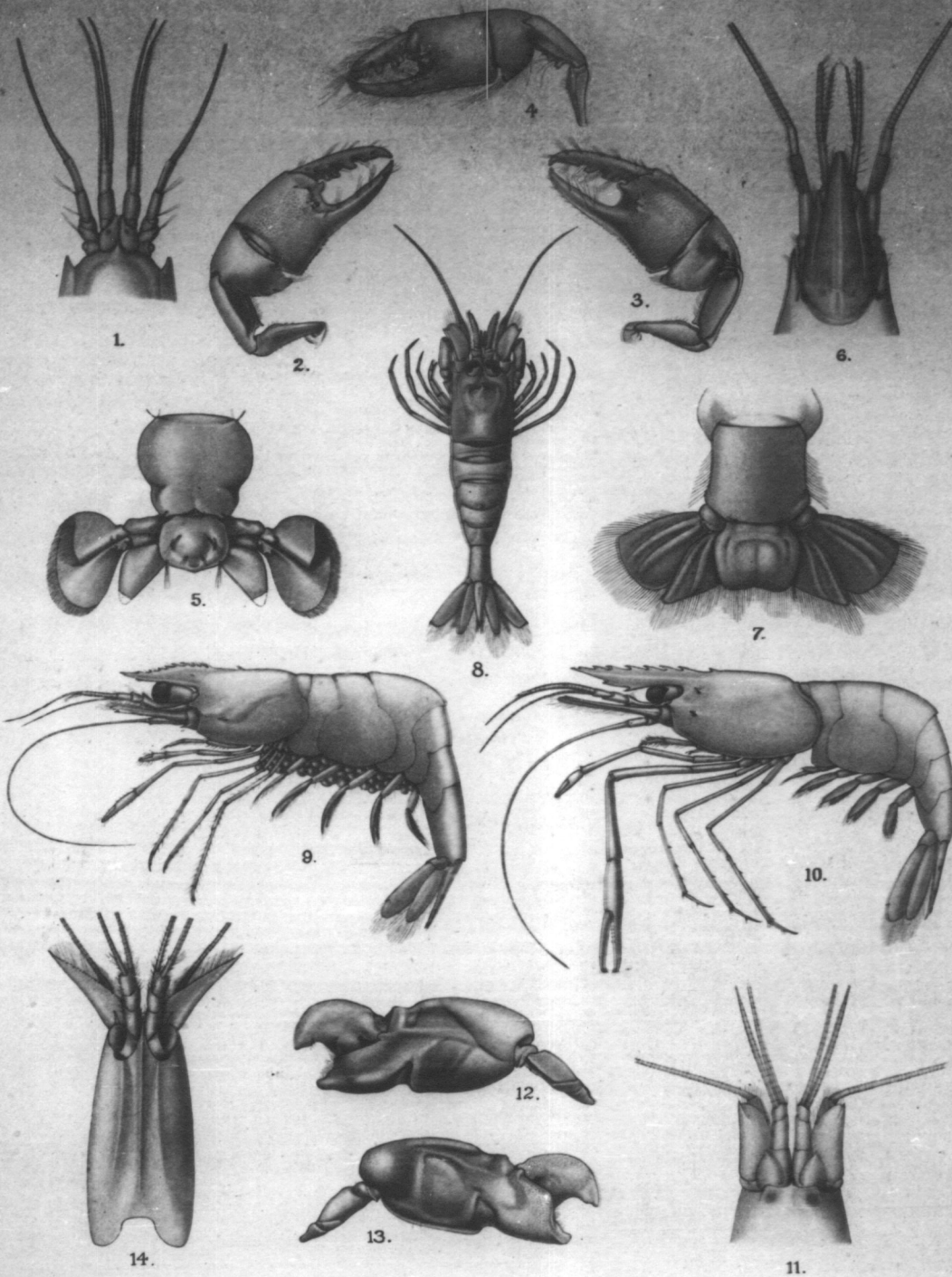
79. Enteg.

1915. Mem. Indian Mus., vol. 5, pp. 261-316, pl. 13, text figs. 26-27.



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CRUSTACEA DECAPODA OF THE CHILKA LAKE.

In the species here described the lateral process of the antennular peduncle is distally rounded, there is no exopod on the first peraeopods, the second peraeopods are comparatively long and reach to the carpus of those of the first pair and there is no appendix interna on the pleopods. In these particulars the species agrees with *echinulatus* (M. Sars) and with *bispinosus* (Westwood, = *nanus*, Kröyer), the latter of which may be taken as the type of Stebbing's *Philocheras*.[1]

Pontophilus hendersoni, sp. nov.

(Plate XIII, fig. 8.)

In general appearance this species bears a close resemblance to *P. bispinosus* (Westwood).

The rostrum is broad, parallel-sided, and bluntly rounded apically; it is deeply channelled longitudinally, the margin forming a raised rim which is contained laterally round the orbits.

In dorsal view, the carapace including the rostrum) is a little longer than broad. Situated in the mid-dorsal line near the rostral base there is small, sharp, forwardly directed spine, which does not, as in many other species, form the termination of a median carina. On either side behind the middle of the orbit, there is in the anterior third of the carapace a blunt longitudinal ridge, which posteriorly sinks imperceptibly to the general level of the carapace, but anteriorly terminates abruptly in the same latitude as the median spine. A feeble groove defines the upper limit of the branchial chamber and is continued forwards as a shallow depression towards the base of the antennae. This depression is bounded beneath by a blunt ridge which is co-terminous anteriorly with the acute antennal spine. There is no hepatic spine. The branchiostegal spine is large and sharp; it is flanked by a short carina and extends far beyond the level of the rostrum (pl. xiii, fig. 8).

The thoracic sterna are broad posteriorly. The last four are furnished with blunt carinae in the middle, each of which terminates anteriorly in a short spine. In front of them a long and sharp spine projects forwards between the bases of the first legs.

The eyes are deeply pigmented; their shape, including the stalks, is almost globular. The basal segment of the antennular peduncle does not bear spines either ventrally or at its outer distal end; its lateral process is subquadrate in outline and is not pointed anteriorly; the second segment is considerably longer than the third; the greatly swollen outer flagellum of the male is about one and a half times the length of the peduncle (text-fig. 25*b*). The antennal scale is about two and a quarter times as long as broad (text-fig. 25*a*). The outer margin is almost straight and terminates in a large spine which reaches as far forwards as the rather sharply angled apex of the lamella.

The ultimate segment of the outer maxillipede is broadly rounded apically and scarcely reaches beyond the distal end of the scale.

[1] Stebbing, *Marine Invest. S. Africa*, I, p. 48 (1902).

The first legs (text-fig. 25*c*) reach almost as far forwards as the outer maxillipedes and do not possess exopods. The merus bears externally a small procurved tooth a little behind its distal end. The carpus is short and apparently does not bear spines. The hand is very broad; the "thumb" of the subchela is extremely large and the maximum breadth, "thumb" included, is considerably more than half the total length. A peculiar feature of the thumb-tooth is that its apex is bifid, composed of two closely adjacent spines (text-fig. 25*c'*). There are coarse serrated hairs at the inner angle of the carpus and on the adjacent margin of the propodus. Finer hairs occur on the cutting edge of the latter segment and on the margins of the merus.

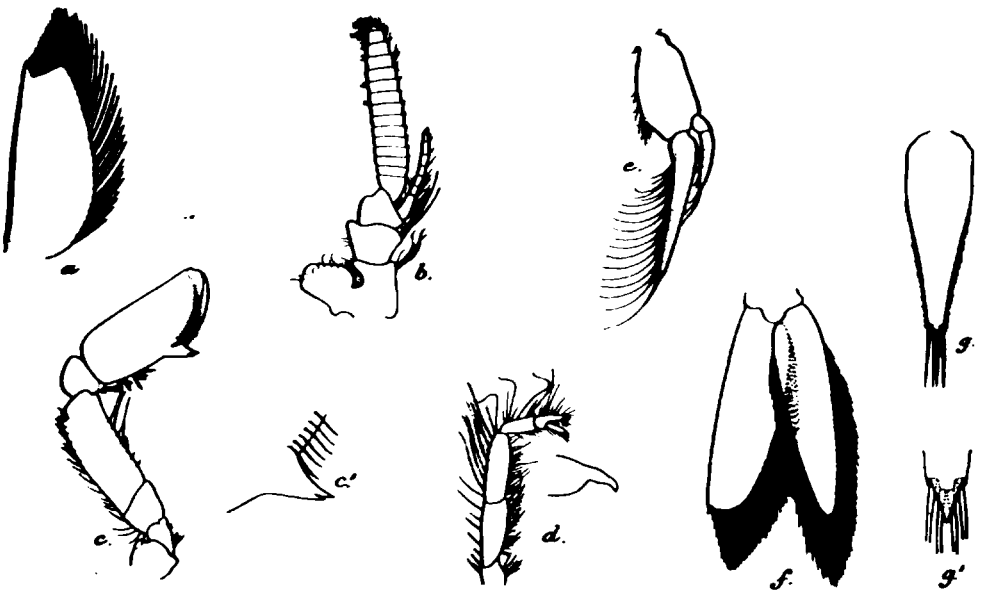

FIG. 25.—*Pontophilus hendersoni*, sp. nov.

a. Antennal scale.
b. Antennule of male.
c. First peraeopod. *c'*. The 'thumb' of the sub-chela further enlarged.
d. Second peraeopod, with apex of fixed finger further enlarged.
e. Second pleopod of male.
f. Outer and inner uropods.
g. Telson. *g'*. Apex further enlarged.

The second legs (text-fig. 25*d*) reach about to the end of the carpus of the first pair and are clothed with fine hairs. The merus and ischium are broad and about equal in length; the carpus is little more than half as long, but is as long as and stouter than the chela. The latter is weakly constructed; the fingers are nearly twice the length of the palm and the inner edges meet throughout their length when the claw is closed; each finger is noticeably constricted at the apex and does not bear a distinct claw.

The third legs are very slender and reach to the apex of the antennal scale. The merus is one and a third times the length of the ischium and is a little shorter than

the carpus. The propodus and dactylus are partially fused; taken together, their length is slightly shorter than that of the merus. Close to the apex of the dactylus there is a small tuft of setae.

The fourth and fifth legs are similar, stouter than those of the third pair. In the fourth pair, which reaches a little beyond the apex of the antennal scale, the merus is the longest segment, almost twice the length of the dactylus. The carpus is a little more than two thirds the length of the merus and is a little shorter than the propodus and a little longer than the ischium. Except for a few hairs on the latter segment and at the base of the merus the segments are naked.

There are no longitudinal carinae on any of the abdominal somites and, except for a feeble transverse groove near their posterior margins, the first five abdominal somites are unsculptured; on the dorsal surface of the third somite, however, not far from the distal margin, is a small tubercle which is a very conspicuous feature in lateral view. The sixth somite is about one and a half times the length of the fifth and is only a trifle shorter than the telson.

The inner branch of the pleopods is in all cases very short and does not bear an appendix interna. Judging from differences in the proportions of the outer antennular flagellum the majority of the specimens obtained are males; in no individual, however, have I been able to find a trace of the appendix masculina (text-fig. 25*e*).

The uropods (text-fig. 25*f*) are a little longer than the telson: the exopod is about three and a half times as long as wide. The telson (text-fig. 25*g*) is not sulcate above and is much narrowed distally: it has setose margins but no dorso-lateral spinules. The apex (*g'*) is very narrow and is formed by an acutely triangular plate bearing two pairs of fine plumose setae.[1] On either side at the base of this plate is a short and blunt spinule and between these spinules (underneath the plate) are two pairs of very large setae.

The largest specimen is only about 10 mm. in length; but is, I believe, fully adult.

The colouration of the species in life is very variable. As a rule there are two transverse bars of dark reddish-brown pigment, one in the anterior half of the carapace and another on the fourth abdominal somite. There are also on the dorsal surface several large black or dark brown chromatophores, the distribution of which is very irregular, and frequently a large white spot at the proximal end of the last abdominal somite. The margins of the abdominal pleura are umber brown; the upper edge of the first legs and the basal segments of the first four legs and last two swimmerets are dark.

Pontophilus hendersoni bears little resemblance to any other Indo-pacific species of the genus. Its nearest ally appears to be *Pontophilus bispinosus* (Westwood), a common European species; from this form, however, it is easily distinguished by the sculpture of the carapace and by numerous minor details.

The species is described from thirteen specimens found in March 1914, in the outer channel of the Chilka Lake. They were caught in nets hauled at a depth of

[1] Not shown in text-fig. 25*g'*.

