Garth, J. & J. Haig
1971

ANTON BRUUN REPORT

NUMBER 6

Scientific Results

of the

Southeast Pacific Expedition

Decapod Crustacea (Anomura and Brachyura) Of the Peru-Chile Trench

John S. Garth

Janet Haig

October

~~1970~~
1971

Decapod Crustacea (Anomura and Brachyura) Of the Peru-Chile Trench[1]

John S. Garth and Janet Haig
Allan Hancock Foundation
University of Southern California
Los Angeles, California

ABSTRACT

Five species of anomuran and six species of brachyuran crabs were collected by the ANTON BRUUN in the Peru-Chile Trench. Of the latter, three proved to be new to science: *Cymonomus menziesi* Garth, *Trachycarcinus hystricosus* Garth, and *Lophorochinia parabranchia* Garth, the last named also a new genus. With regard to vertical zonation, *Cymonomus* and *Trachycarcinus* were bathyal, *Ethusina, Parapagurus,* and *Probeebei* abyssal. *Lophorochinia* was found to occupy the oxygen-minimum layer, to which its swollen gill chambers and operculate outer maxillipeds are an apparent adaptation.

Reduced vision with increased depth was shown by *Cymonomus* and *Munidopsis* species. Tropical submergence was shown by *Lophorochinia* as between its Peruvian and Chilean occurrence. The large eggs of *Munidopsis scabra* and *Trachycarcinus corallinus* suggested abbreviated larval development minimizing opportunities for pelagic dispersal.

Range extensions southward of from 7° to 33° of Latitude were recorded for six of the eleven species. Distributional relationships representing varying degrees of endemicity were found, with *Parapagurus* occurring in all the world's deep trenches, while *Lophorochinia* is restricted to the Peru-Chile Trench alone.

Introduction

In February, March, and April 1891, the U. S. Fish Commission Steamer ALBATROSS, under the scientific direction of Alexander Agassiz, conducted dredging and trawling operations off the west coast of Central America, the Galapagos Islands, and the west coast of Mexico (Agassiz 1892). The account of the stalk-eyed Crustacea of that expedition (Faxon 1895) constitutes the basis for our current knowledge of the deep-water Crustacea of the eastern Pacific. Although the GALATHEA in 1952 and the VEMA in 1958 probed the Costa Rican and the Peruvian depths for the monoplacophoran *Neopilina,* the only significant addition to the bathyal decapod crustacean fauna was the discovery of the pagurid anomuran *Probeebei* in 1925 off Panama by the ARCTURUS (Boone 1926). A new species of *Munidopsis* and a new species of *Ethusa* collected by the GALATHEA off Central America in 1952 remain undescribed at this writing (Wolff 1961b, pp. 147-149).

In October and November 1965, the Research Vessel ANTON BRUUN, under the scientific direction of Robert J. Menzies, conducted dredging and trawling operations off the west coast of South America, specifically in the Milne Edwards Deep of the Peru-Chile Trench system (Menzies and Chin 1966). The account of the decapod Crustacea of this cruise, in keeping with the specialization of the times, was entrusted to various specialists. This paper presents the results on the Anomura (Janet Haig) and the Brachyura (John S. Garth). Each author is responsible for his respective section of the Systematic Account.

Since the only report comparable in scope to this one is that of the late Walter Faxon (1895), let the record speak for itself:

"The route of the 'Albatross' . . . traversed about twenty-nine degrees of latitude, from 1° S. (Galapagos Islands) to 28° N. (Guaymas, in the Gulf of California). In a longitudinal direction the region explored extended from 78° 34′ W. (Gulf of Panama) to 110° 53′ N. (Guaymas) . . . The

[1]Allan Hancock Foundation Contribution No. 335.

bathymetrical range explored was very great, extending as it did from the surface to 2232 fathoms [4,081 m]." (Faxon 1895, with change of tense.)

The route of the ANTON BRUUN traversed about 9° of latitude, from 3° S. (Guayaquil, Ecuador) to 12° S. (Callao, Peru). In a longitudinal direction the region extended from 77° W. (Callao) to 82° 17′ W. (W. of Pta. Negra, Peru). The bathymetric range explored was great, extending from 30 to 6,489 m (16 to 3,568 fms). Only 2° of latitude separated the northernmost station of the ANTON BRUUN from the southernmost station of the ALBATROSS, but from the Equator their tracks diverged, so that their operations were conducted in different hemispheres.

"The littoral as distinguished from the deep-sea fauna may be taken to include the animals living between the shore and a depth of 100 to 150 fathoms. Below the littoral zone there lies a belt, extending from say 150 to 500 fathoms, which forms a sort of debatable ground, invaded on the one hand by littoral types from above, and on the other by characteristic deep-sea forms from below. . . . *Anamathia* [has] its fullest development in the intermediate zone between 150 and 500 fathoms." (Faxon 1895, pp. 231, 241.)

The operations of ANTON BRUUN Cruise 11 were conducted in such a way as to exclude the shallow-water fauna, which has been explored by other vessels, notably the VELERO III in 1935 and 1938. Of the Brachyura collected, the species corresponding most closely to *Anamathia* (= *Rochina*), namely, *Lophorochinia parabranchia,* new genus and species, was trawled in depths of 459 to 509 m (251 to 278 fms), and so clearly belongs in the intermediate zone defined by Faxon.[2]

"Only four species (representing two genera) of Brachyura were discovered by the 'Albatross' below 500 fathoms, and these low on the Brachyuran scale. In the vast amount of material obtained by the 'Challenger' during the circumnavigation of the globe [Miers 1886] only four species (belonging to three genera) of Brachyura came from below 500 fathoms. Two of these [*Ethusa gracilipes* and *Ethusa (Ethusina) challengeri*] are the same as two of the four species secured by the 'Albatross' below the 500 fathom line." (Faxon 1895, p. 247.)

Only five species (representing three genera) of Brachyura were discovered by the ANTON BRUUN below 500 fms (914 m). One is a new species of *Cymonomus,* known heretofore in American waters only from the Caribbean. Allowing for name changes, the same two CHALLENGER deep-sea species were also encountered by the ANTON BRUUN, namely, *Ethusina robusta* and *E. faxonii* (as the eastern Pacific equivalent of *E. challengeri* is now known).

"Only four new genera were found among the Stalk-eyed Crustacea taken at a greater depth than 500 fathoms . . . Of these, *Trachycarcinus* (a Corystoid crab from 546-695 fathoms) is represented in deep water in the Caribbean Sea by an undescribed species [*T. spinulifer* Rathbun 1898, 324-347 fathoms] with which it is probably congeneric, and by *Trichopeltarion* (151 fathoms)." (Faxon 1895, p. 242.)

No new genera were found among the Brachyura taken at a greater depth than 500 fms (914 m) by the ANTON BRUUN. However, two species of *Trachycarcinus* were collected in depths of 907 to 935 and 1,005 to 1,124 m, and one of these, *Trachycarcinus hystricosus,* new species, represents the eastern Pacific counterpart of the Caribbean *T. spinulifer.*

"The following list indicates genera found below the 500 fathom line; those whose range extends beyond 1000 fathoms [*Ethusina, Trachycarcinus, Parapagurus*] are printed in italics." (Faxon 1895, p. 241.)

The only brachyuran genus encountered below 1,000 fms (1,829 m) by the ANTON BRUUN (also by the ALBATROSS) was *Ethusina,* represented by *E. robusta,* 1,887 to 1,934 m, and *E. faxonii,* 3,086 to 3,995 m. *Trachycarcinus,* represented by *T. corallinus* and *T. hystricosus,* occurred no deeper than 1,124 m. The only anomuran genera encountered below 1,000 fms by the ANTON BRUUN were *Parapagurus,* 3,909 to 3,970 m, and *Probeebei,* 3,869 to 3,995 m, the latter not known to Faxon.

Explanation of Measurements

Except where otherwise indicated, measurements refer to the carapace only. Length is measured from the tip of the rostrum to the posterior margin of the carapace. Width is measured at the widest part of the carapace.

Deposition of Types

Holotypes of new species are deposited in the collections of the Allan Hancock Foundation (AHF), University of Southern California, as is the holotype of *Lophorochinia parabranchia,* previously described (Garth 1969). Paratypes of the latter species are deposited in the collections of the U. S. National Museum and the Instituto Central de Biologia, Universidad de Concepción, Chile.

Acknowledgments

The authors are indebted to Dr. Robert J. Menzies, Chief Scientist, ANTON BRUUN Cruise 11, for the opportunity of studying this small but rich collection. One of us (Garth), who visited the British Museum (Natural History), London, and

[2]Since the bathymetric zones defined by Faxon differ somewhat from those used by many biologists today (cf. Bruun 1957), a classification of ANTON BRUUN specimens along more modern lines bathymetrically will follow.

the Muséum National d'Histoire Naturelle, Paris, in 1966 to study types of deep-sea decapod crustaceans collected by the CHALLENGER and the BLAKE, thanks the curators of these institutions for privileges extended. Travel was made possible by a grant from the National Science Foundation (GB-3849).

ANTON BRUUN Cruise 11 Decapoda

Systematic Account

Section Anomura
- **Superfamily Paguridea**
  - **Family Diogenidae**
    - **? *Dardanus sinistripes* (Stimpson)**
  - **Family Paguridae**
    - ***Parapagurus abyssorum* Henderson**
    - ***Probeebei mirabilis* Boone**
- **Superfamily Galatheidea**
  - **Family Galatheidae**
    - ***Munida propinqua* Faxon**
    - ***Munidopsis hystrix* Faxon**
    - ***Munidopsis scabra* Faxon**

Section Brachyura
- **Subsection Dromiacea**
  - **Family Cymonomidae**
    - ***Cymonomus menziesi* Garth, new species**
- **Subsection Oxystomata**
  - **Family Dorippidae**
    - ***Ethusina robusta* (Miers)**
    - ***Ethusina faxonii* Rathbun**
- **Subsection Brachygnatha**
  - **Superfamily Oxyrhyncha**
    - **Family Majidae**
      - ***Lophorochinia parabranchia* Garth**
  - **Superfamily Corystoidea**
    - **Family Atelecyclidae**
      - ***Trachycarcinus corallinus* Faxon**
      - ***Trachycarcinus hystricosus* Garth, new species**

Section ANOMURA
Superfamily PAGURIDEA
Family DIOGENIDAE
? *Dardanus sinistripes* (Stimpson)

Pagurus sinistripes Stimpson 1859, p. 82.

Dardanus sinistripes, Rathbun 1910, pp. 556, 597, Pl. 49, Fig. 2.

Dardanus imbricatus Rathbun 1910, pp. 556, 597, Pl. 49, Fig. 3.

Material: Off Peru, 8° 46′ S., 80° 44′ W., ANTON BRUUN Sta. 169 (Menzies trawl), November 2, 1965, 3,909 to 3,970 m,[3] 1 specimen, glaucothoe stage.

Measurements: Length of carapace 3.5 mm.

