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SYNESTIUS CALIGINUS STEENSTRUP & LUTKEN, A COPEPOD PARASITE OF THE GREY POMFRET

By C. P. GNANAMUTHU, *M.A., D.Sc., F.Z.S., Director, University Zoology Laboratory, Madras.*

The genus *Synestius* with the genotype, *S. caliginus* was established in 1861 by Steenstrup and Lutken on the basis of females found on the gills of grey pomfrets (*Stromateus niger*) from South India. Except for Heller's (1868) record of the species occurring on the gills of *Stromateus argenteus* from the Indian Ocean, there has been no subsequent record or description and the male has remained unknown. The author of the present paper, collected over sixty-five mature females, eight immature females, fifteen mature males and four chalimi from fifteen pomfrets. The male is described here for the first time. A full account of the female (the holotype) is also given in this paper as the sketches and description given by Steenstrup and Lutken are incomplete and out of date.

The author thanks Prof. T. L. Tuxen of Copenhagen University for Steenstrup and Lutken's monograph and Miss H. Dalsgarrd for translating relevant passages.

THE FEMALE.

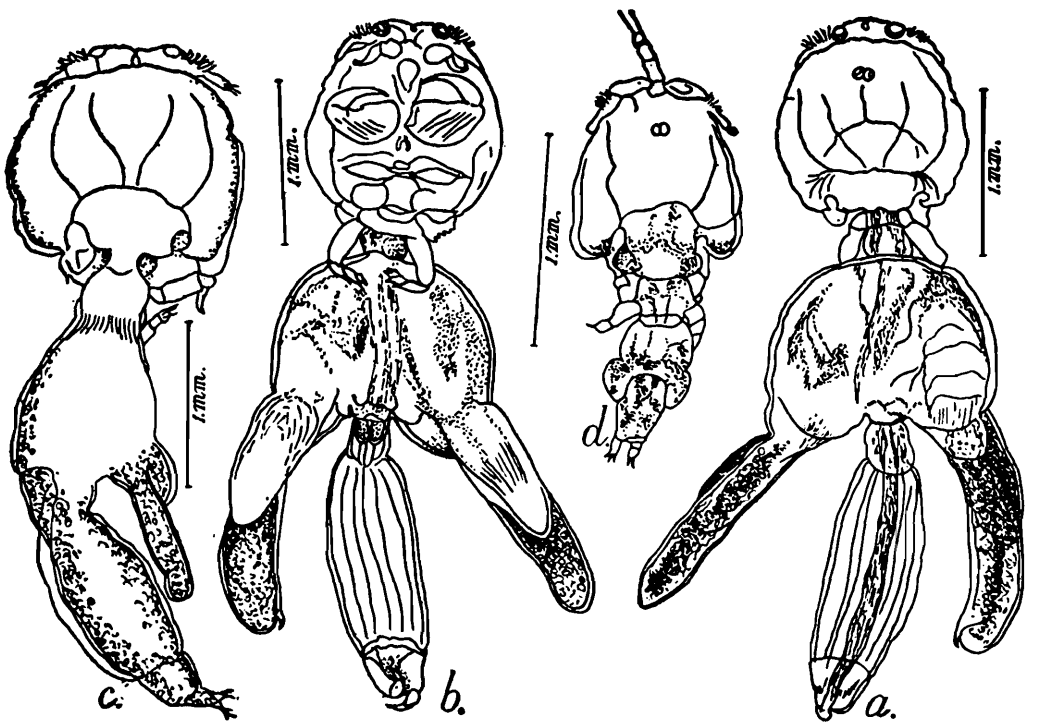
All the parasites were found buried head foremost between the bristles which form a brush-like pad on the roof of the buccal cavity and not one was found on the gills.

Size.—The mature forms were nearly of the same size. Total length of the largest was 4·3 mm.; the cephalothorax 1·2 mm.; the genital segment 1 mm.; the abdomen 1·4 mm.

External appearance.—The general appearance is caligine. The cephalothorax is of a circular form, with the nearly straight hind margin broken by two deep notches, so that the central part forms about a third of the entire breadth. This hind edge of the carapace extends over the fourth segment to some extent and makes the waist appear shorter than in the male when viewed from the dorsal side. The carapace is marked by the caligine pattern of grooves and a double median pinkish eye. The frontal area is delimited by a well-defined transverse groove. The lunules are small, shallow. The cephalothorax is markedly convex above and concave below. The cephalothorax is followed by a waist which is only 0·3 mm. broad. This waist is formed partly by the fourth free segment but mainly by a constricted anterior extension of the broad genital segment. The genital segment proper is 1·4 mm. broad and 1 mm. long. All its sides except the posterior are convex. The two posterior corners are prolonged ventrally to bear two pairs of processes or laminae. Of the two laminae on each side, one is dorsal, cylindrical and long while the other is more ventral, flat, shorter and broader. The broad, flat proximal end of the lamina is so obliquely attached that ventrally the attachment extends more forward.

The abdomen is attached to the dorsal edge of the posterior side of the genital segment. Just ventral to its attachment there are two narrow transverse folds of the skin between which are located the orifices through which the eggs descend into the sacs immediately behind. The vulvae are situated more medially. Two circular spermatophores are usually seen attached to the ventral skin fold close to the vulvae.

The abdomen is cigar-shaped, 1·8 mm. long, being longer than the genital segment. It is two-segmented, the anterior segment is 1·5 mm., and the posterior, 0·3 mm. long. A constriction in the anterior third of the first segment helps to twist the abdomen from its position in a dorsal direction making room for the coils of the stout egg strings. The terminal segment bears two anal laminae. Each lamina is elliptical and carries four plumose spines of which the outer most is shorter than the other three, and the inner second is the longest. The eggs are large, biconvex and circular being 0·22 mm. in diameter and 0·12 mm. in, thickness.



TEXT-FIG. 1.—*Synestius caliginus* Steenstrup and Lutken.

a. Dorsal view of female ; *b.* Ventral view of female ; *c.* Dorsal view of immature female ; *d.* Dorsal view of chalimus female.

The shape and size of the genital segment characteristic of the adult female is attained during maturity as has been noted by the author in other caligines. In the immature form, the genital segment is much narrower in front than behind and the neck-like constriction, so conspicuous in the adult female, is not differentiated and the general outline of the genital segment resembles that of the male more than that of the mature female (the cephalothorax is proportionately much larger than in the adult) and the posterior laminae are much shorter.

Appendages.—The first antenna is two-jointed. The base is stout and bears a dorsal row of about twelve plumose setae and a ventral

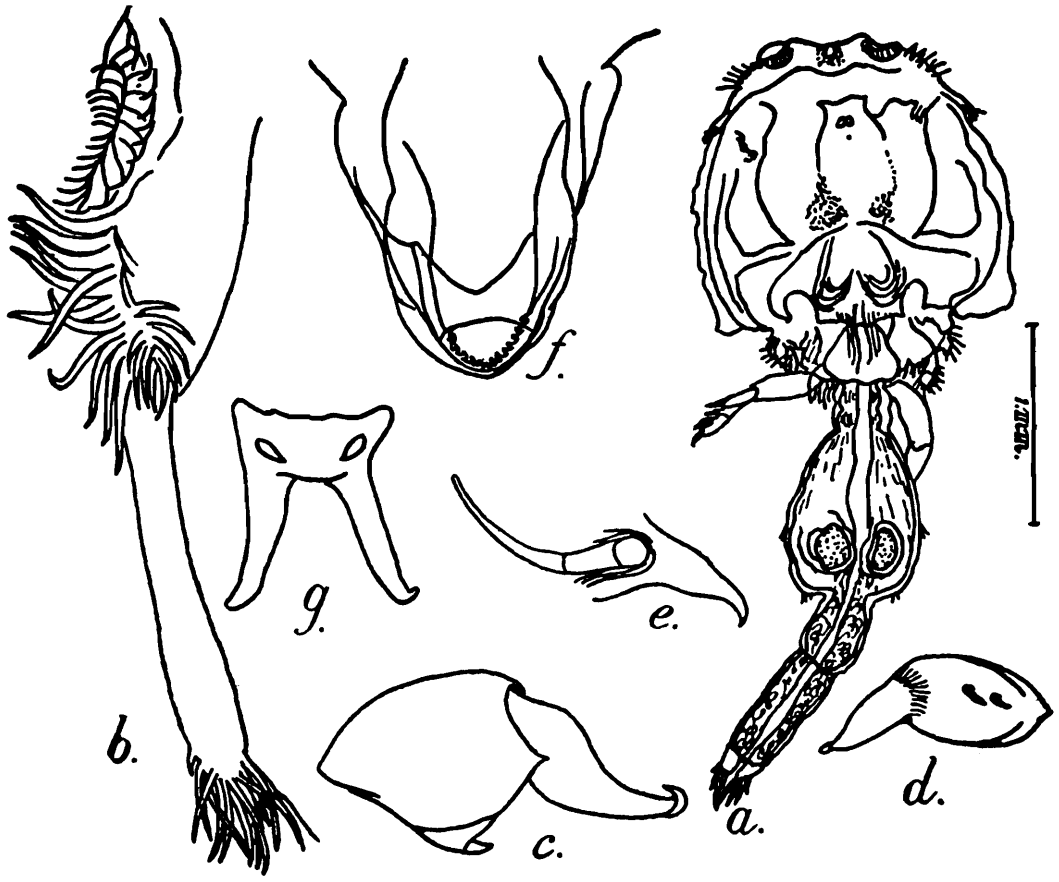
row of as many shorter spiny setae. The lunules are small, shallow. The adhesion appears mainly due to the sucker action of the cephalothorax. The distal segment is more than twice the length of the basal. It is club-shaped and bears twelve spines at the free tip. The second antenna is three-jointed. The proximal joint is long and conical. The second joint is large and stout. A long thick claw forms the distal joint. The mouth tube is broad and conical. Through the anteriorly directed mouth opening, the scythe-shaped, finely-toothed mandibles can be seen. The first maxilla is a simple, short, thick, curved spine situated close to the outer margin of the carapace. On its stout cylindrical base are two aborted setae. The second maxilla is a long sharp spine to the broad base of which is attached a long jointed palp. The first maxillipede is a long, slender, two-jointed appendage. The proximal joint is shorter than the distal which folds like the blade of a pocket-knife and ends in three long claws. The second maxillipede is stout, muscular and two-jointed. The basal joint is large and swollen and bears the distal, long, sharp, curved claw. The furca is of two short, slightly divergent, blunt-tipped rami.

The first leg is uniramous. The protopod is short and bears a jointed spine on the hinder aspect of the distal edge. The exopod is two-jointed. The first joint is long and has its posterior border densely fringed with bristles and bears a short spine on the outer corner of the distal edge. The second joint is of the typical 'hand' form bearing three long spines distally, one on the corner and three plumose setae on the posterior edge. The second leg is biramous. The basipod is two-jointed, consisting of a short base with a plumose seta and a longer, stouter second joint. The exopod is composed of three unequal joints. The first is long and bears a plumose spine. The second is short and bears two plumose spines and a long plumose seta; and the third flattened distal joint bears two spines and six plumose setae. The endopod is three-jointed. The first joint bears a plumose seta on its inner edge and a short curved spine on its distal edge. The second joint bears two plumose setae while the third bears six. The third leg is biramous. The protopod is foliaceous and bears a plumose seta as in all caligines. The exopod is three-jointed. The proximal joint is extremely short and bears a large, stout, curved spine. The second joint is fringed with hairs on its outer edge and bears a large plumose seta on its inner edge; and the distal joint bears three spines on its distal outer corner and four plumose setae on the free margin. The endopod is two-articled. The first is short and bears a plumose seta on its inner side while the larger, flat, circular, distal joint bears six plumose setae. The fourth leg is uniramous. The basipod is long cylindrical and stout and the exopod is three-jointed. The outer distal corners of the first two joints end in sharp curved spines while the distal edge of the last segment bears a very short spine on its inner corner and three longer spines increasing in length from the outer to the inner corner. The fifth and sixth are represented by clusters of four and three spines, seen on the ventral surface of immature forms, with no egg-sacs and long posterior processes to obscure them.

The Male.

Of the fifteen males collected, twelve were taken from nine small pomfrets and only three were from six larger fish. It is probable that both sexes first enter the young fish and that the males disappear when the fish grow larger, leaving the longer-lived females. All the males were found, contiguous to the females.

Size.—The males are 3—3·5 mm. long. In a male 3·5 mm. long, the cephalothorax was 1·4 mm., the free segment 0·3 mm., the genital segment 1 mm. and the abdomen 0·84 mm.



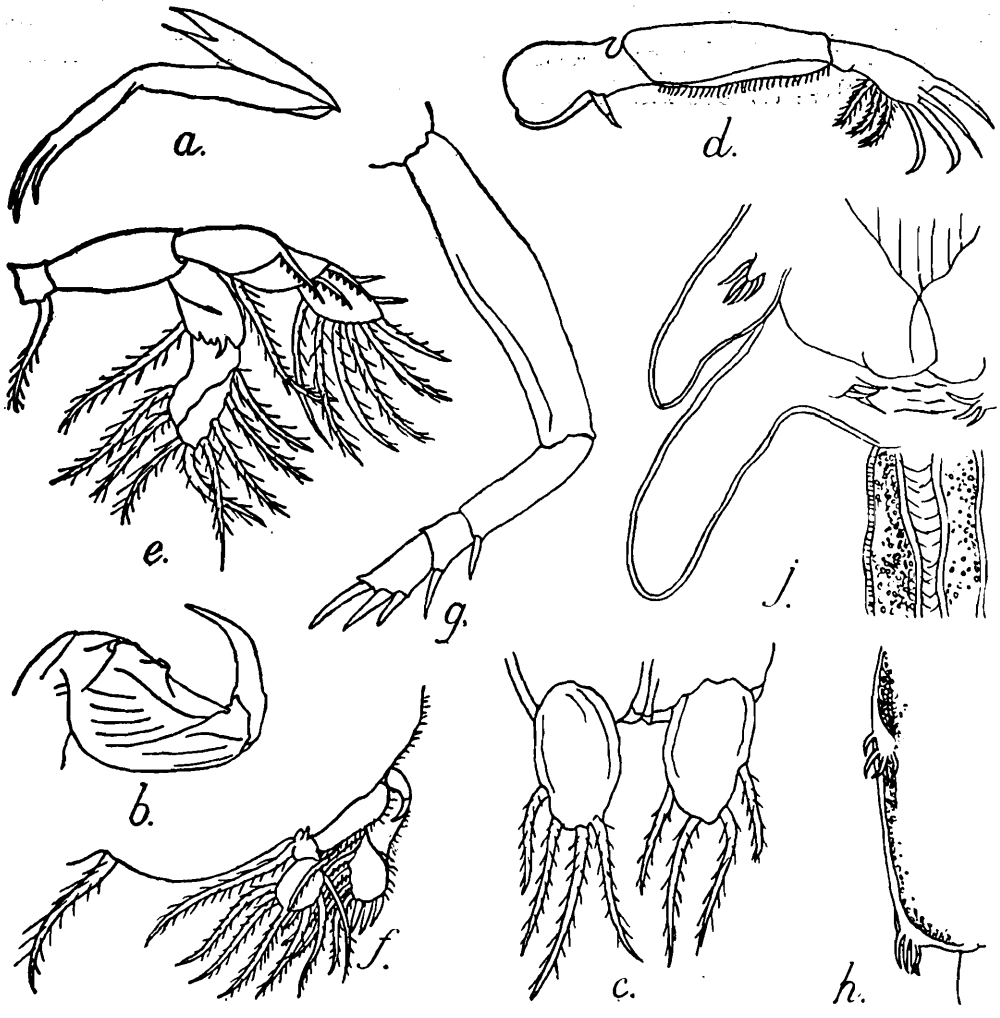
Text-fig. 2.—*Synestius caliginus* Steenstrup and Lutken.

a. Dorsal view of a male; *b.* First antenna in dorsal view; *c.* Second antenna; *d.* First maxilla; *e.* Second maxilla; *f.* Mouth tube; *g.* Furca.

The cephalothorax is nearly circular but has a truncated straight hind border so that the length is slightly less than the breadth (1·5 mm.). The cephalothorax strongly resembles that of the immature female both in its being larger than that of the adult female and in the truncated appearance of the hind margin. The groove marking off the frontal plate, the notches on the hind border, the lunules, the median eye and the markings of the carapace are as in the female. But the posterior margin of the cephalothorax does not extend over the free segment which therefore gives the body the appearance of a longer waist than in the female. The free segment is more clearly defined, rhomboid in form, the front edge being half the breadth of the hind edge. The genital segment is like a flat-bottomed conical flask, the neck being half the width of the base and the two sides convex, the maximum width (0·65 mm.) being about a third of the length from the hind margin. The neck of the genital segment is about a fifth of the length and being

narrower than the free segment, adds to the slender appearance of the male. The abdomen is nearly as long as the genital segment. It is two-segmented as in the female but the first segment is shorter than the second. The anal laminae are as in the female.

Appendages.—Except for the first antennae and the second antennae being larger proportionately, the appendages are exactly alike in both size and structure, the resemblance being obvious even in the number of setae of the first antenna and the swimming feet. The fifth and the sixth legs, however, are noteworthy. At about a third of the length from the hind margin, where the genital segment is broadest is seen a tuft of five long curved bristles, the vestiges of the fifth leg, and further down at the posterior corner of the genital segment is a cluster of four spines representing the sixth leg.



TEXT-FIG. 3.—*Synestius caliginus* Steenstrup and Lutken.

a. First maxillipede; *b.* Second maxillipede; *c.* Anal laminae; *d.* First swimming leg; *e.* Second leg; *j.* Third leg; *g.* Fourth leg; *h.* Vestiges of the fifth and sixth legs; *f.* Vestiges of the fifth and sixth legs of female.

REMARKS.

Apart from the circumstantial evidence of all the males being found close to the females on the same part of the body of the same host fish, the close correspondence of structure between the two sexes and the spermatophores seen within the male being of the same form as those

found deposited on the females show that the males and the females belong to the same species *Synestius caliginus*. The possession of two pairs of laminate processes on the larger swollen genital segment of the female, has been defined as the chief characteristic feature of the genus *Synestius*. In view of the absence of these processes in the male now presented, the generic diagnosis originally given by Steenstrup and Lutken, must be modified to include a statement of the sex difference. The description of the male, given here for the first time, completes the species diagnosis.

