No. 9.

NOTES ON THE HABITACULUM OF TWO SPECIES OF PAGURIDS; A DESCRIPTION OF ONE NEW SPECIES; AND A LIST OF THE ANOMURA RECORDED TO DATE FROM CEYLON WATERS.

With six Figures.

By T. SOUTHWELL, A.R.C.Sc. (Lond.), F.L.S., F.Z.S.

Summary of Contents.

1.—Introduction.

The group of animals known as Anomura, or hermit-crabs, are, strictly speaking, of but little interest to any one save purely scientific men. They have no direct commercial importance, they are not enemies of the pearl oyster, but they serve as food to innumerable fishes of many species.

The members of this group are crabs, characterized by having usually a soft abdomen, which is protected by an adopted empty shell of a mollusc. This does not, however, apply to all the species of this tribe. Some species are quite free. Others, such as Galathea and Munida, live in the cavities of sponges, or dead coral, or on rock. Others, such as Cœnobita, are to be found by the hundred on the shore, feeding on coconut husks or dung. Other species, such as *Birgus latro*, or the robber-crab, are to be found solely on the shore, and are known to climb trees and eat coconuts. The females only enter the water to lay their eggs. So varied are the members of this group.

The present notes were made during a two weeks' inspection of the Ceylon pearl banks. Similar notes have been made continuously by the writer during the last three years, and the results will it is hoped be published later. The following notes form the first instalment.

2.—A Note on the Habitaculum of "Cancellus investigatoris," *Alcock.*

This species was first collected by the "Investigator" off the south-east coast of Ceylon in 32 fathoms, and was described by Alcock in his "Indian Decapod Crustacea, Part II., Anomura Fasciculus: 1, Pagurides," 1905. So far as I am aware it has since been obtained only by the present writer. (Southwell, "Ceylon Reports," vol. V., 1906.)

The striking peculiarity of this species is that certain parts of the legs and chelipeds are modified to form an operculum, which, when the animal is completely retracted, closes the mouth of the shell or shelter and affords complete protection. Not only so, but under such conditions the animals are apt not to be noticed.

Although the modification of certain appendages was duly noted by Alcock, no mention was made of the habitat of the species.

Similarly, also, in the report on the Anomura collected by Professor Herdman, no mention is made of the habitat. It appears likely that in each case the specimens had escaped from their "house" during preservation, and were subsequently found free amongst the general collection.

It is quite obvious that the highly perfected modified portions of the chelipeds and legs serve a very useful end, and a note on the habitat in which this species was found living is therefore of some importance.

During a survey of the Ceylon pearl banks this species was dredged up, occupying a small cavity on the ventral edge of a flattish lobulated piece of *Porites arenosa* four inches in diameter. When the animal was retracted, the modified portions of the chelipeds and legs formed a remarkably perfect operculum, and rendered the specimen difficult to detect. The terminal portion of the abdomen could be slightly protruded through a very small hole situated a little nearer the basal centre of the coral, and the specimen could turn completely round in its shelter. The tube appeared to be lined with reddish Nullipore (*Lithothamnion*).

Alcock gives the following description of the chelipeds and legs :—

"In the left cheliped the upper border of the merus is ill-defined, and the inner lower border is not spinose ; the palm of the hand is as high as long, and the fixed finger is not deflexed ; the whole outer surface of the palm and fingers is granulous ; the spines on the lower edge of the hand are not worn or obsolescent but are acute, and are continued on to the edge of the fixed finger ; there is no oblique crest in the lower part of the outer surface of the palm, but in the upper part there is a row of spines parallel with the upper border."

It was impossible to remove our specimen from its shelter without damaging it, so that the following notes refer to the animal *in situ*. (Plate I., figs. 14 and 15, and Plate II., fig. 13.)

Mouth of the shelter 18 mm. in diameter. Abdominal hole situated 10 mm. nearer the basal centre of the coral and 3 mm. across. Operculum formed entirely by the chelipeds and first pair of walking legs (supported by the second pair), their surfaces being covered with matted setæ and presenting a pavement-like appearance. Colour, variegated red.