Remarks: This glaucothoe, certainly a diogenid, has a combination of features characteristic of glaucothoes of *Dardanus* (cf. Provenzano 1968, pp. 169-172): cornea dilated and wider than the eyestalk; no eyescales; ventral ramus of antennule four-segmented; antennal flagellum with more than 20 articles; chelae symmetrical; two broad teeth on the ventral margin of the dactyl of pereiopods 2 and 3; and telson a little longer than broad, with its posterior margin nearly transverse. The only *Dardanus* known from the area covered by ANTON BRUUN Cruise 11 is *D. sinistripes* (Stimpson) which inhabits shallow waters throughout the tropical eastern Pacific. It was collected in Peru at Bahía de Sechura, between 5° and 6° S. (Rathbun 1910, as *D. sinistripes* and as *D. imbricatus*) and at Bahía de la Independencia at about 14° 15′ S. (unpublished record).

[3]Probably netted at or near the surface.

Family PAGURIDAE
Parapagurus abyssorum Henderson

Parapagurus abyssorum Henderson 1888, p. 87, Pl. 9, Fig. 2.

Parapagurus pilosimanus abyssorum, Faxon 1895, p. 68.

Parapagurus pilosimanus var. *abyssorum,* A. Milne Edwards and Bouvier 1900, p. 191, Pl. 24, Figs. 4 - 6.

Material: Off Peru, 8° 46′ S., 80° 44′ W., ANTON BRUUN Sta. 169 (Menzies trawl), November 2, 1965, 3,909 to 3,970 m, 1 ovigerous female.

Measurements: Length of ovigerous female 8.6 mm.

Remarks: In the eastern Pacific this species is known to occur as far N. as the Gulf of California and as far S. as southern Chile. It was collected by the ALBATROSS at a number of localities from 24° 22′ 30″ N. to 0° 36′ S., and in 770 to 1,823 fms (1,408 to 3,334 m).

Parapagurus abyssorum has generally been considered a subspecies or variety of *P. pilosimanus* S. I. Smith, but Michèle de Saint Laurent, who is currently preparing a revision of the genus, considers it to be a distinct species (cf. Forest and Saint Laurent 1968, p. 114).

Range: World-wide; bathymetric distribution about 1,000 to 4,200 m.

Probeebei mirabilis Boone

Probeebei mirabilis Boone 1926, p. 73, 1 text-fig., unnumbered. Wolff 1961a, p. 11 *et seq.,* Text-figs. 1-10.

Planopagurus galatheae Wolff 1960, p. 169, 1 text-fig., unnumbered.

Material: Off Peru, 12° 00′ S., 78° 46′ W., ANTON BRUUN Sta. 154 (5-ft beam trawl), October 28, 1965, 3,995 to 3,869 m, 1 male (juvenile).

Measurements: Length of juvenile male specimen 37.1 mm.

Remarks: In his thorough description of this species, based on the type specimen collected by the ARCTURUS and 18 specimens taken by the GALATHEA, Wolff (1961a) discussed the great variation in the

number of pleopods present in individuals at different post-larval stages. In the 37.1 mm young male from ANTON BRUUN Sta. 154, the pleopods are as follows: abdominal segment 1, none; segment 2, rudimentary pleopod on left-hand side, scar of disappeared pleopod on right; segment 3, scar on both left and right sides; segments 4 and 5, rudimentary pleopod on left side, scar on right.

Range: Off Costa Rica, 9° 23′ N., 89° 32′ W., and S. of Cocos Island, 4° 50′ N., 87° 00′ W. Depth 1,145 to 3,570 m. The known horizontal distribution is now extended southward through 17° of latitude, and the bathymetric range is extended from 3,570 to 3,995 m.

Superfamily GALATHEIDEA
Family GALATHEIDAE

Munida propinqua Faxon

Munida propinqua Faxon 1893, p. 178; 1895, p. 76, Pl. 18, Figs. 1, 1a. Benedict 1902, pp. 251, 312.

Material: Off Peru, 11° 50′ S., 77° 58′ W., ANTON BRUUN Sta. 144 (5-ft beam trawl), October 26, 1965, 935 to 907 m, 15 males, 15 females (7 ovigerous).

Measurements: Males, length including rostrum 23.6 to 44.6 mm. Non-ovigerous females, length 22.0 to 34.9 mm. Ovigerous females, length 23.2 to 31.5 mm.

Remarks: In all specimens collected at Sta. 144 there is a pair of well-developed spines to the inside of the large gastric pair; these spines were not mentioned by Faxon and are not indicated in the illustration of one of the types. The illustration may be inaccurate in that it depicts the anterior portion of the carapace, from the cervical groove to the base of the rostrum, as slightly longer than the posterior portion. In all specimens collected by the ANTON BRUUN, the cervical groove crosses the midline of the carapace almost exactly half-way between the base of the rostrum and the posterior carapace margin.

The series shows some variation in the relative length of the rostral and supraocular spines and in the number of spinules (8 to 14) on the second segment of the abdomen. The palm of the chela is about the same length as the fingers, except in the largest males, in which the palm is elongate. In most specimens, the cutting edges of the fingers meet for their entire length, but in a few males the fingers gape slightly. The degree of spinulation on the chelipeds varies considerably, being strongest in smaller individuals.

Munida curvipes Benedict, reported from southern Chile in 1,050 fms (1,920 m), is related closely to *M. propinqua,* but appears to differ in lacking a well-developed pair of spines on the carapace between the large gastric pair, in having more transverse striae on the carapace and fewer spines on the second abdominal segment (six in the type specimen), in having a relatively stouter ischium of the outer maxillipeds, and in lacking spines on the anterior margin of the propodus of the walking legs. Benedict (1902, p. 251) distinguished the two species by the supraocular spines reaching beyond the eyes in *M. propinqua* and not reaching beyond the eyes in *M. curvipes.* This, however, is not a valid distinction because, as noted above, *M. propinqua* varies in the length of the supraocular spines. Several of the 30 specimens collected by the ANTON BRUUN have the supraocular spines slightly shorter than the eyes.

Another evidently closely related form is *Munida obesa* Faxon, which is reported from 7° 16′ N. and 7° 12′ N. in 182 to 210 fms (332 to 384 m). *M. obesa* has a different arrangement of carapace spines than does *M. propinqua,* the pleura of abdominal somites 3, 4, and 6 pointed instead of truncate or rounded, the third abdominal somite sometimes armed, and the propodus of the walking legs unarmed along the anterior margin.

From the limited data now available (*M. obesa,* 332 to 384 m; *M. propinqua,* 704 to 935 m; and *M. curvipes,* 1,920 m), it appears that these three species may be separated bathymetrically as well as by relatively minor taxonomic characters.

Range: Gulf of Panama and off Galapagos Islands. Depth 385 to 511 fms (704 to 935 m). The known range is now extended from 1° 3′ S. southward through nearly 11° of latitude.

Munidopsis hystrix Faxon

Munidopsis hystrix Faxon 1893, p. 183; 1895, p. 89, Pl. 19, Figs. 1, 1a. Benedict 1902, pp. 275, 321. Rathbun 1904, p. 166. Schmitt 1921, p. 168, Text-fig. 107.

Material: Off Peru, 11° 50′ S., 77° 58′ W., ANTON BRUUN Sta. 144 (5-ft beam trawl), October 26, 1965, 935 to 907 m, 4 males, 4 females (2 ovigerous).

Measurements: Males, length 15.6 to 30.5 mm. Non-ovigerous females, length 11.1 and 17.0 mm. Ovigerous females, length 20.6 and 22.3 mm.

Remarks: The eggs borne by two of the females were smaller and much more numerous than those found on a female *Munidopsis scabra* collected at the same station.

Range: From off Anacapa Island, California, to off Acapulco, Mexico. Depth 302 to 680 fms (552 to 1,243 m). The known range is now extended from 16° 32′ N. southward through 28° of latitude.

Munidopsis scabra Faxon

Munidopsis scabra Faxon 1893, p. 186; 1895, p. 93, Pl. 21, Figs. 1, 1a. Benedict 1902, pp. 275, 325.

Material: Off Peru, 11° 50′ S., 77° 58′ W., ANTON BRUUN Sta. 144 (5-ft beam trawl), October 26, 1965, 935 to 907 m, 1 male, 2 females (1 ovigerous, 1 post-ovigerous).

Measurements: Male, length 15.6 mm. Ovigerous female, length 14.8 mm. Post-ovigerous female, length 20.5 mm.

Remarks: The specimens collected by the ANTON BRUUN agree closely with the description and illustration of the type material from the ALBATROSS, except that they have a row of about 16 to 20 spinules or denticles along the posterior margin of the carapace instead of about eight as reported for the types. In this they agree with a closely related E. Atlantic species, *Munidopsis acutispina* Benedict.[4] *M. acutispina* differs from *M. scabra* in having no epipods on any of the pereiopods. In *M. scabra* there is an epipod on each cheliped, a character not mentioned by Faxon.

The smaller female specimen has seven large eggs, with a diameter of approximately 1.2 mm each, attached to the pleopods.

Range: W. coast of Mexico off Tres Marias Islands. Depth 676 to 680 fms (1,236 to 1,243 m). The known range of the species is now extended from 21° 19′ N. southward through 33° of latitude, and the bathymetric range may now be expressed as 907 to 1,243 m.

Section BRACHYURA
Subsection DROMIACEA
Family CYMONOMIDAE

Cymonomus menziesi Garth, n. sp.
(Plate I, Figs. 1-5)

Type: Male holotype, AHF No. 659, from off Peru, 7° 58′ S., 80° 37′ W., ANTON BRUUN Sta. 88 (5-ft. beam trawl), October 14, 1965, 1,005 to 1,124 m.

Measurements: Male holotype, length of carapace, including rostrum, 5.0 mm, length of rostrum 1.0 mm, width at branchial level 4.1 mm, at anterolateral level 3.9 mm, at exorbital level 2.0 mm, length of eyestalk 1.4 mm. Length of chela 3.2 mm, of palm 1.6 mm, of dactylus 1.9 mm, height of palm 1.0 mm. Length of merus of first walking leg 3.2 mm, of carpus 2.0 mm, of propodus 2.0 mm, of dactylus 3.5 mm. Length of merus of second walking leg 4.3 mm, of carpus 2.9 mm, of propodus 3.4 mm, of dactylus 6.2 mm.

Diagnosis: Rostrum equal to one-fifth total carapace length, eyestalks half again as long as rostrum. Front advanced beyond line of anterolateral margins. Merus of external maxilliped linear-lanceolate.

Description: Carapace subquadrate, postfrontal length and width subequal, covered with granules that increase in sharpness toward the anterolateral borders. These, rather than being on a transverse line with the orbital borders, fall considerably short of them, the entire facial region protruding noticeably. Rostrum slender, tapering, and pointed, its length equal to one-fifth of carapace length (or one-fourth of post-rostral carapace length). Eyestalks half again as long as rostrum, slender, slightly sinuous, and tapering, inner margins spinulate, tips truncate or slightly concave, no vestige of corneas. Antennules stout, basal segment bulbous, second segment overreaching eyes and antennal peduncle, third segment more than twice length of rostrum. Antennae shorter and more slender, penult article of peduncle falling short of eyes and of second antennular segment, antennal scale visible dorsally external to orbits. Anterolateral margins sloping obliquely, studded with sharp granules, and armed with a granulate spine or tooth externally. Lateral margins slightly constricted at level of cervical groove, carapace widest at branchial level, posterior margin broad. Gastric and hepatic regions laterally confluent, cardiac and intestinal regions delimited from each other and from branchial regions by linear furrows and two paired deeper pits.