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THYSANOTE APPENDICULATA (STEENSTRUP AND LUTKEN), A LERNAEOPODID, SARASITIC ON THE GILLS OF THE GREY POMFRET

By C. P. GNANAMUTHU, *M.A., D.Sc., F.Z.S., Director, University Zoology Laboratory, Madras.*

Steenstrup and Lutken established the species *Brachiella appendiculata* in 1861 on the basis of the males and females they collected from the gills of *Stromateus (paru) niger* from South India. In 1898, Bassett-Smith found these parasites on the same host in Bombay, but not having access to the original account, described the parasites as *Brachiella appendiculosa* sp. n. In 1915, Wilson transferred the species to the new genus *Thysanote*. Kirtisinghe obtained, in 1937, two females alone from *Stromateus fiotola* Bloch in Ceylon. The descriptions given by Steenstrup and Lutken, as well as by Bassett-Smith, are very meagre while Kirtisinghe's account of the female is unsatisfactory and not free from errors. In the present paper a complete account of the male is given for the first time together with a full description of the female.

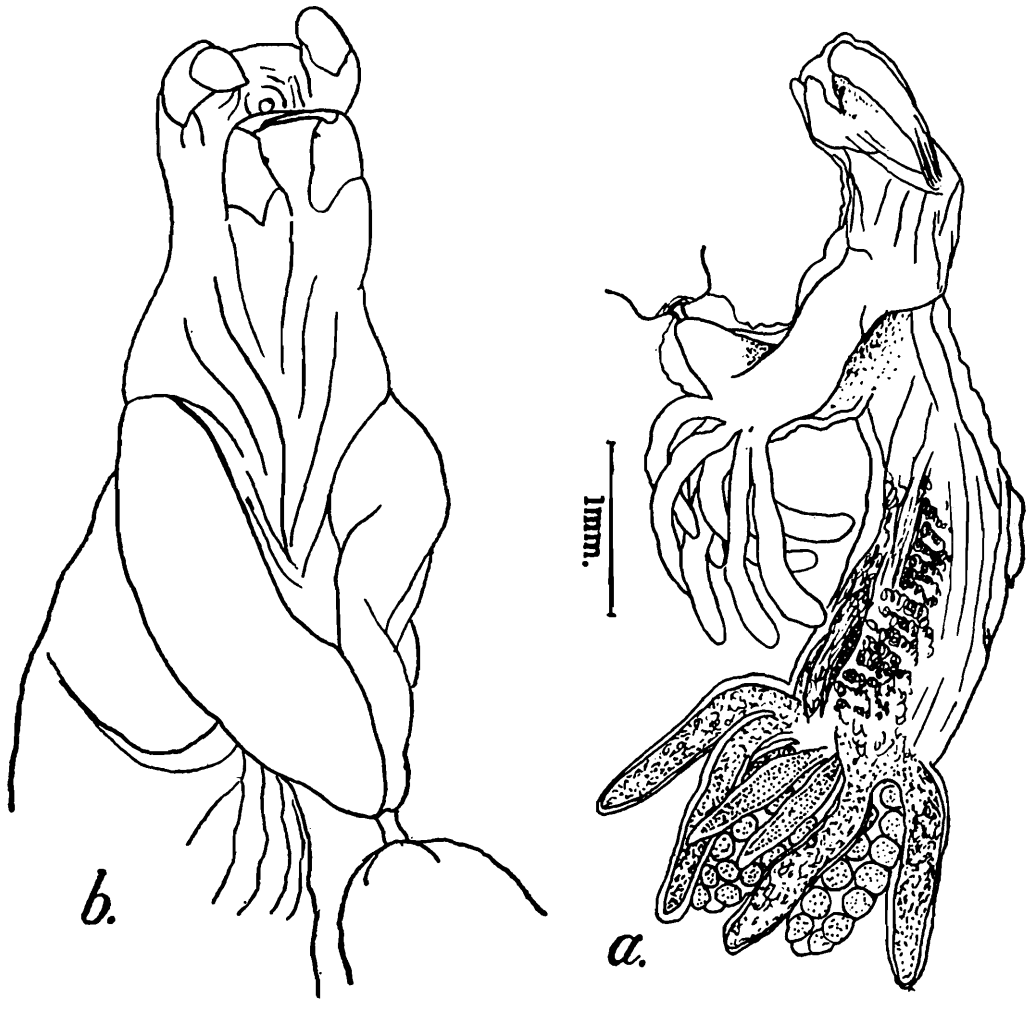
Host and Records.—Eighteen parasites were collected from twenty grey pomfrets (*Strometeus niger*) during August to October. Some of the fishes had two parasites, many had one each while others had none. These parasites were found attached to the gill arches or to the posterior corners of the branchial cavity. Of these only two had males attached to them.

THE FEMALE. (Text-figs. 1 and 2 and Text-fig. 3*a* and *b*).

Size.—As shown in the table, the females varied in size. Measured without the egg-strings and posterior processes, they ranged from 3·04 to 5·6 mm. in length. This size variation was not correlated with the size of the host fish. In a form 4·8 mm. long, the head measured 1·2 mm. the neck upto the second maxilla 0·6 mm. and the rest of the body 3·08 mm. At the posterior margin of the trunk where the body is broadest, it measures 1·4 mm. The fimbriate processes of the arm are 2 mm. long while the posterior processes and the anal laminae measure 1·6 mm. and 1 mm. respectively.

The oval trunk tapers anteriorly to bear the second maxillae. The short neck beyond the arms bears a head 1·2 mm. long. The head is well marked from the neck by a constriction as well as by a thin carapace. This shield has a truncated frontal margin and a hind margin with rounded corners. Anteriorly it is much broader than behind, the lateral corners folding down on each side over the base of the second antennae. The gulf between the upper and lower parts of the head appears reduced by the thick second antennae extending forwards and downwards on either side of the head.

The arms are free upto the tips where they hold the very short manubrium bearing the bulla. Though this bulla is attached at right angles to the surface of the gill arch of the fish, the head and neck are turned laterally towards the surface owing to a 90° twist of the arms, and through another similar bend in the front part of the trunk itself, the ventral surface of the genital region is turned away from the gill surface. The trunk is not only broad behind and narrow in front but also thick posteriorly, becoming thinner anteriorly. The trunk is faintly marked by two grooves giving the appearance of its being three-segmented.

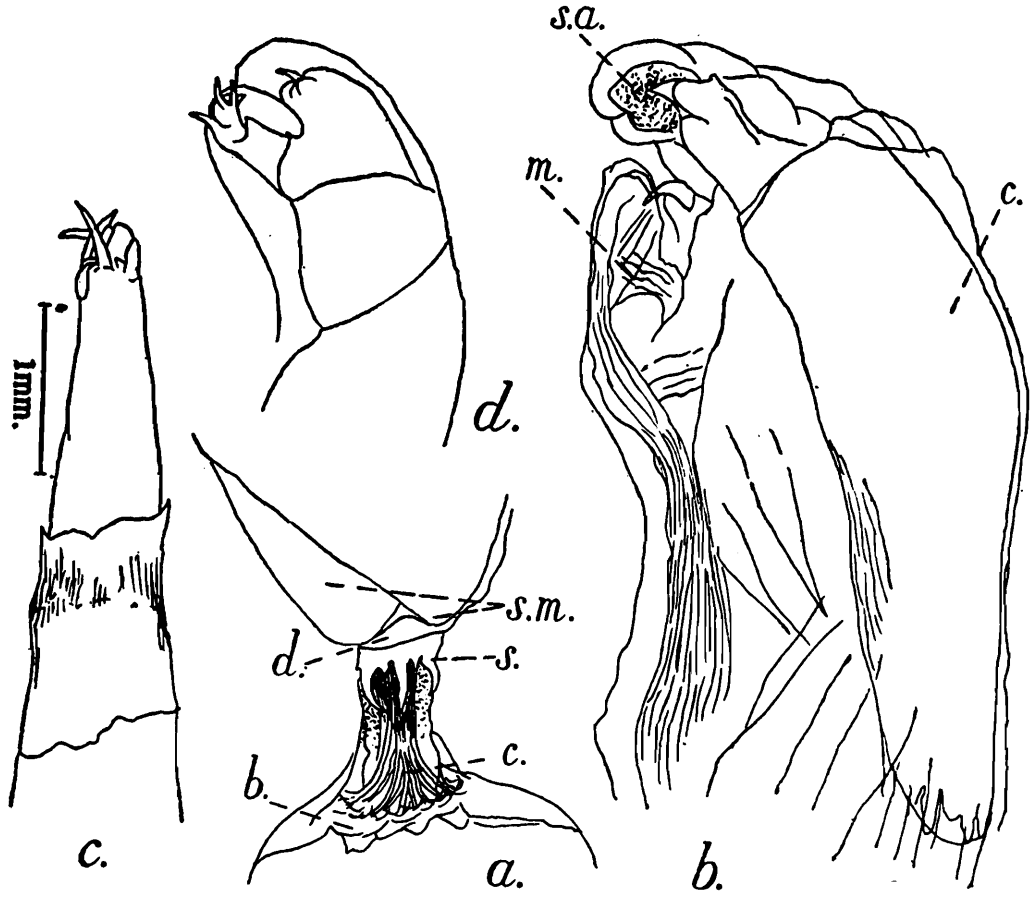


Text-fig. 1.—*Thysanote appendiculata* (Steenstrup and Lutken), Female.
a. Lateral view ; *b*. Oral view.

The fimbriate processes characteristic of the genus are cylindrical, unbranched, and twelve in number. Four pairs of processes are attached to the lower side of the arms where they curve away from the trunk and two pairs are attached ventral to the egg sacs, just below the anal laminae. These laminae can be easily distinguished from the posterior processes by their being cigar-shaped, their being shorter, their more or less fixed length, their more medial and dorsal insertion and by the presence of aborted setae. The four posterior processes which are clustered together with the anal laminae can be further distinguished by their forking from two extensions of the posterolateral corners of the trunk. The egg sacs appear attached more dorsal to the anal laminae. They are very variable in size and reach even a length of 4·8 mm. with 3 to 40 eggs in

each of the 8 to 12 rows. In forms with short egg strings, the eggs appear packed in fewer rows.

The Appendages.—The first antenna (text-fig. 2*c*) is three-jointed, small and directed forwards. The distal joint which is slender and tapering is longer than the other two joints and bears three slender spines and four tubercles. The second antenna (text-fig. 2*d*) is very large being long and stout. It projects straight beyond the frontal end and curves medially and downward on either side of the mouth tube. In this sweep of the second antenna the small first antenna is pressed against the mouth tube and is usually hidden from view. The second antenna is biramous, the two-jointed protopod being far longer than the rami. The exopod is two-jointed. The distal joint bears a short



TEXT-FIG. 2.—*Thysanote appendiculata* (Steenstrup and Lutken), female.

a. Attachment of the host; *b.* Side view of head; *c.* First antenna; *d.* Second antenna.

c., carapace; *m.*, maxillipede; *s. a.*, second antenna.

stout spine half way up its length as well as three spines and a sharp pointed lobe distally. The endopod is large and laminate. The tip shows papillose lobes arranged round a small tentacular process. The mouth cone has a large number of spiny papillae on its distal part fringing the circular downwardly directed mouth. Through the mouth, and the transparent wall of the tube, the long blades of the mandibles bearing six teeth can be seen. The first maxilla (text-fig. 3*a*, *f. m.*) is tripartite, the distal joints of the dactylose lobes are pointed and bent at an angle, and the bases swollen. The palp is much shorter.

but inflated and bears two spines divergently. The maxillipedes (text-fig. 3*b*) appear a little smaller in size compared with the second antennae. They are two-jointed and are directed forward below the mouth cone. A two-jointed short spine is borne on the first joint while a long stout curved claw is attached distally to the second joint. At the base of this claw a slender short accessory spine also can be distinguished. The primary spines of the two maxillipedes work against each other and are usually found overlapping one another. The second maxillae are short and stout and taper distally as they curve towards each other to unite their tips. A disc within this fused part of the arms bears a thick manubrium in its centre, reinforced by a circlet of four long spines from the disc supporting its base. The two canals from the maxillae run up through the manubrium, branch repeatedly as they extend into the bulla so that the truncated edge of the bulla appears fimbriate owing to the nearly ten branches of the canals.

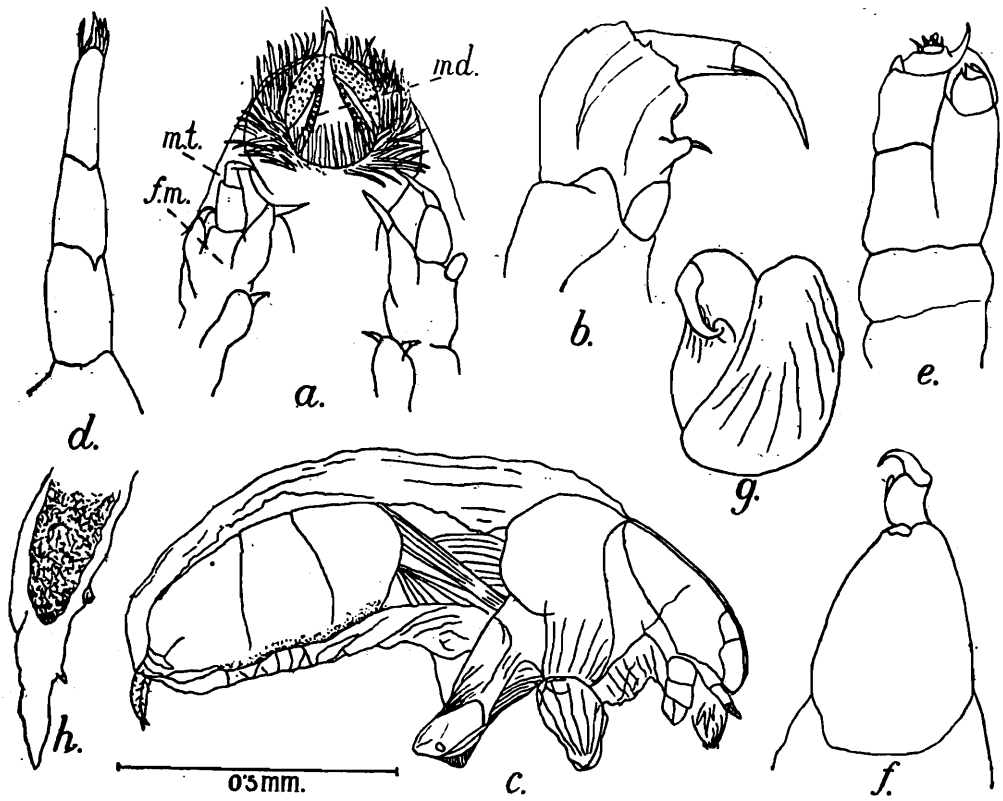
THE MALE. (Text-fig. 3*c-h*).

Ten males were collected from ten females. The males were usually found clinging to the ventral side of the trunk of the female between and behind the arms sheltered by the processes hanging down from each arm, but they were also found on the dorsal side of the trunk and the posterior processes. The wide and unbroken range in the sizes of the females with eggs, shown in the table below, suggests growth even after maturity. On the other hand, the sizes of the males, attached to both small and large females being nearly the same, indicate that the male undergoes no alteration in size after attachment to females. While the lengths of nine males range between a narrow margin of 0·84 mm. and 1·04 mm., the tenth reaching a length of 1·32 mm. suggests the probability of there being "high " and " low " forms such as Sewell found among free-living forms.

	Female.	Male.		Female.	Male.
1	3·0 mm.	0·88 mm.	6	4·7 mm.	0·96 mm.
2	3·5 mm.	0·84 mm.	7	4·7 mm.	0·88 mm.
3	3·6 mm.	1·00 mm.	8	5·0 mm.	1·00 mm.
4	4·0 mm.	0·84 mm.	9	5·6 mm.	1·00 mm.
5	4·6 mm.	1·04 mm.	10	5·1 mm.	1·32 mm.

Beneath the loose transparent cuticle can be seen the arc-like body constricted in the middle (text-fig. 3*c*) ,with the tapering cephalothorax in front and the stout conical trunk behind ending in a pair of anal laminae. The head is marked by a carapace of very thin membranous texture and the forwardly directed antennae, mouth tube and first maxilla. The maxillipedes which serve as the main organs by which the male attaches itself to the female are found behind the second

maxillae in the middle of the body. The anal laminae which are cylindrical, acute tipped, and bear a few aborted setae, probably aid in supporting the body in the rear. The part of the body where the second maxillae are attached is well marked by grooves. The trunk appears divided by two faint grooves into three segments.



TEXT-FIG. 3.—*Thysanote appendiculata* (Steenstrup and Lutken).

a. Mouth parts of female; *b.* Maxillipede of female; *c.* Lateral view, male; *d.* First antenna, male; *e.* Second antenna, male; *j.* Second maxilla, male; *g.* Both maxillipedes, male; *h.* single anal lamina, male.
j. m., first maxilla; *md.*, mandible; *m. t.*, mouth tube.

The Appendages.—The first antenna (text-fig. 3*d*) is uniramous and appears four-articled tapering to a pointed distal extremity. The two basal segments representing the protopod are much stouter while the terminal segment bears six pointed spines of which the central appears stouter than the rest. The second antenna (text-fig. 3*e*) is biramous. The two protopod joints are short and stout. The endopod is two-jointed, the distal joint is laminate, having its rounded tip marked by imbricated lobes. The exopod is three-jointed, the distal segment being a robust sickle-shaped claw, the base of which is a swollen pad of nearly seven short spines, and the large proximal joint being provided with a spine on its inner distal edge and two spiniferous pads. The mandibles are long narrow blades with the slightly expanded distal tips being finely toothed. The first maxilla is biramous. The palp is conical single jointed and bears a long spine. The endopod is tripartite. Of the lobes which are long, dactylose and sharp tipped, two are longer than the third. The second maxilla (text-fig. 3*f*) is three-jointed. The basal joint is stout conical and muscular. To its tapered outer end is articulated a cushion-like joint bearing a pad on to which folds the tip of a sickle-shaped claw. Such a chelate termination helps to hold the

skin of the female between. The maxillipede (text-fig. 3*h*) is two-jointed. The basal joint is stout long and muscular, and twisted, so that the curved distal claw works against a pad on its posterior aspect. This twist of the maxillipede enables the male to have a pinch hold of even an oblique surface of the female's body.