Dorsal "elbow" (Plate II., fig. 13) of the operculum formed by the anterior extremity of the carpus in the chelipeds and by the merus in the first pair of walking legs. The opposing internal edges of those joints of the chelipeds forming the operculum are straight, their external edges convex. Both internal and external edges of those joints of the first pair of legs which form the operculum are curved. The perfection of modification in these parts will be obvious. In all other points the description given by Alcock is correct, so far as I was able to verify. It appears remarkable that this writer laid no emphasis on the opercular surface presented by this species, a point which, together with the fact that the habitat is not mentioned, seems to almost prove that its full significance was not appreciated. A figure of a crab (*Pylocheles miersii*) simulating this habitat is given in Alcock's "Naturalist in Indian Seas," where other cases of partnership are also described.

Alcock states that this species is nearly related to *Cancellus parfaiti* (Edw. and Bouv.). The points of difference are not quoted, but since Alcock's specimens were obtained from Ceylon waters, and agree so closely with this one, I assume mine to be *C. investigatoris*.

The interest and importance of this note is that at least one habitat of this species has been determined. Most probably there are other habitats.

Locality.—West coast of Ceylon, 7 fathoms.

Referring to the Paguridea, Alcock notes that "certain forms which hide in holes do not regain even an apparent symmetry, such as the species of Pagurides which hide in living sponge, and the Troglopagurus that lives in small holes in coral."

Of the latter genus, Thurston discovered and collected many specimens of the *T. manaarensis* from the Ceylon pearl banks, which were found inhabiting small cavities in coral. The genera Troglopagurus and Cancellus are nearly related.*

3.—A Note on "Diogenes rectimanus," *Miers*.

The species of Diogenes are always difficult to identify. This is partly on account of the fact that they are usually of small size, the carapace being from 5 to 15 mm. long on an average, and partly because the genus is very variable.

Certain species seem to merge into each other by insensible gradations, and often enough present slight erratic characters not previously recorded, and which may possibly be purely local variations.

Amongst the many well-defined *groups* of species distributed in this genus, the members of the following group are very closely related :—*Diogenes costatus*, Henderson ; *Diogenes rectimanus*, Miers ; *Diogenes investigatoris*, Alcock ; *Diogenes bicristimanus*, Alcock.

Of these, *Diogenes costatus* may be considered as a type, and the other species variations of a more or less permanent character.

The species *rectimanus* was recently obtained in 7 fathoms of water on the west coast of Ceylon (Moodipani Paar), and was found inhabiting Annelid sand tubes, which latter were attached to dead coral, calcrete, or rock (Plate I., fig. 16). In other instances the species was found inhabiting cavities of living coral (*Goneastrea*, sp.). The specimens were for the most part *adult*, though the carapace measured only 7 mm.

Specimens of this species obtained by Alcock, Henderson, and Lanchester measured respectively 12 mm., 25 mm., 9 mm. long, so that our specimens were rather small. They also differed from other described forms in the following particulars :—

(1) There is no row of spines parallel with those on the upper border of the palm.
(2) The internal faces of the merus, carpus, and dactylus of both chelipeds are mapped out into about eight white plate-like areas, separated from each other by shallow sulci, and set on a pinkish background. This feature was very characteristic.

Alcock speaks of this species as "inhabiting all sorts of broad-mouthed shells" often encrusted with sea-anemones ; and Lanchester's specimens were found in shells of Murex, Rissoa, Gibbula, and Neritina.

Most probably the fact that Alcock found his specimens inhabiting wide-mouthed shells is to be correlated with the large size of his specimens.

The variety of habitaculum assumed by this species is most interesting, and, together with a similar variety noted for the first time in *Cancellus investigatoris*, seems to indicate that the habitat of many other species of Paguridea may be much more varied than is at present known.

I have seen species of the group Paguridea inhabiting the cavities of sponges (*Phyllospongia*, sp., and others), and in other cases found them without shell ; but in both instances the species, unfortunately, was not determined.

