

**On the Modification of the Eye Peduncles in
Crabs of the Genus Cymonomus.**

By

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With Plates 33 and 34.

My attention was drawn to the interesting subject which is dealt with in the present article by a paragraph in Lord Avebury's charming little book, 'The Beauties of Nature.' He there says (p. 331 of the last edition), "Sir Wyville Thomson mentions a kind of crab (*Ethusa granulata*) which, when living near the surface, has well-developed eyes; in deeper water—100 to 400 fathoms—eye-stalks are present, but the animal is apparently blind, the eyes themselves being absent; while in specimens from a depth of 500 to 700 fathoms the eye-stalks themselves have lost their special character, and have become fixed, their terminations being combined into a strong pointed beak." When I came upon this passage it occurred to me that possibly the crab was large enough to form a suitable "exhibit" for the public gallery of the Natural History Museum, and that if so the three stages indicated in Lord Avebury's brief notice would constitute a very interesting and striking demonstration for the general public of the modification of the organ of sight of Crustacea in relation to the presence or absence of light in their environment.

I therefore made inquiries, and found that the specimens dredged by the "Porcupine" in 1869-70, referred to by Lord Avebury, were still in the possession of my old and valued friend the Rev. Canon Norman, F.R.S., who had in 1873 published a description of them. It is a very short one, without figures, and remains the only account we have of these remarkable specimens. Canon Norman at once placed the specimens in my hands (in November, 1902). I found them to be too small for public exhibition. Canon Norman

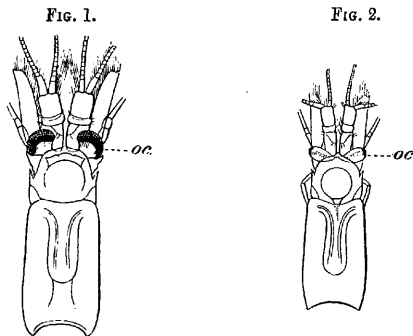


FIG. 1.—*Boreomysis obtusata*, G. O. Sars. 345 to 2740 fathoms. "Eyes normal," Sars, 'Schizopoda,' pl. xxxiii, fig. 2.

FIG. 2.—*Boreomysis microps*, G. O. Sars. Female, $\times 6$. 1250 fathoms. Eyes of smaller size. Sars, 'Schizopoda,' pl. xxxiii, fig. 7.

also gave me the beautiful drawings of the specimens made twenty-five years ago by the late Mr. Albany Hancock, which are now at last published, forming the plates accompanying this article (Pls. 33 and 34). He also furnished me with references to the published notices of the specimens of *Cymonomus* (*Ethusa*), with more or less modified eye-stalks, as well as with references to the literature of the genus; and whilst urging me to undertake the writing of notes to accompany a publication of the drawings—a task which he did not

wish to undertake—he suggested that the account of the facts concerning *Cymonomus* should be illustrated by some figures of the strange modifications shown by the eye-stalks of several deep-sea Mysidæ. These are illustrated in the woodcuts (see text-figures 1 to 7 and accompanying explanations).

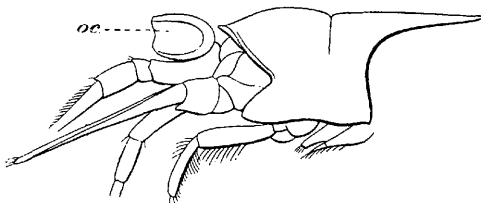


FIG. 3.—*Boreomysis scyphops*, G. O. Sars. Adult female. 1900 fathoms. No ommatidia. The ocular peduncles are converted into cup-like plates. Sars, 'Schizopoda,' pl. xxxii, fig. 4.

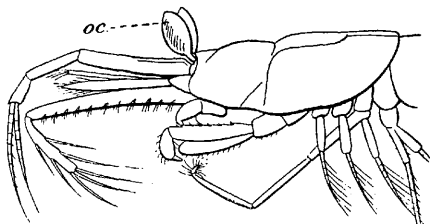


FIG. 4.—*Petalophthalmus armiger*, Willem. Suhm. Male, $\times 4$. 2500 fathoms. No ommatidia. The ocular peduncles are converted into mobile leaflets. Sars, 'Schizopoda,' pl. xxxii, fig. 1.

Apart from these interesting cases in the Schizopoda, the modification of the eyes in deep-sea decapod Crustacea is now recognised as a very frequent occurrence. The degree of degeneration of the optical apparatus and accompanying modification in the character of the ocular peduncles varies from a simple suppression of the ophthalmic pigment and

of the corneal facets (whilst the general form and demarcation of the corneal area is retained) to the complete

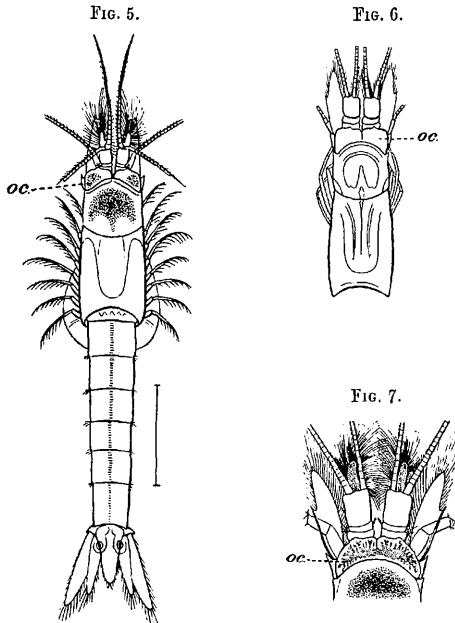


FIG. 5.—*Amblyopsis abbreviata*, G. O. Sars. Norway coast, 100 to 300 fathoms. No ommatidia. The ocular peduncles are seen as two broad plates. 'Carcinologische Bidrag,' pl. vi, fig. 2 (and 22).

FIG. 6.—*Amblyops Crozetii*, Will. Suhm. Male, $\times 5$ times. 1600 fathoms, S. Pacific. The ocular peduncles are united in front of carapace. Sars, 'Schizopoda,' pl. xxxiii, fig. 11.

