

ZOO-GEOGRAPHICAL AND SYSTEMATIC NOTES ON THE NYCTERIBIIDAE (DIPTERA PUPIPARA) OF INDIA, CEYLON AND BURMA.

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More than ten years ago I wrote a paper "On some Oriental Nycteribiidae,"¹ dealing almost entirely with material from Ceylon and India and, nearly three years later, I published a few additional Indian records.² Since that time Nycteribiidae have been submitted to me from various sources, and many notes and records have accumulated. In particular, during 1922 and 1923, four lots of material collected by Captain W. W. A. Phillips, F.Z.S., were received from Ceylon, partly through the kindness of Mr. R. Senior-White and partly direct from the collector. Moreover, early in 1924 and shortly before his regretted death, Dr. N. Annandale was good enough to submit to me almost the whole of the material of this group in the Indian Museum, and Dr. B. N. Chopra has subsequently sent certain further consignments; so that, excepting a few duplicates, I have now seen all the Nycteribiidae in that museum up to date. It seems, therefore, advisable, having determined so much material, to try and give a fuller account of the Nycteribiidae of India, Ceylon and Burma. There remain in my possession, however, some further unpublished records and material, not yet critically studied, from other parts of the East—the Malay Archipelago—as well as from quite other regions of the world.

Of the 18 forms dealt with in this paper, all are known to occur in the countries under review except one, namely *Nycteribia (Acrocholidia) phthisica* Speiser, the single example of which was obtained in Amboina: it is included here, in spite of not being Indian, because the unique type is preserved in the Indian Museum. I am much indebted to the authorities of that institution for allowing the loan of this type, and also of the unique types of *Basilia bathybothyra* Speiser, and *Cyclopodia amiculata* Speiser (all of which I had long wanted to see), and further for their permission to submit these three very desiccated and shrunken specimens to a prolonged soaking in water and afterwards to transfer them to spirit. Preliminary descriptions of these three species were published in 1907 (*Rec. Ind. Mus.* I, p. 295) and Dr. Speiser then stated that detailed descriptions were to follow. It is to be regretted that the detailed descriptions have not appeared, for I, being unable to recognise the species with certainty from the short preliminary descriptions (unaccompanied by figures), have since described and figured the two latter species under other names. These names now fall as synonyms, as explained in the following pages. It may also be remarked here that neither of these forms can be left in the genera to which they were, respectively, originally referred. In the present paper I have myself described three new species, all of them from one sex only—the female, which in Nycteribiidae usually

¹ *Ann. Mag. Nat. Hist.* (8) XIV, pp. 209-235, pl. x-xii (1914).

² *Parasitology* IX, pp. 593-610, pl. xxiv (1917).

presents far better external differentiating characters than the male—and in two cases from single specimens: but it may be hoped that no serious confusion will result, as the descriptions are drawn up from spirit material, are full, and are accompanied by figures.

The figures have all been made with the help of a camera lucida. Excepting those of *N. (A.) phthisica*, which are by myself, they were drawn by Mr. H. C. Gillings, to whom my best thanks are due for the care which he has given to their execution.

The names of the Nycteribiidae collected by Captain Phillips in Ceylon, together with remarks on their hosts, their relative abundance, etc., have been published by him in an article entitled "Ecto-Parasites of Ceylon Bats" [*Spolia Zeylanica*, (= *Ceylon Journal of Science*, Section B) XIII, pp. 65-70, September 1924], which is often cited in the present paper.

RELATIONSHIP OF PARASITE TO HOST, AND GEOGRAPHICAL DISTRIBUTION.—In my earlier paper on Ceylon Nycteribiidae I gave a table showing the distribution of each Nycteribiid, and the number of bat-species on which it had been found. In the present paper, following the example of Dr. Falcoz,¹ more than one table is given; in TABLE 1 the Nycteribiidae are listed, while their distribution is shown in the second, and the known hosts of each appear in the third, column; in TABLE 2 the bats are listed, while their distribution (at least within the countries under review) is summarised in the second, and the Nycteribiidae known to infest each bat appear in the third, column. Dr. Falcoz (*l.c.*) gives a third table, in which the localities are listed in the first column, and the Nycteribiids and bats associated together in each locality are shown in the second and third columns respectively; but nothing corresponding to this is attempted in the present article.

As to the identifications of the bats; the names of those on which the Indian Museum material was found were sent to me from that museum, and Captain Phillips is responsible for determining those from which specimens were collected by him in Ceylon. In the case of some other records published here for the first time, the names of the bats were sent to me when the Nycteribiid material was submitted for identification. The older records summarised here are taken from my own earlier papers and from Speiser's general work "Über die Nycteribiiden."² Mr. Oldfield Thomas, F.R.S., has very kindly checked all the names and indicated to me the up-to-date nomenclature and synonymy. But in cases where a species of bat is no longer referred to the same genus under which it has been cited in earlier works on Nycteribiidae, or to which it is referred in manuscript labels and records accompanying Nycteribiid material, it has seemed best in most cases to insert the older generic name in square brackets after the name of the genus in which the bat is at present placed: thus, *Leuconoe* [*Myotis*] *capaccinii* was referred to as *Myotis capaccinii* in earlier writings on Nycteribiidae, and *Myotis* [*Vespertilio*] *muricola* was called *Vespertilio muricola* on the manuscript label accompanying the parasites from this bat.

¹ L. Falcoz, "Biospeologica, No. 49, Pupipara"; *Arch. Zool. Exper.* LXI, pp. 521-552 (1923).

² *Arch. Naturg.* LXVII (1), pp. 11-78, pl. iii (1901).

TABLE 1.—*Showing all the Nycteribiidae known to occur in India, Ceylon and Burma, together with the geographical distribution and all the known hosts of each species: the names of the bats on which the Nycteribiidae have, severally, been found in the countries under review are printed in heavy black type.*

NYCTERIBIIDÆ.	GEOGRAPHICAL DISTRIBUTION.	HOSTS.
<i>Penicillidia dufouri</i> (Westw.)	Europe, North Africa, Formosa, East and West Himalayas, Kashmir.	Leuconoe longipes Dobs. <i>Leuconoe</i> [<i>Myotis</i>] <i>capaccinii</i> Bon. (?) <i>Leuconoe</i> [<i>Myotis</i>] <i>taiwanensis</i> Lind. <i>Myotis myotis</i> Bork. <i>Myotis oxygnathus</i> Mont. <i>Miniopterus schreibersi</i> (sens. lat.). (?) <i>Pipistrellus abramus</i> . <i>Rhinolophus euryale</i> Bl. <i>Rhinolophus blasii</i> Pet. <i>Rhinolophus hipposideros</i> Bechst. <i>Rhinolophus ferrum-equinum</i> Schreb. <i>Rhinolophus clivosus</i> Rüpp.
<i>Penicillidia jenynsi</i> (Westw.) var. <i>indica</i> , nov.	India (Satara District, Bombay), Ceylon. [Typical form of this species known from China, Formosa, and Sumatra.]	Miniopterus fuliginosus Hodgs. [Host of typical form is <i>Miniopterus schreibersi</i> , sens. lat.].
<i>Penicillidia fletcheri</i> Scott	India (Coimbatore and Mysore)	Scotozous [Pipistrellus] dormeri Dobs.
<i>Penicillidia bathybothyra</i> (Speiser), (<i>fletcheri</i> var. <i>pumila</i> Scott).	India (Calcutta; Khandala, Bombay; Madras), Ceylon, West Africa.	Myotis [Vespertilio] muricola Hodgs. Pipistrellus mimus mimus Wrought. Pipistrellus sp. ? <i>coromandra</i> Gray. ¹

¹ This *Pipistrellus* was in both cases determined as *P. abramus*, and was referred to under that name as the host of *Penicillidia fletcheri* var. *pumila* by me in *Ann. Mag. Nat. Hist.* (8) XIV, pp. 212, 218, 1914. Mr. Oldfield Thomas, however, tells me that the true *P. abramus* is a Far Eastern form, and that the bats under consideration here were probably *P. coromandra*. On the other hand, the species included in the table as a possible host of *Penicillidia dufouri* may quite possibly have been the true *P. abramus*, as the record on which its inclusion is based is from Formosa.

NYCTERIBIDÆ.	GEOGRAPHICAL DISTRIBUTION.	HOSTS.
<i>Penicillidia peali</i> , sp. n.	Assam (Sibsagar).	Unrecorded.
<i>Nycteribia (Acrocholidia) vexata</i> Westw.	Europe, North Africa, Egypt, Sikkim Himalayas	[Himalayan host unidentified.] <i>Miniopterus schreibersi</i> Kuhl. <i>Myotis myotis</i> Bork. <i>Myotis oxygnathus</i> Mont. <i>Rhinolophus euryale</i> Bl. <i>Rhinolophus ferrum-equinum</i> Schreb. <i>Rhinolophus hipposideros</i> Bechst. <i>Rhinolophus</i> sp. [Egypt].
<i>Nycteribia (Acrocholidia) euxesta</i> (Speiser)	Burma, Ceylon, India (Orissa, Assam)	Hipposideros armiger Hodgs. Hipposideros lankadiva Kel. Cynopterus sphinx gangeticus K. And. Rhinolophus subbadius Blyth. Rousettus leschenaulti Desm.
<i>Nycteribia (Acrocholidia) phillipsi</i> , sp. n.	Ceylon	Rhinolophus rouxi rouxi Temm.
<i>Nycteribia (Listropodia) pedicularia</i> Latr.	Europe, North Africa, India (Kashmir ; Darjeeling), China, Formosa, South Africa.	Leuconoe longipes Dobs. <i>Leuconoe</i> [<i>Myotis</i>] <i>dasyncneme</i> Boie. <i>Leuconoe</i> [<i>Myotis</i>] <i>daubentoni</i> Leisl. <i>Myotis myotis</i> Bork. <i>Myotis oxygnathus</i> Mont. <i>Miniopterus schreibersi</i> Kuhl. <i>Rhinolophus hipposideros</i> Bechst. <i>Eptesicus</i> [<i>Vespertilio</i>] <i>serotinus</i> Schreb. <i>Nyctalus</i> [<i>Vespertilio</i>] <i>noctula</i> Schreb.
<i>Nycteribia (Listropodia) allotopa</i> Speiser, (<i>insolita</i> , Scott).	Sumatra, India (Satara District, Bombay), Ceylon, China, Formosa.	Miniopterus fuliginosus Hodgs. <i>Miniopterus schreibersi</i> , sens. lat.

<i>Nycteribia (Listropodia) parvula</i> Speiser, (sauteri Scott).	Sumatra, Formosa, Ceylon, India (Satara District, Bombay).	<i>Miniopterus fuliginosus</i> Hodgs. <i>Miniopterus scheibersi</i> , sens. lat.
<i>Nycteribia (Stylidia) annandalei</i> , sp. n. . . .	India (Singhbhum District, Bengal) . . .	<i>Rhinolophus lepidus</i> Blyth.
<i>Cyclopodia sykesi</i> (Westw.) . . .	India (Assam ; Orissa ; Bihar ; Madras ; Travancore), Burma (Rangoon), Ceylon, Maldiva Is., Judaea.	<i>Pteropus giganteus</i> Brünn. <i>Pteropus giganteus giganteus</i> Brünn. <i>Pteropus giganteus leucocephalus</i> Hodgs. <i>Pteropus intermedius</i> K. And. (?) <i>Pteropus medius</i> Temm. (?) <i>Pteropus vampyrus</i> L. [celaeno]. <i>Scotophilus kuhli</i> Leach.
<i>Cyclopodia ferrarii</i> (Rondani) . . .	Java, Sumatra, Burma, Ceylon, India (Calcutta).	<i>Cynopterus sphinx</i> Vahl. <i>Cynopterus brachyotis ceylonensis</i> Gray.
<i>Cyclopodia (Paracyclopodia) roylei</i> (Westw.) . . .	India (Bengal ; Orissa ; Bihar ; W. Ghats ; United Provinces ; Madras ; Coromandel), Ceylon, Malay Peninsula.	<i>Hesperoptenus (Vesperugo) tickelli</i> Blyth. <i>Scotophilus heathi</i> Horsfield. <i>Scotophilus kuhli</i> Leach. <i>Scotophilus temmincki</i> Leach. <i>Scotophilus wroughtoni</i> Thomas. <i>Megaderma lyra</i> Geoffr. <i>Myotis formosus</i> Hodgs. <i>Pipistrellus</i> sp. (? <i>coromandra</i> Gray). ¹ <i>Tylonycteris pachypus</i> Temm.
<i>Tripselia amiculata</i> (Speiser), (fryeri Scott) . . .	India (Calcutta), Ceylon, Labuan, Assumption I., Tropical Africa (Belgian Congo ; Dahomey).	<i>Taphozous longimanus</i> Hardw. <i>Taphozous mauritanus</i> Geoffr. <i>Saccolaimus saccolaimus</i> Temm. <i>Saccolaimus peli</i> Temm.
<i>Eucampsipodia hyrtli</i> (Kolenati)	Africa (Egypt ; Senegal ; East and South Africa), Comoro Islands, Madagascar, Sumatra, Burma, Ceylon, India (Assam ; Orissa).	<i>Cynopterus sphinx gangeticus</i> K. And. <i>Rousettus leschenaulti</i> Desm. <i>Rousettus seminudus</i> Kel. <i>Rousettus leachi</i> , A. Smith [<i>collaris</i> auctt.]. <i>Rousettus aegyptiacus</i> Geoffr. <i>Tylonycteris pachypus</i> Temm.

¹ See footnote on page 353.

TABLE 2.—Showing the species of bats on which *Nycteribiidae* have been found in India, Ceylon and Burma, together with the distribution of, and the species of *Nycteribiidae* found on, each host-species within the countries under review. The English names of the bats are those used by Capt. W. W. A. Phillips in his work (1924) cited above. The distribution of the bats is mainly compiled from R. C. Wroughton's "Summary of the Results from the Indian Mammal Survey," section on *Chiroptera*, Journ. Bombay Nat. Hist. Soc. XXV, no. 4, pp. 564-598 (1918) and XXVI, no. 1, pp. 19-27 (1918). When the localities recorded in this paper and in other literature on *Nycteribiidae* are included within the areas summarised by the Mammal Survey, they are not separately mentioned, but when not so included, they are added briefly to the summaries of distribution given in the second column; in such cases the areas summarised from the Mammal Survey are distinguished by the letters (M. S. I.) following them, and those taken from the Indian Museum material by (I. M.), while records for which Capt. Phillips is responsible are indicated by (W. W. A. P.), and two taken from my own earlier paper (Sept. 1914) by (H.S.).

CHIROPTERA.	GEOGRAPHICAL DISTRIBUTION WITHIN THE COUNTRIES UNDER REVIEW.	NYCTERIBIID PARASITES.
PTEROPODIDAE.		
<i>Cynopterus sphinx</i> Vahl.	Widely distributed in India, extending as far North as Sikkim and as far East as the Shan States; also Ceylon.	<i>Cyclopodia ferrarii</i> (Rond.).
<i>Cynopterus sphinx gangeticus</i> K. And.	United Provinces, Central Provinces, Palanpur (Bombay) (M. S. I.); Garo Hills, Assam (I. M.).	<i>Nycteribia (Acrocholidia) euxesta</i> (Speiser). <i>Eucampsipodia hyrtli</i> (Kol.)
<i>Cynopterus brachyotis ceylonensis</i> Gray (Ceylon Short-nosed Fruit Bat).	Ceylon	<i>Cyclopodia ferrarii</i> (Rond.).
<i>Pteropus giganteus giganteus</i> Brünn. (Common Flying Fox).	Widely distributed in India, North and South, also Ceylon and Burma.	<i>Cyclopodia sykesi</i> (Westw.).
<i>Pteropus giganteus leucocephalus</i> Hodgs.	Nepal, Assam, Manipur	<i>Cyclopodia sykesi</i> (Westw.).

<i>Pteropus intermedius</i> K. And.	Amherst District, Burma (M. S. I.); Chilka Lake, Madras (I. M.).	<i>Cyclopodia sykesi</i> (Westw.).
<i>Pteropus medius</i> Temm.	Records under this name from Orissa and Travancore (I. M.); probably it should be regarded as synonymous with <i>P. giganteus</i> in these cases.	<i>Cyclopodia sykesi</i> (Westw.).
<i>Rousettus leschenaulti</i> Desm.	Widely distributed in India, as far South as Coorg and Pondicherry, and as far North as Kumaon and Bhutan; also Burma and Tenasserim.	<i>Nycteribia (Acrocholidia) euxesta</i> (Speiser). <i>Eucampsipodia hyrtli</i> (Kol.)
<i>Rousettus seminudus</i> Kel. (Ceylon Fruit-eating Bat)	Ceylon	<i>Eucampsipodia hyrtli</i> (Kol.).
RHINOLOPHIDAE.		
<i>Rhinolophus rouxi rouxi</i> Temm. (Rufous Horse-shoe Bat).	Nepal, Sikkim, Bengal, Bombay (Kanara and Dharwar), Nilgiris, Pondicherry, Ceylon.	<i>Nycteribia (Acrocholidia) phillipsi</i> , sp. n.
<i>Rhinolophus subbadius</i> Blyth	Nepal; Garo Hills, Assam; Mussoorie, U. P.	<i>Nycteribia (Acrocholidia) euxesta</i> (Speiser).
<i>Rhinolophus lepidus</i> Blyth	Kumaon, Bengal, Ganges Valley, Central Provinces, Kanara, South India (Wynaad), Burma (Mt Popa).	<i>Nycteribia (Stylidia) annandalei</i> , sp. n.
<i>Hipposideros armiger</i> Hodgs.	Kumaon, Nepal, Sikkim, Khasi Hills, Burma (as far East as Shan States).	<i>Nycteribia (Acrocholidia) euxesta</i> (Speiser).
<i>Hipposideros lankadiva</i> Kel (Large Indian Leaf-nosed Bat).	Ceylon, Mysore, Bellary, Kanara, Central Provinces (M. S. I.); Garo Hills, Assam (I. M.).	<i>Nycteribia (Acrocholidia) euxesta</i> (Speiser).
MEGADERMATIDAE.		
<i>Hegaderma lyra</i> Geoffr. (Indian Vampire)	Widely distributed in India, as far North as Sikkim and Bhutan Duars; also Ceylon and Burma.	<i>Cyclopodia (Paracyclopodia) roylei</i> (Westw.).

CHIROPTERA.	GEOGRAPHICAL DISTRIBUTION WITHIN THE COUNTRIES UNDER REVIEW.	NYCTERIBIID PARASITES.
VESPERTILIONIDAE ; VESPERTILIONINAE.		
<i>Leuconoe longipes</i> Dobs.	Kashmir (M. S. I., I. M.) . .	<i>Penicillidia dufouri</i> (Westw.).
<i>Myotis muricola</i> Hodgs.	Nepal, Bhutan Duars, Tenasserim (M. S. I.) ; Calcutta (I. M.).	<i>Nycteribia (Listropodia) pedicularia</i> Latr.
<i>Myotis formosus</i> Hodgs.	Nepal, Dharmasala (Punjab), Mussoorie (M.S.I.) ; Bihar (I. M.).	<i>Penicillidia bathybothyra</i> (Speiser), (<i>fletcheri</i> var. <i>pumila</i> Scott).
<i>Pipistrellus</i> sp. (? <i>coromandra</i> Gray) ¹ (Coromandel Pipistrel).	Widely distributed in India as far N. as Sikkim, also Ceylon.	<i>Cyclopodia (Paracyclopodia) roylei</i> (Westw.).
<i>Pipistrellus mimus mimus</i> Wrought. (Southern Dwarf Pipistrel).	Widely distributed in India, North and South ; also Ceylon and Burma.	<i>Penicillidia bathybothyra</i> (Speiser).
<i>Scotozous dormeri</i> Dobs.	Widely distributed in India, N. and S. . .	<i>Pencillidia fletcheri</i> Scott.
<i>Tylonycteris pachypus</i> Temm.	Widely distributed over all the East side of India, North and South, and Burma ; re- presentative form on West coast considered distinct (M.S.I.) ; recorded (<i>sensu lato</i>) from Ceylon (H.S.).	<i>Cyclopodia (Paracyclopodia) roylei</i> (Westw.).
<i>Hesperoptenus tickelli</i> Blyth (Tickell's Bat) . . .	Widely distributed in India, North and South ; also Ceylon.	<i>Cyclopodia (Paracyclopodia) roylei</i> (Westw.).

<i>Scotophilus heathi</i> Horsf.	Madras, Rajputana (M.S.I.) ; Bihar (H.S.) .	<i>Cyclopodia</i> (<i>Paracyclopodia</i>) <i>roylei</i> (Westw.).
<i>Scotophilus kuhli</i> Leach (Common Yellow Bat) . .	Widely distributed in India, North and South ; also Ceylon and Burma.	<i>Cyclopodia</i> (<i>Paracyclopodia</i>) <i>roylei</i> (Westw.). <i>Cyclopodia sykesi</i> (Westw.) : ? accidental, see below, p. 380.
<i>Scotophilus temmincki</i> Leach	This name is not used in the M. S. I., but there is a record from United Provinces under it among the Ind. Mus. material: possibly the bat really belonged to another species of <i>Scotophilus</i> .	<i>Cyclopodia</i> (<i>Paracyclopodia</i>) <i>roylei</i> (Westw.).
<i>Scotophilus wroughtoni</i> Thos. (Wroughton's Bat)	Widely distributed in India, North and South ; also Ceylon and Burma.	<i>Cyclopodia</i> (<i>Paracyclopodia</i>) <i>roylei</i> (Westw.).
MINIOPTERINAE.		
<i>Miniopterus fuliginosus</i> Hodgs. (Long-winged Bat) .	Kumaon, Nepal, Burma (Mt. Popa), W. Ghats, Satara District (Bombay), Ceylon.	<i>Penicillidia jenynsi</i> var. <i>indica</i> , n. <i>Nycteribia</i> (<i>Listropodia</i>) <i>allotopa</i> Speiser. <i>Nycteribia</i> (<i>Listropodia</i>) <i>parvula</i> Speiser.
EMBALLONURIDAE.		
<i>Taphozous longimanus</i> Hardw. (Long-armed Bat)	Widely distributed in India to as far North as Surat and Bengal, also Burma and Tenasse- rim (M.S.I.) ; Ceylon (W.W.A.P.).	<i>Tripselia amiculata</i> (Speiser); (<i>fryeri</i> Scott).
<i>Saccolaimus saccolaimus</i> Temm. (Pouch-bearing Sheath- tailed Bat).	Bengal ; Kanara ; Ceylon	<i>Tripselia amiculata</i> (Speiser).

¹ See footnote on page 353.

From a *geographical standpoint* these Indian Nycteribiidae may be roughly grouped as follows :—(i) A mainly PALAEARCTIC GROUP, consisting of *Penicillidia dufouri*, *Nycteribia* (A.) *vexata*, and *N.* (L.) *pedicularia*. It is true that the last of these is also recorded from South Africa, but it may be doubted whether this record is not based on some very closely allied form, perhaps not yet described. In any case, apart from this, these three species are almost exclusively Palaearctic, the first and the last ranging right across that vast region from Europe to Formosa ; in fact Formosa is the only part of their known range usually regarded as in the Oriental, rather than the Palaearctic, Region, and it is not very far beyond the generally accepted border-line between the two.¹ Though now recorded for the first time from India, these species are only known from Kashmir and the Eastern and Western Himalayas, which, above a certain altitude, are part of the Palaearctic Region. It is significant that the only recorded host of these species in India, *Leuconoe longipes*, on which *P. dufouri* and *N.* (L.) *pedicularia* were found (the Indian host of *N.* (A.) *vexata* is not recorded), also appears to be confined to these parts of India. In view of these facts it is rather surprising that these insects were sometimes taken at relatively low elevations. All three species were found on an unidentified bat at an altitude of only 3,500 feet in the Darjeeling District ; but *P. dufouri* has also been taken from a bat at 8,000 ft. in Garhwal. The elevation of the place in Kashmir where *P. dufouri* and *N.* (L.) *pedicularia* were taken from *Leuconoe longipes* I have been unable to discover. In connexion with the wideness of range, both vertical and horizontal, of Nycteribiidae, the great mobility of their hosts must be borne in mind.

(ii) The second, or characteristically ORIENTAL GROUP, may for the sake of convenience be subdivided into (ii A) SPECIES WIDE-SPREAD IN THE EAST, i.e., *Nycteribia* (L.) *allotopa*, *N.* (L.) *parvula*, and *Cyclopodia ferrarii*, which are known from Java, Sumatra, Formosa, Ceylon, and India. In the last-named country the two former are so far recorded only from the Satara District of Bombay. These two species are only known to occur on certain closely-allied forms of *Miniopterus*, on which they are usually associated with *Penicillidia jenynsi*, the distribution of which is the same as theirs ; but this last is represented in Ceylon and India by a distinct subspecific form, which may be placed in the following subdivision : (ii B) SPECIES KNOWN ALMOST EXCLUSIVELY FROM INDIA, CEYLON, AND BURMA are *Penicillidia fletcheri*, *P. jenynsi* var. *indica*, *Nycteribia* (A.) *euxesta*, *Cyclopodia* (P.) *roylei*, and *C. sykesi*. It is significant that none of these (nor those of the preceding subdivision) has been found in the Himalayas, though they are widely distributed in other parts of the countries under review, and their hosts are for the most part widely ranging Indian forms. *Cyclopodia* (P.) *roylei*, which extends into the Malay Peninsula, appears to be one of the

¹ It is not intended here to enter into any discussion of the peculiar relationships of the fauna of Formosa. The Vertebrates of that island have been discussed from this point of view in Wallace's "Island Life" and probably elsewhere. A considerable amount has been written about the insects, especially in the series of papers entitled "H. Sauter's Formosa—Ausbeute," of which my report on the Nycteribiidae (Feb. 1914) formed a small part ; but I am not aware that any general review of the insect fauna has yet appeared.

most abundant of Eastern Nycteribiids ; it is known from nine different species of hosts (all but one belonging to the Vespertilionidae) and seems especially partial to the genus *Scotophilus*. *Cyclopodia sykesi* is also extremely abundant ; it has been regarded as exclusively associated with the large flying-foxes (*Pteropus*), and as exclusively Oriental ; but this paper includes a single record of it from *Scotophilus*, an occurrence which may be accidental ; while previous opinions as to its distribution are upset by the recent record of this species from Judaea, published by Falcoz. The Judæan specimens undoubtedly are *C. sykesi* but the data as to their capture are not detailed and the host from which they were taken is apparently not named ; no *Pteropus* occurs, but the allied genus *Rousettus* is represented, in that region. Further to the South-East, in the Malay Peninsula and Indo-Malay Islands, *C. sykesi* gives way to *C. horsfieldi*, which extends as far as the Philippines ; while other large forms of *Cyclopodia* (*sensu stricto*) occur still further South and East, in the Moluccas, the Papuan region, New Caledonia, etc., and *C. greeffi* represents the subgenus in Tropical Africa. In some of the Eastern forms the males are extremely closely alike, while the females differ by constant characters in the bristling of the abdomen. As stated below, I am unable to see any external difference between the males of *C. sykesi* and those of *C. horsfieldi*, while the females are easily distinguishable : it would be interesting to examine the males of these forms more closely, and see whether the genitalia or other structures not normally visible present differentiating characters.

(iii) SPECIES OCCURRING IN BOTH AFRICA AND THE ORIENT are *Penicillidia bathybothyra*, *Eucampsipodia hyrtli*, and *Tripselia amiculata*. The first has quite recently been recorded (under the name *P. fletcheri* var. *pumila*) from West Africa, though its host in that region is not stated. *E. hyrtli* is extremely wide-spread and is associated mainly with fruit-eating bats of the genus *Rousettus*, which occur in Africa and in Southern Asia from Palestine to South China. *T. amiculata* is known from Dahomey and the Congo on the West to Labuan on the East ; it appears to be restricted to bats of the family Emballonuridae, from which, conversely, no other Nycteribiids are recorded in the countries now under consideration.

(iv) It is difficult to speak of the new species under this head. *Penicillidia peali* is known from a single specimen from Assam, and its host is unrecorded. If one may venture to foretell, it should, from its affinities, prove to be characteristically Eastern. Consideration of *Nycteribia* (A.) *phillipsi* is best left till its affinities are more sure. *N. (Stylidia) annandalei* belongs to a subgenus hitherto only recorded from Palaearctic countries ; the unique example was taken in the Singhbhum District of Bengal, at an elevation of 2,500 feet, and the host on which it occurred is widely spread in India and Burma.

As to the restriction of particular groups of Nycteribiidae to particular groups of bats, several instances of this have been mentioned in treating of the distribution of the parasites. Table 2 shows that Indian Pteropodidae (Fruit Bats) are specially (though not exclusively) infested by the genera *Cyclopodia* (*s. str.*) and *Eucampsipodia* ; these bats are heavily parasitised by the Nycteribiidae associated with them. Indian Rhino-

lophidae (Horse-shoe and Leaf-nosed Bats) are seen to be victimised by at least three species of Nycteribiidae, though the numbers of individual parasites are not very great; Phillips has remarked on the frequent freedom of these bats from all parasites, and attributes it to their habit of hanging, when at rest, not crowded together, but some distance away from one another. Among Megadermatidae (Vampyres) there is only a single record of infestation by a Nycteribiid (and that a very common species) in India. In the Vespertilionidae twelve species of Indian Vespertilioninae are seen to be parasitised by these insects, in some cases by more than one species; Phillips has noted the complete absence of insect-parasites on bats of the subfamily Kerivoulinae in Ceylon, and I have no records under this group; among Miniopterinae, *Miniopterus* in these countries, as elsewhere, is usually abundantly parasitised by Nycteribiidae of several kinds. Emballonuridae (Short-tailed Bats), as Phillips states, are usually free from parasites, but the genus *Tripselia* is apparently restricted to bats of this family; this may be due to the habit of some, at least, of these bats of living in small isolated groups in the crowns of tall palms.

SUBSPECIFIC FORMS AND INDIVIDUAL VARIATION. These subjects are discussed and some previous references to them recalled under *Penicillidia jenynsi*, *Nycteribia (Acrocholidia) vexata*, *N. (A.) euxesta*, *N. (Listropodia) parvula*, *Cyclopodia (P.) roylei*, and *C. sykesi*. In some cases these phenomena are merely minute variations in chaetotaxy presented by individuals from the same locality, as in *C. sykesi*; or in other cases such minute chaetotaxic variations have occurred in whole series of examples from particular localities, while series from other places do not show them, as in *C. (P.) roylei*. But apart from this, a tendency to form geographical races or subspecies does seem to be exhibited by some species, which is not surprising in view of the greatness of their geographical range. It is desirable, however, to avoid burdening the nomenclature with special names for such forms whenever possible. In some cases they have been named; e.g., *Penicillidia jenynsi* var. *indica*, which may, however, come to be regarded as a separate species, as has happened in the case of the form originally described as *Penicillidia fletcheri* var. *pumila* (= *P. bathybothyra*). It would be interesting to know if subspecies or very closely allied species of Nycteribiidae are associated with particular subspecies of their mammalian hosts, but on this point there is hardly as yet any definite evidence.

LABOULBENIACEOUS FUNGI. The occurrence of Laboulbeniaceae on the bodies of certain of the specimens is noted under *Penicillidia jenynsi* var. *indica*, *Nycteribia (Acrocholidia) vexata* (this case being cited from the writings of Falcoz) and *N. (Listropodia) parvula*. I have previously recorded these organisms on a ♂ *Nycteribia (Listropodia) parilis* Walker, from Amboina (*Ann. Mag. Nat. Hist.* (8) xiv, p. 234, 1914), on one of the specimens of *P. jenynsi* var. *indica*, obtained by Fryer in Ceylon (*op. cit.*, p. 214) and on examples of the typical form of *P. jenynsi*, from Formosa (*Arch. Naturg.* lxxix, A. 8, p. 96, 1914): in the place last cited, the identity of the fungus was discussed and a list was given of the species of Nycteribiidae on which these fungi had previously been recorded.

While the hitherto unpublished localities and other data are given in detail, and also a summary of the known distribution of each species, the records from Ceylon and India contained in my earlier papers are not usually repeated in full.

Genus *Penicillidia* Kolenati.

Penicillidia dufouri (Westwood).

Nycteribia dufouri, Westwood, 1835.

Penicillidia dufouri, Kolenati, 1863; Speiser, 1901; Scott, 1914 (Feb.), *Arch. Naturg.* LXXIX, A. 8, p. 95; P. A. Buxton, 1914 (March), *Ent. Record*, XXVI, p. 68; Falcoz, 1923, *Arch. Zool. Exper.* LXI, p. 537; *id.* 1924, *Bull. Mus. Paris*, XXX, p. 309.

The material from the Indian Museum is as follows: 3 ♂, 1 ♀ from unidentified bat, Painsur, above Lohba, 8,000 ft., Garhwal, W. Himalayas, iv. 1914 (*Tytlér*); 1 ♂ from unidentified bat, Pashok, 3,500 ft., Darjeeling District, E. Himalayas, vi. 1916 (*L. C. Hartless*), in same tube with 1 ♂ and 1 ♀ *N. (Acrocholidia) vexata* and 1 ♂ *N. (Listropodia) pedicularia*; 2 ♂ from *Leuconoe longipes* Dobs., Bumbroo Caves, Matan, Pahlgam Road, Kashmir.

This species has long been known from many localities in EUROPE and NORTH AFRICA; and when recording it in 1914 from FORMOSA, I predicted that it would probably be found in other places between these two extremes, which has now come to pass. The nature of the localities in which it has been taken in INDIA supports the idea that its range is essentially Palaearctic, and it is doubtful whether the species will be found in the plains or southern parts of India. Falcoz (1923) has given a number of detailed records from Algeria, Spain, and France, with notes on the ethology. He lists (1924) as hosts *Rhinolophus euryale* Bl., *R. blasii* Pet., *R. hipposideros* Bechst., *R. ferrum-equinum* Schreb., *R. clivosus* Rüpp., *Leuconoe [Myotis] capaccinii* Bon., *Myotis myotis* Bork., *M. oxygnathus* Mont. The Formosan examples recorded by me were from a crowd of bats, nearly all of which were *Miniopterus schreibersi* (sens. lat.), but among which were a few *Leuconoe [Myotis] taiwanensis* Lind., and *Pipistrellus* sp. (determined as *P. abramus*), so that it is difficult to say exactly which species harboured the specimens of *Penicillidia dufouri*.

