CRUSTACEA DECAPODA OF THE SIJU CAVE, GARO HILLS, ASSAM.

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Plate III.

Three species of Decapod Crustacea were found in the cave, but two of them (*Paratelphusa falcidigitis* and *Palaemon hendersoni*) are common out-door forms which have succeeded in making their way up the stream to which the cave owes its origin. The third, *Palaemon cavernicola*, is a species hitherto unknown which shows partial adaptation to underground existence in its general lack of pigmentation and in the reduced size of the eyes.

Family POTAMONIDAE.

Paratelphusa (Barytelphusa) falcidigitis Alcock.

1910. *Paratelphusa* (*Barytelphusa*) *falcidigitis*, Alcock, *Cat. Ind. Decap. Crust.*, 1, fasc. 2, p. 94, pl. vii, figs. 24, 24*a*.

Twelve specimens of this species were found in the cave at distances varying from 0 to 2,400 ft. from the mouth. All except one, which was found walking on dry land in the cavern at 450 ft., were obtained crawling among stones in the river-bed. All the specimens but one are males and in the largest, which is of this sex, the carapace is 61 mm. in breadth and 44 mm. in length. The specimens do not differ either in structure or colour from individuals found in out-door localities and the species is no doubt a mere straggler into subterranean waters.

Paratelphusa falcidigitis is common in the stream leading from the cave-mouth to the Someswari River, but in pools in the bed of the river the allied but quite distinct *P.* (*B.*) *harpax* Alcock appears to be the predominant form. The latter species does not enter the cave.

Paratelphusa falcidigitis is known only from Assam : from the Khasi Hills, Garo Hills, Naga Hills and Northern Cachar. *P. harpax* has been recorded from the same localities and from Silchar, Sylhet and Sadiya ; it seems, however, to have a more extended range, as we have recently received from Mr. M. Mackenzie a large male, with carapace 82 by 58 mm. obtained near Sepaya in the Saran district of Bihar.

Family PALAEMONIDAE.

Palaemon hendersoni de Man.

1907. *Palaemon* (*Parapalaemon ?*) *hendersoni*, de Man, *Trans. Linn. Soc.* (2) *Zool.* IX, p. 446, pl. xxxiii, figs. 66-68.

1913. *Palaemon hendersoni*, Kemp, *Rec. Ind. Mus.* VIII, p. 303, pl. xix, figs. 19-23.

1918. *Palaemon hendersoni*, Kemp, *Rec. Ind. Mus.* XIV, p. 95.

This species was common in the outer parts of the cave and was particularly abundant in pools in the river-beds at 300 to 350 ft. from the mouth. In the inner parts it occurred more sparingly ; it was found

in some numbers in the main channel between 600 and 1,300 ft. and was taken in the streams at 1,700 and 2,000 ft. A single individual was captured at 3,200 ft. It was frequently found in company with *P. cavernicola*, but in the inner parts of the cave was much scarcer than that species. It could be distinguished at a glance by its large eyes and dark pigmentation.

Specimens from the cave do not differ in any structural details from those found outside ; but in colouration a slight difference was noticed, for though blotched and streaked with pigment in normal fashion, the pigment itself was usually of a decidedly paler shade. This is presumably due to the direct effect of absence of light on the chromatophores of the individual.

The range of this species extends from the Darjiling district, through Assam to Burma, where it is found at least as far south as the Southern Shan States. It appears to be restricted to hilly country but has not been found at high altitudes.

I have pointed out (*loc. cit.*, 1918) that Burmese specimens differ slightly from those found in the Darjiling district or in Assam in the character of the rostrum. The specimens from the cave agree, as might be expected, with those from other parts of Assam. In the colouration of very large males there is probably no real difference between specimens from the two provinces, for one such male, obtained in the stream outside the cave, was tinged with blue on the antennal scale and had blue chelipeds, thus approaching the uniformly blue male which Dr. Annandale found in the Southern Shan States.

Palaemon cavernicola, sp. nov.