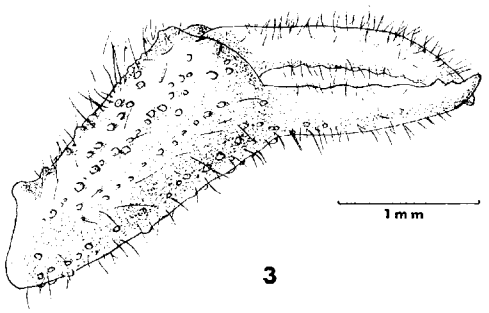
External maxilliped with merus equalling ischium in length, prolonged beyond insertion of palpus into a narrow blade with tip reaching or exceeding exognath.

Chelipeds slightly unequal in male, merus somewhat thicker than merus of first walking leg but considerably shorter, granulate; carpus with a few spinules on inner margin; manus granulate, broadening distally, fingers slender, subequal, tips crossing, a triangular gape at base, dactylus longer than palm. Dactylus of first walking leg as long as carpus and three-fourths of propodus; dactylus of second walking leg as long as carpus and propodus combined. Carapace and appendages sparsely and finely hairy.

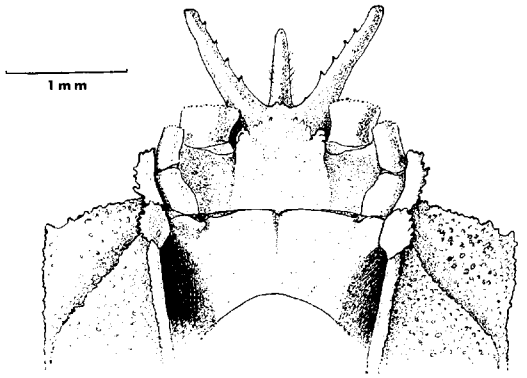
Abdomen of male composed of six somites. Female not known.

Remarks: The male holotype from ANTON BRUUN Sta. 88 was compared with specimens of *Cymonomus quadratus* A. Milne Edwards 1880 at the Paris Museum labeled "typique," BLAKE, Agassiz, 1-99; [Sta. No. 136], 508 brasses (fms), 1 young female, plus fragments; [Sta.] No. 3, 253-480 brasses, 2 females. In all but one of these, the rostrum is broken, but in that one it is just as long as the antennal articles, which are shorter than in the BRUUN specimen. BLAKE females are broader at the

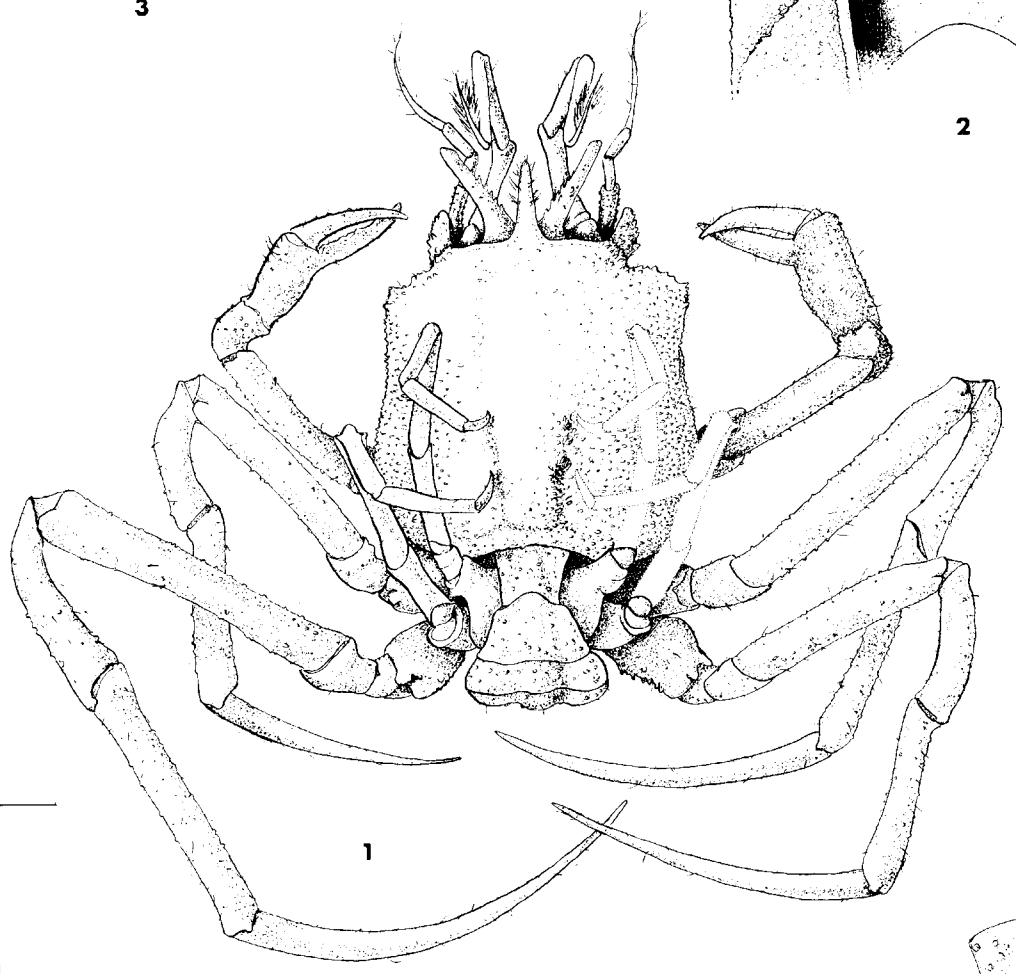
[4]Described as *Munidopsis aculeata* by A. Milne Edwards and Bouvier (1894, p. 275; 1900, p. 327, Pl. 31, Figs. 1-4). Benedict (1902, p. 315) pointed out that the name *aculeata* was preoccupied in *Munidopsis* and substituted *acutispina* for the A. Milne Edwards and Bouvier species.



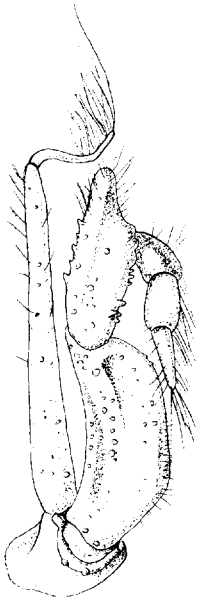
3



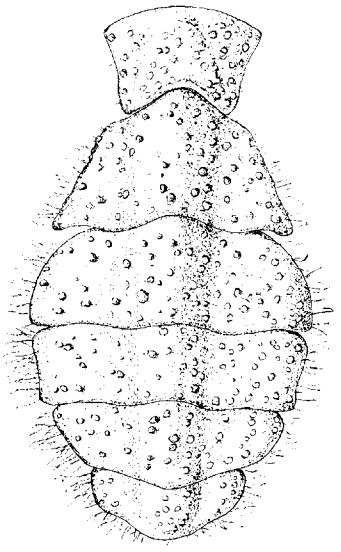
2



1



4



5

Plate I

Cymonomus menziesi *Garth*
Male Holotype

1. *Dorsal view of entire crab*
2. *Ventral view of frontal region (only bases of antennules shown)*
3. *Outer view of right chela*
4. *Right external maxilliped*
5. *Abdomen*

(Drawn by Jens W. Knudsen)

shoulders, the sides convex or straight, not concave. The maxillipeds differ from the BRUUN specimen in being wider and the merus crescent-shaped. The fingers are the same in both, but the manus of the BLAKE females is higher than that of the BRUUN male. Differences attributable to sex aside, there is no doubt but that they represent two distinct species, with the new species here described the first of its genus from the eastern Pacific.

The new species is named for Dr. Robert J. Menzies, Chief Scientist of ANTON BRUUN Cruise 11 and lifelong student of deep-sea Crustacea and other invertebrates.

The suprafamilial designation under the subsection Dromiacea has been omitted pending completion of studies now in progress by Dr. Isabella Gordon, who reports (1963 and *in litteris*) that on the basis of external genitalia *Cymonomus* is related to the Homolidae (formerly Thelxiopeidae), while *Tymolus* and *Xeinostoma* are related to the Dromiidae, and that in the Dromiacea these differences are of family rank, so that Cymonomidae and Tymolidae may now be used.

Subsection OXYSTOMATA
Family DORIPPIDAE

Ethusina robusta (Miers)

Ethusa (Ethusina) gracilipes var. *robusta* Miers 1886, p. 333, Pl. 29, Fig. 2.

?*Aethusina gracilipes,* Faxon 1895, p. 36; not *Ethusa (Ethusina) gracilipes* Miers.

?*Ethusina gracilipes,* Rathbun 1906, p. 891; 1937, p. 94, Pl. 30, Fig. 4; Pl. 31, Fig. 4; not *Ethusa (Ethusina) gracilipes* Miers.

Material: Off Peru, 8° 16′ S., 80° 52′ W., ANTON BRUUN Sta. 103 (5-ft beam trawl), October 17, 1965, 1,887 to 1,934 m, 1 male.

Measurements: Male specimen, length 11.3 mm, width 10.3 mm.

Remarks: The ANTON BRUUN male was compared with the types of *Ethusa (Ethusina) gracilipes* Miers, 2 male and 2 female (1 ovigerous) specimens from CHALLENGER Sta. 207, near the Philippines, 700 fms (1,280 m), and with the type female of var. *robusta* Miers, CHALLENGER Sta. 195, Banda Sea, 1,425 fms (2,605 m), and three female syntypes of var. *robusta,* CHALLENGER Sta. 191, Arafura Sea, 800 fms (1,463 m), in the collections of the British Museum (Natural History). The BRUUN specimen is more like *robusta,* here considered a distinct species from *gracilipes,* but the entire front is longer and inclined at a different plane, the median V is more pronounced, the frontal spines more laterally spread, the inner orbital margin nearly perpendicular. Since these differences also distinguish the BRUUN male from specimens reported by Faxon (1895) and by Rathbun (1937, p. 97, Table 29) as *gracilipes,* it is by no means certain that they are one and the same. The BRUUN specimen is therefore tentatively referred to *robusta* Miers, the Faxon and Rathbun specimens questionably so. Certainly, neither is *gracilipes* Miers, which in addition to its longer and more slender legs differs from *robusta* in having cylindrical, movable eyestalks, and therefore would appear to belong in the genus *Ethusa* (cf. Rathbun 1937, p. 77, key).

Range: From Bay of Panama to off northern Ecuador; Galapagos Islands. Depth 885 to 1,823 fms (1,618 to 3,334 m). Hawaiian Islands. Banda and Arafura seas. The range of the species is extended from the Galapagos Islands, on the Equator, to 8° S. of the Equator, a latitudinal distance of 480 nautical miles.

Ethusina faxonii Rathbun

Aethusina challengeri? Faxon 1895, p. 36; not *Ethusa (Ethusina) challengeri* Miers 1886, p. 331, Pl. 28, Figs. 2-2c.

Ethusina faxonii Rathbun 1933, p. 185; 1937, p. 93, Pl. 26, Fig. 3; Pl. 27, Fig. 3. Garth 1960, p. 120.