Penicillidia jenynsi (Westwood).

Nycteribia jenynsi, Westwood, 1835.

Penicillidia jenynsi, Speiser, 1901; Scott, 1908, *Trans. Ent. Soc. London*, p. 360, pl. 18, figs. 1-8 (♂♀); *id.* 1914, *Arch. Naturg.* LXXIX, A. 8, p. 95; *id.* 1914, *Ann. Mag. Nat. Hist.* (8) XIV, p. 213; Phillips, 1924, *Spolia Zeylanica* XIII, pp. 69, 70.

Var. *indica*, nov.

The ♂ of this species was redescribed by Speiser in 1901, and the ♀ was described for the first time by me in 1908 from Formosan specimens, when I also figured both sexes. I made further remarks on a long series of Formosan examples in 1914 (*Arch. Naturg.*) and, when recording two ♀ from Ceylon later in the same year, mentioned that the Ceylonese examples differed in certain small points from the majority of the

Formosan specimens. I have now had before me additional specimens from Ceylon, including a ♂, and a long series of both sexes from India, and find that both sexes differ from the Formosan examples in certain points which are constant enough to warrant the creatures being regarded at least as a distinct variety. For this the name *indica* is proposed, but it must be added that this form may not be confined to India, as in the ♀ sex some of its distinctive features were also observed to some extent in certain of the examples from Formosa.

The principal characteristic of var. *indica* lies in the form of the 4th sternite of the ♂ abdomen, the hind margin of which is produced to an apex in the middle, so that the sternite is obtusely angulate instead of broadly arcuate behind; instead of the surface of the sternite being almost entirely bare, it is covered with short bristles extending forward from the hind margin to more than half its length, and some long bristles arise among them, while the short "thorn-bristles" on the hind margin are perhaps a little less stout than in the typical form. The other distinguishing features consist in the surface of certain parts being covered

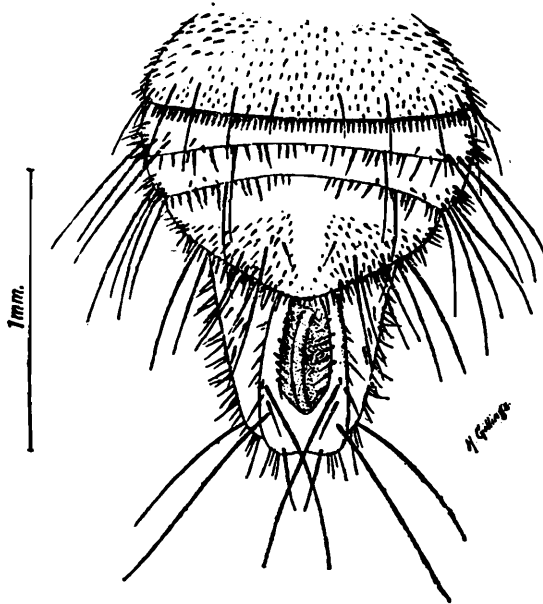


FIG. 1.—*Penicillidia jenynsi*, Westwood var. *indica*, nov. ♂; ventral view of abdomen.

with short bristles instead of being bare; in the ♂ the basal tergite is so covered; in the ♀ the 2nd tergite has a roughly triangular bristly median area, the paired ventral chitinous pieces have more of their surface bristly than is shown in my figure of the typical form (Scott, 1908, fig. 4 b), and the same applies to the transverse chitinous piece (fig. 4 c).

The Indian Museum possesses 19♂, 33♀, from *Miniopterus schreibersi* (sens. lat., probably *fuliginosus* Hodgs.), at Mahabaleshwar, Satara District, Bombay, c. 4,200 ft., 13-16. iv. 1912 (*F. H. Gravelly*), in same tube with 2♀ *N. (Listropodia) parvula* Speiser.

In CEYLON Capt. Phillips obtained 2♂ and 1♀ from *Miniopterus fuliginosus* at Dammeria, Passara, Uva, 3,000 ft., 15. v. 1922.

Types of var. *indica* in the Indian Museum; paratypes in my collection.

P. jenynsi was originally described from CHINA, and has been recorded from SUMATRA and FORMOSA, while var. *indica* represents it in CEYLON and INDIA.

1♂ and 1♀ in the series from Mahabaleshwar bear fungi which I take to be Laboulbeniaceae. Possibly this Nycteribiid is specially prone to infection with these organisms, the presence of which on an example from Ceylon and on three specimens from Formosa has been previously noted in my two 1914 papers.

***Penicillidia fletcheri* Scott.**

Penicillidia fletcheri, Scott, 1914, *Ann. Mag. Nat. Hist.* (8) XIV, p. 214; pl. x, figs. 1-4; *id.* 1917, *Parasitology* IX, p. 605.

The types of this species were taken from *Scotozous* [*Pipistrellus*] *dormeri* Dobs., at Coimbatore, and in 1917 it was recorded from an unnamed host at Bangalore, Mysore. I have seen no further examples either in the Indian Museum collection or elsewhere. A larger form has been described by F. W. Edwards (*Journ. Fed. Malay States Museums* iii, p. 58, 1919) as *P. fletcheri* var. *majuscula*, from *Vespertilio* sp., Sungei Penoh, 2600 ft., Korinchi, West Sumatra, 12. iii. 1914 (*Robinson and Kloss*).

***Penicillidia bathybothyra* (Speiser).**

Basilina bathybothyra, Speiser, 1907, *Rec. Ind. Mus.* I, p. 296.

Penicillidia fletcheri, Scott, var. *pumila*, Scott, 1914, *Ann. Mag. Nat. Hist.* (8) XIV, p. 217, pl. x, fig. 5; *id.* 1917, *Parasitology* IX, p. 606; Falcoz, 1924, *Bull. Mus. Paris* XXX, p. 228.

Penicillidia pumila, Phillips, 1924, *Spolia Zeylanica* XIII, pp. 68, 70.

For reasons given below, this form, originally described as a variety of *P. fletcheri*, must be regarded as a distinct species, and further the name *pumila* must give way to *bathybothyra* Speiser. A short preliminary description was given by Speiser in 1907 from a single male, and the species was referred to *Basilina*, a genus erected by Miranda de Ribeiro (*Arch. Mus. Rio de Janeiro* xii, 1903, p. 177) to contain a South American Nycteribiid, and characterised by the eyes being composed of more than one facet, while the tibiae are not ringed. Having now examined the type of *bathybothyra* under the highest power which can be used without detaching the head and mounting it in balsam, I cannot recognise the presence of more than one facet in the eye, and therefore must refer the insect not to *Basilina* but to *Penicillidia*. The type was dried and exceedingly shrunken and fragile, with the segments of the abdomen much telescoped one into the other and the sides of the thoracic ventral plate bent up, so that this plate appeared deceptively narrow; it was probably not mature when captured; but after prolonged soaking and careful examination of the specimen (now transferred to spirit), I can see no characters distinguishing it from the material subsequently described by me as the male of *pumila*.

As to the advisability of treating this species as distinct from *P. fletcheri*: in 1914, when *P. fletcheri* and var. *pumila* were described, the former was only known from India (Coimbatore), the latter only from Ceylon: the form *pumila* (= *bathybothyra*) is now known from both Ceylon and India, and since there is thus no geographical separation between it and *fletcheri*, while the differences between them seem to be constant, they are best treated as distinct species. This was first

suggested in a letter to me by Dr. Bequaert, as stated in my remarks on the matter published in 1917.

INDIA. The type ♂ of *P. bathybothyra* (Indian Museum) was taken from *Myotis* [*Vespertilio*] *muricola* Hodgs., at Calcutta; 1 ♂, scarcely mature, from Madras (also in the Indian Museum), may also possibly belong to this species; and in 1917 I recorded it from Khandala, Bombay Presidency (host not named).

CEYLON: the material originally described as *fletcheri* var. *pumila* was taken from *Pipistrellus*(?) *coromandra*¹ at Peradeniya. Capt. Phillips has recently collected the following, all at Anasigalla, Matugama, and all from *Pipistrellus mimus mimus* Wrought.; 2 ♂, 2 ♀ (two examples on each of two bats in the same colony), 23. x. 1921; 2 ♂, 3 ♀ from two bats (four parasites on one bat, one on the other) in the roof of a bungalow, 20. iv. 1922; 4 ♂, 5 ♀ off 6 bats living together (one or two parasites on each), 30. vi. 1922. Further records are: 1 ♀ from *Pipistrellus mimus mimus*, 2. x. 1924, locality not stated, probably near Matale (*R. Senior-White*); 1 ♂, 2 ♀ from undetermined bat, Trincomalee, 3. ix. 1910 (Indian Museum).

WEST AFRICA (*teste* Falcoz, *l.c.*).

Captain Phillips remarks (*op. cit.*) that *P. mimus mimus* usually has one or two Nycteribiids on it, sometimes as many as four or five, and that they are often close in under the wings. He records no other species of Nycteribiid from this bat.

Penicillidia peali, sp. nov.

♀. This insect resembles *P. fletcheri* in many respects. *Length* (front of ventral thoracic plate to end of abdomen, which is rather shrunken) about 2.6 mm. *Head* laterally compressed; vertex, bearing a group of about 7 or 8 bristles of moderate length; ocelli darkly pigmented round the edge, otherwise light-coloured; sides of head-capsule with a few very short bristles near the lower border, and rather longer bristles along the lower border towards the front. *Thorax* ventrally conspicuously broad, the length being equal to about $\frac{7}{10}$ of the breadth; the median longitudinal furrow is deeply impressed at the hind end. *Legs* relatively longer than in *P. fletcheri*, tibiae rather long and slender; bristles on the legs (and on the body generally) rufous-brown, lighter in contrast with the pale yellowish-brown chitin than in the type-specimens of *fletcheri*.

ABDOMEN: small *basal tergite* with short erect bristles at the sides, and a close group of long dark bristles on the hind margin at either hind angle, these latter bristles being longer, and the groups much further apart, than in *fletcheri*; the big *2nd tergite* is of much the same form as in that species, it has about 4 short marginal bristles in the middle of each side margin, scanty, very short bristles on the surface, these latter more numerous towards the base and basal angles, a group of very long bristles on each hind angle, and in front of these a close group of short ones, not a transverse series as in *fletcheri*; *connexivum* behind tergite 2 and at the sides posteriorly bare, in strong contrast to that of *fletcheri*; *anal segment* also bare on its surface, but with a few outwardly directed bristles on its

¹ See footnote on p. 353.

side margins and a rather dense group of longer and shorter bristles on either hind angle; ventrally, *sternite* 1 has an impressed mid-longitudinal line and its surface is scantily bristled; this sternite is broad and the ctenidium is composed of more than 60 close-set teeth; the rather shrunken posterior part of the abdomen shows 4 transverse series of bristles of moderate length, longer in the 4th series, those in each series not very close together; at the sides there are outwardly directed bristles, including two groups of very long ones level with the 2nd and 4th trans-



FIG. 2.—*Penicillidia peali*, sp. nov. ♀; inner surface of femur, tibia and tarsus of front leg.

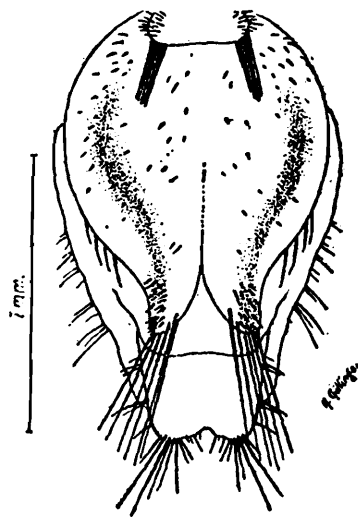


FIG. 3.—*Penicillidia peali*, sp. nov. ♀; dorsal view of abdomen.

verse series respectively; the area between the 3rd and 4th transverse series appears a little more chitinised than the rest and also has a few short bristles on its surface; behind the 4th transverse series is a plate nearly as long as wide, slightly narrowed behind and rounded off at the hind angles; its hind margin bears moderately long bristles (interrupted in the middle of the margin) and there is a group of short ones on the surface towards each hind angle; the surface of this plate is otherwise bare, it appears a little more pigmented towards the hind angles, and has

no bristles on its side margins, those which appear in fig. 4 being really on the sides of the anal segment; the shorter and longer bristles on the hind angles of the latter are of course visible in ventral, as in dorsal, view.

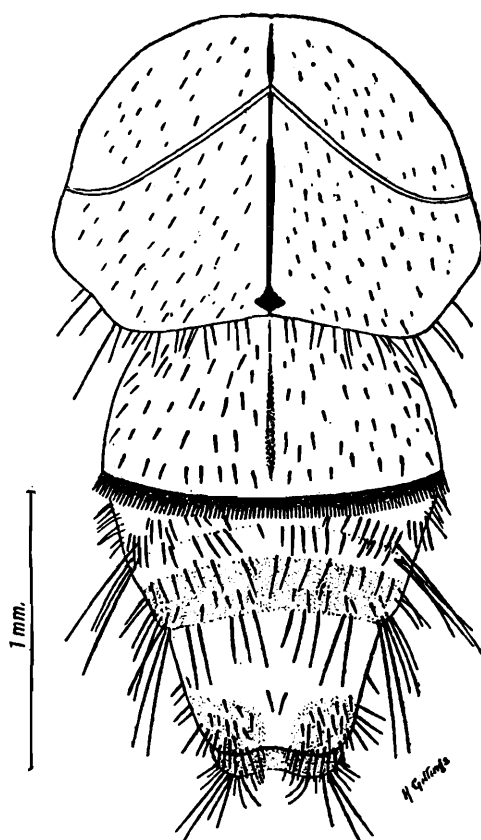


FIG. 4.—*Penicillidia peali*, sp. nov. ♀; ventral view of thorax and abdomen.

INDIA: Sibsagar, Assam, 1 ♀ (*S. E. Peal*); name of host and date not stated. The specimen (*type*) is in the Indian Museum.

This form is so clearly distinct from *P. fletcheri* by its larger size, relatively longer legs, and the other differences enumerated in the above description, that it seems best to describe it as a distinct species, though it is known only from a unique ♀ example. The species is dedicated to its discoverer, the late Mr. S. E. Peal.

Genus **Nycteribia** Latreille.

Subgenus **Acrocholidia** Kolenati.

Nycteribia (Acrocholidia) vexata Westwood.

Nycteribia vexata, Westwood, 1835.

Nycteribia montagui, Kolenati, 1856.

Acrocholidia montagui, Kolenati, 1863.

Nycteribia (Acrocholidia) vexata, Speiser, 1901; P. A. Buxton, 1914, *Ent. Record* XXVI, p. 68; Falcoz, 1923, *Arch. Zool. Exper.* LXI, p. 539; *id.* 1924, *Bull. Mus. Paris* XXX, p. 310.

1 ♂, 1 ♀, from unidentified bat, Pashok, Darjeeling District, 3,500 ft. vi. 1916 (*L. C. Hartless*); these specimens were in the same tube with 1 ♂ *Penicillidia dufouri*, 1 ♂ *N. (Listropodia) pedicularia* and some mites, doubtless from the same host.

The pair from the Indian Museum has been compared with specimens of both sexes taken from *Myotis oxygnathus* Mont., at the subterranean

lake, Hammam Meskoutine, E. Algeria, in 1913. These latter were collected and recorded by P. A. Buxton, and determined by me by comparison with descriptions and figures. Compared with the Algerian examples, the Himalayan specimens have the thorax ventrally even broader in proportion to its length, and the ♂ has short bristles on the surfaces of sternites 2, 3 and 4, which in the Algerian example have their surfaces bare.

The general distribution of this species is: EUROPE, NORTH AFRICA and the HIMALAYAS. It has been recently recorded from Spain by Falcoz, one ♀ out of three bearing a fungus (Laboulbeniaceae). *N. (A.) vexata* occurs in various parts of Europe, Algeria, Tunis and the Sahara, and like the two species of Nycteribiids with which it was associated at Pashok, its distribution appears to be essentially Palæarctic. I have recently seen 2 ♂, 1 ♀, taken by Professor E. Hindle from *Rhinolophus* sp. at the Gizeh pyramids, Egypt, 12. iii. 1921. Falcoz (1924) lists as hosts *Rhinolophus euryale*, *R. hipposideros*, *R. ferrum-equinum*, *Myotis myotis*, and *Miniopterus schreibersi*. As stated above, Buxton (l.c.) recorded the insect from *Myotis oxygnathus*.

***Nycteribia (Acrocholidia) euxesta* (Speiser).**

Penicillidia euxesta, Speiser, 1901, *Arch. Naturg.* LXVII, 1, p. 29.

Nycteribia (Acrocholidia) euxesta, Scott, 1914, *Ann. Mag. Nat. Hist.* (8) XIV, p. 218, pl. x, xi, figs. 6-9; Patton, 1924, *Rec. Ind. Mus.* XXVI, p. 112.

3 ♂, 1 ♀, from *Rousettus leschenaulti* Desm., Khandagiri, Puri District, Orissa, 7-8. xi. 1912 (*F. H. Gravely*); these specimens were in the same tube with the 5 ♂, 4 ♀, of *Eucampsipodia hyrtli* listed below, and are doubtless from the same host-individual (No. $\frac{6151}{19}$ Ind. Mus.). Major Patton has recorded *N. (A.) euxesta* from the Siju Cave, Garo Hills, Assam, where specimens were found on all the bats obtained in the cave; on *Rhinolophus subbadius* Blyth, at the entrance, on *Cynopterus sphinx gangeticus* K. And., at 400 to 500 feet from the entrance, and on *Hipposideros lankadiva* Kel., which ranges from 800 to 3,600 feet from the entrance: he has kindly submitted a specimen (♀) to me for examination, and I find in it certain deviations from the typical form, which are described below.

The general distribution of this species is: BURMA, CEYLON, INDIA. The Burmese examples, on which Speiser described the species, were collected by Fea, one pair from *Hipposideros armiger* Hodgs., at Kachin Cauri, 1886, and one ♂ from the Karen Hills, near Toungoo, ii. 1888.

Var. The single ♀ from the Siju Cave which I have seen is a rather large specimen, with the dorsal side of the abdomen differently bristled from that of the typical form: the connexivum has moderately long bristles evenly distributed all over the dorsal surface, with 4 or 5 longer and stouter ones in the middle behind; whereas in the typical form (cf. my 1914 paper, fig. 6) the longer bristles are confined to the middle part, in sharp contrast to the very short bristles on the dorso-lateral portions, while the conspicuously long and stout bristles on the hind part of the median area are more numerous.

Nycteribia (Acrocholidia) phillipsi, sp. nov.

♀ *Nycteribia (Acrocholidia) blainvillei* (Leach), Phillips, 1924, *Spolia Zeylanica* XIII, pp. 66, 70.

♀. *Length* of a gravid example (front of ventral plate of thorax to end of abdomen) 2.5 mm. *Head* with two pairs of rather short bristles on the front of the vertex, one pair slightly behind, and slightly nearer together than, the other, and with about two short bristles on each side on the lateral margin. *Halteres* with slender pedicel and rounded knob. *Thorax* beneath shown by careful measurement to be about as long as its greatest breadth, but as it is considerably narrowed in front it sometimes gives the impression of being decidedly longer than broad; median longitudinal groove rather deeply impressed behind. *Legs* much as in *N. (A.) vexata*; when the tibia is closed on the femur its apex reaches about to the pale ring in the basal part of the latter; tarsus longer than tibia; spines on the ventral side of the hind trochanters rather strong and close.

ABDOMEN DORSAL: *basal tergite* small, slightly darkened along either side, its surface bare except for a few very microscopic bristles towards the base, its hind margin with about five rather short bristles on either side

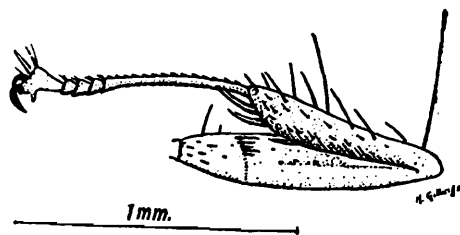


FIG. 5.—*Nycteribia (Acrocholidia) phillipsi*, sp. nov. ♀ outer surface of femur, tibia and tarsus of front leg.

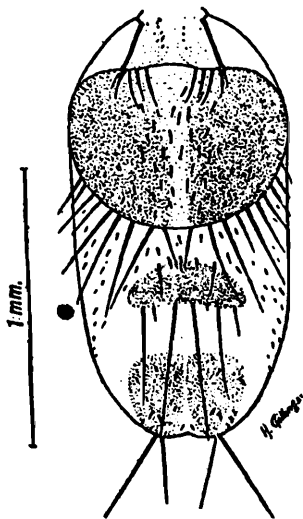


FIG. 6.—*Nycteribia (Acrocholidia) phillipsi*, sp. nov. ♀; dorsal view of abdomen.

and with about the median third bare; *tergite 2* large and long, yellowish-brown, paler along the median longitudinal line, surface with scanty, very short bristles along its middle part but otherwise bare, hind margin forming a very flattened curve but more rounded off at the sides, and set with long bristles of varying lengths; a little distance behind is a small *3rd tergite* only about $\frac{1}{2}$ the width of the distended abdomen, widely arcuate in front its hind margin nearly straight and bearing about four

long and one or two shorter bristles, its surface bare; some distance behind this is a *posterior tergite*, not very sharply delimited in front in

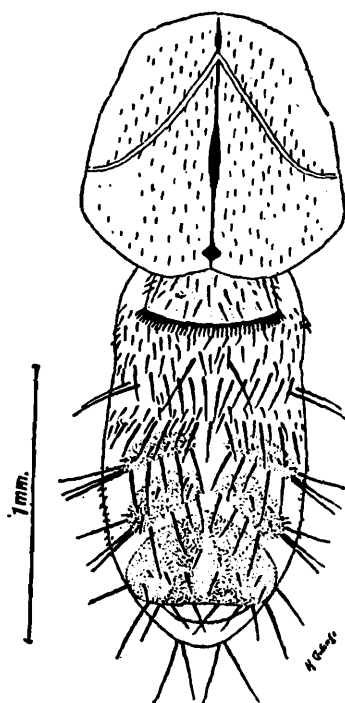


FIG. 7.—*Nycteribia (Acrocholidia) phillipsi*, sp. nov. ♀; ventral view of thorax and abdomen.

the specimen before me, broader at its base than long, narrowing towards the hind end, which is slightly and bluntly produced on either side and sinuate in the middle; this tergite has an indication of a paler median longitudinal line of weakness, each of its hind angles bears two long bristles, and the surface bears a few very minute bristles on either side towards the hind angle; there is no projecting, bilobed *anal segment* such as exists in *N. (A.) euxesta* and *N. (A.) phthisica*, but the anus lies in a vertical plane level with the hind end of the posterior tergite; the whitish *connexivum* bears very sparse short bristles between the 2nd and 3rd tergites and a pair of longer ones at the base of the latter, and extremely short, sparse bristles laterally, but between the 3rd and posterior tergites, and on either side of the latter, it is quite bare.

ABDOMEN VENTRAL: the *basal sternite* appears rather small and narrow, with the hindmost bristles on its surface rather longer than usual and the teeth of the ctenidium close set; behind this is whitish *connexivum* traversed by two transverse series of strong and rather long bristles, the one or two outermost of which on either side are more or less erect; the surface before the anterior series is rather closely covered with shorter bristles and has a pair of longer erect bristles in the middle; surface between the anterior and posterior series also bearing shorter bristles; lateral parts of this *connexivum* closely covered with short bristles; behind the posterior of the two transverse series are two pairs of *chitinous plates*, the posterior of which lie obliquely sloping backwards towards the sides of the body; each plate has a few erect short bristles on its surface, and a series of longer bristles on its hind margin, the inner four or five of the marginal series lying flat while the outer two or three are erect and directed outwards; *subgenital plate* subtriangular, with angles

rounded off, and base of the triangle forming the hind margin; its pale yellowish-brown chitin is divided by a whitish median longitudinal area reaching almost or quite to the front end, its hind margin bears about ten erect bristles, of which the two outer on either side (at the angle) are longer than the median six, and its surface bears an irregular transverse series of about six rather short bristles behind the middle of its length; the anal segment ventrally appears quite bare.

CEYLON: 3 ♀ taken off one or two individuals (part of a bat colony in a cave) of *Rhinolophus rouxi rouxi* Temm., at Anasigalla, Matugama, about 100 feet, xii. 1921 (W. W. A. Phillips). Type in my collection, where the paratypes also remain for the present.

Compared with the ♀ of *N. (A.) vexata*, this species is at once distinguishable by the thorax ventrally being as long as (and appearing longer than) broad, by the much longer and larger 2nd tergite (which recalls somewhat that of *N. (Stylidia) biarticulata*) and the more scanty bristling of the surface of this tergite, by the anal segment being only slightly sinuate at the hind end above the anus, instead of bilobed, and having much fewer bristles, by the longer bristling of the ventral connexivum in front of the two transverse series of bristles respectively, and the oblique position of the posterior ventral chitinous plates.

Although I have before me only the female sex of this species, it has seemed best to describe it, as the insect is quite distinct from any that I have seen, and does not agree entirely with the descriptions of any which I have not seen. Among the latter, the nearest approach to agreement is found in Speiser's redescription (*Arch. Naturg.* LXVII, I, p. 44, 1901) of *N. (A.) blainvillei* Leach, a species very briefly described by Leach from Mauritius in 1817, and to which Speiser referred the examples from Egypt described by him in 1901. Speiser had evidently not seen Leach's type, and I have been unable to find where it is, no specimens bearing the name *blainvillei* being traceable either in the British Museum or the Hope Museum, Oxford. Leach states that his material was communicated to him by his friend Blainville; I have inquired whether the type is in the Paris Museum, but it cannot at present (i. 1925) be found in that institution. In my manuscript notes and correspondence I at first called the Ceylonese specimens "probably *blainvillei* Leach," which led Capt. Phillips to refer to them under that name in his paper cited above. But on further consideration I cannot be certain if they are identical with the examples referred by Speiser to *blainvillei*, and this, coupled with the failure to find and compare Leach's type, has induced me to give the Ceylon insect a name and describe it as a new species, which I have pleasure in dedicating to Capt. Phillips. Leach described the legs of *blainvillei* as long and slender, and Speiser referred the Egyptian examples which he studied to that species mainly on the same character, describing their legs as very long and thin, as long as the body: this applies also to *phillipsi*, in which the middle and hind legs are even longer than the body. Speiser described the ventral surface of the thorax as strikingly longer than broad in *blainvillei*, but, as mentioned above, appearances may be rather deceptive in this respect. His account of the segmentation and bristling of the ♀ abdomen is not detailed enough for close comparison with that of *phillipsi*.

***Nycteribia (Acrocholidia) phthisica* Speiser.**

Nycteribia (Acrocholidia) phthisica, Speiser, 1907, *Rec. Ind. Mus.* I, p. 295.

A short preliminary description of this species by Speiser was published in 1907. I now have the unique type (♀) before me, and after subjecting it to a prolonged soaking in water have been able to remove it from its pin and place it in spirit. Though the specimen was much shrunken through desiccation, it has regained its proper shape to some extent, and it is possible to give the following particulars and figures. The figures must not be taken as completely accurate in every small detail, as, owing to the shrinkage of the abdomen, it has been impossible to discern exactly the arrangement of all the bristles; some, which are broken off but the points of origin of which are clearly visible, are represented by broken lines. Fig. 8*a* shows the dorsal aspect of the abdomen tilted over to the right, so much so that some of the ventral bristles are visible on the left-hand side of the figure: owing to the extremely fragile condition of the specimen no pressure could be applied to make it lie more nearly level.

The *length*, from the front of the ventral thoracic plate to the end of the abdomen, is (after soaking) about 2.3 mm. The insect closely resembles the ♀ of *N. (A.) euxesta* (Speiser), but is distinguished by its considerably smaller size, longer and narrower thorax, the sparser and feebler bristling of the abdomen, and the presence of a chitinous tergite immediately in front of the anal segment. Speiser described the ventral side of the *thorax* as almost twice as long as broad. Actually, though distinctly longer than broad, it is not as long as stated by him; the appearance of extreme narrowness was partly due to desiccation, the side parts being bent upwards strongly in the dried specimen, so that the thorax appeared very narrow. After soaking it has assumed the form shown in fig. 9. The form of the *legs* is shown in fig. 8*b*; it is not possible to say to which pair of legs the example drawn belongs, as it

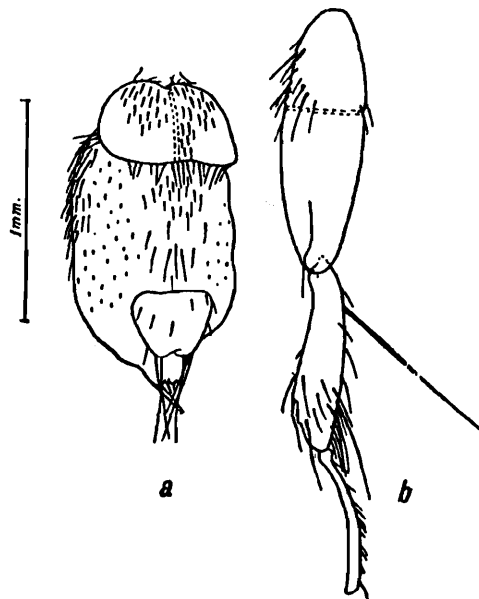


FIG. 8.—*Nycteribia (Acrocholidia) phthisica*, Speiser, ♀; *a*, dorsal view of abdomen (tilted to right); *b*, femur, tibia and metatarsus of one of the legs.

and several others have unfortunately become detached.

ABDOMEN: the dorsal aspect rather closely resembles that of *N. (A.)*

euxesta (compare my fig. 6 of that species, *Ann. Mag. Nat. Hist.*' (8) xiv, 1914, pl. x) ; the small basal tergite has very short bristles on its hind

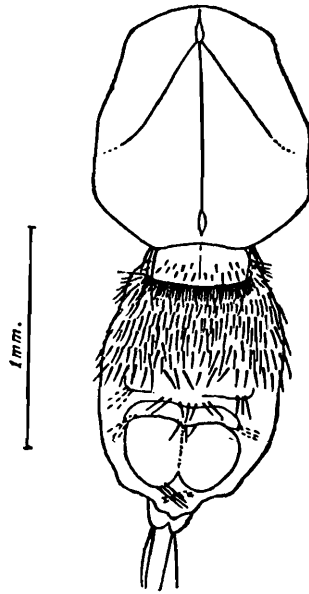


FIG. 9.—*Nycteribia* (*Acrocholidia*) *phthisica*, Speiser, ♀ ; ventral view of thorax and abdomen.

angles ; the large second tergite is of the same form as in *euxesta*, with a line of weakness down the middle, some short bristles on its surface (these are few and situated mostly near the base, but probably a number of others have been broken off), while the hind marginal bristles are fewer and weaker than in *euxesta*, and absent towards the outer angles, though here again some may have been broken away. The connexivum dorsally is almost bare at the sides, and has longer bristles in the middle, but these are much fewer than, and not so long or strong as, those in *euxesta*. There is a rather large posterior dorsal chitinous tergite, narrowing behind, emarginate in the middle of the hind margin, with two long bristles at each hind angle, and a few short erect bristles on the surface at about the middle of its length and near its base ; this tergite appears to be about as long as its breadth at the base, though it has not been possible to measure it exactly. The anal segment is small and bilobed, with two long bristles at either hind angle. Ventrally, the basal sternite is much smaller and narrower than in *euxesta* (cf. Scott, *op. cit.*, pl. xi, fig. 7), and its ctenidium has fewer teeth ; these latter number a little over 40, while in the specimen of *euxesta* used for comparison there are over 50 ; the connexivum bears 5 or 6 quite irregular series of rather long and strong bristles, but they appear a little less close and strong than in *euxesta*. Behind the connexivum are two pairs of short, transverse, partly chitinated areas, each with a group of 3 outwardly-directed bristles at its outer angle and a few bristles at the base in the median part. The *subgenital plate* is large and bilobed, with a line of weakness along the middle, and the hind end of each lobe rounded and bearing a group of 3 long bristles ; there are also a few shorter bristles in the middle at the base.

AMBOINA : 1 ♀ from *Rhinolophus euryotis* Temm. The specimen (*type*) is in the Indian Museum.

The points of difference between this species and *N. (A.) euxesta* have been mentioned above. *N. (A.) phillipsi*, however, has a chitinous tergite in the middle of the connexivum between the large second tergite and the posterior tergite, and this is quite absent in both *phthisica* and *euxesta*. *N. (A.) phillipsi* has a large posterior tergite with a line of weakness along the middle, but no projecting, bilobed anal segment; *euxesta* has a projecting, bilobed anal segment but no posterior tergite in front of it; *phthisica* possesses both these structures.

Subgenus **Listropodia** Kolenati.

Nycteribia (Listropodia) pedicularia Latreille.

Nycteribia pedicularia, Latreille, 1805.

Nycteribia latreillei, auctt.

Listropodia latreillei, Kolenati, 1863.

Nycteribia (Listropodia) pedicularia, Speiser, 1901; Scott, 1914, *Arch. Naturg.* LXXIX A, Heft. 8, p. 100; P. A. Buxton, 1914, *Ent. Record* XXVI, p. 68; Falcoz, 1923, *Arch. Zool. Exper.* LXI, p. 541; *id.* 1924, *Bull. Mus. Paris* XXX, p. 311.

The material in the Indian Museum is as follows: 1 ♂ from unidentified bat, Pashok, Darjeeling District, 3,500 ft., vi. 1916 (*L. C. Hartless*); this example was in the same tube with 1 ♂ *Penicillidia dufouri*, 1 ♂ and 1 ♀ *N. (Acrocholidia) vexata*, and mites, doubtless from the same host; 4 ♂, 4 ♀, "on bats," *Leuconoe longipes* Dobs., Bumbroo Caves, Matan, Pahlgam Road, Kashmir (in same tube with 2 ♂ *Penicillidia dufouri*).