The rostrum varies considerably in length. As a rule it reaches about to the end of the antennular peduncle, but sometimes, more particularly in half-grown individuals, it extends a little beyond this point, while in some very large specimens it reaches only to the end of the second antennular segment. The rostrum is straight, deep in lateral view, the upper border slightly and the lower border very strongly convex. Dorsally it bears from 5 to 9 teeth, usually 6 or 7[1], which are small and with the interspaces set with plumose setae. Two or three of the posterior teeth stand on the carapace behind the posterior limit of the orbit and the interval between the first and second teeth is sometimes, but not always, greater than that between the second and third. The remaining teeth are as a rule more or less evenly spaced, the foremost being rather remote from the apex. On the convex ventral portion of the blade there are from 1 to 3 teeth, usually 2[2] ; the hindmost is generally placed a little in front of the middle point and in the interspaces there are plumose setae.

The carapace does not differ in any noteworthy particular from that of *P. hendersoni*, but the surface in large males is less scabrous than in that species and the ridge that runs backwards from the antennal spine

[1] Of sixty-eight specimens seven have 5 dorsal teeth, twenty-two have 6, thirty one have 7, seven have 8 and one has 9.

[2] Of sixty-eight specimens ten have 1 ventral tooth, fifty-three have 2 teeth and five have 3.

to a point immediately above the origin of the hepatic is rather more strongly defined.

The eyes (Pl. III, figs. 2, 3) are characteristic and exhibit partial adaptation to cavernicolous conditions. In the allied *P. hendersoni* (Pl. III, fig. 5) the length of the cornea in dorsal view is about equal to that of the stalk and its breadth, as in all other species of the genus known to me, is conspicuously greater than that of the stalk : the inner border of the stalk is moreover straight or slightly concave and the usual ocular spot is clearly visible, partially fused with the cornea. In *P. cavernicola* the length of the cornea in dorsal view is very much less than that of the stalk, its breadth is little more than half that of the stalk, the inner border of the stalk is swollen and very conspicuously convex and the ocular spot is entirely missing. As in many species of the genus the cornea is somewhat flattened dorsoventrally.

The antennular peduncle is normal in form and the spine at the distal end of the basal segment reaches almost to the end of the second segment. The outer flagellum, as in *P. hendersoni*, is cleft almost to the base, the fused portion comprising only some 5 or 6 segments. In the proportionate lengths of the flagella of the antennule and antenna the species does not appear to differ from *P. hendersoni* and the form of the antennal scale is the same.

The mandible (Pl. III, fig. 4) differs from that of related forms and from most if not all species of the genus in possessing a palp composed of two segments only. The palp is normal in length, the reduced number of segments being due to the absence of the articulation between the ultimate and penultimate members of the series. The three teeth of the incisorprocess are rather blunter than usual. The remaining oral appendages and the maxillipeds differ in no respect from those of *P. hendersoni*. The third maxillipeds reach to the middle of the terminal segment of the antennular peduncle.

The first legs reach beyond the antennal scale by the chela and, in very large males, by a portion of the carpus as well. In the proportionate lengths of the segments they differ little from those of *P. hendersoni*, but the carpus is frequently rather longer in relation to the chela, sometimes twice its length. There are some longish hairs on the lower edges of the basis and ischium, a setose patch at the distal end of the carpus and near the base of the chela, and the usual tufts of setae on the fingers.

The second legs are usually equal or subequal ; in a few specimens in which they are conspicuously unequal it is probable that one leg of the pair has been lost at some period and subsequently reproduced. In large individuals of both sexes they reach beyond the scale by the chela and the greater part of the carpus.

In the largest male the ischium, merus, carpus and palm are scabrous, being covered with minute sharp-pointed tubercles which are most conspicuous on the under surfaces of the two first-named segments ; between the tubercles very short bristles may frequently be seen. The merus is about 3·5 times as long as broad. The carpus is conical with a deep notch or depression in the distal margin on its supero-internal aspect ; it is rather less than three-quarters the length of the merus and its

greatest breadth is slightly more than half its length. The chela is about 3·7 times the length of the carpus, with the palm slightly but quite decidedly longer than the fingers. The palm is a little flattened dorso-ventrally and is almost 2·5 times as long as broad. The fingers are thinly coated from base to tip with dark brown fur which arises from shallow and irregular longitudinal grooves, much less conspicuous than in *P. hendersoni*. On the inner edge of the dactylus in its proximal half are two rather widely separate teeth. On the fixed finger there is one tooth which fits between those on the dactylus and, close to the base, a rounded crest divided at its summit into four or five lobes.