Material: Off Peru, 8° 22.5′ S., 80° 45′ W., ANTON BRUUN Sta. 111 (5-ft beam trawl), October 18, 1965, 3,086 to 3,202 m, 1 female; 12° 00′ S., 78° 46′ W., ANTON BRUUN Sta. 154 (5-ft beam trawl), October 28, 1965, 3,995 to 3,869 m, 1 male, 1 female; 8° 43′ S., 80° 42′ W., ANTON BRUUN Sta. 168 (5-ft beam trawl), November 1, 1965, 3,969 m, 1 female.

Measurements: Male specimen, length 13.0 mm, width 12.2 mm. Female specimens, length 15.5 mm, width 14.5 mm, and length 16.6 mm, width 16.5 mm.

Remarks: The male and female from ANTON BRUUN Sta. 154 were compared with the female type of *Ethusa (Ethusina) challengeri* Miers from CHALLENGER Sta. 237, Japan Seas, 1,875 fms (3,429 m), in the collections of the British Museum (Natural History). *Ethusina faxonii,* as represented by ANTON BRUUN specimens, has the same texture, the same two cardiac tubercles as *E. challengeri,* but shows less relief, a less protuberant cardiac region, and less acute and outstanding frontal and exorbital spines. It was concluded that Faxon's doubts, as indicated by an interrogation mark (Faxon 1895), were well founded and that Rathbun (1933) was justified in considering the ALBATROSS specimen a distinct species.

Range: W. coast of Mexico, from NW. of Tres Marias Islands, Gulf of California, to S. of Gulf of Tehuantepec, 10° 14′ N., 96° 28′ W. Depth 1,640 to 2,232 fms (2,999 to 4,081 m). The range of the species is extended from 10° N. of the Equator to 12° S. of the Equator, a latitudinal distance of 1,320 nautical miles. The male of the species is now known.

Subsection BRACHYGNATHA
Superfamily OXYRHYNCHA
Family MAJIDAE
Genus *Lophorochinia* Garth

Lophorochinia Garth 1969, pp. 5-7; type species: *L. parabranchia* Garth.

Carapace broadened and rounded posteriorly, branchial regions inflated, meeting but not fusing on mid-line; cardiac region obscured. Rostrum double. A prominent preorbital spine; intercalary spine absent; eye retractile against postocular cup. Basal antennal article moderately broad; antennal flagellum visible dorsally at side of rostrum. Merus of outer maxilliped broadened and rounded anteriorly, forming an effective closure to the similarly produced opening of the efferent branchial channel.

Legs slender and cylindrical; cheliped of adult male elongate and robust.

Abdomen seven-segmented in both sexes. Male first pleopod pisiform (see Garth 1958, p. 249).

Allied to *Rochinia* A. Milne Edwards, a deep-water genus from which it may have been derived, but differing from it in the swollen branchial regions which meet along the mid-line but do not fuse, and in the expanded merus of the external maxilliped which serves as an operculum for the greatly enlarged excurrent opening. In these respects, it closely parallels *Encephaloides* Wood-Mason (Wood-Mason and Alcock 1891, p. 259), a deep-water, Indian Ocean genus with a single rostrum and without a true orbit, which has developed from the genus *Inachoides* of the subfamily Inachinae.

Additional evidence for the close relationship of the new genus and *Rochinia* is provided by *Anamathia beauchampi* Alcock and Anderson (1894, p. 185; 1896, Pl. 20, Figs. 2, 2a), a deep water, Indian Ocean species now referred to *Rochinia,* in which the branchial regions are folded over the cardiac region, which is visible, although depressed.

Lophorochinia parabranchia Garth
(Plate II, Figs. 1-6)

Leucippa pentagona, Nuñez Barron 1967, p. 39, Pl. 1, Fig. 1 (male first pleopod); Pl. 2 (male); Pl. 3 (males and females). Not *L. pentagona* Milne Edwards 1833.

Lophorochinia parabranchia Garth 1969, p. 5, Text-fig. 1.

Material: Off Callao, Peru, 11° 52′ S., 77° 53.2′ W., ANTON BRUUN Sta. 140 (5-ft beam trawl), October 25, 1965, 509 to 469 m, 1 female holotype, AHF No. 658, 5 male and 14 female paratypes. Off Pta. Patache, Chile, 20° 48′ S., 70° 21′ W., MAR CHILE II Sta. 45, July 25, 1962, 282 m, K. Alveal y Córdova, collector, 7 male and 10 female paratypes from V. A. Gallardo, Instituto Central de Biología, Universidad de Concepción, Chile.

Measurements: Female holotype, length of carapace 52.7 mm, width of carapace 49.0 mm, length of rostrum 7.0 mm, width of rostrum 7.2 mm, length of cheliped 53.5 mm, of chela 25.0 mm, of dactyl 10.6 mm, of walking legs 97.5, 86.3, 73.0, and 67.0 mm from first to last, respectively. Male paratype, length 65.5 mm, width 62.0 mm.

Description: Carapace smooth and glistening, sparsely clothed with fine setae, pitted anteriorly, greatly swollen posteriorly, and provided with spines or spinose tubercles as follows: four on the gastric region, including two in the midline and two lateral; one intestinal; one on each hepatic region; and five on each branchial region. Spine at widest part of carapace projecting outward and upward, connected with anterior branchial spine by a blunt ridge; a similar but sharper ridge connecting hepatic spine with postorbital. Rostrum one-seventh length of carapace, basally broader than long, consisting of two slightly divergent horns deeply cleft by a V-shaped sinus. Preocular spine well developed; postorbital process a shallow cup. Branchial regions inflated medially, meeting but not fusing along midline, bringing epibranchial pair of spines into close approximation and obliterating cardiac region. Basal antennal article with a blunt spine at antero-external angle, antennal flagellum visible at sides of rostrum in dorsal view. Buccal area expanded anteriorly into two vaulted arches; merus of maxilliped broadened and rounded anterolaterally, serving with the similarly flattened carpus as an operculum to the excurrent opening.

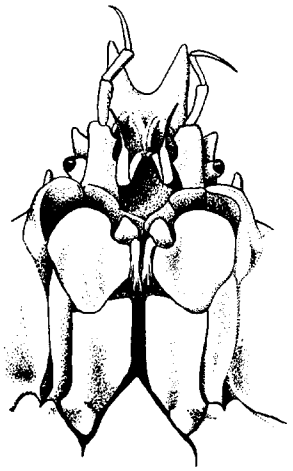
Chelipeds of adult male robust, merus trigonal, carpus rounded with an internal crest, manus crisply carinate above and below, dactyls gaping for basal two-fifths, a tooth in gape, meeting for distal three-fifths, edges denticulate. Chelipeds of female no more robust than other legs and shorter than any of them; fingers considerably shorter than palm. Walking legs cylindrical, slender, hairy, those of first pair longest, others diminishing regularly in

Plate II

Lophorochinia parabranchia *Garth*
(Figs. 1, 3, 5 of female holotype)

1. *Dorsal view*
2. *Outer view of male cheliped*
3. *Ventral view of frontal region*
4. *Male abdomen*
5. *Female abdomen*
6. *Male first pleopod*

(Drawn by Carl Petterson)

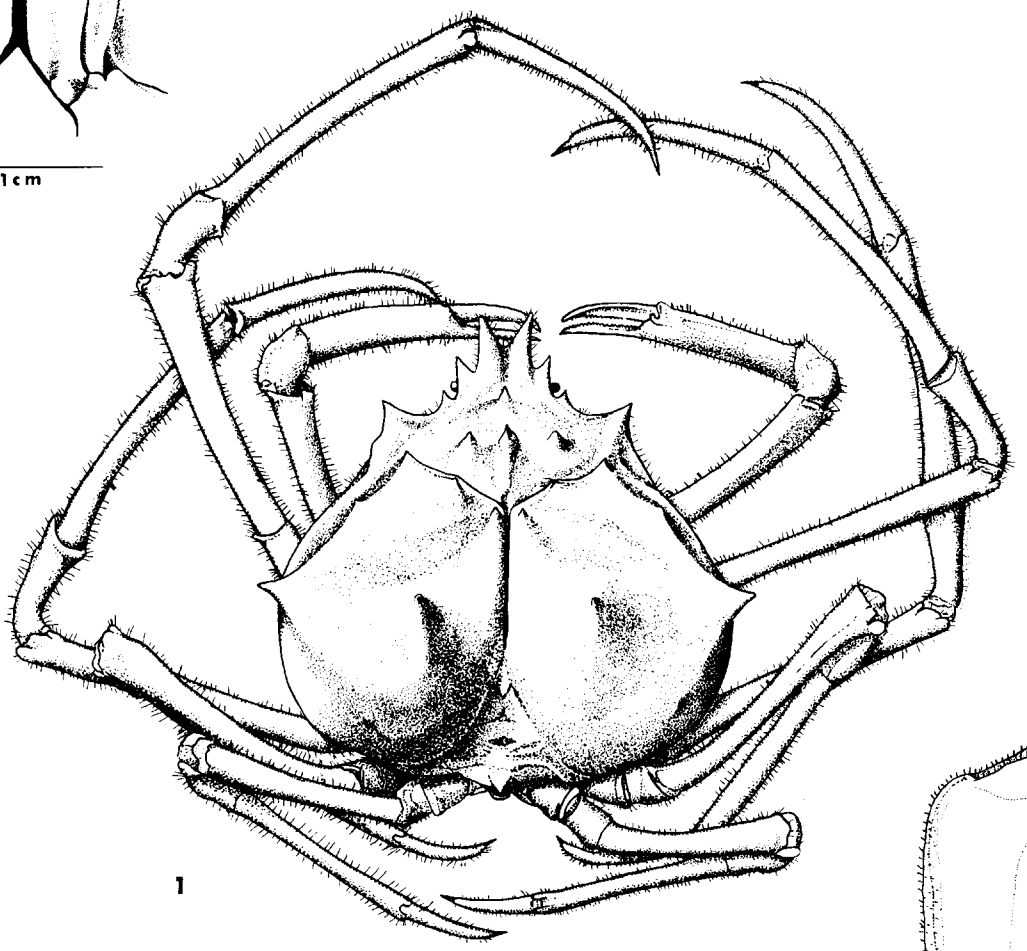


3

1 cm

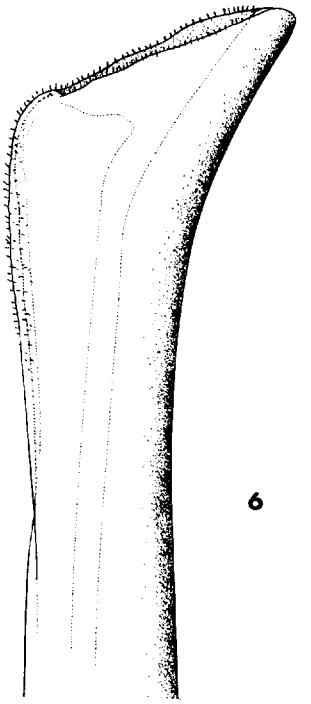
1 cm

2



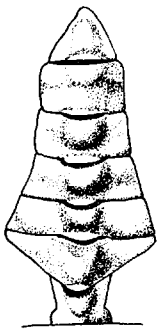
1

1 cm



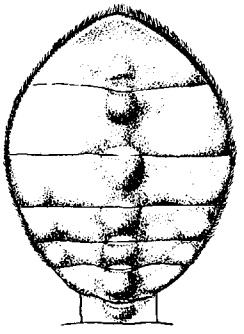
6

.5 mm



4

1 cm



5

1 cm

length. Dactyls of first pair three-fourths as long, of second pair two-thirds as long, as their respective propodi; dactyls of third and fourth legs much shorter.