FIG. 7.—*Pseudomma roseum*, G. O. Sars. Lofoden Isles, 400 fathoms. No ommatidia. The ocular peduncles form a broad plate with peculiar internal arborescent structure. Sars, 'Carcinologische Bidrag,' pl. iv, fig. 25.

disappearance of that area as a distinct structure, and the alteration of the shape and character of the eye-stalk. The

following list of such modifications in deep-sea Decapoda is given by Dr. Ortmann in the fifth volume of the new issue of Bronn's 'Thierreich' (1899), parts 53, 54, and 56, p. 1191:

"*Psalidopus*, in 400—500 fathoms depth, has eyes without pigment and without facets.

"Some species of *Pontophilus* have pale pigment, but in other respects well-developed eyes.

"*Prionocrangon* (200—500 fathoms) has no eyes.

"All *Eryonidæ* are blind: the eyes are reduced to a stump.

"In *Phoberus* the eyes are small and reduced.

"In *Thaumastocheles* they are entirely gone.

"In *Nephropsis* they are reduced.

"*Eiconaxius* has the pigment pale (even in the deeper part of the littoral zone, where it lives in the inside of sponges).

"In *Calastacus* and *Calocaris* the eyes are devoid of pigment and of facets. Among the *Paguridea*, *Chiroplatea* presents only conical eye-stalks. *Catapaguroides microps*, A. M. E. et Bouv., has degenerate eyes.

"The sub-family *Munidopsinæ* (five genera and many species) is characterised in distinction from the *Galatheinæ* by the reduced eyes.¹

"Among the *Dorippidæ*, *Cymonomus* is blind, and in *Cymonomops* the eye pigment is wanting; in *Ethusina*—in contrast with *Ethusa*—the eye-stalks are not capable of movement, and the eyes are reduced.

"An interesting case is presented by one of the *Brachyura*, *Bathyplox typhlus*, A. M. E., in which, when occurring at depths of 400 to 450 fathoms, very short eye-stalks with undeveloped corneæ are found; whereas, in examples which are taken in shallower water, the short eye-stalk carries a small but distinct cornea."

The foregoing summary, relating to the eyes of Decapoda only, was published in 1899.

The description by Dr. Norman of his *Ethusa granu-*

¹ See Figs. 8 and 9.

lata (subsequently placed in his new genus, *Cymonomus*, by Alphonse Milne-Edwards) was published in 1873 in a British

FIG. 8.

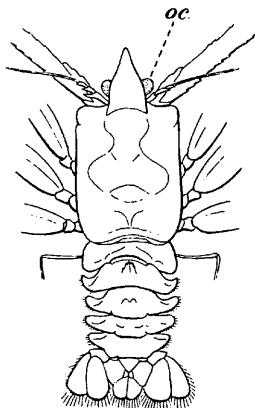


FIG. 9.

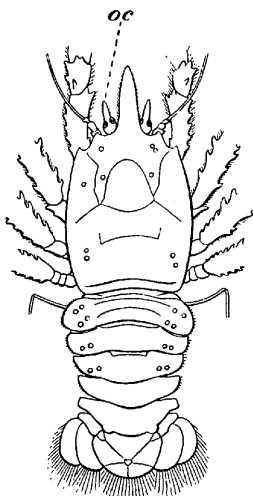


FIG. 8.—*Munidopsis carinipes*, Fax. 695 fathoms. Eyes normal. "Challenger" Reports: 'Stalk-eyed Crustacea,' pl. xxiv, fig. 1.

FIG. 9.—*Munidopsis Hendersoniana*, Fax. 1020 fathoms. The corneal area is reduced and divided, and the ocular peduncle projects beyond it as a rostrum. 'Stalk-eyed Crustacea,' pl. xxiv, fig. 2.

Association Report of that year, and in Sir Wyville Thomson's 'Depths of the Sea.' The figures which occupy our Pls. 33 and 34 were drawn twenty-eight years ago for Dr. Norman by his friend, the eminent naturalist and artist, Albany Hancock.

The original account of *Ethusa* (*Cymonomus*) *granulata* by Norman is given in Sir Wyville Thomson's 'The Depths of the Sea,' 1873, p. 176. He there writes—I

quote from a preliminary notice of the Crustacea by the Rev. A. Merle Norman—" *Ethusa granulata* (sp. n.), the same species as that found off Valentia, but exhibiting a most extraordinary modification of structure. The examples taken at 110—370 fathoms in the more southern habitat have the carapace furnished in front with a spinose rostrum of considerable length. The animal is apparently blind, but has two remarkable spiny eye-stalks, with a smooth rounded termination where the eye itself is ordinarily situated. In the specimens, however, from the north, which live in 542 and 705 fathoms, the eye-stalks are no longer movable. They have become firmly fixed in their sockets, and their character is quite changed. They are of much larger size, approach nearer to each other at their base, and, instead of being rounded at their apices, they terminate in a strong rostrate point. No longer used as eyes, they now assume the functions of a rostrum; while the true rostrum, so conspicuous in the southern specimens, has, marvellous to state, become absorbed. Had there been only a single example of this form procured, we should at once have concluded that we had found a monstrosity; but there is no room for such an hypothesis by which to escape from this most strange instance of modification of structure under altered conditions of life. Three specimens were procured on two different occasions, and they are in all respects similar."

The specimens thus described are those now before me—forming part of the Norman Collection acquired by the trustees of the British Museum. They have, until now, not been figured or further described, and are therefore practically unknown to carcinologists. They are preserved in alcohol in separate tubes, labelled as follows:

a. "Porcupine, 1869; Stations 24, 29, 30; 109 to 1380 fathoms. Between Ireland and Rockall." [These are two specimens of normal form as drawn in Pl. 33, fig. 2, of the present memoir.—E. R. L.]

b. "Off Cape St. Vincent, Station 25; Porcupine, 1870; 374 fathoms." [One specimen of normal form.—E. R. L.]

c. "Porcupine, 1869; Stations 1, 2, 3, 8; 106—808 fathoms. Off S.W. Ireland." [Seven specimens of normal form.—E. R. L.]

d. "Holténia ground, Porcupine, 1869; Stations 47*a* and 88; 542 and 705 fathoms."

