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Plankton of the Bermuda Oceanographic Expeditions. IX.
The Bathypelagic Caridean Crustacea.¹

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INTRODUCTION.

This report deals with the caridean decapod Crustacea taken during the course of the Bermuda Oceanographic Expeditions from 1929 to 1935 in a roughly circular area, eight miles in diameter, whose center is at 32° 12' north latitude and 64° 36' west longitude or nine and one-quarter miles south-southeast of Nonsuch Island, Bermuda. The total depth of water

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in this area increases from 1,000 fathoms at the inner rim of the circle to nearly 1,500 fathoms at the outer edge. Complete data on the 1574 nets towed will be found in Beebe (1931, 1932 and 1936).

Inasmuch as open nets were employed throughout these investigations, any precise distributional evidence disclosed by the collection must be accepted with some reserve. Nets usually were towed, six at a time, at 100 fathom intervals, and the towing time began when all six nets reached their designated depth and ended when the nets started to come up from that level. Nets towed at the deeper levels, therefore, were actually fishing a good deal longer than the time given and the catches from these deeper hauls should be somewhat greater proportionately than those made by the shallower tows. Although it was convenient to use as a quantitative unit the average number of specimens taken by a one meter net in one hour of towing, it is evident that this figure probably never represents the actual number of specimens per towing hour at any one level or in any one month, and it should be used with caution when comparing the relative abundance of species of bathypelagic Caridea in the Bermuda area with those taken elsewhere by other expeditions. Since this figure does not mean exactly the same at different levels, its use in computing the relative abundance of a species at different depths fails to give a perfectly true picture of existing conditions. However, although it varies with the depth, the number of specimens per towing hour can be used as a basis for comparing the relative abundance of different species at each level and distribution graphs for different species based on this unit can be compared directly with little fear of distortion of fact.

Most of the material which forms the basis of this report was taken in 1929, 1930 and 1931; the great majority of the tows made after 1931 were surface hauls and contained no adult Caridea. Since all but one series of the deep water nets were towed in the daytime—most of them in the morning—the collection fails to yield much data on the diurnal migrations of these animals; I have seen no specimens taken in Nets 224 to 229 which were towed at night between 500 and 1,000 fathoms. In general, specimens from several nets from the same level were put together, but in 1929 and 1930 these combined hauls seldom represented a period of more than two or three weeks and a rough idea of the seasonal distribution of each species could be obtained. In 1931, however, tows as much as six to eight weeks apart were put in the same container so that it was found impractical to derive any seasonal distribution data from this 1931 material.

After taking all of these factors into consideration, it was felt that the greatest value in the collection was its completeness. This, the first extensive expedition to devote its resources to the investigation of the deep water fauna of a relatively small column of water, accumulated such a vast amount of material that it is unlikely that future work in the Bermuda area will find many forms not represented in this collection unless they be extremely rare or accidental strays from another oceanic area. In the belief that the Bermudas offer an ideal base for oceanographic exploration and, therefore, that more and more work of this nature will be carried on there in the future, it seemed advisable to make of this report a guide to the identification of the bathypelagic caridean prawns of the Bermudian region. The known geographical distribution of many of the species indicates that the fauna is representative of a large part, if not all, of the Sargasso Sea area as well, and the report may therefore serve as a supplement to the excellent guide to the more northern forms of the North Atlantic to be found in Kemp, 1910.

Wherever practical the figures have been made from Bermuda specimens. In the few cases where it has been necessary to copy previously published figures, due acknowledgment is given. Among the references dealing with each species an attempt has been made to include, besides the reference to the original description, all synonyms and one of the best recent references from which a complete list of authors may be traced. The bibliography, in

the main, is made up only of those works to which reference is made in the text, but these include most of the important papers dealing with bathypelagic Caridea published to date.

This opportunity is taken to express my gratitude to those who have assisted in this report. First, I wish to thank Dr. William Beebe for entrusting this unique collection to me and for supplying valuable notes from life on certain of the prawns. Dr. Stanley Kemp has been most helpful in solving several perplexing problems both by sharing his wealth of carcinological knowledge and by supplying specimens for direct comparison. Dr. Robert Gurney, as an expert on larval development, has been ever willing to lend his aid in verifying or refuting certain conclusions. Mr. John C. Armstrong, of the American Museum of Natural History, offered many helpful suggestions on methods of attacking the quantitative aspects of the report while engaged in postgraduate work at the Museum of Comparative Zoology. My deepest thanks go to Miss Jocelyn Crane of the Department of Tropical Research of the New York Zoological Society. Miss Crane has most generously turned over to me copious notes made from life on many of the prawns—color notes, notes on luminescence, activity and feeding—which add immeasurably to the value of the report; all such remarks on color and other aspects of the living animal, unless otherwise credited, have been taken from Miss Crane's notes. I wish to express my sincere gratitude to Mr. M. D. Burkenroad of the Bingham Oceanographic Foundation at Yale University for the great amount of valuable time he gave up to sorting out this material and sending it on to me. Acknowledgment is also hereby made of the kindness of the Secretary of the Smithsonian Institution in permitting mention to be made of specimens of certain species of Oplophoridae in the collections of the U. S. National Museum.

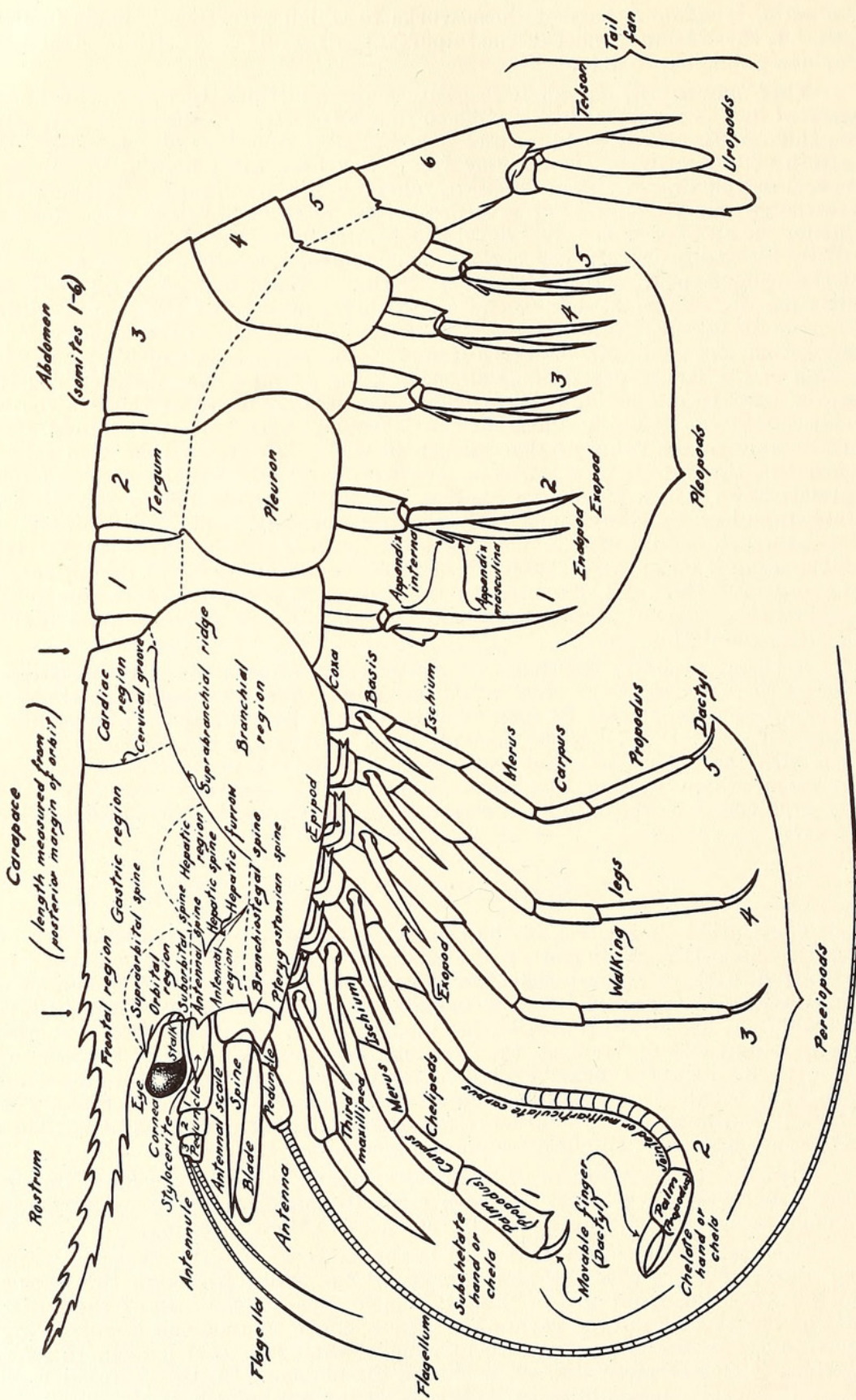
It is unfortunate that lack of time prevents a more complete investigation of certain aspects of this collection. When there is insufficient time to cover all angles of a study such as this, it is only natural that only those phases of greatest interest to the individual worker are treated. It is therefore with the realization that the possibilities of the present collection are far from exhausted that this report is submitted, and it is hoped that the few problems brought to light may lead to further investigations of a similar nature.

SYSTEMATIC DISCUSSION.

The Caridea form one of the tribes of the most primitive suborder of the Decapoda, the Natantia or the shrimps and prawns. The suborder is divided into three tribes; the Penaeidea, the Caridea and the Stenopidea. The Caridea are characterized by usually having the abdomen more or less sharply bent at the third somite, the pleura of the second abdominal somite overlapping those of the first, the first maxillipeds with a lobe at the base of the exopod, the third maxillipeds composed of from four to six joints—not seven, the third pereopods never chelate and the gills phyllobranchiate. The simplest and most useful character for distinguishing carideans at a glance is the overlapping of the first abdominal pleuron by the second.

Text-fig. 1 is a diagram of an ideal caridean showing the more important structures. An attempt has been made to employ the simplest terms in common usage where there is no confusion as to their meaning.