This species is known from the whole of EUROPE, from ALGERIA (Buxton, *op. cit.*), TUNI and FORMOSA (Scott, *op. cit.*), while from CHINA I recently saw 1 ♂ taken from an unidentified bat at Foochow, 7. iv. 1922, and 1 ♂, 1 ♀ from an unidentified bat in the same place, date not given (*C. R. Kellogg*: these examples were submitted to me by Mr. F. J. Cox on behalf of the late Hon. N. C. Rothschild). Its range therefore seems to embrace the whole Palæarctic Region, and in addition it is recorded from SOUTH AFRICA (Speiser, 1901, pp. 53, 54). Falcoz has recently given several detailed records from France and Spain. The two other species of *Nycteribiidae* found on the same hosts with it at Pashok and in Kashmir are, so far as known, essentially Palæarctic. In 1914 (*op. cit.*) I gave reasons for regarding *Listropodia blasii* Kol. as a form of *N. (L.) pedicularia*. The hosts of this species, as listed by Falcoz (1924), are *Rhinolophus hipposideros* Bechst., *Eptesicus [Vespertilio] serotinus* Schreb., *Nyctalus [Vespertilio] noctula* Schreb., *Leuconoe [Myotis] dasycneme* Boie, *L. [M.] daubentoni* Leisl., *Myotis myotis* Bork., *M. oxygnathus* Mont., and *Miniopterus schreibersi*.

Nycteribia (Listropodia) allotopa Speiser.

Nycteribia (Listropodia) allotopa, Speiser, 1901, p. 37; Scott, 1914 (Feb.), *Arch. Naturg.* LXXIX A, Heft 8, p. 97; *id.* 1914 (Sept.), *Ann. Mag. Nat. Hist.* (8) XIV, p. 221; Phillips, 1924, *Spolia Zeylanica* XIII, pp. 69, 70.

Nycteribia (Listropodia) insolita, Scott, 1908, *Trans. Ent. Soc. London*, p. 364, pl. xviii, figs. 9-13, ♂ ♀.

The Indian Museum possesses the following material: About 39 ♂ and 67 ♀ from *Miniopterus schreibersi* (sens. lat.; probably *M. fuliginosus*

Hodgs.), Mahabaleshwar, Satara District, Bombay, about 4,200 ft., 13-16. iv. 1912 (*F. H. Gravely*); these were in the same tube with a long series of *N. (Listropodia) parvula* from the same host. There is in the British Museum 1 ♂ (given by Hon. N. C. Rothschild) from *Miniopterus* sp., at Helwak, near Satara, 30. v. 1900.

In CEYLON Phillips took 6 ♂, 4 ♀ from *Miniopterus fuliginosus* at Dammeria, Passara, Uva, 3,000 ft., 15. v. 1922.

This species was incompletely described by Speiser from SUMATRA and redescribed and figured by me from FORMOSA under the name of *insolita*. I subsequently (1914, Feb.) gave additional records from Formosa and recorded the species from Amoy in CHINA, and still later (1914, Sept.) from CEYLON, pointing out certain features in which the Ceylonese examples differed from the Formosan specimens. The insect is here recorded for the first time from INDIA.

Though the host-bat has been identified on several occasions it has always proved to be a species of *Miniopterus* (*M. schreibersi*, sens. lat., or *M. fuliginosus*), on which *N. (L.) allotopa* seems often to be extremely abundant—witness the long series above, and the Formosan material, which amounted to 375 specimens (183 ♂, 192 ♀), 318 of which (155 ♂, 163 ♀) were taken on 3 days in the same week at the same place, apparently all in an old temple where the bats congregate (see Scott, 1914 (Feb.), pp. 94, 98). Moreover, *N. (L.) allotopa* is frequently associated on the same hosts with the following species, *N. (L.) parvula*.

***Nycteribia (Listropodia) parvula* Speiser.**

Nycteribia (Listropodia) parvula, Speiser, 1901, p. 38, ♀; Scott, 1914 (Feb.), *Arch. Naturg.* LXXIX A, Heft 8, p. 98; *id.* 1914 (Sept.), *Ann. Mag. Nat. Hist.* (8), XIV, p. 222; Phillips, 1924, *Spolia Zeylanica* XIII, pp. 69, 70.

Nycteribia (Listropodia) sauteri, Scott, 1908, *Trans. Ent. Soc. London*, p. 366, pl. xviii, figs. 14-18, ♂ ♀.

From the Indian Museum: 2 ♀ from *Miniopterus schreibersi* (sens. lat.; probably *M. fuliginosus* Hodgs.), Mahabaleshwar, Satara District, about 4,200 ft., 13-16. iv. 1912 (*F. H. Gravely*), in the same tube with the long series of *Penicillidia jenynsi* var. *indica* recorded above; 36 ♂, 35 ♀, same host, date and place as the preceding, in same tube with the long series of *N. (L.) allotopa* recorded above.

In CEYLON Phillips took 2 ♂ from *Miniopterus fuliginosus* at Dammeria, Passara, Uva, 3,000 ft., 15. v. 1922.

The general distribution of this species includes SUMATRA, FORMOSA, CEYLON and INDIA. No other hosts besides those mentioned above are recorded.

This species, like the preceding, was originally described from Sumatra, redescribed and figured by me from Formosa under the name *sauteri*, and later recorded from Ceylon. It is here recorded for the first time from India. In the Indian material the anal segment of the ♀ frequently has a regular transverse series of about six or seven short bristles before the middle of its length, and indications of a posterior series, interrupted in the middle, just before the hind margin; the Formosan ♀ figured in 1908 (*op. cit.*, pl. xviii, fig. 17) had only two or three short bristles on the dorsal surface of this segment.

Two of the ♂ from Mahabaleshwar bear Laboulbeniaceae, as do some of the examples of *Penicillidia jenynsi* var. *indica* taken at the same time and place.

Like *N. (L.) allotopa*, the species under discussion has never been recorded from any hosts but *Miniopterus schreibersi*, or *M. fuliginosus*, on which it sometimes occurs in great numbers, as shown by the long series from Mahabaleshwar and that from Formosa; in the latter country 166 examples (89 ♂, 77 ♀) were obtained on 3 days in the same week in an old temple at Tainan. The association of *N. (L.) parvula* with the two other species of Nycteribiids found with it at Mahabaleshwar has also been placed on record before, since it was found with both *N. (L.) allotopa* and with the typical form of *P. jenynsi* in Formosa, and with *N. (L.) allotopa* and *P. jenynsi* var. *indica* in Ceylon (see Scott, *op. cit.*, 1914, Feb. and Sept.).

Subgenus **Stylidia** Westwood.

Nycteribia (Stylidia) annandalei, sp. nov.

♀. *Length* of a gravid example (front of ventral plate of thorax to end of abdomen, not including the styles) about 2.1 mm. Distinctly smaller than *N. (S.) biarticulata* Herm. *Tibiae* shorter in proportion to the length of the femora; this is especially noticeable in the front legs, in which the tibiae are nearly as long as the femora in the examples of *biarticulata* used for comparison, but are only about $\frac{2}{3}$ the length of the femora in *annandalei*; the tibiae are also distinctly shorter than the tarsi. Ventrally, the *thorax* appears distinctly long in proportion to its breadth.

Abdomen: the small basal tergite has short bristles along the whole of its hind margin, not merely a group at either angle; second tergite much shorter than in *biarticulata*, wider than long, very much rounded off at the sides behind, with scarcely any apparent median longitudinal line of weakness (only a slight darkening of the pigmentation on either side of the middle line), and the hind margin bearing only 4 long bristles, widely spaced, in the middle, and 3 shorter ones on either side; connexi-

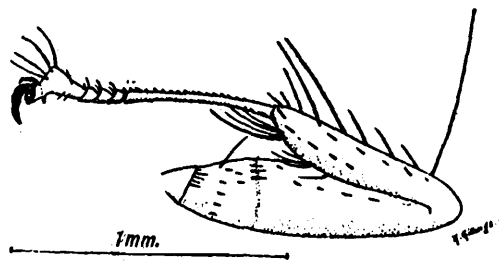


FIG. 10.—*Nycteribia (Stylidia) annandalei*, sp. nov. ♀; outer surface of femur, tibia and tarsus of front leg.

vum behind the second tergite bare in the mid-dorsal region; posteriorly there is a very small median chitinous area, with surface bare and 3 long bristles and 1 short bristle on its curved hind margin; behind this the extremity of the abdomen is chitinated on either side of the middle line and bears a group of about 5 short bristles at the base of either style. Basal sternite small and narrow; behind this the connexivum bears

about 5 transverse rows of bristles, neither very short nor very close ; among these there are three pairs of longer, more outstanding bristles near the base, the anterior near the middle line, the next pair much wider, and the third pair still wider apart ; behind the transverse rows of bristles are two pairs of very short, transverse, chitinated patches, each patch bearing 2 or 3 very short bristles on its surface, 2 or 3 long bristles on its hind margin, and a group of 3 laterally directed bristles at its outer angle ; behind the second of these pairs the surface is chitinated on either side of the middle line, forming two not very well-defined ovoid areas, each with about two long and two shorter bristles at its hind end.

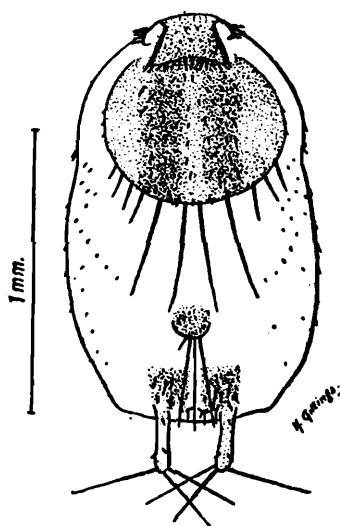


FIG. 11.—*Nycteribia (Stylidia) annandalei*, sp. nov. ♀ ; dorsal view of abdomen.

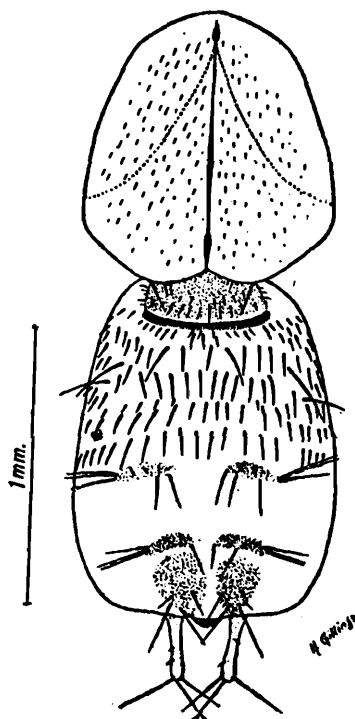


FIG. 12.—*Nycteribia (Stylidia) annandalei*, sp. nov. ♀ ; ventral view of thorax and abdomen.

INDIA : 1 ♀, taken from *Rhinolophus lepidus* Blyth, at hæmatite mine, Manharpur, Singhbhum District, Bengal, 2,500 ft. The specimen (*type*) is in the Indian Museum.

This interesting subgenus has not, to my knowledge, previously been recorded from any Oriental locality. I have seen examples of *N. (S.) biarticulata* from various parts of its range (England, Algeria, Palestine, etc.), but *annandalei* differs so markedly from *biarticulata* by its smaller size, narrower thoracic ventral plate, shorter tibiae, and differently shaped abdominal segments, that it must be described as a distinct species, even though only from one sex and from a single specimen. The chitinous parts of the example are very pale yellowish, but in other respects it seems mature, and the abdomen is swollen and gravid.

Besides *biarticulata*, the only other described species of the subgenus is *Nycteribia ercolanii* Rondani 1879, from Emilia (Italy). This species was referred to the subgenus *Stylidia* by Speiser and is distinguished from *biarticulata* in his key (*Arch. Naturg.* LXVII, 1, 1901, p. 69) by the relative shortness of its tibiae. I am much indebted to Professor Angelo Senna of Florence for having kindly lent me, in June 1924, a ♀ *Nycteribia ercolanii* from Rondani's collection; Professor Senna wrote that he was unable to say which of the examples in that collection is to be regarded as the actual type of the species. The specimen sent was pinned, and is much shrunk; at first I thought it to be a much desiccated *Listropodia*, but after examination I concluded that it is almost certainly a genuine *Stylidia*. In any case it is quite distinct from *N. (A.) annandalei*; the chitinous piece on the dorsal side of the abdomen before the anal segment is short, broad and truncate behind, and has both very long and quite short bristles along its hind margin; the second tergite is much shorter than in *biarticulata* and the thoracic ventral plate is relatively broader; the tibiae are (as remarked by Speiser) shorter, and are also broader and more flattened, than in *biarticulata*.

N. (S.) annandalei is named in memory of the late Dr. N. Annandale.

Genus **Cyclopodia** Kolenati.

Subgenus **Cyclopodia**, s. str., Scott, 1917, *Parasitology* IX, p. 607.

Cyclopodia sykesi (Westwood).

Nycteribia sykesi, Westwood, 1835, ♀.

Nycteribia hopei, Westwood, 1835, ♂.

Cyclopodia sykesi, Kolenati, 1863; Speiser, 1901; Scott, 1908 (Feb.), *Trans. Ent. Soc. London* 1907, pp. 421-428, figs. 1, 2; *id.* 1914, *Ann. Mag. Nat. Hist.* (8) XIV, p. 228; Phillips, 1924, *Spolia Zeylanica* XIII, p. 70; Falcoz, 1924, *Bull. Mus. Paris* XXX, p. 389.

Cyclopodia hopei, Enderlein, 1901, *Arch. Naturg.* LXVII, I, Heft 2, pp. 175-178, figs. 1, 2.

The material submitted to me from the Indian Museum is as follows: 2 ♂, 3 ♀ from *Pteropus giganteus leucocephalus* Hodgs., at Sadiya, N. E. Assam, 24. xi. 1911 (*S. W. Kemp*, Abor Exped.¹); 10 ♂, 8 ♀ from *Pteropus* sp., Balugaon, Puri District, Orissa, 21-31. vii. 1913 (*Annandale*); 3 ♂, 1 ♀ (dried) from *Pteropus medius* Temm., Satpara, Puri District, Orissa, 8-12. xii. 1908 (*J. Caunter*; other examples in the Indian Museum, not seen by me); 2 ♂, 1 ♀, preserved dry, from *Pteropus medius*, at Bhogaon

¹ One example of this series, a ♀, preserved dry, was labelled *Cyclopodia horsfieldi*, Meij.

Factory, Purneah, Bihar, 18. x. 1907 (C. A. Paiva¹); 1 ♂, 2 ♀ "on body of flying-fox," Barkuda Island, Chilka Lake, Ganjam District, Madras, 10. vi. 1923 (B. J. F.); 7 ♂, 2 ♀ "on *Pteropus intermedius*," same locality as preceding, 23. i. 1923; 2 ♂, 2 ♀ "from *Scotophilus kuhli*," same locality as preceding, 25. ix. 1919 (Annandale); 8 ♂, 3 ♀ "from greater flying-fox" (*Pteropus* sp.), Peradeniya, Ceylon, 22. vi. 1910. I am informed that there is also in the Indian Museum other material of this species taken from *Pteropus medius* at Trivandrum, Travancore.

In CEYLON Phillips took 4 ♂, 1 ♀ from *Pteropus giganteus giganteus* Brunn., at Anasigalla, 100 ft., 24. vi. 1922; 4 ♂ from the same species of bat at the same place, 2. i. 1922; 16 ♂, 24 ♀ from four lots of bats (numbering 24 individuals in all) of the same species at St. George, Matugama, 100 ft., 27. ii. 1923. Capt. Phillips remarks (*l.c.*) that nearly every specimen of the Common Flying Fox examined had on it one or more examples of *C. sykesi*, and some had as many as eleven; they were usually among the hair of the nape of the neck, or under the wings. It may be recalled that one hundred examples of this Nycteribiid were found on eleven specimens of *Pteropus* at Barberyn Island, Ceylon, by Mr. T. B. Fletcher in 1907 (see Scott, 1908, *op. cit.*). Mr. Senior-White's collection contains 2 ♂ from the neck-fur of the same species of bat, Suduganga, 4. ii. 1920.

From BURMA I have recently seen the following: 3 ♂, 2 ♀ from *Pteropus giganteus*, Rangoon, 18. i. 1917; and 3 ♂, 3 ♀ from unidentified bats collected by Mr. Ripley at Rangoon, viii. 1916; these were all sent to Professor Nuttall by Dr. H. H. Marshall.

The record given above of specimens from *Scotophilus kuhli* is most unusual. I have never before seen examples recorded from any bat outside the genus *Pteropus*. One is tempted to imagine that the insects may have wandered on to the *Scotophilus* accidentally, if it happened to alight in a place where *Pteropi* either were, or had been, resting.

The general distribution includes INDIA, BURMA, CEYLON, the MALDIVES, and JUDÆA. The last-named country has been recently added by Falcoz (*l.c.*), and is based on specimens in the Paris Museum, two of which Dr. Falcoz kindly allowed me to examine; they were dried and on long pins, and were labelled "Muséum Paris, Judée, Roux"; they appeared to be undoubtedly a ♂ and a ♀ *Cyclopodia sykesi*. The locality is surprising as previous records have been exclusively Oriental. According to the British Museum Catalogue of Chiroptera, no *Pteropus* occurs in Judæa, but there are species of the allied genus *Rousettus* in Cyprus and Palestine.

After carefully examining specimens of the two species side by side, I can see no superficial characters satisfactorily distinguishing *C. sykesi* and *C. horsfieldi* in the male sex, though the females are sufficiently distinct.

INDIVIDUAL VARIATION. The ♂ of *C. sykesi* varies very little, but the ♀ displays some variation in the number of the large dorsal tubercles situated in the middle of the abdominal connexivum. Normally there are four arranged in a square; but in 1908 (*Tr. Ent. Soc.* 1907, pp. 423-4) I described and diagrammatically figured abnormal individuals with

¹ These specimens were placed as *C. horsfieldi*.

five, six, and even seven big tubercles, and Enderlein in 1901 (*op. cit.*) figured a single individual in which they are five in number. Further examples of this abnormality occur in the Indian Museum collection; both the ♀ obtained at Barkuda Island, 23. i. 1923, have five big tubercles, arranged in one example in a circle, in the other case in an irregular rectangular figure, three on one side, two on the other; and one of the ♀ from Balugaon also has five big tubercles irregularly arranged, three on one side, two on the other; the ♀ from Purneah, Bihar, has these big tubercles four in number but irregularly placed, the left-hand tubercle of the hind pair being behind, instead of level with, the right-hand member of the same pair.

Cyclopodia ferrarii (Rondani).

Nycteribia ferrarii, Rondani, 1878.

Cyclopodia ferrarii, Speiser, 1901, *Arch. Naturg.* LXVII, I. p. 55; Scott, 1914, *Ann. Mag. Nat. Hist.* (8) XIV, p. 222, pl. xi, figs. 10-15; *id.* 1917, *Parasitology* IX, p. 607 (remarks under discussion of characters of the genus); Phillips, 1924, *Spolia Zeylanica* XIII, p. 70.

INDIA: 4 ♂, 6 ♀, from an undetermined bat, taken in the Museum building, Calcutta, 26. xi. 1914, were submitted to me. I am told that the Indian Museum contains other examples taken from *Cynopterus marginatus* (= *sphinx* Vahl) in the same place, namely the Museum compound, Calcutta.

In CEYLON Phillips took 2 ♂ from *Cynopterus brachyotis ceylonensis*, at St. George, Matugama, 150 ft., 9. i. 1923.

In BURMA 1 ♂ and 7 ♀ were obtained by Fea at Bhamó xi. 1886 (*teste* Speiser, *l.c.*).

The general distribution includes JAVA, SUMATRA, BURMA, INDIA and CEYLON.

Subgenus **Paracyclopodia** Scott, 1917, *Parasitology* IX, p. 608.

Cyclopodia (Paracyclopodia) roylei Westwood.

Nycteribia roylei, ♂, Westwood, 1835; Kolenati, 1863.

Cyclopodia roylei, ♂, Scott, 1908, *Trans. Ent. Soc. London*, p. 368, pl. xviii, fig. 19.

Nycteribia (Acrocholidia) chlamydophora, ♂ ♀, Speiser, 1903, *Fascic. Malay. Zool.* I, p. 123.

Cyclopodia roylei, ♂ ♀, Scott, 1914, *Ann. Mag. Nat. Hist.* (8) XIV, p. 224, pl. xii, figs. 16, 17.

Cyclopodia (Paracyclopodia) roylei, Scott, 1917, *Parasitology* IX, p. 608; Phillips, 1924, *Spolia Zeylanica* XIII, pp. 68, 70.

In 1917 I gave reasons for treating this species as the type of a distinct subgenus, *Paracyclopodia*. It is in some respects (*e.g.*, the structure of the ♀ abdomen) one of the most remarkable *Nycteribiids*, and it also seems to be one of the most abundant. From the Indian Museum there have been submitted to me thirteen separate lots of specimens: 6 ♂, 4 ♀, from unidentified bat, probably from Calcutta, 10. i. 1911 (*I. H. Burkill*); 5 ♂ from *Scotophilus kuhli*, taken in the Museum building, Calcutta, 14. i. 1922 (*S. W. Kemp*); 2 ♂, 11 ♀ from *Scotophilus wroughtoni*, Barkul, Puri District, Orissa, 9-13. xi. 1912 (*F. H. Gravely*); 9 ♂, 15 ♀ from *Hesperoptenus [Vesperugo] tickelli* at Balighai, near Puri, Orissa, 16-20.

viii. 1911 (*Annandale and Gravelly*); 3 ♂, 3 ♀ on *Pipistrellus* sp. (? *coromandra*¹) taken "at light; flew into the bungalow," Balugaon, Puri District, 21-31. vii. 1918 (*Annandale*); 7 ♂, 5 ♀ on *Myotis formosus*, Siripur, Saran, Bihar, 1. xi. 1912; 2 ♀ from *Scotophilus temmincki* at Hardwar, United Provinces; 1 ♂, 1 ♀ from *S. wroughtoni*, Barkuda Island, Chilka Lake, Ganjam District, Madras, 12. x. 1920; 1 ♂ from *S. wroughtoni*, Barkuda I., Sta. 26; 3 ♂ from *S. kuhli*, Barkuda I., 15-22. vii. 1916 (*F. H. Gravelly*); 1 ♂ and 7 ♂, 4 ♀, same data as preceding, but probably from different bat-individuals; 1 ♂ from *S. kuhli*, Coromandel, S. India, ca. 2,500 ft., 23. x. 1910 (*Museum Collector*). I am told that the Indian Museum also contains specimens, not seen by me, taken from a bat at Madhupur, Bengal (*C. Paiva*). In my 1914 paper I recorded this species from *Scotophilus heathi* at Pusa, Bihar; from *S. kuhli* at Saidapet, Madras; and from *Megaderma lyra* in Madras. In 1917 I recorded it from *S. wroughtoni* taken near Satara, Western Ghats.

In CEYLON Phillips took 2 ♂, 2 ♀ from *S. kuhli* at Bentota Rest House, at sea-level on the west coast of the Southern Province, 2. x. 1921. Details of the earlier records from Ceylon will be found in my 1914 paper: they include a species of host not listed above, namely *Tylonycteris pachypus*.

General distribution: MALAY PENINSULA, CEYLON, INDIA.

A curious little variation is noticeable in the number and arrangement of the bristles on the longitudinally divided 5th sternite of the ♀. This was figured (Scott, 1914, pl. xii, fig. 17) as having an anterior pair of short bristles, a median pair, and a posterior transverse series of five or six; this was the condition in the Ceylonese material examined. Among the Indian material listed above, only the anterior and median pairs are present, and the posterior transverse series is absent, in all the 15 ♀ examples from Balighai, Orissa, in the 3 ♀ from Balugaon, Orissa, in the 11 ♀ from Barkul, Orissa, and in the 4 ♀ labelled "? Calcutta, 10. i. 1911"; while the posterior transverse series is present, in addition to the anterior and median pairs, in the 2 ♀ from Hardwar, in the 5 ♀ from Siripur, Saran, and in two lots of respectively 1 ♀ and 4 ♀ from Barkuda Island, Chilka Lake. This is not the only kind of variation known to exist in the chaetotaxy of the 5th sternite, since in my 1914 paper (p. 227) I noted that 1 ♀ from Pusa, Bihar, had an extra four bristles midway between the anterior (basal) and median pairs; while in the 2 ♀ recently collected in Ceylon by Captain Phillips there is an extra pair of bristles between the anterior and median pairs.

Genus ***Tripselia*** Scott, 1917, *Parasitology* IX, p. 608.

***Tripselia amiculata* Speiser.**

Cyclopodia amiculata, Speiser, 1907, *Rec. Ind. Mus.* I, p. 296.

Nycteribia (Acrocholidia) fryeri, Scott, 1914, *Trans. Linn. Soc. London*, ser. 2, Zool. XVII, p. 163, figs. 1-4.

Tripselia fryeri, Scott, 1917, *l.c.*; Phillips, 1924, *Spolia Zeylanica* XIII, p. 70; Falcoz, 1924, *Bull. Mus. Paris* XXX, p. 311.

In 1917 (*l.c.*) I expressed the opinion that *T. fryeri* might prove to be identical with *T. amiculata* (Speiser), and having now had the unique

¹ See footnote on p 353.

type (♀) of *amiculata* before me I am confirmed in this view. The type of *amiculata*, preserved dry, was very much shrunken, and the ventral plate of the thorax had bent up greatly on each side; but now that the specimen has undergone prolonged soaking in water and been transferred to spirit, gentle pressure with a fine needle causes the ventral plate to become more flattened and to assume a width just as great in proportion to its length as in *fryeri*. The specimens described as *fryeri* have only three bristles, rather long and wide apart, on each lateral margin of the big second tergite of the ♀, while in the type of *amiculata* these bristles are four in number on each side and a little shorter.

Distribution :—INDIA, CEYLON, LABUAN, ASSUMPTION I., TROPICAL AFRICA.

The type of *T. amiculata* was taken from *Taphozous longimanus* Hardw., at Calcutta. In Ceylon Capt. Phillips took 1 ♀ off a bat, *Taphozous longimanus*, and a single ♀ off another bat, *Saccolaimus saccolaimus* Temm., in both cases at Anasigalla, Matugama, Kalutara, at an elevation of about 50 feet, 18. x. 1921. The type and paratypes of *T. fryeri* were taken from *Taphozous mauritanus* Geoffr., in Assumption Island; I have also recorded the species under that name from *Saccolaimus saccolaimus* at Labuan, and from *S. peli* Temm., in the Belgian Congo. Falcoz (*l.c.*) records it from an unidentified small grey "Roussette" in Dahomey.

Type of *T. amiculata* in the Indian Museum, Calcutta; types (♂ ♀) of *T. fryeri* in the British Museum.

Phillips remarks (*op. cit.*) that in his experience this very wide-ranging Nycteribiid is usually quite solitary. This does not, however, apply to the material from Assumption Island, where 18 examples (3 ♂, 15 ♀) were taken from the only two bats captured out of a small colony. In Assumption Island the bats (*Taphozous mauritanus*) were clinging to the stem of a coconut-palm just below the leaves; and Phillips states that in Ceylon the allied *Taphozous longimanus* is "a somewhat uncommon bat living solitary or in twos and threes in the crown of coconut palms."

As I stated in 1917 (*op. cit.*, p. 609) there appears to be a second species of this genus, of which I possess examples from Sumatra, but which I have as yet been unable to study in detail. Falcoz (*op. cit.*, p. 312) has described a new subgenus and species from West Africa; this subgenus, *Neotripselia*, is characterised by the presence of a single pigmented ocellus on either side of the head, but has the tibiae three-ringed as in *Tripselia*, s. str.

Genus **Eucampsipodia** Kolenati.

Eucampsipodia hyrtli (Kolenati).

Nycteribia hyrtli, Kolenati, 1856.

Eucampsipodia hyrtli, Kolenati, 1863, *Horae Soc. Ent. Rossicae* II, p. 78, pl. xii, figs. 26 d. e (♀), pl. xiv, figs. 26 a-c (♂); Speiser, 1901, p. 48; *id.* 1908, in Voeltzkow, *Reise in Ost-Afrika*, II, 1908, p. 202; Scott, 1914, *Ann. Mag. Nat. Hist.* (8) XIV, p. 228, pl. xii, figs. 18, 19 (♀); *id.* 1917, *Parasitology* IX, p. 610; Falcoz, 1923, *Arch. Zool. Exper.* LXI, p. 549; *id.* 1924, *Bull. Mus. Paris* XXX, p. 315; Patton, 1924, *Rec. Ind. Mus.* XXVI, p. 112.

From the Indian Museum: 5 ♂, 4 ♀, from *Roussettus leschenaulti* Desm., Khandagiri, Puri District, Orissa, 7-8. xi. 1912 (F. H. Gravely),

in the same tube with 3 ♂ and 1 ♀ *N. (Acrocholidia) euxesta* (No. $\frac{6151}{19}$ Ind. Mus.). Major Patton has recorded *E. hyrtli* from the Siju Cave, Garo Hills, Assam, where many specimens were taken on *Cynopterus sphinx gangeticus* K. And., at 400-500 feet from the entrance; he kindly submitted 1 ♂ to me before publishing this record.

In CEYLON Phillips obtained 2 ♂, 3 ♀ from *Rousettus seminudus* Kel., at Mousakande Estate, Gammaduwa, East Matale, 3,000 ft., 27. viii. 1923; and Mr. Senior-White's collection (at present, i. 1925, at the British Museum) contains, 1 ♂, preserved dry, from the breast-fur of the same host-species, taken at Suduganga, Matale, 6. i. 1920. Fryer's specimens, recorded in 1914, were taken at Peradeniya from *Rousettus seminudus* and *Tylonycteris pachypus*.

This species is known from various parts of AFRICA (Egypt, Senegal, East and South Africa); COMORO ISLANDS; MADAGASCAR; SUMATRA; BURMA (Farm Caves, near Moulmein, *teste* Speiser 1901, *op. cit.*, p. 58); CEYLON; INDIA. A recent record is that of Falcoz (1923), from *Rousettus leachi* A. Smith, at Shimoni, Seyidié District, British East Africa. Some of the older records are from *Rousettus aegyptiacus* Geoffr. "South Africa" is included in the distribution on the strength of several ♂ and ♀ taken from *Rousettus collaris* (= *leachi*) at Salem, Cape Province, ix. 1904; these belong to the Albany Museum, Grahamstown, and were submitted to me in January 1915 through Dr. J. Waterston; I have not published the record before and am not aware that it has appeared elsewhere.

Since this paper was set up in type, I have received from Mr. A. Musgrave a copy of an interesting article on Australian Nycteribiidæ (*Rec. Australian Museum*, XIV, pp. 289-300, pl. xlv, xlv, 1925), in which he proposes changes in the names of two of the subgenera of *Nycteribia*. According to Musgrave, *Acrocholidia* Kol. should be known as subgenus *Nycteribia* [s. str.] Latr., and *Stylidia* West. should fall as a synonym of *Celeripes* Montagu. I have not yet had time to go into the matter and follow out Musgrave's reasons for these changes, so "*Acrocholidia*" and "*Stylidia*" remain in use in this present paper at all events. As might be expected, none of the five Australian species discussed by Musgrave is identical with any known Indian form.—H. S.

ON CERTAIN SUCCINEID MOLLUSCS FROM THE WESTERN GHATS, BOMBAY PRESIDENCY.

By H. SRINIVASA RAO, M.A., D.Sc., Assistant Superintendent, Zoological Survey of India.

The material dealt with in this paper was collected by Dr. Sunder Lal Hora at various places on the Western Ghats in the Poona District of Bombay Presidency during the months of August and September, 1924. It includes three species belonging to two genera. Of these one has proved to be new, and the second is the rare and interesting species *Lithotis rupicola* Blanford, while the third is a new form of *Succinea gravelyi* Rao, which has been recorded from Madras. *Lithotis rupicola* was first discovered by Blanford who described it in the year 1863. Since that time up to the present day the species was in obscurity and nothing more was known about its habitat or anatomy than what was described by Blanford and Binney respectively. In March, 1918 the late Dr. Annandale, who investigated the fauna of the hill-streams in the same district, did not find the species. Since that time up to the year 1923 the locality in which Blanford found the species was revisited by members of the Zoological Survey on two or three occasions with the same result. It was, however, reserved for Dr. Hora to rediscover the species in great numbers near the Khandalla waterfall during the rainy season of the year 1924. The specimens he collected are in a very good state of preservation, and have enabled me to study the anatomy of this interesting species in some detail. The knowledge thus gained establishes beyond doubt the position of the genus *Lithotis* as distinct from *Succinea*, not only in respect of the shell but also in that of the soft parts, of which the jaw and the radula were but imperfectly known hitherto.

The species here described as new is of considerable bionomic interest apart from its being distinct in respect of the shell and the soft parts from other species of *Succinea*. Dr. Hora has a separate note immediately following this on the habits of the living animal in a state of hibernation both in its natural habitat and under artificial conditions in the laboratory. That a species of *Succinea* has the habit of aestivating on bark of trees during the rainy season is perhaps a hitherto unknown fact, though rock-inhabiting species such as *S. girnarica*, *S. collina*, *Camptonyx theobaldi* and *L. rupicola* are known to occur in Western India from Kathiawar down to Poona and Mahabaleshwar. But among these the habits of none but *L. rupicola* are known. A knowledge of the habits would be of great use in understanding the factors that govern the life and evolution of these terrestrial forms.

An explanation is perhaps necessary in this connection as regards the applicability of the terms "amphibious" and "terrestrial" to the species of this family. They have been used hitherto in a broad sense and cannot be employed to indicate intermediate conditions of life. It is not suggested that fresh terms would make it easier to appreciate the

inter-relation of the organism and its environments, but it is thought that a clear statement of the exact nature of the surroundings in which a particular species is found will be more useful than short terms which convey but a vague idea.

It is a well known fact that no known species of *Succinea* is truly aquatic in the sense in which members of the family Limnaeidae are. Certain species like *S. indica*, *S. elegantior*, *S. rutilans* and *S. godivariana* seem to be strictly amphibious. They are found sticking to floating vegetation and other objects in pools, lakes and swamps, or at any rate in some area of water which contains rotting vegetation on which they seem to feed as a rule. Some of these have been observed to swim upside down attached to the surface film of water. They, however, never survive immersion in water. In exceptional instances they may be picked up some distance away from water on reeds and other shore plants.