Abdomen of both sexes with seven segments; degree of fusion, if any, difficult to ascertain because of thinness and flexibility of the integument.

Male first pleopod slender, flaring distally, and opening terminally between blunted keel and pointed tip.

Remarks: The largest male with chelipeds attached has the cheliped less than half as long as the first walking leg and slightly shorter than the last walking leg. From detached chelipeds present among dismembered males, it is apparent that this member becomes enlarged and elongated in mature specimens. Because of the impossibility of determining to which of several males a particular cheliped belonged, comparative leg lengths are given for the female only. For the same reason a female, rather than an adult male, has been designated holotype.

Range: From off Callao, Peru, to off Pta. Patache, S. of Iquique, Chile. Depth 282 to 509 m.

Superfamily CORYSTOIDEA
Family ATELECYCLIDAE
Trachycarcinus corallinus Faxon

Trachycarcinus corallinus Faxon 1893, p. 156; 1895, p. 26, Pl. A. Rathbun 1898b, p. 599; 1930, p. 165, Pl. 72. Not *T. corallinus,* Balss 1922, p. 99 (= *T. balssi* Rathbun 1930, p. 165).

Material: Off Peru, 7° 58′ S., 80° 37′ W., ANTON BRUUN Sta. 88 (5-ft beam trawl), October 14, 1965, 1,005 to 1,124 m, 1 ovigerous female.

Measurements: Ovigerous female, length 18.6 mm, width 20.0 mm.

Remarks: The single female carried 127 eggs, from 1.3 to 1.5 mm diameter, attached to her pleopods. The relatively large size of eggs of deep-sea decapod Crustacea was noted by Faxon (1895, p. 250), with the inference that in such cases the young leave the egg in an advanced stage of development.

Range: From off Acapulco, Mexico, to W. of Punta Mariato, Panama; off Chatham Island, Galapagos Islands. Depth 546 to 695 fms (834 to 1,280 m). This record extends the range of the species 7° S. of the Equator from the Galapagos Islands, which are in turn 7° S. of the Bay of Panama localities (cf. Rathbun 1930, p. 166, table), a total latitudinal distance of 840 nautical miles.

Trachycarcinus hystricosus Garth, n. sp.
(Plate III, Figs. 1-5)

Type: Female holotype, AHF No. 6510, from off Peru, 11° 50′ S., 77° 58′ W., ANTON BRUUN Sta. 144 (5-ft beam trawl), October 26, 1965, 935 to 907 m.

Measurements: Female holotype, length of carapace 19.7 mm, length to base of rostrum 18.0 mm, width of carapace 22.0 mm, width at base of third anterolateral spine 18.0 mm, exorbital width 12.8 mm, frontal width 4.9 mm, length of chela 9.8 mm, of dactyl 6.0 mm, height of palm 4.0 mm.

Diagnosis: Longer spines of carapace distributed over entire dorsal surface. Lateral spines curving strongly forward and upward. Orbital spines as robust as frontal spines. Merus of external maxilliped subquadrate.

Description: Carapace pentagonal, anterolateral margins arcuate, exceeding posterolateral, surface densely covered with clavate setae, regions well delimited, each marked by one or more conical to spinate tubercules surmounted by longer setae. Front tridentate, teeth spinate, median tooth less advanced than outer pair and inclined downward at an angle to them. Internal and external orbital spines of similar size to outer frontals and inclined toward one another, a minute, naked spinule between; a similar but slightly larger infraorbital spine visible dorsally internal to it. Eye of good size, retractile, cornea faintly and uniformly pigmented. Four lateral marginal spines (including orbital), equally spaced, curving forward and upward; carapace widest opposite third spine, fourth spine smallest in size, posterolateral in position. Principal carapace spines disposed as follows: four in a line with second anterolateral spine or slightly in advance of it; five in a line with the hiatus between second and third anterolateral spines, the median the anterior of two mesogastric spines; four in a line with the hiatus between third and fourth anterolateral spines, the median pair the cardiac; numerous lesser spines, including one on or just inside posterolateral border.

External maxilliped with merus as broad as long, anteroexternal angle rounded, anterointernal angle obliquely truncate, bearing a few spinulous granules below insertion of coarse palp.

Chelipeds of female (left missing) presumed subequal, small, although not feeble, merus with three spines visible at side of carapace arranged in a triangle with base anterior; carpus with 11 spines arranged in transverse rows increasing in width distally, a prominent spine at inner angle; manus with seven or eight superior spines in linear arrangement, outer surface, as that of merus and carpus, densely felted with vesicular setae; of the longer hairs, one typically arising from near base of each spine. Fingers longer than palm, hairy to tips, meeting without gape, edges denticulate, tips crossing, pollex deflexed. Walking legs moderately long,

Rathbun, Mary J. 1904. Decapod crustaceans of the northwest coast of North America. Harriman Alaska Exped., 10: 1-210.

Rathbun, Mary J. 1906. The Brachyura and Macrura of the Hawaiian Islands. U. S. Fish Comm., Bull. 23 (for 1903): 829-930.

Rathbun, Mary J. 1910. The stalk-eyed Crustacea of Peru and the adjacent coast. Proc. U. S. Nat. Mus., 38: 531-620.

Rathbun, Mary J. 1930. The cancroid crabs of America of the families Euryalidae, Portunidae, Atelecyclidae, Cancridae, and Xanthidae. U. S. Nat. Mus., Bull. 152: xvi + 1-609.

Rathbun, Mary J. 1933. Preliminary descriptions of nine new species of oxystomatous and allied crabs. Proc. Biol. Soc. Washington, 46: 183-186.

Rathbun, Mary J. 1937. The oxystomatous and allied crabs of America. U. S. Nat. Mus., Bull. 166: vi + 1-278.

Schmitt, W. L. 1921. The marine decapod Crustacea of California. Univ. California Pubs. Zool., 23: 1-470.

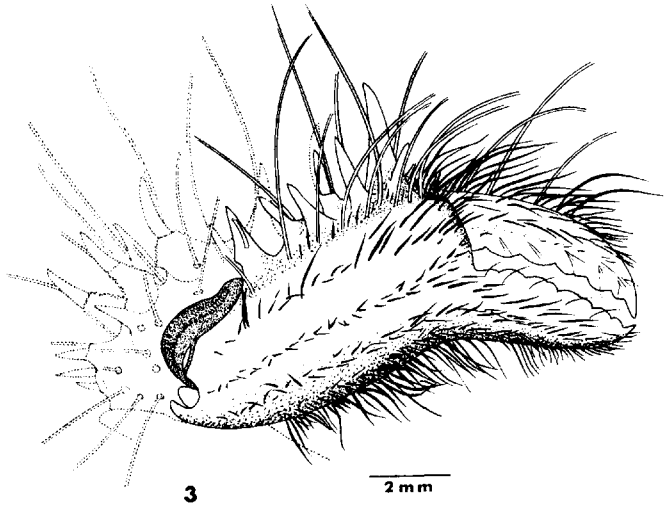
Stimpson, W. 1859. Notes on North American Crustacea, No. 1. Ann. Lyc. Nat. Hist. New York, 7: 49-93.

Wolff, T. 1960. Strejflys over dybhavets dyreliv. Naturens Verden [Copenhagen], June 1960: 161-191.

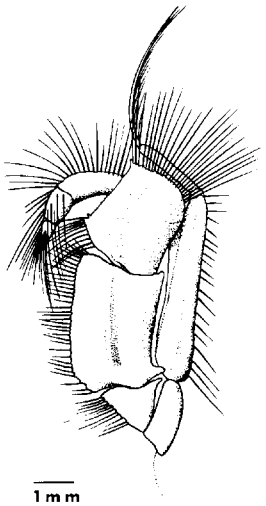
Wolff, T. 1961a. Description of a remarkable deep-sea hermit crab, with notes on the evolution of the Paguridea. Galathea Rep., 4: 11-32.

Wolff, T. 1961b. Animal life from a single abyssal trawling. Galathea Rep., 5: 129-162.

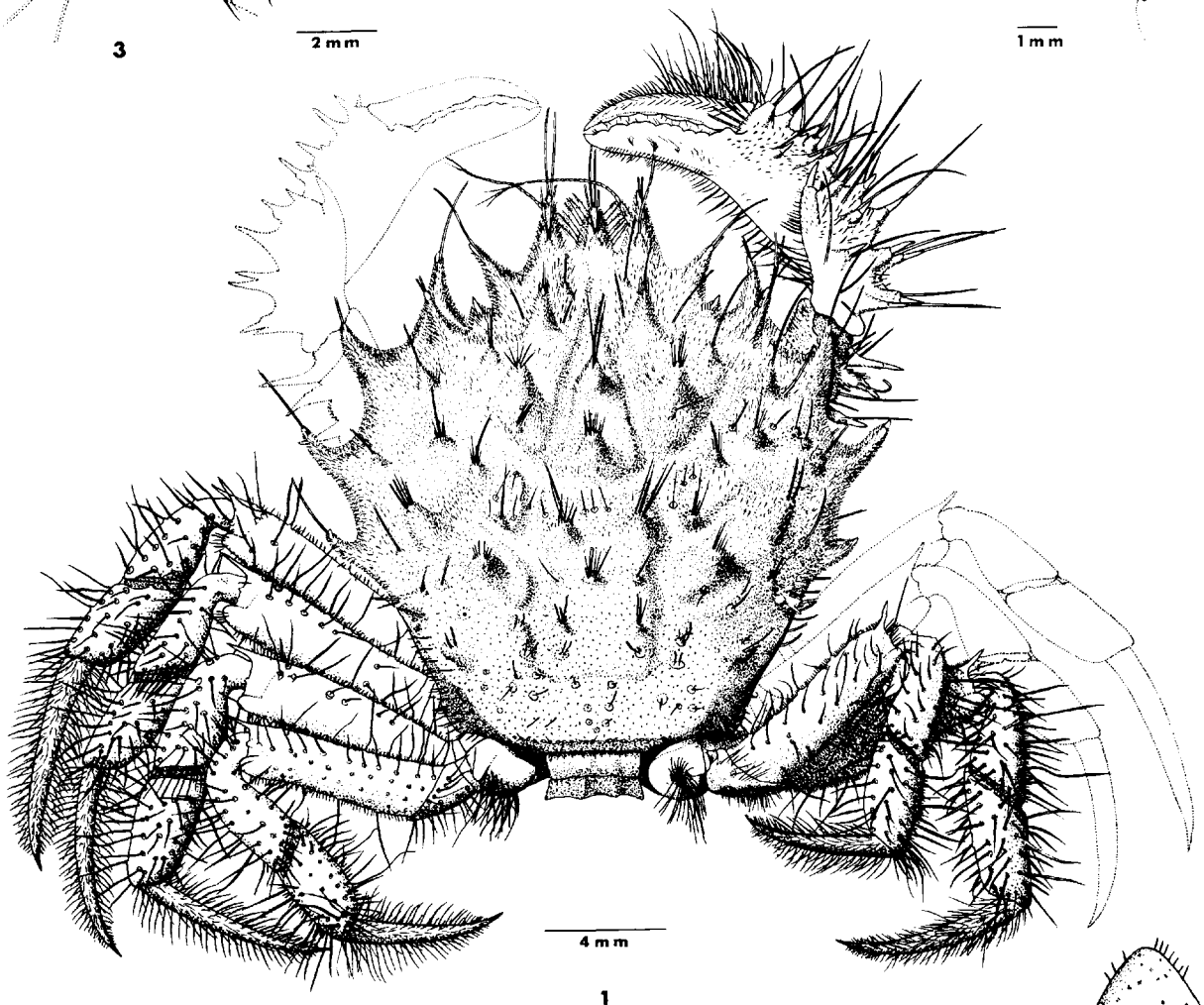
Wood-Mason, J., and A. Alcock 1891. Natural history notes from H. M. Indian Marine Survey steamer "Investigator" . . . No. 21. Note on the results of the last season's deep-sea dredging. Ann. Mag. Nat. Hist., (6) 7: 258-272.