4.—A Description of "Clibanarius willeyi," n. sp. (Plate I., figs. 17 and 18.)

Carapace smooth, minutely punctate, sharply truncated anteriorly, well calcified in front of the cervical groove, the cardiac region being clearly defined. Length 12 mm. Greatest breadth 7 mm., narrowing anteriorly to 4 mm.

Rostrum minute, scarcely extending beyond the edge of the carapace, and barely reaching the base of the ophthalmic scales.

* Since the foregoing was written twenty-seven other specimens have been dredged from the Kondatchi Paar in 3 fathoms (April, 1910), all inhabiting holes in *Porites arenosa*, and answering perfectly to the above description.

Eyestalks long and slender, longer than the anterior extremity of the carapace, and considerably longer than the antennal peduncle. Right eyestalk 5 mm. long, left eyestalk 6 mm. in the male, and *vice versâ* in the female.

Antennular peduncles 4 mm. long, stout, longer than the antennal peduncles, but shorter than the eyestalks. Flagellum short, 1 mm. long only.

Antennal peduncle two-thirds the length of the eyestalk. Proximal joint setose internally, and shorter, but stouter than the second joint, which latter is nude. Antennal flagellum 1 cm. long.

Antennal acicle spinose internally, glabrous, and but slightly overlapping the terminal joint of the peduncle.

Ophthalmic scales very broad at the base, tapering somewhat suddenly, and approximated throughout their whole length.

Left cheliped considerably stouter than the right one, 10 mm. long in a straight line, shorter than the carapace, smooth throughout, somewhat flattened internally, and minutely punctate externally.

Merus 5 mm. long and 2·5 mm. broad. Carpus 2·5 mm. long, and as broad.

Palm slightly longer than the merus, and twice as long as the fingers.

Fingers curved, with a hiatus between them when closed. A few bundles of minute yellowish setæ occur on the opposing surface of the fingers, which open and close in a plane almost vertical.

Right cheliped as long as the left cheliped, but not nearly so stout, considerably flattened, smooth internally; smooth, punctate, and less flattened externally. Merus smooth internally, minutely punctate externally, 4 mm. long, 2 mm. broad, slightly crested dorsally and ventrally, the crests bearing a few short silky hairs.

Carpus 2 mm. long, and as broad, slightly crested dorsally and ventrally, the dorsal crest bearing a few short scattered silky hairs and terminating anteriorly in a minute colourless spine.

Hand 5 mm. long, smooth internally, smooth and punctate externally, crested dorsally, the crest bearing four small teeth, near which occur a few scattered external tubercles. Movable finger small, 1½ mm. long, and tuberculated dorsally. There is a small hiatus between the fingers when closed, and they meet distally in two opposing circular horizontal discs.

Hand and fingers slightly setose, smooth internally, the fingers opening and closing in a plane barely horizontal.

The two pairs of walking legs permanently deflexed, smooth, and slightly flattened externally. Merus of second leg greatly flattened laterally, with a few hairs on its dorsal and ventral crests, 5 mm. long, 2 mm. broad. Merus of third leg exactly similar, save that the external surface is more convex.

Carpus of both legs 3 mm. long, 2 mm. broad, also with a few scattered setæ on their dorsal and ventral crests.

Propodite (of both legs) 5 mm. long, 1½ mm. broad, with a few scattered setæ on the dorsal surface, and tufts of yellow setæ on the ventral surface, increasing greatly in number anteriorly.

Dactylopodites 3 mm. long, tapering to an extremely sharp black corneous claw, with masses of short setæ arising in tufts on their ventral surfaces, and scattered setæ on their dorsal surfaces.

The merus of both walking legs is fixed almost at right angles to the carpus, and the dactylopodites are similarly fixed almost at opposite right angles to the propodites.

Third pair of legs small, sub-cheliform, with a pad of imbricating corneous granules at the base of the claw; less defined in the fourth pair, which are also small.

No paired appendages on the abdomen of either sex, except on the tail fin, where those of the left side are larger than those on the right side.