Remarks.—The details of the structure of the male presented here for the first time, support Wilson's transfer of *Brachiella appendiculata* Steenstrup and Lutken to the genus *Thysanote.*

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STUDIES IN INTRASPECIFIC VARIATION.

V.—Statistical supplement to the analysis of biometrical data on body-size, etc., of various types of individuals of the Desert Locust, presented in Part III.[1]

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and

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Contents.

I.—Introduction.

In Part III (Roonwal, 1949*a*) of this series, detailed biometrical data were published in regard to the more important types of individuals of the Desert Locust, *Schistocerca gregaria* (Forskål) [Orthoptera, Acrididae], *viz.*, phase *gregaria* 6-eye-striped,[2] phase *solitaria* 6-eye-striped and phase *solitaria* 7-eye-striped (Roonwal, 1936-1947). The biometrical data referred to the size of certain body-parts, *e.g.*, the length of the elytron (E), the hind-femur (F), etc., and the ratios of some of these, *e.g.*, E/F, etc. The main conclusions reached (Roonwal, 1949*a*, pp. 163-164) were as follows :—(i) " Regarding the length of the elytron (E) and that of the hind-femur (F), *gregaria* individuals were the smallest (except in male E), 6-striped *solitaria* larger, and 7-striped *solitaria* the largest." (ii) " Within each group, the females are larger than males in respect of all the body-parts, the sexual dimorphism being greatest in 7-striped *solitaria* and least in *gregaria*." (iii) " The mean E/F ratio is lowest in 7-striped *solitaria* (2·02), higher in 6-striped *solitaria* (2·07), and highest in *gregaria* (2·22). It also exhibits sexual dimorphism, being higher in females than in males ; the dimorphism is greatest in *gregaria*, and least in 7-striped *solitaria*."

[1] For Parts I-IV, see References, at the end of this paper, under Roonwal (1946*a*-1949*b*).

[2] The expression " 6-eye-striped " and " 7-eye-striped " have, in this paper, often been abbreviated to " 6-striped " and " 7-striped ".

In the present part, the data given in Part III have been subjected to more rigid statistical tests. As a reuslt, it has been confirmed that the above mentioned results stand unchanged in all essential respects, except in the few cases which are pointed out.

The mean values given here in Table 1*a* agree essentially with those given in the earlier paper, the only noticeable difference being in two cases as follows :—In phase *gregaria* males (6-eye-striped) the mean of elytron-length is 52·85 mm. here as against the earlier 53·03 mm. ; and the mean of hind-femur length is 24·32 mm. against the earlier 24·4 mm. The present values may in all cases be taken as the more accurate.

In addition, the biometrical statistics of the fawn-type *solitaria* forms are also given here. Owing to the small number of observations that are available for this type, it is considered desirable to give only the probable limits of mean value (known as the ' confidence ' or ' fiducial' limits, *vide infra*), rather than the precise means ; nearly 95 per cent of means of such populations are expected to fall with these confidence limits.

This opportunity is also taken to point out certain printing errors that have occurred in the Tables in Part III (Roonwal, 1949*a*). These are as follows :—

Page 155, Table 3, solitaria : 7-striped, ♀♀ :

Value of E/F, under category " 2·17—2·19 " *For* " 3 " *read* " 1 ".

Same, last column (Total).—*For* " 34 " *read* " 84 "

In the following account, except where otherwise stated, the statistics regarding the *solitaria* phase refers to the blue-grey type (often abbreviated to ' blue type ') of individuals.

The *original data* (Tables 1-10) of the individual measurements on which the present analysis, as well as that given in Part III (Roonwal, 1949*a*), are based, have been deposited in the Library of the Zoological Survey of India, Indian Museum, Calcutta, and may be consulted with the permission of the Director.

II.—SIZE OF BODY-PARTS.

(*a*) *Length of elytron* (*E*) *and hind-femur* (*F*).

The mean length (in mm.) of the elytron in males is 52·85±0·52 in phase *gregaria* (6-eye-striped), 52.15±0·24 in 6-eye-striped *solitaria* and 52·38±0·42 in 7-eye-striped *solitaria*. The corresponding mean lengths in females are 58·01±0·81, 61·56±0·31 and 62·90±0·26 mm. respectively (Table 1).

The mean length (in mm.) of the hind-femur in males is 24·32±0·20 in phase *gregaria* (6-eye-striped), 25·4±0·12 in 6-eye-striped *solitaria* and 26·13±0·21 in 7-eye-striped *solitaria*. The corresponding mean lengths in females are 26·44±0·37, 29·37±0·18 and 30·92±0·13 mm. respectively (Table 1).

TABLE 1.—*Schistocerca gregaria* (Forsk.), ph. *gregaria* and ph. *solitaria* (grey-blue type).

[From Tables 1, 2, 5, 6, 9 and 10 of original data.]

Statistical constants relating to the lengths (in millimetres) of elytron and hind-femur and their ratios in phase gregaria *and phase* solitaria *(grey-blue type) individuals.*

Abbreviations :—*Greg.*, phase *gregaria*; *Sol.*, phase *solitaria* ; *No. of obs.*, number of observations (individuals measured) ; *6- or 7-striped* 6- or 7-eye-striped.

Phase, sex, and number of eye-stripes	Elytron (E)		Hind-femur (F)		Ratio	
	No. of obs.	Length of elytron (E) (in mm.)	No. of obs.	Length of hind-femur (F) (in mm.)	No. of obs.	E/F
			(a) Means, with standard errors.			
Greg. ♂♂ (6-striped)	14	52·85±0·52	25	24·32±0·20	11	2·17±0·02
Sol. ♂♂ (6-striped)	89	52·15±0·24	89	25·40±0·12	89	2·05±0·01
Sol. ♂♂ (7-striped)	25	52·38±0·42	25	26·13±0·21	25	2·00±0·01
Greg. ♀♀ (6-striped)	26	58·01±0·81	34	26·44±0·37	23	2·25±0·02
Sol. ♀♀ (6-striped)	63	61·56±0·31	63	29·37±0·18	63	2·09±0·01
Sol. ♀♀ (7-striped)	84	62·90±0·26	84	30·92±0·13	84	2·03±0·007
			(b) Standard deviations, with standard errors.			
Greg. ♂♂ (6-striped)	14	1·93±0·36	25	0·99±0·14	11	0·08±0·02
Sol. ♂♂ (6-striped)	89	2·23±0·17	89	1·12±0·08	89	0·06±0·004
Sol. ♂♂ (7-striped)	25	2·10±0·30	25	1·04±0·15	25	0·06±0·01
Greg. ♀♀ (6-striped)	26	4·12±0·57	34	2·13±0·26	23	0·08±0·01
Sol. ♀♀ (6-striped)	63	2·49±0·22	63	1·44±0·13	63	0·06±0·01
Sol. ♀♀ (7-striped)	84	2·42±0·19	84	1·21±0·09	84	0·06±0·01
			(c) Coefficients of variation, with standard errors.			
Greg. ♂♂ (6-striped)	14	3·65±0·69	25	4·07±0·58	11	3·69±0·79
Sol. ♂♂ (6-striped)	89	4·28±0·32	89	4·42±0·33	89	2·93±0·22
Sol. ♂♂ (7-striped)	25	4·01±0·57	25	3·98±0·56	25	3·00±0·42
Greg. ♀♀ (6-striped)	26	7·10±0·98	34	8·06±0·98	23	3·51±0·52
Sol. ♀♀ (6-striped)	63	4·04±0·36	63	4·90±0·44	63	2·87±0·26
Sol. ♀♀ (7-striped)	84	3·85±0·30	84	3·92±0·30	84	2·96±0·23

The variabilities in the lengths of the elytron and the hind-femur are more or less uniform in almost all cases. The coefficients of variation (Table 1) lie between 3·65 per cent and 4·90 per cent in all cases, except in the case of phase *gregaria* females (6-striped) where the coefficients are 7·10 per cent and 8·06 per cent in the lengths of the elytron and hind-femur respectively.

The significance of differences (as judged by Fisher's *t* test of significance) in the lengths of the elytron and the hind-femur among the various types of individuals is given in Table 2. It will be seen that, except in the following 3 cases, all the differences are significant at one per cent level of probability; in other words, they are highly significant. The 3 exceptional cases refer to the elytron-length of males, where it is not significantly different (i) between phase *gregaria* and 6-striped *solitaria* individuals; (ii) between phase *gragaria* and 7-striped *solitaria* individuals; and (iii) between 6-striped *solitaria* and 7-striped *solitaria* individuals. This lack of significant difference in the 3 cases just mentioned was not appreciated in the earlier account (Part III, Roonwal, 1949*a*, p. 151), where it was stated that " the male elytron of *gregaria* is, however, exceptional in being longer "; in the light of the present analysis, this statement should now read as follows :— " The male elytron is, however, exceptional in not showing any significant differences in length between the three types of individuals."

Leaving aside the exceptional cases of the male elytra, the following conclusions are valid for the elytron and hind-femur lengths, the two sexes being separately analysed (Table 2) :—

TABLE 2.—*Schistocerca gregaria* (Forsk.), ph. *gregaria* and ph. *solitaria* (grey-blue type).

Significance of differences (as judged by Fisher's t *test) in mean values, given in Table 1, regarding statistics of lengths (in millimetres) of elytron and hind-femur and their ratios.*

Abbreviations :—As in Table 1.

Difference between	Length of elytron (E)		Length of hind-femur(F)		Ratio E/F	
	Mean	Fisher's *t*	Mean	Fisher's *t*	Mean	Fisher's *t*
(i) *Sol.* ♂ (6-striped)	52·15	1·11	25·36	4·22*	2·05	5·96*
and						
Greg. ♂ (6-striped)	52·85		24·32		2·17	
(ii) *Sol.* ♀ (6-striped)	61·56	5·00*	29·37	8·03*	2·09	9·66*
and						
Greg. ♀ (6-striped)	58·01		26·44		2·25	

* Significant at one per cent level of probability, *i.e.*, highly significant.

Table 2 continued on next page.

TABLE 2. *contd.*—*Schistocerca gregaria* (Forsk.), ph. *gregaria* and ph. *solitaria* (grey-blue type).

Difference between	Length of elytron (E)		Length of hind-femur (E)		Ratio E/F	
	Mean	Fisher's *t*	Mean	Fisher's *t*	Mean	Fisher's *t*
(iii) *Sol.* ♂ (7-striped)	52·38	0·69	26·13	6·30*	0·09	7·01*
and						
Greg. ♂ (6-striped)	52·85		24·32		0·06	
(iv) *Sol.* ♀ (7-striped)	62·90	7·50*	30·92	14·41*	2·03	14·61*
and						
Greg. ♀ (6-striped)	58·01		26·44		2·25	
(v) *Sol.* ♂ (6-striped)	52·15	0·46	25·36	3·09*	2·05	3·62*
and						
Sol. ♂ (7-striped)	52·38		26·13		2·00	
(vi) *Sol.* ♀ (6-striped)	61·56	3·28*	29·37	7·07*	2·09	5·90*
and						
Sol. ♀ (7-striped)	62·90		30·92		2·03	
(vii) *Greg.* ♂ (6-striped)	52·85	5·36*	24·32	5·04*	2·17	3·57*
and						
Greg. ♀ (6-striped)	58·01		26·44		2·25	
(viii) *Sol.* ♂ (6-striped)	52·15	24·01*	25·40	18·35*	2·05	2·84*
and						
Sol. ♀ (6-striped)	61·56		29·37		2·09	
(ix) *Sol.* ♂ (7-striped)	52·38	21·30*	26·13	19·39*	2·00	0·42
and						
Sol. ♀ (7-striped)	62·90		30·92		2·03	

* Significant at one per cent level of probability, *i.e.*, highly significant.

(i) Among *solitaria* phase, the 7-striped individuals are slightly larger than the 6-striped ones. (ii) The *gregaria* phase individuals (all 6-striped) are considerably smaller than the 6-striped *solitaria* and even more so than the 7-striped *solitaria* individuals. The statistically significant differences between the 6-striped and 7-striped *solitaria* individuals are of particular interest because the populations analysed were taken from the same area (Mekran Coast, S. Baluchistan) and at the same period (during the year 1936). The differences, therefore, cannot reasonably be attributed to different origins of the samples, and should be regarded as genuine differences correlated with eye-stripes.

The actual degree of significant difference varies between the sexes and the types of individuals. Taking the 6-eye-striped *solitaria* at 100, the degree of difference, expressed as a percentage, is as follows (Table 3), the plus and minus signs indicating excess and defect respectively over the standard value of 100 :—

TABLE 3.—*Schistocerca gregaria* (Forsk.), ph. *gregaria* and ph. *solitaria* (grey-blue type).

Percentage of differences in the means (see Table 1) of the lengths of the elytron (E) and hind-femur (F) and the ratio E/F in various types of phase gregaria *and phase* solitaria *(grey-blue type) individuals, taking 6-eye-striped* solitaria *as 100.* (Cf. *Table 6 of Part III, Roonwal, 1949a, p. 159*). (*All the values of difference given here, except those marked with an asterisk*, are significant at one per cent level of probability.*)

Abbreviations :—As in Table 1.

Phase, sex and number of eye-stripes.	E	F	E/F
Greg. ♂♂ (6-striped)	+1·34*	—4·25	+5·85
Sol. ♂♂ (6-striped)	100	100	100
Sol. ♂♂ (7-striped) . .	+0·44*	+2·87	—2·44
Greg. ♀♀ (6-striped)	—5·77	—9·98	+7·66
Sol. ♀♀ (6-striped)	100	100	100
Sol. ♀♀ (7-striped)	+2·17	+5·28	—2·87

* Not significant at one per cent level of probability (Table 2).

Elytron length.—Ph. *gregaria* (6-striped): ♀♀, —5·77 per cent; ph. *solitaria* (7-striped): ♀♀, +2·17 per cent. The males, as already mentioned, are not significantly different.

Hind-femur length.—Ph. *gregaria* (6-striped): ♂♂, —4·25 per cent; ♀♀, —9·98 per cent; ph. *solitaria* (7-striped): ♂♂, +2·87 per cent; ♀♀, +5·28 per cent. It is noteworthy that the degree of difference is more pronounced (irrespective of direction) in females than in males.

A comparison of the exceptional behaviour of the male elytron-length in *Schistocerca gregaria* with the condition obtaining in other Acrididae is of interest and has already been referred to in Part III (Roonwal, 1949*a*, p. 151).

TABLE 4.—*Schistocerca gregaria* (Forsk.), ph. *solitaria* (fawn type).

[From Tables 3, 4, 7 and 8 of original data.]

Confidence limits of the means relating to the length (in millimetres) of elytron (E) and hind-femur (F) and their ratio (E/F) in phase solitaria *(fawn type) individuals.*

Abbreviations :—As in Table 1.

Character	No. of obs.	Range	Means, with standard errors	Confidence limits of mean
		(*a*) *Males.*—6-eye-striped.		
E (mm.)	8	51·0—57·0	53·25±0·67	51·67—54·83
F (mm.)	8	24·0—28·0	25·85±0·52	24·62—27·08
E/F	8	1·96—2·23	2·06±0·03	1·99— 2·13
		(*b*) *Males.*—7-eye-striped.		
E (mm.)	5	49·0—56·5	52·80±1·25	49·33—56·27
F (mm.)	5	24·0—28·0	25·80±0·68	23·91—27·69
E/F	5	1·97—2·11	2·04±0·02	1·98— 2·10
		(*c*) *Females.*—6-eye-striped.		
E (mm.)	5	59·5—64·2	62·14±0·89	59·67—64·61
F (mm.)	5	29·3—31·7	30·50±0·47	29·20—31·80
E/F	5	1·96—2·13	2·03±0·03	1·95—2·11
		(*d*) *Females.*—7-eye-striped.		
E (mm.)	5	61·0—66·0	63·80±0·90	61·30—66·30
F (mm.)	5	29·5—31·5	30·70±0·34	29·76—31·64
E/F	5	2·01—2·12	2·07±0·02	2·01— 2·13

Fawn-type, phase solitaria (Table 4).—Since the mean values in the case of the ' fawn types ' phase *solitaria* individuals are estimated from very small samples (the number of observations not exceeding 8), the confidence limits (or ' fiducial interval ' of Fisher, 1933) (*vide* Snedecor, 1946) of the means are shown. The *t* ratio of small sample theory is defined by the formula :—

$$\pm t = \frac{x-m}{s_x},$$

where x is the sample mean, s_x the standard error of the mean and m the population-mean for which the confidence limits are to be found out.

The probability distribution of t has been found out and the probability values of t are given by Fisher (1933). By choosing the 5 per cent level of probability, the values of t corresponding to the appropriate number of degrees of freedom are noted from Fisher's table. Then the confidence limits of m are given by the formulae :—

$$l_1 = x - t_{0\cdot05}s_x \text{ ; and } l_2 = x + t_{0\cdot05}s_x,$$

where l_1 and l_2 are the lower and upper limits respectively. If we say that the population mean, m, lies between these limits, the probability of being misled by the sampling is only 0·05. The statistical constants of the fawn type of phase *solitaria* individuals are given in Table 4, from which it is not possible to discern any marked departures from the corresponding values in the blue-grey types of phase *solitaria* individuals discussed above.

TABLE 5.—*Schistocerca gregaria* (Forsk.).

[From Table 9 of original data.]

Statistical constants, of phase gregaria *(6-eye-striped) individuals from swarms, relating to the (i) maximum width (in mm.) of head in the genal region* (C) ; *(ii) length (in mm.) of pronotum at the keel* (P) ; *(iii) height (in mm.) of pronotum* (H) ; *(iv) width (in mm.) of pronotum at the construction* (M) ; *and (v) the ratios* P/C, H/C *and* M/C.

Abbreviations :—As in Table 1.