[Three specimens of the form with modified eye-stalks and rostrum (see Pl. 34, figs. 8, 10, 11). These are the specimens referred to by Canon Norman in the extract above given from 'The Depths of the Sea,' and appear to be the only specimens of this form hitherto found. It seems important to point out at once that, so far as actual depth is concerned, the extreme depth of the stations in which the normal specimens were found exceeds that at which the modified form from the Holténia ground was procured. Female specimens show a length of 4 mm. from the posterior margin of the carapace to the base of the rostrum; male specimens are as small as 2.4 mm. in the same dimension.—E. R. L.]

It will be obvious at once that Dr. Norman only described two forms of his *Ethusa granulata*—both of them blind; but whilst the one still retained a corneal area on the eye peduncle, the second form had lost this character, and the eye-stalks had become immovable and more or less pointed (see Pls. 33 and 34).

It is, therefore, remarkable that Lord Avebury should speak in the paragraph cited at the commencement of this memoir of three forms, adding a form "living near the surface" and having "well-developed eyes." This third form has not yet been discovered in the genus *Cymonomus*, but Lord Avebury is quite right in principle, since there is no doubt that such a shallow-water form has existed, and very possibly still exists. In other genera closely allied to *Cymonomus*—for instance, in *Cyclodorippe uncifera*, Ortm.—a form from a depth of fifty metres is described (Doflein, 'Biol. Centralblatt,' August, 1903) with well-pigmented eyes and longer eye-stalks; whilst in specimens of the same species from a depth of 700 metres

the pigment is feebly developed, the ommatidia few and incompletely developed, and the eye-stalk short. Thus Cycloporippe completes the eye-series of Cymonomus, and like the less closely related Bathyplox cited at the end of Dr. Ortman's list, justifies in large measure Lord Avebury's supposition of a Cymonomus-form living in shallow water and having well-developed eyes.

Dr. Norman's very brief account of *Ethusa* (*Cymonomus*) *granulata*, which he intended to supplement by further publication many years ago, has led to some misapprehensions. In the first place it cannot be maintained, on considering the facts recorded as to depth at which the specimens were taken, that the more modified form is correlated with origin from deeper water. Normal specimens occur at 808 fathoms, and even at 1380 fathoms, whilst the peculiar forms with rostriform eye-stalks occur at 542 fathoms. It seems to be of greater significance that the locality in which the latter were found is what Wyville Thomson and Carpenter called "the *Holtenia* ground." This fact may perhaps be brought into relation with the discovery by the eminent carcinologist Dr. Hansen of a similarly modified *Cymonomus* among the Crustacea dredged by the "Ingolf" around Greenland and Iceland and north and west of the Faroe Islands. Dr. Hansen has been good enough to communicate this fact to me, and a drawing¹ of the single specimen obtained. It was taken at a depth of 486 fathoms (bottom temp. 5.5° C.) in lat. N. 62° 58', long. W. 23° 28'.

I am, therefore, inclined to regard Dr. Norman's form with rostriform eye-peduncles as having a geographical and not merely a bathymetrical correlation.

I may further remark that Dr. Norman's words as to the modification of the eye-stalks in his deeper water form have been misunderstood by subsequent writers. He says "they terminate in a strongly rostrate point. No longer used as eyes, they now assume the functions of a rostrum." This has

¹ See text-figure 12.

led, naturally enough, to the interpretation that "their terminations become combined into a strong pointed beak." But Dr. Norman's intention was to describe each eye peduncle as converted into a separate rostrum, the points of which do not combine, but diverge widely from one another (see figures in Pls. 33 and 34).

I now pass on to a brief statement of the foundation of the genus *Cyonomus* by Alphonse Milne-Edwards for a West Indian crab, his *C. quadratus*, and the subsequent discovery of Norman's normal form of *Ethusa granulata* (not the form with rostral eye-stalks) by the French naturalists in the Mediterranean, and the reference by Milne-Edwards of this *Ethusa* to his genus *Cyonomus*.

It was in 1880 that Alphonse Milne-Edwards established the genus *Cyonomus* in the 'Report on the Results of Dredging by the United States Coast Survey steamer "Blake;"' viii, "Études préliminaires sur les Crustacés," Ire partie, p. 26.

He writes, "*Cyonomus* (nov. gen.): La carapace est étroite et terminé en avant par un rostre pointu de chaque côté duquel s'insèrent les pédoncules oculaires grêles, de grosseur uniforme et dépourvus de corneules. Les antennes internes sont grandes et ne peuvent se reployer sous le front. Les antennes externes prennent naissance au dessous et en dehors des antennules, et elles sont notablement plus courtes qu'elles: le tubercule auditif se développe en une saillie spiniforme. Le cadre buccal porte en avant, sur la ligne médiane, une large échancrure; il est entièrement caché par les pattes machoires qui s'avancent beaucoup de manière à recouvrir la base des antennes. L'exognathe est très allongé; le mérognathe est étroit, et son extrémité déborde de beaucoup le peu [sic] d'insertion du palpe. Les pattes antérieures sont courtes et terminées par les doigts pointus. Les pattes de la 2e et de la 3e paire ressemblent à celles du *Cyclodorippe*, celles de la 4e et 5e paire sont très petites relevées sur le dos et terminées par un petit ongle crochu, mais elles ne sont pas cheliformes. L'abdomen du mâle est

très court. Le dernier article de l'abdomen de la femelle est triangulaire et arrondi à son extrémité. Les œufs sont très gros et en petit nombre. Les orifices génitaux de la femelle s'ouvrent sur l'article basilaire des pattes de la 3e paire."

The species assigned by Milne-Edwards to this new genus is *C. quadratus*, n. sp., from the West Indies, taken at depths ranging from 175 to 500 fathoms.

No figure was at this time published of *C. quadratus*, the fuller publication of the "Blake" Crustacea being deferred, and subsequently accomplished (as noted below) by Prof. Bouvier in collaboration with Prof. Milne-Edwards.