1 or 2 feet over the hard sand near the mouth of the lake. At the time when they were obtained the water in the outer channel was as salt as that of the sea outside the lake. In September 1914, when it was quite fresh we searched carefully for the species in the same place, but were unable to discover any more specimens. The species appears to be only a casual visitor to the extreme outer parts of the lake during the salt-water season.

The type specimens bear the no. 8970/10 in the Museum register.

Family PALAEMONIDAE.

Borradaile in a short preliminary paper, recently published [1], has divided the Palaemonidae into four sub-families, the Desmocaridinae, Pontoniinae, Palaemoninae and Typhlocaridinae. The characters used in the separation of the first three of these subfamilies are, in the main, those to which Sollaud has already drawn attention. I am inclined to think that the arrangement suggested is not likely to be permanent; but the number of forms obtained in the Chilka Lake is so small that the occasion is not a suitable one for a discussion of the matter.

The Palaemonidae found in the lake comprise seven species belonging to the genera *Palaemon*, *Leander*, *Urocaris* and *Periclimenes*. The last two genera are represented by single species which are described as new; they are able to live in either fresh or salt water and to tolerate considerable periodic variations in salinity. Both species occur among weeds and *Urocaris* is one of the commonest and most widely distributed Crustacea in all parts of the lake: the *Periclimenes* is found only in the outer channel.

The single species of *Leander* and one of the Palaemons, *P. scabriculus*, must be regarded as casual visitors to the lake, the former from the sea, the latter from the ponds or rice fields.

Only females of *Palaemon malcolmsoni* and *P. lamarrei* have been found in the lake and our observations lead us to conclude that these species visit its waters only for breeding purposes. This is also the case with the remaining species of the genus, *P. rudis*, the males of which accompany the females at this period. Adults of these three forms do not live in water as salt as that of the Bay of Bengal; but the young of *P. rudis* were found in the outer channel at the salt-water season, while adults of *P. lamarrei* are able to tolerate a considerable degree of salinity. *P. malcolmsoni* was found only in fresh water.

Although the species of *Periclimenes* and *Urocaris* are here described as new, they also occur at other places on the east coast of India, the *Periclimenes* at the mouth of the Adyar river at Madras, the *Urocaris* in backwaters in the same neighbourhood and also in pure sea-water inside the coral reefs and in the shallows of the Gulf of Manaar. The *Urocaris* is a very close ally of a species found in the Gulf of California and on the Pacific Coast of Mexico.

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[1] Borradaile, *Ann Mag. Nat. Hist.* (8), XV, p. 206 (1915).

Genus PALAEMON, Fabricius.

Palaemon lamarrei, Milne-Edwards.

1908. *Palaemon (Eupalaemon) lamarrei*, de Man, *Rec. Ind. Mus.*, II, p. 222, pl. xix, fig. 4.

This species is represented in our collection by numerous specimens found at Rambha in February and at Barkul in March 1914. All the larger examples are females and a great number bear eggs.

The measurements (in mm.) of four specimens are as follows[1]:—

Sex.	Total length.	Length of carapace.	Length of chelipede.	Chelipede (2nd leg): length of				
				Ischium.	Merus.	Carpus.	Palm.	Dactylus.
♀	58	13·4	25·5	5·0	5·7	8·0	3·4	2·6
♀	54	12·4	22·6	4·5	5·1	7·1	2·6	2·1
♀	50	11·0	21·6	4·4	5·0	6·9	2·3	2·0
♀	44	9·6	19·0	4·1	4·3	6·0	1·9	1·7

It will be noticed that there is some difference between these figures and those given by de Man for younger specimens; the carpus, in particular, though still decidedly longer than the chela, is proportionately shorter.

The rostrum, in adult females, reaches only to the apex of the antennal scale, or a little beyond it. In other respects the specimens agree closely with de Man's description.

Henderson and Matthai have pointed out[2] that the eggs in this species are very large and by hatching experiments have succeeded in proving that development is direct and without metamorphosis. In the Chilka specimens eyed eggs average 1·5 mm. in length by 1·1 mm. in breadth, measurements which differ somewhat from those obtained by the above-mentioned authors from specimens found near Madras.

Palaemon lamarrei, originally described by Milne-Edwards from the coasts of Bengal, is common in the Gangetic Delta in fresh or slightly brackish water and, as noticed above, has been found near Madras. De Man (*loc. cit.*) has pointed out that

[1] In this table, and in the measurements given on succeeding pages, the total length is taken from the tip of the rostrum to the apex of the telson and the length of the carapace from the back of the orbit to the mid-dorsal point at its posterior end. The chelipede is measured from the basipodite (which forms a convenient point of application for a pair of callipers) to the tip of the chela. In the case of individual segments the measurements represent the greatest length of each segment. The instrument used in taking all measurements under 100 mm. is a pair of callipers fitted with a dial which gives direct readings to ·1 mm.

[2] Henderson and Matthai, *Rec. Ind. Mus.*, V, p. 301 (1910).

the records by Ortmann from Brazil and by de Haan from Japan are to be discredited.

In the Chilka Lake the species is not abundant, but was found in some numbers in February 1914, near Rambha, when the specific gravity of the water was 1·011. The specimens, however, were taken near the mouth of a small stream and in this locality the water was doubtless less salt than in other places in the vicinity. The examples obtained in March of the same year at Barkul were caught by fishermen.

The large number of ovigerous females in the collection, and the total absence of individuals which can be recognised as males, are facts which suggest that the species migrates from the fresh water in the neighbourhood to liberate its young in the lake.

Palaemon malcolmsoni, Milne-Edwards.

1910. *Palaemon malcolmsoni*, Henderson and Matthai, *Rec. Ind. Mus.*, V, p. 83, pl. xv, figs. 2*a–f*.

Ten large ovigerous females of this species were obtained in September 1914, at Barkul, in company with numerous examples of *Palaemon rudis*.

The rostrum, in its shape and dentition, agrees precisely with the description given by Henderson and Matthai. The measurements of the specimens (in mm.) are as follows:—

Number.	Total length.	Length of carapace.	Length of right chelipede.	Length of left chelipede.	Larger chelipede: length of					Proportionate length of segments of larger chelipede to total length of chelipede (100):				
					Ischium.	Merus.	Carpus.	Palm.	Dactylus.	Ischium.	Merus.	Carpus.	Palm.	Dactylus.
1	136	37·9	108	108	19·9	21·4	27·5	20·3	16·9	18·2	19·6	25·2	18·6	15·5
2	136	36·5	101	104	18·8	20·4	25·9	20·0	16·7	18·0	19·6	24·9	19·2	16·0
3	125	30·5	97	98	17·1	18·4	22·2	19·7	16·5	17·4	18·8	22·6	20·1	16·8
4	122	35·3	98	93	17·5	19·5	22·8	20·5	14·9	17·8	19·9	23·3	20·9	15·2
5[1]	122	29·9	88	92	15·9	18·7	20·5	20·6	14·1	17·3	20·4	22·3	22·5	15·4
6	119	32·4	81	86	15·8	16·1	19·6	16·6	13·2	18·3	18·7	22·7	19·3	15·3
7	116	31·7	84	84	15·3	16·8	20·4	15·4	12·2	18·2	20·0	24·3	18·3	14·5
8	116	29·4	77	78	14·4	15·2	18·8	15·2	11·1	18·4	19·5	24·1	19·5	14·2
9	105	27·5	73	78	14·0	14·6	17·8	16·0	11·9	17·9	18·7	22·8	20·5	15·2
10	107	28·8	72	77	13·0	15·2	18·3	15·1	10·2	16·9	19·8	23·8	19·6	13·6
								Average ..		17·8	19·5	23·6	19·7	15·2

At the time of their capture the distinctions between these specimens and females of *Palaemon rudis* were not appreciated. The two forms may be distinguished by the following characters:—

[1] The palm in this specimen is quite abnormal in length and has been omitted in calculating the average proportionate length of the segment. The palm of the other chelipede in the same individual is of normal dimensions.

P. malcolmsoni, ♀.	*P. rudis*, ♀.
Rostrum longer, reaching to or beyond apex of antennal scale; proximal margin of upper border markedly convex, apex a little upturned. Dorsal teeth aggregated on proximal part; teeth on distal part few, either confined to apex or very widely separated. Three dorsal teeth on carapace.	Rostrum shorter, reaching at most to apex of antennal scale. Upper margin straight or very slightly convex, apex not upturned. Dorsal teeth almost evenly spaced throughout length of rostrum. Two dorsal teeth on carapace.
Inner and outer margins of antennal scale subparallel.	Inner and outer margins of antennal scale anteriorly convergent.
Chela of first peraeopods with fingers decidedly shorter than palm. Palm with large patch of coarse setae on its infero-internal aspect. Fingers gape at base when claw is closed.	Chela of first peraeopods with fingers equal in length to palm. Palm with small patch of coarse setae on its infero-internal aspect. Fingers do not gape at base when claw is closed.
Second peraeopods with fine spinules arranged in longitudinal rows. Dactylus in very old females densely covered with hairs. Carpus shorter than palm + half the length of fingers.	Second peraeopods practically glabrous. Carpus longer than palm + half the length of fingers.

A series of very much smaller specimens found at Satpara in March 1914 may also belong to this species, though they differ markedly from the larger individuals noticed above. The series comprise several ovigerous females and a few males in which the appendix masculina is to all appearances fully formed; the largest specimen, an egg-bearing female, is 58·5 mm. in total length. The great difference in size between this individual and those found at Barkul is not, of itself, sufficient to disprove the specific identity of the two series of specimens. Henderson and Matthai have pointed out that species of *Palaemon* may be sexually mature when extremely small in size and that males may possess well-developed testes containing free spermatozoa long before their chelipedes have reached the dimensions characteristic of large members of their sex. There is reason to believe that a precocious sexual development of this nature occurs in the case of *Palaemon rudis* in the Chilka Lake (*vide infra*).

In the specimens from Satpara the rostrum in both sexes is much more strongly upturned distally and the crest on the dorsal margin is less elevated than in the large females found at Barkul. The teeth are also rather larger proportionately and those on the upper margin are more evenly distributed, though those situated behind the one or two placed at the apex are in most cases separated by distinctly wider intervals than those near the rostral base. There are 11 or 12 dorsal and 5 or 6 ventral teeth; of the former three are situated on the carapace behind the level of the orbit.

The antennal scale is distinctly narrowed towards its distal end, thus differring from that of the larger specimens; in the chela of the first peraeopods there is a closer resemblance, but the fingers do not gape at the base when the claw is closed.

The length of the second peraeopods, in both males and females, is only about 70 % of the total length and the proportionate length of the ischium, merus, carpus,

palm and dactylus are approximately as 18, 18½, 26, 17 and 15. The ischium, as Henderson and Matthai have shown, is as a rule proportionately longer in young (but not necessarily non-adult) Palaemonidae, than in full grown individuals. If allowance be made for this point it will be seen that the proportions are not strikingly different from those of large females. The segments bear small spinules precisely as in the large specimens.

A notable difference exists in the armature of the telson tip. In the Satpara specimens the inner pair of terminal spinules project far beyond the apex, whereas in large *P. malcolmsoni* they fall considerably short of it.

Whether the series from Satpara is correctly referred to *P. malcolmsoni* or not—and I am extremely doubtful of the accuracy of the determination—it is clear that it does not include any fully developed males and is therefore inadequate for a complete specific description. If the specimens are not young *P. malcolmsoni* they certainly cannot be identified with any other form known from Indian waters.

It will be noticed that in the specimens from Pondicherry, referred by Nobili to Heller's *P. danae*[1] and regarded by Henderson and Matthai as young *P. malcolmsoni*, there are fewer teeth on the lower border of the rostrum and no spinules on the segments of the second peraeopods.

The carapace of living examples from Satpara was dotted with chromatophores which formed definite spots laterally and an indefinite longitudinal dorsal streak. There was a conspicuous dorsal patch of white in the posterior part of the third abdominal somite and the legs were banded with maroon, with all the joints orange yellow and the dactyli of the last three pairs clear red. The chela of the second peraeopods and caudal fin were mottled with maroon and yellow pigment and the edges of the abdominal pleura were brown.

In the case of the large females from Barkul the legs were not banded, but had a purplish tinge. The margins of the abdominal pleura were usually bordered with pure white, but those of the last two segments were in some cases brown. There was no white patch on the third abdominal somite. The eggs in both cases were of an olivaceous tint.

The large females from Barkul were obtained when the water was quite fresh. The fact that, among numerous specimens examined, no large males were to be found, suggests that the females, as with *P. lamarrei*, may migrate to the lake when their eggs are ready to hatch.

The specimens of doubtful identity, obtained at Satpara, were found in water as salt as that of the Bay of Bengal near the mouth of the lake.

Palaemon rudis, Heller.