Character	No. of obs.	Means, with standard errors	Standard deviations, with standard errors	Coefficient of variation, with standard errors
		(a) Males.		
C	34	7·55 ±0·04	0·26 ±0·03	3·44 ±0·42
P	31	9·87 ±0·08	0·44 ±0·06	4·46 ±0·57
H	34	8·39 ±0·05	0·32 ±0·04	3·81 ±0·47
M	34	5·86 ±0·04	0·26 ±0·03	4·44 ±0·54
P/C	31	1·305±0·011	0·063±0·008	4·828±0·618
H/C	34	1·112±0·008	0·045±0·005	4·047±0·494
M/C	34	0·779±0·008	0·045±0·005	5·777±0·706
		(b) Females.		
C	40	7·89 ±0·07	0·47 ±0·05	5·96 ±0·67
P	40	10·49 ±0·13	0·84 ±0·09	8·01 ±0·90
H	43	8·92 ±0·10	0·64 ±0·07	7·17 ±0·78
M	42	6·36 ±0·08	0·49 ±0·05	7·70 ±0·85
P/C	37	1·324±0·009	0·055±0·006	4·154±0·486
H/C	40	1·126±0·007	0·045±0·005	3·996±0·450
M/C	40	0·805±0·005	0·032±0·004	3·975±0·447

(b) Measurements of head and pronotum.

For the head and pronotum, measurements are available only for phase *gregaria* individuals, the number of observations being 31-43. The mean values, with standard errors, etc., will be found in Table 5 ;

they do not show any material departure from the values given in Part III (Roonwal, 1949*a*, p. 151, and Table 4).

III.—SEXUAL DIMORPHISM.

As shown in Part III (Roonwal, 1949*a*, pp. 160-163), within each type, females are significantly larger than males as regards the absolute length of the elytron and hind-femur (Table 2, items vii-ix). The degree of sexual dimorphism in E and F, whether expressed as " sexual dimorphism ratio " or as " sexual dimorphism percentage ", is, as shown in Part III (Roonwal, 1949*a*, pp. 160, 161, Tables 7 and 8), nearly double (*ca.* 18-20 per cent in E and *ca.* 16-18 per cent in F) in the *solitaria* phase as compared to *gregaria* phase individuals (*ca.* 9 per cent in E and 8 per cent in F). Regarding other body-measurements, *viz.*, C, P, H and M, the degree of sexual dimorphism within the *gregaria* phase (for which alone values are available) is less pronounced but follows the same significant pattern as in E and F (Table 6).

TABLE 6.—*Schistocerca gregaria* (Forsk.), *phase* gregaria.

Significance of sexual differences (as judged by Fisher's t) *in mean values, given in Table 5, of the characters* C, P, H *and* M *and the ratios* P/C, H/C *and* M/C.

Character	Mean (*Male*)	Mean (*Female*)	Mean difference	Standard Error of Difference	Fisher's *t*
C . . .	7·55	7·89	0·34	0·08	4·25*
P . . .	9·87	10·49	0·62	0·15	4·13*
H . . .	8·39	8·92	0·53	0·11	4·82*
M . . .	5·86	6·36	0·50	0·09	5·56*
P/C . .	1·305	1·324	0·019	0·014	1·36
H/C . .	1·112	1·126	0·014	0·010	1·40
M/C . .	0·779	0·805	0·026	0·009	2·89*

* Significant at one per cent level of probability, *i.e.*, highly significant.

In E/F ratio also a certain degree of sexual dimorphism is observable, as already mentioned in Part III of this series. Within each type of individuals, females have slightly but significantly higher E/F ratios than males, except in 7-striped *solitaria* where the difference between the two sexes is not significant.

In regard to other ratios, in phase *gregaria*, females have slightly but significantly higher ratios than males for the ratio M/C; the sexual difference in other ratios, *viz.*, P/C and H/C, is not significant at one per cent level of probability. For phase *solitaria* these ratios are not available.

IV.—BIOMETRICAL RATIOS.

(*a*) *Elytron/hind-femur (E/F) ratio.*

The mean E/F ratio in males is 2·17±0·02 in phase *gregaria* (6-striped), 2·05±0·01 in 6-eye-striped *solitaria* and 2·00±0·01 in 7-striped *solitaria* individuals. The corresponding values in females are 2·25±0·02, 2·09±0·01 and 2·03±0·007. The significance of the differences (as judged by Fisher's *t* test of significance) in the mean values between the various types of individuals is given in Table 2. It will be seen that all the differences are significant at one per cent level of probability; in other words, they are highly significant. The actual degree of significant difference varies between the sexes and the types of individuals. Taking the 6-striped *solitaria* at 100, the degree of difference, expressed as a percentage, is as follows (Table 3), the plus and minus signs expressing excess and defect respectively over the standard value of 100:— Phase *gregaria* (6-striped): ♂♂, +5·85 per cent; ♀♀, +7·66 per cent. Phase *solitaria* (7-striped): ♂♂, —2·44 per cent; ♀♀ —2·87 per cent.

It is thus possible to confirm the previous conclusions (Part III, Roonwal, 1949*a*, p. 162), *viz.*, that (i) irrespective of sexual variation, the 6-striped *solitaria* individuals have a significantly higher mean E/F ratio than 7-striped *solitaria*; and (ii) the *gregaria* (6-striped) individuals have a higher ratio than even the 6-striped *solitaria*. Irrespective of direction, the degree of difference is, in both cases, slightly more marked among females than in males.

(*b*) *Other ratios.*

The mean values of other ratios, *viz.*, P/C, H/C and M/C, for phase *gregaria* only, will be found in Table 5, and do not call for further comment.

V.—SUMMARY.

1. The present part deals with a more rigid statistical analysis than was previously done, of the same data on biometry of the Desert Locust as was presented in Part III (Roonwal, 1949*a*). The statistics refer to the length, etc. of the various body-parts, *viz.*, the elytron, hind-femur, pronotum and head, and the various ratios of these measurements.

2. The significance of differences between the mean values of elytron-length, etc., is judged from Fisher's *t* test. In the case of the 'fawn' type of *solitaria* phase individuals, where the number of observations is very small, the confidence (or fiducial) limits of means are given in addition to the calculated means.

3. As a consequence of this more rigid analysis it has been possible to confirm, on a more firm basis, nearly all the conclusions arrived at in Part III, except a few which are mentioned.

4. The exceptional cases refer to the length of the male elytron which was formerly considered longer in phase *gregaria* than in phase *solitaria* individuals. The present results, however, show that the male elytron does not show any significant difference between the three types of

individuals, *viz.*, phase *gregaria* (6-eye-striped), phase *solitaria* (6-eye-striped), and phase *solitaria* (7-eye-striped).

5. Marked sexual dimorphism (significant at one per cent level of probability) exists within each type, females having higher values than males in E, F, C, P, H, M, and the ratios E/F and M/C. In P/C and H/C no significant difference is noticeable. Regarding E and F, the degree of sexual dimorphism is nearly double in the *solitaria* phase individuals as compared to *gregaria* phase individuals.

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ON A NEW GENUS OF PHREATOICID ISOPOD FROM WELLS IN BANARAS.

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(Plates XVII—XX.)

INTRODUCTION.

Material.—Some time in 1946, Dr. M. Sharif of the Haffkine Institute of Preventive Medicine, Bombay, sent to the Zoological Survey of India for identification some specimens of an Isopod that had been collected in a *pucca* well at Lohagara Railway Station, eighteen miles from Allahabad. Though a cursory examination showed them to be unusual in several respects, the specimens were kept aside for subsequent detailed study on account of more pressing work. A little later, Dr. A. K. Mitra of the Department of Anthropology brought to the Survey a living Isopod that he had found in a pail of water drawn from a well near his residence in Banaras. This Isopod also showed the same unusual characters that had been observed earlier in the specimens from the Allahabad District. This specimen was kept alive in a jar of well water for studying its habits, etc., and, simultaneously, attempts were made to collect more material from the same and other wells in Banaras. The specimen continued to live for nearly two months, and apart from changing occasionally the water in which it was kept, it required no other attention in the way of additional food, etc. A considerable number of specimens was later collected from several wells in Banaras.

A careful examination of the material showed that the animals belong to the Isopodan sub-order Phreatoicoidea. This sub-order is known to have a very interesting distribution, being somewhat plentiful in Australia, Tasmania and New Zealand and having been found outside this region only in the Cape Province of South Africa. Its occurrence in South Asia was, therefore, considered to be of particular significance, and the find was reported by one of us (Chopra, 1947, p. 176) early in 1947. The work had so far been carried out by the first author only but as he was transferred from the Zoological Survey of India soon after this, he handed over his notes, illustrations, etc., to the second author, who continued the investigation from the point at which it had been left. Though the two authors have been in constant touch with each other throughout the progress of the investigation, the major part of the work such as drawing up of the descriptions and preparing the manuscript of the paper, etc., has been done by the second author.

Locality and Ecology.—Banaras, from where the major part of the material on which the paper is based was obtained, is in the Eastern part of the State of Uttar Pradesh, in 25° 18′ north latitude and 83° 1′ east longitude. " The whole district of Benares forms part of the Gangetic plain and its geology exposes nothing beyond the ordinary alluvium. The northernmost outliers of the Vindhyan Hills are in Mirzapur to the South and rock never appears in Benares. The depth of alluvium has never been proved but sections obtained by sinking wells generally give some 35′ of loam, or clay mixed with sand in varying proportions, 30′ of blue silt, 20′ of strong clay and below that a water bearing stratum of reddish sand " (Nevill, 1909, p. 2).

Banaras stands on the left bank of the Ganges and though a part of the water supply of the town comes from the river, there are numerous wells all over the town, mainly for drinking purposes. The wells are generally three to five feet in diameter and the water level is about 20′ to 40′ below the surface. The depth of water in the wells varies from 30′ to 60′ The wells are always lined with brick and many are plastered with lime or cement. The mouth of wells is always raised above the surface and is surrounded by a masonary platform. Many wells have their mouths partially covered with wooden planking. Because of the small opening and the low level of water, very little direct sunlight reaches the surface of water.

Besides these Isopods, one species of *Cyclops* is very common in most of these wells.

General Observations on Systematics.—The sub-order Phreatoicoidea is believed to be of ancient origin and is supposed to have established itself in the early Mesozoic period. The occurrence of living representatives of this sub-order in the Australian region at one end and through India to South Africa at the other, further supports the geological hypothesis of the existence of the Gondwanaland during the Mesozoic era.

Nicholls (1943*a* and 1943*b*) has published two excellent memoirs on the Phreatoicoidea which contain a detailed account of all the known members of this group, together with their affinities, distribution, etc. A careful comparison of our material with the numerous forms described by Nicholls has shown that the Indian specimens cannot be referred to any of the known genera of this group and we have, therefore, been obliged to create a new genus for it. A new sub-family has also been established to accommodate the Indian genus, as it cannot be referred to any of the so far known sub-families.

Acknowledgments.—We are greatly indebted to Professor G. E. Nicholls not only for kindly examining some of our specimens and verifying our identification, but also for numerous helpful suggestions. Our thanks are also due to Drs. M. Sharif and A. K. Mitra for bringing their interesting finds to our notice and to Dr. B. S. Chauhan of the Zoological Survey of India for helping the second author in the course of this work.

SYSTEMATIC ACCOUNT.

Family AMPHISOPIDAE.

Sub-family *NICHOLLSINAE.*

Body long, vermiform and smooth. Head with an incomplete cervical groove; eyes absent. First peraeon segment short, ventrally expanded and free from head. Pleura of the pleon segments not greatly produced downwards. Tail-piece long; telson emarginate, its lateral free edges crenulate. Antennule long, filiform. Gnathopods similar in both sexes; bases of peraeopods not appreciably expanded; fourth peraeopod not sexually modified in male. Oostegites on first four pairs of peraeopods of female. Posterior pleopods sub-equal to anterior series; coupling hooks absent; few entangling setae on sympodites; exopod smooth, bilobed (except in first pair), the lobe displaced more laterally; endopod reduced, smooth, cleft longitudinally up to the middle; penial stylet short, curved, with a complex musculature. Outer ramus of uropod longer than the inner, and much longer than the tail-piece in males.

The sub-family Nichollsinae is related to the Mesamphisopinae (Nicholls, 1943*a*, p. 29) on account of the short first peraeon segment free from head, and to the Hypsimetopinae (Nicholls, 1943*a*, p. 120) on account of the absence of coupling hooks on the sympodite of pleopods.

Genus **Nichollsia**[1], nov.

Body slender, smooth and vermiform, maintaining a uniform width throughout; length 14 to 16 times its width in adult specimens. Head short, longer than wide, and as wide as deep; fronto-lateral projections prominent, sub-ocular incisure deep, mandibles forwardly placed, posterior process wanting; post-mandibular portion of the head almost equal to the mandibular portion; cervical groove incomplete; eyes wanting. Peraeon wider than deep; first segment short, free from the head and expanded ventro-laterally; pleura of peraeon segments obsolete, exposing the ventral parts; sterna of the peraeon segments keeled. Pleon rather long, deeper than peraeon, with pleura very slightly projecting downwards; tail-piece long, as wide and deep as pleon; suture between the sixth pleon segment and telson wanting; apex of telson emarginate dorsally, its descending lateral edges crenulate.

Antennule long, filiform; both mandibles with lacinia mobilis. Gnathopods normal and similar in both sexes; bases of peraeopods very slightly expanded; fourth peraeopod not modified in male. Posterior pleopods not much reduced, endopod clefted in the middle; penial stylet short, stout, curved and with a complex musculature. Peduncle of uropod mesially ridged, produced into three blunt tubercles at the disto-lateral angle; outer ramus lamellar, much longer than the inner, and in adult males longer than the tail-piece.

Four pairs of oostegites in female.

[1] Named after Prof. G. E. Nicholls, lately Professor of Zoology, University of Western Australia.

Genotype.—Nichollsia kashiense, sp. nov.

The genus *Nichollsia* shows some similarities with *Phreatoicoides* Sayce (1900, p. 122), *Hypsimetopus* Sayce (1902, p. 219) and *Hyperoedesipus* Nicholls and Milner (1923, p. 23). This question is discussed in some detail in a subsequent part of the paper.

Nichollsia kashiense, sp. nov.

(Plates XVII—XX.)

Body (Pl. XVII, figs. 2 and 3).—The body is long, slender and vermi form. Width is uniform throughout. Length of body measures 14 to 16 times in width in adult specimens preserved in spirit. Except for a few short and stiff hairs, the body is smooth and devoid of any sculpturing.

Head (Pl. XVII, fig. 1).—Head is rather short. It is subequal to the second peraeon segment and shorter than the third and fourth. It is somewhat shallow, being longer than deep. Width and depth are equal. Its dorsal surface is faintly convex. Seen in dorsal view (Pl. XVII, fig. 3) it is roughly rectangular in shape. The antero-dorsal margin of the head is strongly convex, the front sloping steeply forwards. Fronto-lateral corner (Pl. XVII, fig. 1, fr. p.) is produced into a large angular projection on each side. The sub-ocular incisure is deep. Antero-ventral corner of the head is bluntly angular, and behind this the sub-orbital notch (fig. 1, *sub. orb.*) is conspicuous. A shallow genal groove begins from the hinder angle of the sub-ocular incisure and ends in the sub-orbital notch. Behind the sub-orbital notch, the ventral edge of the head forms an oblique, sloping line with the mandible (Pl. XVII, fig. 2,). Posterior process is wanting and post-mandibular portion of the ventral margin of head is horizontal, and equal to mandibular region. Postero-dorsal margin of head is convex, the sides descending obliquely forwards up to the middle, from where they descend vertically to meet the ventral border. This vertical lower half of the postero-lateral edge is slightly overlapped by antero-ventral expansion of the first peraeon segment. Cervical groove (Pl. XVII, fig. 1, *c.gr.*) is conspicuous only on sides. In younger examples, and in some adults also, a faint groove, parallel to the ventral edge of head is present, and it meets the ascending arm of the cervical groove. Eyes are absent. The ocular area (which is very prominent in fresh specimens) is seen as a shallow triangular depression in specimens preserved in spirit for a long time.

Peraeon (Pl. XVII, figs. 2 and 3).—Peraeon is long with uniform width and depth. It is wider than deep. The *first* segment (fig. 1, *per.* 1.) is very short in mid-dorsal line, measuring from one-third to one-fifth of the dorsal length of head. The antero-dorsal margin is strongly concave, the corresponding posterior margin being straight. The antero-ventral border of this segment is expanded and overlaps the lower half of the hinder margin of the head. Segments *two* to *four* show a progressive increase in length, the *fourth* being the longest; posterior to *fourth* the remaining segments progressively decrease in length. Each segment

is longer than wide, and wider than deep. The ratio of length to breadth is maximum in the *fourth* segment, but less in the segments in front, or behind it. The antero-ventral corners of *second* to *fourth* segments are produced in front of their respective coxal attachments. Postero-ventral corners are rounded. In the posterior series of *fifth* to *seventh* segments both antero- and postero-ventral corners are rounded and ventral edges are slightly emarginate in the region where the legs are attached. The sterna of *all* segments are compressed, and produced posteriorly, this compression being more conspicuous in the posterior segments.

Pleon (Pl. XVII, figs. 2 and 3).—Pleon, when compared with that of the other subterranean genera of the family Amphisopidae, is rather long. If the length of cephaloperaeon is taken as 100, the length of pleon varies from 63 to 82, and compared with the total length of body, this ratio is as 100 : 40-45. The great increase in length of the pleon is partly due to elongation of tail-piece (Pl. XVII, figs. 2 and 3, *t.p.*), which is more than half as long as the rest of pleon segments taken together. The proportion of combined length of the pleon-telson to tail-piece is as 11 : 4. Pleon is as wide as peraeon, but deeper than it owing to a slight downward extension of the pleura, which, however, do not cover the sympodites of pleopods. First *four* pleon segments are short, sub-equal, and wider than long; the *fifth* is longer than the rest, but not longer than the combined length of any two. Depth of *first four* segments is distinctly greater than their length or width; the *fifth* is, however, somewhat longer than wide, and only slightly deeper than long. Free pleural margins of each segment are straight, posterior corners angular, and anterior ones blunt. Seen dorsally or laterally, the pleon segments are rectangular and except for scattered individual hairs, the pleon is smooth. The tail-piece (*sixth* pleon segment+telson) (Pl. XVII, fig. 2, *t.p.*) is one and a half-time as long as deep, and twice as long as wide. Its dorsal surface (fig. 3) is rounded and ventral surface (fig. 10) flat. The antero-lateral margin of tailpiece obliquely ascends upwards (Pl. XVII, figs. 2 & 4), attachment with the fifth pleon segment being in the upper half. Antero-ventral angle is rounded. Ventral margin is straight, and anteriorly it bears three backwardly directed spines. Telson is firmly united with sixth pleon segment. Telsonic apex (Pl. XVII, figs. 2, 3, 4, 5 and 11, *po.ma.* and *la.m.*) is strongly emarginate. Dorsally the telson (Pl. XVII, fig. 5, *po. ma.*) is of the shape of a shallow horse-shoe. Below the postero-dorsal corner, the free lateral edge (Pl. XVII, fig. 4, *la.m*) is turned downwards and backwards in an undulating curve, the upper half containing two rather widely-separated notches and the lower half being more compactly crenulated. As it reaches the region of uropodal peduncle (fig. 4, *u.p.*), this descending edge turns anteriorwards, running parallel to, and in contact with the peduncle, behind which it steeply turns down vertically to meet the ventral edge of tail-piece at right angles. The ventral surface of tail-piece (fig. 10) is flat with parallel sides, the anterior margin straight, and posterior margin produced mesially into an angle between uropodal peduncles. Anus (Pl. XVII, fig. 5, *an.*) is a vertical slit on the posterior face, above the insertion of peduncle of uropods.