There are species like *Indosuccinea semiserica* and allied forms which are found living on shrubs and trees in the rainy season. They never seem to require large areas of water as a necessary condition for their existence or sustenance. During the drier months they apparently hibernate in concealed positions on the plants on which they live, and with the approach of the rainy season they rouse themselves to activity and feed chiefly on fresh vegetable matter such as leaves and shoots of plants.

There are other species such as *S. gravellyi* and *S. bensoni* which seem to live in moist moss-grown places near small areas of water, but they often wander farther away from their haunts in search of cryptogamic vegetation on which they feed.

Finally there are the true rock-inhabiting species such as *Camptonyx theobaldi*, *S. girnarica*, *S. collina*, *Lithotis rupicola* and *L. tumida* which prefer moist but exposed areas on which sun and rain have free play. They feed on minute cryptogams which cover the rocks during the rainy months. At the approach of summer, when the exposed rocks get rapidly dried up, they seem to retire into crevices, hollows or other sheltered spots, and there withdrawing themselves completely into the shell aestivate during the whole of the dry period.

Thus the members of the family would seem to come under three distinct oecological groups, namely—(1) the truly amphibious, living closely associated with aquatic animals in fairly large areas of water and feeding on decaying vegetation, (2) the pseudo-amphibious, which live close to aquatic areas but in concealed situations feeding on moss and other minute plants, and (3) the strictly terrestrial, which live exposed either on leaves and barks of plants or on rocks and feed exclusively on fresh vegetation such as tender leaves, minute algae, moss or lichens. It is the members of the last-named group that seem to aestivate, as a rule, during the drier months of the year and resume active life when the rains set in.

***Succinea gravellyi* f. *bombayensis*, nov.**

Shells of this form are very similar in outline to the Andamanese form of *S. gravellyi* but are relatively less coarse. The last and penultimate

whorls are tumid and the sides of the shell in dorsal view are obliquely parallel. The suture is well-impressed. This form seems to serve as a connecting link between *S. daucina* and the typical *S. gravelyi*, but as nothing is known about the anatomy or the habits of the former a comparison of the two species would be of little value.

The jaw of this form agrees in several features with that of *S. gravelyi* but has the cutting piece and the basal plate slightly broader.

The radular teeth are very similar to those of the typical species with the difference that the ectocones of the laterals are longer.

The genitalia also agree in every respect with those of *S. gravelyi*.

Type-specimens.—M¹²⁵¹³/₂ Zool. Surv. Ind. (*Ind. Mus.*).

A few living animals were taken by Dr. Hora at Kapurwala, Bombay Presidency, on the surface of wet rocks close to a small waterfall and on grass, etc., growing on them.

***Lithotis rupicola* Blanford.**

1870-76. *Succinea rupicola*, Pfeiffer, *Novitates Conchologicae* (Ser. I), IV, p. 11, pl. 112, figs. 1-4.

1924. *Lithotis rupicola*, Rao, *Rec. Ind. Mus.* XXVI, p. 372.

Shells of this species are of a dull brown colour, but in the fresh condition the colour is obscured by a deposit of foreign matter which, however, can be removed easily. The inner surface of the shell is generally of a pale or yellowish brown colour often shining on the margins. The sculpture is very rough and consists of well-marked transverse striae and often of ridges. The columellar callus is elongately triangular and tapers from behind forwards with a sharp edge on the side of the peristome. The outer margin of the peristome and the upper part of the callus meet above to form a triangular area which appears to be distinct from the last and the penultimate whorls. The columellar callus is translucent and shining. The largest shell in the collection of Dr. Hora has the following measurements in millimeters.

Height.	Maximum breadth.	Height of aperture.	Maximum breadth of aperture.
10.0	7.0	9.0	6.5

The colour of the animal in spirit is pale blue on the foot and the mantle edge, and smoky black on the whole of the spire. The region of the kidney is yellowish, generally superimposed by a dark shade. The region of the mantle anterior to the kidney is minutely streaked black but often inconspicuous.

The animal is apparently capable of retracting completely within the shell. In the preserved specimens before me no part of the animal is visible beyond the margin of the shell when viewed from above. The mantle is extensive and covers a great portion of the animal. Its edge is broad and thickened and sometimes folded upwards. On the right side, at the point where the pulmonary chamber communicates with the outside by means of a roundish or at times a slit-like aperture, the mantle edge has a special thickening which is, presumably, concerned in the

formation of a groove-like siphon on the inner side of the shell. That part of the mantle which lies in the groove may be raised as a fold or

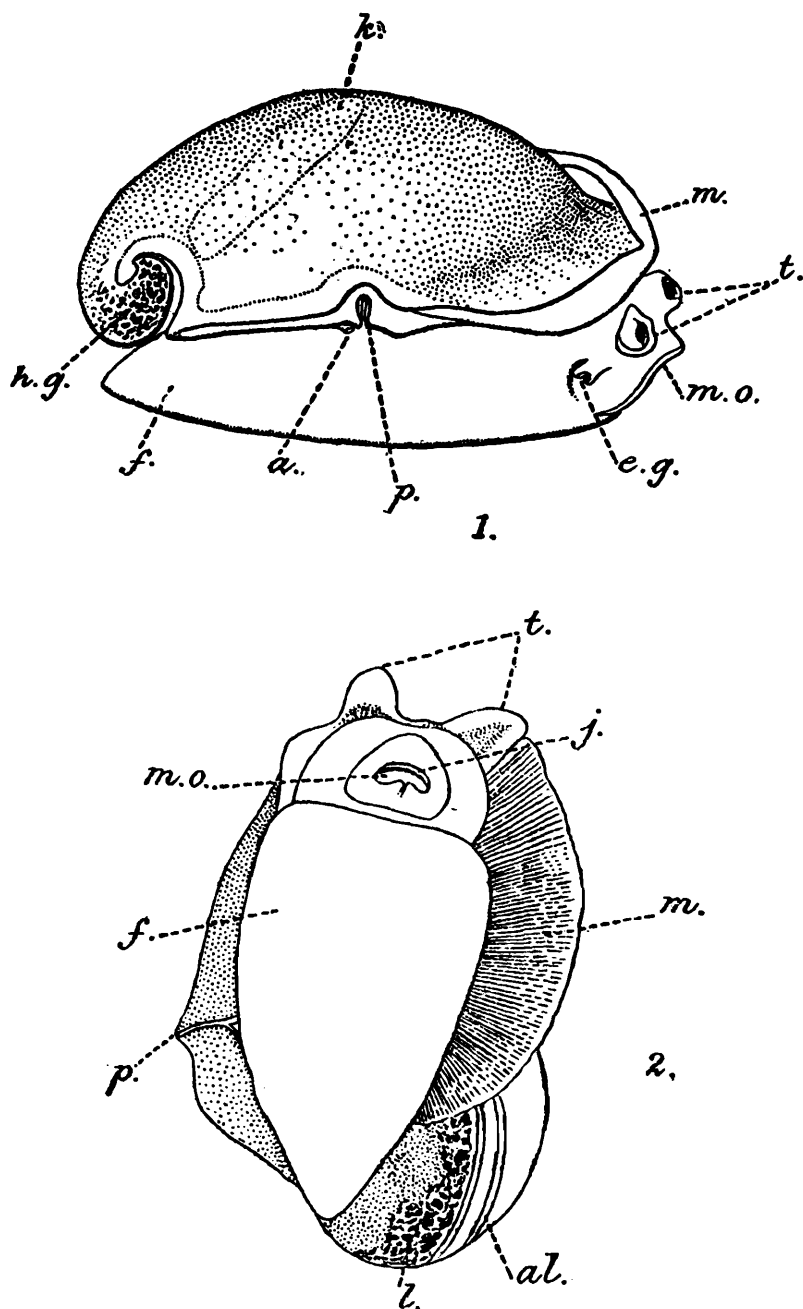


FIG. 1.—*Lithotis rupicola*. Animal removed from shell.

(1) Viewed from the right side. (2) Viewed from below.

a. anus; al. intestine; e. g. external opening of genitalia; f. foot; h. g. hermaphrodite gland; j. jaw; k. kidney; l. liver; m. edge of mantle; m. o. mouth; p. pulmonary opening; t. tentacles.

convex ridge extending up to the apex of the spire. It must be pointed out that the ridge is not always present on the mantle even in instances where the groove is deep. Close to the pulmonary opening, a little below and behind it, lies the elliptical anal opening. A groove commencing from the pulmonary opening and running underneath it obliquely backwards connects the anal aperture. Often a short groove branches off from the main one a little above the anus and runs straight at right angles to the extreme edge of the mantle. Anteriorly the head bears a pair of stout eye-bearing tentacles the bases of which are pigmented black. They are partially contracted in the preserved specimens before me.

The mouth is an elongated slit bent like the arc of a circle with its convex side anterior. A part of the jaw is often found protruding through the mouth as a strip of chitin, and in exceptional cases a good portion of the jaw may be projecting outside. The genital openings are minute and are placed close together in a shallow depression a little behind the base of the right tentacle. The foot is large and broadly lanceolate or ovate and extends beyond the outline of the visceral hump.

The mouth leads into a short oesophagus which communicates with an enlarged sac which may be termed the crop. The latter contains a mass of filamentous algae and diatoms. It is followed by the stomach, which is a thin-walled transverse sac, but not much differentiated from it. The liver is very compact and is traversed by the coils of the intestine which cut deep grooves on its surface. A short wide duct of the liver opens into the stomach at the commencement of the intestine. There is a single whitish finger-shaped caecum close to the duct of the liver. The intestine forms a double loop above and behind the liver mass and leads to a short rectum on the right side which, emerging from the undersurface of the liver, opens into the anus.

The pulmonary cavity is a closed chamber the roof of which is formed by the mantle and the floor by a thin membrane enveloping the viscera. Its anterior boundary is the head and the posterior the kidney which stretches diagonally as a rectangular block from the left to the right. The mantle is fused in front with the integument of the head, on the sides with that of the foot and at the posterior end with the membrane enclosing the liver, intestines and other structures of that region. A

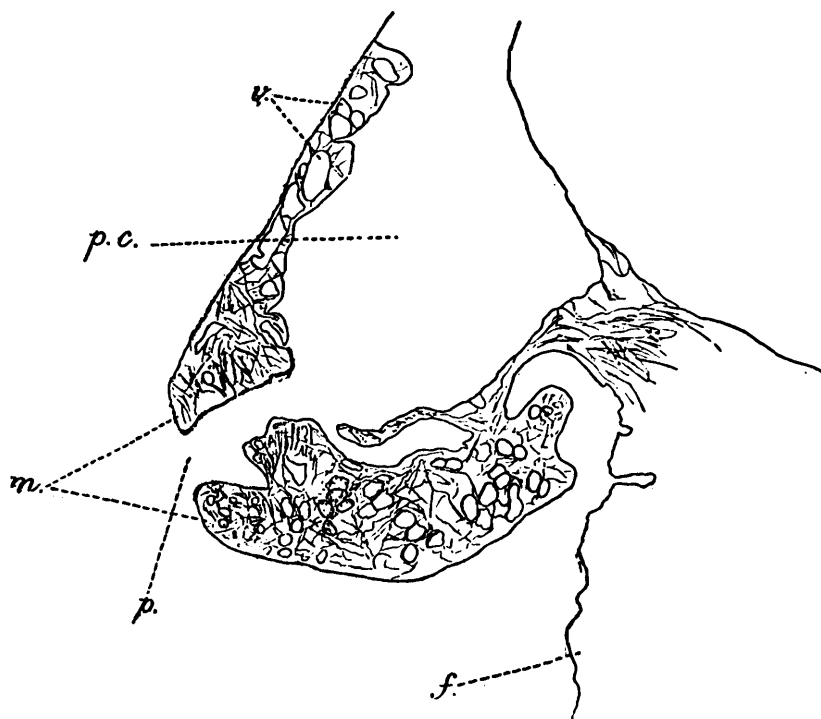


FIG. 2.—*Lithotis rupicola*. Vertical transverse section through the pulmonary opening. *e. m.* edge of mantle; *f.* foot; *p.* pulmonary opening; *p. c.* pulmonary chamber; *v.* vascular vessels of mantle.

flap-like extension of the mantle serves as the connection between the mantle and the body on the sides and in front. The mantle-edge is very

much thickened and seems to contain numerous blood-sinuses. At the point where the pulmonary aperture is placed the mantle-edge, as already mentioned, has a special thickening in the form of a raised ridge which seems to be present from a very early stage of development of the animal, as may be presumed from the fact that the siphonal groove extends from the apex of the spire to the very margin of the aperture in all the specimens that I have examined. The function of the groove must for the present remain obscure as the habits of this species in its natural haunts are still imperfectly known. It may perhaps be suggested that the groove serves to increase the quantity of air in the pulmonary chamber when needed.

The jaw and the radular teeth were first figured by Binney¹ in 1874, long after the species was discovered by Blanford, and since then nothing further was known about these structures. Thanks to Dr. Hora's fairly large collection I am now enabled to say something more about them with confidence. The jaw is distinct from that of the closely allied *L. tumida*. It has an almost square outline with short, blunt, rounded arms to the cutting piece. In some cases the extremities of the arm may be angled posteriorly and rounded anteriorly. A definite median process

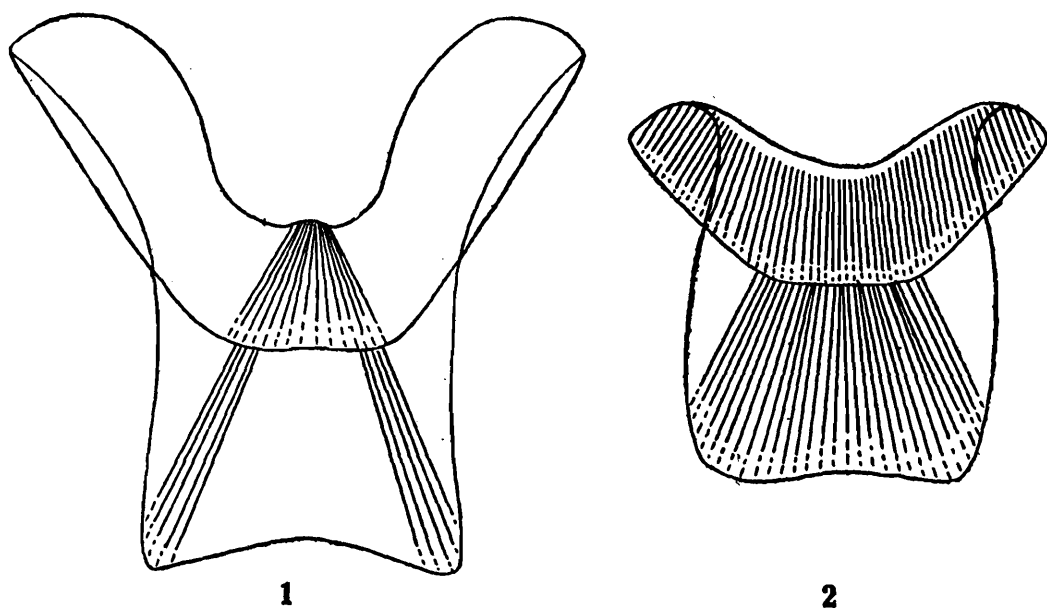


FIG. 3.—Jaws of (1) *Succinea arboricola* and (2) *Lithotis rupicola*.

on the anterior margin of the cutting piece is absent though slight indentations of the margin by injury or wear may be mistaken for the process. I have examined over twenty specimens and I have not found a definite median process in any of them. It occurs, if at all, only as an abnormality. The cup-like depression of the anterior margin is much more marked than in *L. tumida* but never so deeply as in many species of *Succinea*. The striations of the jaw are well marked over the whole surface. The cutting piece is subject to some variability.

The radular teeth are remarkable in this species in their very distinct form and do not seem to approach those of any other species of the family. They have a general resemblance to the teeth of certain species

¹ Binney, *Proc. Acad. Nat. Sci. Philadelphia*, pl. v, figs. 3-6 (1874).

of Testacellidae, but are never so sharp and elongate. The cusps of the central and the laterals are high, blunt at the apex, and are without accessory denticles at their base. The marginals are quadrate in form. The first few of them and sometimes nearly half the number of marginals in one half of a row bear one to three secondary cusps, while the extreme marginals have four to seven cusps. The basal plate of the marginals is produced below into a triangular protruberance. The highest point of the basal plate is, as a rule, shorter than the main cusp in all the teeth of a transverse row. The radular teeth are subject to variability both as regards the occurrence of denticles on the laterals and the number of cusps present on the marginals. Abnormalities occur in rare instances in the laterals and marginals. The approximate dental formula is 34.11.1.11.34.

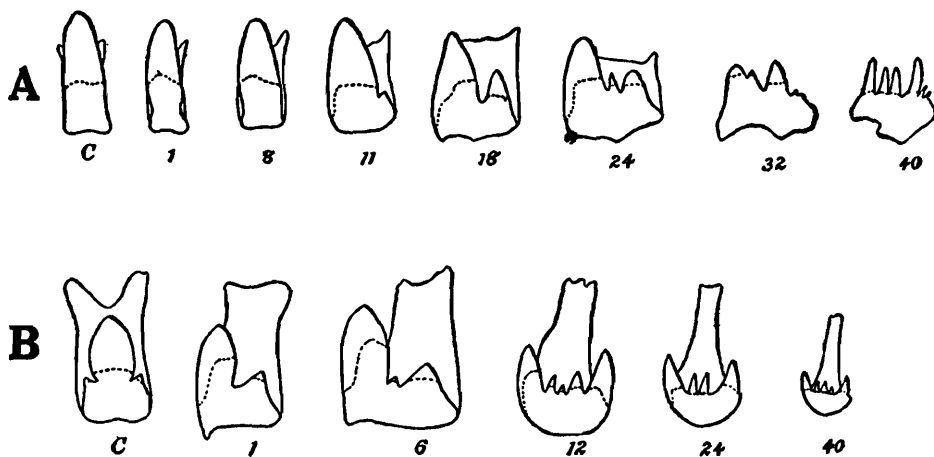


FIG. 4.—Radular teeth of (A) *Lithotis rupicola* and (B) *Succinea arboricola*.

It may be seen that in respect of the jaw and the radular teeth there is no agreement between this species and *L. tumida* or any other species of the family.

A great portion of the genitalia occupies the right half of the anterior part of the animal, and on removing the mantle and the membranous covering of the viscera, the coiled oviduct, the albumen gland, and a portion of the prostate appear conspicuously. The penis and the uterus may also be seen in some cases as two wide tubes placed close to each other. The relation of the various parts of the genitalia to one another can, however, be made out by dissection. The hermaphrodite gland is found in the usual position at the apex of the spire and is a compact mass having the appearance of a bunch of grapes. From a short cleft on its anterior face emerges the hermaphrodite duct which has a wavy course for a short distance at its commencement. It then has a straight course before entering the albumen gland. The latter is large and roughly triangular with a convex dorsal surface. Its ventral side has a large depression in which are lodged the spermatheca, the seminal vesicles and part of the prostate. The hermaphrodite duct divides into two short branches at the level of the base of the albumen gland, one of which enters the latter, while the other after receiving the seminal vesicle enters the prostate gland on its left a little above the base. The prostate is an oval or pear-shaped body placed close to and below the albu-

men gland on its right side. From its anterior face emerges the stout muscular vas deferens which has a short course before it enters the penis.

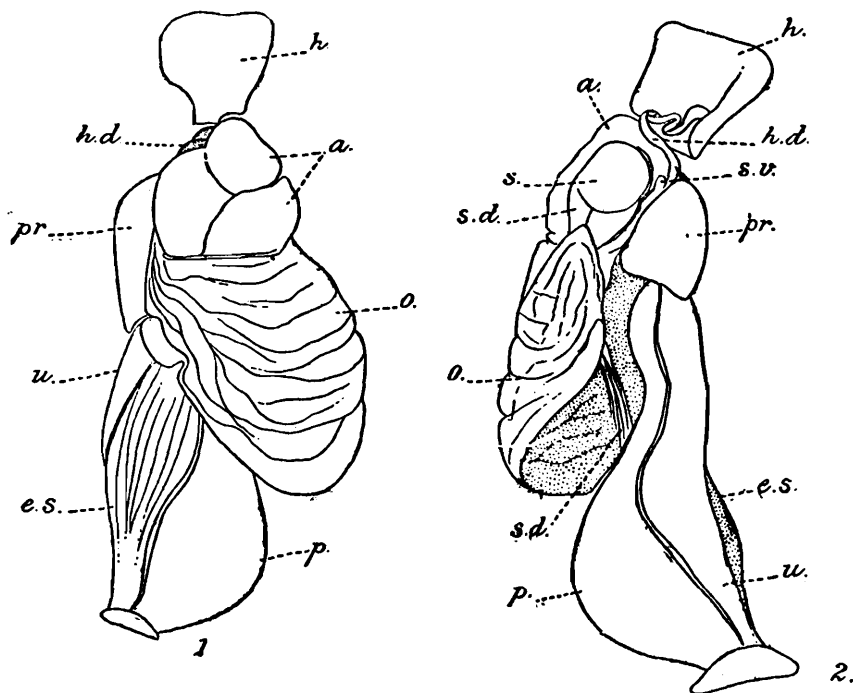


FIG. 5.—*Lithotis rupicola*. Genitalia in situ. (1) Dorsal view. (2) Ventral view. a. albumen gland; e. s. dilated end of duct of spermatheca; h. hermaphrodite gland; h. d. hermaphrodite duct; o. oviduct; p. penis; pr. prostate gland; s. spermatheca; s. d. duct of spermatheca; s. v. seminal vesicles; u. uterus.

The oviduct on leaving the albumen gland is very much coiled in the form of the letter U being doubled up as a loop on either side, the whole presenting the appearance of a solid mass of cream-white substance. The distal portion of the oviduct, which has a straight course for a short distance and is distinct from the coiled portion, may be termed the uterus. On a level with the anterior face of the coiled portion of the oviduct the uterus receives the long duct of the spermatheca. The spermatheca is a spherical sac which lies usually hidden from view on the left side of the prostate. Its form seems to be variable in accordance with the volume of its contents. It may have a small dilatation at the commencement of its duct. But at the point where it joins the uterus it has a definite and constant sac-like, muscular enlargement which is about twice as wide as the uterus itself. From the junction of the spermatheca and the uterus a short tube leads to the external genital opening. This short tube may be termed the vagina. The penis is short and bulbous and about just as long as the enlarged sac of the spermathecal duct, and is without a retractor muscle. Though the buccal and columellar muscle strands run very close to the penis no branch of them has been found to reach the penis. There is a club-shaped epiphallus which is apparently capable of expansion and contraction. It is traversed by a wide duct which is often thrown into transverse folds in the upper part of its course. The surface of the epiphallus is usually covered by some foreign particles, apparently minute grains of sand or other material, which seem to stick to it at the time of copulation. The seminal vesicles, the position of which has

already been mentioned, consist of the usual pair of club-shaped sacs with a well developed fecundation pouch. They lie closely pressed to-

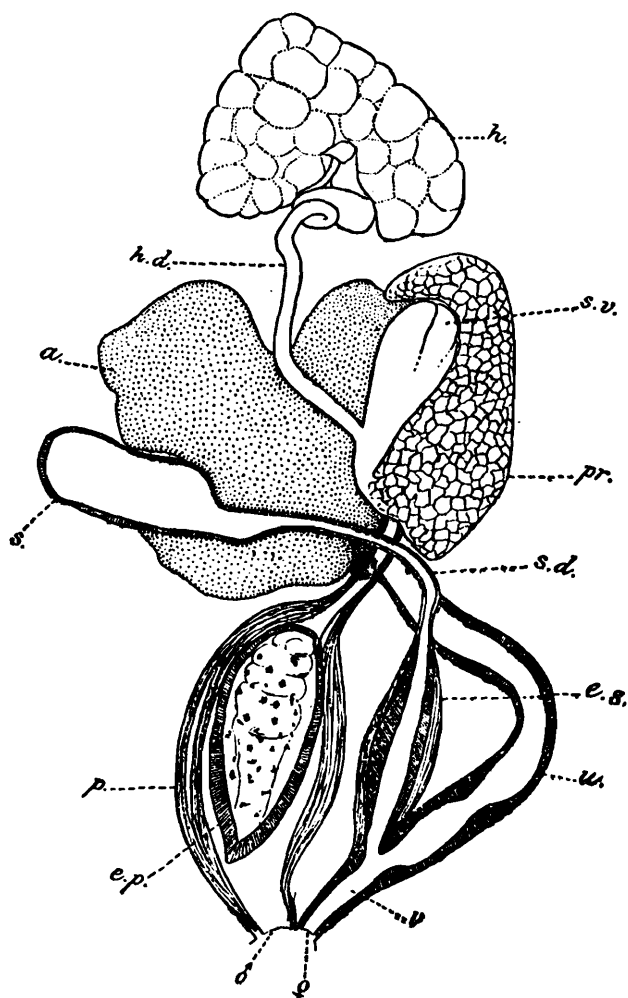


FIG. 6.—*Lithotis rupicola*. Ventral view of genitalia (dissected out). *a.* albumen gland; *e. p.* epiphallus; *e. s.* dilated end of duct of spermatheca; *h.* hermaphrodite gland; *h. d.* hermaphrodite duct; *p.* penis; *pr.* prostate; *s.* spermatheca; *s. d.* duct of spermatheca; *s. v.* seminal vesicles; *u.* uterus; *v.* vagina.

gether and except in good light under a high power of the microscope present the appearance of a single large sac. They and the hermaphrodite gland and duct are usually covered by a thin membrane on which black pigment is displayed in a reticulate pattern.

Self-fertilisation appears to be an occasional phenomenon in this species. In one of the specimens dissected I found the elongated epiphallus curved and extending from the male opening through the vagina up to the junction of the spermatheca and the uterus.

The striking features of the genitalia of this rare species are (1) the remarkably muscular genital ducts having thick walls, (2) the presence of a dilatation at the distal end of the spermathecal duct, (3) the shortness of the vas deferens, and (4) the occurrence of a short, stout penis with a particularly well developed epiphallus but without a trace of the retractor muscle. Of these features the most distinctive are the second and the last.

Compared with the genitalia of other species of the family it seems that *L. rupicola* approaches the terrestrial species *Indosuccinea semiserica*

in the condition of the penis, and in the distinctness of the male and female openings. But it differs from the latter in the prostate gland not being spiral and in the spermatheca not having a separate opening to the outside. The condition of the duct of the spermatheca, however, seems to me to be intermediate between that found in *I. semiserica* and *S. indica*, species occupying the two extremes of biological groups of the family.

With regard to the other structures such as the jaw, radula and mantle there is little that may be considered as common between the present species and all the other species in the family.

Dr. Hora has the following note on the habitat of the species :—

“ *Lithotis rupicola* was found in great abundance on the wet rocks at the sides of the waterfall at Khandalla. The rocks were overgrown with algal slime and were kept constantly moist by the spray produced by the waterfall. *Cremnoconchus syhadrensis* was the only other species found with these animals under similar conditions but in much larger numbers. It is rather significant that in spite of a very thorough and careful search not a single specimen of these two species of molluscs was found anywhere between Karjat and Mahabaleshwar except on the rocks at the sides of the Khandalla waterfall. Unlike *Cremnoconchus syhadrensis* the animals of *L. rupicola* lost all vitality when removed from their natural habitat. When examined after a few hours captivity most of them were found dead.”

***Succinea arboricola*, sp. nov.**

The shell in this species is more or less regularly ovate with the left anterior margin often slightly converging towards the main axis. The convexity of the left posterior margin of the shell in dorsal view is well marked, and the posterior half of the last whorl is evenly convex. It never consists of more than $2\frac{1}{2}$ whorls the last being nearly five times as large as the spire. The penultimate whorl is quite tumid and has its base about $\frac{1}{3}$ as broad as the last whorl at this point. The suture is oblique and well-defined though not deeply impressed. The shell is fairly thick and tough even in young individuals and has conspicuous parallel oblique striae often interspersed with coarser ones. The sculpture on the penultimate whorl is rather poorly developed. The aperture is oblique and ovate-conical in outline. The extreme margin of the shell in front and on the sides of the aperture is slightly reflected upwards. The columellar callus is very thin and never conspicuous in shells of advanced age. The right margin is continuous with that of the aperture at its apex. The columellar ridge is a narrow translucent strip which narrows down to a line where it meets the left margin of the aperture. The inner surface of the shell near the anterior end has a silky white deposit which is iridescent. The extent to which this deposit is developed varies in different individuals. The colour of the shell varies from a pale yellow to yellowish brown. In life the shells are, as a rule, covered by a greenish deposit of algae or other plant growth. Its rough surface apparently facilitates the growth of microscopic plant life.

The shell as a whole has a general resemblance to that of *I. semi-serica* but is distinguished by its relatively small size, by the quite convex

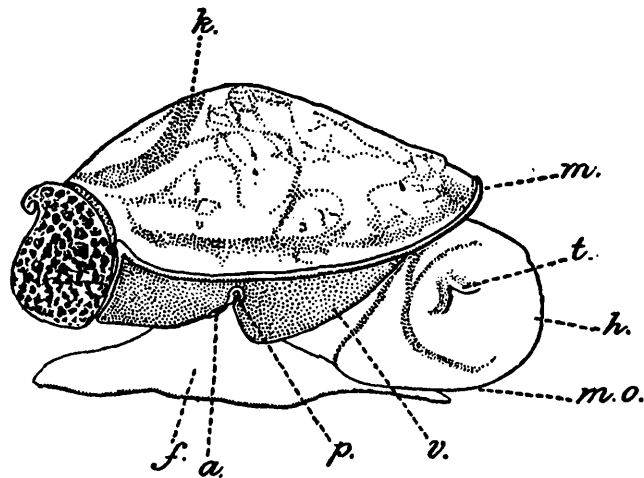


FIG. 7.—*Succinea arboricola*. Animal removed from shell and viewed from the right side. a. anus; f. foot; h. head; k. kidney; m. edge of mantle; m. o. mouth; p. pulmonary opening; v. m. visceral mass; t. tentacle.

whorls, by the comparatively thick shell and by the well-defined columellar ridge.

The largest shell in the collection has the following measurements in millimeters :—

Height of shell.	Height of aperture.	Maximum breadth of shell.	Maximum breadth of aperture.
7.3	6.5	4.8	4.0

External features.—As most of the individuals of this species were obtained in a state of hibernation no information is available as to their

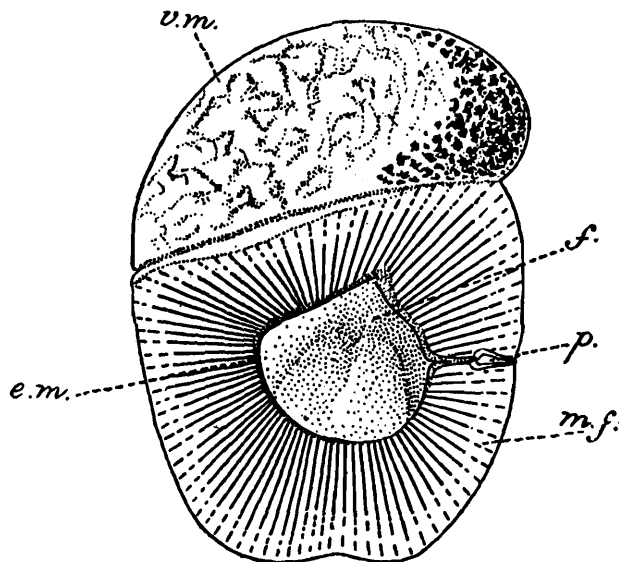


FIG. 8.—*Succinea arboricola*. Ventral view of a contracted animal. e. m. edge of mantlefold; f. foot seen from below mantle-fold; m. f. fold of mantle covering the foot; p. pulmonary opening; v. m. visceral mass.

external features in active life, but the following description is drawn from hibernating specimens preserved in spirit. The outline of the

animal seems to vary with the extent to which the animal is withdrawn into the shell, but in general it is ovate-conical with the anterior end broad and rounded. The ground colour of the animal is pale yellow, but on the dorsal surface a black pigment is present chiefly on the mantle extending from the anterior margin of the kidney to a little behind the extreme margin of the mantle. Streaks of pigment may also be present on the membrane covering the intestines and other structures behind the kidney. The membrane is so transparent that portions of the liver, the intestine and the genitalia are visible through it. The kidney is a rectangular structure extending obliquely from left to right behind the pulmonary chamber. The edge of the mantle is thickened and has a distinct broad flap which extends horizontally all round on the ventral surface of the animal enclosing a considerable portion of the foot. A small oval area in the centre is left uncovered by the extension of the mantle through which the central part of the foot projects as a convex mass. Near the middle of the mantle flap on the right side lies the minute oval or elliptical opening of the pulmonary chamber. A minute transverse cut extends from the pulmonary opening to the margin of the mantle-flap. On separating the edges of the flap at this point a V-shaped groove with its arms stretching outwards may be seen below. The anus is placed near the posterior arm of the V-shaped groove as a small elliptical aperture.