In 1881 M. Milne-Edwards, in a summary account of some dredging operations made in the Mediterranean ('Comptes Rendus Acad. Sci.,' Paris, xciii, p. 879), refers to Norman's species as "*Cymonomus* (*Ethusa*) *granulatus* (Norman)," and records it as occurring in a new locality, viz. the Mediterranean. No figure was at this time in existence of any *Cymonomus*, but in 1883 *C. granulatus*, Norman, appears in the 'Recueil de figures des Crustacées nouveaux ou peu connus,' produced by M. Alphonse Milne-Edwards, and, as I believe, privately distributed. This was the first occasion on which a figure of *C. granulatus*, or indeed of any *Cymonomus*, was published.

The drawings on this plate are reproduced in pl. xi of the 'Expéditions scientifiques du "Travailleur" et du "Talisman":' Crustacées Décapodes, par A. Milne-Edwards et E. L. Bouvier,' published in 1900. A drawing showing the frontal region of the carapace from below, with the eye-stalks, antennules, and antennæ in position, has been re-executed, but the large figure of the whole animal, seen from the dorsal surface, is reproduced without modification. This is in some ways to be regretted, since the eye peduncles have been removed from the specimen before it was given to the artist for portraiture, and consequently two cavernous, deeply shaded areas are represented, one on each side of the frontal rostrum, between it and the large extra-orbital spine. The fact that the specimen is incomplete is not mentioned in the explana-

tion of the plate, and though obvious to the carcinologist has led to some misunderstanding. Thus in the excellent volume 'La vie au fond des Mers,' by the late Professor Filhol, a woodcut of this mutilated specimen is given as representing the species concerning the eye-stalks of which Dr. Norman's observations are quoted in full, although the figure shows no eye-stalks at all!

The drawing made by Mr. Albany Hancock in 1875, and now published as fig. 2 in Pl. 33 of the present memoir, really represents accurately the normal *C. granulatus* of Norman as it actually appears; and it will be seen, if this drawing be compared with those given in the earlier publications, that there are important deficiencies in the latter. Having carefully compared the type specimen of Norman now in the British Museum (Natural History) with Mr. Hancock's drawings, I have satisfied myself that they could not be improved upon, and have therefore reproduced them untouched. Those who have already learnt to know the accuracy and artistic ability of that admirable naturalist will not be surprised that this course has been followed.

With regard to the other species of *Cymonomus*, the *C. quadratus* for which Milne-Edwards established the genus, no figure was published until the year 1902, when in the 'Memoirs of the Museum of Comparative Zoology at Harvard College,' vol. xxvii, No. 1, MM. Milne-Edwards and Bouvier published their account of the crabs of the families Dromiacea and Oxystoma, dredged by the U.S. Coast Survey steamer "Blake."

The genus *Cymonomus* is there described by MM. Milne-Edwards and Bouvier as forming with the genera *Palicus*, *Ethusa*, *Cymopolus*, *Corycodus*, *Clythrocerus*, and *Cyclodorippe*, the family *Dorippidæ*, M.-Edw.

Two species of *Cymonomus* are described, viz. *C. quadratus*, M.-Edw., the type species, and *C. granulatus*, Norman. A plate (pl. xvii) is given to the illustration of *C. quadratus*, which, although described at an earlier date by Milne-Edwards, was not figured when that author published his figure of *C. granulatus* in the "Travailleur" volume.

The drawing of a dorsal view of the complete *C. quadratus* given in fig. 1 of this plate shows a form which is closely related to *C. granulatus*, Norm., but with well-marked, distinct specific character. A very astonishing feature, however, is represented in the figure, namely, the two posterior pairs of thoracic limbs are pictured as being chelate, as in some Dromiidae. This feature would necessitate the complete generic separation of *C. quadratus* from *C. granulatus*; and as this remarkable condition of the hinder thoracic limbs is not mentioned in the text, and in the earlier description of the genus by M. Milne-Edwards is expressly denied, I felt sure that by a curious oversight the artist had figured the hinder limbs of a Dromiid in place of those of the actual specimen of *Cymonomus* which he had set out to draw. Such a confusion of specimens by the artist, and the subsequent escape of the error from detection by the zoologist for whom the drawings have been made, is a possible psychological phenomenon, and is comparable to a revoke in the game of whist when a card in the player's hand escapes his observation, although he is looking at it, and knows that he must play such a card if he have it.

I accordingly wrote to my friend Professor Bouvier, the distinguished naturalist in charge of the collections of Arthropoda in the Muséum d'Histoire Naturelle of Paris, and he has informed me that he is utterly astonished to find the figure as it is, in spite of the fact that this and all the other plates were carefully revised by him. He states that the fourth and fifth thoracic pairs of limbs of *C. quadratus* are not chelate, but resemble those of *C. granulatus*. At the same time he was kind enough to send me some of the type specimens of *C. quadratus* for examination, which show the hinder limbs in place and of the usual form. He was also so good as to send me specimens of *C. granulatus* from the Mediterranean for comparison with Norman's types.

We are now in a position to deal more definitely with Dr. Norman's original specimens of *C. granulatus*.

In the first place it is to be noted that M. Milne-Edwards

has expressly stated that he has not received any specimens corresponding to Norman's aberrant form with rostriform immobile eye peduncles and aborted rostrum. His specimens were dredged off Porto, Gibraltar, Villefranche, Marseilles, and Ajaccio. He says ('Travailleur,' p. 39), " Dans tous les spécimens que nous avons étudiés, et ils sont nombreux, les pédoncles oculaires sont mobiles, la surface cornéenne est lisse et parfois même un peu colorée, le rostre en outre est très saillant. Comme ces spécimens habitent des profondeurs très variables (de 300 à 350 mètres), on peut conclure que la transformation des yeux en pointes rostrales [resp. Norman's aberrant specimens—E. R. L.] est fonction, non point de la distribution bathymétrique, mais de la distribution géographique. Les exemplaires du nord, en d'autres termes, présenteraient seuls cette transformation."

I think it will be most convenient, as well as logical, to regard Norman's aberrant form as a distinct species, to which I shall give the name *C. Normani*. It appears from a reference to MS. in the "Travailleur" report that Dr. Norman himself had contemplated treating this form as a distinct species under the name *Ethusa mirabilis*. I should adopt the name so long ago suggested by my friend were it not for the fact that it seems possible that there may be other forms—terms in the series—allied to *C. granulatus* and *C. Normani*, and that it will be convenient to associate the name of each form so far as possible with some person or thing distinctive of its discovery.