Antennule (Pl. XVII, fig. 6).—Antennule is long and filiform, consisting of 16 joints. It exceeds the peduncle of antenna by four to six of its terminal joints. First three or four joints are longish, the distal joints become progressively short and narrow. Short scattered hairs are present on all joints.

The antennule of *N. kashiense* is longer than that in other subterranean genera. Nicholls (1943*a*, p. 6) believes this type of antennule to be more primitive than the short, club-shaped antennule found in a large number of Phreatoicids. A long, filiform antenule is characteristic of the Amphisopinae and Phreatomerinae among Amphisopids.

Antenna (Pl. XVII, fig. 7).—Antenna is moderately long, being somewhat less than half the length of body. The five-jointed peduncle is almost half as long as the flagellum. First three joints of the peduncle are short and sub-equal, fourth is longer and fifth is twice the length of the fourth. Flagellum consists of thirty joints. The basal joints are longer, and length of the joints progressively diminishes towards the distal extremity. A few stiff hairs are present on the peduncle and flagellum.

Labrum (Pl. XVII, fig. 8) is large and assymetrical and resembles that of *Mesamphisopus capensis* (Barnard, 1914, p. 223, and Nicholls, 1943*a*, p. 31).

Mandible (Pl. XVII, fig. 2, *mnd.*, and Pl. XVIII, figs. 1 & 2).—Both mandibles possess lacinia mobilis. They form an oblique sloping line with the ventral edge of head, behind the sub-orbital notch in which fits the fulcral process of mandible. The left mandible is somewhat larger than the right. The incisor (Pl. XVIII, fig. 1, *i.pr.*) of the left mandible bears four strongly chitinised teeth. Its lacinia mobilis (Pl. XVIII, fig. 1, *la.m.*) is tridentate and chitinised. Spine row (Pl. XVIII, fig. 1, *sp.*) is borne on a ridge sub-parallel to the lacinia mobilis and carries about half a dozen spines, pectinate on one side. This is followed by a row of plumed setae, about eight or nine in number, borne on a ridge between the base of spine row and molar process. Molar process (Pl. XVIII, fig. 1, *m.pr.*) is well developed; its anterior and lower margins are fringed with cilia, the lowermost five or six of which are long and setose. The shallow, convex shaft also appears to be ciliated. A fringe of cilia also borders the bend between the incisor and molar. Acetabular process (Pl. XVIII, fig. 1, *ace.*) is well developed. Fulcral process (Pl. XVIII, fig. 1, *f.pr.*) is conical and prominent. The palp (Pl. XVIII, fig. 2, *mnd.p.* and Pl, XVIII, figs. 1 and 2) is three-jointed—first joint is short, second nearly double the length of first, and third sub-equal to second and compressed Inner margin of the first joint is ciliated. The third joint is broadly triangular, its distal half on the inner side being concave. The apex of the third joint bears eight or nine, long, finely dentate setae; the inner concave margin carries a fringe of about two dozen shorter dentate setae. Other joints are beset with scattered stiff setae. In the right mandible, incisor is weakly chitinised, lacinia is non-chitinised and its teeth are finely serrate, and the fringe of cilia on the margin of mola shaft is longer. The spine row carries a smaller number of pectinate and plumed spines.

Maxillula (Pl. XVII, fig. 9).—Proximal endite (*pr.end.1*) is short, its apex broad and truncated. The apex carries a row of nine hairy spines of which the first and last are short. The distal endite (*dis.end.1*) is longer, and somewhat broader than the proximal. The apex bears about fifteen pectinate spines, disposed in transverse rows of three each in the proximal series and five or six in the distalmost. These spines are slightly chitinised. The distal half of the posterior edge of the proximal endite and that of the anterior edge of distal endite are fringed with cilia.

Maxilla (Pl. XVIII, fig. 3).—Maxilla shows typical amphisopid condition. The proximal endite (*pr.end.2*) is triangular, with a broad base and narrow, truncated apex. Its mesial edge (*mes.*) is almost straight, with no sharp demarcation between the basal and apical regions. The row of filtratory setae (*fil.se.*), about 36 in number, is well developed, but the setae do not appear to be ciliated. Submarginally, the posterior surface bears a row of about fifteen pectinate spines (*pct.*) which continue upto the apex, and behind this row of spines there is a row of dense cilia. Basally the posterior surface is fringed with small cilia. On the anterior side there are four or five setae in the submarginal concavity at the base. Apex of this endite bears about fifteen setose spines and its distal free margin is ciliated. The middle and outer lobes of the distal endite (*dis.end.2*) are broader and more elevated than the proximal endite. The apex is oblique anteriorly and bears dentate spines, which are about a dozen in number on the middle lobe and about a dozen and a half on the outer. Free margins of these lobes are ciliated. The outer lobe, behind the apical dentate spines, carries a few short and simple spines. The maxillae are similar on both sides and in both sexes.

Labium (Pl. XVIII, fig. 4) is large and bilobed. Apex of each lobe is densely ciliated on the inner side ; towards the base, the cilia are shorter and less dense.

Maxillipede (Pl. XVII, fig. 1, *mxp.* and Pl. XVIII, figs. 5 and 6).—Maxillipede does not show any marked departure from the usual Phreatoicine pattern. Coxa (*co.*) is short and its epipodite (*ep.*) is large, broadly elliptical and free from cilia and hairs. Basis (*ba.*) is twice as long as broad, fringed with a row of simple, short setae on its outer edge, and a single large plumed spine on the postero-distal corner. Endopodite (*end.*) arises in the middle of the basis. It is broad distally and extends up to the end of triangular merus. Its antero-mesial and distal edges are fringed with long, brush setae. A single large coupling hook (*co.h.*) is present in the usual position. Posterior edge is bare except for a few short, simple setae. Ischium (*is.*) is short. Merus (*me.*) is sub-triangular, with a short postero-distal projection bearing two simple setae. Carpus (*ca.*) and propodus (*pr.*) are elongate oval, fringed with a row of long simple setae on the anterior, and only a few setae on the posterior edge. Dactylus (*da.*) is short, narrow and elongate, with apex fringed with long setae.

Peraeopods (Pl.XIX, figs. 1 to 8).—Peraeopods resemble those of *Hyperoedesipus plumosus* Nicholls and Milner (1923, pp. 23-33, Pls. II-V and Nicholls, 1943*a*, pp. 49-57, figs. 12, 13) except that the ganthopod

and fourth peraeopod are not sexually modified in males. Coxae of all peraeopods are fused with the epimera of their respective segments; the first four pairs are attached on the anterior, and last three on the posterior end of the segments.

Gnathopod (Pl.XIX, figs. 1 and 2) is similar in both sexes, resembling that of the female of *Hyperoedesipus*. It is short and stout. Coxa is broad. Basis (*ba.*) is long and moderately expanded. Ischium (is.) is shorter than basis. Merus (*me.*) is sub-quadrangular, and its antero-distal angle is somewhat produced. Carpus (*ca.*) is short and triangular. Propodus (*pr.*) is about as long as the basis and moderately expanded. It is narrow basally; its anterior (dorsal) edge is convex and posterior (ventral) straight. Its posterior margin bears five or six spines, and a sub-marginal row of a few short hairs. The dactylus (*da.*) is shorter than the ventral margin of propodus and is usually flexed below the latter. Its inner edge, facing the propodus is straight, the outer edge being somewhat convex. Distally it tapers into a long, narrow, inwardly bent claw. The posterior edge (which faces the propodus when in flexed condition) is dentate, carrying about eight short, forwardly directed teeth and a sub-margical row of six setae. The free edges of all the joints of the gnathopod are beset with scattered spines, which are more numerous on the anterior margin of the dactylus and antero-distal angle of palm. The carpus bears four short spines and about half a dozen setae on its posterior edge.

Of the succeeding pairs of peraeopods, those of the anterior series of three (Pl. XIX, figs. 3, 4 and 5) are somewhat stouter than those of the posterior series (Pl. XIX, figs. 6, 7 and 8). In the second (fig. 3), third (fig. 4) and fourth (fig. 5) peraeopods bases are expanded a little and individual joints are somewhat compressed. Merus (*me.*) is slightly produced antero-distally. The posterior three pairs, fifth (fig. 6), sixth (fig. 7) and seventh (fig. 8) are slender and their individual joints are elongated, the antero-distal projection of merus being more obsolete. Dactylus in all peraeopods is very short and ends in a stout, curved claw which bears a short unguis at its base. The posterior border of propodus bears a row of spines, four or five in the anterior series, and seven or eight in the posterior. Edges of all legs are fringed with setae and spines, which are more numerous on the posterior edge of carpus, and antero-distal angle of merus.

Coxae of seventh peraeopods bear a pair of long penes (Pl. XVII, figs. 12 and 13, *pe.*).

Pleopods (Pl. XX, figs. 1, 2, 3, 4 and 5).—Pleopods are foliaceous and probably respiratory in function. Epipodites are absent, and the sympodites are not covered by the downwards extension of pleura of pleon segments. Coupling hooks are absent, but each sympodite bears two entangling setae on the inner side, carried on a slight ridge, the upper seta being long and the lower one very short. Exopodites and endopodites are smooth and free from plumose setae. Lobe on exopodite is very laterally displaced. Endopodites are very reduced and cleft in the middle. Unlike other Phreatoicids, the posterior pleopods are not much shorter than the anterior ones. First three pairs are sub-equal,

fourth slightly shorter and broader than the first and the fifth is a little shorter than the fourth.

First pleopod (fig. 1) has an elongate oval, smooth exopodite (*exo.*) whose apex is somewhat narrow. The endopodite (*end.*) is about half as long as the exopodite and very narrow. A median longitudinal cleft extends from the distal extremity, up to one third the length of the entire endopod, giving it an appearance of a 'tuning fork'. The exo- and endopod are free from setae or cilia.

Exopodite of second to fifth pleopods is bilobed. In the second pleopod (fig. 2) the exopodite, which is slightly longer than that of the first, is broadly, triangular with a narrow rounded apex. Its outer margin is almost straight, and is produced proximally. The inner margin is oblique up to two-thirds of its length, where it meets the shaft that bears the lateral lobe (exo. l.). The lateral lobe is long and narrow and springs from a triangular shaft, which projects from the inner margin in the basal third of exopod. The lobe is narrow basally and broadens out apically. External to the insertion of the lobe, the shaft bears numerous simple spines. The endopodite in female is similar to that of the first pleopod. In males, however, endopodite of second pleopod bears a complex penial stylet (fig. 2, *pe. st*). In this pleopod, the endopodite is long and consists of a muscular peduncular region and a distal forked portion, with a feeble constriction at the junction of the two regions. The penial stylet springs from the apex of the peduncular region, and, except at the point of attachment, is completely free from the endopodite. The muscular base of the stylet lies apposed to the endopod for some distance, beyond which it takes a sharp downwards bend. The body of the stylet consists of a thick muscular rim, enclosing a membraneous area. The inner margin (which is away from the endopodite) is strongly convex and thick, and projects beyond the straight outer margin (facing the endopod) in the form of a beak. The margin facing the endopodite is thin and straight and there is a stout spine at the angle where the outer and inner margins meet. The inner margin bears three less stout spines. Third pleopod (fig. 3) appears to be somewhat larger than the preceding two. It is similar in structure to the second pleopod of female. Fourth (fig. 4) and fifth (fig. 5) pleopods are slightly shorter, fifth being the shorter of the two. They are similar to the third but both the exopod and endopod are broader, more rounded and less elongate.

Uropoda (Pl. XVII, figs. 4, 5, 10 and 11).—Peduncle (figs. 4, 5, 10 & 11, *u.p.*) is short and stout and extends beyond the telsonic edge. Its inner mesial edge is ridged and fringed with a few short, stiff setae, and the disto-mesial angle is produced into three large tubercles. Outer ramus (*o.r.*) of uropod is longer than the inner. It is lamellar and narrows towards the apex, which bears a tuft of long spines. Inner ramus (*i.r.*) is short, stout and style shaped. It is broad basally and tapers towards the apex. It bears on the outer margin sub-apically, a few short setae. In adult males (fig. 10) the outer ramus is very long, and may be one and a half times as long as the tail-piece. In females, the outer

ramus (figs. 4 & 5) is much shorter than the tail-piece, although still longer than the inner-ramus.

Females.—Females are smaller in size than males. They do not differ much from the males in general structure, except in the outer ramus of the uropod, which is shorter than the tail-piece. There are four pairs of oostegites on peraeopods one to four. Each oostegite is as long as the basis, and broadly quadrangular in shape.

Early Stages.—There are numerous young specimens in the collection. In the smallest example about 7·0 mm. in length, the outer ramus of uropod is very short, being hardly longer than the inner ramus. As growth proceeds, this ramus (outer) increases at a faster rate than the tail-piece, the differential growth being much faster in the males, than in the females. Sex can be determined at a very early stage, by the presence of tiny bud like penes on the coxae of seventh peraeopods and also by the penial stylet, which appears as a pea-shaped, small outgrowth in the peduncular region of the endopodite of second pleopod of males.

Size.—The largest male example in the collection measures 25·6 mm. Mature males vary in length from 20·0 mm. to 25·0 mm. The largest female with brood pouches measures 16·0 mm.

Holotype.—1♂, Regd. No. C2898/1, Zoological Survey of India, Calcutta.

Paratypes.—Numerous ♂♂ and ♀♀, No. C2899/1, Zoological Survey of India, Calcutta.

Type locality.—Banaras. The holotype and paratypes were collected from the well in the outer lawn of the Kaiser-Castle, Banaras Cantt.

Colouration.—Living specimens were semi-transparent. Specimens preserved in spirit are white.

Habits.—Specimens of *Nichollsia kashiense* can be kept alive in laboratory for months, if the water in the vessel containing them is regularly changed. This species has so far been obtained in wells with very clear water free from carbondioxide and other impurities, and can not probably tolerate dirty or stagnant water. One specimen which was kept in a jar containing a small quantity of cooked rice was attacked by fungus and died within three days.

This species does not swim as gracefully as many other Isopods and it moves about in water by a series of wriggling movements of the body. Specimens kept in laboratory aquaria mostly crawled about around the edge on bottom and rarely came up to the surface of water. As in other Isopods, the first four pairs of legs are directed forwards during locomotion and these serve to hold the substratum while the posterior three pairs, which are directed backwards, appear to push the animal forward. The gnathopods usually do not take part in walking, but are raised up to the level of maxillipedes. Sometimes the animal flexes its telson below the abdomen and proping it against the substratum, turns over completely. While crawling on the bottom the flat ventral surface of tail-piece rubs against the substratum and the outer rami of uropods are fanned out. The middle of the body is slightly raised up in

the form of hump when the animal crawls. The pleopods show very feeble movements and probably serve as respiratory organs only.

Gnathopods appear to be used for digging up food matter. Usually while crawling, the dactyli of gnathopods stir up the substratum and by a simultaneous movement of the mouth parts, food particles appear to be drawn in. Examination of the contents of intestine revealed mostly particles of red sand which forms the bottom of wells in Banaras. It is, however, interesting to record that one batch of specimens kept under observation in the laboratory had nibbled at the surface of the paper label that had been placed in the jar containing them.

N. kashiense does not appear to show any marked reaction to light. Specimens kept in partial darkness did not show any particular preference to it, but moved about equally freely in the brightly lit and the darkened portions of the jar.

Specimens of *N. kashiense* kept in a jar containing red sand at the bottom did not show any tendency to burrow, although they often entered a small glass tube which had been placed on the bottom of the jar.

This species has only been obtained from wells so far, and attempts to obtain it from other habitats have proved unsuccessful.

Distribution.—Wells in Banaras and Lohgara (Allahabad District), U. P. It is possible that the species has an extensive distribution in underground waters of the Gangetic plains.

Remarks on affinities.—The absence of other Phreatoicid material for comparison at our disposal has made it somewhat difficult for us to define clearly the relationships of our new genus *Nichollsia* with other known members of this group. Though this genus has an extremely specialised habitat, in which it has probably been living for a long time, the fact that many unrelated or remotely related genera of this diverse sub-order sometimes show striking similarities, which can only be accounted for by convergence, has further added to our difficulties.

Subterranean Phreatoicids show certain features in common. All the three previously known subterranean genera of the family Amphisopidae, *viz.*, *Hyperoedesipus* (sub-fam. Mesamphisopinae), *Hypsimetopus*, and *Phreatoicoides* (sub-fam. Hypsimetopinae), have a slender vermiform body, reduced pleural extensions of pleon, tendency towards loss of setae on pleopods, lateral displacement of the lobe on the exopodite of pleopods and reduction of the endopodite of the same. *Nichollsia* exhibits all these characters in a more or less aggravated form. In this genus the body is comparatively more slender than that in the above-mentioned three genera, the exopodite of pleopods has completely lost the setae, endopodite is very much reduced and smooth and lobe on the exopodite is more laterally displaced. If any gradation in the characters referred to above is an indication of the time at which a genus took to subterranean habitat, then *Nichollsia* is probably the oldest denizen of underground waters. The Hypsymetopines probably took to this habitat somewhat later, and *Hyperoedesipus* was, perhaps, the last to go down.