Mantle and pulmonary chamber.—The mantle forms a hood over the anterior half of the animal and is fused posteriorly with the membrane covering the structures in that region. Anteriorly and on the sides it is fused with the foot. The chamber enclosed between the mantle above and the membrane below covering the internal organs is the pulmonary

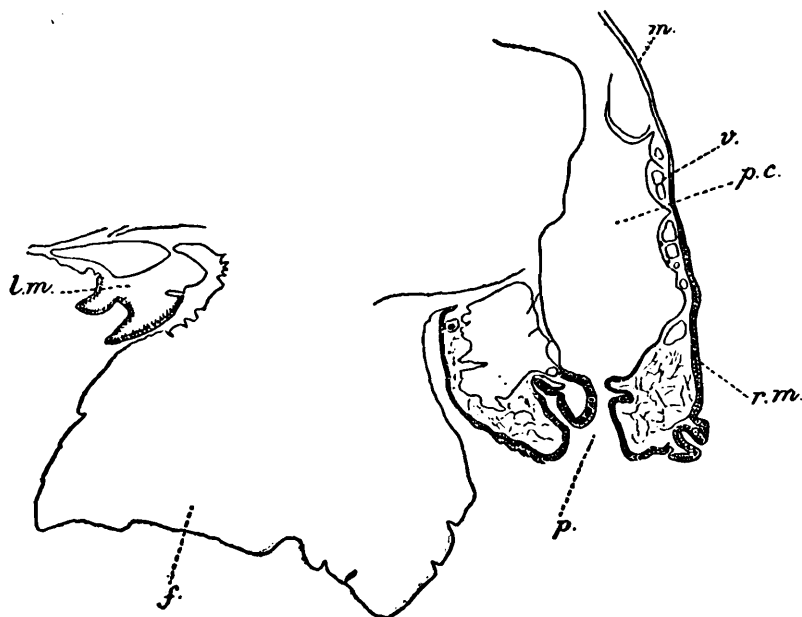


FIG. 9.—*Succinea arboricola*. Vertical transverse section through the region of the pulmonary opening showing relationship of the lobes of the mantle to the aperture.

f. foot; l. m. left mantle-edge; m. mantle; p. pulmonary opening; p. c. pulmonary chamber; r. m. right mantle edge; v. vascular vessels of mantle.

cavity. It communicates with the outside by a single minute opening on the right side of the animal in the position described under external

features. It is thus a closed chamber with only a small opening by which communication with the outside atmosphere is maintained as for instance in the land snails of the genus *Ariophanta*. The mantle is traversed by minute vascular vessels which are thus in close relation with the air of the pulmonary chamber. The edge of the pulmonary aperture, which forms part of the transverse flap of the mantle, is thickened, and when the animals in a state of hibernation are forcibly stimulated to activity by exposure, the aperture opens and closes at intervals for the purpose of carrying on respiration. The extreme edge of the mantle is traversed by a deep groove which is apparently formed by a process of invagination. On the right side the mantle edge is more conspicuously thickened than on the left.

Alimentary system.—The jaw is of strong build with a remarkable development of chitin. A tendency to form oblique chitinous ridges on the cutting piece, as in some land snails, is to be noticed. The accessory basal plate has prominent striae often confined to the two sides. There appears to be considerable variability in the shape of the jaw and no precise description can be usefully attempted. The figure on p. 390 represents the jaw taken from a fairly large individual soaked in cold caustic potash for several hours and cleaned first in water and then in a mixture of glycerine and formaldehyde. Jaws mounted on slides under pressure of the coverslip usually break and do not preserve their natural shape. The figure given has been drawn from a jaw not subjected to any pressure.

In the strong chitination of the jaw though not in actual form the present species approaches *I. semiserica*.

The radular teeth are relatively small and are arranged in regular transverse rows. There are usually about sixty teeth in each half of a transverse row in a full-grown individual. The number of teeth seems to be proportionately less in many young specimens. The central is very little variable and has an ovato-conical cusp with a well-defined denticle at its base on each side. The laterals are very few in number, often not exceeding five, while the marginals may be as many as fifty-five. The laterals very gradually grade into the marginals, and it is at first sight difficult to clearly define the limits of the two sets of teeth. They are somewhat quadrate and never bear more than three cusps, whereas the marginals are distinctly aculeate and have five and six cusps, the ectocones and entocones being relatively large in size. There is, however, considerable variability in this respect. In young individuals (which comprise the whole collection except two which are full-sized adults) the radular teeth exhibit some interesting features. In these, the differentiation between laterals and marginals is rendered more difficult by the presence of additional cusps on the laterals than is the case in the two adult individuals examined. In the first few laterals there usually occur two small cusps between the ento- and ectocones. Their size increases gradually as the outer teeth of the series are reached until they more or less resemble the first few marginals of the adult specimen. These differentiations presumably represent growth change in the radular teeth and have nothing to do with variability of the struc-

tures in this species.¹ A certain amount of variability perhaps occurs as in other species of *Succinea* but with the material before me it is difficult to say anything on the point. The only striking feature of the marginals in this species is the occurrence of long and narrow basal plates, though in this respect it approaches *S. indica* and *I. semiserica* which are relatively large species. The approximate radular formula is 55. 5. 1. 5. 55.

The position of the head in hibernating individuals is remarkable. It is not found in its usual position at the anterior end, but has receded towards the posterior end lying closely adpressed to the liver mass. The oesophagus and stomach are consequently folded up and found close to the head. The contents of the stomach in specimens examined were a pulpy mass in a more or less digested condition and included broken bits of diatoms. The disposition of the alimentary canal is not unlike that of other Succineids.

The situation of the kidney has been pointed out already. Its inner wall is thrown into several lamellate folds which project into its cavity. These folds are lined by spherical or cubical cells each of which contains an oval or spherical calcareous concretion. On the anterior side of the kidney lies a large vascular vessel which traverses its whole length. The heart lies close to the left extremity of the kidney.

Genitalia.—All except two specimens in Dr. Hora's collection are immature and the genital ducts are very poorly developed, though the glands are to be found in their usual positions in a much less compact condition than in the adult. In one of the two adults the genitalia were intact and the following description and the accompanying figure are based on them. The hermaphrodite gland is a roughly triangular structure followed by a much coiled hermaphrodite duct which is usually covered by a thin, dark membrane. The duct leads on to a pair of seminal vesicles which open into it. A thick-walled, compressed tube, much shorter than the vesicles, apparently corresponding to the fecundation pouch of other Succineids, is found closely adpressed to the seminal vesicles. The albumen gland, the prostate gland and part of the oviduct were, however, in a state of disintegration. A well developed bladder-like spermatheca is present on the left of the albumen and prostate glands. The shape of the spermatheca is evidently abnormal as a result of compression by other structures lying close to it. It has a fairly long duct which opens on the oviduct some distance from the external genital opening. The oviduct is wide and expands into an uterus below at the point where it unites with the terminal portion of the male genitalia. The penis is remarkably short and stout, much broader at its proximal end than at the distal. It is muscular and has a well-defined retractor muscle which divides into two separate strands on reaching the proximal end of the penis. There is a short stout vas deferens which connects the prostate glands with the penis. The uterus and the penis are united for a short distance from the external genital opening. Except for the peculiar form of the penis there is nothing in

¹ Annandale, *Rec. Ind. Mus.* XXVI, pp. 549-551, fig. 11 (1924); Sewell, *ibid.*, XXVI, pp. 542-544.

the genitalia which distinguishes the species from other Succineids in which the genitalia are known. Besides it would be premature to

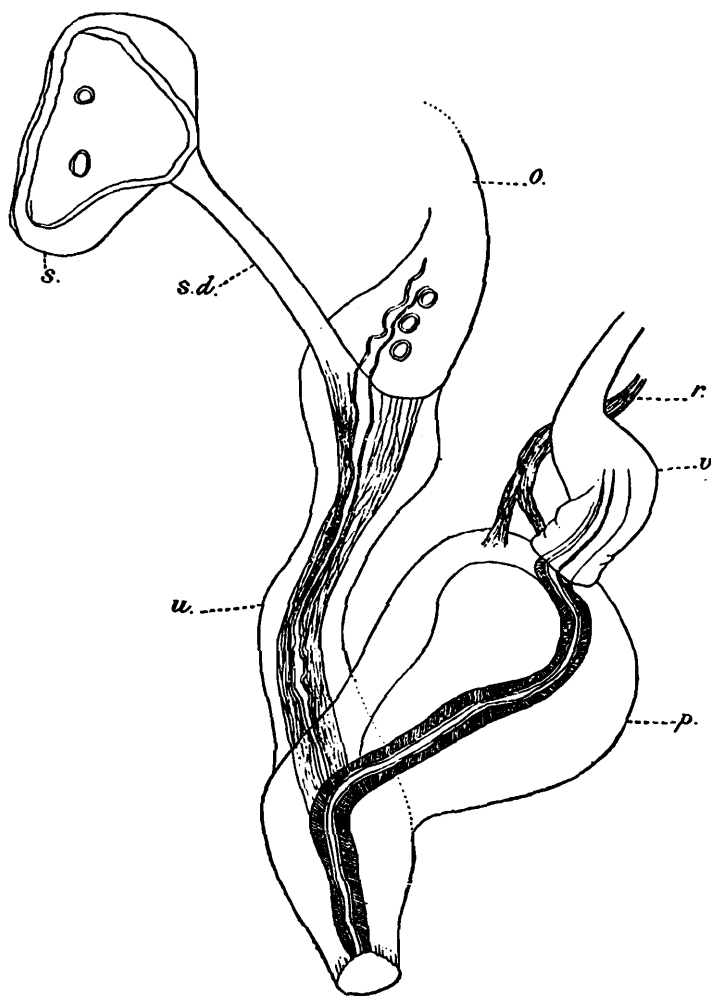


FIG. 10.—*Succinea arboricola*. Dorsal view of terminal portion of genitalia. *o.* oviduct; *p.* penis; *r.* retractor muscle of penis; *s.* spermatheca; *s. d.* duct of spermatheca; *u.* uterus; *v.* vas deferens.

institute comparisons until the genitalia are more definitely known from an examination of several adult individuals of the species.

In the only other adult specimen in the collection a curious abnormality of the genitalia was observed. A pair of long cylindrical thin-walled tubes tapering gradually towards their distal extremity was found in the position occupied by the genitalia in the normal specimen. Their external openings were narrow and placed close together. A little way from the external opening of one tube an elongated sac with a narrow neck joined it, while in the other a fan-shaped structure with finger-like processes. The free extremity of the tubes had reddish-brown spots arranged more or less in a concentric manner, while a little below was found a regularly interrupted broad band of the same colour round the tube. How the genitalia came to be modified in the manner described is difficult to say, but it is clear from the position of the structures in the animal in which no trace of the genitalia was found, that they represent the latter and have undergone modification as a result, apparently, of parasitisation by some organism.

Type-specimen.—M $\frac{2514}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

Dr. Hora¹ found several young individuals and two adults in a state of hibernation on the bark of mango trees in the compound of the Hamil-

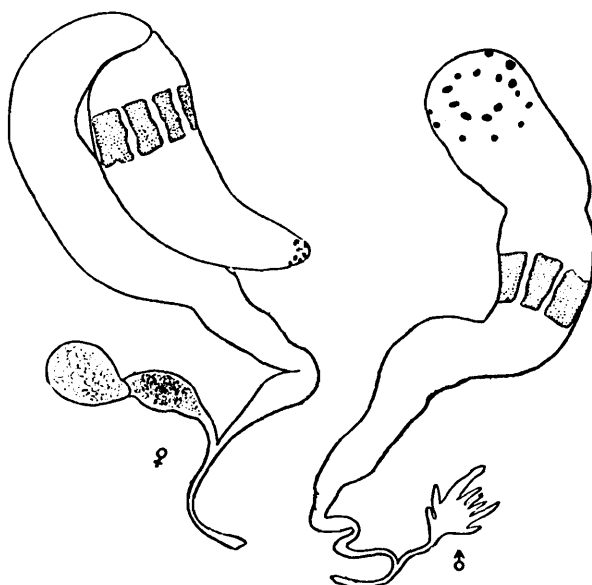


FIG. 11.—*Succinea arboricola*. Abnormal genitalia.

ton Hotel at Lonavla, Bombay Presidency, and two active young specimens on moss at base of trees on the way to Khandalla.

Several examples of young *S. arboricola* have since been found in a collection of *I. semiserica* f. *khandalla* made by Mr. R. Hodgart in the same place where Dr. Hora got his two active specimens.

Several specimens of *Pupisoma evezardi* Blanford were found living in close association with them on the bark of mango trees. This species was first recorded by Colonel Evezard at Karkalla, near Khandalla.

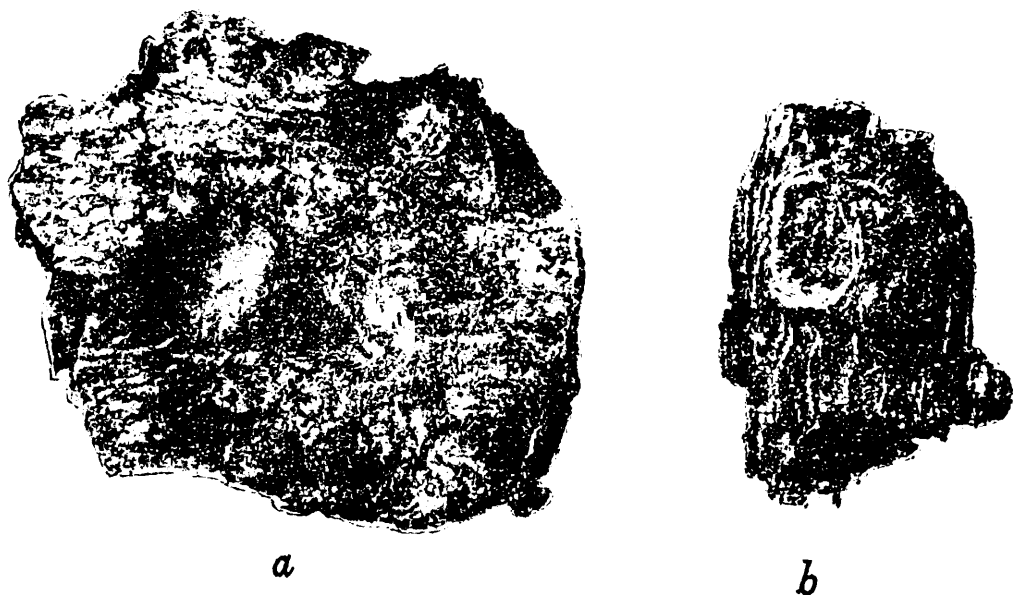
There seems to be little doubt that the species is strictly terrestrial in habit. The species, while being distinct in its shell, mantle and penis, has some points of resemblance to other terrestrial and amphibious species. Although the jaw and the radular teeth agree in some respects with those of *I. semiserica*, the genitalia are very different in the two species. In respect of the genitalia, however, the species approaches *S. bensoni*, *S. indica* and *S. gravellyi*, especially in the relative positions of the uterus, penis and spermatheca.

¹ A detailed account of the habits of the species is given by Dr. Hora in the paper following this.

ON THE HABITS OF A SUCCINEID MOLLUSC FROM THE WESTERN GHATS.

By SUNDER LAL HORA, *D.Sc., Officiating Superintendent, Zoological Survey of India.*

Towards the end of August, 1924 a short visit was paid to the part of the Western Ghats lying in the Poona and the Satara Districts of the Bombay Presidency to collect certain peculiar Littorinid shells of the genus *Cremnochonchus*. While searching for *Cremnochonchus* I availed myself of the opportunity to make an extensive collection of molluscs. In this short note I have recorded a few observations on the habits of a Succineid mollusc—*Succinea arboricola* Rao—collected at Lonavla.



TEXT-FIG. 1.—Hibernating animals of *Succinea arboricola* Rao.

(a) Three hibernating animals on bark of mango tree.

(b) Scar left on bark by forcibly detaching a hibernating animal.

Living specimens of *Succinea arboricola* were found hibernating on the bark of mango trees in the compound of the Hamilton Hotel, Lonavla. They were adhering very tenaciously to the surface and in form and colouration resembled wart-like outgrowths of the bark. In fact the resemblance was so close that the shells were first discovered by mere chance and in collecting them afterwards great difficulty was experienced. A sort of dead vegetable growth, consisting mostly of lichens, which covers the barks of trees in those parts, covered the shells also. Some individuals were also found on the under surface of leaves of mango trees; they were very sluggish and the shells in them were not covered with vegetable growth. Most of the individuals picked up from leaves were very young.

Two young individuals of this species were collected by me among wet moss at the base of a large mango tree on the way to Khandalla. Mr. R. Hodgart had obtained several active specimens of *S. arboricola* a few weeks before me in the same locality (Lonavla-Khandalla road).

When an animal is forcibly detached from the bark it leaves a scar behind and often a portion of the epiphragm forming the edge of the scar. The epiphragm consists of a thin white membrane, which covers the mouth of the shell. On removing the epiphragm the animal is found in a comatose condition. The foot, which is lightly coloured, is seen almost in the middle of the exposed animal and is on all sides surrounded by the mantle. Shortly afterwards the animal begins to show extensive movements of the foot and the mantle and a sticky substance is secreted at the same time. It was also seen that at irregular intervals the animal alternately opened and closed the pulmonary opening for the purpose of respiration. If the individuals thus disturbed found a suitable surface for attachment a new epiphragm was formed within 10 to 15 minutes. If on the other hand the animal was kept with the mouth of the shell exposed, an epiphragm was only formed in exceptional cases and that after a long time, while in most cases the molluscs dried up in 10 to 12 hours.



TEXT-FIG. 2.—Quiescent animal of *Succinea arboricola* Rao.

- (a). The hibernating pose of the animal. A portion of the foot is seen in the middle surrounded by the mantle on all sides. The remains of the old epiphragm are seen along the lips.
- (b). The same animal formed a new epiphragm after a quarter of an hour. A portion of the epiphragm is cracked.

The first epiphragm is usually formed very close to the lips, while the subsequent ones are formed deeper and deeper within the mouth of the shell and the animal ultimately is retracted entirely within the upper half of the body-whorl only. The peristome of the shell is slightly recurved outwards. This is probably an adaptation for helping the animals to stick tightly to the substratum.

In the laboratory these animals were kept under different conditions for some time for watching the effects of different temperatures on their peculiar habit of aestivation. Some specimens were kept at a constant temperature of 104°F., some in an ice-box with ice and a few were left in the open air for about a week. The result in all cases was the same. Not a single animal became active. I am, therefore, unable to adduce any evidence to show as to what time of the year these molluscs are active. It is, however, to be surmised from the fact that some shells were found on the under surface of leaves towards the end of August that these animals probably become active after the rains.

These animals are still being kept under observation and up to the time of going to the press (August, 1925) the molluscs were found alive

hibernating on the bark. Even those that had formed an epiphragm after detachment were also alive.

The phenomenon of hibernation is not uncommon among Succineidae. *Succinea girnarica*, *Camptonyx theobaldi*, the two species of the peculiar Indian genus *Lithotis*, and certain members of the genus *Indosuccinea* are all known to aestivate during periods of draught. The peculiarity about *Succinea arboricola* lies in the fact that it was found in a comatose condition during the rainy season, when almost all of its family members are known to be very active. The rainy season at Lonavla is very long and the annual rainfall is about 400 inches. In all probability the peculiar habit of hibernation during the rains in the case of *S. arboricola* is a device for protecting the animal from being washed down by heavy rains. Other Succineidae with this habit have hitherto been found adhering only to rocks and the present example is, so far as I can find from the literature on the subject, the first record of a Succineid mollusc being found hibernating on bark of trees.

I am indebted to Mr. Srinivasa Rao for the identification of shells and for details of technical characters. Dr. Baini Prashad has gone through the paper with me and made valuable suggestions; for all this my best thanks are due to him.

NOTES ON LAMELLIBRANCHS IN THE INDIAN MUSEUM.

By B. PRASHAD, D.Sc., Officiating Director, Zoological Survey of India.

6. INDIAN SPECIES OF THE GENUS *PISIDIUM*.

(Plates VII, VIII.)

The Indian species of the genus *Pisidium*, as was stated by me elsewhere,¹ are very imperfectly known. The original descriptions of the species are very scanty and inaccurate, while the published figures of the various species owing to their small size are of no value. Owing to a number of types of the Indian species being in the British Museum (Natural History), South Kensington, London, I was not able to deal with this genus till I had examined the types myself. The opportunity came in 1922, when I examined the type-specimens in the British Museum, and I have here to express my sincere thanks to Mr. G. C. Robson, for the facilities given and for getting photographs of the types prepared for me. Owing to pressure of other work the publication of the results has been delayed. I was further hoping to be able to deal with the anatomy of all the Indian species at the same time, but unfortunately it has not been possible to get spirit material of all the species and only in the case of three of the species I am able to add some notes on their anatomy.

I have in the course of my studies on this genus had the advantage of the help of Mr. A. W. Stelfox of the Natural History Museum, Dublin, who carefully went over the greater part of the Indian material with me, gave me all facilities for examining his extensive collection of European *Pisidia* and helped me in elucidating various difficult points. For all this I owe him my hearty thanks.

Dr. A. Weber, Custodian of the mollusc collections in the Munich Museum, was kind enough to send me the type-specimen of his species (*P. zugmayeri*) for examination, and informed me that the bivalve was collected from the Pangkong Lake, Tibet, and not from the Wular Lake in Kashmir, as is stated in his paper.²

The first reference to any Indian species of the genus is by Benson, who distributed specimens labelled *Pisidium parvulum* from India. This species is referred to by Prime³ and Hanley & Theobald⁴ but is nothing more than a manuscript name of a species which was neither described nor figured. G. & H. Nevill described the species *P. clarckeanum*

¹ Prashad, *Rec. Ind. Mus.* XXII, p. 618 (1921).

² Weber, *Zool. Jahrb. (Syst. Geogr. & Biol.)* XXIX, p. 310 (1910). In the summary at the end of the paper Weber has given the correct locality for the species.

³ Prime, *Cat. Corbiculidae* p. 17 (1863), also see Prime, *Amer. Journ. Conch.* V, p. 171 (1870).

⁴ Hanley & Theobald, *Conch. Ind.* p. 63 (1876).

in 1871¹ from Moirakha, Bengal. Theobald in 1876² described *P. bombayanum*, *P. nevilleianum* and *P. atkinsonianum* from various parts of India. Of these *P. bombayanum*, as is shown further on, is synonymous with *P. clarckeanum*. In the same year Theobald in his "Catalogue of Land and Freshwater shells"³ gave a list of the known Indian species, and included in it a species, *P. stoliczkanum*, from Port Canning, Bengal. This species according to the author is described in "*P. A. S. B.* 1875." No such species was, however, described by the author and the name must be considered as a *nomen nudum*. In 1878⁴ he described a species from Kashmir under the name *P. hydaspicola*. Preston in his volume⁵ in the "Fauna of British India" gave a complete list of all the species, but wrongly included the two Tibetan species *P. stewarti* Preston and *P. zugmayeri* Weber in the list of the Indian species.

Excluding the two Tibetan species mentioned above, we have four species, *P. clarckeanum*, *P. nevilleianum*, *P. atkinsonianum* and *P. hydaspicola*. In addition I have found it necessary to describe two new species, one from Paresnath Hill, Bihar, under the name *P. annandalei* and the other from Manasbal Lake, Kashmir, as *P. mitchelli*.

Geographical Distribution:—*P. clarckeanum* G. & H. Nevill is the common species found in various parts of India and Burma in the plains. It is common in tanks, lakes and streams. *P. nevilleianum* was found at Rurki, United Provinces, and also appears to be a still-water form. *P. atkinsonianum* is common at altitudes of 5,000-10,000 ft. in the Eastern Himalayas in ponds or small streams. *P. annandalei* was found in a small stream on Paresnath Hill, Bihar, at an altitude of 4,000 ft. *P. hydaspicola* and *P. mitchelli* are both confined to Kashmir, the former occurs in small streams or ponds all over the valley at different altitudes, while the latter was found in Manasbal Lake at an altitude of ca. 5,000 ft. above sea-level.

I have followed Mr. B. B. Woodward in the method of describing the species and have to acknowledge here my indebtedness to his valuable work.

The illustrations accompanying this paper were prepared by the artists of the Zoological Survey of India and I have to express my thanks to them for the extreme care they have taken in their preparation.

As has been discussed by Woodward in detail the earlier divisions of the genus into groups on shell-characters as attempted by Clessin,⁶ Westerlund,⁷ and Dall⁸ are not tenable. Odhner⁹ has recently, on anatomical grounds, divided the genus *Pisidium* into two subgenera, *Eupisidium* and *Neopisidium*. These two subgenera seem to be well founded, but a great deal of work on the genus still remains to be done.

¹ G. & H. Nevill, *Journ. As. Soc. Bengal* XL, pt. ii, p. 9, pl. i, figs. 4, 4a-d (1871).

² Theobald, *Journ. As. Soc. Bengal* XLV, pt. ii, pp. 188, 189 (1876).

³ Theobald, *Cat. Land Freshw. Moll.* p. 45 (1876).

⁴ Theobald, *Journ. As. Soc. Bengal* XLVII, p. 147 (1878).

⁵ Preston, *Faun. Brit. Ind. Freshw. Moll.* pp. 224-228 (1915).

⁶ Clessin in Martini & Chemn. *Conch.-Cab.* Cycladeen, pp. 7, 8 (1874).

⁷ Westerlund, *Faun. pal. Reg. Binen-Conch.* VII, pp. 18, 19 (1890).

⁸ Dall, *Proc. Biol. Soc. Washington*, XVI, pp. 5-8 (1903).

⁹ Odhner, *Journ. Conch.* XVI, p. 222 (1921).

Pisidium Pfeiffer.1913. *Pisidium*, Woodward, *Cat. Brit. Pisidium*, p. 2.1915. *Pisidium*, Preston, *Faun. Brit. Ind. Freshw. Moll.* p. 224.

Woodward, in the work cited above, has gone into the question of the validity of the name *Pisidium* very fully, and has given full references regarding its synonymy and discussed the various unsuccessful attempts at subgeneric division of the genus by different authors before his time. He has also given an amended description of the genus which I quote below :—

“ Shell close, ovoid to orbicular, equivalve, inequilateral, posterior side the shorter, more or less concentrically striate, thin, with olive-horny periostracum, sometimes, especially in young individuals and certain species, sparsely covered with short hairs ; umbones sometimes prominent, sometimes tumidly obtuse, nepionic shell usually smooth ; ligament subexternal ; hinge formula :

$$\begin{array}{rcccl} \text{R. V. } a. I : a. III & \left| & : c. 3 : & \right| & p. III : p. I^1 \\ \text{L. V. } : a. II : & \left| & c. 2 : c. 4 & \right| & : p. II : \end{array} \quad \begin{array}{c} \\ l \end{array}$$

A change in this definition is necessitated by the discovery, made independently, by Odhner² and Stelfox according to which the shell of *Pisidium* is porous and not hairy and the so-called hairs are fine thread-like prolongations from the pallial epithelium “ which penetrate mostly perpendicularly, into the calcareous layer of the shell but not into its cuticle.”

Of the six Indian species of the genus *Pisidium* mentioned above, *P. nevillianum*, *P. annandalei* and *P. mitchelli* are only represented by dried shells and I have not been able to examine their soft parts. Of *P. hydaspicola* only a half-dried specimen was available, but this was fortunately sufficient for deciding the exact subgeneric position of the species. The East-Himalayan species *P. atkinsonianum* was represented by a few specimens preserved in spirit, but the material was in rather a poor state of preservation and I have not been able to elucidate the various anatomical features in detail. *P. clarckeanum* is fairly abundant in the Calcutta tanks and I am therefore able to deal with its anatomy fairly fully. I have also examined animals of the species from other parts of India.

As a result of my anatomical studies I find that *P. clarckeanum* belongs to the subgenus *Neopisidium* Odhner. *P. nevillianum* which is closely allied to it also probably belongs to this subgenus. *P. hydaspicola* and *P. atkinsonianum* are both to be referred to *Eupisidium* Odhner, and probably *P. mitchelli* also will have to be placed with them. It is not possible, however, to be certain about *P. annandalei*. As noted further on it is allied to the Tibetan *P. stewarti* Preston, but the animals of both the species are unknown.

¹ The hinge formula is after Bernard, *Bull. Soc. Geol. France* (3) XXIII-XXV (1895-97). The contractions employed are :—R. V. Right Valve ; L. V. Left Valve ; a. anterior lateral teeth ; p. posterior lateral teeth ; c. cardinal teeth ; l. ligament,

² Odhner, *Journ. Conch.* XVI, pp. 219, 220 (1921).

***Pisidium clarckeanum* G. & H. Nevill.**

1871. *Pisidium clarckeanum*, G. & H. Nevill, *Journ. As. Soc. Bengal*, XL, pt. ii, p. 9, pl. i, figs. 4, 4a-d.
 1876. *Pisidium Clarckeanum* and *P. Clarkeanum*, Hanley & Theobald, *Conch. Ind.* p. v and p. 63, pl. clv, fig. 10.
 1876. *Pisidium Bombayanum*, Theobald, *Journ. As. Soc. Bengal*, XLV, pt. ii, p. 188.
 1876. *Pisidium clarckeanum* and *P. Bombayanum*, Theobald, *Cat. Land & Freshw. Moll.* p. 45.
 1915. *Pisidium clarckeanum* and *P. bombayanum*, Preston, *Faun. Brit. Ind. Freshw. Moll.* pp. 225, 226, fig. 28, 1-3.
 1918. *Pisidium casertanum* (Annandale nec Poli), Annandale, *Rec. Ind. Mus.* XIV, p. 142, pl. xix, figs. 13, 14.
 1921. *Pisidium clarckeanum* and *P. hydaspicola* (Prashad nec Theobald), Prashad, *Rec. Ind. Mus.* XXII, p. 618.

As was pointed out by Theobald in the note under his description of *P. bombayanum* (*loc. cit.*) and as has been noted by me already, the brothers Nevill in their description of *P. clarckeanum* inadvertently described the posterior as the anterior side. In my notes on the species (*loc. cit.*) I was not able to say anything about Theobald's *P. bombayanum* as the type of the species was not available to me in Calcutta. I have since examined the type of *P. bombayanum* in the British Museum, London, and find that it is only a young shell of *P. clarckeanum*.

As the original description of the species is very short the species is redescribed below.

Shell (Pl. VII, figs. 1, 1a, 2) of a fair size, moderately thick, very oblique, greatly inflated; superior margin greatly curved; superior anterior slope distinct, somewhat curved; anterior end broadly rounded, situated a little above the middle, inferior margin only slightly curved; posterior broadly truncate; umbo situated posteriorly, prominent, swollen, and greatly projecting over the hinge; surface pale yellow, somewhat shining, with regular closely situated striae on the surface, much closer on the body than on the umbonal region.

Hinge (Pl. VII, fig. 1a; pl. VIII, fig. 1) more than $\frac{3}{4}$ the length of the shell, fairly broad and projecting well inwards, arched, with two distinct flexures in both the valves, better marked in right than in the left.

R. V. *a. I.* a little more than $\frac{1}{3}$ the length of the hinge-line, very strong, somewhat curved and inclined inwards, *base* very strong, swollen; *apex* on distal side of centre, not very prominent, somewhat rounded, obtuse; *ridges* rather blunt, distal fairly steep, umbonal curved and descending to a much lower level than the distal.

a. III. about $\frac{1}{3}$ the length of and lying parallel to the distal ridge of *a. I.*; straight, narrow, erect, linear, without a well marked apex, rather sharp.

c. 3. prominent, sharply flexed and deeply notched underneath the umbo; *a* short, slightly curved, sharp, higher towards the middle, running downwards and forwards from the umbo across the hinge-plate, and not reaching the margin; *b* running downwards and backwards from the umbo to beyond the margin of the hinge-plate, swollen at the base and somewhat pyriform.

- p. I.* about $\frac{1}{4}$ the length of the hinge-line, narrower than *a. I.*, strong, slightly bent inwards ; *base* thick, shelving into shell-wall ; *apex* near distal end, obtuse ; *ridges* rather rounded, distal short, descending to a lower level than the umbonal.
- p. III.* about $\frac{1}{2}$ the length of *p. I.*, curved inwards and merging into the umbonal ridge of *p. I.*, without distinct apex, ridge-like, sharp.
- L. V. *a. II.* about $\frac{1}{2}$ the length of the hinge-line, narrow, bowed inwards in the umbonal region and outwards in the distal ; *base* thick, merging into the shell-wall ; *apex* on distal side of centre and bent upwards with the distal ridge curved below it, and continued outwards along a short distance ; umbonal ridge fairly high near the apex, then curving sharply inwards to below the umbo.
- c. 2.* prominent, sharp, somewhat curved, marked off from the hinge-plate by a low depression ; *base* parallel to hinge-plate and continuous with *a. II.* ; *apex* rounded and directed inwards.
- c. 4.* lamelliform, sharp, slanting, parallel to the posterior margin of *c. 2.*
- p. II.* less than $\frac{1}{3}$ the length of the hinge-line, broad, rather thin, bowing outwards ; *base* very strong, shelving into the shell-wall ; *apex* prominent, curving upwards and outwards near the distal end, obtuse, sharp ; *ridges* rather thick, umbonal sloping gradually, distal somewhat curved.

Ligament prominent, thick, of a brownish colour ; ligament pit narrow, about $\frac{1}{3}$ the width of the hinge-plate.

Measurements (in millimetres).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Length	5.6	5.4	4.7	4.5	3.0	3	3.5	5	5.6	3.7	5.2	4.5	3.4	3.2	3.7	3.5	3.8	4
Altitude	4.7	4.5	4.2	4	3.2	2.6	3.1	4.1	4.7	3	4.4	4.2	3	2.9	3	3	3.2	3.4
Thickness	3.6	3.4	3.0	2.7	2.1	2	2.1	3.2	3.5	2.2	3	3.1	2.1	2	2.2	1.8	2.2	2.4

Specimens 1, 2 type and cotype from Moirakha ; 3-5 also from Moirakha ; 6-9 from Calcutta tanks, Bengal ; 10 from Bhagalpur, Bihar ; 11, 12 from Rurki, United Provinces ; 13, 14 from the environment of Bombay ; 15 from He-Hó plain ; 16 from Inlé Lake ; 17, 18 from Maymyo, Burma.

Type-specimen. No. M. $\frac{12531}{2}$ in the collections of the Zoological Survey of India (*Indian Museum*), Calcutta.

Distribution :—This is the most widely distributed of the Indian species of the genus. The type-shells were collected from tanks at Moirakha on the banks of the Damodar river in Bengal. I have examined specimens from Hazrapur, Calcutta, Chittagong, Bengal ; Bhagalpur, Bihar ; Rurki, United Provinces ; environments of Bombay, Bombay Presidency, and Maymyo, He-Hó plain, Inlé Lake, Burma. It is the common species in Calcutta tanks.

Remarks :—Theobald's *P. bombayanum*, as already stated, is based on young shells of this species. Annandale identified shells from He-Hó plain and the Inlé Lake, Southern Shan States, after comparison with specimens from Lake Biwa, Japan, as *P. casertanum*. I have carefully compared these shells with large numbers of specimens of *P. clarckeanum* and I am of opinion that the Burmese specimens are *P. clarckeanum* and not *P. casertanum*. In my paper cited above, I had identified some shells from streams in Manipur Valley as *P. hydaspicola* Theobald. In the same paper I referred to a young depauperated shell in the collections of the Indian Museum from Bhagalpur, Bihar, to the same species. As a result of more detailed study of all these shells and of the type-shell of Theobald's *P. hydaspicola*, I am now of opinion that they are all *P. clarckeanum*.