The standard measurement used is the carapace length, measured from the posterior margin to the hind margin of the orbit. Although this procedure has its disadvantages in that it fails to give a clear idea of the entire size of the animal and the ratio of carapace length to abdomen is not always constant, it is far more accurate in general than the total length. In most Caridea it is extremely difficult to extend the abdomen to its greatest length after the specimen has been in preservative for any length of time, and the



Text-figure 1.
Lateral view of a caridean prawn (in part after Schmitt, 1921).

length of the rostrum varies so much from one species to another that its inclusion in the measurement only leads to greater confusion.

As a standard size in comparing one species with another it has been found convenient to use the carapace length of young males in which the appendix masculina has not attained its full length. It is found that this appendix grows so rapidly that the carapace seldom increases more than a millimeter in length from the time the appendix first appears until it attains its full growth. The stage at which the appendix first appears also is remarkably constant in specimens from one locality; whether a different environment affects the size of the prawn at this stage remains to be seen. Although the size of the smallest egg-bearing female may more nearly define the actual size of the animal at maturity, a long series of specimens is necessary to determine this measurement, whereas a single young male will yield a fairly accurate standard figure by the first method.

It is nearly impossible to make any definite rule for the determination of sex in Caridea. In general, the safest procedure is to look for the appendix masculina on the inner margin of the endopod of the second pleopods. In the Oplophoridae, the family to which the greatest number of bathypelagic species belong, the endopod of the first pleopods is usually sexually modified so that this character is frequently easier to use when one becomes familiar with its form in both sexes. There are certain species however, scattered among several families, in which there is no appendix masculina in the male and the endopod of the first pleopod fails to show any clear sexual dimorphism; in such instances the abdominal pleura are usually modified in one sex, but familiarity with the form in each species is necessary in order to distinguish the sexes in these species.

KEY TO THE BERMUDIAN FAMILIES OF BATHYPELAGIC CARIDEA.

1. Exopods present on some or all pereopods; first two pairs of pereopods obviously chelate; second pereopods with an undivided carpus.....2
 No exopods on any pereopods; first pereopods either simple or microscopically chelate; second pereopods with a segmented carpus.....4
2. First two pairs of pereopods much longer and stouter than last three pairs*Pasiphaeidae*
 First two pairs of pereopods shorter than last three pairs.....3
3. Third abdominal somite not produced as a broad cap over the fourth somite; mandibles imperfectly cleft.....*Oplophoridae*
 Third abdominal somite produced as a broad cap over the fourth somite; mandibles distinctly cleft.....*Bresiliidae*
4. Integument firm; carapace not inflated; mandibles deeply cleft with a three-jointed palp*Pandalidae*
 Integument thin and fragile; carapace inflated; mandibles without incisor process or palp.....*Physetocaridae*

Family Pasiphaeidae.

Rostrum short or absent; in the latter case it is represented by a post-frontal gastric spine. First two pairs of pereopods chelate, much longer and stouter than last three pairs, and with the carpus undivided. Exopods present on all pereopods, much reduced or absent on second maxillipeds. Terminal joint of second maxillipeds normal, not applied as a strip to the end of the preceding joint. Mandibles without a molar process and with or without a palp.

KEY TO THE BERMUDIAN GENERA OF PASIPHAEDAE.

1. Fourth pereopod much shorter than either third or fifth; size medium or large, adults more than two inches long..... 2
 Last three pereopods progressively diminishing in length from the third to the fifth; size small, less than an inch in length; rostrum arising from frontal margin; mandible with a one-jointed palp..... *Leptochela*
2. Rostrum in the form of a post-frontal spine; mandible without a palp..... *Pasiphaea*
 Rostrum arising from the frontal margin; mandible with a two-jointed palp..... *Parapasiphaë*

Genus ***Pasiphaea*** Savigny, 1816.

Rostrum represented by a post-frontal gastric spine. Orbits poorly defined. Fourth pereopod shorter than fifth. Mandible without a palp.

KEY TO ADULTS OF THE BERMUDIAN SPECIES OF *Pasiphaea*.

- Carapace dorsally carinate; abdomen neither carinate nor dentate; fingers of chelae of second pereopods shorter than palm..... *P. liocerca*
- Carapace not dorsally carinate in posterior half; abdomen carinate on second to fifth somites and dentate on fourth to sixth; fingers of chelae of second pereopods longer than palm..... *P. hoplocerca*

Pasiphaea liocerca, sp. nov.

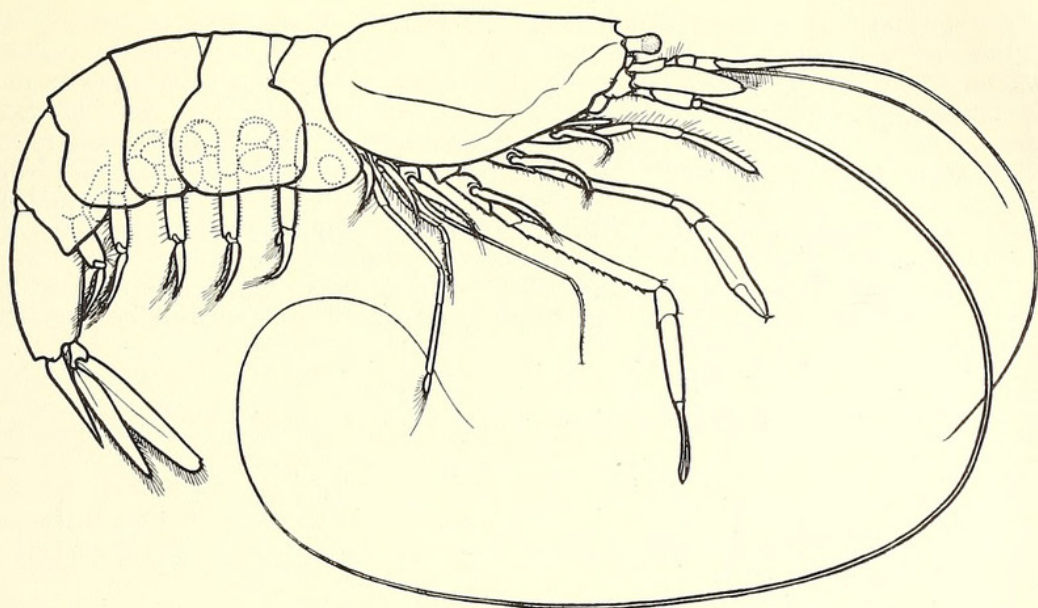
Text-figs. 2 and 3.

Type: Holotype ovigerous female, Cat. No. 31,1229, Department of Tropical Research, New York Zoological Society; Net 1160; August 10, 1931; 800 fathoms.

Diagnosis: Carapace dorsally carinate. Abdomen smooth, not carinate. Telson strongly forked. Gastric spine not attaining anterior margin of carapace. First pereopods unarmed. Fingers of chelae of second pereopods not longer than palm.

Description: Carapace dorsally carinate for nearly its entire length. Gastric tooth short, horizontal, falling short of the anterior margin of the carapace. Branchiostegal sinus obtuse, with a small submarginal spine anterior to it. Abdomen without a dorsal carina or armature on any somite. The sixth somite is strongly compressed near the dorsal margin, but still there is no trace of a carina. Telson sulcate for the entire length of its dorsal surface and terminating in a fork which is armed with 21 barbed spines. Eyes pale yellow in alcohol, without trace of an inner protuberance. Stylocerite spatulate and armed with a small terminal spine which falls far short of the end of the first antennular segment. Antennal scale convex along its outer margin and bearing a triangular terminal spine which projects but little beyond the end of the blade. There is a small spine on the antennal peduncle below the base of the scale. First pereopods without spines on any segment. The fingers of the first chelae are about two-thirds as long as the palm. Second pereopods armed with 11 to 13 spines on the merus and one spine at the lower angle of the carpus. The fingers of the second chelae are very slightly shorter than the palm.

Measurements: Total length about 46 mm.; length of carapace 14 mm. The eggs measure about 1.3 by 2.0 mm. in shorter and longer diameter.



Text-figure 2.

Pasiphaea liocerca. Holotype female. $\times 2.16$.

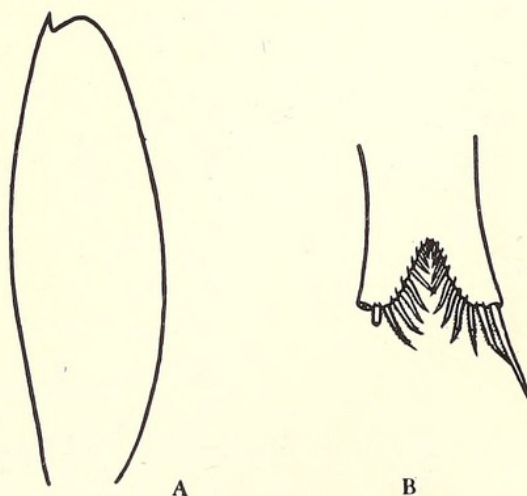
Color in Life: Body and appendages scarlet with the chelae and the tips of the pleopods deeper scarlet. Eyes bronze with golden centers. Eggs scarlet.

Remarks: The carinate carapace, smooth abdomen and strongly forked telson distinguish this species from all but five of the described species of *Pasiphaea*. Of these five, *P. longispina* Lenz, 1914, and *P. scotiae* (Stebbing, 1914) may be separated by the extremely long gastric spine; *P. alcocki* (Wood-Mason, 1891), *P. rathbunae* (Stebbing, 1914) and *P. corteziana* Rathbun, 1902, differ in having spines on the meri of the first pereopods and the latter have the fingers of the second chelae distinctly longer than the palm.

In the present collection there are two young specimens of *Pasiphaea* which have been tentatively assigned to this species. Each has a carapace length of about 6.0 mm. One was taken in Net 63; May 3, 1929; 600 fathoms, and the other in Net 626 or 637; May 23 or 28, 1930; 500

Text-figure 3.