Besides the common features mentioned above, *Nichollsia* exhibits certain other structural similarities, of a somewhat remote nature, with these genera. With *Hyperoedesipus*, *Nichollsia* shares the short and free first peraeon segment, long truncated tail-piece and general structure of the head and mouth parts. In this connection it is interesting to record that in very young examples of *Nichollsia*, the mandibles are as forwardly placed as in *Hyperoedesipus*. The pattern of mouth parts conforms to the same general plan as in *Mesamphisopus capensis* (Barnard) but the differences between the two are rather too marked to suggest any close affinity between the Mesamphisopinae and the Nichollsinae.

Whereas in the structure of cephaloperaeon and its appendages, *Nichollsia* resembles to some extent the Mesamphisopinae, the Nichollsinae appears to be much nearer to the Hypsimetopinae in the structure of pleon and its appendages. The common characters here are the absence of coupling hooks on the sympodites of pleopods, the presence of a few entangling setae on the sympodite, curved short peinal stylet, an antero-dorsally articulated tail-piece and four pairs of oostegites in females. *Nichollsia*, however, can neither be accommodated in the sub-family Mesamphisopinae, because of the absence of coupling hooks on the sympodites of pleopods, nor in the Hypsimetopinae on account of the short first peraeon segment free from the head.

The long filiform antennule of *Nichollsia* is not met with in any of the other subterranean forms, but is a character of Amphisopinae and Phreatomerinae (Nicholls, 1943*a*, p. 86).

The characters which are confined to *Nichollsia* alone are proportionately long pleon-telson, forked endopods of pleopods and the sub-equal posterior pleopods. The structure of uropods of *Nichollsia*, as already described, is very peculiar. The outer ramus of uropod is longer than the inner and in adult males it is enormously elongated. In young ones, however, the outer ramus is rather short, although still slightly longer than the inner, a condition which approximates to that of the sub-equal rami of *Onchotelson* Nicholls (1943*b*, p. 86).

From what is stated above, it is obvious that *Nichollsia* is a very specialised genus of Phreatoicoidea, although certain primitive features can still be noticed. Its position appears to be intermediate between *Hyperoedesipus* and Hypsimetopine Amphisopids and assuming that all these forms have evolved from a generalised type of common Gondwanaland ancestor, it appears likely that divergence from the ancestral type and independent development along different directions must have started very early.

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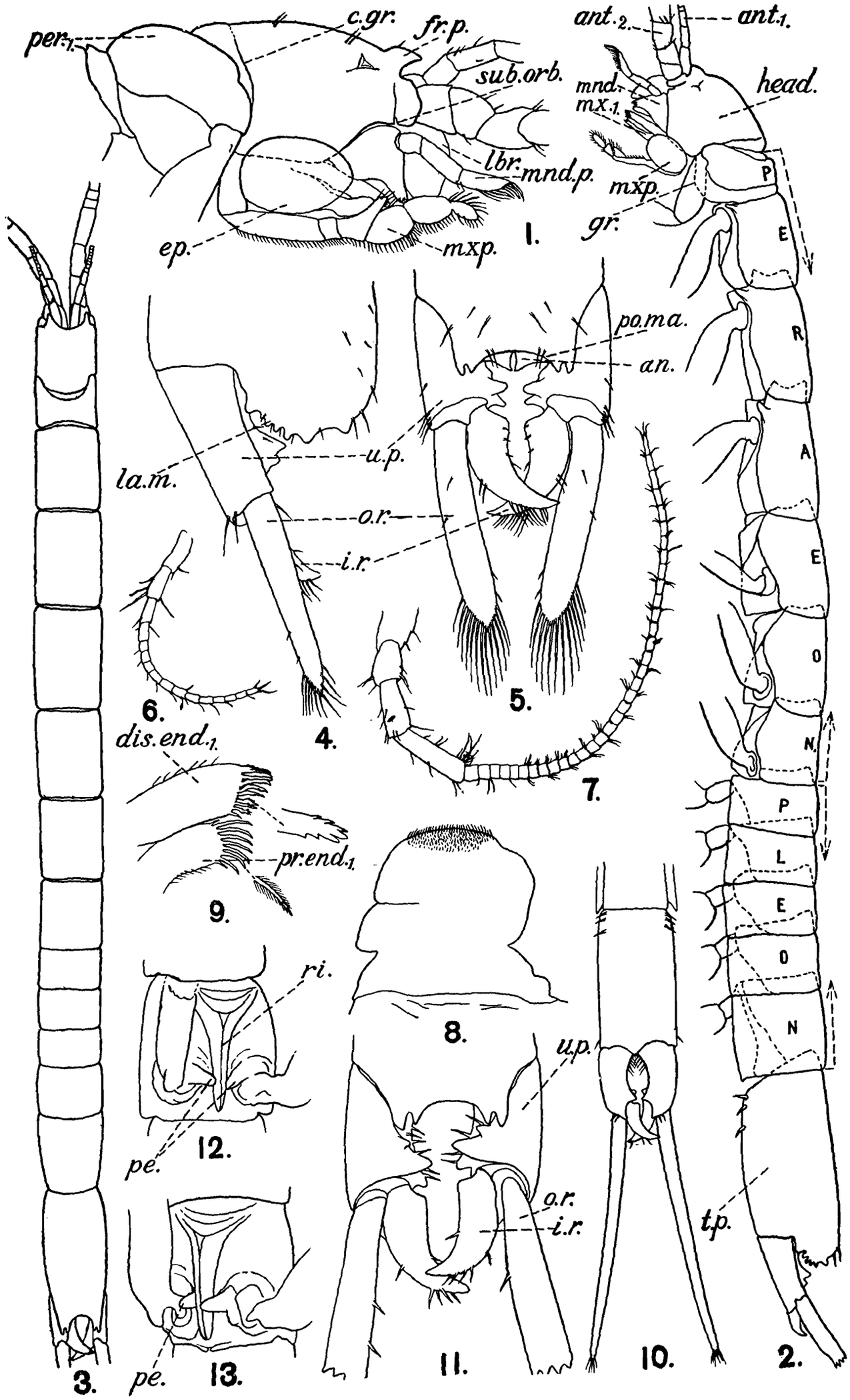
EXPLANATION OF PLATE XVII.

A New Phreatoicid Isopod from Banaras.

Nichollsia kashiense, gen. *et.* sp. nov.

FIG. 1.—Lateral view of the head, ♂ ; × 11¼.
FIG. 2.—Lateral view of entire animal, ♂ : ×9.
FIG. 3.—Dorsal view of entire animal, ♂ : ×5.
FIG. 4.—Posterior end of tailpiece and uropod, ♀, in lateral view ×25½.
FIG. 5.—Dorsal view of the same : ×25½.
FIG; 6.—Antennule : ×25.
FIG. 7.—Antenna : ×25.
FIG. 8.—Labrum : ×31½.
FIG. 9.—Maxillula : ×24½.
FIG. 10.—Tailpiece, ♂, ventral view : ×7.
FIG. 11.—Posterior end of tailpiece, ♂, in dorsal view : ×17½.
FIGS. 12 & 13.—Seventh peraeon segment, ♂, ventral view : ×25.

an., anus ; *ant. 1.*, antennule ; *ant. 2.*, antenna ; *c. gr.*, cervical groove ; *dis. end. 1*, distal endite of maxillula ; *ep.*, epipodite of maxillipede ; *fr. p.*, fronto-lateral proeess; *gr.*, gnathopod ; *i. r.*, inner ramus of uropod ; *la. m.*, postero-lateral margin of tailpiece ; *lbr.*, labrum ; *mnd.*, mandible ; *mnd. p.* mandibular palp ; *mx. 1.*, maxillula ; *mxp.*, maxillipede ; *o. r.*, outer ramus of uropod · *pe.*, penes ; *per. 1.*, first peraeon segment ; *po. ma.*, postero-dorsal margin of tailpiece ; *pr. end. 1*, proximal endite of maxillula ; *ri.*, sternal ridge in peraeon segment ; *sub. orb.*, sub-orbital notch ; *t. p.*, tail-piece ; *u. p.*, uropodal peduncle.



Nichollsia kashiense, gen. *et* sp. nov.

EXPLANATION OF PLATE XVIII.

A New Phreatoicid Isopod from Banaras.

Nichollsia kashiense, gen. *et.* sp. nov.

FIG. 1.—Left mandible, ♂, anterior view : ×65.

FIG. 2.—Mandibular palp : ×29.

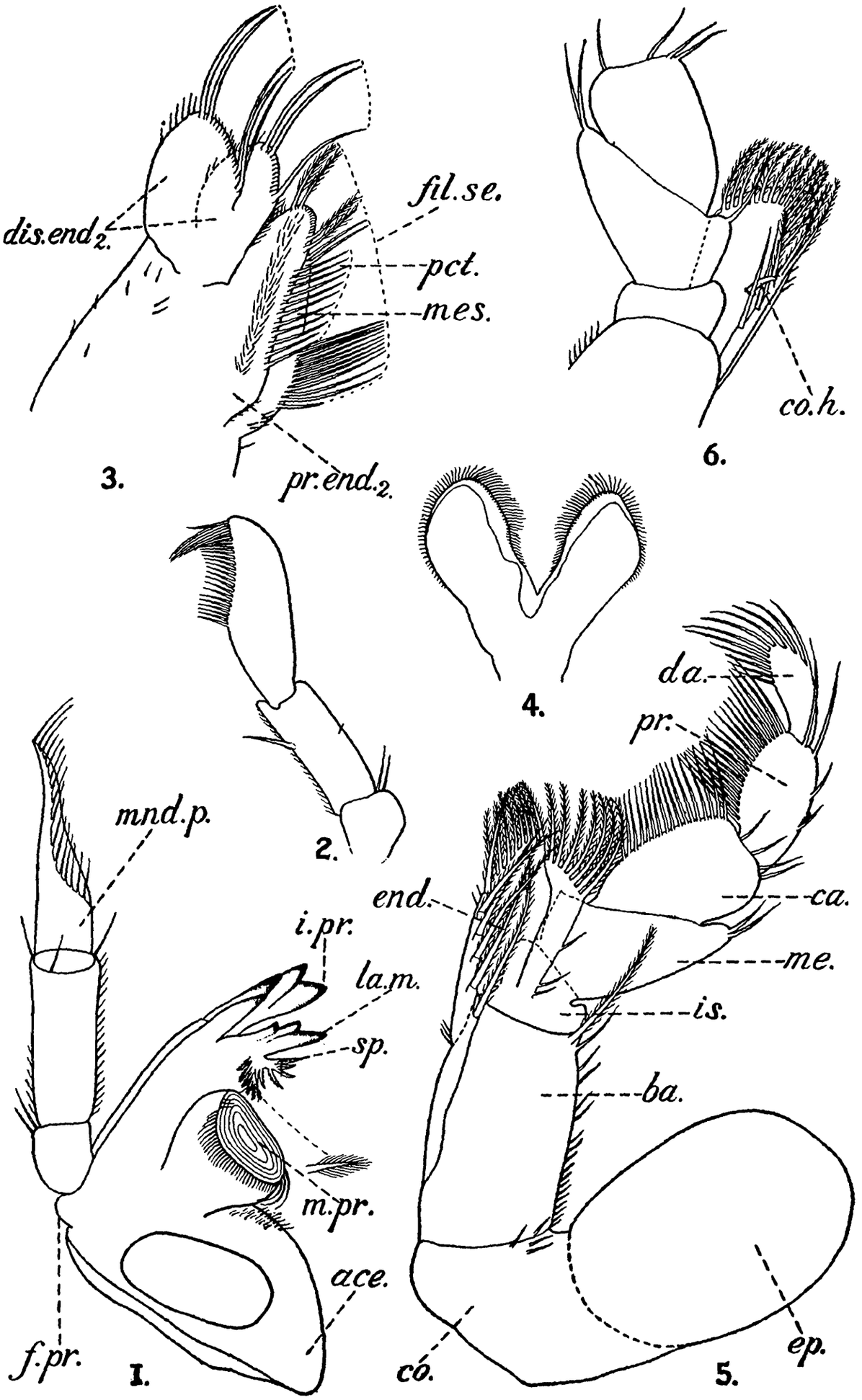
FIG. 3.—Right maxilla, ♂, posterior view : ×65.

FIG. 4.—Labium : ×38.

FIG. 5.—Right maxillipede, ♀ : ×65.

FIG. 6.—Portion of right maxillipede, ♀, anterior view : ×65.

ace., acetabular process ; *ba.*, basis ; *ca.*, carpus ; *co.*, coxa ; *co. h.*, coupling hook ; *da.*, dactylus ; *dis. end. 2.*, distal endite of maxilla ; *end.*, endopodite of maxillipede ; *ep.*, epidodite of maxillipede ; *f. pr.*, fulcral process ; *fil. se.*, filtratory setae ; *i. pr.*, incisor process of mandible ; *is.*, ischium ; *la. m.*, lacinia mobilis ; *m. pr.*, molar process ; *me.*, merus ; *mes.*, mesial surface of maxilla ; *mnd. p.*, mandibular palp ; *pct.*, pectinate setae ; *pr.*, propodus ; *pr. end. 2.*, proximal endite of maxilla ; *sp.*, spine row



Nichollsia kashiense, gen. *et* sp. nov.

R. Bagchi and K. K. Tiwari *del.*

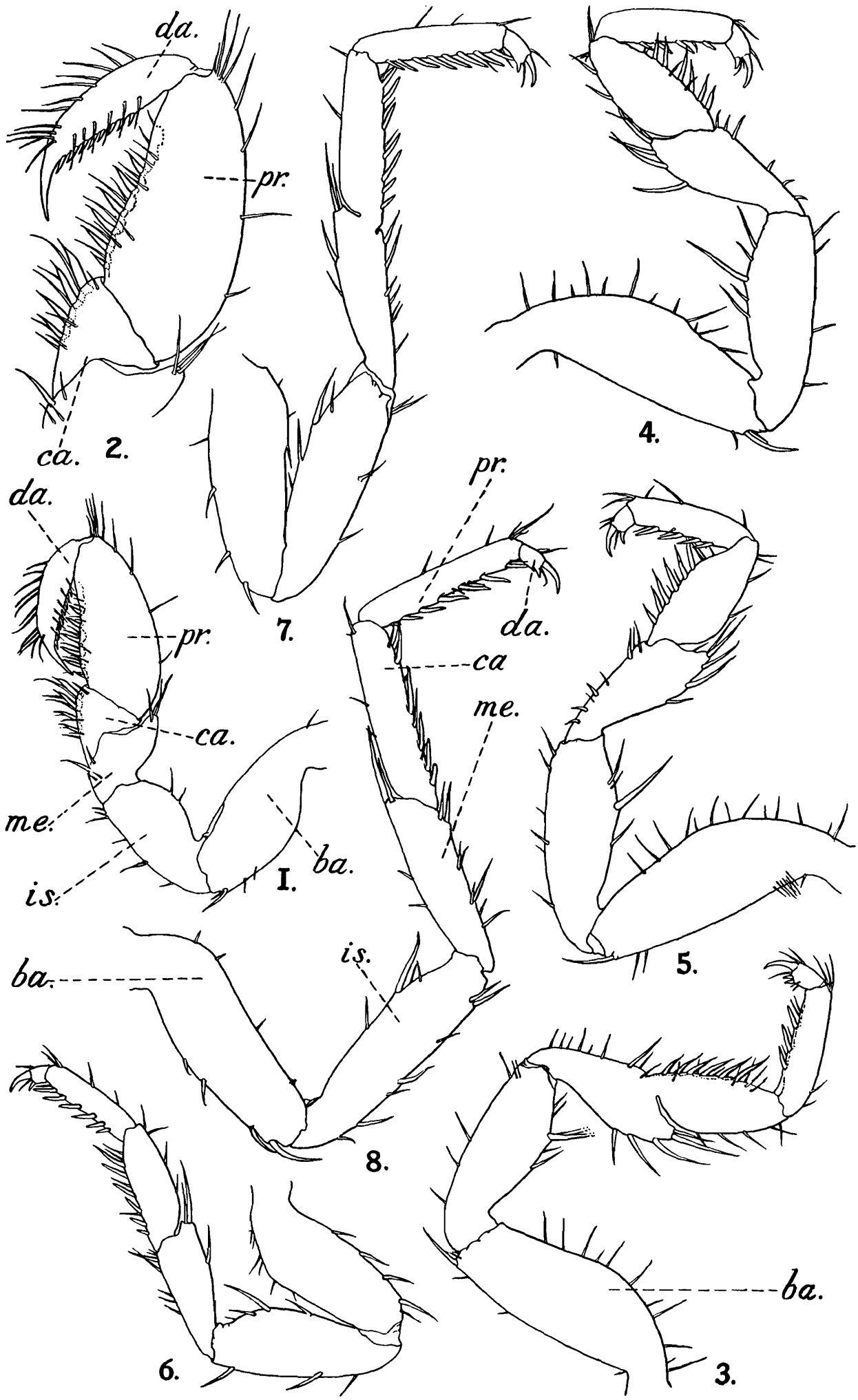
EXPLANATION OF PLATE XIX.

A New Phreatoicid Isopod from Banaras.

Nichollsia kashiense, gen. *et.* sp. nov.

FIG. 1.—Gnathopod, ♂: ×30.
FIG. 2.—Hand of gnathopod, ♂: ×48.
FIG. 3.—Second peraeopod, ♂: ×30.
FIG. 4.—Third ,, , ♂: ×30.
FIG. 5.—Fourth ,, , ♂: ×30.
FIG. 6.—Fifth ,, , ♂: ×30.
FIG. 7.—Sixth ,, , ♂: ×30.
FIG. 8.—Seventh ,, , ♂: ×30.

(Lettering as in plate XVIII).



Nichollsia kashiense, gen. *et* sp. nov.