In shape and outline *P. clarckeanum* resembles the European *P. subtruncatum* Malm, but the hinge and other characters are more like those of *P. casertanum* (Poli). It is distinguished from the latter by the shape of its shell, its more elongate anterior end, the more prominent umbones, the more strongly developed hinge and differences in the form of the various teeth and sculpture.

The soft parts, however, are quite different, for *P. casertanum* according to a casual reference to this species by Odhner¹ is a *Eupisidium*, while the characters of the soft parts of *P. clarckeanum* are essentially those of a *Neopisidium*.

The soft parts of *P. clarckeanum* as noted above place it in the sub-genus *Neopisidium*. These characters are (i) a single gill on each side, (ii) a single siphon, and (iii) the simple organisation of the nephridium. The animal is described in detail below.

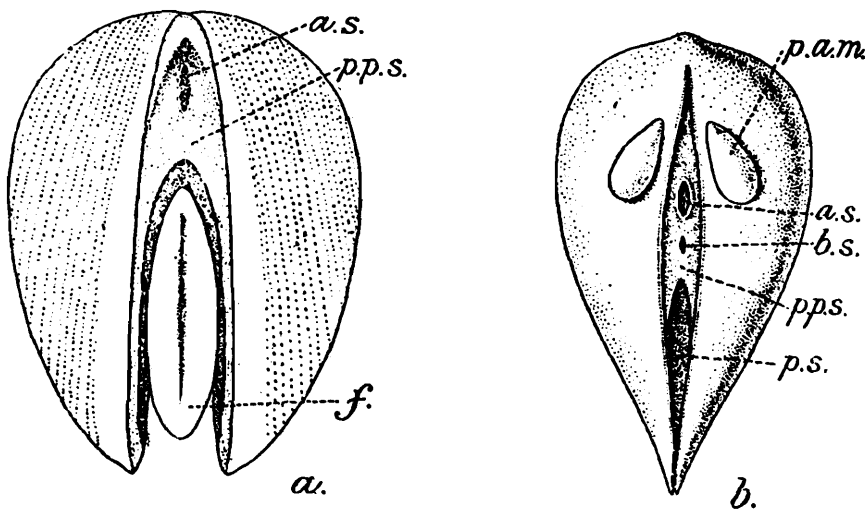


FIG. 1.—Animals of Indian *Pisidia* seen from the posterior side. In fig. b. the shell is removed to show the position of the posterior adductor muscle.

a. *P. clarckeanum* G. & H. Nevill.

b. *P. atkinsonianum* Theobald.

a. s. anal slit ; b. s. branchial slit ; f. foot ; p. a. m. posterior adductor muscle ; p. p. s. post-pedal suture ; p. s. pedal slit.

Mantle :—The mantle of *P. clarckeanum* resembles that of *P. clessini* and *P. torquatum* described by Odhner. There is a long pedal slit (text-fig. 1a and pl. VIII, fig. 2) extending from somewhat below the posterior

¹ Odhner, *Proc. Malacol. Soc. London*, XV, p. 161 (1923).

adductor muscle posteriorly to slightly below the anterior adductor muscle on the anterior side. The post-pedal suture is short, about as high as the posterior adductor muscle, and is about $1\frac{1}{2}$ times the size of the anal slit. There is no separate branchial slit.

Gill :—As has been noted already in *P. clarckeanum* there is only a single gill on each side. This gill of each side, as Odhner has shown, represents the inner gill of other Eulamellibranchs and corresponds to the anterior of the two gills of the members of the subgenus *Eupisidium*. It (Pl. VIII, fig. 3) consists mainly of the outer lamella with a very short reflected lamella only along a limited extent of the gill. The uppermost filament of the gill forms the axis along which the gill is attached to the body as in all Pisidia. The next 10-11 filaments run straight and their ends are not recurved inwards and upwards. Of these the first 4-5 filaments become attached to the body surface. The next filament, as shown in fig. 3, pl. VIII, are recurved upwards and inwards, but the recurved lamella is very narrow being not more than one-third of the total height of the filament. The posterior 10-11 filaments are again nearly straight. Of these the last 4-5 of each side unite behind the foot with those of the opposite side to form the interbranchial septum and the marginal blood vessel runs through it. Inter-filamentor junctions are present between the filaments at equal distances ; I was able to count 10 of them in one preparation.

Nephridium :—The nephridium lies near the posterior adductor muscle and is slightly more complex than that of *P. clessini* described by Odhner. The pericardial branch starts with the ciliated funnel and after

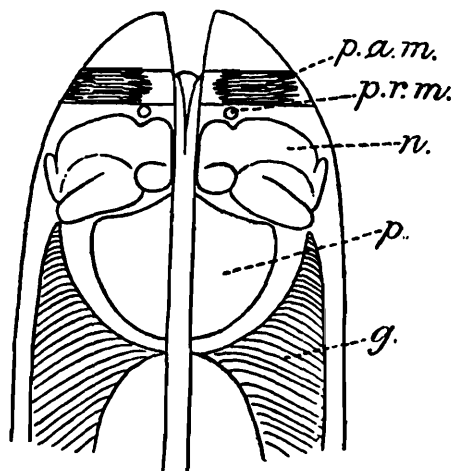


FIG. 2.—Posterior half of the animal of *P. clarckeanum* G. & H. Nevill seen from above.
g. gill ; *n.* nephridium seen through the mantle ; *p.* pericardial region ;
p. a. m. posterior adductor muscle ; *p. r. m.* posterior retractor muscle.

a short course backwards turns forwards and upwards. From this place it curves backwards to near the posterior adductor muscle and then curves up to form the big dorsal pouch which curves backwards and downwards and crossing over the pericardial lobe broadens into the terminal pouch to open near the ciliated opening. The dorsal lobe has a distinct fissure.

Stomach :—As is shown in the outline drawing of the anterior part of the alimentary canal (text-fig. 3), the stomach of *P. clarckeanum* resembles that of *P. clessini*. It has no posterior caecum, but the left

anterior caecum is well developed. The duodenum forms a double coil in front of the stomach and the intestine runs over the stomach on the right side.

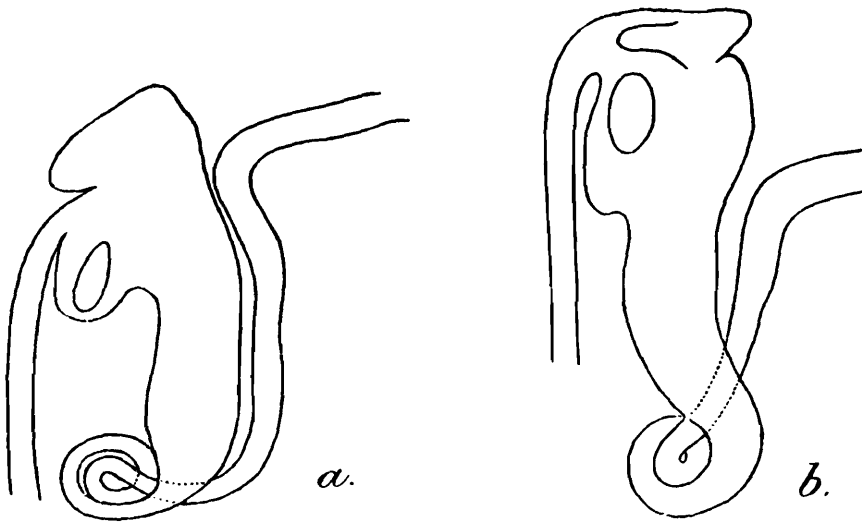


FIG. 3.—Stomach and a part of the alimentary canal of Indian *Pisidia*.

a. *P. clarkianum* G. & H. Nevill.

b. *P. atkinsonianum* Theobald.

✠ In other particulars the anatomy of this species is similar to that of *P. obtusale* described by Odhner.¹

***Pisidium nevilleianum* Theobald.**

1876. *Pisidium Nevilleianum*, Theobald, *Journ. As. Soc. Bengal*, XLV, p. 188.

1876. *Pisidium Nevilleianum*, Theobald, *Cat. Land Freshw. Shells*, p. 45.

1915. *Pisidium nevilleianum*, Preston, *Faun. Brit. Ind. Freshw. Moll.* p. 227.

Theobald's description of *P. nevilleianum* in Latin is very brief and quite insufficient for the recognition of this interesting form. The species has not been figured so far. It was described from a unique type-specimen now in the collection of the Zoological Survey of India (Indian Museum, Calcutta). I give below a detailed description and figure of the type-specimen.

Shell (Pl. VII, figs. 3, 4) large, trigonal, rather tumid, thin and porcelainous; striae all over, very distinctly marked, very regular, umbonal region with much stronger and closely placed striae umbones prominent, round, without appendiculae, placed behind the middle towards the posterior end; dorsal margin sloping regularly and equally on both sides of the umbo, passing gradually into the posterior margin, while there is a more or less well-marked notch between the anterior margin of the umbo and that of the shell; anterior margin subrostrate, elongately rounded; posterior margin somewhat convex, broadly rounded; ventral margin arcuate.

Hinge (Pl. VII, fig. 3a; pl. VIII, fig. 4) nearly $\frac{4}{5}$ of the length of the shell; much thickened with the inner lateral teeth strongly developed,

¹ Odhner, *Naturw. Unters. Sarekgeb. Schwed.-Lappland* gel. von. Dr. A. Hamberg, IV, pp. 162-165, pl. ii (1908.)

and the inner hinge-plate greatly arched with two distinct flexures in the right valve, flexures less distinct in the left valve.

R. V. *a. I.* more than $\frac{1}{3}$ the length of hinge-line, stout, gradually curving inwards ; *base* deep, solid, greatly swollen ; *apex* further from centre, somewhat rounded, obtuse ; *ridges* moderately rounded, umbonal sloping gradually, distal suddenly sloping down and somewhat arched outwards.

a. III. more than half the length of *a. I.*, from which it is separated by a deep notch anteriorly but meeting it on the umbonal side ; *apex* not prominent, distal to centre ; *ridges* somewhat rounded, umbonal very long and gradually sloping, distal short and steep.

c. 3. arcuate ; posterior part corresponding to *b* feebly thickened, very slightly clavate, not reaching the margin of the hinge-plate ; anterior part corresponding to *a* very thin, slightly curved and running nearly parallel to the shell-margin.

p. I. shorter than *a. I.*, and much less strongly developed, narrow, slightly curving inwards ; *base* moderately swollen ; *apex* low, but distinctly marked, very obtuse ; *ridges* slightly rounded, umbonal long, gradually sloping to form a very regular curve under the umbo, distal short, gently sloping.

p. III. nearly $\frac{3}{4}$ the length of *p. I.*, narrow, separated by a deep furrow anteriorly, then curving in its apical region towards *p. I.*, and then turning outwards to meet the ligament pit ; *apex* near proximal end, recurved over *p. I.*, low, very obtuse ; *ridges* only slightly thickened, umbonal short, distal long, gradually curving downwards and outwards, somewhat sinuate.

L. V *a. II.* more than $\frac{1}{3}$ the length of the hinge-line, very stout, strongly deflected inwards ; *base* very strongly swollen ; *apex* distal to centre, prominent, obtuse, rounded ; *ridges* rounded, umbonal more so than distal, umbonal gradually sloping, distal rapidly sloping and somewhat arched.

c. 2. triangular, fairly large, base continued towards *a. II.*, apex obtuse, rather sharp, directed upwards and outwards.

c. 4. sharp, lamellar, slightly curved, nearly $\frac{3}{4}$ the width of the hinge-plate, from the umbo downwards running nearly parallel to the posterior side of *c. 2.*

p. II. slightly shorter than *a. II.*, less stout, more straight but with more distinctly marked outward curvature ; *base* deep, strong and thickened ; *apex* slightly distal to centre, obtuse, rather rounded, directed distally and recurved outwards ; *ridges* rounded, umbonal rather longer than distal, gradually sloping, distal with a short rapid slope, then nearly straight.

Ligament pit comparatively long and deep, nearly straight below, about half the width of the hinge-plate in the middle, narrowing gradually on the two ends.

Measurements (in millimetres).

			1	2
Length	..	..	4.2	3.6
Height	..	..	4	3.3
Thickness	..	..	2.3	2.2

1, Type-shell from Rurki, United Provinces ; 2, shell without any locality.

Type-specimen. No. M¹²⁵³²/₂ in the collections of the Zoological Survey of India (*Indian Museum*), Calcutta.

Distribution :—The unique type-shell is from Rurki, United Provinces. The second shell which I assign to the species is without any label as to locality. It was provisionally identified *P. bombayanum* Theobald = *P. clarckeanum*) by G. Nevill.

Remarks :—*P. nevillianum* Theobald is apparently allied to *P. clarckeanum* Nevill, but differs in the shell being trigonal, the hinge more strongly developed and by the differences in the cardinal and lateral teeth. Some of the young shells of *P. clarckeanum* resemble *P. nevillianum* in form, but the hinge and particularly the teeth c. 3., and a. 1. are quite different in the two species. It to some extent resembles the European *P. supinum* Schmidt¹ in outline and form of the hinge.

Theobald's reference to this species in his catalogue (*loc. cit.*) is wrongly given as "*P. A. S. B.* 1875" while his measurements of the type-shell are also wrong.

***Pisidium hydaspicola* Theobald.**

1878. *Pisidium, hydaspicila*, Theobald, *Journ. As. Soc. Bengal*, XLVII, p. 147

1915. *Pisidium hydaspicola*, Preston, *Faun. Brit. Ind. Freshw. Moll.* p. 225, fig. 27.

Theobald gave a very scanty and confused description of this species. Preston who copied the original description inverted the measurements and published the figures of the type-shell as seen from above and of the right valve. I have examined the type-shell in the British Museum and I have before me a fair number of shells from various localities in Kashmir. I give below a detailed description of the species. It may also be noted that the type-shell is not a full-grown specimen and that the species grows to a much larger size.

Shell (Pl. VII, figs. 5-7a) of fair size, strong, sub-cordate, ovate, very inequilateral, somewhat tumid ; striae very feeble but distinct and running concentrically, more marked in young than in full grown shells ; umbones slightly swollen and not very prominent, placed behind the middle nearer the posterior end ; dorsal margin sloping regularly, more along the anterior than on the posterior side ; anterior margin short, evenly rounded ; posterior margin truncate, broadly rounded ; ventral margin nearly straight. The young shells are yellowish while full-grown specimens are deep yellow with darker olive bands.

Hinge (Pl. VII, figs 5, 6a, 7a ; pl. VIII, fig. 5) about $\frac{3}{4}$ the length of the shell, rather narrow, but projecting well inwards, greatly arched,

¹ Schmidt, *Zeitschr. Malakozool.* VII, p. 119. See also Woodward, *Cyt. Brit. Pisidium*, pp. 100-105, pls. (1913).

more so in the right than in the left valve, with two rather open fluxures in the right valve.

R. V. *a. I.* more than $\frac{1}{3}$ the length of the hinge-line, moderately strong and thick, slightly curved and inclined outwards; *base* very thick, swollen; *apex* nearer the proximal end, obtuse; *ridges* not sharp, both fairly steep, distal more so than the umbonal, umbonal swollen near the base.

a. III. less than $\frac{1}{2}$ the length of *a. I.*, and sloping towards it on its umbonal end, somewhat arched, rather low and thick; *apex* opposite that of *a. I.*; *ridges* sloping unequally, distal short and steep, umbonal long and gradually sloping towards *a. I.*

c. 3. rather feebly developed, greatly flexed, and only slightly notched; *a* shorter than *b*, slightly curved, only little inclined from the umbonal end outwards, thin and sharp, running parallel to the upper margin of the hinge-plate; *b* somewhat triangular at the base and rod-like above, greatly curved inwards and forwards in the middle, not reaching the lower margin of the hinge-plate.

p. I. about $\frac{1}{3}$ the length of the hinge-plate, fairly thickened and not sharp, slightly curved inwards, *base* thick but gradually merging into the shell-wall; *apex* proximal to centre, obtusely rounded; *ridges* rather thick, distal longer than umbonal and reaching a much lower level than the umbonal.

p. III. less than $\frac{1}{2}$ the basal length of *p. I.*, ridge-like, without distinct apex, greatly reflexed outwards; somewhat swollen at the base.

L. V *a. II.* little more than $\frac{1}{3}$ the length of the hinge-line, thick and greatly reflexed inwards, rather broad; *base* greatly swollen but gradually shelving into the hinge-plate; *apex* obtusely pointed; *ridges* rather thickened, not sharp, umbonal ridge shorter than distal which, after a sharp slope, gradually merges into the hinge plate.

c. 2. not very prominent, apex obtuse, sharp, pointing downwards, only slightly thickened, basal part running parallel to hinge-plate and continuous with *a. II.*

c. 4. lamelliform, sharp, very thin, running at an angle to the distal end of *c. 2.*, nearer it in the umbonal region but reaching further outwards in the distal.

p. II. shorter than *a. II.*, rather broad and somewhat reflexed inwards; *base* greatly swollen in the middle, slightly curved and gradually shelving on the two sides into the hinge-plate; *apex* proximal to centre, obtuse; *ridges* not very thick and rather sharply sloping from the apex.

Ligament pit comparatively long and deep, extending to about the middle of the hinge-plate and from anterior to the centre of the umbo to the end of *p. III.* in the right valve, and umbonal ridge of *p. II.* in the left valve.

Measurements (in millimetres).

	1	2	3	4	5	6	7	8	9	10
Length	4.2	4.6	4.4	4	2.5	2.5	3.6	3	3	3.2
Height	3.5	3.8	3.4	3.1	2	2	3.1	2.5	2.4	2.7
Thickness	2.3	2.5	2.2	2.1	1.2	1.1	2.1	1.5	1.3	1.6

1 Type shell from Shupion ; 2 from Mousterman ; 3 from Olus Valley ; 4, 5 from Islamabad ; 6 from Pandrenthan tank ; 7—10 from Eishmukam, Kashmir Valley.

Type-specimen in the British Museum (Natural History), South Kensington, London.

Distribution :—Theobald's unique type was found in the stream near Shupion, Kashmir. I have, as noted already, examined a fair number of specimens from Mousterman, Olus Valley, Wean, Islamabad, Pandrenthan tanks and Eishmukam and Manasbal Lake. All the localities are in the Kashmir Valley. I have also seen a fossil shell from Kuardo, Kashmir, Quarternary, recent Mall, collected by the late Col. H. H. Godwin-Austen. This specimen is in the Indian Museum. A photograph of the hinge of the type-shell is reproduced on pl. VII, fig. 5.

Remarks :—*P. hydaspicola* belongs to the same groups as the European *P. casertanum* (Poli). It differs from its Indian ally *P. clarkeanum* in that the shell is smaller, less tumid, sculpture not so marked, umbones much less prominent and the hinge less strongly developed. The hinge teeth are also differently disposed.

Animal (Pl. VIII, fig. 6) :—As noted in the introductory remarks, I had only a half-dry and badly preserved specimen of this species from Islamabad, Kashmir, in spirit, and I am not able therefore to deal with the anatomy of the species in detail. There is no doubt, however, that the species belongs to the sub-genus *Eupisidium* Odhner.

Mantle :—The pedal slit is large and extends to shortly in front of the anterior outline of the posterior adductor muscle. The post-pedal suture is broad and nearly as high as the posterior adductor muscle. There is a short branchial slit about $\frac{1}{2}$ — $\frac{2}{3}$ the size of the anal slit, the two apertures being separated by an area slightly larger than the anal slit. The anal slit is not more than $\frac{2}{3}$ the size of the post-pedal suture and has thickened margins.

Gill :—There are two gills on each side. The posterior gill, which, as has been demonstrated by Odhner, corresponds to the outer of the gills of each side of other Eulamellibranchia, is very much reduced and is represented only by the reflected lamella. In *P. hydaspicola* it is about half as long as the anterior gill and barely reaches its ventral margin. It consists of 13-14 filaments. The anterior gill which corresponds to the inner gill consists of 30-31 filaments. Each filament consists of a well developed outer lamella which extends to about half the width of the outer lamella. Along its lower $\frac{1}{2}$ — $\frac{2}{3}$ the reflected lamella is fused with the direct outer lamella. The reflected lamellae of the last 10-11 filaments are fused behind the foot with the reflected lamellae of the gill of the opposite side. It was not possible to determine the numbers of the lamellae which are attached to the body anteriorly.

I was not able to study in detail the structure of the nephridium, the stomach and the pericardium owing to the poor condition of the material.

Pisidium atkinsonianum Theobald.

1876. *Pisidium atkinsonianum*, Theobald, *Journ. As. Soc. Bengal*, XLV, pt. II, p. 189.

1876. *Pisidium atkinsonianum*, Theobald, *Cat. Land Freshw. Shells*, p. 45.

1915. *Pisidium atkinsonianum*, Preston, *Faun. Brit. Ind. Freshw. Moll.* p. 226, fig. 29.

The description of the species by Theobald is very inadequate and Preston's figures of the type do not help in the recognition of the species. Indeed it was this which led Annandale¹ to consider this species as "merely a dwarfed form" of what he considered to be *P. casertanum* (see *antea* p. 410). It is, however, quite a distinct species and is nearly allied to *P. hydaspicola*.

The species may be redescribed as follows :—

Shell (Pl. VII, figs. 8-10a) of medium size, rather thin in the half-grown type-shells but growing thicker with age; orbiculate-ovate; not much swollen; feebly striate in young, but with the striae much more irregular and better marked in full grown specimens; umbones only slightly tumid, not prominent, placed behind the middle with very minute striae, dorsal margin sloping slightly with a well-marked shoulder on the posterior slope; anterior margin subtruncate, broadly arched; posterior margin short, rounded; ventral margin only slightly curved; young shells are yellowish in colour but full-grown specimens become dirty olive.

Hinge (Pl. VII, figs. 8, 9a, 10a; pl. VIII, fig. 7) about $\frac{2}{3}$ the length of the shell, rather narrow, but projecting well inwards, strong, slightly arcuate with two marked flexures in the right valve.

R. V *a. I.* more than $\frac{1}{3}$ the length of the hinge line, stout, curving inwards; *base* very thick and strong; *apex* distal to centre, prominent, distally directed, somewhat rounded, obtuse; *ridges* rounded, distal descending steeply, umbonal sloping gradually and to a lower level than the distal.

a. III. more than $\frac{1}{2}$ the length of *a. 4.*, narrow, opposed to shell margin and running parallel to it; *apex* distal to centre, broadly rounded; *ridges* rather sharp, distal very short and descending quite steeply, umbonal very long and sloping very gradually.

c. 3. distinctly curved, prominent, lying close to but not reaching the margin of the hinge-plate; part corresponding to *b* swollen, knob-like, *a* sharp, lamelliform.

p. I. about $\frac{1}{3}$ the length of the hinge-line; stout, only slightly curving inwards; *base* strong but not much swollen; *apex* slightly distal to centre, rather sharp, obtuse; *ridges* rounded, both umbonal and distal subequal and descending about equally.

p. III. about $\frac{2}{3}$ the length of *p. I.*, stout, greatly curving outwards towards the shell margin; *apex* distal to the centre, slightly pointed, obtuse; *ridges* rounded except for proximal half of distal which is somewhat sharp, curved and folded outwards, umbonal sloping regularly to about the posterior extent of the ligament pit.

¹ Annandale, *Rec. Ind. Mus.* XIV, p. 142 (1918).

- L. V. *a. II.* about $\frac{3}{8}$ the length of hinge-line, fairly strong, stout, nearly straight; *base* very stout, swollen; *apex* subcentral, prominent, acuminate, directed inwards and upwards; *ridges* only slightly rounded, sloping about equally.
- c. 2.* prominent, somewhat triangular with a deep depression at its base; *apex* directed upwards.
- c. 4.* sharp, lamelliform, anterior portion above *c. 2.*, posterior part curving down to below the middle of the hinge-plate.
- p. II.* somewhat smaller than *a. II.*, fairly strong, stout, slightly curved; *base* strong but not much swollen; *apex* proximal to centre, pointing inwards and downwards, acuminate; *ridges* rather sharp, distal somewhat curved, proximal straight, sloping gradually.

Ligament pit about $\frac{2}{3}$ the length of the umbo; deep, nearly reaching below the middle of the hinge-plate, ventral margin straight.

Measurements (*in millimetres*).

	1	2	3	4	5	6
Length	3.4	4.7	4.4	4	4.2	4.3
Height	2.8	3.9	3.6	3.3	3.2	3.5
Thickness	1.8	2.5	2.5	2.2	2.1	2.2

1 from Sureil, Darjeeling District; 2—4 from Sonada, Darjeeling District; 5, 6 Gangtok, Sikkim.

Type-specimen in the British Museum (Natural History), South Kensington, London.

Distribution:—Theobald's type-shells were collected at Tonglu, Sikkim, at an altitude of 10,000 ft. I have examined these shells and compared others from various localities in the Darjeeling district at altitudes between 5,000 and 10,000 ft., and can find no differences between them.

Remarks:—The species is allied to *P. hydaspicola* Theobald, but is distinguished by the form of the shell, the much less prominent umbones and the different arrangement of its hinge-teeth.

The soft parts of this species (Pl. VIII, fig. 8) show that like *P. hydaspicola* it is to be referred to Odhner's subgenus *Eupisidium*. The main characters are (i) the two pairs of gills, (ii) separate branchial and anal slits in addition to the pedal aperture, and (iii) the nephridial structure. Unfortunately the specimens of this species were not very well preserved and it was not found possible to investigate the structure of the nephridium in detail.

Mantle (text-fig. 1b):—The pedal aperture is large and extends anteriorly to below the anterior adductor muscle and posteriorly to a short distance in front of the posterior adductor muscle. The post-pedal suture is short, being only about half the height of the posterior adductor muscle. The branchial slit is narrow and is only a little more than the post-pedal suture. Its edges are not greatly thickened and it is separated from the anal slit by an area slightly shorter than the post-pedal suture. The anal slit is surrounded by thick muscles and is about twice as high

as the branchial slit. The margin of the mantle is thickened uniformly and shows the radiating muscles.

Gills (Pl. VIII, fig. 9) :—There are two gills on each side. The posterior gill, as in the case of *P. hydaspicola*, is greatly reduced and consists of 18 filaments. It is very narrow but is more extensive than in the case of *P. hydaspicola*. The filaments are not recurved and are greatly reduced in the lower region.

The anterior gill consists of the well developed direct lamella and a reflected lamella which, as shown in the figure, reaches different levels in different parts of the gill. The margin of the lamella is attached to the body along about half of its length, while behind the foot lamellae of the gills of the two sides are united to form the interbranchial septum. In some of the gravid specimens the developing embryos were contained in this part of the gills, which, as in other species, serves as the brood pouch. The reflected lamella is fused with the outer lamella along more than half of its extent, while the marginal blood vessel runs along its margin.

Nephridium :—The nephridium of *P. atkinsonianum*, so far as I have been able to elucidate its structure, resembles that of *P. personatum* described by Odhner.¹ The pericardial tube is more extensive and coiled while the dorsal lobe is large with a deep fissure.

Stomach (text-fig. 3b) :—The structure of the stomach is similar to that of *P. personatum* described by Odhner (*loc. cit.*). There is a distinct posterior caecum in addition to a left caecum of the stomach. The duodenum is coiled in front of the stomach and runs backwards to the intestine on the right side of the stomach.

Pisidium mitchelli, sp. nov.

Shell (Pl. VII, figs. 11, 11a) large, subtrigonal, very tumid, rather thin, fragile, with well-marked, thick closely set striae all over; umbones prominent, placed behind the middle towards the posterior end; dorsal margin sloping regularly, more along the posterior than on the anterior slope; anterior margin broadly rounded; posterior margin sub-truncate, rounded; ventral margin greatly arched; shell of deep-horn colour, shining.

Hinge (Pl. VII, fig. 11a; pl. VIII, fig. 10) more than $\frac{2}{3}$ the length of the shell, fairly wide, projecting and with the teeth recurved upwards, arched with two distinct flexures in the right valve.

R. V. *a. I.* more than $\frac{1}{3}$ the length of the hinge-line, strong, curving inwards; *base* strong and swollen; *apex* subcentral, obtusely acuminate; *ridges* slightly rounded, fairly steep, sloping about equally.

a. III. nearly $\frac{3}{4}$ the length of *a. I.*, strong, opposed to the shell margin; *apex* not prominent, subcentral, rounded, obtuse; *ridges* somewhat rounded, sloping equally.

c. 3. arcuate, thin, lamelliform, with the portion corresponding to *b* only slightly swollen, portion corresponding to *a* running parallel to the shell margin.

¹ Odhner, *Proc. Malacol. Soc. London* XV, pp. 160, 161 (1923).

- p. I.* more than $\frac{1}{2}$ the length of and about as broad as *a. I.*, strong, curving upwards; *apex* distal to centre, slightly rounded, obtuse; *ridges* somewhat rounded, umbonal sloping regularly, distal shorter than umbonal and sloping steeply.
- p. III.* slightly shorter than *p. I.*, narrow, strong, slightly curved, opposed to the shell margin; *apex* subcentral, obtusely pointed; *ridges* sharp, distal sloping a little more than umbonal.
- L. V. *a. II.* more than $\frac{1}{3}$ the length of the hinge-line, stout, strongly curving upwards and outwards; *base* strong, swollen; *apex* distal to centre, acute, pointed, sharp; *ridges* sharp, umbonal sloping suddenly and then curving regularly, distal descending rapidly for a very short distance and then regularly.
- c. 2.* rather short, ridge-like, in continuation of the umbonal ridge of *a. II.*, running parallel to and near the hinge-plate margin.
- c. 4.* longer than *c. 2.*, lamelliform, slightly arcuate, curving over anterior margin of *c. 2.*, and running diagonally to near the margin of the hinge-plate.
- p. II.* about $\frac{3}{4}$ the size of *p. I.*, broad, strong, curved, inclined upwards and outwards; *base* strong, swollen; *apex* subcentral, pointed, obtuse; *ridges* sharp, umbonal descending gradually along a somewhat arched course, distal sloping very suddenly and then running nearly straight.

Ligament pit more than half the length of the umbo and arising from in front of its centre, reaching to about the middle of the hinge-plate and ending in front of the umbo.

Measurements (*in millimitres*).

	1	2	3	4
Length	3.8	3.8	3.6	3.8
Height	3.6	3.6	3.3	3.5
Thickness	3.1	3	2.5	3

All specimens from Manasbal Lake; No. 1 is the type-shell.

Type-specimen. No. $M \frac{12533}{2}$ in the collections of the Zoological Survey of India (*Indian Museum*), Calcutta.

Distribution:—About a dozen complete shells of the species were collected by Mr. F. J. Mitchell of Srinagar, Kashmir, out of the stomach of a trout caught in the Manasbal Lake at an altitude of ca. 5,000 ft.

Remarks:—The species resembles the European *P. lilljeborgii* Clessin¹ but differs in the form of the shell and the different type of hinge. It is closely allied to *P. hydaspicola* Theobald.

***Pisidium annandalei*, sp. nov.**

Shell (Pl. VII, figs. 12, 12*a*) small, subtrigonal, thin, porcellaneous, slightly tumid; concentrically striate, with close-set regular lines running

¹ Clessin, *Malakol. Blatt.* (N. F.) VIII, p. 119 (1886). See also Woodward, *Cat. Brit. Pisidium*, pp. 111-116 (1913).

all over the surface, striae less marked on the umbonal region ; umbones not prominent, only slightly projecting, subcentral ; dorsal superior margin short, slightly arched with well marked shoulders on both anterior and posterior slopes ; anterior margin regularly and narrowly curved ; posterior margin broadly arched, subtruncate ; ventral margin curved, shell of a shining horny colour.

Hinge (Pl. VII, fig. 12a ; pl. VIII, fig. 11) more than $\frac{3}{4}$ the length of the shell, fairly broad, projecting inwards, very strong, very arched with two distinct flexures in both the valves.

R. V *a. I.* about $\frac{1}{2}$ the length of the hinge-line, broad, strong, slightly curving inwards and upwards ; *base* strong, swollen ; *apex* distal to centre, prominent, acuminate, obtuse ; *ridges* somewhat rounded, distal arched, umbonal straight, descending gradually.

a. III. less than $\frac{1}{2}$ the length of *a. I.*, running parallel to the shell wall, nearly straight ; *apex* not well marked, proximal to centre, very obtuse ; *ridges* sharp, umbonal very short.

c. 3. very prominent, greatly projecting inwards, slightly curved, the rounded end *b* knob-like, nearly reaching the margin of the hinge-plate ; upper part corresponding to *a* nearly straight, sharp.

p. I. about $\frac{1}{2}$ the length of the hinge-line, broad, strong, only slightly narrower than *a. I.*, *base* strong, swollen ; *apex* distal to centre, obtuse, somewhat rounded ; *ridges* slightly rounded, sloping unequally, umbonal somewhat arched, distal short and descending suddenly.

p. III. more than $\frac{1}{3}$ the length of *p. I.*, running parallel to shell wall, narrow, evenly developed ; *apex* distal to centre, obtuse, acuminate ; *ridges* sharp, descending unequally, umbonal long, distal very short.

L. V *a. II.* more than $\frac{1}{3}$ the length of the hinge-line, broad, nearly straight ; *base* very strong and swollen ; *apex* proximal to centre, not very prominent, very obtuse, somewhat rounded, greatly curved inwards and upwards ; *ridges* sharp, sloping very steeply and about equally.

c. 2. prominent, obtusely triangular ; *apex* directed upwards and outwards towards the umbo ; *base* continuous with umbonal ridge of *a. II.*

c. 4. thin, arc-like, sharp, prominent, arising from near the shell-margin and curving over the posterior margin of *c. 2.* to near the margin of the hinge-plate.

p. II. smaller than *a. II.*, broad, strong, nearly straight ; *base* strong, swollen ; *apex* subcentral, prominent, directed upwards and somewhat onwards, obtuse, pointed ; *ridges* sharp, umbonal descending regularly, distal descending sharply at first and then running nearly straight.