1910. *Palaemon rudis*, Henderson and Matthai, *Rec. Ind. Mus.*, V, p. 291, pl. xvii, figs. 5*a*—*b*.

Palaemon rudis is the commonest species of its genus in the Chilka Lake and is represented in our collection by a large number of specimens both young and adult.

[1] Nobili, *Boll. Mus. Torino*, XVIII, No. 452, p. 7 (1903).

The teeth on the rostrum are more variable in number than is indicated in the description given by Henderson and Matthai. On the upper margin there are from 9 to 12 (usually 10 or 11) and on the lower margin from 3 to 5 (usually 4). In all cases the three posterior dorsal teeth are situated on the carapace.

The measurements of a series of males are shown below. Of these specimens, nos. 1—16 are fully developed,—that is to say, they have assumed the characters typical of large individuals of their sex. The second peraeopods or chelipedes are usually unequal in length and the larger of the two is nearly equal to, or considerably longer than, the total length; the segments are clothed with a fine velvety pubescence and tubercles are present on the fingers on either side of the cutting edge. With these features a well marked colour distinction is correlated, the chelipedes being dark blue-grey with a pale dorsal stripe.

Number.	Total length.	Length of carapace.	Length of right chelipede.	Length of left chelipede	Larger chelipede : length of					Proportionate length of segments of larger chelipede to total length of chelipede (100) :				
					Ischium.	Merus.	Carpus.	Palm.	Dactylus.	Ischium.	Merus.	Carpus.	Palm.	Dactylus.
1	108	33·2	182	209	21·0	41·4	63 5	45·0	35·7	10·0	19·8	30·4	21·5	16·6
2	114	34·4	202	138	20·0	39·1	60·3	46·9	35·8	10 0	19·5	30·2	23·4	17·9
3	110	35·0	182	198	20·0	38·6	58·5	43·0	36·8	10 1	19 5	29·5	21·7	18·6
4	106	32·2	180	198	20 8	40·7	59·5	40·4	35·3	10·5	20·6	30·0	20·4	17·8
5	112	33·5	173	192	20 5	38·0	60 3	40 0	32·0	10 7	19·8	31·4	20·8	16·7
6	108	33 7	165	179	19 9	35·8	53·2	37·2	32·3	11·0	20·0	29·8	20·8	18·1
7	108	32·0	162	174	19 0	34·0	51·3	38·5	31·0	10 8	19·4	29·2	21·9	17·7
8	94	28·1	144	173	17·7	35·0	53 4	35·4	29 8	10·2	20·2	30·8	20 5	17·2
9	112	34·2	156	168	20 8	34·8	49·1	38·4	31 2	12 5	20·9	29·5	23·0	18·7
10	94	28·8		120	14·0	23·2	33 0	26·8	21·6	11·7	19·3	27·5	22·3	18·0
11	94	28·2	105	111	13·7	21 9	32·0	23·7	19 3	12·3	19·7	28·8	21·3	17·4
12	100	28·7	104	104	13·2	21·3	30·2	19·0	16·7	12·7	19·5	29 0	18·2	16 0
13	94	27·4	91	85	11·9	17·2	25·4	18 5	15·0	13 1	18·9	27·9	20·3	16·5
14	98	28·8	90	86	11·8	17·8	26·4	16 5	16·3	13·1	19 6	29·3	18·3	18·1
15	77	20·4	87·5	80	10·5	16·3	25·5	19·5	15·0	12 0	18·6	29·1	22 2	17·1
16	89	25·5	84	87·5	11·2	17·3	25·6	15·1	16·3	12·8	19·7	29·2	17 2	18·6
17	71	18·8	52·5	53·5	8·2	10·1	14·8	10·3	9 4	15·3	18 9	27·7	19·3	17·6
18	68	17·5	47·8	47·8	8·e	9·6	13·2	8·8	7·2	16·7	20·1	27·6	18·4	15·0
19	57	14·1	42·7	42·7	6 5	8·0	11·8	7·7	7·6	15·2	18·7	27 6	18·0	17·8
20	39·5	9·3	25 5	25·5	4·1	4 8	6·9	4·1	4 3	16·1	18·8	27·0	16·1	16·9
21	26·5	5·4	14·3	14·3	2·6	2·9	4·1	2·3	2·1	18·2	20·3	28·7	16·1	14·7
22	19·5	3·7	10·6	10·6	1·9	2·3	3 1	1 8	1·8	17·9	21·7	29·2	17·0	17·0
23	58·5	13·1	36·0	..	6 3	7·3	10 0	5·2	7·0	17·5	20 3	27·8	14·5	19·5
24	53	11·9	32 5	33·2	5·3	6·6	8·5	4·0	6·8	15·9	19 9	25·6	12·0	20·5
25	39	8 7	23·2	23·2	4·2	4·8	6·7	3·3	4·3	18·1	20·7	28·8	14·2	18·5
					Average of specimens nos. 1—9 ..					10·6	20 0	30 1	21·6	17·7
					,, ,, ,, nos. 11—16 ..					12·5	19·3	28·7	20·0	17·4
					,, ,, ,, nos. 17—22 ..					16·6	19·7	28·0	17·5	16·5

In specimens nos. 17–22 the chelipedes are equal, or nearly so, and there are no tubercles on the fingers. In nos. 17 and 18 an inconspicuous pubescence, sparse and

very short, is to be seen on the carpus and palm, in the other specimens it is invisible.

As regards the proportions of the segments in specimens of different sizes, it will be seen from the averages of the percentage figures that the most noticeable change is that the ischium becomes proportionately shorter with increased size, *i.e.*, it grows much more slowly than the other segments. Henderson and Matthai have found that this takes place in several Palaemons and it probably occurs in the males of most species of the genus. In the case of *P. rudis* the disproportionate growth of this segment is counterbalanced by a considerable increase in the length of the palm and by a less considerable increase in the carpus and dactylus. The merus in its relative length remains practically constant during growth.

Judging from the collection made in the Chilka Lake, the greater part of the change in the proportionate lengths of the segments takes place suddenly. In males in which the chelipedes are decidedly shorter than the total length (specimens up to about 70 mm.) the proportions are similar to those of females. In larger individuals, in which the larger chelipede is equal to, or less than one and a half times the total length, notable differences are found; but the ischium is still proportionately larger (12·5 %) than in the largest examples—those in which the larger chelipede exceeds one and a half times the total length. From these facts it seems legitimate to infer that the change from the female type of limb to that characteristic of the fully grown male is, or may be, attained in two months.

A striking feature of the series of males from which the measurements given on p. 269 are derived, is that the appendix masculina is fully developed in all specimens except no. 22, in which it is rudimentary. As far as I am aware no precise observations have been made on the age at which this stylet becomes evident; but, from its intimate association with the sexual process, one would infer that it made its appearance only when the testes became functionally active. That it should be perfectly developed in specimens less than one quarter the maximum length of the species is most remarkable. Henderson and Matthai have already shown that a precocious sexual development may occur in at least some Palaemonidae, and it is probable that *P. rudis* affords an instance of the same phenomenon.

Three small males, nos. 23-25 of the series on p. 269, differ noticeably from any others in the collection in the great relative length of the dactylus. They differ in no other way from typical *P. rudis* of similar size, and I am inclined to regard them as abnormalites; it will be noticed that in normal specimens the dactylus is the most variable of all the segments of the chelipedes in its proportional length. It is possible that the great length of the fingers in these examples may indicate something more than an abnormality and that individuals with this character may be aggregated in certain localities to form a definite race; but at present we have no evidence that this is so.

The measurements of a series of females are shown on p. 271; of these all except the smallest (no. 11) bear eggs. The segments in their proportional lengths bear a close resemblance to those of young males and show but little change during growth;

a slight decrease in the relative length of the ischium is counterbalanced by an increase in the lengths of the palm and dactylus.

Number.	Total length.	Length of carapace.	Length of right chelipede.	Length of left chelipede.	Larger chelipede : length of					Proportionate lengths of segments of larger chelipede to total length of chelipede (100):				
					Ischium.	Merus.	Carpus.	Palm.	Dactylus.	Ischium.	Merus.	Carpus.	Palm.	Dactylus.
1	103	27·8	84	84	12·2	15·8	23·1	16·0	13·6	14·5	18·8	27·5	19·0	16·2
2	94	25·0	65·5	65·5	10·4	12·7	18·6	11·8	10·2	15·9	19·4	28·5	18·1	15·6
3	92	23·9	63	64	10·1	12·7	17·5	12·4	10·6	15·8	19·8	27·3	19·3	16·5
4	92	23·6	61	25	9·9	12·2	17·7	10·0	9·3	16·2	20·0	29·0	16·4	15·3
5	84	21·1	58	58	8·9	11·1	15·2	10·9	9·4	15·3	19·1	26·3	18·7	16·2
6	83	21·0	55·5	55·5	9·1	11·1	16·0	10·6	9·3	16·4	20·0	28·8	19·1	16·7
7	86	21·4	55·5	55·5	9·0	11·2	16·3	9·7	8·7	16·2	20·2	29·3	17·5	15·7
8	82	21·0	49	49	8·4	10·0	14·0	8·5	7·2	17·1	20·4	28·6	17·3	14·7
9	67	16·8	43	43	7·0	8·7	12·4	7·1	6·3	16·3	20·2	28·8	16·5	14·6
10	51	12·9	33	27	5·9	6·9	9·5	5·6	4·7	17·9	20·9	28·8	17·0	14·2
11	35·5	7·2	18·3	18·3	3·3	3·9	5·1	2·8	2·7	17·9	21·3	27·8	15·3	14·7
								Average ..		17·2	20·0	28·2	17·7	15·5

In life, females and young males differ noticeably in colour from adults of the latter sex. In young specimens and in females there is a pair of dark dorso-lateral streaks on the carapace and distinctive dark lateral markings. The first of these is situated on the gill-cover and is ∪-shaped with the anterior limb of the ∪ turned forwards towards the base of the antennal scale. Behind this is another mark which is ⌐-shaped and placed, not on the branchiostegite, but on the inner wall behind the gills. On the abdomen there is a faintly marked transverse patch at the end of the third abdominal somite and the margins of the pleura are dusky. The antennules are dull red and there is a conspicuous streak of reddish chromatophores up the middle of the antennal scale. All the legs are suffused with reddish-purple, the joints being tinged with orange yellow. The chelae of the second legs are not marbled as in the young individuals referred to *P. malcolmsoni*, and the fingers are reddish or colourless. The telson and uropods are stained with reddish-brown. In very large females the margins of the abdominal pleura are whitish and the claws of the second legs obscurely marbled with yellow. The distinctive colour markings on the carapace are faint or absent and there is, in general, a very marked resemblance to adult females of *P. malcolmsoni*.

Large males are of an almost uniform dull bluish or greenish-grey colour which becomes darker and has a mottled appearance on the telson and uropods. The antennules and antennae are grey and the scale is transparent in its external half, but possesses internally a broad dark grey longitudinal band. The second legs are dark bluish-grey, paler beneath and conspicuously mottled above with a very pale

grey. A broad and well defined pale streak extends along the dorsal surface of the merus, ischium and palm and is especially distinct on the last segment. The other legs are pale, slightly darker on the dactylus and at the distal end of the propodus.

Adults of both sexes of this species were found not uncommonly in the Chilka Lake in the months of September and November, when the water was fresh or very slightly brackish. During the former month they were obtained in abundance at Barkul, where they are trapped in large numbers by the fishermen. Specimens were also found off Nalbano, near Barnikuda I., and in the vicinity of Arupatna in the outer channel. In the last locality they were found on the banks among submerged roots of screw-pines. The females found at this season of the year were bearing eggs.

No adults of either sex were found at any other time of the year; but young individuals were frequently met with in February and March round the rocks at the foot of Ganta Sila, at Chiriya I. and at Barkul Point, in water of moderate salinity (sp. gr. 1·009—1·011), and in the latter month were abundant at Satpara in water as salt as that of the Bay of Bengal near the lake (sp gr. 1·0265).

We are convinced that in this species—and the facts already brought forward in reference to *P. malcolmsoni* tend to show that the same is the case with it also—the prawns, when they have attained a certain size, leave the lake and, during the monsoon, resort to the flooded rice-fields and other bodies of fresh water to which ingress is easy. In the freshwater season, probably that of the following year, they return to the lake when the eggs of the females are ripe. At this period, in the case of *Palaemon rudis*, adult males accompany the females, whereas in *P. malcolmsoni* it is apparently only the latter sex that visits the lake at the breeding season. In the last species impregnation of the ova probably takes place outside the lake before the annual migration of the females has begun.

Palaemon rudis is known from E. Africa, Mozambique, Madagascar and Ceylon. The species is not uncommon in the vicinity of Calcutta and is recorded by Henderson and Matthai from Coconada and Madras.