Pasiphaea liocerca. **A.** Antennal scale. **B.** Tip of telson.



fathoms. These specimens differ from the type of *P. liocerca* in having a slightly more pronounced gastric spine, no discernible dorsal carina on the posterior two-thirds of the carapace and only five spines on the merus of the second pereopods. Although the absence of a complete carina on the carapace and the small number of meral spines on the second pereopods would seem to ally these specimens more closely to the following species, the fact that the fingers of the second chelae are shorter than the palm very nearly precludes that possibility. Of these two species, *P. liocerca* and *P. hoplocerca*, the only representatives of the genus so far known from the Bermudian area, these young specimens are best accommodated in the first, and the differences noted between them and the type may well be due to their immaturity.

***Pasiphaea hoplocerca*, sp. nov.**

Text-figs. 4 and 5.

Types: Holotype female, Cat. No. 30,1688 Department of Tropical Research, New York Zoological Society; Nets 713, 753, 778; June-July, 1930; 700 fathoms.

One young; Net 22; April 15, 1929; 600 fathoms.

One young; Net 171; June 15, 1929; 600 fathoms.

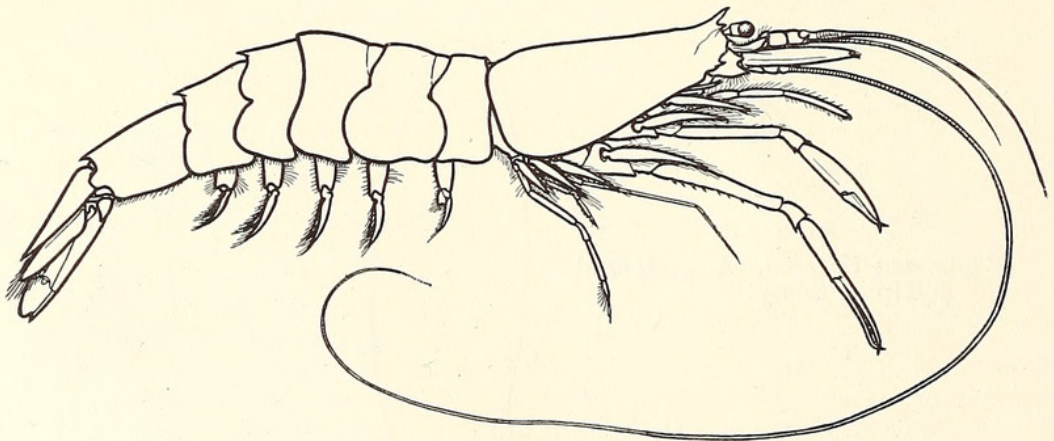
One female, one young; Net 195; June 20, 1929; 700 fathoms.

One young; Nets 199, 205, 217, 224, 232, 238 and 248; June 21-July 4, 1929; 500 fathoms.

One young; Nets 258, 264, 270, 276, 282 and 289; July 5-11, 1929; 900 fathoms.

Diagnosis: Carapace not sharply carinate dorsally behind gastric tooth. Abdomen carinate on second to fifth somites inclusive and dentate on fourth, fifth and sixth; telson strongly forked. Gastric spine reaching slightly beyond anterior margin of carapace. First pereopods unarmed except for a blunt tooth at lower end of basis; fingers of chelae of second pereopods much longer than palm.

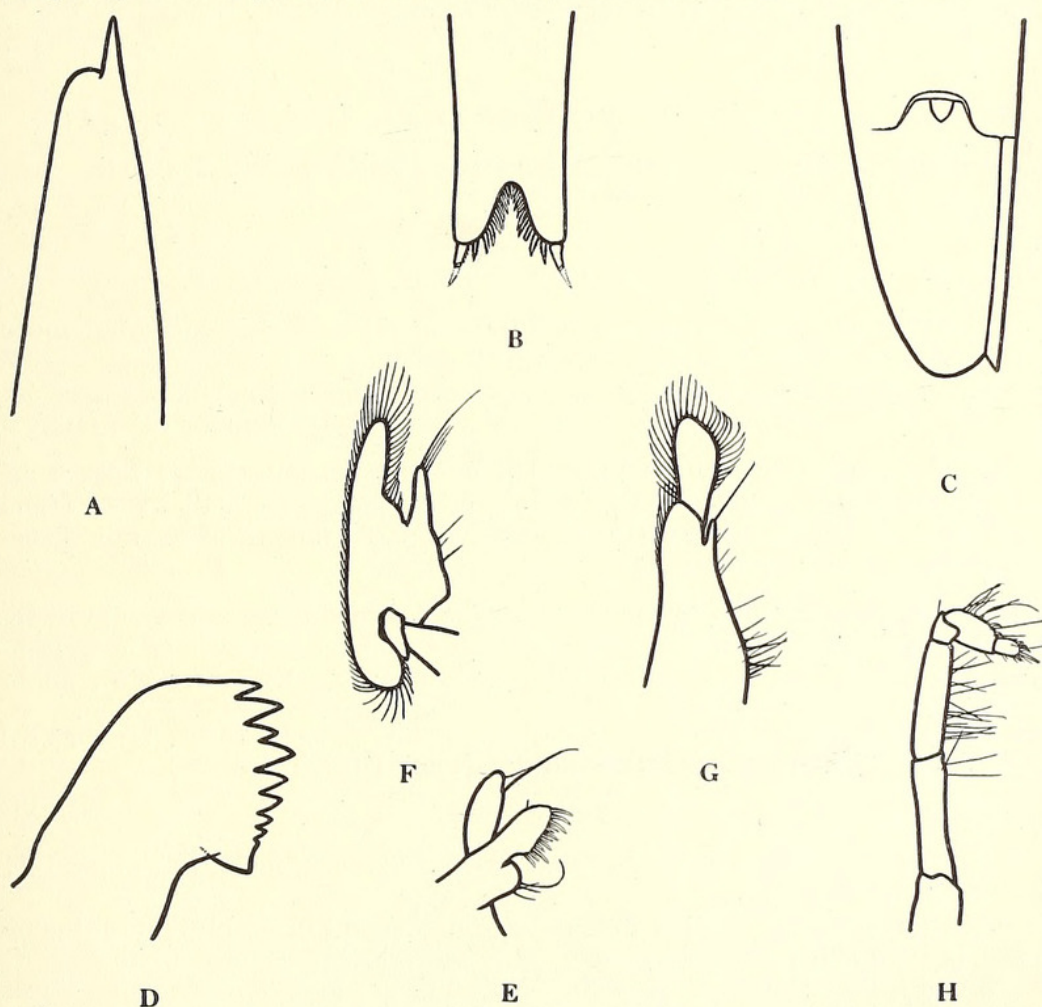
Description: Carapace not sharply carinate dorsally except on the strong gastric tooth which extends slightly beyond the anterior margin of the carapace. Behind this tooth a blunt carina extends backward along the dorsal mid-line and disappears at about the posterior fifth of the carapace. Branchiostegal sinus well marked, forming nearly a right angle.



Text-figure 4.

Pasiphaea hoplocerca. Holotype female. $\times 1.59$.

Anterior to this sinus is a strong branchiostegal spine arising from the margin of the carapace. On the lateral surface of the carapace, the supra-branchial ridge is obsolete; the only apparent ridges are a pair of short ones running backward from the orbital margin. Abdomen sharply carinate on the second, third, fourth and fifth somites and terminating in strong posterior teeth on the fourth, fifth and sixth. At the lower posterior angle of the sixth somite is a minute recurved spine which can be distinguished only with high magnification. Telson dorsally sulcate for nearly its entire length and forked at the end where it is armed with 21 barbed spines. Stylocerite reaches very slightly beyond the first segment of the antennular peduncle where it tapers to a point. There is a well marked spine on the antennal peduncle below the base of the scale. The latter bears a long outer spine reaching far beyond the end of the blade. Third pereiopods do not extend quite as far as the tip of the antennal scale. First pereiopods with a blunt tooth at the lower end of the basis and no spines on the merus or any other segments. Second pereiopods with a similar basal tooth, merus armed with five to eight ventral spines and a single spine at the lower distal angle of the carpus. Fingers of the first chelae slightly shorter than the palm, those of the second one-fourth again as long as the palm.



Text-figure 5.

Pasiphaea hoplocerca. Paratype. A. Tip of antennal scale. B. Tip of telson. C. End of outer branch of uropods. D. Mandible. E. First maxilla. F. Second maxilla. G. First maxilliped. H. Second maxilliped.

Measurements: Total length of holotype 52.5 mm.; length of carapace 15.5 mm.

Color in Life: Unknown.

Remarks: The four smallest specimens (carapace length 8.3 to 9.3 mm.) differ from the type in having much less distinct abdominal carinae and the posterior spines of the fourth and fifth somites minute, although still visible.

Of the 34 known species of *Pasiphaea*, 24 apparently have no teeth on any of the abdominal somites, seven have a tooth on the sixth somite and one, *P. orientalis* Schmitt, 1931, has teeth on the third and sixth somites but none on the fourth and fifth. *P. hoplocerca* can therefore be readily distinguished from all other described forms with the exception of the two mentioned below by the posterior spines on the fourth, fifth and sixth somites of the abdomen. Two species, *P. amplidens* Bate, 1888, and *P. longispina* Lenz, 1914, have been described from specimens in which part or all of the abdomen was missing. From the first, *P. hoplocerca* differs in the smaller gastric spine and in having the fingers of the second chelae longer rather than shorter than the palm. *P. longispina* apparently differs in having a very long horizontal gastric spine similar to that in *P. scotiae* (Stebbing, 1914) with which species it may prove to be synonymous.

Genus *Parapasiphaë* Smith, 1884.

Rostrum arising from frontal margin. Fourth pereopod shorter than fifth. Mandible with a two-jointed palp.

KEY TO THE BERMUDIAN SPECIES OF *Parapasiphaë*.

1. No spines on anterior margin of lateral portion of carapace; not more than two spines on dorsal carina of carapace.....2
Antennal and branchiostegal spines present; more than two spines on dorsal carina of carapace; fingers of second chelae shorter than palm. 3
2. Dorsal carina of carapace unarmed, but sulcate anteriorly; fingers of second chelae not longer than palm.....*P. sulcatifrons*
One or two spines on dorsal carina of carapace; fingers of second chelae distinctly longer than palm.....*P. macrodactyla*
3. Rostrum terminating in a short spine which does not reach beyond middle of eyestalks.....*P.*, sp. a.
Rostrum a long, stout spine which reaches nearly to tips of eyes. *P.*, sp. b.