Ligament pit placed very far back, starting from near the posterior end of the umbo and running to opposite the apex of *p. II.* in the left valve.

There is a very deep depression in the hinge-plate behind and above the c. 3., in the same situation in which it is found in *P. stewarti* Preston.¹

Dimensions.—The type-specimen measures $2.6 \times 2.2 \times 1.4$ mm., while the single right valve measures 2×1.7 mm.

Type-specimen. No. M $\frac{7033-7034}{1}$ in the collections of the Zoological Survey of India (*Indian Museum*), Calcutta.

Locality:—One complete shell and a right valve were collected by the late Dr. Annandale from Pareshnath Hill, Bihar, at an altitude of 4,000 ft.

Remarks:—The species is closely allied to *P. stewarti*, but is distinguished by the different facies and the different type of hinge.

¹ Preston, *Rec. Ind. Mus.* III, p. 116, fig. 3 (1909). See also Preston, *Faun. Brit. Ind. Freshw. Moll.* p. 227 (1915).

EXPLANATION OF PLATE VII.

Photographs of figures 2, 5, and 8 were obtained through the kind help of Mr. G. C. Robson of the British Museum, Natural History, London. All the other figures are reproductions of direct photographs magnified 6 times; in reproduction they have been reduced to $\frac{2}{3}$ of this size.

***Pisidium clarckeanum* G. & H. Nevill.**

FIG. 1.—Outer view of the two valves of the type-shell from Moirakha, Bengal.

FIG. 1a.—Inner view of the two valves of the specimen reproduced in fig. 1 showing the hinge.

FIG. 2.—Inner view of the two valves of the type-shell of the species *P. bombayanum* Theobald.

***Pisidium nevillianum* Theobald.**

FIG. 3.—Outer view of the two valves of the type-shell from Rurki.

FIG. 3a.—Inner view of the valves of the shells reproduced as fig. 3.

FIG. 4.—Outer view of the two valves of another specimen without locality.

FIG. 4a.—Inner view of the two valves of the shell reproduced in fig. 4.

***Pisidium hydaspicola* Theobald.**

FIG. 5.—Inner view of the two valves of the type-shell from Shupion Kashmir.

FIG. 6.—Outer view of the two valves of a specimen from Mousterman, Kashmir.

FIG. 6a.—Inner view of the two valves of the shell reproduced in fig. 6.

FIG. 7.—Outer view of the two valves of a specimen from Eishmukam, Kashmir.

FIG. 7a.—Inner view of the two valves of the shell reproduced in fig. 7.

***Pisidium atkinsonianum* Theobald.**

FIG. 8.—Inner view of the two valves of the type-shell from Tonglu, Sikkim.

FIG. 9.—Outer view of the two valves of a shell from Gangtok, Sikkim.

FIG. 9a.—Inner view of the two valves of the shell reproduced in fig. 9.

FIG. 10.—Outer view of the two valves of a shell from Sureil, Darjeeling District.

FIG. 10a.—Inner view of the two valves of the shell reproduced in fig. 10.

***Pisidium mitchelli*, sp. nov.**

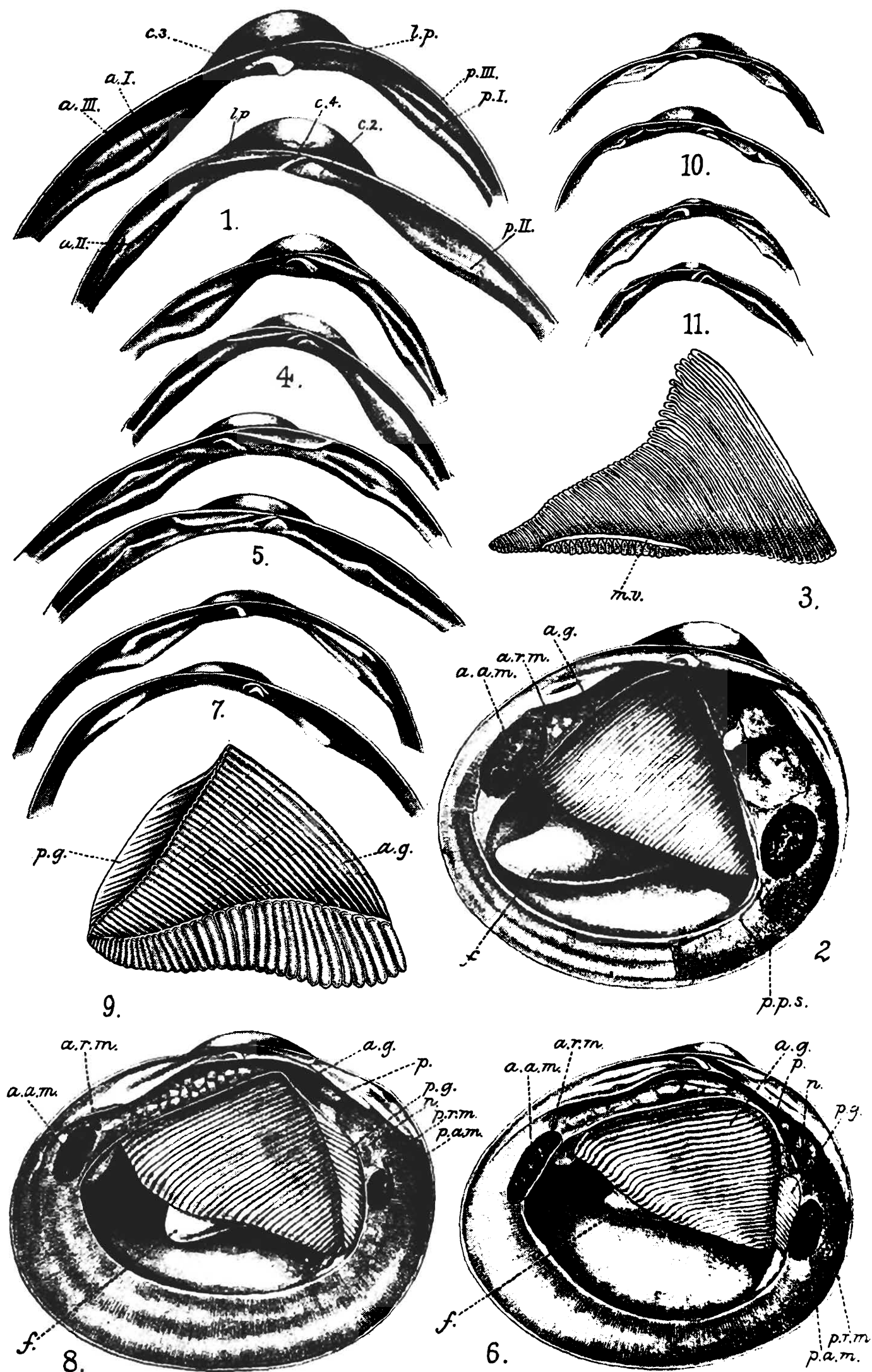
FIG. 11.—Outer view of the two valves of the type-shell from Manasbal Lake, Kashmir.

FIG. 11a.—Inner view of the two valves of the shell reproduced in fig. 11.

***Pisidium annandalei*, sp. nov.**

FIG. 12.—Outer view of the two valves of the type-shell from Paresnath Hills, Bihar.

FIG. 12a.—Inner view of the two valves of the shell reproduced in fig. 12.



EXPLANATION OF PLATE VIII.

FIG. 1.—Hinge-teeth of *P. clarkeanum* G. & H. Nevill.

a. I.—*a. III*, anterior lateral teeth ; *c. 2*—*c. 4*, cardinal teeth ;
l. p. ligament pit ; *p. I.*—*p. III*, posterior lateral teeth.

FIG. 2.—Animal of *P. clarkeanum* G. & H. Nevill.

a. a. m. anterior adductor muscle ; *a. g.* anterior gill ; *a. r. m.* anterior retractor muscle ; *f.* foot ; *n.* nephridial area ; *p.* pericardial region ; *p. a. m.* posterior adductor muscle ; *p. p. s.* post-pedal suture ; *p. r. m.* posterior retractor muscle.

FIG. 3.—Left gill of *P. clarkeanum* G. & H. Nevill, seen from the under surface.

m. v. marginal blood vessel.

FIG. 4.—Hinge-teeth of *P. nevillianum* Theobald.

FIG. 5.—Hinge-teeth of *P. hydaspicola* Theobald.

FIG. 6.—Animal of *P. hydaspicola* Theobald.

p. g. posterior gill ; other letters same as in fig. 2.

FIG. 7.—Hinge-teeth of *P. atkinsonianum* Theobald.

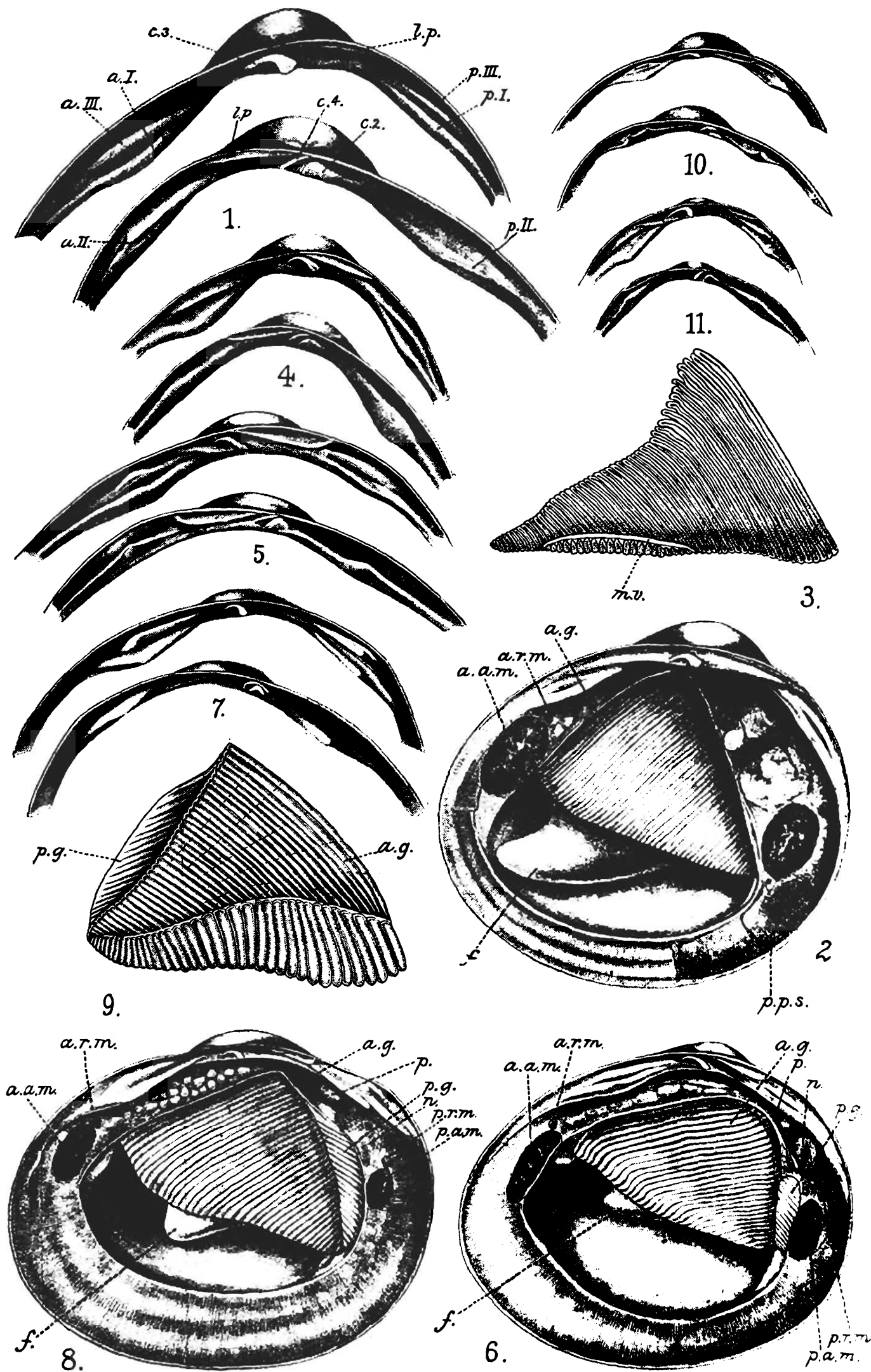
FIG. 8.—Animal of *P. atkinsoninum* Theobald.

Reference letters same as in figs. 2 and 6.

FIG. 9.—The two gills of the left side of *P. atkinsonianum* Theobald, seen from the under surface.

FIG. 10.—Hinge-teeth of *P. mitchelli*, sp. nov.

FIG. 11.—Hinge-teeth of *P. annandalei*, sp. nov.



THE TRUE POSITION OF THE GENERA *OROGOMPHUS* AND
CHLOROGOMPHUS AS DEMONSTRATED BY A STUDY OF
THE LARVAE OF *O. ATKINSONI* AND *O. CAMPIONI* AND
BY A COMPARISON OF THE LATTER WITH THE
LARVA OF *ANOTOGASTER NIPALENSIS* (ODONATA).

By MAJOR F. C. FRASER, I.M.S., F.E.S.

(Plates IX, X.)

In the Memoirs of Pusa, Vol. VIII, No. 3, Feb. 1923, I described the exuvia of *Orogomphus atkinsoni* Selys. A large number of these exuviae were found clinging to rocks in the bed of a stream at Kurseong, Sikkim, 5,000 ft., by Mr. T. Bainbrigg Fletcher. Mr. Fletcher was very emphatic that no other large dragonflies were about at the time except *O. atkinsoni*, so that there was every reason to surmise that the exuviae belonged to that species.

On first examination I reported all the exuviae sent to be males, this owing to the ovipositor scale being so minute that I entirely overlooked it. The result of this error was to cast considerable doubt on the exuvia being that of an *Orogomphus* at all, thus Dr. Ris, having read the description quoted above, wrote to me as follows :—

“Let me tell you that this discovery, if it holds good, is a disappointment. The sub-family loses its ambiguous position and becomes a group of Cordulegasterinae. With your description and figures of the nymph in hand, I have very carefully confronted again the venation of *Orogomphus-Chlorogomphus* and *Cordulegaster*; really there is nothing so radically different that the two might not be united. I should have expected from this larva something between a Gomphine and a Macromia larva but not simply a Cordulegaster type. What you have figured is clearly like *Cordulegaster*. It is very unfortunate that you have no female nymph cases. They would decide the case at once. For *Oro-Chloro-gomphus* something like the structure of *Gomphus* is to be expected (two minute tubercles, or better, a minute, deeply cleft scale, so as to form two tubercles at the terminal border of the 8th sternite), whereas the *Cordulegaster* female larva bears a large sheath for the future ovipositor. I must say that so far as I am concerned, the question remains open, so long as no nymph has been observed in actual transformation, or so long as no female nymph of *Oro-Chloro-gomphus* has come to hand.”

Dr. Ris of course had every right to express such doubts, as there was only circumstantial evidence to support the claim of the exuvia to be that of *Orogomphus atkinsoni*.

In March 1924, Dr. Chopra of the Zoological Survey of India, secured a single larva in the Balasan River, below Kurseong, 1,500 ft., which unfortunately also turned out to be a male. I made a careful examination of the venation depicted in the wings of this specimen but here again failed to get any conclusive evidence. Parts of the venation

were heavily pigmented and thus easily discernible, but the essential parts, the triangles, etc., were far too obscure to be made out with any degree of certainty. So far as I could interpret the venation, the wing was that of a *Cordulegasterine* type. As a control, I made an examination of the gizzard folds, with the result that I found them to be typically *Cordulegasterine*, differing only in minor details.

The accumulated evidence was all in favour of Dr. Ris' view, and it only needed the discovery of a female exuvia or larva to make this conclusive.

In May 1924, Mr. Bainbrigge Fletcher, collecting at Shillong, 5,000 ft., Khasia Hills, Assam, secured several more exuviae which he forwarded to me for examination. Some of these were similar in size and morphology to those from Kurseong and undoubtedly belonged to the same species. An important fact was that Mr. Fletcher again took several specimens of teneral *Orogomphus atkinsoni* clinging to bushes alongside the stream where the exuviae were found, thus coinciding with his experience at Kurseong.

In addition to these exuviae, and on the same stream, he found three much larger exuviae, very similar however in appearance and with a *Cordulegasterine* mask. He forwarded these as females of the former, but on making a close examination, I found two only to be females, both of these possessing a very large projecting ovipositor scale. A comparison of these with the smaller species quickly revealed differences in detail, clearly proving their specific distinctness.

The comparatively enormous size of the ovipositor scale in these specimens, coupled with the remarks of Dr. Ris, led me at this time to make a re-examination of the Kurseong exuviae in the hope that I might find some evidence of an ovipositor scale, in at least some of them, especially as in the imago of *O. atkinsoni* the ovipositor is nearly obsolete. The examination was made under a quarter inch objective and to my surprise I was able to make out a very minute ovipositor in nearly half of the specimens. Possibly my failure to notice this organ at my primary examination was due to the fact that most of the exuviae were coated with clinging detritus and diatomaceous material. Thus Dr. Ris' argument against the exuviae belonging to an *Orogomphus* was met, but it still needed a larva in which the venation could be read clearly to render the proof conclusive. With this object in view, I determined to make a great effort to find the adult larva of *Orogomphus campioni*, a species which occurs in Coorg and South Kanara, from April to the early part of June. In the former locality, its particular haunt is in the jungles at the source of the Sampaji river. Rising here as a small brook with sandy bottom, the river winds steeply down amidst dark gloomy primeval jungle, forming occasional pools with muddy or rocky bottoms, and later, after receiving several tributaries, expands into a mountain river of great magnitude.

During the month of May I had often seen as many as fifteen specimens of *O. campioni* soaring above the jungle at the source of this river (Plate IX, fig. 2). I had also seen considerable numbers at Khatlkad, near Mercara, but as the approach to the stream feeding this area had to be negotiated through dense thorny lantana, and involved the des-

cent of about 1,000 ft. of precipitous hill-side, I determined to first explore the Sampaji river, which was of easy approach from the Mangalore ghat road. As it was essential that an adult larva should be secured, I had to postpone my search till as late a date as possible before the emergence of the insects in April, but as I was due to leave Coorg in February, I had to carry out my explorations at a date earlier than I could have wished.

On the 13th January I carried out extensive dredging in the upper part of the stream where it flows through very dense dark jungles, but after some hours was compelled to cease, partly from fatigue and partly from the approach of nightfall. I had secured a number of larvae which appeared to be Gomphine in nature, but amongst which, when examined at leisure in my laboratory, I found a single Cordulegasterine larva. Now the subfamily Cordulegasterinae has no known representative in India south of the northern montane tracts, nor is it at all likely that any occur. (In this particular district of Coorg I had collected continuously for two years, motoring to various collecting grounds a total distance of 17,000 miles during that period, so that it was improbable that so large an insect as a *Cordulegaster* could have escaped my notice.)

Apart from its juvenile condition, my new find was exactly similar to the larva taken by Dr. Chopra at Kurseong. The remaining larvae collected on this date proved to be all Gomphines belonging to two species :—*Gomphus nilgiricus* Laid. and *Acrogomphus fraseri* Laid.

On the 15th January I again dredged this stream, but at a point lower down where it emerges from the jungle and flows through a narrow valley under paddy cultivation (Plate IX, fig. 1). Here the stream is bordered by cane brakes and is favoured by such dragonflies as *Megalogomphus*, *Gomphus*, *Heliogomphus*, *Gomphidia*, *Neurobasis*, *Pseudophaea* and *Rhinocypha*. A prolonged search in many likely pools and rivulets resulted in dredging up more larvae of *Acrogomphus* and a few of *Orthetrum* and *Neurobasis*. Many pools were cleaned entirely of stones and accumulated sand until the bare bed-rock was exposed, so that after the great toil involved, the result was most disappointing.

A third attempt to find the larva was made two days later, 17th January, this time the river being worked higher up from a point a little below where it rises in a cardamom swamp. After dredging for nearly two hours I turned up from clean sand, at the bottom of a pool about one foot deep, two adult Cordulegasterine larvae in two successive dips. Both were females and exactly similar otherwise to the Kurseong larva.

A third larva was secured after much toil, on the 5th February, also feminine in sex.

An examination of the wings of these proved them to be indisputable specimens of *Orogomphus campioni*. In the first female examined, the venation is so clearly depicted, that the most minute details are easily readable. Thus one notes the characteristic *Orogomphine* triangles, the incomplete basal antenodals and the nervures traversing the median space. Specific differences are present, proving it to be *campioni*,—thus the nodal indices agree, the number of cells in the loop,

the number under the pterostigma, the number of cells in the triangles and the arrangement of cells at the proximal end of the discoidal field. The dental folds of the gizzard are typically Cordulegasterine but show marked differences, of a specific value, from those of *O. atkinsoni*. (These are given in detail below.)

The larva taken on the 5th February was kept alive for a few days to observe its habits. It was placed in a bowl with a few inches of sand at the bottom, obtained from the Sampaji river. (This sand is of a rusty tint and the larva corresponds in colour, especially its head and dorsum of thorax). Placed on the surface of the sand, it remained quiescent for some time and then began burrowing vigorously with its *hind legs*. (Quite contrary to the habits of Gomphines which use their especially adapted forelegs.) The end of the abdomen was curled up evenly and used as a plough as the insect burrowed down and backwards. Thus the middorsum was the first part of its anatomy to be lost to sight. As soon as the head had descended to a level with the plane of the sand, it was brought into use as a spade, and the use of the spade-like frons, common to all the Cordulegasterinae, was thus explained. This curious instrument is used in precisely the same way as is the similar structure found in scavenger beetles.

At times the insect only sank into the sand until all but its head and fore part of thorax was visible, and in such a posture, owing to its cryptic colouring, it was quite invisible except to the trained eye.

All the larvae were found at the foot of miniature waterfalls in moderately deep pools containing about a foot of clean sand at the bottom.

The Kurseong and Shillong exuvia and larva resemble that of *O. campioni* so closely that there can be no doubt that they belong to the same genus, and the fact that *atkinsoni* was taken in the same neighbourhood is sufficient proof that they belong to the latter species.

The late Mr. Herbert Champion pointed out that the two sexes of *O. campioni* combined the characters of *Orogomphus* and *Chlorogomphus*, the male being a typical *Orogomphus*, whilst the female was equally typical of the second genus. It is clear from this that *Chlorogomphus* can no longer stand as a distinct genus. As regards the sub-family Chlorogomphinae, in the light we now possess of two species of larvae, it is clear that the two known genera belong to the family Cordulegasteridae, or at the most cannot be considered of greater value than a group within the family.

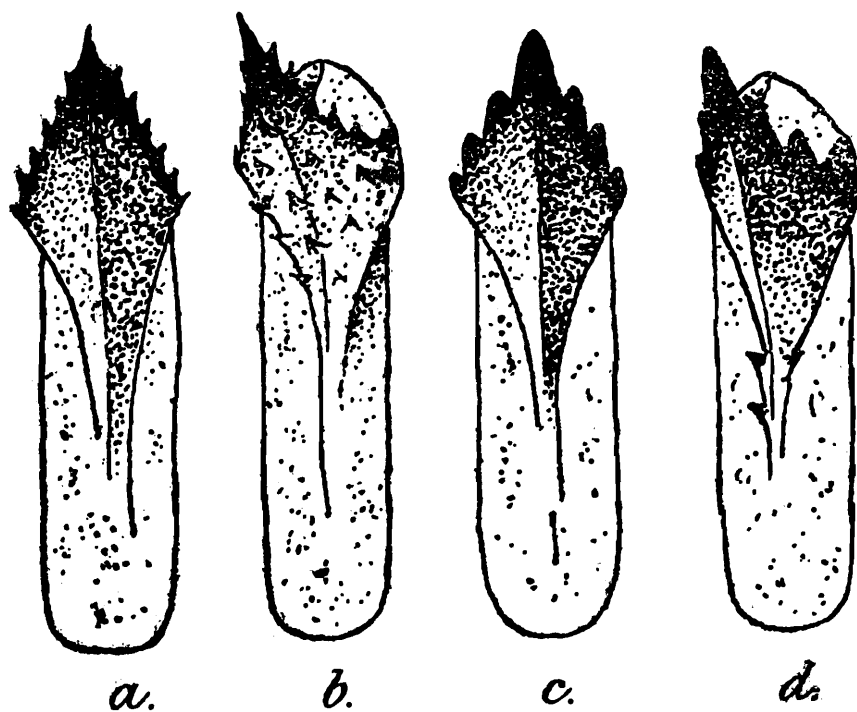
The description of the exuvia of *O. atkinsoni* has already been published (*Mem. Pusa*, l. c.), and it only remains to add a note on its larva.

Larva of *Orogomphus atkinsoni* Selys.

Bright yellow ochre in colour, the face and fore part of head clouded with blackish brown. Structure similar to that already described for the exuvia. Wing cases rather widely divaricate.

Dental folds of gizzard typically Cordulegasterine in shape. Four folds, of which two are anterior and two posterior. Each fold ending

in a very robust dark brown tooth sharply pointed at its apex and presenting six acutely pointed teeth along each foreborder. In



TEXT-FIG. 1.

a and *b*. Posterior and anterior gizzard folds of *Orogomphus atkinsoni* Selys. The posterior tooth is naked, the anterior beset with scattered spines.

c and *d*. The same of *Orogomphus campioni* Fras. The anterior tooth bears three basal spines.

addition, the two anterior teeth have the hinder surface coated with twelve to thirteen spines of various sizes (text-figure 1, *a* and *b*).

Larva of *Orogomphus campioni* Fras.

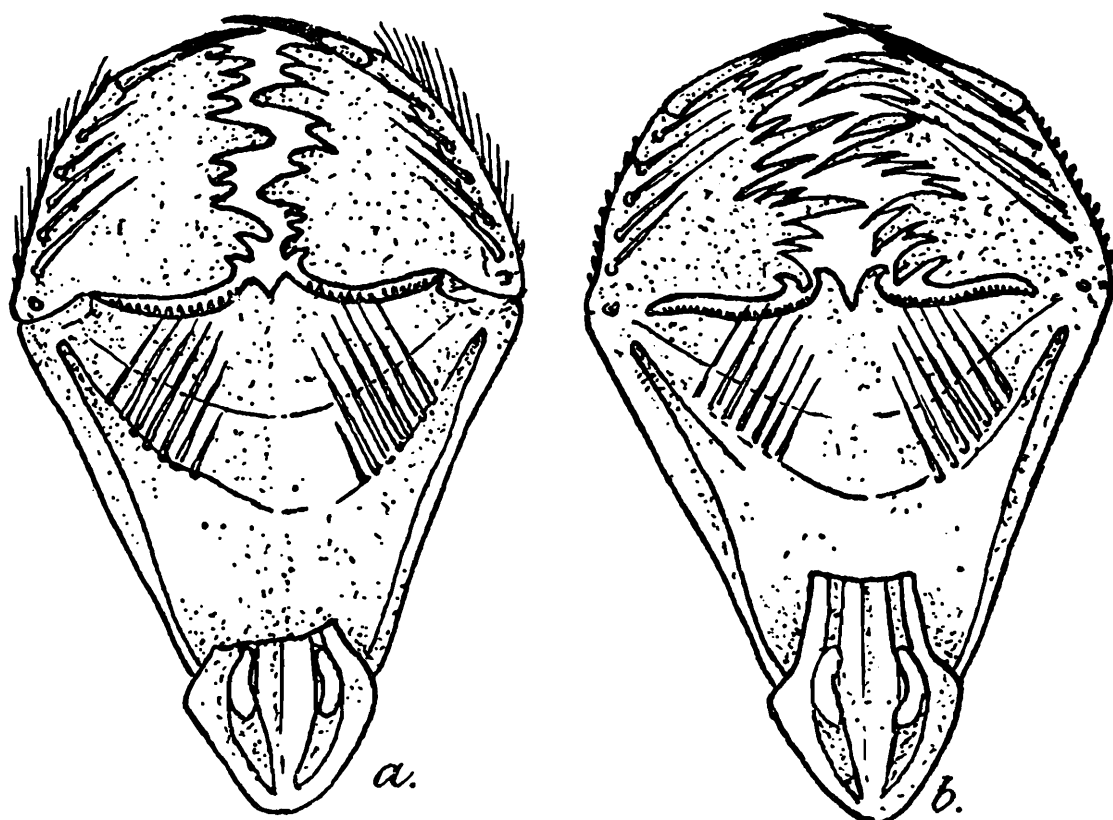
(Plate X, figs. 2, 2*a* and 3).

Total length ♂ 33 mm., ♀ 35 mm., abdomen 24-26 mm., hind femur 7 mm. General colouring ochreous, dorsum of head and thorax rust red, face and mask blackish brown.

Form of head, thorax and abdomen exactly similar to those of *atkinsoni*. The mask with two or three more teeth than in the latter species and with seven setae on the body of mask instead of five (text-figure 2, *b*).

Dental folds of gizzard typically Cordulegasterine, four in number and differing from those of *atkinsoni* in the following particulars; the teeth are smaller, the apices are bluntly pointed, the secondary teeth along the free borders very robust, bluntly pointed and only three in number. Each of the two anterior teeth presents three robust spines at its base in place of the more numerous, smaller scattered spines seen in *atkinsoni* (text-figure 1, *c* and *d*).

The hindlegs are more robust than is suggested in the figure illustrating the exuvia in the Memoirs quoted. Vulvar scale in both species cleft into two minute triangular tubercles (plate X, 2a).



TEXT-FIG. 2.

a. Mask of *Anotogaster nipalensis* Selys, inner aspect.
b. The same of *Orogomphus campioni* Fras.

Exuvia of *Anotogaster nipalensis* Selys.

(Plate X, figs. 1 and 1a.)

Dimensions of male slightly smaller than the female, of the latter :— Total length 52 mm., abdomen 32 mm., width of head 10 mm., width of abdomen at segment 5, 8.5 mm.; hind femur 5.5 mm. in length. (Total length of male 45 mm.)

Body very elongate and cylindrical, abdomen tapering gradually to a point. Head flattened above, wide and markedly squared laterally where the eyes form prominent antero-lateral corners. Frons produced into a squarish flattened plaque similar to that found in *C. annulatus* and *Orogomphus*, this plaque furnished anteriorly with a fringe of coarse thick vibrissae. Antennae 9-jointed. Wing-cases widely divaricate, overlapping the 4th abdominal segment. Legs comparatively stout and short, probably formed for burrowing as in *Orogomphus*, the hind femora the most robust.

Mask very similar to that of *Cordulegaster annulatus* or *Orogomphus*, but the teeth of lateral lobes fewer, shorter and decidedly more obtuse than in the latter. Five setae on the lateral lobes, six to seven on body of mask, these latter unequal in length (text-figure 2, a).

The ovipositor sheath highly developed and projecting, extending from the base of the 8th sternite for the whole length of the 9th, triangular, with a median suture (plate X, fig. 1a).

Two females and one male exuvia found clinging to trees alongside a stream at Shillong, Assam, 12. V. 24. A large number of exuvia of *Orogomphus atkinsoni* were found clinging to rocks in this same stream on the same date.

The projecting frons of the imago, common to all species belonging to the family Cordulegasteridae, and which has been regarded as an archaic structure, appears to be merely an expression of the same organ found in the larva and, as has been shown above, is used by the larva for purposes of ploughing its way through sand and mud in search of food.

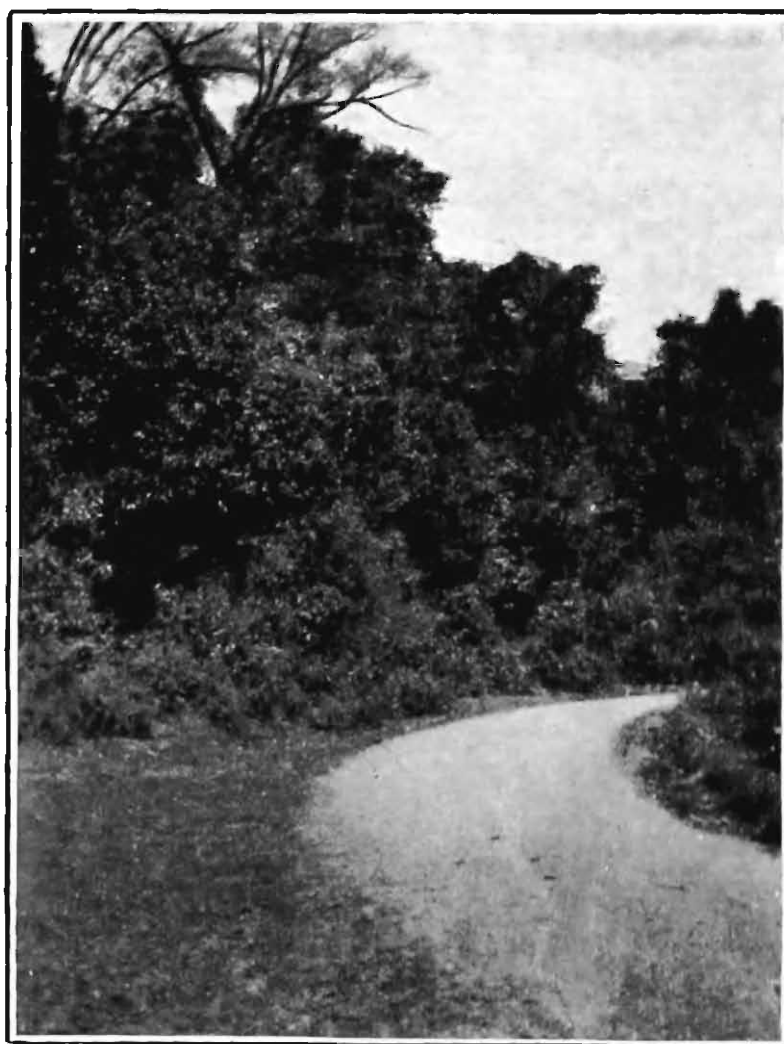
EXPLANATION OF PLATE IX.

FIG. 1.—The Sampaji river near its source, a little below where the larvae of *Orogomphus campioni* were found. At this spot, the following dragonflies were taken :—*Gomphidia kodaguensis* and *fletcheri*, *Burmagomphus pyramidalis*, *Gomphus nilgiricus*, *Acrogomphus fraseri*, *Macromia indica*, *Neurobasis chinensis*, *Pseudophaea dispar* and *fraseri*, *Lamellogomphus acinaces* and *nilgiriensis*, and *Melanoneura bilineata*.