In females and in younger males the limb is less scabrous. The carpus is proportionately rather longer and is more slender, the length being always considerably more than twice the distal breadth. The fingers are always distinctly longer than the palm, but are less conspicuously covered with fur, especially towards the tips; they show scarcely a trace of the grooves underlying the fur and the teeth on the inner margins, if present, are small and inconspicuous.

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

Sex.	Total length.	Length of carapace.	Length of second leg.	SECOND LEG.					
				Length of merus.	Length of carpus.	Breadth of carpus.	Length of palm.	Breadth of palm.	Length of finger.
♂	54	18·5	51·5	9·3	6·7	3·4	11·4	4·6	13·4
♀	53·5	16·5	40·7	7·8	5·8	2·5	9·6	3·3	10·8
♀	47·5	15·2	34·8	6·7	5·2	2·0	6·8	2·4	8·5
♂	46	13·1	34·4	6·7	5·1	2·1	6·9	2·7	8·2
♀	36	11·0	24·5	4·7	3·9	1·4	4·7	1·7	5·3
?	28·5	8·0	16·6	3·5	3·1	0·9	2·9	1·1	3·2

The last three legs are rather stout; the third reach beyond the scale by the length of the dactylus, the fifth to or rather beyond the end of the antennular peduncle. In each pair the propodus bears short spinules and some setae, the latter, in the fifth pair only, forming a thick tuft at the distal end. In the third and fourth pairs the propodus is about 2·5 times as long as the dactylus, in the fifth pair fully 3·5 times. The dactylus is slightly curved, bears a number of rather long setae, and ends in a yellow claw.

The telson bears the usual tuft of setae in the middle of the dorsal surface near the base and the usual two pairs of dorsal spines. The anterior pair of spines is placed behind the middle of the telson-length;

the posterior about midway between the anterior pair and the apex. The apex itself is rather broad with a prominent median point. The inner of the two pairs of terminal spines may reach by almost half their length beyond the median point: the outer spines are very small. Below the spines the apex is thickly fringed with plumose setae.

The eggs borne by ovigerous females are very large, from 1·9 to 2·1 mm. in length and from 1·4 to 1·7 mm. in breadth. The largest specimen is a male, 54 mm. in length from the tip of the rostrum to the tip of the telson.

When living the species was in general of a semitranslucent whitish colour. The hepatic and gastric organs were somewhat greyish and the gonad white or yellowish white. In the pools of still water in which the majority of the specimens were obtained the prawn would have been almost invisible were it not for the conspicuous white patch of the gonad. On close examination minute red chromatophores could be detected on the eyestalks and scattered over the carapace and abdomen. Those on the eyestalks were much the most evident, forming a stripe along the inner border and a patch on the upper side. The small cornea was jet black. All the appendages were colourless and the eggs were pale sage green or pale grey.

The modifications which this species has undergone in response to the unusual conditions in which it lives are, on the whole, not very striking, for the only characters in which it differs from normal members of the genus *Palaemon* are (1) colour, (2) greatly reduced eyes, and (3) reduction in the number of segments in the mandibular palp.

Colour, as Annandale and Gravely have pointed out in their account of the fauna of the limestone caves of Burma, is more readily affected by cavernicolous conditions than structural characters, and the general lack of pigment in *Palaemon cavernicola* is no doubt correlated with its underground existence. Except for the black corneal pigment and the minute red chromatophores noticed above it is quite typical of cavernicolous crustacea.

The colouration in my opinion is to be regarded as a character of the species and is not due (as it is considered to be in the pale variety of the snake *Coluber taeniurus*, which inhabits the Batu and Jalor caves) to the direct effect of absence of light on the individual. This at any rate is true if arguments drawn from analogy with *P. hendersoni* are admissible, for specimens of this species, obtained in the cave at considerable distances from the mouth, are blotched with pigment in exactly the same way as those from out-door localities, though the pigment itself is usually rather paler in shade.

The fact that the chromatophores which exist are red is perhaps significant, for red is a particularly common colour among crustacea living in the deep sea where light is feeble or absent.[1] Red is, however, potentially present in the lipochrome pigmentation of most if not all

[1] Reference may also be made to *Barbouria poeyi* Rathbun, a Hippolytid found in brackish water in a cave near the sea-shore in Cuba. The whole of the body is described as being translucent crimson in life, with the antennae and first legs white. As in *P. cavernicola* the eyes are pigmented. (Rathbun, *Bull. Mus. Comp. Zool. Harvard* LIV, p. 457, 1912).

decapod crustacea and can be produced in freshwater Palaemonidae, as in many other families of Caridea, by the action of boiling water or alcohol on the olive, brown or blue pigments which ordinarily prevail. It is quite exceptional to find all the chromatophores naturally of this colour in *Palaemon*.