Parapasiphaë sulcatifrons Smith.

Text-fig. 6.

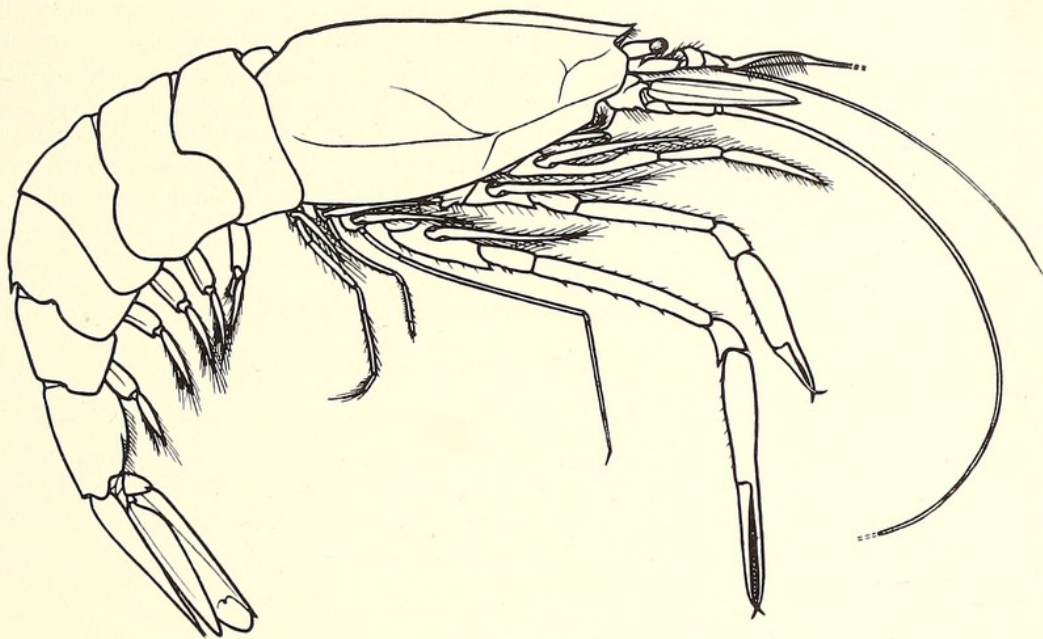
Parapasiphaë sulcatifrons Smith, 1884, p. 384, pl. 5, fig. 4, pl. 6, figs. 1-7; Stephensen, 1935, p. 34.

Diagnosis: Dorsal carina of carapace unarmed above, but the anterior fourth is broadened and provided with a well marked groove in the adult. Rostrum attains middle of eyestalk. No spine on anterior edge of lateral portion of carapace. Abdomen with a small median spine at end of fourth somite. Fingers of second chelae not longer than palm.

Measurements: The smallest recognizable male specimen, in which the appendix masculina of the second pleopods is no more than a bud, has a carapace length of 16.0 mm. The largest male has a carapace length of 22.5

mm. and the appendix masculina is about two-thirds as long as the other appendix. The ovigerous females range in carapace length from 22 to 26 mm., but only one specimen has a carapace length of less than 23 mm., whereas the females without eggs have a carapace length of 16 to 23 mm. and only one is more than 22 mm. Most of the young are little more than post-larvae, having a carapace length of only five or six mm.

Color in Life: General color scarlet, with the carapace and chelae brighter than the rest. Eyes light amber to bronze. Antennae salmon-orange and the other appendages like the body. Eggs scarlet with the developing embryo salmon-orange.



Text-figure 6.

Parapasiphaë sulcatifrons. Male taken in September, 1929, from 700 fathoms. $\times 1.66$.

General Remarks: The collection contains 497 specimens of this species but only 36 are adult; 10 males and 26 females of which 14 are ovigerous. Whether this is merely indicative of the normal mortality of the young, whether proportionately larger numbers of adults might be expected in greater depths or whether some other factor is involved cannot be ascertained from the present material. *P. sulcatifrons* is one of the few bathypelagic prawns in which the stomach is occasionally everted upon being brought to the surface. Three specimens of this species were found in the stomachs of fish; one from the stomach of *Photostomias guernei* and two from *Gonostoma elongatum*.

Seasonal Distribution: Obviously the number of adults is too small to supply any information on the seasonal abundance of this form. It may be worthy of mention that ovigerous females were taken in April, June, July, August and September and attention is called to the fact that all but one of the female specimens having a carapace length of more than 22 mm. were carrying eggs. The number of immature and young, likewise, is not sufficient to warrant any definite conclusions. However, a comparison of the number of young taken in 1929 and 1930 with the towing hours at each depth indicates that the smallest number of specimens is found from April to June,

with an increase in July and August and a very slight falling off again in September.

Vertical Distribution: Of the 36 adult specimens two were taken in 600 fathoms, four in 700, eight in 800, twelve in 900 and ten in 1,000. Compared with the towing hours at each depth and realizing that open nets were employed, the center of abundance appears to be between 800 and 900 fathoms. The immature and young were found between 500 and 1,000 fathoms with two specimens being taken in 400 fathoms. Although there may be some seasonal shift in the vertical range of this population, the center of abundance seems to be between 600 and 800 fathoms, or somewhat nearer the surface than is the case for the adults.

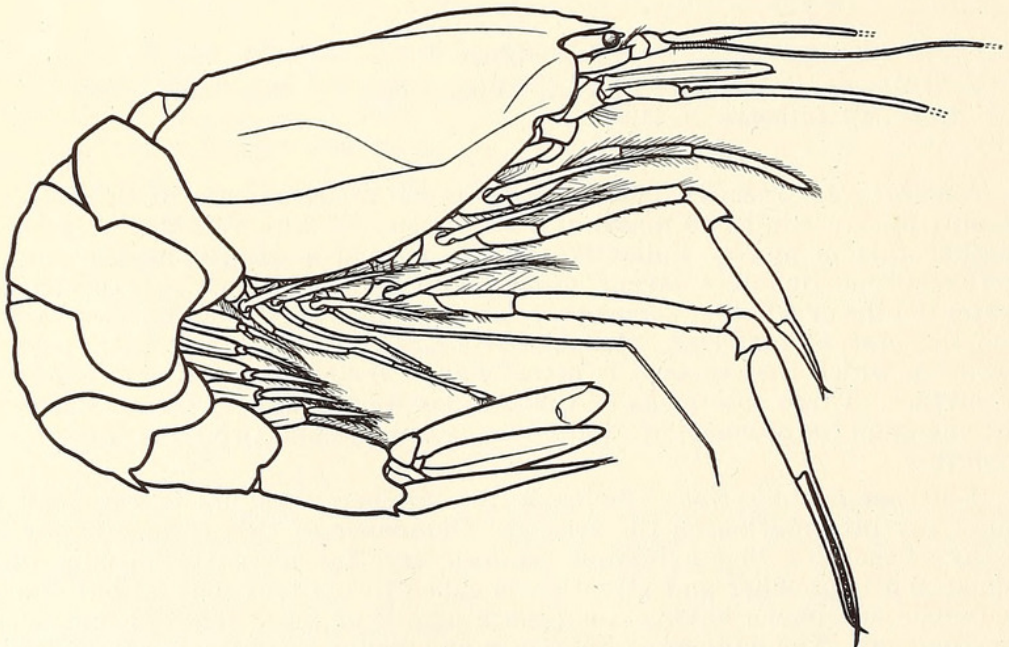
Geographical Distribution: The known distribution of the species includes the following areas; off the east coast of the United States from 35° to 41° north latitude, Davis Straits, between Greenland and Iceland, south of Iceland, southwest of Ireland, the Bay of Cadiz and, finally, off Cape Point, Cape Colony, South Africa, according to Stebbing, 1914a. This distribution would suggest that *P. sulcatifrons* is not a true Sargasso Sea form, but it is dangerous to form such conclusions until more is known of the caridean fauna of the Sargasso area.

***Parapasiphaë macrodactyla* Chace.**

Text-fig. 7.

Parapasiphaë macrodactyla Chace, 1939, p. 33.

Diagnosis: Dorsal carina of carapace armed with one or two teeth above the orbit. Rostrum reaches as far as the cornea. No spine on anterior edge of lateral portion of carapace. Abdomen with a median spine at end of fourth somite. Fingers of second chelae distinctly longer than palm.



Text-figure 7.

Parapasiphaë macrodactyla. Holotype female from off the coast of Cuba. $\times 1.88$.

Measurements: The type female from off Cuba has a carapace length of 24.8 mm. The male in the present collection has a carapace length of 19.0 mm. and the female, 21.3 mm. Similar measurements in the young range from 4.8 to 11.0 mm. In the male the appendix masculina is less than half as long as the other appendix.

Color in Life: Unknown.

General Remarks: There are 30 specimens of this species in the collection, one male, one female and 28 young. *P. macrodactyla* is easily distinguished from the preceding species, even in the smallest specimens, by the presence of one or two spines at the base of the rostrum and, particularly, by the much longer fingers of the second chelae.

Seasonal Distribution: In 1929, fifteen specimens were captured, of which nine were taken in September and the remaining six in May, June, July and August. Of the four specimens taken in 1930, three were found in September and the other in June. In 1931, eleven specimens were captured but were separated in such a way that monthly totals could not be obtained. The adult male was taken in June, 1930, and the female in September, 1929.

Vertical Distribution: Both adult specimens were found in 1,000 fathoms. Of the young, three were taken in 600 fathoms, ten in 700, four in 800, five in 900 and six in 1,000.

Geographical Distribution: Aside from the present specimens, *P. macrodactyla* is known only from the type taken off Bahia de Guantnamo, Cuba.

***Parapasiphaë*, sp. a.**

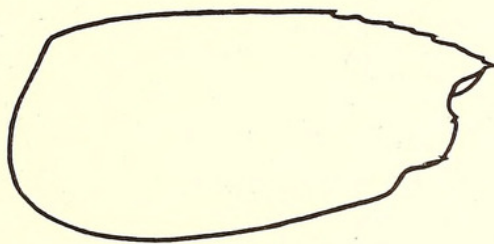
Text-fig. 8.