R. Bagchi and K. K. Tiwari *del.*

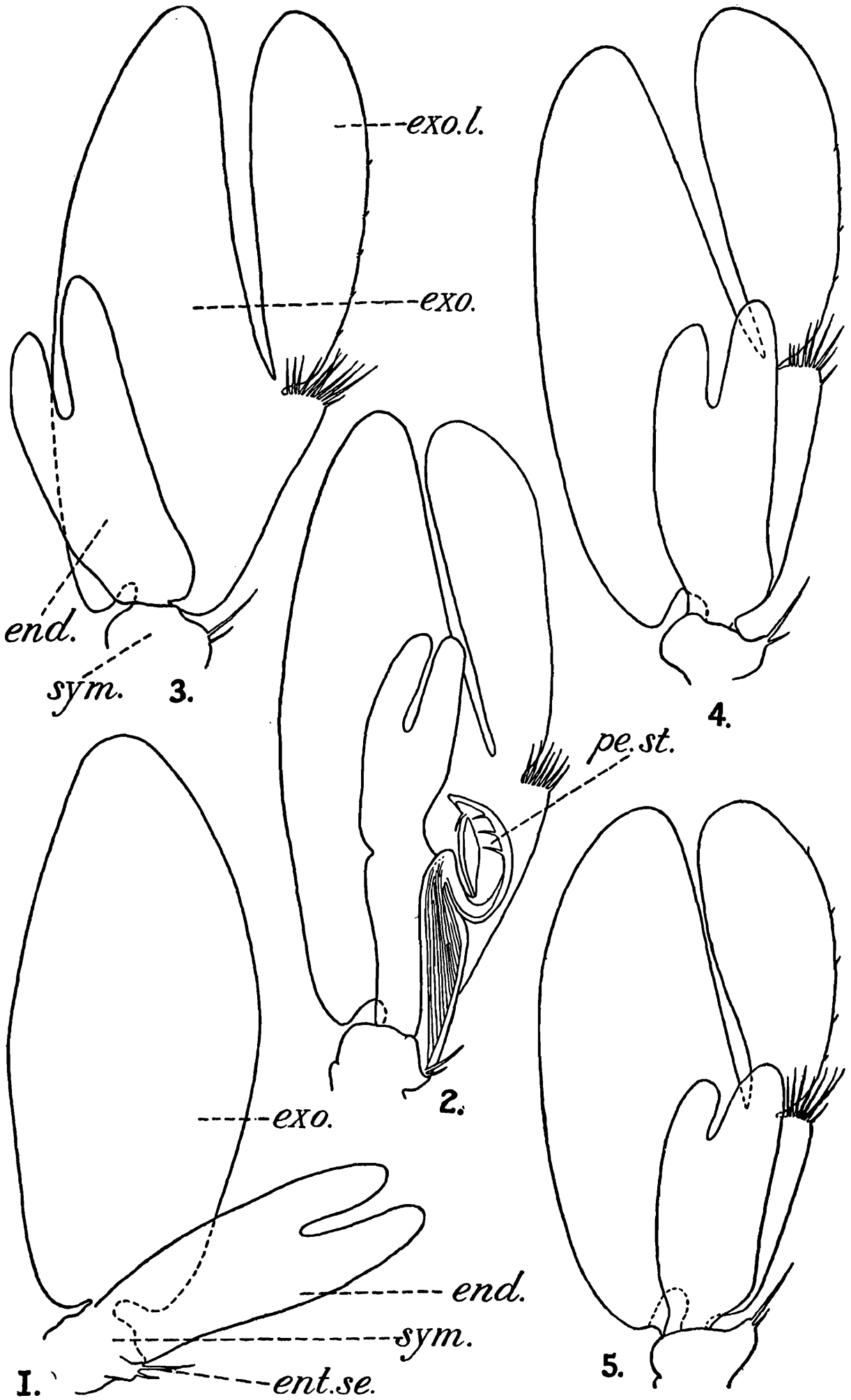
EXPLANATION OF PLATE XX.

A New Phreatoicid Isopod from Banaras.

Nichollsia kashiense, gen. *et.* sp. nov.

FIG. 1.—First pleopod, ♂: ×30.
FIG. 2.—Second „ , ♂: ×30.
FIG. 3.—Third „ , ♂: ×30.
FIG. 4.—Fourth „ , ♂: ×30.
FIG. 5.—Fifth „ , ♂: ×30.

end., endopodite; *ent. se.*, entangling setae; *exo.*, exopodite; *exo. l.*, lobe on exopodite; *pe. st.*, penial stylet; *sym.*, sympodite.



Nichollsia kashiense, gen. *et* sp. nov.

R. Bagchi and K. K. Tiwari *del.*

ON SOME NEW SPECIES OF THE GENUS *CENTRORHYNCHUS* LUHE, 1911.

By E. N. Das, *M.Sc., Department of Zoology, Vidarbha Mahavidyalaya Amraoti, Berar, India.*

The Acanthocephalan fauna of India is very insufficiently known. Not more than a dozen species have been so far described by Van Cleave, Dutta, Bhalerao, Chandler and Thapar. Acanthocephala, either in the encysted form in the mesentery, or free in the intestine, are found in most vertebrates dissected in the laboratories in India. I have in my possession several forms collected from various hosts. This paper describes four new species of the genus *Centrorhynchus* obtained from a fish and birds. Meyer records 32 species of this genus and since the publication of Meyer's book, six more species have been described. These are *C. maryassis* Datta (1932) from India, *C. insularis* Tubangui (1933) from Philipine islands, *C. elongatus* Yamaguti (1935), *C. turdi* and *C. bubonis* Yamaguti (1939) from Japan and *C. conspectus* Van Cleave and Pratt (1940) from North Carolina.

Two chief attempts were made to classify this group of worms, one by Southwell and MacFie (1925) and another by Thapar (1927). Meyer (1933) proposed a classification different from these two and I have followed his classification.

Genus Centrorhynchus

The genus *Centrorhynchus* was created by Lühe in 1911. It was included by Meyer in the family Polymorphidae and sub-family Centrorhynchinae. Its distinguishing characters, according to Meyer, are (i) the presence of two kinds of hooks on the proboscis ; (ii) 1-3 cement glands in East Asian species, and 4 in others ; (iii) oval eggs with concentric coverings and (iv) preying birds as hosts.

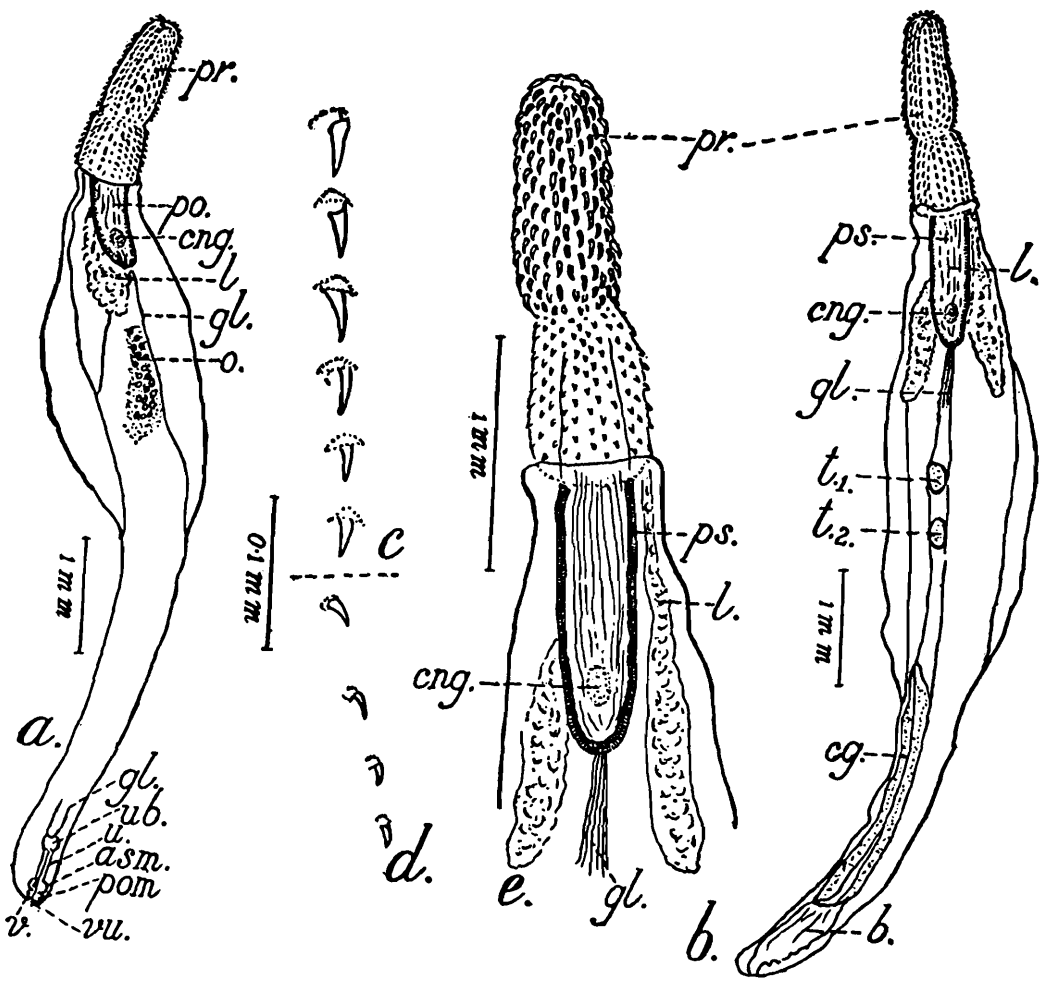
Centrorhynchus falconis, sp. nov.

Both male and female forms were found in the intestine of the host. The proboscis was invariably embedded in the wall of the intestine, rest of the body being in the lumen.

Males and females are almost of the same size measuring 8·8 and 8·7 mm. in length respectively. The body is broadest in the middle where it measures 0·52 mm., the width of the anterior portion of the body being 0·40 mm.

The proboscis (text-fig. 1*a*, *b* and *e*, pr) is long and cylindrical, measuring 0·95 mm. and the whole proboscis-like structure with the neck is 1·62 mm. long. There are 28 to 30 longitudinal rows of hooks, each row having 21 to 23 hooks. The hooks of adjacent rows alternate

with each other throughout the length of the proboscis. The hooks present on the true proboscis are 12 to 14 in number and measure 36 μ in length (text-fig. 1*c*), whereas those present on the neck are less numerous being 9 in number (text-fig. 1*d*) and are smaller in size measuring 17 μ in length, about half the size of those on the true proboscis.



TEXT-FIG. 1.—*Centrorhynchus falconis* sp. nov.

a. Entire female; *b.* Entire male; *c.* Some of the hooks on the prob scis; *d.* Some of the hooks on the neck; *e.* Proboscis with proboscis sheath; *asm.* anterior sphincter muscle; *b.* bursa; *cg.*, cement gland; *gl.*, genital ligament; *l.* lemnisci; *o.*, ovary; *pr.*, proboscis; *ps.*, proboscis sheath; *psm.*, posterior sphincter muscle; t_1., anterior testis; t_2., posterior testis; *u.*, uterus; *ub.*, uterine bell; *v.* vagina; *vu.*, vulva.

The proboscis sheath (text-fig. 1*a*, *b* and *e*, ps) is double-walled and measures 1·81×0·30. mm.

The body wall has a thin cuticle. The lacunar system consists of two main lateral canals from which smaller branches arise and form a closed network.

The lemnisci (text-fig. 1*a*, *b* and *e*, l) are of medium size. They measure 1·7 mm. in length, and extend up to 0·55 mm. beyond the base of the proboscis sheath.

Female genitalia.—The ovary (text-fig. 1*a*, o) lies about the middle of the body, 0·20 mm. behind the posterior end of the lemnisci. It is divided into a number of rounded egg masses which are held together within the genital ligament (text-fig. 1*a*, gl) which arises from the posterior

end of the proboscis sheath and runs on to the two sides of the body enclosing the ovary. Posteriorly, they are attached to the anterior part of the oviduct known as the uterine bell (text-fig. 1*a*, ub), thus helping to keep in position the posterior genital apparatus, which includes the uterine bell, uterus (text-fig. 1*a*, u), vagina (text-fig. 1*a*, v) and vulva (text-fig. 1*a*, vu) and measures 0·12×0·10 mm.; its wall is muscular and disposed to receive the eggs. Posteriorly it communicates with the funnel shaped anterior end of the uterus. The uterus is a tubular structure having a muscular wall. It measures 0·25 mm. in length. Posteriorly it opens into the vagina which measures 0·19×0·10 mm. The vaginal canal is enclosed within the anterior and posterior sphincter muscles (text-fig. 1*a*, asm and psm) and opens into the vulva which forms the external opening.

Male genitalia.—There are two testes of almost the same size measuring 0·30×0·20 mm. They are held in position by the genital ligament (text-fig. 1*b*, gl) in the body cavity. The anterior testis (text-fig. 1*b*,t_1) is placed at a distance of 3·8 mm. from the anterior end of the worm and the posterior testis 4·3 mm. The cement glands (text-fig. 1*b*, cg) are 2 in number and are long and tubular. The bursa (text-fig. 1*b*, b) is stout and consists of several muscular rays. It is about 0·95 mm. long.

Comparison with other species.—*Centrorhynchus falconis* sp. nov. has 28 to 30 longitudinal rows of hooks and there are 12 (14) hooks in a row on the proboscis and 9 in a row on the neck. The following table shows species which have 28 to 30 longitudinal rows of hooks :—

Name of Species	Long : rows	Hooks in each row	Hooks on proboscis and neck in each row
C. aluconis (Muller, 1780)	30	15	..
C. buteonis (Schrank, 1788)	30—32	12—16	7—10, 5—7.
C. globocaudatus (Zedder, 1800)	30	18—21	5—6, 13—15.
C. leptorhynchus (Meyer, 1933)	28—30	22	10(9), 4(5), 8.
C. spinosus (Van Cleave, 1924)	30—32	22—23	8(9), 14.
C. polymorphus (Travassos, 1926)	30	17	10, 7.
C. albidus (Meyer, 1933)	28—30	20	7, 13.
C. horridus (Von Linstow, 1897)	26—28	15—16	5—6, 10.
C. turdi (Yamaguti, 1935)	26—29	11—14	..
	26—34	11—13	..
C. elongatus (Yamaguti, 1935)	26—31	13—19	..
C. conspectus (Van Cleave & Pratt, 1940)	30—32	17—18	..

In none of the above species the proboscis bears 23 hooks except *Centrorhynchus spinosus* (Van Cleave, 1924) and in none there are 12 (14)

hooks on the head and 9 on the neck. *Centrorhynchus spinosus* is a much larger worm and has a much larger number of hooks on the neck and the hooks are of much larger size. I therefore consider *Centrorhynchus falconis* to be a new species.

Diagnosis.—Males and females with the same length; proboscis 0·95 mm. in length and with neck 1·62 mm.; 28 to 30 longitudinal rows of hooks, 21 to 23 hooks in each row; 12(14) on proboscis and 9 on neck; hooks measure 36 μ and 17 μ respectively; lemnisci 1·7 mm. in length and extend upto 0·55 mm. beyond the base of the proboscis sheath; the proboscis sheath double walled, measures 1·81×0·30 mm.; cement glands 2, long and tubular in shape; two testes of almost the same size measuring 0·30×0·20 mm.

Host.—The Pale Harrier, *Circus macrourus* (Gmn.).

Locality.—Amritsar (East Punjab), India.

Type-specimens.—(W..... .) are deposited in the collection of the Zoological Survey of India.

Centrorhynchus macrorchis, sp. nov.

Only two specimens of this species were found in the posterior portion of the intestine of the host sticking firmly to the wall of the intestine. Both were males. They were of a dark brown colour when alive, a character which makes them peculiar among Acanthocephala.

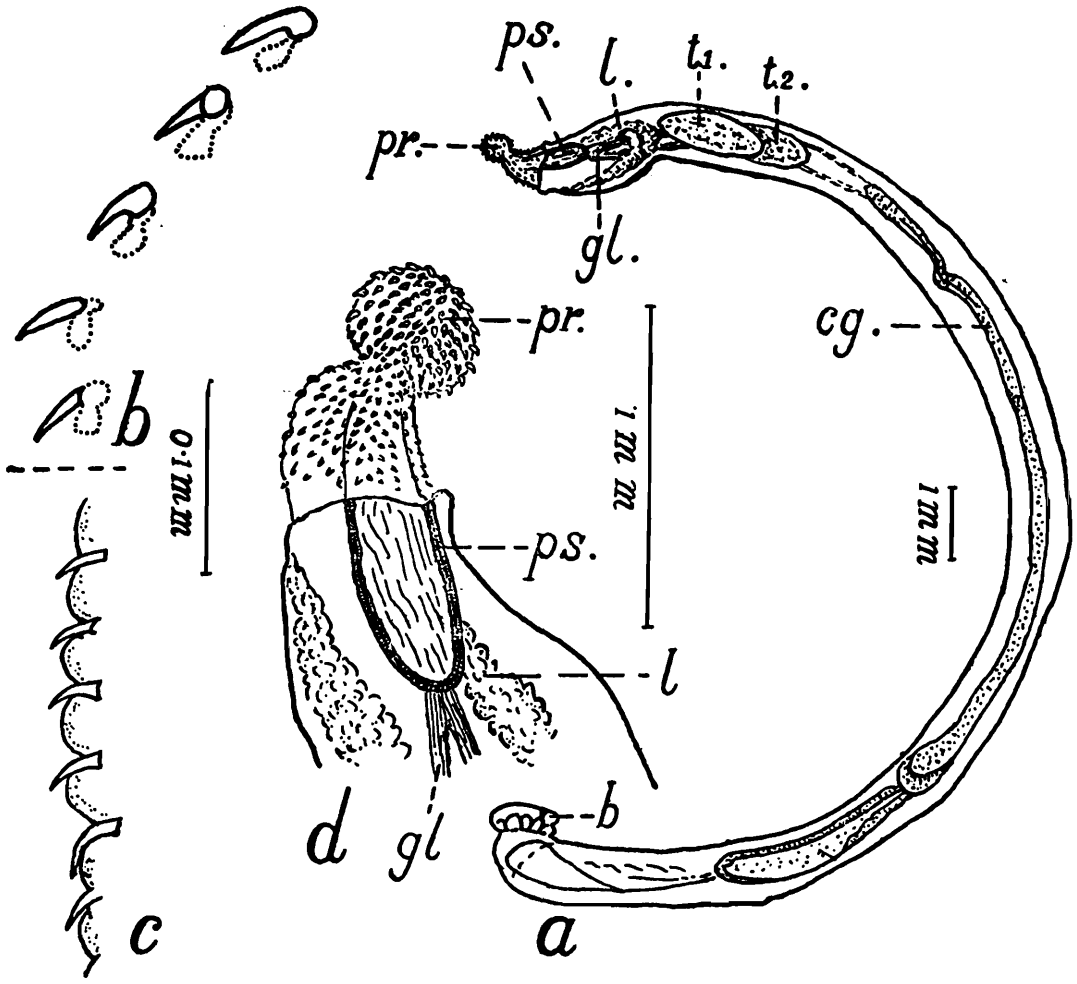
The body is stout, tubular, uniform in girth and curved. The form is fully matured, its total length is 18·8 mm. Its breadth is uniform and measures 0·82 mm.