The reduction in size of the cornea is the most striking structural character of the species and it differs in this respect from all previously known species of the genus. In its proportionate size there is extremely little variation and the character appears to be fixed and definitely specific. Externally the facets are less conspicuous than in the eye of *Palaemon hendersoni*, but internally, as may be seen in sections,[1] all the normal visual elements are to be found, apparently without the least sign of degeneration. Three optic ganglia are present as in the normal eye, but whereas the two distal ganglia seem to have undergone reduction in size, *pari passu* with that of the cornea, the proximal ganglion is as large as, or even perhaps larger than it would have been if the whole eye were normal in its dimensions (Pl. III, fig. 3). In this respect a parallel may be drawn with *Palaemonetes eigenmanni*, a blind cave shrimp of Cuba, in which, though the visual elements are completely degenerate and the two distal optic ganglia have apparently altogether disappeared, the proximal ganglion is still very large and occupies, as in *P. cavernicola*, the greater part of the eyestalk.[2]

Apart from the structural evidence there is proof that the eyes are functional in the fact that the species when alive is slightly but quite definitely attracted by light. So far as I have been able to observe the species is not modified for life in subterranean waters by an increase in the length of its sensory appendages or by an increased number of sensory hairs on these appendages.

The reduction in the size of the eye affords a problem which it is not easy to explain in a satisfactory manner. In itself it does not seem to be of any use to the animal and it is difficult to understand how it can have been brought about. It differs essentially from that of the land mollusc (*Opeas*) found in the same cave in that there is no evidence of individual variability and that no specimen with complete lack of ocular pigment was found in the large series examined. In the mollusc this occurred in 6 per cent of individuals.

In the reduced number of segments in the mandibular palp the species appears to be unique in the genus, but it is improbable that the character is in any way concerned with life in subterranean waters. In the allied genus *Leander* the palp is normally three-segmented, but occasionally (*e.g.*, *L. squilla* and *L. semmelinki*) it is two-segmented.

Apart from the reduced cornea and the structure of the mandibular palp the species is distinguished from *Palaemon hendersoni*, which appears to be its nearest ally, by the characters commonly used in the distinction of species of the genus. In *P. hendersoni* the ventral teeth of the rosturm are generally placed closer to the tip, the fluting of the fingers of the second leg is much deeper and, if specimens of the same size and sex be

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[1] The eyes were partially decalcified in weak hydrochloric acid, sectioned in paraffin and stained with van Gieson (haematoxylin followed by picro-fuchsin).

[2] See Pike, *Biol. Bull. Woods Hole, Mass.* XI, p. 267 (1906).

compared, the carpus of the second leg is comparatively much stouter and shorter in relation to the chela.

From the information available I conclude that the species has been evolved from *P. hendersoni*, or from some similar form, which succeeded in establishing itself in the subterranean water-ways in the neighbourhood of Siju and I think it unlikely that it will ever be found elsewhere.

The credit for the discovery of this species rests with Mr. R. Friel, I.C.S., who when visiting the cave in 1917 brought back two specimens in addition to other examples of the cave-fauna.

Palaemon cavernicola is a common species in the Siju cave and penetrates to its furthest limit at a distance of nearly three-quarters of a mile from the mouth. Besides occurring in the main river-channel it was found abundantly in small streams at depths of 2,000 and 3,600 ft. and in practically all the still pools in the section between 2,200 and 3,000 ft. Several were discovered in isolated pot-holes little more than 2½ ft. broad. The nearest point to the entrance at which the species was seen was in a small pool in the L-shaped passage about 550 ft. from the mouth. In this pool some five or six specimens were found but the species was on the whole scarce in the outer parts of the cave. In the rainy season it is probable that specimens are occasionally carried out of the cave by the flood-waters.