The position and characters of the three species of *Cymonimus* may accordingly be thus given :

Section *Oxystoma*, M.-Edw. (of the *Brachyura genuina*, Boas).

Family Dorippidæ, M.-Edw., including sub-families Cyclo-dorippinæ and Dorippinæ.¹

¹ The characters of these divisions and the included genera are very fully given by MM. Edwards and Bouvier in the "Blake" volume quoted above.

Sub-family Cyclodorippinæ, including two tribes, Cymonomæ (genera Cymopolus and Cymonomus); Cyclodorippæ (genera Corycodus, Clythocerus, Cyclodorippa, and Cymonomops).

Tribe Cymonomæ.

Characters (taken from Edwards and Bouvier).—Carapace quadrate, rugose; rostrum somewhat narrow, triangular, with pointed termination. Afferent orifices very much reduced or rudimentary. Efferent orifices more or less separate, and situated far behind the frontal margin. Exopodite of the first maxillipedes more developed than their external lacinia; that of the second maxillipedes quite normal. An exopodial flagellum and a reduced or rudimentary epipodite present on the third maxillipedes. Probably always three pairs of swimmerets in the female.

Genus *Cymonomus*, A. M.-Edw., 1880.

Characters (as given by Edwards and Bouvier).—Efferent orifices very far separate from one another, and situate at the base of the antennæ. External lacinia of the first maxillipedes much shorter than the base of the exopodite. Second maxillipedes with a rudimentary epipodite, but without any branchiæ. Third maxillipedes with reduced epipodite, dilated and articulated at its base, with the mesopodite standing forward and carrying the carpus on its internal face. A single pleurobranch: three pairs of swimmerets in the female. Blind. The antennæ cannot conceal themselves completely beneath the rostrum (in *Cymopolus* they can).

Species 1.—*C. quadratus*, A. Milne-Edwards. 'Bull. Mus. Comp. Zool.,' vol. viii, No. 1, p. 26 (1880).

The characters which distinguish this species from *C. granulatus* are stated by M. M.-Edwards and Bouvier as follows:

1. All the parts of the body are less granular and much

less richly furnished with hairs; these latter notably are not present on the dorsal face of the carapace.

2. The cervical groove is much more marked in *C. quadratus*, but the branchial region is less so, and in fact presents no distinct limit anteriorly.

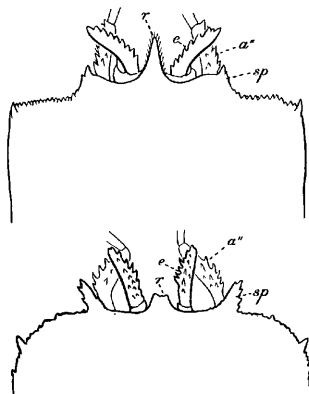


FIG. 10.—Outline diagrams of the anterior margin of the carapace, the rostrum, and ocular peduncles of two specimens of *Cymonotus quadratus*, M.-Edw. The upper figure is taken from M. Milne-Edwards' figure in the "Travailleur" volume, and the lower is drawn from a specimen kindly communicated by M. Bouvier. Both figures show the peculiar form of the ocular peduncles, *e*, differing both from those of *C. granulatus* and *C. Normani*; also the proportionate size of the rostrum, *r*. The lower figure shows a greater size attained by the extra-orbital spines, *sp*, and a rounding off of the lateral angles of the carapace, as compared with the type.

3. The rostral region¹ is less pronounced, and advances less distinctly in front of the carapace; the rostrum is much narrower, and has no denticles on its margins.

4. The ocular peduncles are much more delicate, and are gradually attenuated from the base to the summit; their

¹ See our text block, Fig. 10, *r*, and compare with Pl. 33, fig. 2.

corneal surface is no longer distinct as in *C. granulatus*, and numerous spinules are grouped in a row on the internal border of the peduncles.¹

5. The second joint of the antennary peduncles, instead of being delicate and almost smooth as we see in *C. granulatus*, is much larger than the others, and possesses spines on its external border.²

6. The notch of the palatine border is less extensive than in *C. granulatus*, so that the two halves of the border pass considerably to the inner side of the urinary tubercle. On the contrary, the palatine surface is complete in *C. granulatus*, whilst presenting on each side a small antero-posterior crest.

7. The base of the exopodite of the first and second maxillipedes advances less in front than in *C. granulatus* [*quadratus* in original—E. R. L.].

8. The last abdominal segment of the female has regularly rounded-off side borders in *C. granulatus*; whilst in *C. quadratus*, on the contrary, the border on each side forms an inwardly convex curvature.

Distribution.—*C. quadratus* represents in the Caribbean region the *C. granulatus* of the Mediterranean and North Atlantic.

Species 2.—*C. granulatus*, Norman. 'Brit. Assoc. Reports' (as *Ethusa granulata*), 1873.

In addition to the definite points of difference between this species and *C. quadratus* quoted above from M. M.-Edwards and Bouvier may be mentioned the generally more granular condition of the surface, and the tendency to an

¹ See our text block, Fig. 10, *e*, and compare with Pls. 33 and 34.

² See Pl. 34, fig. 12. The joint referred to is what appears in the drawing as the first or proximal, the true first being fused with and hidden beneath the carapace. The observation as to the difference of the spinulation of this joint in *C. granulatus* and *C. quadratus* is confirmed by the examination of our specimens in the Nat. Hist. Mus. But *C. Normani* has as spinose a margin to the joint as *C. quadratus*, and has the next joint also spiniferous, although it is quite smooth in *C. granulatus* (see p. 457).

exuberance in the production of spines and spinules, which exhibits individual variation.

As stated by M. M.-Edwards and Bouvier, *C. granulatus* is more richly beset with fine hairs than is *C. quadratus*. These hairs are not represented in Mr. Albany Hancock's drawings reproduced in our plates, but are present in Norman's specimens both on the eye peduncles and other appendages as well as on the carapace.