Natural Colours.—Carapace (both dorsal and ventral surfaces) black, chelipeds black, with yellow finger tips. Walking legs black, with a band of yellow round the dactylopodite, and yellow plates on the ventral surface of the ischium.

Antennæ and antennal acicle orange. Antennules blue, with an orange flagellum.

Eyestalks pale yellow when young, developing a dark dorsal surface in older specimens. Eyes deep rich blue.

In the mature male the abdomen is mottled green, and dirty white on the dorsal surface and right side. Left side salmon-coloured. In immature males dirty brown dorsally, gray ventrally. In females the abdomen is an even dirty brown. Eggs brilliant maroon.

Colours in Formalin.—Carapace dark maroon, both dorsally and ventrally. Chelipeds dark maroon, with yellowish finger tips.

Second and third pair of walking legs dark maroon, with intensely black tips. Antennæ yellow. Antennal acicle yellow. Antennular peduncle grayish yellow, with brilliant orange flagellum. Eyestalks yellow, with a dark dorsal longitudinal band. Eyes blue. Fourth and fifth pair of legs with brownish cross bands.

Abdomen various. Eggs yellow. In a few young specimens the maroon colours had faded to a brick red, and in some other specimens the colours were varied.

Locality.—Found living on the surface of the Tallaivillu coral reef, west coast of Ceylon, and covered by only six inches of water at ebb tide.

Sixty-four specimens, including males, females, and young forms. Found inhabiting Muricine shells, which in every case were strongly encrusted with Nullipore (*Lithothamnion*).

I have pleasure in naming this species in honour of Dr. Arthur Willey, F.R.S., who assisted in making the collection during a very pleasant trip we had together.

5.—A Complete List of Anomura recorded from Ceylon Waters.

The following is a complete list of the Anomuran Fauna of Ceylon recorded up to the present:—

(1) Anomura collected by Thurston in the Gulf of Mannar and described by Henderson (Trans. Linn. Soc. (2), vol. V., Zoology, 1893).

Dromidia unidentata, Rupp.
Dromidia australiensis, Haswell.
Cryptodromia pentagonalis, Hilg.
Pseudodromia integrifrons, Hend.
Raninoides serratifrons, Hend.
Hippa asiatica, Milne-Edw.
Albunea symnista, Linn.
*Albunea thurstoni, Hend.
*Cœnobita rugosa, Milne-Edw.
*Diogenes diogenes, Herbst.
*Diogenes merguiensis, De Man.
*Diogenes miles, Herbst.
Diogenes custos, Fabr.
Diogenes planimanus, Hend.
Diogenes avarus, Heller.
*Diogenes costatus, Hend.
*Pagurus punctulatus, Oliv.
Pagurus deformis, Milne-Edw.
Pagurus varipes, Neller.
*Pagurus setifer, Milne-Edw.
*Troglopagurus manaarensis, Hend.
*Aniculus aniculus, Fabr.
*Aniculus strigatus, Herbst.
*Clibanarius padavensis, De Man.
Clibanarius arethusa, De Man.
*Eupagurus zebra, Hend.
Petrolisthes dentatus, Milne-Edw.
Petrolisthes boscii, Aud.
*Petrolisthes militaris, Heller.
Procellanella triloba, White.
*Polyonyx obesulus, Miers.
Polyonyx tuberculosus, De Man.
*Galathea elegans, White.
Galathea spinosirostris, Dana.
Munida spinulifera, Miers.

Of the above 35 species, Professor Herdman found the 16 marked with the star, and also 32 additional species which were not obtained by Thurston, and which are described by Southwell in vol. V., "Ceylon Reports," 1906.