Palaemon scabriculus, Heller.

1910. *Palaemon scabriculus*, Henderson and Matthai, *Rec. Ind. Mus.*, V, p. 296, pl xvii, figs. *7a-c*, pl. xviii, figs. *7a-p*.

To this species I refer two specimens caught by fishermen near Rambha at the south end of the lake. One of them, in which there is a marked inequality in the second pair of legs, is, I believe, a young male; the appendix masculina, however, is not developed and the large chelipedes only bear scanty hairs in place of the dense felted coating found in adults. The other individual is a female

In the female the rostrum bears twelve teeth above and two beneath and reaches a little beyond the end of the antennular peduncle. In the male there are thirteen dorsal teeth and two ventral, the blade reaching only to the end of the peduncle. The four proximal dorsal teeth, in both cases, are situated on the carapace behind the orbit.

The specimens yield the following measurements (in mm.):—

Sex.	Total length.	Length of carapace.	Length of right chelipede.	Length of left chelipede.	Larger chelipede: length of Ischium.	Merus	Carpus.	Palm.	Dactylus.
♀	54	14·4	33	31·5	5·2	6·7	7·0	6·8	5·8
♂	47·8	12 0	26·3	30·6	4·7	6·3	6·1	6·8	5·4

P. scabriculus must be regarded merely as an occasional visitor to the lake. It is evidently very scarce and there is little likelihood that it ever breeds in the water near Rambha which, throughout the year, retains some trace of salinity. At the time the specimens were obtained the specific gravity of the water in this neighbourhood was 1·011.

Other references to *P. scabriculus* will be found in the paper cited above. The species is common in S. India and is known from Kotri on the R. Indus and from Pondicherry. It has also been recorded from Ceylon, from Saleyer and from Celebes.

Genus **LEANDER**, Desmarest.

Leander styliferus (Milne Edwards).

1837. *Palaemon longirostris*, Milne-Edwards, *Hist. nat. Crust.*, II, p. 394 (not *P. longirostris*, *ibid.*, p. 392).
1840. *Palaemon styliferus*, Milne-Edwards, *Hist. nat. Crust.*, III, p. 638 (*nom. nov.* for *P. longirostris*, *loc. cit. supra*, p. 394).
1893. *Leander longirostris*, Henderson, *Trans. Linn. Soc., Zool.* (2), V, p. 439.
1902. *Palaemon styliferus*, Rathbun, *Proc. U.S. Nat. Mus.*, XXVI, p. 51.
1908. *Leander* sp., de Man, *Rec. Ind. Mus.*, II, p. 220, pl. xviii, fig. 3.

The single specimen of this species found in the Chilka Lake is a non-ovigerous female 62 mm. in total length: it agrees closely with Henderson's description. The basal crest of the rostrum bears six teeth and there are two other dorsal teeth near the apex; on the lower margin are eight teeth. The mandibular palp, as in the genus *Palaemon*, is composed of three segments.

The specimens recorded by de Man from Amoy in China[1] appear to be distinct from this species. Apart from the differences noted by de Man in the proportions of the branchiostegal and antennal spines (explained by Henderson as a clerical error in the description), the short filament of the antennules is much longer in the Chinese specimens and the second peraeopods considerably shorter. These legs in large individuals from the Gangetic Delta reach beyond the antennal scale by the whole length of the carpus and chela and, in smaller specimens, by at least the entire length of the chela. The fingers in Indian examples are always much longer than the palm.

[1] De Man, *Notes Leyden Mus.*, III, p. 141 (1881).

The forms described by Ortmann[1] under the names *Leander longirostris* var. *japonicus* and var. *carinatus* are now regarded as distinct species.[2] The specimens recorded by de Man (*loc. cit.*) under the name *Leander* sp. are almost certainly young examples of *L. styliferus*.

Leander styliferus is extremely common in brackish water in the Sunderbuns and the Gangetic delta, the locality from which the original specimens described by Milne-Edwards were obtained. It is also recorded by Henderson and Miss Rathbun from Karachi and by the former author from Mergui and the Gulf of Martaban.

The species is evidently nothing more than a casual visitor to the Chilka Lake. The single specimen obtained was found at Satpara in March 1914, in water of the same salinity as that of the Bay of Bengal in the vicinity.

Genus UROCARIS, Stimpson.

1860. *Urocaris*, Stimpson, *Proc. Acad. Nat. Sci. Philadelphia*, XII, p. 39.
1902. *Urocaris*, Rathbun, *Bull. U.S. Fish Comm. for* 1900, XX, ii, p. 126

Urocaris is one of the genera which lie on the border-line between the Pontoniidae and Palaemonidae, families which until recently have been regarded as distinct. The absence of a palp on the mandible and the rather deeply cleft outer antennular flagellum induced most authors to regard it as an ally of *Palaemonetes*, but Sollaud[3] has very correctly pointed out that the reduced gill-formula and the presence of three pairs of spines at the apex of the telson indicate a position near *Periclimenes* and other less specialized genera of the old Pontoniidae.

In the species of *Urocaris*, found in the Chilka Lake, the branchial formula is as follows:—

	VII	VIII	IX	X	XI	XII	XIII	XIV
Exopods ..	1	1	1	..	..	..	..	..
Podobranchs ..	ep.	ep.	ep.	..	..	..	..	..
Arthrobranchs ..	..	..	1	..	..	..	..	..
Pleurobranchs ..	..	..	..	1	1	1	1	1

This formula is almost identical with that found in *Periclimenes*, from which, however, *Urocaris* may be separated by the more deeply cleft outer antennular flagellum and by the great length of the last abdominal somite. In *Urocaris*, also, the inferior portion of the rostrum, *i.e.* that situated below the midrib, is ill-developed or absent and ventral teeth, if present, are placed close to the apex. These characters are not very convincing, though, in combination, they give the typical species of the genus a very distinct facies.

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[1] Ortmann, *Zool. Jahrb., Syst.*, V, pp. 519-521, pl. xxxvii, figs. 14, 14z.
[2] See Rathbun, *loc. cit.*, and Doflein, *Abhandl. k. bayer. Akad. Wiss.*, XXI, p. 639, pl. iii, fig. 8 (1902).
[3] Sollaud, *C. R. Acad. Sci., Paris*, Dec., 1910, p. 1.

In *U. longicaudata*, Stimpson, the type species of the genus, and in its two near allies, *U. infraspinis*, Rathbun, and *U. indica*, described below, the dactyli of the last three peraeopods bear a slender inferior spine, thus differring notably from all *Periclimenes*. In the two other described species of *Urocaris*, *U. longipes*, Stimpson, and *U. psamathe*, de Man, forms which differ widely from the more typical representatives of the genus, the dactyli are stated to be unarmed. In *U. psamathe* the mandible has apparently not been examined and in both species we lack information regarding the branchial formula.

Urocaris indica, sp. nov.

(Plate XIII, fig. 9.)

? 1905. *Urocaris longicaudata*, Pearson (*nec* Stimpson), *Rep. Pearl Oyster Fisheries, Ceylon*, IV, p. 78, pl. i, figs. 5, 5*a*.

The rostrum reaches almost to the end of the antennular peduncle. The upper portion of the blade, that is to say that situated above the midrib, is deep and forms a strongly arched crest rising above the general level of the carapace and armed with 8, 9 or 10 more or less evenly spaced teeth.[1] The first of these teeth is situated a little behind the orbit, while the second is immediately above it. The crest is continued backwards as a well-marked carina for two-thirds the length of the carapace and bears, a little in front of the middle point of the latter, a single isolated spine. The portion of the rostral blade below the midrib is obsolete and the lower edge is, in consequence, straight or even a trifle concave. This margin is unarmed throughout the greater part of its length; but, close to the apex and below, or in front of the most distal tooth of the dorsal series, bears from 1 to 3 (usually 2) minute teeth (pl. xiii, fig. 9).

The carapace, except for the median carina noticed above, is smooth. It is provided with sharp antennal and hepatic spines and the sub-orbital angle is narrowly produced and rounded at the extremity.

The eyes are rather long, reaching almost to the end of the basal antennular segment; they possess a well-defined ocellus.

The lateral process of the antennular peduncle (text-fig. 26*a*) has the form of a sharp external spine situated at the proximal end. The outer margin in front of this process is convex; it bears a strong spine anteriorly and is continued forwards beyond this to a point much in advance of the insertion of the second segment. The extreme length of the basal segment is about twice that of the two following combined. The outer antennular flagellum is distally divided into two unequal rami, the inner long and slender, the outer stout and, including the basal fused portion, of a length equal to that of the peduncle. The length of the stout outer branch is variable, but usually less than half that of the fused portion.

The antennal scale (text-fig. 26*b*) reaches only a trifle beyond the antennular peduncle. It is from three and a third to three and three quarter times as long as

[1] In one wholly abnormal specimen there are only five dorsal teeth.

wide and the broad but rather sharply angled apex of the lamella extends beyond the spine which terminates the straight outer margin for a distance not greater than the length of the spine.

The mandible is without palp; the incisor process terminates in three teeth. The epipod of the first maxillipede is a little emarginate but is not bilobed. The exopod of the third maxillipede reaches about to the end of the antepenultimate segment, which is furnished with a variable number of spinules on its outer margin. The ultimate segment is about two-thirds the length of the antepenultimate.

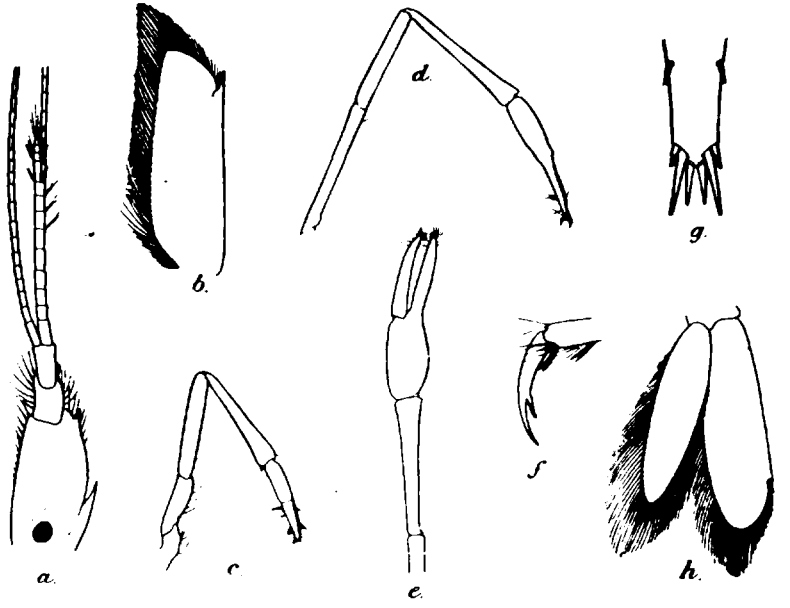

FIG. 26.—*Urocaris indica* sp. nov.

a. Antennule.
b. Antennal scale.
c. First peraeopod.
d. Second peraeopod.
e. Carpus and chela of 2nd peraeopod from above.
f. Dactylus of fifth peraeopod.
g. Apex of telson.
h. Uropoda.

The first peraeopods (text-fig. 26*c*) reach to two-thirds the length or almost to the apex of the antennal scale. The merus and carpus are of equal length and about one sixth longer than the chela. The dactylus is equal in length to the palm and there are a few tufts of setae on the fingers, at the base of the palm and at the distal end of the carpus.

The second peraeopods (text-figs. 26*d*, *e*) reach beyond the end of the scale by the length of the fingers and sometimes by almost the entire length of the palm as well. The lengths of the segments (in mm.) of seven specimens are as follows:—

Sex.	Second peraeopod: length of				
	Ischium.	Merus.	Carpus.	Palm.	Dactylus.
♀	1·8	1·4	1·75	·9	1·0
♀	1·5	1·2	1·4	·7	·7
♀	1·5	1·0	1·4	·7	·8
♀	1·4	1·1	1·4	·8	·9
♀	1·3	1·1	1·4	·7	·8
♂	1·2	·9	1·2	·6	·65
♂	1·0	·7	1·0	·4	·4

The fingers are provided with inturned claws and with a few setae placed distally, but are without teeth on the cutting margins. There are no spines on any of the segments.

The third peraeopods reach almost or quite to the end of the antennular peduncle; those of the fifth pair are a little longer. In all the last three pairs the posterior margins of the propodi bear tufts of longish setae and the dactylus is naked and biunguiculate, bearing a slender spine near the apex (text-fig. 26*f*). In those of the fifth pair the ischium and carpus are of equal length; the carpus is a little more than half the length of the merus and a little less than half the length of the propodus; the latter segment is rather less than four times as long as the dactylus.