The prawns appeared to be more abundant in isolated pools and small streams than in the main channel, but this was probably due to the fact that they were much less easily detected in the latter, owing to the rapid flow and the ripples on the surface. Their presence in isolated pools is no doubt to be explained by changes in water-level. At the close of the rainy season the floods probably abate very rapidly, leaving the prawns imprisoned in the pools. In such situations they find it difficult to maintain themselves until the next year's floods bring release, for the water of the pools is perfectly clear and contains no other visible organisms on which they can feed. They must be dependant for food on drowned insects or other animals—a very scanty and precarious supply—or on the mud which covers the floor of the pools and may contain organic debris. These sources of food appear to be inadequate, for we noticed numbers of dead individuals, some of which were being devoured by the survivors.

It is not, indeed, easy to understand what the species finds to eat in the streams and main water-channel, for here also food-supplies seem very scarce. They would, however, have better opportunities of obtaining dead insects and could roam further in search of the vegetable debris which, in some places at any rate, is washed in by the floods. They also possibly feed on bat-guano which, although rapidly washed away by the current, must at some points fall into the water in abundance. On one occasion we found a number of prawns eating a bat which had been drowned; they had cleaned the skull very perfectly and were evidently determined to waste no morsel of their feast. But whether dead bats are sufficiently numerous to form a staple source of food is doubtful: in our experience they were very scarce.

On one occasion we were astonished to find a prawn on the top of a boulder about 2 ft. above the surface of the stream and on the thin layer

of mud which covered the boulder we noticed a number of tracks made by prawns. I have never before seen a prawn deliberately leave the water and on this occasion there seemed no object in the exploit, unless it were to look for food, for the stone was completely surrounded by water. The prawns in the pools and pot-holes, though they appeared to be starving, either lacked the initiative of this specimen or realized that the distances that separated them from a more favourable environment were too great for their capacity.

On placing a strong light on the edge of a pool the prawns showed some slight response, moving, if not frightened, slowly and a little uncertainly towards it.

Our collection consists of 72 specimens, ranging in length from 13 to 54 mm., but contains only a small number of fully developed males and very few ovigerous females. We could easily have obtained more half-grown specimens if we had so desired. The eggs borne by the females are all in a very early stage of development and we found no larvae.

The following Palaemonidae have hitherto been recorded from subterranean waters :—

PALAEMONINAE.[1]

Palaemonetes antrorum Benedict,[2] from an artesian well at San Marcos, Texas.

Palaemonetes eigenmanni Hay,[3] from a cavern at Ashton, Cuba.

Palaemonetes calcis Rathbun,[4] from a cave in western Cuba.

Euryrhynchus wrzesniowskii Miers,[5] from a well at Cayenne.

Euryrhynchus burchelli Calman,[6] from a well at Pará.

TYPHLOCARIDINAE.

Typhlocaris galilea Calman,[7] from a well on the shores of the Lake of Tiberias.

Typhlocaris lethaea Parisi,[8] from the Grotto of Lethe, Bengasi, Cyrenaica.

Of the species in this list those belonging to the genus *Euryrhynchus* alone retain the normal pigmentation of the eye. The eye itself is, however, reduced in size, much as in *P. cavernicola*. In all the others the pigment has completely disappeared.

Palaemon cavernicola is the only known species of the genus which shows any adaptation to cavernicolous existence and is the only cave Decapod yet found in the Oriental region.

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[1] The genus *Palaemonias* Hay from the Mammoth Cave of Kentucky belongs to the family Atyidae.

[2] Benedict, *Proc. U. S. Nat. Mus.* XVIII, p. 615 (1896).

[3] Hay, *Proc. U. S. Nat. Mus.* XXVI, p. 431, fig. 2 (1903).

[4] Rathbun, *Bull. Mus. Comp. Zool. Harvard* LIV, p. 451, figs. 1-5 (1912).

[5] Miers, *Proc. Zool. Soc. London*, 1877, p. 662, pl. lxvii, figs. 2-2*b*; Calman, *Ann. Mag. Nat. Hist.* (7) XIX, p. 297, fig. 1 (1907).

[6] Calman, *loc. cit.*, p. 297, figs. 2-8.

[7] Calman, *Trans. Linn. Soc.* (2) *Zool.* XI, p. 93, pl. xix (1909); Annandale and Kemp, *Journ. Asiat. Soc. Bengal* (n.s.) IX, p. 245.

[8] Parisi, *Atti Soc. Ital. Sci. Nat. Milano* LIX, p. 241 (1920).