The following are the 32 species not obtained by Thurston, but collected by Professor Herdman :—

Remipes testudinarius, Laterille.
Mastigochirus gracilis, Stimpson.
Cœnobita clypeatus, Latreille.
Diogenes investigatoris, Alcock.
Diogenes rectimanus, Miers.
Pagurus asper, De Haan.
Clibanarius æquabilis, var. merguiensis, De Man.
Calcinus giamard, Milne-Edw.
Calcinus elegans, Milne-Edw.
Eupagurus carpoforaminatus, Alcock.
Spiropagurus spiriger, De Haan.
Catapagurus ensifer, Henderson.
Paguristes hians, Henderson.
Paguristes incomitatus, Alcock.
Paguristes pusillus, Henderson.
Cancellus investigatoris, Alcock.
Nematopagurus muricatus, Henderson.
Nematopagurus, sp.
Troglopagurus jousseaumii, Bouvier.
Petrolisthes armatus (?), Gibbes.
Petrolisthes serratus, Henderson.
Procellana quadrilobata, Miers.
Procellana serratifrons, Stimpson.
Procellana hornelli, Southwell.
Polyonyx biunguiculatas, Dana.
Pachycheles pulchellus, Haswell.
Galathea longirostris, Dana.
Galathea corallicola, Haswell.
Galathea australiensis, Stimpson.
Galathea grandirostris (?), Stimpson.
Munida japonica, Stimpson.
Munida alcocki, Southwell.

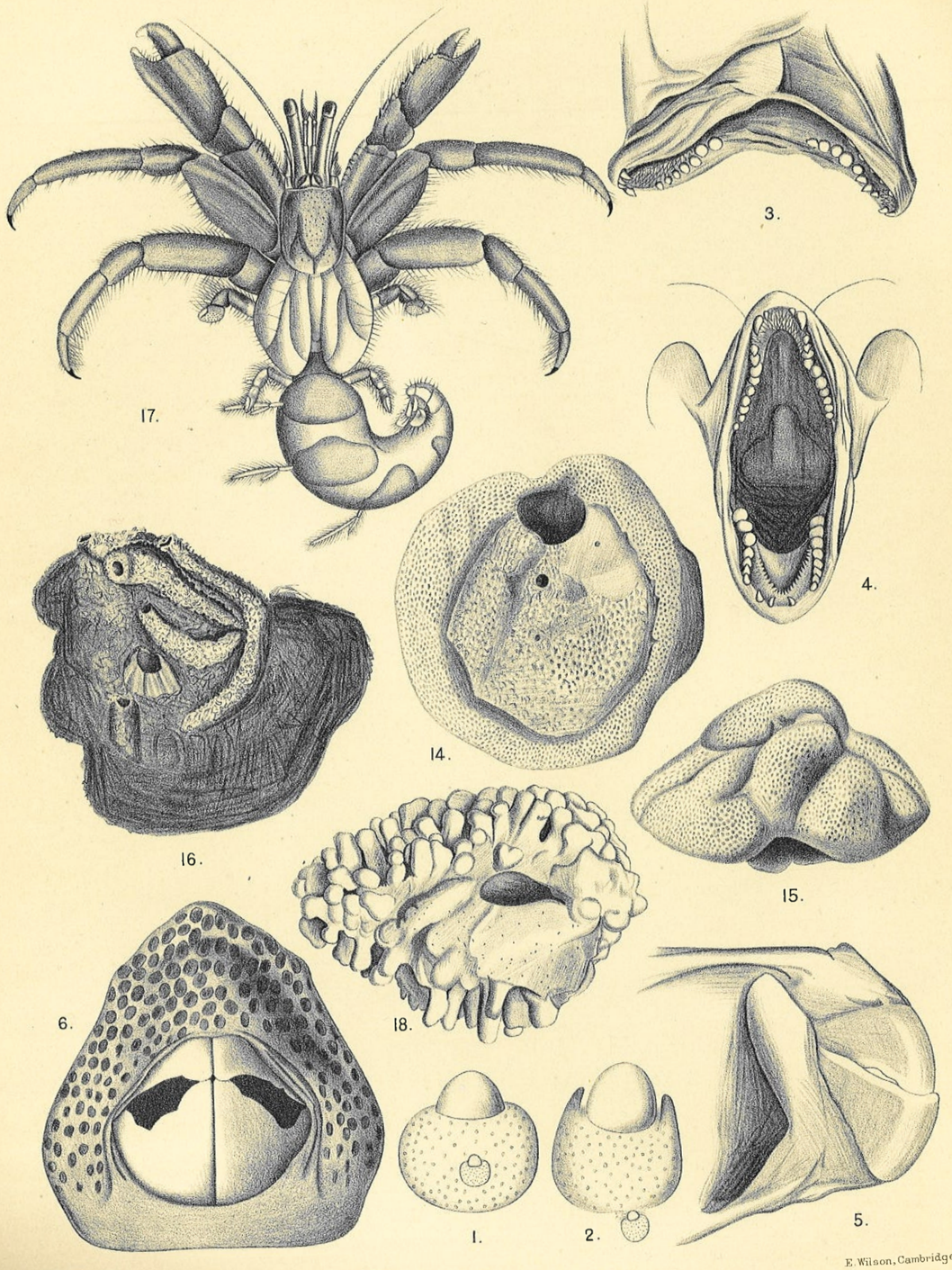
Since the "Report on the Anomura in the Ceylon Reports" was made, the following species have been collected and identified by the writer :—