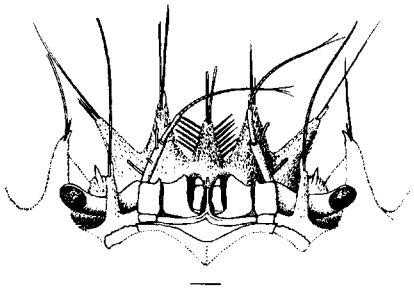
3



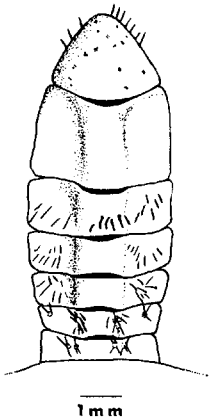
4



1



2



5

Plate III

Trachycarcinus hystricosus *Garth*
Female Holotype

1. *Dorsal view of entire crab*
2. *Ventral view of front*
3. *Outer view of right cheliped*
4. *Left external maxilliped*
5. *Abdomen*

(Drawn by Carl Petterson)

Table 1. Vertical zonation of Anomura and Brachyura, Peru-Chile Trench.

Northern Transect (08° S)				Southern Transect (12° S)			
Sta.	Temp. (°C)	Depth (m) Actual	Approx.	Actual	Temp. (°C)	Sta.	
79	7.8	507	500	509-469	8.1	140	*Lophorochinia parabranchia*
88	4.7	1005-1124	1000	935-907	4.5	144	*Trachycarcinus hystricosus* *Munida propinqua* *Munidopsis hystrix* *Munidopsis scabra*
103	2.3	1887-1934	2000	1960-1932	2.25	159	
111	1.8	3086-3202	3000	-		-	
168	1.8	3969	4000	3995-3869	1.8	154	*Ethusina faxonii* *Probeebei mirabilis*
169	1.8	3909-3970	4000				

Trachycarcinus corallinus
Cymonomus menziesi
Ethusina robusta
Ethusina faxonii
Ethusina faxonii
Parapagurus abyssorum

cylindrical, pubescent, a spine at distal end of merus, carpus and propodus with rows of hair-tipped tubercles. Dactyli long, straight, slender, exceeding propodi, and tipped with a short, incurving nail.

Abdomen of female seven-segmented, segments distinct; sixth segment longer than preceding segments or terminal segment. Male sex not known.

Remarks: The proposed new species is the eastern Pacific counterpart of the western Atlantic *Trachycarcinus spinulifer* Rathbun (1898a, p. 278, Pl. 6, Fig. 1), from which it differs in having the longer spines of the carapace distributed over the dorsal surface instead of restricted to the anterolateral and posterolateral margins, the lateral spines strongly curving forward and upward instead of straight, horizontal, and directed backward, and the orbital spines as robust as the frontal, instead of slender and spinulous.

At least six species of the genus *Trachycarcinus* are now known. Of these, three are Asiatic: *T. glaucus* Alcock and Anderson, Travancore coast of India; *T. balssi* Rathbun and *T. sagamiensis* Rathbun, Japan. The other three are American: *T. corallinus* Faxon and *T. hystricosus,* new species, W. coast; and *T. spinulifer* Rathbun, E. coast. The last differs from the rest (except possibly *T. hystricosus,* in which the male is unknown) in having the chelipeds of the male of equal size, rather than grossly disproportionate. If the male of *T. hystricosus,* when discovered, proves to have subequal chelipeds also, it would appear that this character, plus the spinulosity shown by both, might be sufficient basis for withdrawing these two species, one Atlantic and one Pacific, from *Trachycarcinus* and erecting a new genus to accommodate them. *Trachycarcinus* would then be restricted to species like the type species, *T. corallinus,* having the chelipeds dissimilar in the male and the carapace granulate rather than spinulate.

Vertical Distribution

Although the vertical zonation of the ANTON BRUUN Cruise 11 decapod crustaceans has been compared with that of the ALBATROSS deep-sea decapods in the introduction, an analysis of the BRUUN collections is warranted based on concepts of zonation developed subsequent to Faxon (1895), whose sole criterion was depth. In more recent studies, such as Bruun (1957), increasing attention is given to temperature in defining zonal limits, with the realization that at a given latitude temperature is a factor of depth, decreasing as depth increases except under special circumstances, as in ocean basins, where temperature remains constant below sill depth. In an open ocean situation, therefore, and in a transect made perpendicular to a N.-S. trending coastline, depth may still be used as an empirical indicator of temperature change that controls zonation, rather than as a cause of zonation *per se.*

On Cruise 11 two transects were made of the Milne Edwards Deep, a northern transect between 7° 57′ S., 80° 32′ W., and 8° 26′ S., 81° 37.5′ W., and a southern transect between 11° 50′ S., 77° 51′ W., and 12° 00′ S., 77° 46′ W. Of these, the northern transect was the more extensively sampled, with Menzies trawl and beam-trawl stations at 500-m intervals to maximum depth of 6,400 m, accompanied by use of Campbell grab, Phleger corer, and multi-exposure camera. Stations at which anomuran and brachyuran crustaceans were collected were those corresponding to depths of 1,000, 2,000, 3,000, and 4,000 m, none having been obtained from stations corresponding to 500, 1,500, 2,500, and 3,500 m, or from stations below 4,000 m. As a result, the distribution of crabs is stratified neatly according to 1,000-m intervals, the only species to occur at more than one level being *Ethusina faxonii,* which was found at both 3,000-m and 4,000-m depths (Table 1).

Sampling on the southern transect was less extensive in that while beam trawling was done at 500-m intervals, the 1,500-m and 3,000-m stations were eliminated, as were Menzies trawls (except one at 4,000 m), Campbell grabs, and Phleger corers. Photographic coverage, however, was complete with 10 multi-exposure camera stations to 4,000 m. Stations at which anomuran and brachyuran crustaceans were collected correspond to 500, 1,000, and 4,000 m, there being no decapods from the 2,000-m station and no station with which to compare the 3,000-m station of the northern transect. Apart from this unfortunate discontinuity, however, the results are strictly comparable. At the 500-m level, which in the northern transect was devoid of crabs, the remarkable new genus and species of spider crab, *Lophorochinia parabranchia,* was encountered. At the 1,000-m level, which in the northern transect was occupied by *Trachycarcinus corallinus,* a new species of *Trachycarcinus, T. hystricosus,* was discovered. Although there were no *Cymonomus menziesi* at this level, as in the northern transect, three species of galatheids, two of them *Munidopsis,* were found. Since trawls made by the BRUUN at 2,000 and 2,500 m failed to capture any galatheids, the statement by Faxon (1895, p. 241) that *Munidopsis* are deep-water species that overlap in the mid-water belt cannot be confirmed. Finally, at 4,000 m *Ethusina faxonii* was again encountered, while the anomuran present proved to be not *Parapagurus abyssorum* of the northern transect, but *Probeebei mirabilis* of ARCTURUS and GALATHEA fame.

When temperatures are fitted to these approximate depths, the stratification becomes even more apparent. The 500-m depth occupied by *Lophorochinia* has a temperature of approximately 8.1° C (Menzies and Chin 1966, Sta. 185, Hydrocast 521). The 1,000-m depth occupied by *Trachycarcinus* and *Cymonomus* has a temperature of about 4.7° C (Menzies and Chin 1966, Fig. 5). At the 2,000-m depth, where *Ethusina robusta* occurs, the temperature is about 2.3° C, and at 3,000 m and below, where *Ethusina faxonii, Parapagurus abyssorum,* and *Probeebei* occur, the temperature drops to 1.8° C. The constancy of temperature below 3,000 m (2,500 m on the bottom profile) in the Milne Edwards Deep suggests the basin effect mentioned above, and implies a closed system in its lower portion. Using 10° C as the lower limit of the upper warm-water masses, the thermosphere (Bruun 1955, p. 66), it is apparent that all ANTON BRUUN Cruise 11 decapod crustaceans, except the single glaucothoe of *Dardanus sinistripes,* which was probably netted near the surface, were collected in the deeper, cold-water masses, the psychrosphere, of the lower ocean latitudes. Applying a second suggested temperature, 4° C, to limit the bathyal from the abyssal, it is apparent that *Trachycarcinus* and *Cymonomus* are bathyal, whereas *Ethusina, Parapagurus,* and (among BRUUN and GALATHEA collections) (Wolff 1961b) *Probeebei* are abyssal. The unique position occupied by *Lophorochinia* is best discussed in relation to oxygen content rather than to temperature.

Even more revealing than temperature data are data on dissolved oxygen obtained by the ANTON BRUUN. It is clearly established that oxygen content decreases with depth to a certain level, known as the oxygen-minimum layer, then increases again as depth increases. Animals either avoid the oxygen-minimum layer entirely, migrate through it dielly, or develop compensating mechanisms that enable them to remain there permanently. ANTON BRUUN Sta. 185, Hydrocast 521 (Menzies and Chin 1966), shows an oxygen minimum of 0.16 ml/liter at both 300 and 400 m and an oxygen content of not more than 0.17 ml/liter between 250 and 500 m. Sta. 185 was the hydrographic station that accompanied beam-trawl Sta. 140 (Menzies and Chin 1966, Table 2), at which the remarkable new genus and species of spider crab, *Lophorochinia parabranchia,* was encountered at a depth of 469 to 509 m.

The greatly swollen gill chambers and enlarged excurrent openings of this crab, the latter controlled by opercular outer maxillipeds, would appear to be unusual adaptations that enable it to move into an otherwise depauperate area and dominate it, to the apparent exclusion of other organisms. The relatively large size of *Lophorochinia,* as compared to other deep-water decapods obtained by ANTON BRUUN Cruise 11, as well as its abundance whenever collected, testify to its success in this demanding environment. According to Frankenberg and Menzies (1968, p. 626): "The benthic fauna in the region of the oxygen minimum zone off Peru is composed of many individuals of a few taxa, suggesting that those species which can tolerate the low oxygen content of the environment attain high densities due to the abundance of food in the bottom sediments. The benthic fauna [at Sta. 21 at a depth of 126 m near the upper limit of the oxygen minimum zone] was dominated by large numbers (2273/m^2) of small cirratulid polychaetes which made up 95.8 percent of the fauna collected. The characteristically complex respiratory structures of cirratulids suggests that these organisms are well adapted to exist under low oxygen conditions."