The difference in the form of the eye-stalks is very striking—those of *C. granulatus* presenting a well-marked corneal area which is absent from those of *C. quadratus*, and also being more robust, rounded in cross-section instead of flattened, and beset with numerous spinules. The row of spines on the inner margin is not so regular as in *C. quadratus* (see Pl. 33, figs. 5 and 6). The rostrum also is larger and more robust, and provided with coarser spinules in *C. granulatus* than in *C. quadratus*, and projects considerably further forward than the eye-stalks, whereas in *C. quadratus* it is not so long as the eye-stalks.

In both species there is a well-developed extra-orbital spine on the frontal margin of the carapace on each side (Pl. 34, fig. 7, *sp.*, and text-fig. 10, *sp.*). But this spine is much larger and more coarsely denticulate in *C. granulatus* than in *C. quadratus*. It appears to be subject to variation in *C. quadratus*, as it is larger in the lower specimen drawn in our text-fig. 10 than in the upper, which is taken from the figure of M. M.-Edwards and Bouvier. It seems to me that the prominence and great size of this extra-orbital spine, forming with the base of the rostrum an almost cup-like cavity on each side of that structure, as shown in A. Milne-Edwards' drawing of a mutilated specimen devoid of eye peduncles ('Travailleur,' loc. cit., pl. xi, fig. 5), is eminently characteristic of *C. granulatus* as compared with *C. quadratus*.

Distribution.—Mediterranean and North Atlantic.

Species 3.—*Cyonomus Normani*, n. sp. (1903).

As *C. granulatus* in all characters except the following.

The rostrum is reduced to a small process in the mid-frontal line (see Pl. 34, fig. 8): two other forms of the diminutive rostrum are seen in Pl. 34, figs. 10 and 11, thus necessitating the emendation of the character as to the size and form of the rostrum by which the tribe *Cyclodorippæ* were supposed to be separated from the tribe of the *Cyonomæ*.

The ocular peduncles of *C. Normani* have moved from the lateral position which they occupy in *C. granulatus*, and approach the middle line from each side. Their bases are actually fused to one another beneath the rudimentary rostrum, and they are immovably united to the margin of the carapace (see Pl. 39, fig. 8). Further, the free diverging¹ stems of the ocular peduncles differ greatly in form from those of *C. granulatus*. Like those of *C. quadratus*, they are entirely devoid of a corneal area, and taper gradually to the extremity. But, unlike those of *C. quadratus*, the ocular peduncles of *C. Normani* are not straight, and denticulate on the inner face only. They present, on the contrary, a curvature, first inwards, then outwards, and then again strongly inwards at the extremity (Pl. 34, fig. 10). They are very much more richly beset with spinules than are the ocular peduncles of *C. granulatus*, and the spinules are of larger size.

Speaking generally, the spinules on the frontal region of the carapace, extra-orbital spines, basal antennary joints, and eye peduncles are coarser and more exuberant in *C. Normani* than in *C. granulatus*. As shown in Pl. 34, fig. 8, the theoretical third (the actual second) joint of the antennary peduncle, *a''*, is fringed externally with spines in *C. Normani*; these are wanting in *C. granulatus* (Pl. 34, fig. 7, *a''*).

Distribution.—Only three specimens of this species are known, viz. those originally dredged by the Rev. Canon Norman on the *Holténia* ground in 1869 in the cruise of the "Porcupine."

¹ Not united to form a single rostrum as Dr. Norman's brief description had led some of his readers to suppose.

Since the present memoir was completed my attention has been drawn to an article in the 'Biolog. Centralblatt,' August, 1903, written by Mr. F. Doflein, on "The Eyes of Deep Sea Crabs." The article contains interesting observations on the microscopic structure of the more or less degenerate eyes of certain species. I have already inserted above a reference to Mr. Doflein's description of the more and the less degenerate condition of the ommatidia in specimens of *Cycloporippe uncifera* from deeper and shallower waters. Mr. Doflein makes some remarks upon *Cymonomus granulatus*, Norm., of which he figures an eye peduncle taken

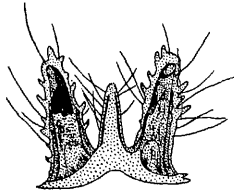


FIG. 11.—Rostrum and eye peduncles of a species of *Cymonomus*, dredged by the "Valdivia" off the east coast of Africa. Reproduced from Doflein.

from a Mediterranean specimen communicated to him by Prof. Bouvier. He also gives a drawing, reproduced here (text-fig. 11), of the rostrum and ocular peduncles of a *Cymonomus* taken (a single example) on the East African coast by the Valdivia Expedition at a depth of 1000 metres. Mr. Doflein refers this specimen to *Cymonomus granulatus*, and considers it to be a form of that species with degenerate eyes.

It seems to me, from the drawing given and here reproduced, that this East African *Cymonomus* is much nearer to *Cymonomus quadratus* than it is to *C. granulatus*. The ocular peduncles are in the condition which is normal and typical in *C. quadratus*, whilst the rostrum is relatively little shorter than in that species (conf.

text-fig. 11). On the other hand, the long and somewhat coarse hairs on both eye-stalks and rostrum seem to distinguish this species from *C. quadratus*. It certainly is not likely that this East African form should be identical with the Mediterranean and North Atlantic *C. granulatus*. I think that it will prove to be either a hairy variety of *C. quadratus* or a sufficiently distinct form to be entitled to a specific name, in which case I propose to speak of it as *Cymonomus Valdiviæ*.

Still more recently I have received a most interesting

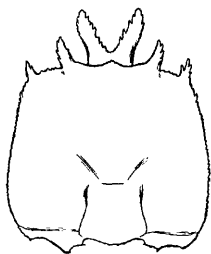


FIG. 12.—Outline diagram from Dr. Hansen's drawing of the "Ingolf" specimen of *Cymonomus* allied to *C. Normani*.

communication from my friend Dr. Hansen, of Copenhagen, relative to a *Cymonomus* dredged by the Ingolf Expedition in lat. N. 62° 58', long. W. 23° 28', at a depth of 486 fathoms, to which I have already referred above.