The true proboscis (text-fig. 2*a* and *d*, pr) is a small knob-like structure, almost spherical in shape and measures 0·32×0·32 mm. The neck is long and stout and broader than the true proboscis, measuring 0·42 mm. at its base. The whole proboscis measures 0·74 mm. The proboscis sheath (text-fig. 2*a* and *d*, ps) is double walled and measures 0·95×0·29 mm. There are 24 to 28 longitudinal rows of hooks, each row consisting of 19 hooks, arranged as 9+10. Each hook borne by the bulbous head measures 34 μ (text-fig. 2*b*) and each hook on the neck measures 11 to 13 μ (text-fig. 2*c*).

There are two testes (text-fig. 2, t_1 and t_2), which are rather large and disposed so much towards the anterior end that the two lemnisci (text-fig. 2*a*, l) are folded over each other. The anterior testis is placed at a distance of 2·19 mm. from the extreme anterior end and measures 1·40×0·51 mm. The posterior testis is slightly smaller and is overlapped by the anterior testis; it is 3·1 mm. behind the anterior end and measures 1·10×0·41 mm.

The cement glands, four in number, are long and tubular; they form two pairs, the anterior pair being longer than the posterior.

The bursa (text-fig. 2*a*, *b*) is thick and muscular and is studded with plate-like structures at its root.



Text-fig. 2.—*Centrorhynchus macrorchis*, sp. nov.

a. Entire male; *b*. Some of the hooks on proboscis; *c*. Some of the hooks on the neck; *d*. proboscis with proboscis sheath. Other letterings as in the text-fig. 1.

Comparison with other species.—*Centrorhynchus macrorchis* sp. nov. is characterised by the possession of 24 to 28 rows of hooks on the proboscis, each row having 19 hooks, 10 on the proboscis and 9 on the neck. The following table shows other species of *Centrorhynchus* having approximately the same number of rows of hooks :—

Name of Species	Long : rows	Hooks in each row	Hooks on proboscis and neck in each row
C. leptorhynchus (Meyer, 1933)	28—30	22	10(9), 4(5), 8.
C. giganteus (Travassos, 1919)	24—26	27—28	16—17, 11.
C. opimus (Travassos, 1919)	24	12—13	..
C. tumidulus (Rudolphi, 1819)	26	23	..
C. simplex (Meyer, 1933)	22—24	24	14, 10.
C. albidus (Meyer, 1933)	28—30	20	7, 13.
C. horridus (Von Linstow, 1897).	26—28	15—16	5—6, 10.
C. turdi (Yamaguti, 1935).	26—29	11—14	..
	26—34	11—13	..
C. elongatus (Yamaguti, 1935)	26—31	13—19	..

The above table indicates clearly that *C. macrorchis* sp. nov. differs from all others not only in number of hooks but also in the distribution of the hooks on the proboscis and the neck. In view of the above facts I consider it to be a new species.

Diagnosis.—Male measuring 18·8 mm. in length and 0·82 mm. in girth; proboscis 0·32×0·32 mm.; proboscis with neck measures 0·74 mm.; 24 to 28 longitudinal rows of hooks, each row consisting of 9 hooks on the knob like head and 10 hooks on the neck; hooks measuring 34 μ and 11 to 13 μ respectively; proboscis sheath double walled, measuring 0·95×0·29 mm.; testes two situated near the lemnisci; anterior testis 1·40×0·51 mm., posterior 1·10 × 0·41 mm.; cement glands in two pairs, long and tubular, anterior pair longer than posterior; bursa thick and muscular, studded with plate like structures at its root.

Host.—Cerchneis tinunculus tinunculus.

Locality.—Amraoti, Berar, India.

Type-specimens.—(W .) are deposited in the collection of the Zoological Survey of India.

Centrorhynchus brevicaudatus sp. nov.

Only one male specimen was found in the intestine of the host. The total length of the parasite is 3·31 mm. The body is fusiform. At its anterior end it measures 0·32 mm. In the middle where it is broadest it measures 0·70 mm. The posterior part of the body narrows to form a tail-like structure, which is short and slightly broader at the extreme end and measures 0·75 mm.

The proboscis (text-fig. 3*a* and *d*, pr) is 0·50 mm. in length whereas the neck is 0·51 mm. The proboscis is 0·28 mm. at its broadest point.

There are 24 to 26 longitudinal rows of hooks, each row having 23 to 24 hooks. The hooks of the proboscis (text-fig. 3*b*) are slightly larger than the hooks present on the neck (text-fig. 3*c*). They measure 38 μ and 30 μ respectively.

The proboscis sheath (text-fig. 3*a* and *d*, ps) is double walled and measures 0·62×0·18 mm.

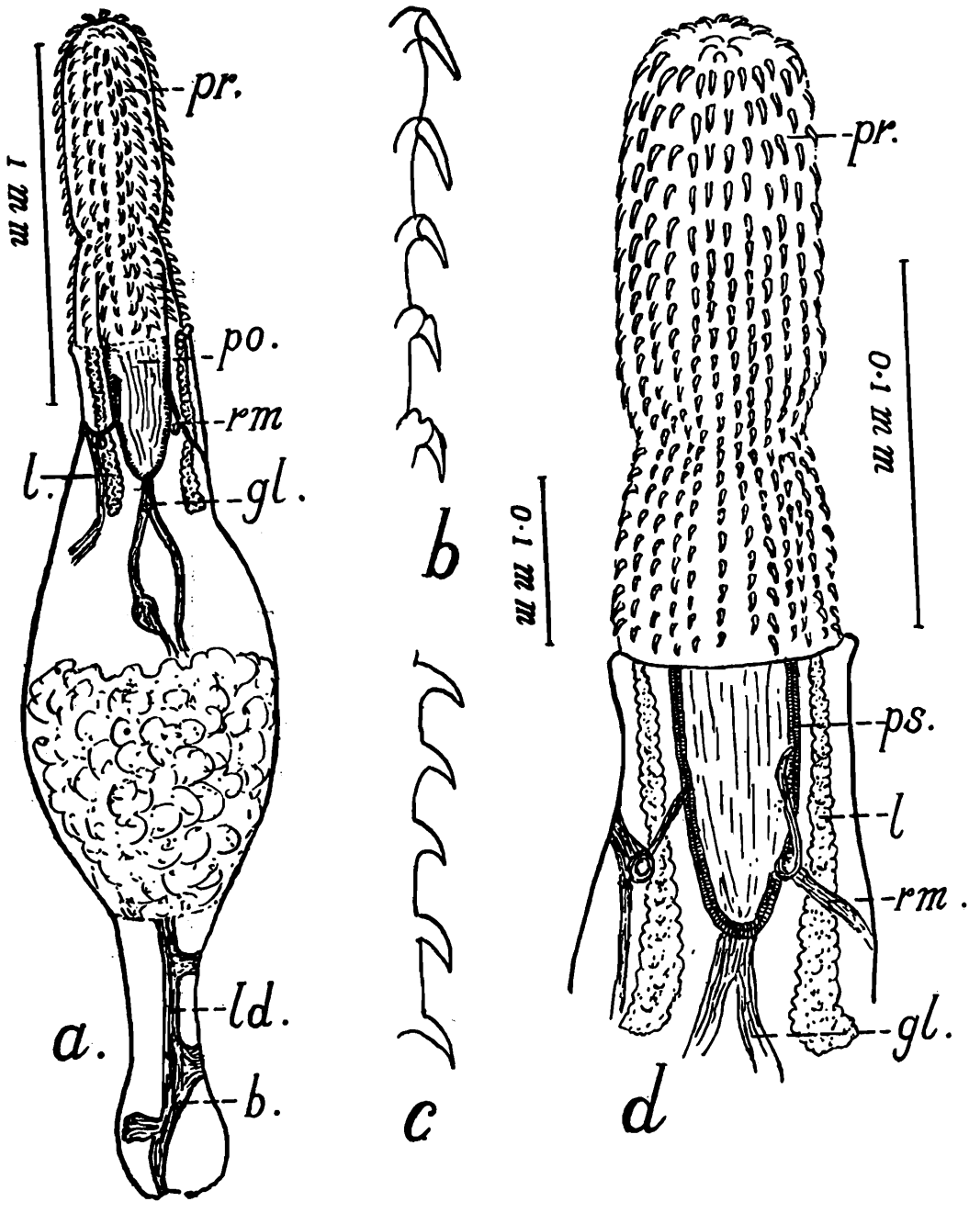
The retractor muscles (text-fig. 3*a* and *d*, rm) of the proboscis seem to come down and bend over themselves for some distance and finally attach to the musculature of the body wall on each side.

Lemnisci (text-fig. 3*a* and *d*, l) are thin and coiled and measure 0·55 and 0·48 mm. in length.

The genital ligament (text-fig. 3*a*, gl) arises from the posterior end of the proboscis and proceeds backwards in the body cavity enclosing the genitalia of which a single testis is visible.

The single cement gland (text-fig. 3*a*, cg) seems to be a big coiled mass filling completely the posterior half of the body.

The ejaculatory duct (text-fig. 3*a*, ed) and the bursa (text-fig. 3*b*) are supported by muscular bands which are attached to the body wall.



TEXT-FIG. 3.—*Cenrtrohynchus brevicaudatus*, sp. nov.

a. Entire male; *b*. Some of the hooks on the proboscis; *c*. Some of the hooks on neck; *d*. Proboscis with proboscis sheath; *ed*., ejaculatory duct; *rm*., retractor muscles. Other letterings as in text-fig. 1.

Comparison with other species.—*Centrorhynchus brevicaudatus* sp. nov. has 24 to 26 longitudinal rows of hooks. Each row has 13(14)

hooks on the head and 10 on the neck. Other species having approximately the same number of hooks are given in the following table :—

Name of Species	Long : rows	Hooks in each row	Hooks on proboscis and neck in each row
C. giganteus (Travassos, 1919)	24—26	27—28	16—17, 11.
C. opimus (Travassos, 1919)	24	12—13	..
C. tumidulus (Rudolphi, 1819)	26	13	..
C. simplex (Meyer, 1933)	22—24	24	14, 10.
C. horridus (Von Linstow, 1897)	26—28	15—16	5—6, 10.
C. turdi (Yamaguti, 1935)	26—29	11—14	..
	26—34	11—13	..
C. elongatus (Yamaguti, 1935)	26—31	13—19	..

Of all the forms listed in the above table, in none the number of hooks in each row and distribution of hooks on the head and neck resembles that in *C. brevicaudatus*. I therefore consider it to be a new species.

Diagnosis.—Length 3·13 mm. ; maximum width 0·70 mm. proboscis and neck measure 0·50 mm. and 0·51 mm. respectively ; 24 to 26 longitudinal rows of hooks, each row having 23 to 24 hooks, 13(14) in each row on the head and 10 on neck ; hooks on the proboscis and neck 38 μ and 30 μ in length respectively ; proboscis sheath double walled measuring 0·62×0·18 mm. ; lemnisci measuring 0·55 mm. and 0·48 mm. in length ; single cement gland forming a big coiled mass filling completely the posterior half of the body.

Host.—*Ophiocephalus* sp.

Locality.—Nagpur, Central Provinces, India.

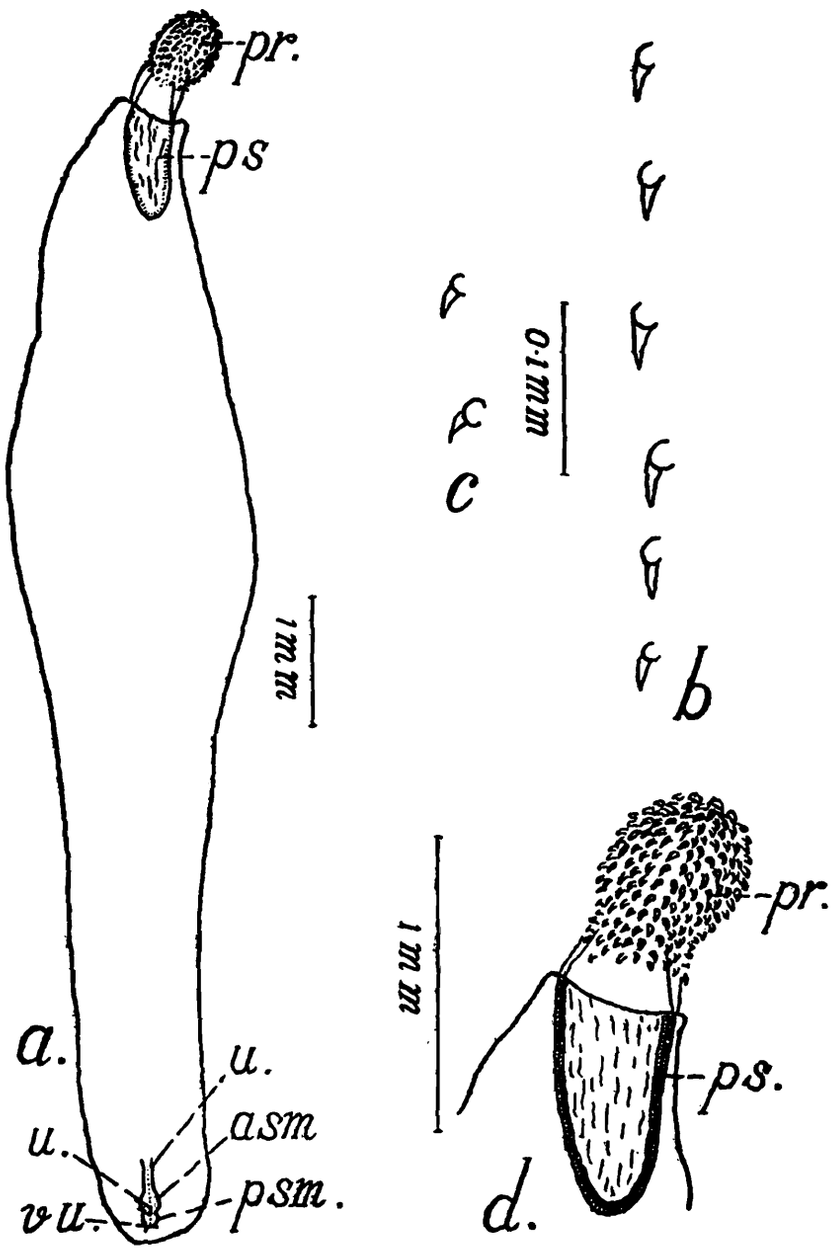
Type-specimen.—(W .) is deposited in the collection of the Zoological Survey of India.

Centrorhynchus brevicanthus, sp. nov.

A single female specimen was obtained. Body is spindle shaped with a blunt tail end, and measures 8·59 mm. in length and 0·51 mm. in breadth at the anterior end. It is broadest in the middle of the body, measuring 1·70 mm., the posterior end being 0·85 mm. broad and rounded

The proboscis (text-fig. 4*a* and *d*, pr) is knob-like and 0·39 mm. broad. The proboscis with the neck measures 0·75 mm. in length. The proboscis sheath (text-fig. 4*a* and *d*, ps) is double walled and measures 0·98×0·45 mm.

There are 30 to 32 longitudinal rows of hooks with 11 to 12 hooks in each row, all with roots directed backwards. Hooks on the proboscis proper and the neck are similar. Other details could not be made out.



TEXT-FIG. 4.—*Centrorhynchus brevicanthus*, sp. nov.

a. Entire female; *b*. Some of the hooks on proboscis; *c*. Some of the hooks on the neck; *d*. Proboscis with proboscis sheath. Other letterings as in text-fig. 1.

Comparison with other species.—*Centrorhynchus brevicanthus* sp. nov. has 30 to 32 longitudinal rows of hooks, in each row there are 11 to 12 hooks, with 9 on the head and 2 on the neck.

The following table shows number and distribution of hooks in species which have approximately the same number of longitudinal rows of hooks :—

Name of Species	Long : rows	Hooks in each row	Hooks on proboscis and neck in each row
C. aluconis (Muller, 1780)	30	15	.
C. buteonis (Schrank, 1788)	30—32	12—16	7—10, 5—6.
C. globocaudatus (Zedder, 1800)	30	18—21	5—6, 13—15.
C. lancea (Westrumb, 1821)	30	11—14	7—8, 4—6.
C. leptorhynchus (Meyer, 1933)	28—30	22	10(9), 4(5), 8.
C. pinguis (VanCleave, 1918) .	32	16	..
C. spinosus (VanCleave, 1924)	30—32	22—23	8—9, 14.
C. polymorphus (Travassos, 1926)	30	17	10, 7.
C. albidus (Meyer, 1933) .	28—30	20	7, 13.
C. turdi (Yamaguti, 1935) .	26—29	11—14	..
	26—34	11—13	..
C. elongatus (Yamaguti, 1935)	26—31	13—19	..
C. conspectus (VanCleave and Pratt, 1940)	30—32	17—18	..

The above table indicates that *Centrorhynchus brevicanthus* differs from all the other species both in the number of hooks and their distribution on the head and neck.

I therefore consider this a new species.

Diagnosis.—Female 8·59 mm. long ; maximum breadth 1·70 mm ; proboscis knob-like ; 30 to 32 longitudinal rows of hooks with 11 to 12 hooks in each row, 9(10) and 2 hooks on the head and neck respectively.

Host.—Black headed Maina, *Temenuchus pagaodarum* (Gmn.).

Locality.—Nagpur, Central Provinces, India.

Type-specimen.—(W... ....) is deposited in the collection of the Zoological Survey of India.

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MGIPC—M—4ZSI—11-12-50—400.