Clibanarius willeyi, Southwell.
Clibanarius infraspinatus, Hilgendorf.
Clibanarius humulis, Dana.
Pagurus dearmatus, Henderson.
Pagurus euopsis, Dana.
Pagurus fabimanus, Dana.
Petrolisthes dentatus, Milne-Edwards.
Petrolisthes tuberculosa, Milne-Edwards.
Polyonyx hendersoni, Southwell.
Porcellana gækwari, Southwell.
Porcellana unilobotus, Henderson.
Albunea oxyophthalma

There are at present known about 650 species of Anomura, distributed amongst 73 genera.

This list is approximate, and includes the group Paguridea proper, the Galathidea, and other nearly related families whose systematic position is somewhat uncertain. Whilst some of the species of these two groups are cosmopolitan, most others have but a limited distribution. Others again only occur in very deep water.

Twenty-seven genera, including about 71 species, have already been recorded from the Ceylon pearl banks, and although in comparison this list appears very small, it compares most favourably with similar lists of other localities. It will, of course, be remembered that the pearl banks are very limited in area, and really only include a littoral fauna.



G. Henry del.

E. Wilson, Cambridge.

EXAMINATION OF PLATES.

Plate I.

Figures 1 and 2 .. Diagrams showing endogenous reproduction in *Tetrarhynchus unionifactor*. (× 100.)
Figure 3 .. Jaw of *Lethrinus miniatus* in profile. Natural size.
Figure 4 .. Jaw of *Lethrinus miniatus*, front view. Natural size.
Figure 5 .. Jaw of *Tetrodon stellatus* in profile. Slightly reduced.
Figure 6 .. Jaw of *Tetrodon stellatus*, front view. Slightly reduced.
Figure 14 .. Habitaculum of *Cancellus investigatoris*, ventral view. Natural size.
Figure 15 .. Habitaculum of *Cancellus investigatoris* in profile. Natural size.
Figure 16 .. Habitat of *Diogenes rectimanus*, showing tubes. Natural size.
Figure 17 .. *Clibanarius willeyi*, n. sp. (× about 5.)
Figure 18 .. Muricine shell, containing *Clibanarius willeyi*, n. sp. Natural size.

Plate II.

Figure 7 .. Jaw of a large *Rhyncobatis djeddensis*, showing plate-like arrangement of teeth for crushing. (× ½.)
Figure 8 .. Jaw of *Trygon sephen*, showing teeth. (× ½.)
Figure 9 .. Jaw of *Ginglymostoma concolor*, front view. (× ½.)
Figure 10 .. Teeth of *Ginglymostoma concolor*, back view, membrane removed to show growth. (× ½.)
Figure 12 .. A single tooth removed and enlarged from *Ginglymostoma concolor*. (× 2.)
Figure 11 .. Jaw of *Trygon sephen*, showing bottom teeth. (× ½.)
Figure 13 .. *Cancellus investigatoris*, showing modification of the chelipeds to form an operculum. (× 1½.)