The abdominal somites are smooth; the third is somewhat strongly arched in lateral view and overhangs the succeeding somite. The sixth somite is about twice the length of the fifth and is a little longer than the telson.

Both uropods extend beyond the apex of the telson, the outer being the longer and about three and a half times as long as broad (text-fig. 26*h*). The telson is narrow with two pairs of dorso-lateral spinules. The apex (text-fig. 26*g*) is produced in the middle to a bluntly rounded lobe and bears three pairs of spinules. The tips of the inmost pair fall only a little short of those of the intermediate pair, the outermost being much the shortest.

Large ovigerous females reach a length of nearly 16 mm.

Urocaris indica is very closely allied to *U. infraspinis*, Rathbun[1], from California and the Pacific coast of Mexico. It agrees with this species and differs from *U. longicaudata*, Stimpson[2], the type of the genus, in possessing an antennal spine and a well defined ocellus at the base of the cornea. The characters separating *Urocaris infraspinis* from the form found on the Indian coasts appear to be as follows:—

[1] Rathbun, *Proc. U. S. Nat. Mus.*, XXIV, p. 903 (1902) and *Harriman Alaska Exped.*, X, p. 31, text-figs. 10*a*, *b* (1910).

[2] This species, examples of which I have examined, is recorded from the West Indies and the adjacent eastern coast of America. See Stimpson, *Proc Acad. Nat. Sci. Philadelphia*, XII, p. 39 (1860) and Rathbun, *Bull. U.S. Fish Comm. for* 1900, XX, ii, p. 126 (1902).

U. infraspinis.	*U. indica.*
Rostrum slightly shorter, with 5-7 teeth above[1] and 1 or 2 below.	Rostrum slightly longer, with 8-10 teeth above[1] and 2 or 3 below.
Basal segment of antennular peduncle narrower, its outer margin nearly straight.	Basal segment of antennular peduncle broader, its outer margin convex.
Apex of antennal scale produced far beyond the spine which terminates the outer edge	Apex of antennal scale produced not so far beyond the spine which terminates the outer edge.
Second peraeopods with merus and ischium subequal; palm a little shorter than ischium.	Second peraeopods with merus decidedly shorter than ischium; palm little, if at all, more than half the length of ischium.
Sixth abdominal somite less than twice as long as fifth.	Sixth abdominal somite twice as long as fifth.
Size larger, up to about 21 mm.	Size smaller, not more than 16 mm.

Some of these distinctions would perhaps break down on actual comparison of specimens, while others, possibly of greater value, might be found.

With the two remaining described species of *Urocaris*, *U. longipes*, Stimpson[2] and *U. psamathe*, de Man[3], the Indian form has little in common.

I think it very probable that the specimen recorded by Pearson (*loc. cit.*) under the name *U. longicaudata*, Stimpson, from the Ceylon Pearl Banks should be referred to this species. In the Indian Museum are numerous examples of *U. indica* obtained at the north end of the Gulf of Manaar, a locality not far distant from the Pearl Banks, and these are indistinguishable from individuals found in the Chilka Lake. The fact that an antennal spine was present in Pearson's example clearly indicates that it was incorrectly referred to the West Indian species; in the figures, however, no ocellus is shown and the rostrum is less elevated than in any example of *U. indica* that I have seen.

Examined when alive, specimens of *Urocaris indica* are almost perfectly transparent to the naked eye, but under a lens small speckles of white arranged in transverse rows are seen on the abdomen, at the tip of the telson, on the uropods and on the eyestalks. There are also minute maroon specks on the carapace and abdomen, the amount of pigmentation present varying greatly in different individuals. The eggs borne by the females are sage green in colour.

This species is very common in the Chilka Lake, especially near the shores among weeds. It is extremely abundant at the south end of the lake and at Barkul and is equally common at localities near the inner end of the outer channel, where the bottom is composed of muddy sand and weed is plentiful. The species is able to tolerate extreme variations in salinity, having been found in water that was quite fresh as well as in that which was as salt as the Bay of Bengal near the lake.

Ovigerous females were found in February, March, July and September. In the latter month, however, egg-bearing individuals were obtained only at the south

[1] Excluding the tooth situated on the carapace behind the rostrum.

[2] Stimpson, *Proc. Acad. Nat. Sci. Philadelphia*, XII, p. 39 (1860).

[3] De Man, *Abhandl. Senckenb. naturf. Ges., Frankfurt*, XXV, p. 816, pl. xxv, fig. 51 (1902).

end of the lake in water which was slightly brackish; no ovigerous specimens were seen out of many collected during this month at other localities in fresh water, and it appears that the species breeds only in water containing some trace of salinity.

In addition to a long series from the Chilka Lake, there are in the Indian Museum specimens of *U. indica* found by Dr. Annandale at Ennur and in the Adyar R. near Madras, and others which I myself obtained living in pure sea-water inside the fringing coral-reef at Kilakarai at the northern end of the Gulf of Manaar. The specific gravity of the water in which specimens were taken at Ennur in January 1915, varied from 1·000 to 1·0045; the collection includes numerous ovigerous females, but there had been a sudden inflow of fresh water, abnormal at that time of year, just previous to their capture.

The type specimens bear the number 8997-8/10 in the Indian Museum register.

Genus **PERICLIMENES**, Costa.

1852. *Anchistia*, Dana, *U. S. Explor. Exped., Crust.*, I, p. 577.
1898. *Periclimenes*, Borradaile, *Ann. Mag. Nat. Hist.* (7), II, p. 380

Periclimenes demani, sp. nov.

(Plate XIII, fig. 10.)

The carapace is smooth with broadly rounded antero-lateral angles. Supra-orbital and hepatic spines are present, the latter being placed a little below the level of the antennal spine.

The rostrum, in the female, reaches almost or quite to the apex of the antennal scale, sometimes a little beyond it in the male; in lateral view the blade is broad in front of its middle point and is very slightly upturned towards the apex. On the upper edge there are 7 to 9 teeth and on the lower 1 to 3; in nearly all the specimens there are 8 or 9 above and 2 or 3 below. The proximal tooth is remote from the rest of the series and is situated on the carapace at the junction of the middle and anterior thirds of its length. The second tooth is placed over the orbit and from this onwards the teeth are, as a rule, regularly spaced; the distal tooth is usually situated close to the apex (pl. xiii, fig. 10).

The cornea of the eye is a trifle wider than the stalk and in the female is, as in some allied species, traversed by a dark band. The band commences near the ocellus —which in this species is conspicuous—and extends round the inner half of the cornea, meeting the stalk again on its ventral side.

The antennular peduncle (text-fig. 27*a*) extends to about two-thirds the length of the antennal scale. The broad basal segment is more than one and a half times the length of the second and third segments combined; its outer margin is furnished proximally with a spine-like lateral process and terminates in a stout tooth; the margin inwards of this tooth is strongly sinuous and is bordered with setae. The outer flagellum is unequally bifid distally and the thickened part (*i.e.* the fused portion, composed of 12 to 14 segments, + the stouter and shorter of the two terminal

branches) extends beyond the apex of the antennal scale by two-thirds of its length in the male, by a little less in the female.

The antennal scale (text-fig. 27*b*) is about three and three quarter times as long as broad in large females, about four and a half times as long as broad in males. The outer margin is nearly straight in the female, a little concave in the male, and terminates in a spine which reaches to, or a trifle beyond, the apex of the lamella; the apical portion of the latter is not strongly narrowed as in *P. ensirostris* (Dana).

The mandible is without palp. The molar process is trilobed terminally and the incisor process ends in three sharp teeth.

The outer maxillipedes reach to the end of the antennal peduncle. The ante-

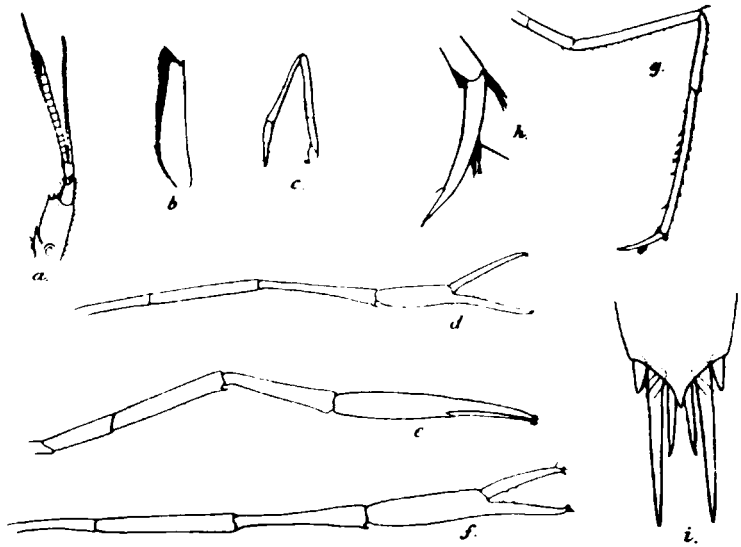

FIG. 27.—*Periclimenes demani*, sp. nov.

a. Antennule.
b. Antennal scale of male.
c. First peraeopod.
d. Second peraeopod of male from L. Chilka.
e. Second peraeopod of female from L. Chilka.
f. Second peraeopod of female from Madras.
g. Fifth peraeopod.
h Dactylus of fifth peraeopod.
i. Apex of telson.

penultimate segment is exceeded in length by the exopod and its outer margin is as a rule bare, without spinules or setae. The ultimate segment is about three quarters the length of the penultimate.

The first peraeopods (text-fig. 27*c*) reach a trifle beyond the antennal scale. The carpus is about one-fifth longer than the merus and nearly twice the length of the chela. The palm is a little shorter than the fingers and bears on its inner face numerous setae arranged in transverse rows. The fingers also bear a few tufts of setae on their margins and are without teeth on the cutting edge.

The second peraeopods (text-figs. 27*d*, *e*, *f*) are equal. In the female they extend beyond the apex of the antennal scale by the length of the chela, or, in very large

individuals, by the length of the chela and half the carpus. In the male they are decidedly longer proportionately, reaching beyond the scale by the chela and two-thirds the length of the carpus. The limbs of five separate specimens yield the following measurements[1] (in mm.):—

Sex.	Second peraeopod : length of				
	Ischium.	Merus.	Carpus.	Palm.	Dactylus.
♂	2·2	3·2	3·2	2·0	2·1
♂	2·0	2·9	3·0	1·9	2·1
♀	2·1	3·2	3·3	2·4	1·8
♀	2·0	2·7	2·7	2·2	1·5
♀	2·0	2·6	2·7	2·1	1·6

It will be seen that the merus and carpus are about equal in length and that the latter segment is considerably longer in the male than in the female and in the former sex is conspicuously longer than the palm. The fingers in the male are a little longer than the palm, while in the female they may be less than three-quarters its length. There is a spine at the distal end of the merus, situated inferiorly, and one at the distal end of the carpus, placed internally. There are a few very small teeth, sometimes as many as six, on the inner half of the fixed finger and others, still more minute, similarly placed on the dactylus.

The third, fourth and fifth pairs of peraeopods reach to, or a little beyond, the apex of the antennal scale. In those of the fifth pair (text-fig. 27*g*) the propodus is a trifle longer than the merus, about twice the length of the carpus and nearly three times the length of the dactylus. The propodus bears setae at its distal end and five or six spinules on the inner border; the dactylus is slender, slightly curved and with a few setae in the middle of its outer margin.

The only gills which are well developed are the five pleurobranchs. The pleurobranch found in *Palaemon* at the base of the third maxillipedes is absent, while the arthrobranch of the same segment is represented only by a few lamellae. There is, apparently, no trace of a podobranch on the second maxillipede.

There is a marked difference between the sexes in the form of the pleopods. In the male the protopodite is about equal in length to the exopod, whereas in the female it is proportionately half as long again. The greater length of the segment in the latter sex is correlated with the greater depth of the abdominal pleura; it is doubtless a provision to enable the pleopods to have free play when the female is heavily laden with eggs.

The abdominal somites are smooth; the sixth is little more than half the length

[1] These measurements are taken from specimens found in the Chilka Lake. In ovigerous females from the neighbourhood of Madras, which are of considerably larger dimensions, and in a few examples from the Chilka lake (text-fig. 27*e*) the palm is a little longer proportionately, about equal in length with the carpus and merus. In a male from Madras the proportional lengths of the segments of the second leg are much as in the Chilka specimens, but the limb is longer, reaching beyond the apex of the scale by the chela and the whole length of the carpus.

of the telson (terminal spines included). The outer and inner uropods are equal in length, the former being about two and a fifth times as long as broad. The telson bears two pairs of dorso-lateral spinules and is not sulcate above; the apex (text-fig. 27*i*) is sharply acute and is furnished with three pairs of spines, those of the intermediate pair twice, or more than twice, the length of the inner and several times longer than the outer.