Diagnosis: Dorsal carina of carapace armed with about six small, unequal spines in its anterior half. Rostrum short, terminating in a small spine which falls far short of the tips of the eyes. Antennal and branchio-stegal spines present. Abdomen carinate on third and fourth somites, the latter armed with a large, sharply carinate spine overhanging the fifth somite. Fingers of second chelae distinctly shorter than palm.

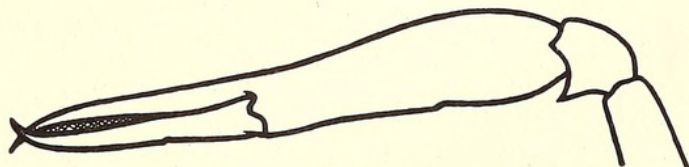
Text-figure 8.

Parapasiphaë, sp. a.

A. Lateral view of carapace. B. Chela of second pereopod.



A



B

Remarks: This form is represented by a single young specimen having a carapace length of about 8 mm., taken in Net 819, 844, 862 or 867, August 29 to September 10, 1930, from 800 fathoms. It is apparently related to *P. serrata* Rathbun, 1902, (p. 904) and 1904 (p. 25, fig. 7), from off the coast of southern California, as indicated by the form of the rostrum, the tooth on the fourth abdominal somite and the proportionate lengths of the palm and fingers of the second chelae.

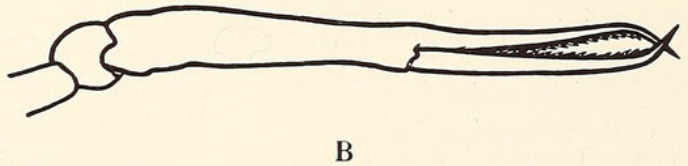
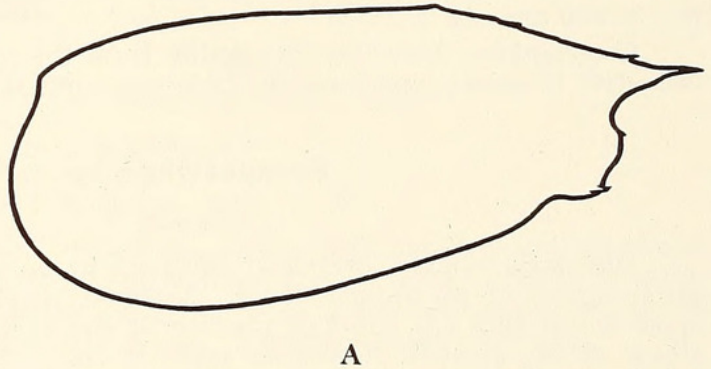
***Parapasiphaë*, sp. b.**

Text-fig. 9.

Diagnosis: Carapace denticulate on anterior half of dorsal carina and drawn out to a slender, pointed rostrum which reaches nearly to the tips of the eyes. Antennal and branchiostegal spines present. Fourth abdominal somite armed with a small tooth or spine. Fingers of second chelae somewhat shorter than palm.

Text-figure 9.

Parapasiphaë, sp. b. **A.** Carapace of specimen from net 1502. $\times 11$. **B.** Chela of second peraeopod of specimen from net 657.



Remarks: Two specimens, one having a carapace length of about 6.5 mm. from Net 657, June 2, 1930, 700 fathoms, the other with a carapace length of about 5.0 mm. from Net 1502, July 25, 1934, 500 fathoms, are assigned to this indeterminable species. The larger specimen is moulting but seven distinct spines, exclusive of the long, slender rostrum, can be seen on the anterior half of the dorsal margin of the carapace. This specimen also has a distinct spine on the fourth abdominal somite. The smaller figured specimen has a similar rostrum but the spines behind it are much less distinct and the spine on the fourth abdominal somite is scarcely visible. The form of the rostrum and the denticulate carina of the carapace recalls similar structures in *P. gilesii* Wood-Mason, 1893 (p. 166), and Ill. *Investigator* (pl. 3, fig. 8) from the Indian Ocean.

Genus **Leptochela** Stimpson, 1860.

Rostrum arising from frontal margin. Last three pereopods similar, diminishing in length from third to fifth. Mandible with a palp which consists of a single joint. Adults usually less than an inch in length.

There is but one species of the genus known from the Bermuda area.

Leptochela bermudensis Gurney.

Text-fig. 10.

Leptochela bermudensis Gurney, 1939, pp. 426-433, figs. 1-10.

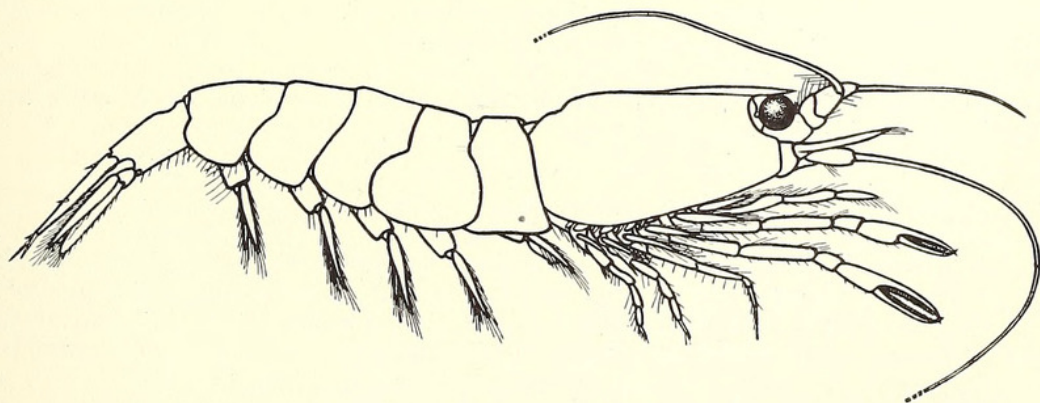
Diagnosis: Orbital margin smooth, not denticulate. Abdomen not carinate on fourth or fifth somites; telson with one pair of dorsal and one pair of lateral spines.

Measurements: The two males in the collection have a carapace length of 3.2 and 4.5 mm. The females have corresponding measurements of 2.9 to 3.2 mm., both ovigerous females having the carapace 3.2 mm. long. In the young the carapace is from 1.3 to 1.8 mm. long.

Color in Life: Integument transparent, showing the pinkish or brownish heart and other whitish internal organs. Bases of all legs and middle of second segments of pleopods bright spectrum red; in one ovigerous female these markings were pure scarlet instead of spectrum red. All appendages otherwise transparent with a faint violet tinge on the distal segments. In one lot, faint scarlet markings were noticed on the maxillipeds. Eyes deep, dull violet-blue. Eggs orange-pink.

A number of these prawns were kept alive in a refrigerator for about eighteen hours. At about the tenth hour, lateral spectrum red spots appeared on the abdomen, the violet tinge became more pronounced and in the larger specimens the internal organs appeared greenish-yellow.

General Remarks: Since there are only sixteen specimens in the collection, two males, six females, of which two are ovigerous, and eight young, it is probable that the species is found only sporadically in the Bermuda area. There also is a good indication that swarming occurs in this species, for Gurney obtained no less than 45 adult individuals from a single net. As in other species of the genus, ovigerous females have three dorsal carinae on the carapace, whereas males and females without eggs have only the median



Text-figure 10.

Leptochela bermudensis. Male from net 989. $\times 6$.

carina developed for the entire length. Of the specimens kept alive in the refrigerator, a few of the smaller ones became very lively after their periodic removal from the ice, but the larger specimens were at all times sluggish and feeble.

Luminescence: The following notes were made by Miss Crane on specimens taken in Net 1028; June 20, 1931; surface at night.

"These abundant small shrimps seemed to be the source of most of the luminescence in this net (save for the minute sparks furnished by very small copepods). They emitted, both when isolated and when in the company of their kind, short, tiny flashes of bright white light. The part of the body from which these flashes came could not be determined. Dissection was not particularly helpful, as no structures were found which resembled typical light-organs of any kind I have yet observed: the best possibility seems to be that the pigment spots, seemingly superficial, at the bases of the pleopods, are in reality photophores.

"Although a couple of specimens were kept alive until the following evening by frequently changing the water and by alternately placing them in and removing them from the refrigerator, no luminescence whatever was produced even by tapping the glass and directly prodding them. They were dead the following morning."

Seasonal Distribution: The type specimens, of which twelve were ovigerous, were taken on June 14, 1938. In the present collection one male and three females were captured on September 25, 1930; one female on September 26, 1930; one male, one ovigerous female and five young on June 3, 1931; three young on June 20, 1931; and one ovigerous female on November 2, 1931.

Vertical Distribution: There is evidence of a marked diurnal migration in this species. Between one and two P.M., specimens were found at 700 fathoms; between nine-thirty A.M. and one P.M. they were taken in 400 fathoms; and three lots were taken in surface nets between seven-thirty and eight P.M., between eight-thirty and nine P.M. and between nine-thirty and ten P.M. Apparently *L. bermudensis* is normally found at or near the surface at night and sinks to considerable depths during the hours of sunlight.

Geographical Distribution: According to our present knowledge, *L. bermudensis* is known only from the Bermuda region.

Family Oplophoridae.

Rostrum always present but extremely variable in form. First two pairs of pereopods chelate, usually shorter than the last three pairs and with the carpus undivided. Last three pairs not abnormally long. Exopods present on the maxillipeds and on all of the pereopods, but there is no lash on the exopod of the first maxilliped. Terminal joint of second maxilliped applied as a strip to the end of the preceding joint. Mandibles imperfectly cleft and provided with a palp.

KEY TO THE GENERA OF OPLOPHORIDAE.

