciculate and on the middle third with five longitudinal carinae which are slightly convergent caudad, the median and the two outside carinae complete and much more strongly developed than the other two; posterior face of propodeum transversely aciculate, coarsely so toward

apex and with a complete longitudinal carina; mesopleurum finely coriaceous, with a few scattered punctures; metapleurum closely longitudinally aciculate; stigma about twice as long as broad, emitting the radius from slightly beyond the middle; postmarginal vein not distinct; radius gently curved, about three-fourths complete; second to fourth segments of anterior tarsi cordate, the first to fourth with apical spines; middle tibiae with some distinct spines on the outer side; tarsal claws cleft, the inner tooth small.

Abdomen slightly shorter than the thorax, acuminate; two basal tergites glabrous and entirely polished; the following sparsely hairy; the third, fourth, and fifth each with a few minute punctures toward the base.

Black; mandibles and antennae pale ferruginous; wings a little clouded; tibiae and tarsi mostly dark brown; third abdominal segment on the sides, and the following entirely, red.

Type locality.—Coimbatore, India.

Type.—U. S. N. M. No. 50143.

Described from a single female taken on castor oil plant, May 14, 1932.