Eyed eggs borne by females are about 0·58 mm. by 0·44 mm. in longer and shorter diameters.

Large specimens from the Chilka Lake do not exceed 21 mm. in total length; individuals from the Madras backwaters are frequently larger, up to 25 mm. in length.

The presence of supra-orbital and hepatic spines and the long and slender carpus of the second peraeopods, outstanding characters of *P. demani*, are shared by six described representatives of the genus; namely—

Periclimenes aesopius (Bate).

1863. *Anchistia aesopia*, Bate, *Proc. Zool. Soc., London*, p. 502, pl. xli, fig. 5.

Periclimenes danae (Stimpson), Borradaile.

1898. *Periclimenes danae*, Borradaile, *Proc. Zool. Soc., London*, p. 1004, pl. lxiii, figs 4, 4*a*, *b*.

Periclimenes edwardsi (Paulson).

1875. *Anchistia edwardsii*, Paulson, *Crust. of the Red Sea*, p. 114, pl. xvii, figs. 2, 2*a*, *b*.

1906. *Anchistia edwardsi*, Nobili, *Ann. Sci. nat., Paris*, (9), iv, p. 53.

Periclimenes elegans (Paulson).

1875. *Anchistia elegans*, Paulson, *ibid.*, p. 113, pl. xvii, figs. 1, 1*a-h*.

1906. *Anchistia elegans*, Nobili, *ibid.*, p. 52.

Periclimenes ensifrons (Dana) [=*P. vitiensis*, Borradaile and ? *P. grandis* (Stimpson)].

1852. *Anchistia ensifrons*, Dana, *U.S. Explor. Exped., Crust.*, I, p. 578, pl. xxxvii, figs. 5*a-l*.

1902. *Periclimenes ensifrons*, de Man, *Abhandl. naturf. Ges. Frankfurt*, XXV, p. 826.

Periclimenes tenuipes (Holmes *nec* Borradaile).[1]

1900. *Anchistia tenuipes*, Holmes, *Occas. Papers California Acad. Sci.*, VII, p. 216.

1910 *Periclimenes tenuipes*, Rathbun, *Harriman Alaska Exped.*, X, *Crust.*, p. 34, text-fig. 12.

P. aesopius is readily distinguished from *P. demani* by the form of the third abdominal somite which is "postero-dorsally carinated and elevated into a hump-like tooth." From all the other species listed above *P. demani* may be distinguished

[1] I am unable to understand Nobili's statement (*Ann. Mus. Zool. Napoli*, II, 1907, No. 21, p. 5) that Heller regarded *Palaemon biunguiculatus* as a synonym of "*Periclimenes tenuipes*, Leach." Heller in 1857 (*Crust. südlich. Europ.*, p. 256) cites *P. unguiculatus* as a synonym of *Anchistia scripta*; but there is no reference to any species of Leach and I am unable to discover that that author ever described a Palaemonid under the name of *Periclimenes tenuipes*. If this is so, *tenuipes* may legitimately be used for the Californian species described by Holmes, while *P. borradailei*, Rathbun (1904) should be employed for *P. tenuipes*, Borradaile. Nobili (*Bull. sci. France Belg.*, XL, 1906, p. 42) has suggested the name *brevinaris* for the form which he described in the preceding year (*Bull. Mus. d'Hist. Nat., Paris*, 1905, p. 159) as *P. borradailei*.

by the greater length of the carpus of the second peraeopods which, even in the female, is as long or longer than the palm.

In addition it differs notably from *P. ensifrons* and *P. elegans* in the form of the antennal scale, which in those species is concave externally and terminates in a spine which far outreaches the narrow apex of the lamella. *P. danae*, as identified and figured by Borradaile, has three posterior rostral teeth situated on the carapace and the ultimate segment of the outer maxillipedes (according to the figure) only about half the length of the penultimate. In *P. edwardsi* two posterior rostral teeth are placed on the carapace and the antennular peduncle is longer, reaching the apex of the antennal scale.

In the scheme of classification recently proposed by Borradaile[1] *P. demani* apparently finds a place in the subgenus *Falciger*.

Periclimenes demani, when alive, is transparent, speckled with greenish-yellow chromatophores. A dark brown stripe is conspicuous in lateral view on either side of the mouth and another similar stripe in front of the first pair of legs. The rostrum, antennules and antennae are transparent with occasional greenish-yellow chromatophores. The legs are entirely transparent, except for the fingers of the large claw which are bluish, and for a suffusion of bright orange yellow at the junction of the fingers and palm of the same limb. On the thoracic sternum is a broad transverse maroon band which involves the basal segments of the third legs. The margins of the abdominal pleura and uropods are mottled with maroon and the eggs are sage green.

The species is not uncommon in the Chilka Lake, though much less abundant than *Urocaris indica*. Unlike the latter form it is entirely absent from the main area of the lake. It has been found in numerous localities in the outer channel, living among weeds in quite shallow water; it has been taken off Barnikuda I., in Seruanaddi, at Satpara, near Mahosa, and, in the flood season, among submerged vegetation near Manikpatna.

The species appeared to be equally abundant both in March, where the water was of the same salinity as that of the sea outside the lake and in September when it was quite fresh. In March the breeding season was just beginning, a few females bearing eggs that were not eyed; by September it was apparently almost over, or a second breeding period was almost completed, for the eggs borne by the single ovigerous female that was then obtained were fully eyed and on the point of hatching.

The specimens from the neighbourhood of Madras, where the species appears to be commoner than in the Chilka Lake, are, as already noted, of a larger size than those found in the Chilka Lake. They were obtained by Dr. Annandale in October 1913, in the Adyar River in water that was almost fresh, and also in the Ennur backwater in January 1915, in water of specific gravity varying from 1·000 to 1·0045. On both occasions ovigerous females were taken.

The type specimens bear the number 8981-4/10 in the Indian Museum register.

[1] Borradaile, *Ann. Mag. Nat. Hist.* (8), XV, p. 207 (1915).

Family ALPHEIDAE.

Five species of Alpheidae occur in the Chilka Lake, but only two of them, *Alpheus crassimanus* and *A. paludicola*, inhabit the main area. All of them are able to exist in pure fresh water as well as in water as salt as that of the Bay of Bengal in the vicinity of the lake. The species of *Athanas* is remarkable for the existence in the males of a well-marked trimorphism.

Genus OGYRIDES, Stebbing.

1860. *Ogyris*, Stimpson, *Proc. Acad. Nat. Sci. Philadelphia*, XII, p. 36.
1899. *Ogyris*, Coutière, *Ann. Sci. nat., Zool* (8), IX, p. 332.
1911. *Ogyris*, de Man, *Decap. 'Siboga' Exped.*, II, Alpheidae, p. 135.
1914. *Ogyrides*, Stebbing, *Ann. S. African Mus.*, XV, p. 31.

The name *Ogyrides* has recently been proposed by Stebbing in substitution for Stimpson's *Ogyris*, preoccupied by Doubleday (1847) in Lepidoptera.

The genus is extremely abnormal in type, exhibiting in the feeble dimensions of the first peraeopods a condition which is in all probability primitive, while the attenuated eyestalks, the form of the antennular peduncle and antennae, the great length of the exopods of the first two pairs of maxillipedes and the reduced branchial formula are indications of extreme specialization. The relationship of *Ogyrides* with more typical Alpheidae is traced through *Automate*, a genus in which the antennular peduncle and antennal carpocerite are of great length and in which, as in *Ogyrides*, the eyes are not concealed.

The branchial formula of the species of *Ogyrides* found in the Chilka Lake is as follows:—

	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.
Podobranchs ..	ep.	ep.	ep.	..	..	..	..	..
Arthrobranchs ..	..	..	..	..	..	..	..	..
Pleurobranchs ..	..	..	..	1	1	1	1	1

The branchiae are fewer in number than in any other genus of Alpheidae; but, except for the absence of an arthrobranch at the base of the third maxillipede, the formula resembles that found in *Cheirothrix* and *Synalpheus*.[1]

The single species of this genus found in the Chilka Lake appears to find its nearest ally in a form recorded from the mouth of the Tocantins River in Brazil.

Ogyrides striaticauda, sp. nov.

The rostrum is flat and triangular and slightly curved downward distally; it scarcely reaches beyond the infero-orbital angle of the carapace (text-figs. 28*a*, *b*). The apex is acute and the margins are furnished with setae. Behind it the carapace is keeled in the mid-dorsal line for nearly half its length, the carina bearing a series of

[1] *Cf.* Coutière, *Ann. Sci. nat., Zool.* (8), IX, p 276 *et seq.* (1899).

from 7 to 9 forwardly directed teeth. On either side the carapace is rather thickly clothed with plumose setae. A cervical groove (*e* of Boas' terminology) is distinct, the orbits are semicircular, the infero-orbital angle bluntly rounded and the pterygostomian obtusely pointed.

The eyes are very long and slender and extend beyond the antennular peduncle for a distance equal at least to the length of the last segment of the latter. The stalks are broad at the base, but very narrow in the middle, expanding slightly at the distal end. Each bears a row of setae on the inner margin towards the end of the proximal third of its length.

The basal segment of the antennular peduncle reaches to half the length of the

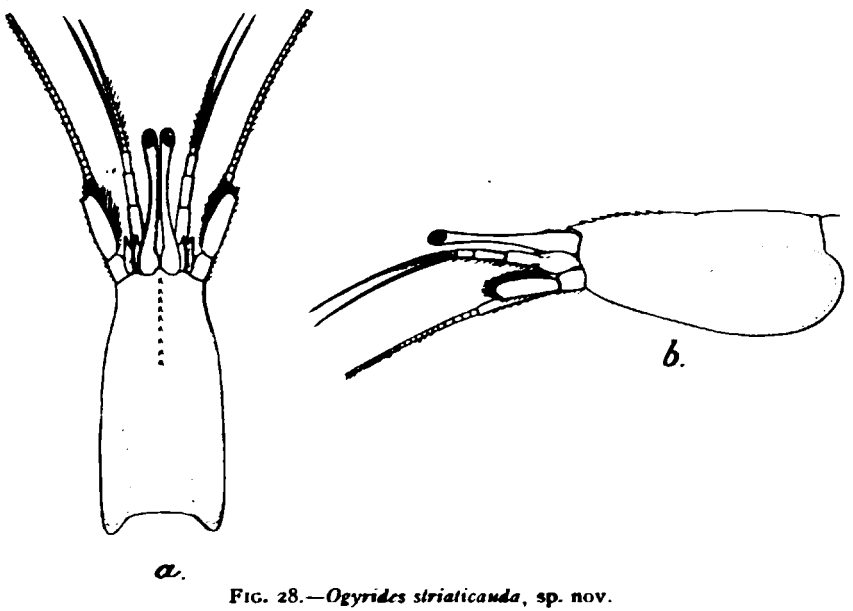

FIG. 28.—*Ogyrides striaticauda*, sp. nov.

Carapace and anterior appendages. *a*. Dorsal view. *b*. Lateral view. The fine setae on the carapace are not shown.

eyestalks. The lateral process has two ridges, the lower, which corresponds to the outer margin of the process in normal forms and the upper, which is nearly vertical and lies close to the outer edge of the eyestalk. Each of these ridges terminates anteriorly in a strong spine; the tips of the spines are on a level and reach to about three fifths the length of the segment. The second segment of the peduncle is rather more than half the length of the first and the third about half the length of the second. The flagella are of the same length, about as long as the peduncle.

The basicerite of the antenna bears a single external spine; the carpocerite is very long, reaching to the last segment of the antennular peduncle. The antennal scale reaches only to the middle of the second segment of the peduncle; it is about

three and a quarter times as long as wide and the outer margin is straight terminating in a spine which reaches almost to the apex of the lamella.

The mouth parts are illustrated in text-figs. 29*a-f*. In the mandible the incisor process is comparatively narrow and terminates in four or five teeth. The palp is two-segmented, the basal segment being broadly expanded distally. The outermost of the three portions that compose the first maxilla is bifid at the extremity, each part bearing a single long seta.

The first and second maxillipedes (text-figs. 29*d*, *e*) are provided with large epipods; that of the former appendage is bilobed. The third maxillipedes reach beyond

FIG. 29.—*Ogyrides striaticauda*, sp. nov.

a. Mandible.
b. First maxilla.
c. Second maxilla.
d. First maxillipede.
e. Second maxillipede.
f. Third maxillipede.

the end of the eyes by the length of the ultimate segment, which is invariably flexed upwards; the exopod reaches nearly to the end of the antepenultimate segment. The long plumose setae which clothe the limb are specially numerous on the ultimate segment, which is rather less than half the length of the penultimate. It will be noticed that the latter segment is much longer proportionately than in any other genus of the family.