1. Exopods of at least the third maxillipeds and first pair of pereopods foliaceous and often rigid; outer margin of antennal scale usually armed with a series of spines; telson not truncate at tip, but ending in a sharp point; eyes large and well pigmented.....*Oplophorus*
- None of the exopods of the pereopods foliaceous or rigid.....2
2. Last four abdominal somites, at least, dorsally carinate.....3
- Sixth abdominal somite not dorsally carinate.....4

3. Usually no straight ridge or carina running entire length of lateral surface of carapace along median lateral line; hind margin of hepatic furrow not usually cut off abruptly by an oblique ridge or carina. Incisor process of mandible toothed for entire length of the cutting edge *Acanthephyra*
 Carapace provided with at least one straight carina traversing the lateral surface from orbit to hind margin of carapace; hind margin of hepatic furrow abruptly cut off from branchial region by an oblique carina. Anterior half of cutting edge of incisor process of mandible unarmed *Notostomus*
4. Ischial and meral joints of pereopods abnormally broad and flat. *Ephyrina*
 Pereiopods normal 5
5. Eyes very small and poorly pigmented; anterior margin of first abdominal somite entire, not toothed; telson terminating in a truncate, spinose tip *Hymenodora*
 Eyes very large and well pigmented; anterior margin of first abdominal somite armed with a distinct lobe or tooth overlapping hind margin of carapace; telson terminating in a sharp-pointed end-piece laterally armed with spines *Systellaspis*

Genus *Acanthephyra* A. Milne Edwards, 1881a.

Carapace usually without a straight ridge or carina running along the median lateral line from orbit to hind margin, and without an oblique ridge or carina delimiting the hind margin of the hepatic furrow. Abdomen carinate on the last four somites, at least. Telson more or less truncate at the tip, not terminating in a sharply pointed end-piece laterally armed with spines. Pereiopods not abnormally broad and flattened. Exopods of third maxillipeds and pereiopods neither foliaceous nor rigid. Eyes well pigmented even when small. Outer margin of antennal scale not armed with a series of spines. Incisor process of mandible toothed for the entire length of its cutting edge.

KEY TO THE BERMUDIAN BATHYPELAGIC SPECIES OF *Acanthephyra*.

1. Second somite of abdomen dorsally carinate; integument firm 2
 Second somite of abdomen not dorsally carinate; integument membranous 7
2. Carapace not dorsally carinate on posterior third 3
 Carapace dorsally carinate throughout its length 6
3. Branchiostegal spine supported by a very short carina 4
 Branchiostegal spine supported by a long carina which extends back to posterior half of branchial region 5
4. No posterior spine on fourth abdominal somite; telson armed with about four pairs of lateral spines *A. purpurea*
 A posterior spine on fourth abdominal somite; telson armed with eight to eleven pairs of lateral spines *A. haeckelii*
5. Rostrum triangular and drawn out to a sharp point; telson armed with six to fifteen pairs of lateral spines *A. curtirostris*
 Rostrum very convex dorsally so that it appears somewhat semicircular in outline; telson armed with about three pairs of lateral spines *A. stylorostrata*

6. First abdominal somite dorsally carinate; telson obscurely sulcate dorsally *A. acutifrons*
 First abdominal somite not dorsally carinate; telson obscurely ridged dorsally *A. eximia*
7. Third abdominal somite armed with a large, fleshy spine which usually overreaches fourth somite *A. brevirostris*
 Spine of third abdominal somite, if present, not abnormally large 8
8. A spine on third abdominal somite *A. gracilipes*
 No spine on third abdominal somite *A.*, sp. ?

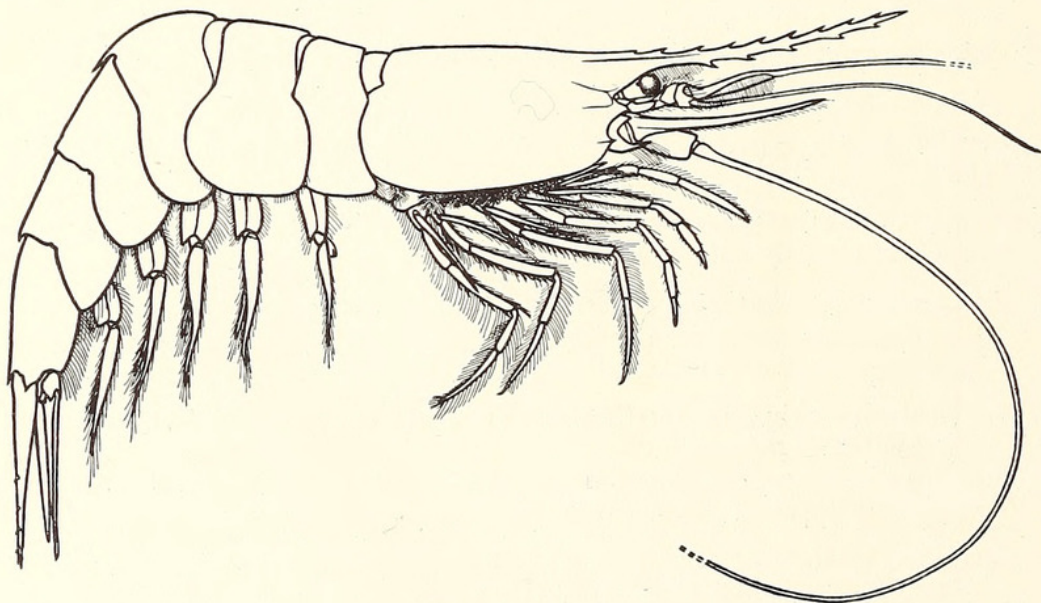
***Acanthephyra purpurea* A. Milne Edwards.**

Text-figs. 11-17.

Acanthephyra purpurea A. Milne Edwards, 1881, p. 933; Murray & Hjort, 1912, pl. 3, fig. 2, (col. fig.); Stephensen, 1923, p. 44; Kemp, 1939, p. 576.

Diagnosis: Integument firm. Rostrum long and slender. Carapace not dorsally carinate posteriorly. Branchiostegal spine supported by a short carina. Abdomen carinate on all but the first somite and with a median posterior spine on the third, fifth and sixth somites, but without any on the fourth; telson dorsally sulcate on proximal half and armed usually with four pairs of lateral spines.

Measurements: The smallest recognizable males in which the appendix masculina is little more than a bud have a carapace length of 7.5 mm. The largest male in the collection has a carapace length of 18.8 mm. and all of the larger specimens, in which the carapace is more than 17 mm. long, are males. The smallest ovigerous female examined has the carapace measuring 9.5 mm. Incidentally, the eyes of the embryos were easily seen in the eggs of this specimen, indicating that they were nearly ready to hatch. The youngest specimens have a carapace length of about 3.0 mm.



Text-figure 11.

Acanthephyra purpurea. Male taken in August, 1931, from 600 fathoms. $\times 1.58$.

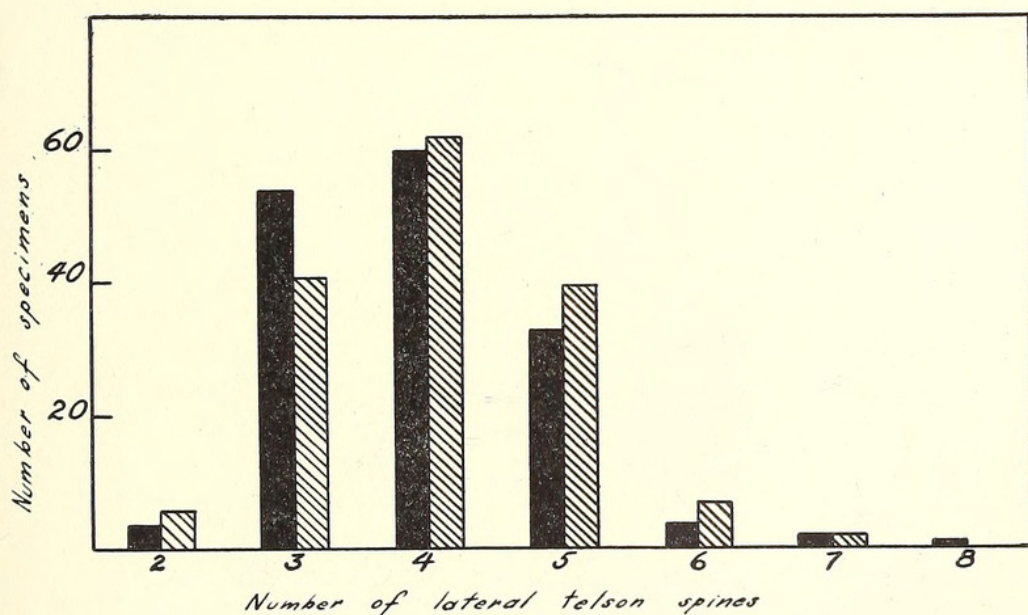
Color in Life: Body and appendages brilliant scarlet-red with setae of flame-scarlet. Eye black. Eggs scarlet-red, with the abdominal portion of the developing embryo peach-red.

General Remarks: The collection contains 4,572 specimens of this species; 909 males, 796 females, of which 278 are ovigerous, and 2,867 young. Of the ovigerous specimens, 79 are carrying eggs in which the eyes are visible.

A. purpurea is distinguished from the following species by the absence of a tooth or spine on the fourth abdominal somite, by having fewer lateral spines on the telson and by its somewhat smaller size. There is but one specimen in the collection, a female with a carapace length of 9.0 mm., which has the combination of four pairs of telson spines and a tooth on the fourth abdominal somite. Of the 4,572 specimens, only 158 do not have four spines on either side of the telson. This does not take into consideration about 3.7 per cent of the remaining 4,414 specimens in which the telson is damaged so that the determination of the number of telson spines is impossible. If allowance is made for this, however, probably all but three or four per cent of the specimens have the normal armature of four spines on either side of the telson. Text-fig. 12 shows graphically the numerical distribution of the spines in those specimens which do not have four pairs of lateral telson spines. Of these 158 specimens, 122 have the normal number of four spines on either the right or the left side of the telson. If the number of specimens is doubled to include the spines on either side, it is found that in only 26 out of 316 cases are there more or less than three to five spines, and in practically all of these few instances the telson is so malformed that it might be classed as a freak or as the result of injury.

The following notes on the eggs and embryos of this species were made by Miss Crane from a specimen taken in Net 1107; July 27, 1931; 400 fathoms.