According to Gallardo (1963, p. 5, Table I; p. 14), data for MAR CHILE II Sta. 45, 20° 48′ S., 70° 21′ W., off Punta Patache, Chile, at which *Lophorochinia parabranchia* was also taken, show an oxygen minimum of only 0.11 ml/liter at 282 m, with 120 brachyurans, two polychaetes, and one lamellibranch collected in the triangular dredge, none in

the Petersen grab. Indeed, according to the English summary (Gallardo 1963, p. 11): "Standard benthic sampling carried out during the MAR CHILE II Expedition to the north of Chile (July, 1962) revealed unusually low standing crops of benthic macrofauna correspondent with very low oxygen concentrations of the Gunther Current."

Reduced vision as a concomitant of increasing depth is well demonstrated by ANTON BRUUN Cruise 11 decapods. Of the new species, *Lophorochinia parabranchia,* from a depth of 469 to 509 m, and *Trachycarcinus hystricosus,* from a depth of 907 to 935 m, are sighted (eyed), as is the previously known *T. corallinus,* from a depth of 1,005 to 1,124 m, although the eyes of both *Trachycarcinus* species are small and faintly pigmented. *Cymonomus menziesi,* also from a depth of 1,005 to 1,124 m, is sightless, the long, movable eyestalk terminating without a vestige of a cornea. The *Munidopsis* species, *M. hystrix* and *M. scabra,* from a depth of 907 to 935 m, are also sightless, suggesting that of these borderline species (as between bathyal and abyssal), *Trachycarcinus* is derived from the upper, lighted zone, *Cymonomus* and *Munidopsis* from the lower, lightless zone. The *Ethusina* species, *E. robusta,* from a depth of 1,887 to 1,934 m, and *E. faxonii,* from a depth of 3,086 to 3,995 m, have tiny eyes, borne on immovable eyestalks, but pigmented. Like other pagurids, *Probeebei mirabilis* and *Parapagurus abyssorum,* both from depths of 3,869 to 3,995 m, have the eyes apparently unmodified, although at these depths they must be useless.

Evidence for tropical submergence (or for its opposite, polar emergence) is found when depths at which ANTON BRUUN decapods were collected are compared with depths at which the same species were collected by the MAR CHILE II to the south (Gallardo 1963) and by the ALBATROSS to the north (Faxon 1895). *Lophorochinia parabranchia,* trawled by the BRUUN at a depth of 509 to 469 m off Peru at 11° 52′ S. lat., was dredged by MAR CHILE II at a depth of only 282 m off northern Chile at 20° 48′ S. lat., showing a rate of emergence poleward of approximately 26 m per degree of latitude. *Munidopsis hystrix,* trawled by the BRUUN at a depth of 907 to 939 m off Peru at 11° 50′ S. lat., was obtained by the ALBATROSS at a depth of 901 m off Acapulco, Mexico, at 16° 32′ N. lat. and at a depth of 1,236 to 1,243 m off Tres Marias Islands, Mexico, at 21° 15′ N. lat. Unpublished AHF records of 731 m in the Gulf of California and of 417 to 804 m off southern California display polar emergence more strongly to the north than to the south. *Munidopsis scabra,* also trawled by the BRUUN at a depth of 907 to 935 m off Peru at 11° 50′ S. lat., was obtained by the ALBATROSS at a depth of 1,236 to 1,243 m off Tres Marias Islands, Mexico, at 21° 15′ N. lat. *Ethusina robusta,* trawled by the BRUUN at a depth of 1,887 to 1,934 m off Peru at 8° 16′ S. lat., was obtained by the ALBATROSS (as *E. gracilis*) at a depth of 1,322 fms (2,379 m) on the Equator at 0° 36′ S. lat., showing a rate of equatorial submergence of approximately 58 m per degree of latitude. On the other hand, *Trachycarcinus corallinus,* trawled by the BRUUN at a depth of 1,005 to 1,124 m off Peru at 7° 58′ S. lat., was obtained by the ALBATROSS at a depth of 634 fms (1,141 m) on the Equator at 0° 36′ S. lat., at depths of 546 fms (983 m) and 695 fms (1,251 m) off Panama at 7° 09′ and 7° 06′ N. lat., and at a depth of 660 fms (1,188 m) off Acapulco, Mexico, at 16° 33′ N. lat., showing only slight equatorial submergence and polar emergence.

Horizontal Distribution

The horizontal distribution of deep-sea decapod crustaceans is discontinuous and depends on the discontinuities of the deep ocean basins, which are separated not only by the continents, as are the littoral marine provinces, but also by their shelves and slopes. These may be broad and include offlying islands, as off SE Asia, or narrow and sloping abruptly to the abyssal plain. Where the continental slope broadens, it may include deep basins, as off southern California. Where it slopes abruptly, it may be folded to encompass one or more deep trenches parallel to shore. The ridges separating such trenches from the open ocean may be regarded as submerged extensions of the continental cordilleras, the trenches themselves as drowned valleys: in the case of the Peru-Chile Trench off South America, of which the Milne Edwards Deep is a part, as a drowned valley of the Andean Chain.

Just as the Andes have their continuation northward into the Rockies of North America, separated by near sea-level gaps across the Isthmus of Panama, so has the Peru-Chile Trench system its northern continuation into the Middle American Trench system, of which the Costa Rican and Acapulco deeps are part, separated by extensive regions of abyssal plain. And just as alpine animals once able to migrate freely along the Cordillera are now restricted to its isolated peaks, their slopes and intervening highlands, so are bathyal and abyssal animals that once enjoyed continuous ranges in the eastern Pacific now restricted to its isolated deeper basins, their adjacent continental slopes and/or abyssal rises. In the case of benthic marine animals, like decapod crustaceans, in which the early stages, where known, are pelagic, only the sedentary adults would appear restricted for life to the basin or plain on which they settle. Their larvae may be transported from basin to basin or from rise to rise by powerful undercurrents that frequently travel in directions opposite to the surface currents

with which the littoral marine zoogeographer customarily deals. The degree of endemicity within each basin or upon each rise therefore would appear to depend on whether one is dealing with a closed circulatory system, with little or no overturn below sill depth, or with an open system, with sufficient overturn to permit transport of plankters by overriding undercurrents.

In the case of deep-sea decapods, the early stages of which are incompletely, if at all, known, there is another possibility to account for restricted dispersal. The large size of the eggs carried by females of ANTON BRUUN specimens was observed by both of us (Garth and Haig) independently. The smaller female of *Munidopsis scabra* had seven large eggs with a diameter of approximately 1.2 mm each attached to the pleopods. The single female of *Trachycarcinus corallinus* carried 127 eggs of from 1.3 to 1.5-mm diameter. These are smaller clutches of larger eggs than would be carried by related littoral species of these latitudes, suggesting an abbreviated larval stage with minimum exposure to pelagic dispersal. Analogy with egg-size of decapods from Arctic and Antarctic regions, where similar conditions to those of the deep sea prevail, supports such a suggestion.

The endemicity, if it can be established, will be of two different levels: an endemicity of species restricted to a single basin or trench system, such as the Peru-Chile, or an endemicity of species common to the basins and trenches of the entire eastern Pacific, together with adjacent continental slopes and abyssal rises. If the first level of endemicity prevails, related species of the same genera will be sought in other trenches of the eastern Pacific, such as the Middle American. If the second level of endemicity prevails, related species of the same genera will be sought in the trenches of the western Atlantic or in the basins and trenches of seas adjacent to other continents. It is here that comparative studies assume importance: for the eastern Pacific with the decapods of the ALBATROSS and ARCTURUS expeditions; for the western Atlantic with the ALBATROSS and BLAKE expeditions; and for the western Pacific and Indian oceans with the CHALLENGER and INVESTIGATOR expeditions and other deep-water surveys.

The merit of the ANTON BRUUN collections is that they provide information on the distribution of animal life from the shelf to hadal depths in an orderly sequence of sampling. "It is probable that no other world trench has been as thoroughly sampled at such a depth sequence." (Menzies and Chin 1966, p. 4). Yet the representation of decapods is meager, consisting in the majority of species (three out of five anomurans; four out of six brachyurans) of but a single specimen. This is probably due to the small types of gear used by the BRUUN as opposed to the large beam trawl used by the ALBATROSS and the otter trawl employed by the GALATHEA. Yet if this be the result of an orderly plan of operation, how much less representative must be the samplings obtained from trenches in which the collecting has been random or unplanned?

Granted that all deep-water benthic sampling conducted to date leaves much to be desired by way of completeness, much can be learned nonetheless from an attempted faunal comparison.

Among the anomurans, the monotypic pagurid, *Probeebei mirabilis,* occurs in both the Peru-Chile and Middle American trenches, but apparently is restricted to the eastern Pacific. *Parapagurus abyssorum* occurs in both Peru-Chile and Middle America trenches, in the Atlantic, the western Pacific, and Indian oceans. The genus *Parapagurus* is currently under review, and it is not known whether *P. abyssorum* will remain a cosmopolitan species. *Munida propinqua* occurs in both Peru-Chile and Middle America trenches. It is closely related to *M. curvipes,* also of the Peru-Chile Trench, and to a series of similar but evidently distinct species in various deeps around the world.

Among the brachyurans, the genus *Cymonomus* occurs in the western Atlantic, the western Pacific and Indian oceans, and, with the discovery of *C. menziesi,* in the eastern Pacific. Its closest relative appears to be *C. quadratus* of the western Atlantic; certainly it belongs to the *quadratus* group in which the eyestalks exceed the rostrum. Some authors (cf. Ihle 1916) go so far as to consider the Indian Ocean and East Indian *C. valdiviae* and *C. andamanicus* as but subspecies of the Caribbean *C. quadratus.* Such a view tends to minimize the isolating effect of the deep basins leading to endemicity of species inhabiting them. In such a context, *C. menziesi* would also be considered a subspecies of *C. quadratus,* rather than a coordinate member of a species group. It should be stated that there is as yet no eastern Pacific representative of the *C. granulatus* group, to which *C. indicus, C. japonicus,* and *C. curvirostris* are similarly related.

The status of the eastern Pacific representative of *Ethusina challengeri* of the western Pacific (Japan Seas) was settled forthrightly by Rathbun (1933), who accorded it specific status under the name of *E. faxonii.* The most common brachyuran among ANTON BRUUN collections (if the dorippids are brachyurans and if three captures makes a species common), *E. faxonii* also occurs in the Middle America Trench off W. Mexico (Faxon 1895, as *E. challengeri?*) and in the southeastern part of the

Gulf of California (Garth 1960). No regional differences have been detected. Eventually the status of the eastern Pacific species referred to by both Faxon (1895) and Rathbun (1906, 1937) as *Ethusina gracilipes* of the western Pacific (Philippine Islands) will perhaps be decided similarly; however, its closer similarity to *E. gracilipes* var. *robusta* (Banda and Arafura seas) causes it to be referred to Miers' variety, here elevated to a full species, with the suggestion that *E. gracilipes* belongs in *Ethusa*. *Ethusina* is represented in the Caribbean by *E. abyssicola*, a species that has as its counterpart the eastern Pacific *E. smithiana*, a species not encountered by the ANTON BRUUN.