FIG. 2.—The Mangalore Ghat road at the spot where the Sampaji river rises in the heavy jungle on the left of picture. It was here that the larvae of *Orogomphus campioni* were found. The adult insect is often seen patrolling this road or more often soaring high above the trees in the background of the picture or resting on the bare twigs of the tree in the nearer foreground. Other dragonflies seen at this spot are :—*Acrogomphus fraseri* and *Idionyx saffronata*, more rarely *Vestinus apicalis* and *Cratilla calverti*.



1.



EXPLANATION OF PLATE X.

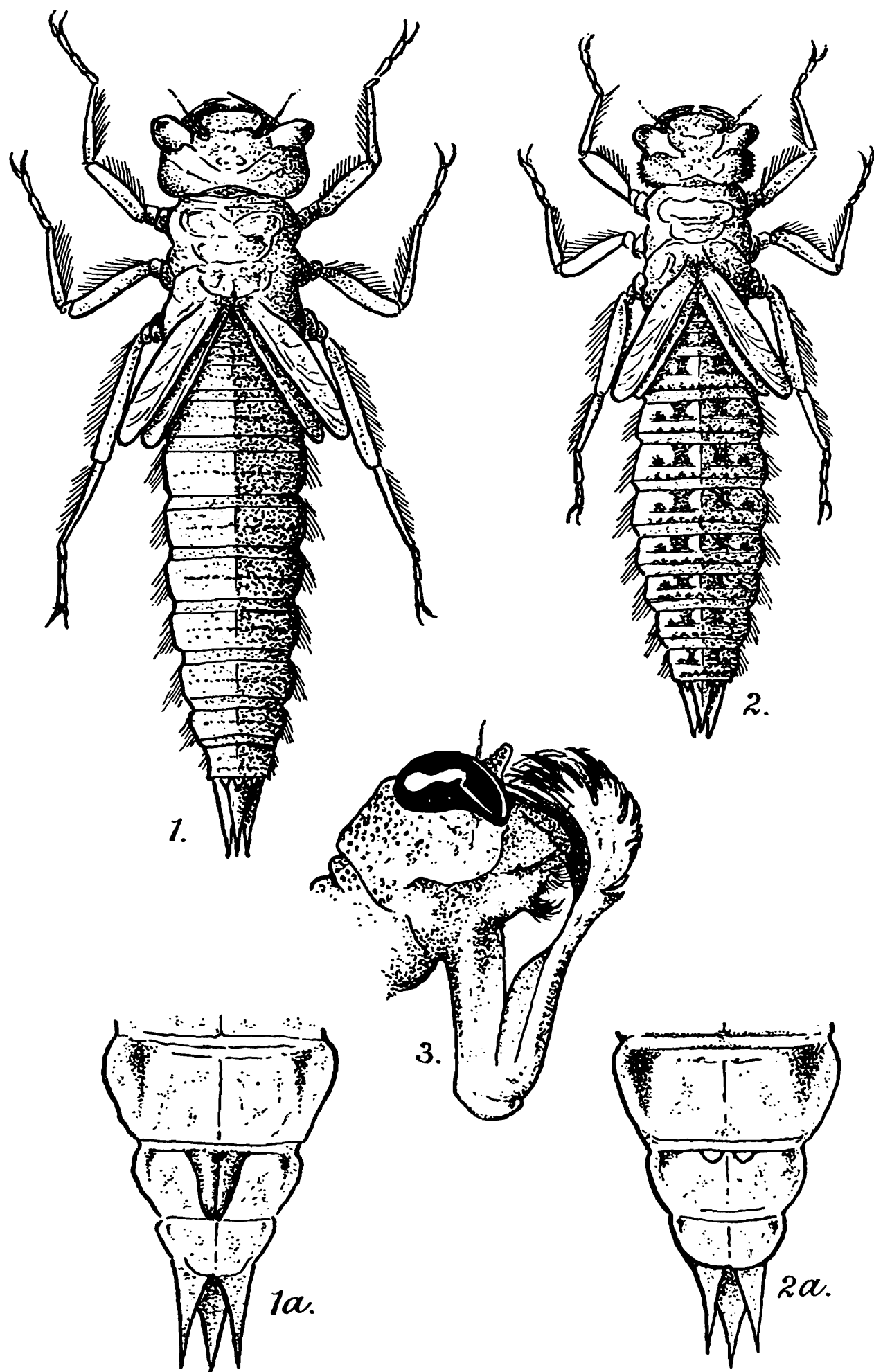
FIG 1.— Larva of *Anotogaster nipalensis* Selys.

FIG. 1*a*.—Ventral aspect of abdomen seen from beneath, exhibiting the long ovipositor casing.

FIG. 2.— Larva of *Orogomphus campioni* Fras.

FIG. 2*a*.—Ventral aspect of abdomen seen from beneath, exhibiting the rudimentary ovipositor casing.

FIG 3.—Head of *Orogomphus campioni* showing the projecting frons in profile and the mask partially ejected.



TWO NEW CESTODES FROM INDIAN COLUMBIDAE.

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(From the Hookworm Research Laboratory, School of Tropical Medicine,
Calcutta.)

An examination of the intestines of the domestic pigeon and the Red Turtle-Dove (*Oenopopelia tranquebarica* Herm.) revealed the presence of three Davaineid worms.

Domestic pigeons were found to be heavily infected with two species ; one of them is apparently identical with *Cotugnia cuneata* var. *nervosa* Meggitt (5) and the other is an entirely new species of *Raillietina*, sub-genus *Ransomia* Führmann. Both species were invariably found together in every one of the thirty to forty pigeons I examined.

Cotugnia cuneata var. *nervosa* Meggitt, 1924.

My specimens are 32-43 mm. long and in no case did they reach the length of 60 mm. recorded by Meggitt ; the maximum width varied from 2.7-4.5 mm. (Meggitt—3 mm.) ; scolex 0.77-0.79 mm. wide (Meggitt—0.26 mm.) ; rostellum 0.31-0.42 mm. wide (Meggitt—0.12 mm.) ; the cirrus-sac does not reach the longitudinal excretory vessel (Meggitt—cirrus-sac extending immediately internal to or as far as ventral excretory vessel).

They resemble *C. cuneata* var. *nervosa* Meggitt (5) in the number, arrangement, and size of rostellar hooks, in the musculature of the body, in all the proglottids being broader than long, and in the arrangement of the testes and the egg-capsules.

I do not consider that the differences mentioned above are of sufficient value to justify the creation of a new species and, therefore, I consider that my specimens are specifically identical with those described by Meggitt (5).

Raillietina (*Ransomia*) *nagpurensis*, sp. nov.

The worm is 250-274 mm. in length with a maximum width of 1.9 mm. at the posterior extremity of the gravid segments. The strobilus consists of approximately 465-530 segments, all of which are broader than long. Proglottids with mature genital organs are 352-396 μ long and 968 μ -1.7 mm. wide. The gravid segments are 704-880 μ long and 1.34-1.9 mm. wide.

The scolex (fig. 1) is more or less rounded, 339 μ -382 μ in width. The rostellum is 216-241 μ in maximum width and in all the specimens I had was retracted ; it is not possible, therefore, to state its length. It is armed with a double row of hammer-shaped hooks, approximately 220 in number. The hooks are of two sizes, 19 μ and 17 μ long, the larger

ones being set at a higher level and alternating with the shorter ones. The suckers are oval in shape, 142μ by 114μ , and armed with a single row of hooks at the margins; the length of the acetabular hooks is approximately 7μ .

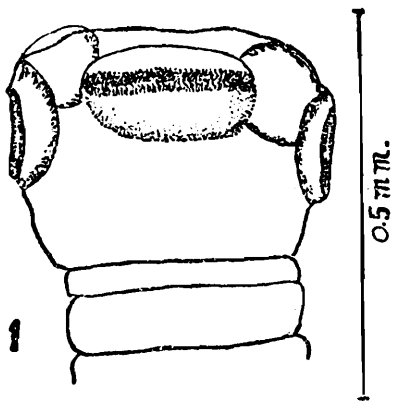


FIG. 1.—*Raillietina (Ransomia) nagpurensis*, sp. nov.
Scolex $\times 37$.

There is no neck, segmentation commencing immediately behind the scolex a short distance behind the level of the suckers.

The genital apertures are unilateral and are situated near the middle of the lateral margin of the proglottid; the position, however, varies slightly, being sometimes more anterior. There is a well-developed genital atrium.

The testes (fig. 2, *t.*), 19-22 in number, are all situated within the medullary region. They are lateral and posterior to the ovary: mostly aporal, two between the ovary and the vitelline gland and only two or three poral. The size of a well-developed testis is 78μ by 72μ . The

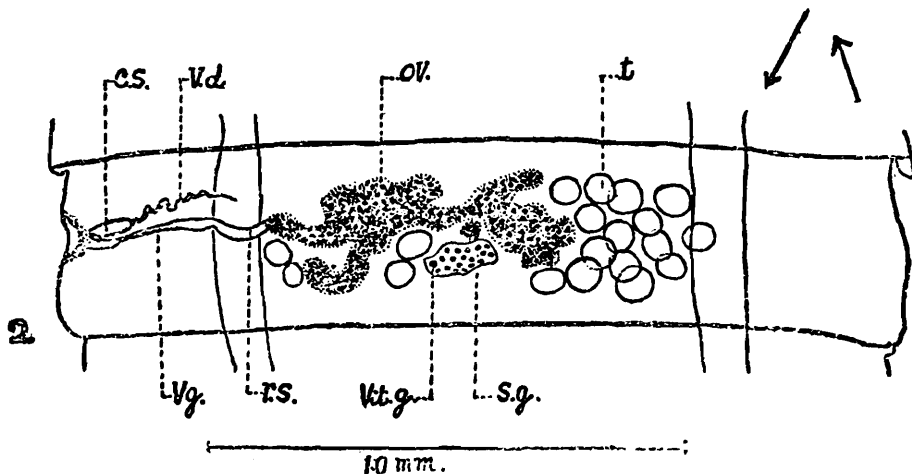


FIG. 2.—*Raillietina (Ransomia) nagpurensis*, sp. nov. A mature segment $\times 75$.

c.s., cirrus-sac; ov., ovary; r.s., receptaculum seminis; s.g., shell-gland;
t., testes; v.d., vas deferens; vit. g., vitelline gland; v.g., vagina.

vas deferens (*v.d.*) is a small coiled tube. The cirrus-sac does not reach the longitudinal excretory vessel and is 90μ long and 30μ wide. It persists through the majority of the gravid segments, where it is longer and wider, being 111μ by $39-42\mu$.

The ovary (fig. 2, *ov.*) is a large irregularly lobed structure; its maximum transverse width is 645μ and it is situated slightly towards the poral side. The vagina (*vg.*) opens posteriorly to the cirrus-sac in the genital atrium and at the level of the longitudinal excretory vessel enlarges slightly into a receptaculum seminis (*r.s.*), which first curves downwards and then upwards. It is 190μ long and 28μ wide. The vitelline gland (*vit. g.*) is situated centrally in the segment posterior to the ovary and is of irregular shape, being approximately 200μ in transverse diameter. The shell-gland (*s.g.*) lies in the angular space between the ovary and the vitelline gland.

The egg-capsules (fig. 3) fill nearly the whole of the medullary space except a narrow strip at the anterior and posterior extremities of the

proglottid. They extend slightly beyond the wide longitudinal excretory vessels, being situated ventral to them. There are usually 50-75

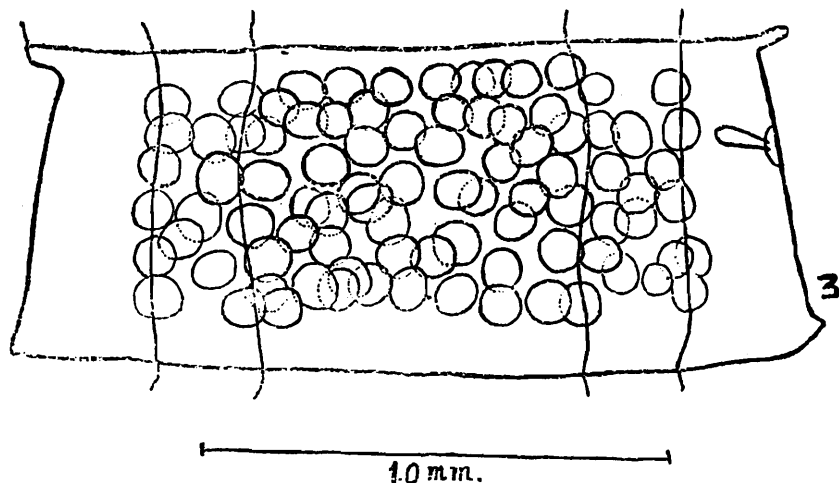


FIG. 3.—*Raillietina (Ransomia) nagpurensis*, sp. nov. A gravid segment $\times 75$.

and rarely 94 egg-capsules in each gravid segment. In specimens mounted in balsam, they are in different states of contraction and are approximately $100\text{-}119\mu$ by $87\text{-}100\mu$ (fig. 4). They usually contain 5-6 eggs, rarely 3-8. Eggs (in balsam) measure about 50μ by 43μ and the contained embryo (in balsam) approximately 17μ by 14μ .

The specific characterisation of this species is as follows :—

Length 250-274 mm., maximum width 1.9 mm.; all proglottids broader than long; width of scolex $339\text{-}382\mu$; rostellum $216\text{-}241\mu$ wide, armed with approximately 220 hooks in two rows 19μ and 17μ long, alternating; suckers 142μ by 114μ , armed with a single row of hooks 7μ long. Testes 19-22, mostly aporal, 78μ by 72μ ; cirrus-sac 90μ long and 30μ wide, not reaching the longitudinal excretory vessel. Ovary large, 645μ in transverse width; receptaculum seminis 190μ long and 28μ wide. Eggs (in balsam) approximately 50μ by 43μ ; onchosphere (in balsam) approximately 17μ by 14μ .

Habitat: Intestine of domestic pigeon; locality: Nagpur, C. P., India.

***Raillietina (Ransomia) quadritesticulata*, sp. nov.**

I examined the intestines of two individuals of the Red Turtle-Dove (*Oenopopelia tranquebarica* Herm.) both of which contained this worm, five specimens being obtained from one bird and two from another. Some of the worms were flattened between glass slides and fixed in Mann's Fluid. The measurements of the entire worm and of the proglottids relate to the unflattened specimens, whereas the measurements of the organs were made on flattened specimens.

Length 62-137 mm.; maximum width 924μ -1.23 mm. at the posterior border of the gravid segments. All the proglottids are broader

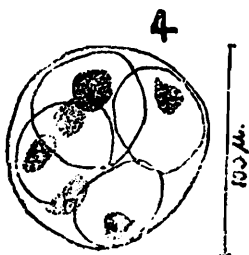


FIG. 4.—*Raillietina (Ransomia) nagpurensis*, sp. nov. A single egg-capsule (size approximately $\times 200$).

than long. Those containing mature genitalia are $352\text{--}505\mu$ long and $528\text{--}880\mu$ wide. Gravid segments are $880\text{--}906\mu$ long and $924\mu\text{--}1.23\text{ mm.}$ wide. The last twenty-five segments, all of which are gravid, are easily detachable.

The scolex (fig. 5) is bluntly rounded and has a maximum width of 165μ at the level of the hooks on the retracted rostellum. The rostellum is 96μ wide and is armed with a double row of very small alternat-

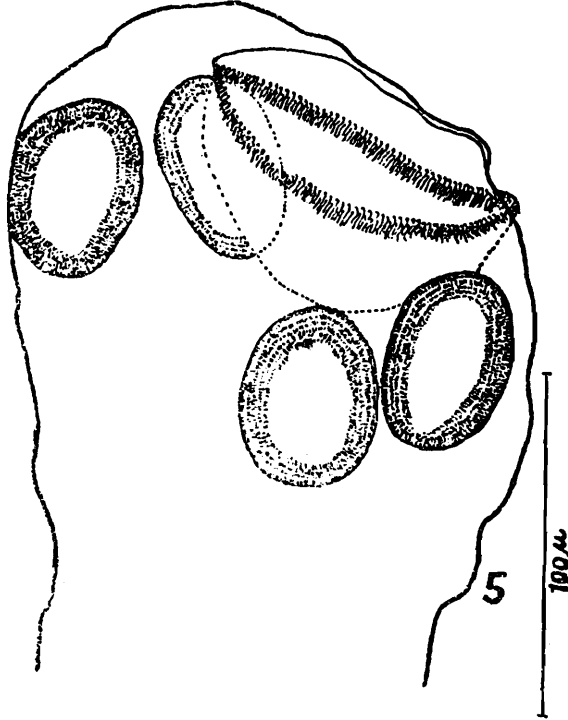


FIG. 5.—*Raillietina* (*Ransomia*) *quadritesticulata*, sp. nov. Scolex (from unflattened specimen) $\times 32$.

ing hooks, approximately 180 in number; the hooks of both rows are of the same size, about 6μ long. The suckers measure $52\text{--}54\mu$ by $35\text{--}40\mu$ and are armed with approximately 5 rows of hooks.

The unsegmented neck region, approximately 1 mm. in length, is not sharply demarcated from the scolex. There are approximately 188–196 segments. In one specimen with 196 segments, the first 24 recognisable segments contain no genital organs. The cirrus-sac appears first and after the 59th segment all the genital organs are clearly visible, though they attain their maximum development between the 90th and 118th segment. Segments from 147 to 196 are full of egg-capsules.

The genital apertures are unilateral and are situated in the middle of the lateral margin of the proglottid. There is a well developed genital atrium.

There are only four testes (fig. 6, *t.*): one posterior to the vitelline gland and three lateral to the ovary on its aporal side. The diameter of the testes is $68\text{--}75\mu$ by $75\text{--}77\mu$. The vas deferens (*v.d.*) is a loosely coiled tube. The cirrus-sac (*c.s.*) is muscular and conical, 138μ in length and 68μ in width. It does not reach the longitudinal excretory vessel and persists through all the gravid segments except the last eight.

The vagina (fig. 6, *vg.*) opens into the genital atrium posterior to the cirrus-sac and runs ventral to the excretory vessel. Between the large

excretory vessel and the poral side of the ovary it enlarges into an elongate receptaculum seminis (*r.s.*), 108μ long and 32μ wide. The lobu-

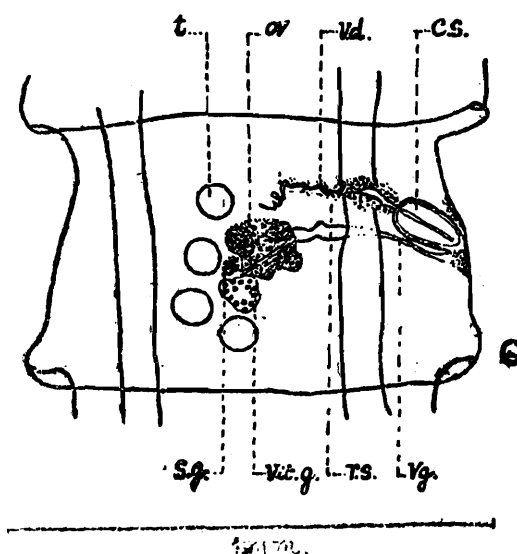


FIG. 6.—*Raillietina (Ransomia) quadritesticulata*, sp. nov. A mature segment (from a flattened specimen) $\times 47$.

c.s., cirrus-sac; *ov.*, ovary; *r.s.*, receptaculum seminis; *s.g.*, shell-gland; *t.*, testes; *v.d.*, vas deferens; *vit. g.*, vitelline gland; *v.g.*, vagina.

lated ovary (*ov.*) is situated near the centre of the proglottid and measures 138 – 176μ in transverse diameter. The vitelline gland (*vit. g.*) is situated

posterior to the aporal portion of the ovary. The shell-gland (*s.g.*) is lateral to the ovary on its aporal side and anterior to the vitelline gland.

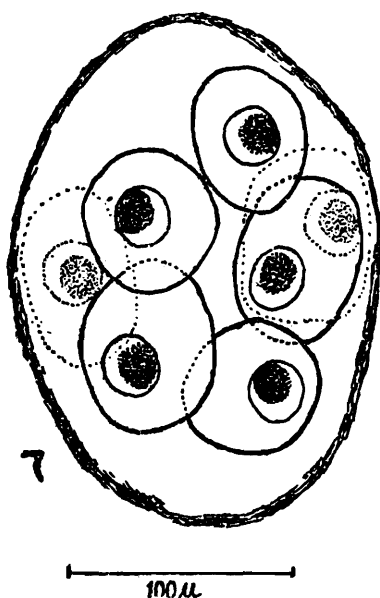


FIG. 7.—*Raillietina (Ransomia) quadritesticulata*, sp. nov. A single egg-capsule (from a flattened specimen). Size approximately $\times 200$.

There are forty to fifty egg-capsules in each segment, confined to the medullary region and not extending beyond the longitudinal excretory vessels. In specimens mounted in balsam, owing perhaps to the different state of contraction, all the egg-capsules are not of the same size; a fairly large-sized egg-capsule measures 228μ by 164μ . Each egg-capsule (fig. 7) contains 6 to 8 eggs, which measure, on an average (in balsam), 67μ by 54μ . The contained embryo (in balsam) measures approximately 18μ by 16μ and its outer envelope approximately 25 – 27μ by 23 – 25μ .

The specific characterisation of this species is as follows:—

Length 62 – 132 mm., maximum width 924μ – 1.23 mm.; all proglottids broader than long; width of scolex 165μ ; rostellum 96μ wide, armed with a double row of small alternating hooks 6μ long; suckers 52 – 54μ by 35 – 40μ , armed with approximately five rows of hooks. Testes four, posterior to the vitelline gland and lateral to the ovary on its aporal side, 67 – 75μ by 75 – 77μ ; cirrus-sac not reaching the longitudinal excretory vessel, 138μ

long and 68μ wide. Ovary lobulated, receptaculum seminis 108μ by 32μ . Egg-capsules not extending beyond the excretory vessels, 40-50 in each segment, approximately 228μ by 164μ , each containing six to eight eggs, approximately (in balsam) 67μ by 54μ , embryo (in balsam) approximately 18μ by 16μ .

Habitat :—Intestine of *Oenopopelia tranquebarica* Herm.; locality : Nagpur, C. P., India.

The possession of hammer-shaped hooks on the rostellum, a single set of reproductive organs in each segment and the presence of egg-capsules place both these worms in the genus *Raillietina* Führrmann, 1920, and the fact that the egg-capsules contain several eggs and that the genital pores are unilateral, in the sub-genus *Ransomia* Führrmann, 1920. The hosts of both these worms belong to the family Columbidae. A complete list of cestodes occurring in birds of this family has recently been recorded by Joyeux (2) and also by Meggitt (5).

R. nagpurensis, sp. nov. is readily distinguished from *Ransomia goura* Führr. (1), *R. paucitesticulata* Führr. and *R. micracantha* Führr. by the fact that the suckers are unarmed; *R. cryptacantha* Führr. is included by Meggitt (4) in the category of species having unarmed suckers, but according to Joyeux's key (2) the suckers are armed. This species, however, can be distinguished by the smaller size of the rostellar hooks (7μ) and the smaller number of testes (8-12) (Führrmann, 1, p. 105).

Comparing the present species with other species of *Ransomia* recorded from Columbidae, it can readily be distinguished from *R. spiralis* Bacz., 1914, *R. clerici* Führr., 1920 (= *crassula* Clerc, 1906, nec Rud.), *R. gendrei* Joyeux, 1923, and *R. fuhrmanni* Southwell, 1922 by the size of the rostellar hooks; from *R. spiralis* Bacz., *R. clerici* Führr., *R. weissii* Joyeux, 1923, *R. senaariensis* Weithofer, 1916, and *R. fuhrmanni* Southwell by the number of testes.

With reference to the key to the species of *Raillietina* given by Meggitt (4), in which the sub-genera are not recognised, my species falls in the group including *D. friedbergi* v. Linstow, *D. multicapsulata* Führrmann, *D. cyrtus* Skrj., *D. ceylonica* Bacz., and *D. tetragona* (Molin). Of these species *D. cyrtus*, *D. ceylonica*, and *D. tetragona* are distinguished by the smaller size of their rostellar hooks, *D. multicapsulata* by the absence of a receptaculum seminis, and *D. friedbergi* by the number of eggs in the capsules.

Three other species, *D. allomyodes* Kotlán, 1921, *D. causurii* Kotlán, 1923, and *D. infrequens* Kotlán, 1923 described since the publication of Meggitt's key (4), are distinguished as follows: *D. allomyodes* by the smaller number of rostellar hooks and smaller number of egg-capsules (Southwell, 6, p. 142), *D. causurii* by the larger size of the rostellar hooks ($48-54\mu$ long) and larger number of testes (50-60), and *D. infrequens* by larger rostellar hooks ($27-34\mu$ long) and smaller number of testes (9-12) (Kotlán, 3, p. 49).

R. quadritesticulata, sp. nov. differs widely from all other species of *Raillietina* in the number of testes, excepting *D. oligorchidna* Führr., *R. spiralis* Bacz., and *R. micracantha* Führr. 1909, in which the number

of testes is 5-6, 6-7 and 6-7 respectively, but the uniform presence of four testes is sufficient to distinguish it from these. Furthermore, *R. micracantha* Führ. has unarmed suckers and *D. spiralis* Bacz. has much larger rostellar hooks. The description of *D. olichorchidna* is not accessible to me.

Type slides of both these species have been deposited in the collections of the Zoological Survey of India, Indian Museum, Calcutta.

In conclusion I desire to express my gratitude to Dr. Asa C. Chandler, in-charge Hookworm Research Laboratory, for very valuable guidance.

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SOME ASIATIC SPECIMENS OF *APUS*.

By ROBERT GURNEY.

The records of the occurrence of the genus *Apus* in Asia are few and were summarised by Kemp in 1911.¹ I think it therefore worth while to publish the following notes on a small collection of *Apus* kindly submitted to me by Dr. Baini Prashad from the collection of the Indian Museum. They belong to three species.

Apus cancriformis Schäffer.

The collection includes two small immature specimens taken in Kashmir (27-10-13) by Mr. F. Smith and 28 adult or nearly adult specimens from paddy fields about 8 miles from Gandarbar, Kashmir (Kashmir Survey St. 10-25-6-21).

TABLE 1.

Apus cancriformis Schäffer, Kashmir, 25-6-21.

	Length of shield.	Width.	Total length.	Furcal rami.	Somites exposed.	Legless somites.	Denticles on sul- cus.	Total number of somites.
Female	10.5 mm.	8	..	broken	14	7	38	36
Do.	17	12	..	17	15	7	34	..
Do.	18	11	..	18	16	7	36	..
Do.	13	8	17	..	15	7	36	..
Do.	12	10	18	18	16	7	36	..

These adults are relatively small and agree in all respects with the European type. All are females and there is remarkably little variation among them. Table 1 gives the measurements of five specimens but the following notes may be added. The median ridge of the shield ends in a strong projecting tooth, and in all cases is more or less serrated posteriorly. In some cases there are 5-8 quite conspicuous tooth-like projections similar to those found in Scottish examples.² The whole, or the posterior half, of the surface of the shield is covered with minute points which are easily seen if the animal is more or less dried.

The arrangement of the spines on the telson is surprisingly regular, having regard to the variability found in European and North African

¹ *Rec. Ind. Mus.* VI, p. 356 (1911).

² Gurney, *Ann. Mag. Nat. Hist.* (9) XI, p. 498 (1923).

specimens. In all cases there is a single posterior median spine, a spine on either side of the anal sulcus and a few very small spinules in the middle line. Not more than two spines are visible dorsally at the base of the furcal rami.

Kemp (1911) has already recorded the occurrence of *A. cancriformis* in Kashmir and at Bulandshahr in the plains, and has expressed the opinion that *A. himalayanus* Packard is not distinct from it. With this opinion I fully agree.

It appears that *A. cancriformis* is a species of extremely wide range having local varieties which have led to the naming of distinct but untenable species. Its distribution has been fully set out by Lundblad,¹ but the following localities may now be added :—Italy (Pavia, Vercelli, Novara, Pontedera, Lecce). Cyrenaica. Morocco. Eritrea (Colosi 1923). Asia Minor (Spandl 1923).

***Apus asiaticus* Gurney.**

The specimens come from the same locality, though taken on a later occasion, as those which I have already discussed,² namely Panchgani, Bombay Presidency. The original specimens reached me in a damaged condition and this new consignment enable a few additional points to be noted.

These specimens are rather small, but are mature, and the males, which outnumber the females, are readily separable. In the female the colour is deep green while the males are paler in colour and tend towards a brown tinge. Whereas the shield of the female is as vaulted as it is in *A. cancriformis*, in the male it is much flattened. The longest flagellum of the first leg is much shorter than the shield in the female, but may reach very nearly to the end of it in the male. On the other hand the furcal rami, which show no sexual difference in the form of the spines, are longer in the male than in the female. In these specimens the number of legless somites (including telson) is 11-13 in the female and 13-14 in the male. The majority of females examined had 12 which is one more than I found in the original collection.

***Apus granarius* Lucas.**

Simon, *Ann. Soc. Entom. France* (6) VI, p. 446 (1886).

Three specimens labelled "Peking, China, 4-10-16" are somewhat puzzling. All three have been at one time dried up, consequently reliable measurements are impossible, but they are otherwise well preserved and the flagella unbroken.

Their characters may be summed up as follows :—Shield orbicular, flattened, less than half total length of body. Median ridge not projecting into sulcus. Denticles on sulcus about 50, very minute, but becoming larger towards the outer angle. Posterior ventral edge of shield denticulate.

¹ *Arkiv. f. Zoologi*, 13 (1920).

² *Ann. Mag. Nat. Hist.* (9) XIV, p. 566 (1924).

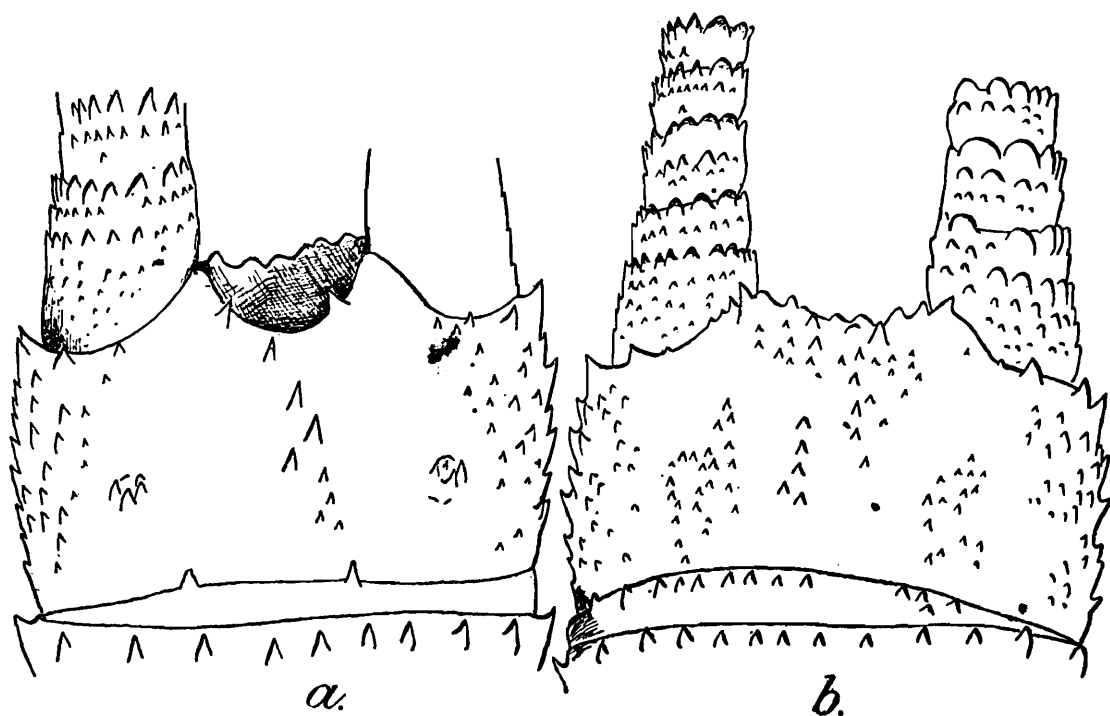
TABLE 2.

Apus granarius Lucas, Peking.

	Length of shield.	Total length.	Furcal rami.	Longest flagellum of first leg.	Somites exposed.	Legless somites.	Denticles on sulcus.
Male	13 mm.	24	18	..	21	12	46
Female	15	25	23	..	19	10	56

Abdominal somites with about 10 rather small spines visible dorsally; ventrally with a few scattered denticles in addition to the ring of larger spines.

Telson as shown in figure.



Apus granarius Lucas. Male.
Telson. a. Dorsal view. b. Ventral view.

Furcal rami longer in female than in male and with blunt spines or knobs in the latter in place of the slender spinules present in the female.

Longest flagellum of first leg reaching in both sexes far beyond the shield to about half the length of the abdomen.

Though there is a distinct resemblance to *A. asiaticus* that species is definitely excluded by the length of the flagellum of the first leg and the sexual difference in the furcal rami. There remains the probability that this is the true *A. granarius* Lucas, which was also taken in China.

Lucas' description is very incomplete and the number of legless somites is omitted, but there are certain points in which agreement is exact.

- (1) The length of the flagellum of first leg.
- (2) Telson "fere ut in *A. numidico*."

- (3) The furcal rami “ valde annulati et saltem prope basin obtuse dentati haud setosi.” (Most of Lucas' specimens were males!).
- (4) The sulcus teeth very minute and scarcely visible.

In the measurements of the body there is considerable discrepancy, but my specimens are contracted by drying and the difference cannot therefore be considered. I believe that I am justified in naming these specimens *A. granarius* Lucas.

On the other hand there is only one character in which these specimens differ definitely from *A. numidicus*, namely in the much greater length of the flagellum of first leg ; but it is advisable, provisionally at all events, to maintain *A. granarius* as a distinct species until the group can be satisfactorily revised.