"Silky threads bind the eggs to one another, the substance seemingly



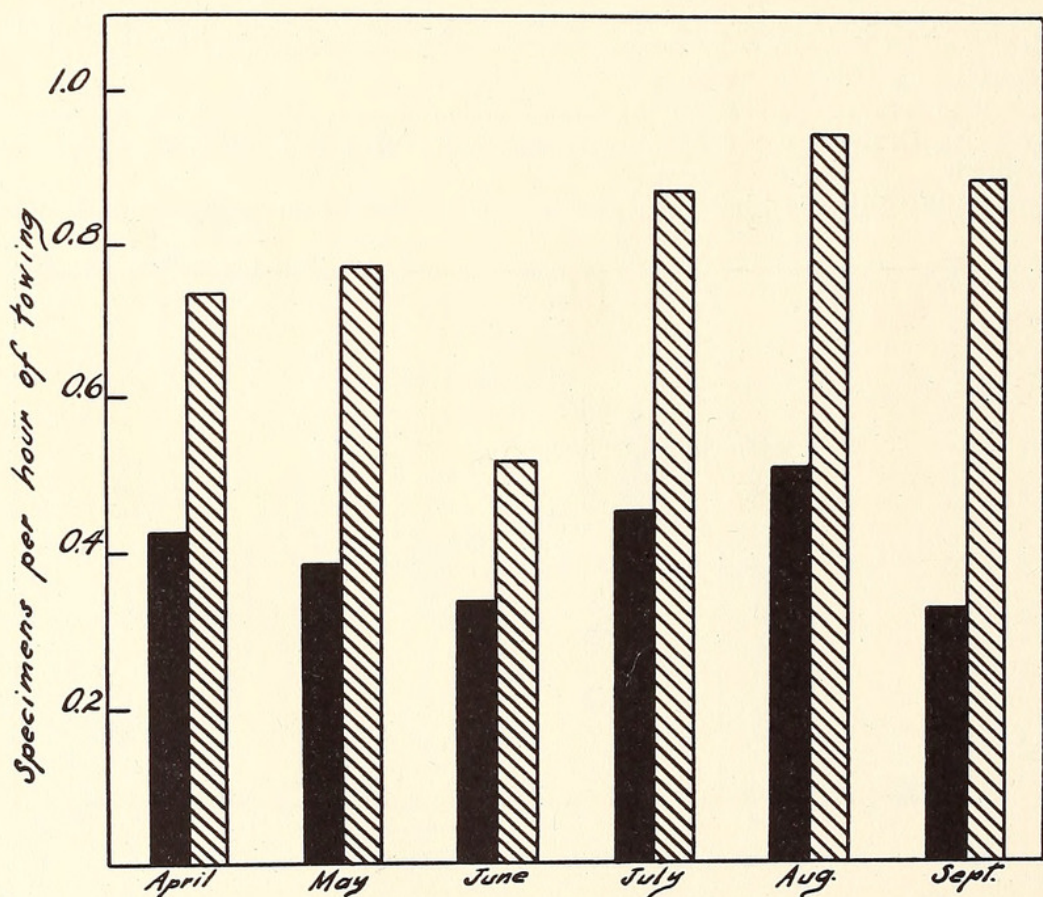
Text-figure 12.

Distribution of lateral telson spines in individuals of *Acanthephyra purpurea* which do not have four spines on either side of the telson. Solid bars represent spines on the left side of the telson; hatched bars those on the right.

continuous with the egg membrane itself. There are usually half a dozen points of attachment on each egg—one at each end and four in the vicinity of the equator. These threads are very fine, though tough and elastic, and in at least several I can quite clearly see that they are tubular in structure—as if each egg were enclosed in the common atrium into which the six tubes open.

“The well-formed, salmon-orange embryos are nearly ready to hatch, the tip of the abdomen in some cases already projecting from the ruptured, transparent egg membrane. The scarlet-red yolk sac remains only along the dorsal side of the head and thorax of each embryo, which is curled up in the longitudinal plane of the egg, the abdomen flexed beneath the thorax. The uropods and telson, perfectly formed except for the four or five pairs of spines and the feathery setae of the adult, fit exactly between the two pairs of antennae, which are already the longest of the appendages. I am reasonably certain that the enormous structure almost covering the side of the head is a compound eye, comparable to that of a Hyperiid amphipod, but further observation is required. The anlage of the rostrum is visible as a small, blunt projection. The thoracic appendages are outlined, but fixed to one another, and there are, of course, no pleopods.”

In three instances, *A. purpurea* was found in the stomach of the fish, *Gonostoma elongatum*.

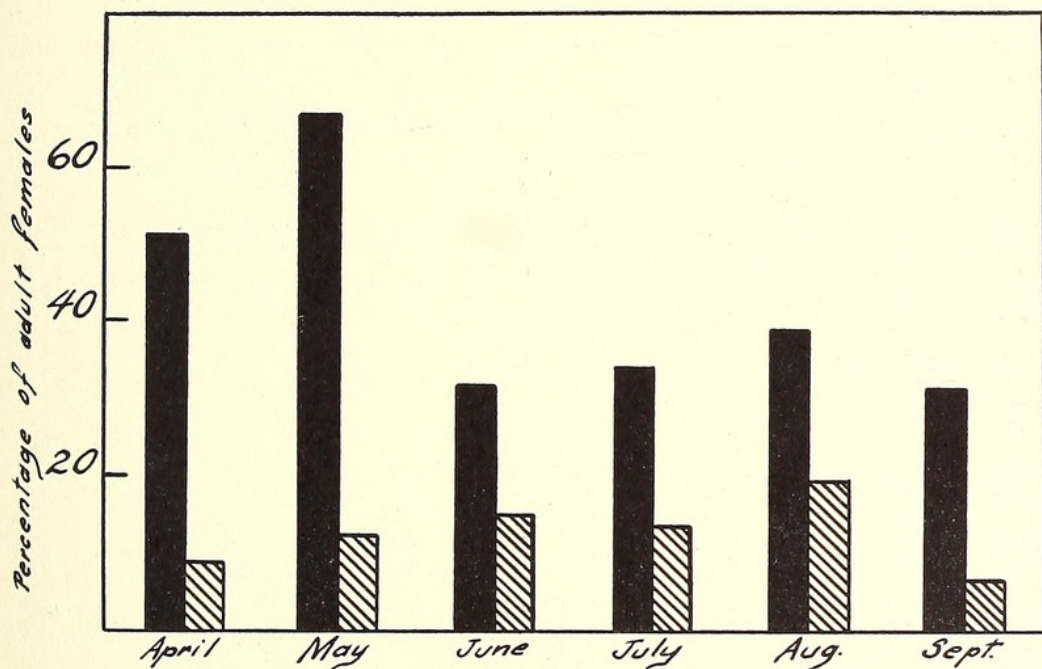


Text-figure 13.

Seasonal distribution of adults (solid bars) and young (hatched bars) of *Acantheephyra purpurea* computed from specimens taken in 1929 and 1930 between 500 and 1,000 fathoms.

For remarks on the food of this species, see the general discussion at the end of this paper.

Seasonal Distribution: Text-fig. 13 shows the fluctuation in the population of *A. purpurea* from April to September for the years 1929 and 1930. Although the population, particularly in regard to the proportion of young or immature specimens, is reasonably uniform throughout this period of the year, it will be noted that there is apparently a perceptible increase in the total population in July, August and September. It will also be noticed that there is a much greater proportion of young in September than in June. Although a slightly larger proportion of the September tows were made in shallow water where young are somewhat more abundant, this difference is hardly great enough to produce such a change in the total population. It must be kept in mind that no attempt was made to segregate various sizes of young and the presence of more than one age class might very well serve to confuse the general aspect of the results. However, there is certainly an indication of an increase in the numbers of young individuals early in the fall.



Text-figure 14.

Seasonal distribution of ovigerous females of *Acanthephyra purpurea* computed from specimens taken in 1929 and 1930 between 500 and 1,000 fathoms. Solid bars represent the percentage of all females which were ovigerous; hatched bars the percentage of all females which carried eggs in which the eyes were visible.

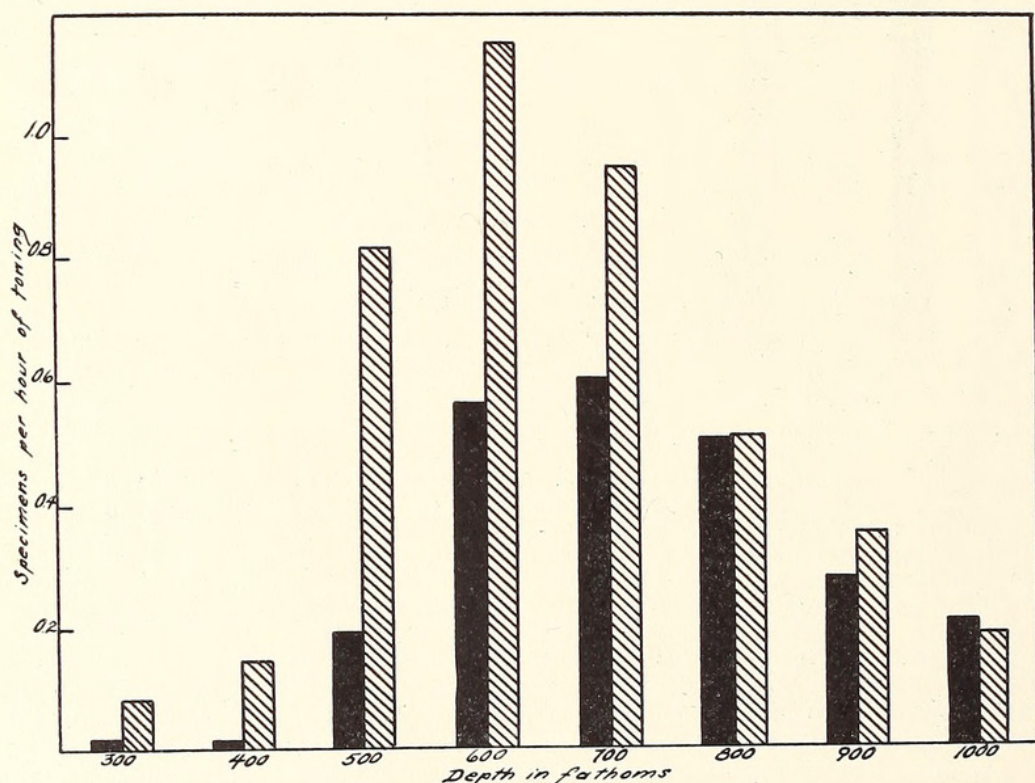
The distribution of ovigerous females over the same six months period, as shown in Text-fig. 14, indicates little more than that there is no sharply defined "breeding period" during this part of the year. Whether the eggs are carried throughout the year in this area can be ascertained only by additional towing in the winter months. The suggestion has been advanced that the eggs are carried by the female for a considerable length of time but hatch only during a short period when conditions are most favorable, but if it is assumed that eggs in which the eyes of the larvae are visible are nearly ready to hatch the present material would seem to refute this hypothesis.