Dr. Hansen has been kind enough to send me an excellent drawing of the dorsal view of the remarkable "Ingolf" specimen. He will himself describe it hereafter in full, but I may say here that it is most distinctly a further term in the development of those special features which distinguish *C. Normani* from *C. granulatus*. In the Ingolf's *Cymonomus* the rostrum, as shown in the outline here given (text-fig. 12), is not even represented by a trifold spine; it is reduced to a scarcely prominent process of the margin of the carapace.

The extra-orbital spines are larger than in *C. Normani*, and the spines at the latero-frontal angles of the quadrate carapace are emphasised. The eye peduncles seem to be straighter and stronger than in *C. Normani*, and more broadly united to one another at the base.

I am not able to speak with any certainty on the next point, but if I may judge by Dr. Hansen's drawing the *Ingolf's* *Cymonomus* is less generally beset with spinules, and these are less prominent than is the case with *C. Normani*. In this respect the "*Ingolf*" form appears not to carry on the distinctive characters of *C. Normani* in an exaggerated degree. But we shall no doubt receive fuller information on the subject from Dr. Hansen.

It is worth noting by the way that degrees of degeneration of the eyes are known in the genus *Cymopolus*, *M.-Edw.*, as well as in the allied genus *Cymonomus*.

Cymopolus Agassizii, *M.-Edw.*, has the corneal surface very greatly reduced, and there is an absence of pigment; whilst in *Cymopolus asper*, *M.-Edw.*, the corneal area of moderate size is strongly pigmented with black.

Apparently *Cymonomus quadratus* is the only member of the *Cyclodorippine* crabs (or of any *Brachyurous* group except *Bathyplox*) which has hitherto been described as having the corneal area completely absent, and the ocular peduncle persisting as a mere pointed rod. *C. Normani* is now added to that list, as well as the forms dredged by the "*Valdivia*" and the "*Ingolf*."

NOTE BY DR. A. M. NORMAN, F.R.S.

The range of the described members of the genus *Cymonomus* is as follows:

1. *Cymonomus Normani*, E. Ray Lankester.

"*Porcupine*," 1869. Lat. $59^{\circ} 34'$ N., long. $7^{\circ} 15'$ W., 542 fathoms; and lat. $59^{\circ} 26'$, long. $8^{\circ} 23'$, 705 fathoms. These dredgings are to the north-west of the Butt of Lewis, and in the

“warm area” to the south of the “Wyville-Thomson Ridge.”

2. *Cyonomus granulatus*, Norman.
 - a. In many “Porcupine” dredgings in 1869 off the west and south-west of Ireland, in 106—1350 fathoms.
 - b. Off the coasts of Spain and Portugal, dredged by the “Porcupine,” 1870, “Travailleur,” “Talisman,” and “Hirondelle.”
 - c. Northern Mediterranean, off the south of France and off Corsica, “Travailleur,” 1881. Southern Mediterranean, “Porcupine,” 1870; Station 56; lat. 37° 3' N., long. 11° 36' E., that is near the island Pantellaria, between Tunis and Sicily, in 390 fathoms.
 - d. African coast. Taken by the “Talisman” more than twenty degrees south of the Mediterranean, off Arguin, lat. 21° 53' N., in 655 metres.
3. *Cyonomus quadratus*, A. Milne-Edwards, 1880.

Among the West Indian islands, in 175—508 fathoms.

The number of species of Crustacea Brachyura rapidly diminishes as we descend in our investigations into the depths of the ocean; and it is worthy of notice here that the only species, I believe, which have as yet been found in depths exceeding 1000 fathoms belong to genera allied to *Cyonomus*, as will be seen in the following list.

<i>Cyonomus granulatus</i> (Norman), as		
above		1380 fathoms.
<i>Ethusa microphtalma</i> , S. I. Smith.		
U.S. Fish Comm. dredgings, 1884	1047	”
“Challenger”	1000	”
<i>Ethusina abyssicola</i> , S. I. Smith.		
“Albatross,” 1883, Atlantic	1497—1735	”
“Talisman”		4060 metres.

Ethusina Challengeri, E. I. Miers.	
"Challenger"	1875 fathoms.
"Albatross," Pacific	2232 "
Ethusina gracilipes, E. I. Miers.	
"Challenger"	1425 "
"Albatross," Pacific	1322—1823 "
Ethusina Talismani, E. Milne-Edwards and Bouvier.	
"Talisman"	2235 metres.
"Princesse-Alice," 1897	1935 "

EXPLANATION OF PLATES 33 & 34,

Illustrating Prof. Ray Lankester's memoir on
 "The Eye Peduncles of *Cymonomus*."

Reference Letters.

a' = Antennule. *a*** = Basal articulation of same. *a'* = Antenna. *e* = Eye-stalk (ocular peduncle). *r* = Rostrum. *sp* = Extra-orbital spine or process of the carapace. *x* = Small scale, probably an abnormality.

FIG. 1.—*Cymonomus Normani*, n. sp. Male specimen, showing the modified rostrum and eye-stalks.

FIG. 2.—*Cymonomus granulatus*, Norman. Male specimen, showing the normal rostrum and eye-stalks.

FIG. 3.—Abdomen of male *C. granulatus*.

FIG. 4.—Abdomen of female *C. granulatus*.

FIGS. 5 and 6.—Eye-stalks of *C. granulatus*.

FIG. 7.—Frontal region of *C. granulatus* further enlarged.

FIG. 8.—Frontal region of *C. Normani* further enlarged.

FIG. 9.—Maxillipede of third pair of *C. granulatus*.

FIG. 10.—Eye-stalks and rostrum of a female specimen of *C. Normani*.

FIG. 11.—Eye-stalk and rostrum of a second male specimen of *C. Normani*.

FIG. 12.—Antennule and antenna of *C. granulatus*.

FIG. 13.—Part of antennule of *C. granulatus* further enlarged.

The following remarks in reference to these drawings and the original specimens are kindly furnished by Dr. W. T. Calman, who is now engaged on carcinological work in the Natural History Museum.

"The specimen represented in Figs. 1 and 8 is a male, the carapace of which measures about 3.4 mm. in length to the base of the rostral process. Fig. 10 is taken from a female specimen with carapace 4 mm. in length, and Fig. 11 from a male 2.4 mm. in length.