The new genus and species of majid crab, *Lophorochinia parabranchia*, appears to be a Peru-Chile Trench endemic. Its discovery off northern Chile by the MAR CHILE II in an oxygen-depleted zone characteristic of the Gunther Current (an undercurrent of warmer water flowing in the opposite direction below the Peru or Humboldt Current) suggests at once the cause of its unique specialization and the course of its migration from near the Galapagos Islands, where *Rochinia occidentalis*, the most nearly related species from which it might have been derived, is found. Its superficial resemblance to *Encephaloides armstrongi* of the Indian Ocean (Alcock and Anderson 1896, Pl. 19, Figs. 2 and 2a), a member of the Inachinae, is considered a matter of convergence.

Trachycarcinus corallinus, like *Ethusina faxonii*, also occurs off western Mexico, but has not been reported from the Gulf of California to date. It is found at suitable depths off Panama and the Galapagos Islands, so that its extension to waters off Peru is not unexpected. A wide variation in the coral-like encrustations of the carapace is sufficient to include within the species individuals from all eastern Pacific localities: not, however, to include the western Pacific *T. corallinus* of Balss (Japan), now known as *T. balssi* Rathbun (1930, p. 165). The new species of *Trachycarcinus*, *T. hystricosus*, represents the eastern Pacific analogue of the western Atlantic *T. spinulifer*, which it resembles both in spinulosity and hairiness. If, when the male becomes known, the chelipeds of *T. hystricosus* prove to be of equal size rather than grossly disproportionate, the two might justifiably be withdrawn from *Trachycarcinus* as a separate genus of atelecyclid crabs.

In summary, five kinds of distributional relationships representing varying degrees of endemicity have been found among anomuran and brachyuran crabs of the ANTON BRUUN Cruise 11: (1) A genus and species probably endemic to the Peru-Chile Trench system: *Lophorochinia parabranchia;* (2) A genus and species or species common to the Peru-Chile Trench and other deeps or rises of the eastern Pacific: *Probeebei mirabilis; Ethusina faxonii, Trachycarcinus corallinus;* (3) Species occurring in the Peru-Chile Trench (and possibly elsewhere in the eastern Pacific) with the most closely related species in the western Atlantic: *Cymonomus menziesi, Trachycarcinus hystricosus;* (4) Species occurring in the Peru-Chile Trench either identical to western Pacific species or most closely related to them: *Ethusina robusta;* (5) Species occurring in the Peru-Chile Trench and in the western Atlantic, western Pacific, and Indian oceans: *Parapagurus abyssorum; Cymonomus quadratus* (if *C. menziesi* be considered a subspecies).

Finally, when an attempt is made to relate horizontal distribution with vertical distribution, it is found that of the two genera endemic to the eastern Pacific, the more restricted, *Lophorochinia*, is upper bathyal, the less restricted, *Probeebei*, is abyssal; while of the several species endemic to the eastern Pacific, the more restricted, *Cymonomus menziesi, Trachycarcinus hystricosus*, and *T. corallinus*, are lower bathyal, the more widely ranging, *Ethusina faxonii*, is abyssal. *Parapagurus abyssorum*, the species of world-wide distribution, is also abyssal. The more restricted distribution of bathyal than of abyssal species is in good agreement with several previous observations, notably those of Madsen (1961, p. 203) concerning the Porcellanasteridae: "It has been amply proved in the course of the exploration of the deep-sea that the fauna of the more moderate depths, the bathyal fauna, has to be distinguished into a number of different zoogeographical divisions. . . . A cosmopolitan distribution is undoubtedly the general rule for all truly abyssal genera; the exceptions are few, considering how scanty the exploration of the deep-sea still is . . ." But, if we postulate that endemicity decreases with depth, with the most highly endemic species occupying the upper zones, the most widely distributed the lower zones, it would seem that the position of the two *Ethusina* species should be reversed, with *E. robusta*, found also in the western Pacific, occurring below *E. faxonii*, found only in the eastern Pacific, rather than above it. It will have been noted, however, that *E. faxonii* was first identified as *E. challengeri* of the Philippines, while it is by no means certain that *E. robusta* of the Peru-Chile Trench is identical with *E. robusta* of the Arafura Sea. Thus distributional criteria may be applied to test taxonomic conclusions otherwise derived and often may suggest, as in this case, that the last word has not been said.

Two other thoughts occur, of possible value to taxonomists as well as zoogeographers: (1) of the two genera apparently endemic to the eastern

Pacific trenches and basins, the abyssal genus, *Probeebei,* is much more likely to be found in trenches and basins of other seas than the upper bathyal genus, *Lophorochinia;* (2) the tendency toward separating species found in both eastern and western Pacific oceans (*Trachycarcinus balssi* from *T. corallinus*; *Ethusina faxonii* from *E. challengeri*) is probably more justified in the case of bathyal than abyssal species, and, conversely, the tendency toward combining deep-water species found in different oceans (*Cymonomus quadratus* with *C. valdiviae, C. andamanicus,* and possibly *C. menziesi*) is probably more justified in the case of abyssal than bathyal species, other considerations, such as degree of morphological difference, being equal.

References

Agassiz, A. 1892. Reports on the dredging operations off the west coast of Central America to the Galapagos, to the west coast of Mexico, and in the Gulf of California . . . by the U. S. Fish Commission steamer "Albatross," . . . II. General sketch of the expedition of the "Albatross," from February to May, 1891. Bull. Mus. Comp. Zool. Harvard, 23 (1):1-89.

Alcock, A., and A. R. Anderson 1894. Natural history notes from H. M. Indian Marine Survey steamer "Investigator" . . . No. 14. An account of a recent collection of deep sea Crustacea from the Bay of Bengal and Laccadive Sea. J. Asiat. Soc. Bengal, 63: 141-185.

Alcock, A., and A. R. Anderson 1896. Crustacea. *In* Illustrations of the zoology of the Royal Indian marine surveying steamer Investigator . . . Part 4. Calcutta.

Balss, H. 1922. Ostasiatische Decapoden. IV. Die Brachyrhynchen (Cancridea). Arch. für Naturg., 88A (11): 94-166.

Benedict, J. E. 1902. Descriptions of a new genus and forty-six new species of crustaceans of the family Galatheidae, with a list of the known marine species. Proc. U. S. Nat. Mus., 26: 243-334.

Boone, Lee 1926. A new family of Crustacea. Preliminary technical description. Zool. Soc. Bull. [New York]: 73.

Bruun, A. F. 1955. New light on the biology of *Spirula,* a mesopelagic cephalopod, p. 61-72. *In* Essays in the Natural Sciences in Honor of Captain Allan Hancock. Univ. S. Calif. Press, Los Angeles.

Bruun, A. F. 1957. Deep sea and abyssal depths, p. 641-672. *In* J. Hedgpeth [ed.], Treatise on Marine Ecology and Paleoecology, Vol. 1, Geol. Soc. Amer., Mem. 67.

Faxon, W. 1893. Reports on the dredging operations off the west coast of Central America to the Galapagos, to the west coast of Mexico, and in the Gulf of California . . . by the U. S. Fish Commission steamer "Albatross," during 1891 . . . VI. Preliminary descriptions of new species of Crustacea. Bull. Mus. Comp. Zool. Harvard, 24: 149-220.

Faxon, W. 1895. Reports on an exploration off the west coasts of Mexico, Central and South America, and off the Galapagos Islands . . . by the U. S. Fish Commission steamer "Albatross," during 1891 . . . XV. The stalk-eyed Crustacea. Mem. Mus. Comp. Zool. Harvard, 18: 1-292.

Forest, J., and Michèle de Saint Laurent 1968. Campagne de la *Calypso* au large des côtes atlantiques de l'Amérique du Sud (1961-1962). 6. Crustacés décapodes: Pagurides. Ann. Inst. Océanogr., (n. s.) 45 (2):47-169.

Frankenberg, D., and R. J. Menzies 1968. Some quantitative analyses of deep-sea benthos off Peru. Deep-Sea Res., 15: 623-626.

Gallardo, A. 1963. Notas sobre la densidad de la fauna bentónica en el sublitoral del Norte de Chile. Gayana, Zool., 10: 1-15.

Garth, J. S. 1958. Brachyura of the Pacific coast of America. Oxyrhyncha. Allan Hancock Pac. Exped., 21: xii + 1-854.

Garth, J. S. 1960. Distribution and affinities of the brachyuran Crustacea. *In* The Biogeography of Baja California and Adjacent Seas (Symposium). Syst. Zool., 9: 105-123.

Garth, J. S. 1969. A new genus and species of oxyrhynchous crab from the west coast of South America (Crustacea, Decapoda, Brachyura). Bol. Soc. Biol. Concepción, 41: 5-7.

Gordon, Isabella 1963. On the relationship of Dromiacea, Tymolinae and Raninidae to the Brachyura, p. 51-57. *In* H. B. Whittington and W. D. I. Rolfe [eds.], Phylogeny and Evolution of Crustacea. Spec. Publ. Mus. Comp. Zool., Harvard.

Henderson, J. R. 1888. Report on the Anomura collected by H. M. S. *Challenger* during the years 1873-76. Rep. Zool. Challenger Exped., 27: xi + 1-221.

Ihle, J. E. W. 1916. Die Decapoda Brachyura der Siboga-Expedition. II. Oxystomata, Dorippidae. Siboga-Expeditie, Monogr. 39b[1], livr. 78: 1-62 (97-158).

Madsen, F. J. 1961. On the zoogeography and origin of the abyssal fauna in view of the knowledge of the Porcellanasteridae. Galathea Rep., 4: 177-218.

Menzies, R. J., and E. Chin 1966. Cruise report, research vessel *Anton Bruun,* Cruise 11. Texas A&M Univ. Mar. Lab. Spec. Rep. No. 1: 1-16. (Technical report.)

Miers, E. J. 1886. Report on the Brachyura collected by H. M. S. *Challenger* during the years 1873-1876. Rep. Zool. Challenger Exped., 17: 1 + 1-362.

Milne Edwards, A., and E.-L. Bouvier 1894. Considérations générales sur la famille des Galathéidés. Ann. Sci. Nat., (7) 16: 191-327.

Milne Edwards, A., and E.-L. Bouvier 1900. Crustacés Décapodes. Première partie. Brachyures et Anomoures. Expéd. Scient. Travailleur et Talisman, Fasc. 6: 1-396.

Núñez Barron, S. 1967. Crustáceos de la Expedición Arica 1962. Brachyura Majidae. Rev. Univ. del Norte [Antofagasta], No. 2: 39-42.

Provenzano, A. J., Jr. 1968. The complete larval development of the West Indian hermit crab *Petrochirus diogenes* (L.) (Decapoda, Diogenidae) reared in the laboratory. Bull. Mar. Sci., 18: 143-181.

Rathbun, Mary J. 1898a. The Brachyura of the Biological Expedition to the Florida Keys and the Bahamas in 1893. Bull. Lab. Nat. Hist., State Univ. Iowa, 4: 250-294.

Rathbun, Mary J. 1898b. The Brachyura collected by the U. S. Fish Commission steamer *Albatross* on the voyage from Norfolk, Virginia, to San Francisco, California, 1887-1888. Proc. U. S. Nat. Mus., 21: 567-616.