The first peraeopods (text-fig. 30*a*) reach about to the end of the basal segment of the antennular peduncle. The ischium is swollen and, as in *O. sibogae*, is notched inferiorly at the base. The proportional lengths of the ischium, merus, carpus and chela are as 10, 18, 19 and 14½. The fingers are rather less than twice the length of

the palm; they gape slightly at the base when the claw is closed and their cutting margins are entire. Setae are thinly scattered on the lower edges of the ischium and merus[1] and on both margins of the carpus; on the chelae they are more numerous.

The second peraeopods (text-fig. 30*b*) reach a little beyond the tips of the eyes, the carpus, as in *O. occidentalis* and *O. sibogae*, being composed of four segments. The proportional lengths of ischium, merus, carpus and chela are as 13, 20, 22 and 10. Of the four segments which compose the carpus, the first is very long, nearly one and a third times the length of the three following combined; the second and fourth are nearly equal in length, almost twice as long as the third. The fingers

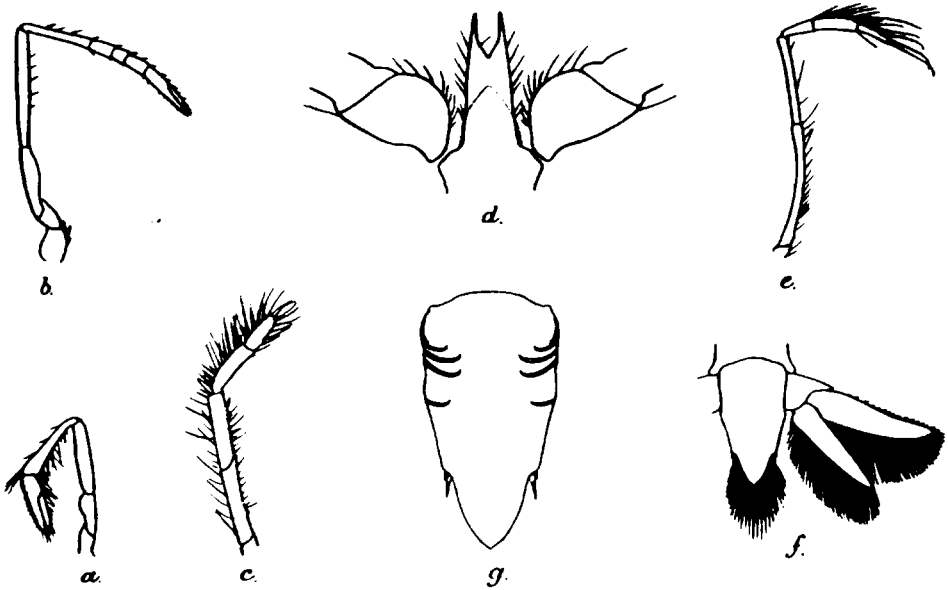

FIG. 30. – *Ogyrides striaticauda*, sp. nov.

a. First peraeopod.
b. Second peraeopod.
c. Third peraeopod.[2]
d. Sternal process at base of 4th peraeopods.
e. Fifth peraeopod.
f. Telson and right uropods from above.
g. Telson from below.

are a little more than one and a half times the length of the palm. The limb bears setae on the distal part of the carpus and on the chela.

Of the last three pairs of peraeopods the fourth is the longest, reaching as far forwards as the first, the third (text-fig. 30*c*) is the stoutest and the fifth (text-fig. 30*e*) the most slender. In the third and fourth pairs the dactylus[2] is very small; the

[1] These are not shown in text-fig. 30*a*.

[2] The dactylus of the third peraeopod is not well shown in text-fig. 30*c*; it is very much more slender than the propodus and about one-third its length, bearing two short setae apically. The figure conveys the erroneous impression that the dactylus is absent and that the propodus bears two long setae, which are crossed, at its apex.

merus of the third bears a stout spine near the distal end of its lower border. All the segments bear setae, most thickly on the carpi and propodi of the third and fourth pairs and on the last two segments of the fifth. The proportional lengths of the ischium, merus, carpus, propodus and dactylus in the third pair are as 16, 14, 9½, 6 and 2: of the same segments in the fourth pair as 16, 23, 11, 10 and 2: of the same segments in the fifth pair as 22½, 15, 5½, 7½ and 5½. Attached to the proximal segments of the fourth pair of legs is a curious elongated plate (text-fig. 30*d*) which extends forwards to the base of the third pair, lying close to the sternum. The lateral margins of this plate are straight, a little convergent distally, and its apex is deeply bifurcated.

The abdominal somites are smooth above; their pleura are rounded inferiorly. The length of the sixth somite is about equal to that of the fifth.

The telson is a little longer than the sixth somite and is shorter than both inner and outer uropods; it is slightly sulcate above and bears two pairs of small dorsal spinules (not shown in text-fig. 30*f*). At the distal end of each lateral margin are two pairs of spines and the apical portion between them is produced and at the extremity rather sharply angled. The innermost pair of spines, which is much the longest of the two, reaches to less than half the length of the produced median part. The breadth at the level of the spines is a little more than one-third the total length. The telson does not possess a feeble lateral prominence but on either side, situated in the proximal third and on the ventral surface, are four oblique ridges, the three anterior ones placed close together, the other rather more distant. The arrangement of these ridges, which appear to be characteristic of the species, is shown in text-fig. 30*g*. In spirit specimens they have a nacreous lustre and perhaps represent a stridulating organ, but I am unable to find that they possess transverse striae and there does not appear to be any ridge on the basal segment of the uropods which could be brought to bear upon them.

The outer uropod (text-fig. 30*f*) is longer than the inner; it is distally pointed, setose on both margins and about three and a half times as long as broad.

The largest specimen, an ovigerous female, is about 14 mm. in length.

A synoptic key and references to the four hitherto known species of the genus is supplied by de Man.[1] *O. striaticauda* is evidently a very close ally of *O. occidentalis*, Ortmann[2], from the mouth of the Tocantins River in Brazil. Ortmann's description is very brief and neither in it nor in the figures is there any indication of the ridges found on the telson in the Indian species; it is probable, therefore, that a well-marked difference exists in this respect between the two forms. In *O. occidentalis*, also, the eyes do not extend beyond the antennular peduncle and, according to the figures[3], the antennal scale is considerably longer than in *O. striaticauda*, the basal

[1] De Man, *Decap. 'Siboga' Exped.*, II, *Alpheidae*, p. 135 (1911).

[2] Ortmann, *Decap. Schizop. Plankton-Exped.*, p. 46, pl. iii, figs. 4, 4*a-z*. (1893).

[3] The figures are perhaps not very reliable. That of the third leg at least is almost certainly erro-

segment of the mandibular palp is not widened distally, the exopod of the outer maxillipedes is much shorter, the three distal subsegments of the carpus of the second legs are of equal length and the telson is narrower, with the apex evenly rounded.

Living specimens of *O. striaticauda* were for the most part transparent, the greenish visceral and hepatic masses being clearly visible through the walls of the carapace. The eyestalks, antennules and antennae were pale red and the oral appendages, maxillipedes and first two pairs of legs bright red. On the first abdominal somite there were two transverse rows of red pigment spots and one similar row on each of the succeeding somites. The pleural margins were also red and the eggs borne by the ovigerous female were bright green.

O. striaticauda is apparently very scarce in the Chilka Lake: in all, only eight specimens were obtained. They were found in the outer channel in March, when the water was as salt as that of the sea outside the lake area, and in September, when it was entirely fresh. Three individuals were caught on the clean sandy bottom between Manikpatna and the mouth of the lake in company with *Pontophilus hendersoni*, while the remainder were obtained on the muddy ground in the vicinity of Barhampur I. No specimens were met with in the main area of the lake. The ovigerous female was found in March in salt water.

In addition to the Chilka lake specimens, there are in the Indian Museum numerous other examples obtained by Mr. F. H. Gravely in September 1914, in the Cochin backwaters near Ernakulam. There are ovigerous females among these specimens, though none were found at the same time of the year in the Chilka Lake. A few specimens were also taken in the Ennur backwater in January 1915, by Dr. Annandale. They were living on a bottom of almost pure sand in water of very low specific gravity. One female bore eggs.

Genus ATHANAS, Leach.

1899. *Athanas*, Coutière, *Ann. Sci. nat., Zool.* (8), IX, p. 323.

Among the species of this genus most marked differences exist in the degree of development of the first pair of legs. In most forms those of the male are greatly enlarged, much as in the genus *Alpheus*, and may be symmetrical or asymmetrical. In females the first legs may resemble those of the male, or one or both limbs may be small and slender.

In the species of *Athanas* found in the Chilka Lake the first pair of legs presents features of unusual interest and it seems desirable therefore, in the first place, to summarise our knowledge of the development of these limbs in the various forms that have been described.[1]

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neous, for Ortmann has apparently failed to discern the true division between the merus and ischium and has represented what is really the produced lower distal angle of the latter as a spine at the base of the former.

[1] A most valuable key to the species of *Athanas* has been supplied by de Man, *Decap. 'Siboga' Exped.*, II, *Alpheidae*, p. 146 (1911).

Species.	First pair of peraeopods.	
	Male.	Female.
Group of *A. nitescens.*		
A. nitescens, Leach ..	Asymmetrical, both enlarged ..	Asymmetrical, one only a little enlarged.
A. naifaroensis, Coutière..	Unknown..	Symmetrical, not greatly enlarged.
A. aratiformis, Coutière ..	One enlarged, the other unknown	One not greatly enlarged, the other unknown.
A. grimaldi, Coutière ..	Symmetrical, enlarged ..	Symmetrical, enlarged.
A. granti, Coutière ..	Asymmetrical, both enlarged ? ..	Asymmetrical, both enlarged ?
A. parvus, de Man ..	Unknown..	Symmetrical, not enlarged.
Group of *A. dimorphus.*		
A. dimorphus, Ortmann..	Symmetrical, enlarged ..	Symmetrical, not enlarged.
A. minibosensis, Coutière..	Asymmetrical, both enlarged .	Asymmetrical, one only enlarged.
A. haswelli, Coutière ..	Unknown..	One (? both) not enlarged.
A. orientalis, Pearson ..	Unknown..	Asymmetrical, one only enlarged.
A. djiboutensis, Coutière..	Asymmetrical, both enlarged ..	Asymmetrical, one only enlarged.
A. sibogae, de Man ..	Asymmetrical, both enlarged ..	Asymmetrical, both enlarged.
A. jedanensis, de Man ..	One enlarged, the other unknown	Symmetrical, not enlarged.
A. tenuipes, de Man ..	Unknown..	Unknown.

The single species of *Athanas* found in the Chilka Lake belongs, apparently, to a form hitherto unknown, but is closely allied to Ortmann's *A. dimorphus*. It was unfor-

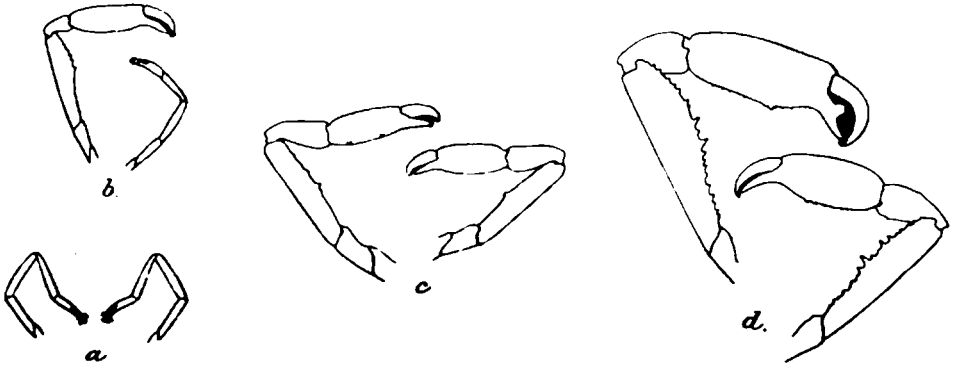

FIG. 31.—*Athanas polymorphus*, sp. nov.

a. First peraeopods of female. *c.* First peraeopods of male, form II.
b. *do.* of male, form I. *d.* *do.* of male, form III

tunately very scarce, and of the twenty-seven specimens obtained only nine are males. These nine males, however, present a most notable diversity of form, a fact which has led me to assign to the species the name *Athanas polymorphus*.