"The originals of the other figures cannot now be identified.

"In the specimen shown in Figs. 1 and 8 the eye-stalks are not quite so near together at the base as in the figure, though they are somewhat nearer than in the specimens from which Figs. 10 and 11 have been drawn. One of these (Fig. 10) has at the tip of the eye-stalks a slight trace of the brownish coloration which in normal specimens distinguishes the corneal area, but this cannot be discerned in either of the other two specimens.

"Fig. 12 shows a small scale (*x*) apparently articulating with the end of the proximal joint of the antennal peduncle. This appears to be exceptional in occurrence, and is not present in the specimens examined by me. It seems to be a development of the primitive third joint of the peduncle, usually fused with the second and indicated only by a sutural line.—W. T. C."

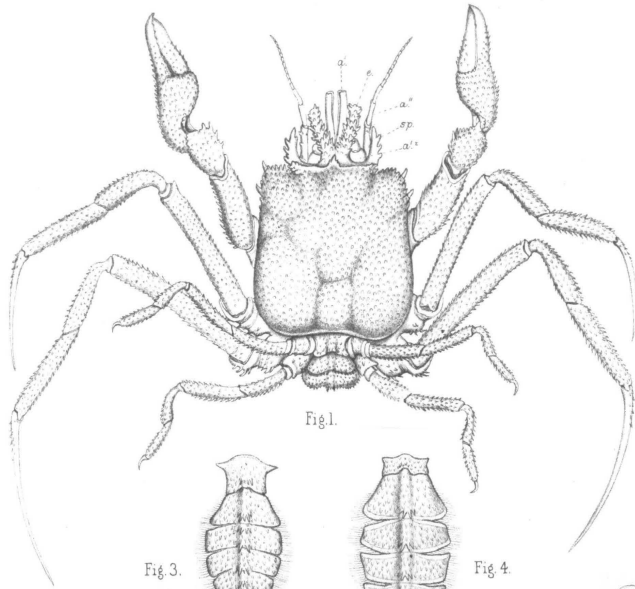


Fig. 1.

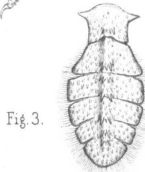


Fig. 3.

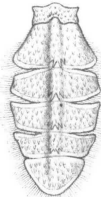


Fig. 4.



Fig. 5.

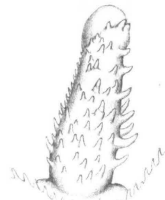


Fig. 6.

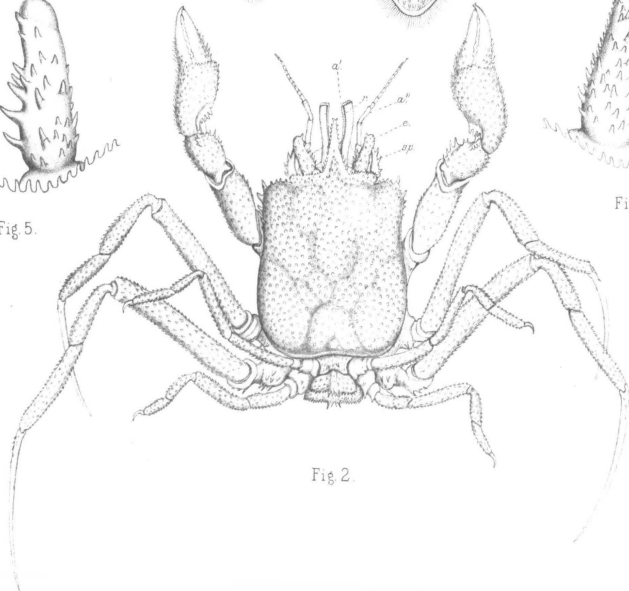


Fig. 2.



Fig. 10.

Fig. 13.

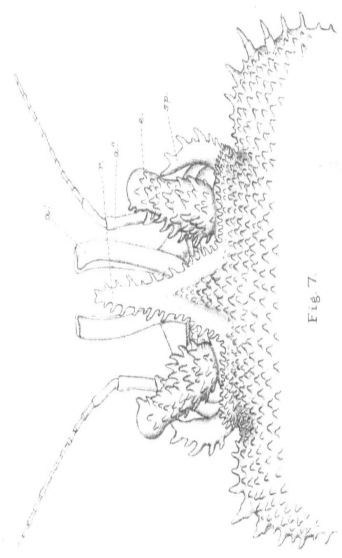


Fig. 7.

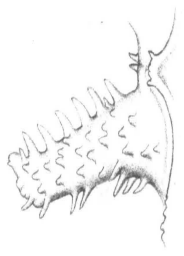


Fig. 11.

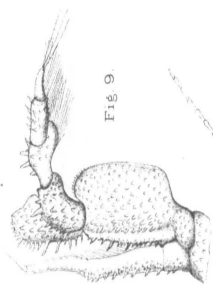


Fig. 9.

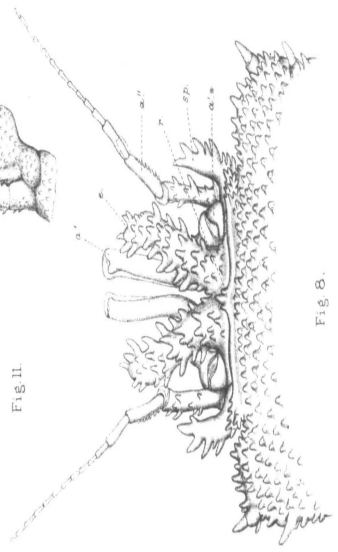


Fig. 8.

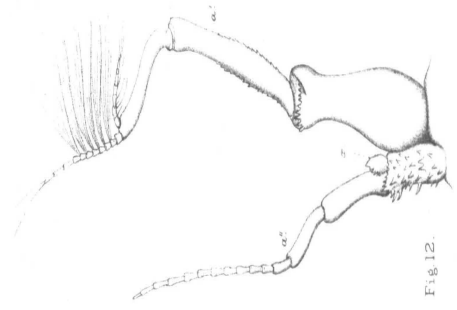


Fig. 12.