As in *A. dimorphus* the first legs in the female are both slender (text-fig. 31*a*), with the carpus longer than the chela and are wholly dissimilar in structure from the large limbs of the male. But, apart from this feature, which evidently influenced Ortmann in his choice of a specific name, the males in the new species can be separated into three clearly defined groups according to the degree of development which

the first legs have attained. In the smallest males (five specimens) one of the first legs, either right or left, is identical in structure with that of the female, while the other is greatly enlarged, the fingers of the chela being curved and not provided with teeth (text-fig. 31*b*). In other males (two specimens) both legs of the first pair are equally enlarged, each being closely similar to the large limb borne by the preceding form (text-fig. 31*c*). In others again (two specimens) both legs are enlarged, but asymmetrical; one limb, except for the greater number of spines on the merus, is similar to that in the preceding group, while the other is a little larger and, apart from more trifling differences in forms, is provided with a huge rounded tooth on the fixed finger (text-fig. 31*d*).

The characters of the nine males may be tabulated thus:—

Date of capture.	Length of carapace.[1]	First peraeopods.
1914.	mm.	Form I, text-fig. 31*b*.
Sept. 9th	2·6 2·5	Asymmetrical. One, either right or left, enlarged, without tooth on fixed finger and with few spines on merus. Other slender, of proportions similar to those of female.
Sept. 10th	3·2 2·8	
Sept. 12th	2·3	
		Form II, text-fig. 31*c*.
March 22nd	5·0 4·3	Symmetrical. Both enlarged, without tooth on fixed finger and with few spines on merus.
		Form III, text-fig. 31*d*.
March 16th	4·4 4·1	Asymmetrical. Both enlarged, with numerous spines on merus. Right leg in both specimens with large rounded tooth on fixed finger. Left, in one specimen without tooth on finger (*i.e.* similar except for spines on merus to Form II), in the other specimen missing.

In all these specimens the appendix masculina on the second pleopods is well developed; there is thus no doubt regarding their sex. Also, it is in my opinion impossible that the small limb found in Form I is the result of regeneration. In almost all cases it is easy to distinguish a limb that has been broken off and subsequently grown again and it is, I think, inconceivable that in each of the five individuals of this form it should be equally and perfectly re-developed.

The case therefore is one of trimorphism, at any rate in a somewhat loose application of that term; but the specimens are so few in number that I have found it

[1] The measurement is taken from the posterior mid-dorsal edge of the carapace to the tip of the eye.

impossible to do more than make a few suggestions, some perhaps rather more probable than others, to account for the existence of this curious phenomenon.

It will be seen from the table given above that the largest and most fully developed specimens, Forms II and III, were caught in March, while all belonging to Form I are smaller and were obtained in September. The breeding season is apparently in March, for it was only in this month that ovigerous females were found. Judging by its size, Form I is probably the youngest and may represent a non-breeding phase; but it would be very extraordinary if the three forms were merely stages in the life-history of the species. In very young males, perhaps early post-larval forms, it is probable the first limbs are both slender, resembling those of the female and, if Forms I, II and III represent successive stages in growth, the development is, as far as I am aware, without parallel. On this theory the young male would, in the course of a few months, develop one enlarged limb, the pair being greatly asymmetrical (Form I). Later, at a subsequent moult, the other limb would be similarly enlarged, the pair thus becoming symmetrical (Form II), while still later asymmetry would again be manifest in the form of the chelae, the spines on the merus being increased in number in both limbs. According to this theory the males could not strictly speaking be regarded as trimorphic, the case would merely be one of a most unusual post-larval metamorphosis.

Another and perhaps rather more plausible suggestion may be made. The males may be strictly dimorphic, Forms II and III each representing the ultimate development in the life of an individual, each being a fixed type which never alters in the course of subsequent moults. On this theory Forms II and III would be developed simultaneously at the beginning of the breeding season from the non-breeding phase represented by Form I.

One more theory remains. The males may be strictly trimorphic, each of the three forms representing a fixed and unalterable type, predetermined perhaps from an early age. The facts available regarding the size and date of capture of the specimens seem to indicate that this view has but little to recommend it.

The three suggestions which have been made must, I think, exhaust all probable explanations of the case, for it is impossible that the three forms merely represent items in a series exhibiting normal variation. My suggestions may be summarised thus :—

Theory I. That the three forms of male represent merely so many stages in the life-history of this sex of the species.

Theory II. That the males are truly dimorphic, Forms II and III representing unalterable types developed simultaneously at the breeding season from the non-breeding Form I.

Theory III. That the males are truly trimorphic, each of the forms representing a type unalterable in the life of the individual.

At first glance it seems possible to find an analogy between the three forms of male in *Athanas polymorphus* and the three forms of the same sex known in certain

Oxyrhynch crabs; but it does not seem probable that the two cases are really identical, though in both it is the development of the first legs that is concerned.

According to Geoffrey Smith's investigations [1] three types of males are to be found in some species of Oxyrhyncha and he names these three types "low," "middle" and "high." In both low and high males the chelae are swollen, there being a marked difference between the two groups in the comparative size of the limbs. The chelipedes of the middle form are, on the contrary, scarcely swollen at all, resembling those of the females. The low males are smaller than the high and the middle intermediate in size. During the breeding seasons the majority of the males that are found belong to the low or high forms, while in the intervening seasons middle males predominate. The low male in the course of its development to the high form passes through a middle stage in which the sexual function is in abeyance.

The investigations made by Hagen [2] and Faxon [3] on American crayfish referred to *Cambarus* have brought to light the fact that in this genus there are two forms of male, distinguished by the shape of the first abdominal appendages, and it has been shown that these two forms represent breeding and non-breeding phases. An almost precisely similar phenomenon has been noticed by Wollebaek [4] in one of the Pandalidae, *Pandalus montagui* (= *annulicornis*), though it apparently does not occur in allied species of the genus.

It is evident that these two last instances, although the organs concerned are more directly connected with the sexual function, belong to the same category as that of the Oxyrhynch crabs, in which the peculiarities are shown in the chelipedes. Although phenomena of the kind seem to be rare in the Decapods, it is clear that instances of a seasonal sexual dimorphism occur in at least three widely separated groups of the order, *viz.* the Caridea, Nephropsidea and Oxyrhyncha.

True dimorphism, *i.e.* the "definitive dimorphism" of Smith, is well known in many insects; but, if it ever exists, is of extremely rare occurrence among Decapoda.[5] Henderson and Matthai [6] have, indeed, brought forward facts which seem to indicate that the Palaemonidae known as *Palaemon scabriculus*, *P. dolichodactylus* and *P. dubius* are in reality true trimorphic forms of a single species, differing from one another in the proportionate measurements of the large claws of the male. Further evidence is, however, necessary before this view can be accepted as definitely proved.[7]

It appears to be impossible to bring the case of *Athanas polymorphus* into line with any of these instances. That the males show a definitive trimorphism is, I

[1] Smith, *Mitth. zool. Stat. Neapel*, XVII, p. 312 (1905).

[2] Hagen, *Ill. Cat. Mus. Comp. Zool.* II, pp. 20, 21 (1870).

[3] Faxon, *Mem. Mus. Comp. Zool.*, X, 4, p. 12 (1885).

[4] Wollebaek, *Bergens Museums Aarbog*, 1912, No. 8, p. 64.

[5] See my paper in *Rec. Ind. Mus.*, X, pp. 84-87 (1914) for a criticism of the supposed dimorphism in certain Hippolytidae and Palaemonidae.

[6] Henderson and Matthai, *Rec. Ind. Mus.*, V, p. 280 (1910).

[7] A definitive dimorphism is of course well known in Crustacea other than Decapods.

believe, most improbable, for the specimens of Form I were not obtained during the breeding season and in the non-breeding season occurred apparently to the exclusion of Forms II and III. It is clear, too, that the instance is not merely one of a seasonal sexual dimorphism such as occurs in *Cambarus* and *Pandalus*, though this may in part account for the peculiarities which have been noted.

On the evidence which I am able to offer, a parallel with the Oxyrhynch crabs also cannot be maintained, for Form I, which approximates most nearly to the female and might therefore be regarded as the representative of Smith's "middle" crabs, is not intermediate in size between Forms II and III, nor do these last forms show the marked difference in dimensions that one would expect if they corresponded respectively to the "low" and "high" forms in the Oxyrhynchs. Similarly it is impossible to regard the specimens of Form II as "middle" individuals: the measurements do not tally and the examples were found during the breeding season, at which time Form I was apparently absent.

The widespread though rare occurrence of a seasonal sexual dimorphism in the Decapoda suggests that this phenomenon will afford a partial explanation of the three forms of male in the Chilka species of *Athanas*. Form I, even though the appendix masculina is to all appearances fully developed, is probably a non-breeding phase of the sex. It is likely, on the other hand, that Forms II and III are breeding phases and, from the scanty evidence available, it seems reasonable to regard them as definitive dimorphic forms. This theory, the second of those listed on p. 292, appears to me the most plausible of any.

With further material it will be possible to determine if it is correct, and we may also be able to discover if Form I comprises specimens which have never bred or is a phase of a form that was once sexually active. From the specimens available it seems on the whole most probable that the former explanation is the true one and that males of Forms II and III perish at the close of the breeding season.[1]

The knowledge of the existence of three distinct forms of male in *Athanas polymorphus* must, I believe, have a marked effect on our views as to the systematic treatment of the genus, for it is not unlikely that different forms of the same species have been described under separate names.

I am inclined to think, also, that sufficient care has not been taken in determining the sex of the specimens described. When two forms of a species are found, that with the most highly developed limbs is considered to be the male and the other the female. Even Dr. de Man in his account of *Athanas sibogae* describes a specimen which "is considered to be the female of this species, with some doubt, because it carries no eggs"; it is not improbable that this example is really a second form of the

[1] Eventually it may perhaps be possible to find some analogy between the phenomena found in *Athanas* and those discovered by Sewell in Copepoda. Sewell, in tracing the development of certain species of this group by the application of "Brooks' Law", has found that in the male there may be two definitive dimorphic forms, both mature. Individuals of stage IV of Sewell's terminology may develop directly into the "low" form or, with the intervention of an additional immature stage, may reach the "high" form. See Sewell, *Rec. Ind Mus.*, VII, p. 316 *et seq.* (1912).

male. In the determination of the sex it is essential that the second pleopods should be examined to ascertain whether the appendix masculina is present or absent.

There is one other point of more than systematic interest in the specimens of *Athanas* found in the Chilka Lake, and this concerns the development of the second pair of legs. The carpus of these limbs in *Athanas* is composed of five sub-segments, whereas in the allied genus *Arete* there are only four. In twenty-three specimens of *Athanas polymorphus* the carpus is on both sides composed of five sub-segments and has a similar development in the single limb of the pair which alone persists in two additional specimens. The two remaining examples are, however, abnormal. In one of them, a male belonging to Form I, the carpus on one side is five-, and on the other four-segmented, while in the other specimen, which is a female, both the carpi are composed of only four segments (text-fig. 32*e*). The last specimen, if it had been taken alone, would almost certainly have been described as a new species of *Arete*, bearing a close resemblance to *Athanas*.

It is, however, through the *nitescens* group of *Athanas* that Coutière would derive *Arete* and not through the *dimorphus* group to which the Chilka species belongs.

Athanas polymorphus, sp. nov.

The rostrum is without teeth and reaches almost to, or a little beyond the end of the second segment of the antennular peduncle. In two large males (those belonging to Form III) it has evidently suffered injury and is abruptly curtailed at the apex, reaching only to the middle or end of the basal antennular segment. The dorsal carina of the rostrum extends backwards and is visible in the anterior sixth of the carapace. The supra-corneal spine is entirely absent; the extra-corneal is well developed, reaching to about half the length of the eye. The infra-orbital angle ("dent infra-cornéene" of Coutière) is small, but acute, though less spinous in character than the extra-corneal. There is also a sharp tooth opposite the insertion of the antennae, absent in *A. dimorphus*, which must, I think, be the homologue of the pterygostomian spine (text-figs. 32*a*, *b*).

The eyes are small, but well pigmented. The antennular peduncle reaches to the apex of the rostrum. The basal segment is little longer than the second and on its infero-internal margin bears, as is usual, a well-marked longitudinal crest, which terminates anteriorly in a tooth reaching almost to the distal end of the segment. The lateral process (stylocerite) is composed of a long spine which extends only a little beyond the end of the segment. The second segment is about one and three quarter times as long as the third. The inner antennular ramus is longer than the outer: the latter is distally bifid and the thicker of its branches, which is much the shorter, is about as long as the peduncle. The fused part is composed of from 8 to 10 segments and the free portion of the outer and thicker of the two branches is from one half to three quarters its length.

The carpocerite reaches almost to the end of antennular peduncle. The anten-