Vertical Distribution: The vertical distribution of the total catch of *A. purpurea* from 1929 through 1935 is given in the following table:

Fathoms	Males	Females	Young
300.....	2.....	2.....	19
400.....	2.....	1 (ovig.).....	31
500.....	57.....	80 (31 ovig.).....	584
600.....	161.....	220 (79 ovig.).....	782
700.....	227.....	193 (80 ovig.).....	662
800.....	203.....	150 (51 ovig.).....	356
900.....	138.....	70 (16 ovig.).....	260
1,000.....	115.....	78 (20 ovig.).....	171
1,100.....	4.....	1.....	2
1,200.....	.....	1.....	.....

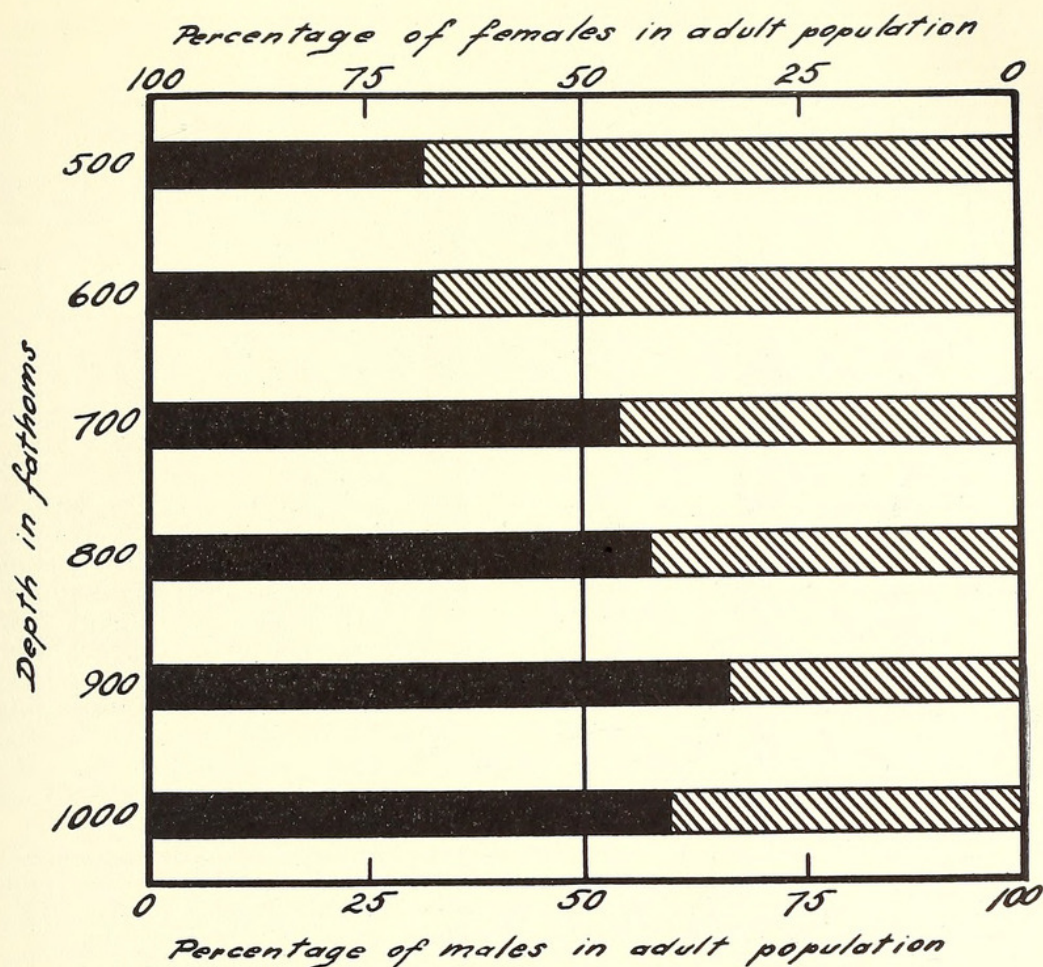
Text-fig. 15 shows the distribution of all adult and young specimens captured between 300 and 1,000 fathoms. All of these specimens were taken in the daytime; in fact, I have seen no specimens from nets 224 to 229 which were towed at night between 500 and 1,000 fathoms. This may or may not indicate that the center of distribution of the species is above 500 fathoms at night (see Welsh, Chace & Nunnemacher, 1937, p. 190). It is obvious that in the daytime most adults are to be found between 600 and 800 fathoms and, inasmuch as open nets were employed, it is not unlikely that there are fewer individuals at 900 and 1,000 fathoms than indicated here. The center of abundance of the young population, on the other hand, is slightly nearer the surface, between 500 and 700 fathoms, and the greatest number of young in proportion to the number of adults is found at 500 fathoms.

This collection has disclosed the interesting fact that the male portion



Text-figure 15.

Vertical distribution of adults (solid bars) and young (hatched bars) of *Acantheephyra purpurea*.

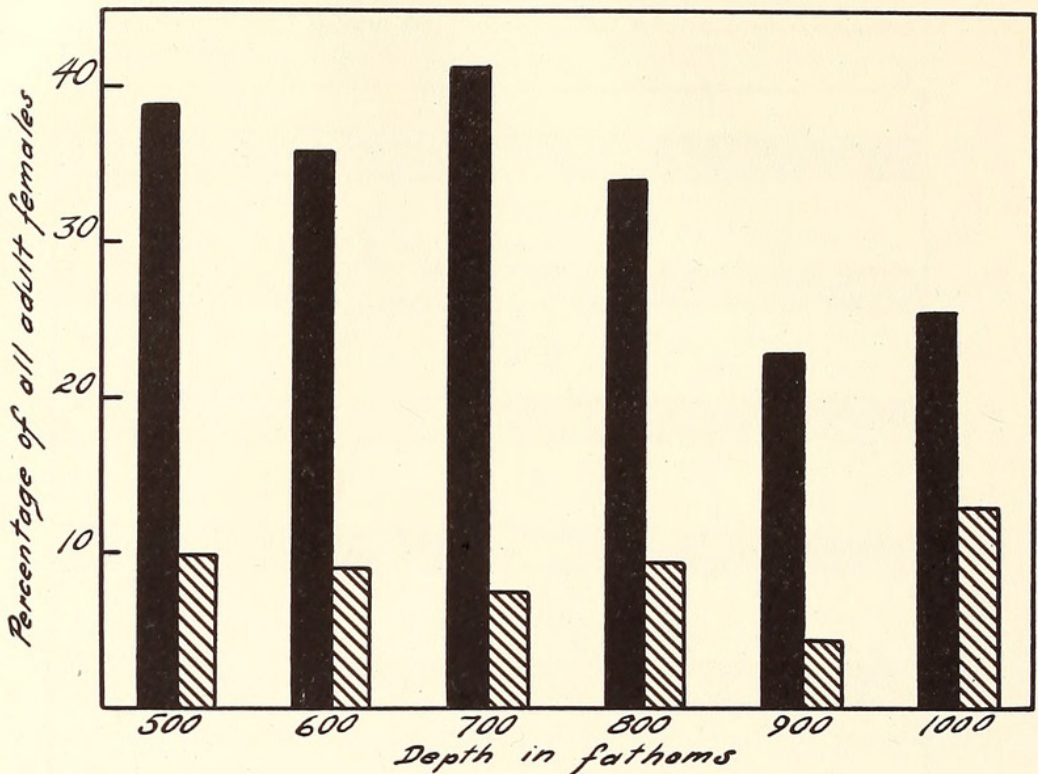


Text-figure 16.

Relative abundance of males and females of *Acanthephyra purpurea* from 500 to 1,000 fathoms. Solid bars represent the male fraction of the adult population; hatched bars the female.

of the adult population is found in somewhat deeper water than the female portion, as shown in Text-fig. 16. If these findings accurately represent the actual conditions, one would expect to find equal numbers of males and females at about 675 fathoms, whereas above that level the females are in the majority and below it, the males. Whether the female population increases slightly again in proportion at 1,000 fathoms as shown by these data is problematical since it must be kept in mind that catches from the deeper tows must have been somewhat contaminated with specimens from lesser depths through the use of open nets. It might be supposed that this curious distribution of the two sexes in *A. purpurea* could be accounted for by the possibility that ovigerous females came up into lesser depths to hatch their eggs, but this is hardly borne out by the present material as shown in Text-fig. 17, which shows the percentage of all females which are ovigerous at each depth. Although there is a slightly larger proportion of ovigerous females from 500 to 800 fathoms, the largest fraction is found at 700 fathoms where more than half of the population is made up of males. These data also tend to refute the theory that the eggs are hatched near the surface, for the largest proportion of specimens carrying eyed eggs was taken in 1,000 fathoms.

Geographical Distribution: Inasmuch as many workers, including my-



Text-figure 17.

Vertical distribution of ovigerous females of *Acanthephyra purpurea*. Solid bars represent the percentage of all females which were ovigerous; hatched bars the percentage of all females which carried eggs in which the eyes were visible.

self, have previously confused several closely related species with *A. purpurea*, the distribution of this form is somewhat in doubt. However, as Kemp (1939) has shown, it is not a world-wide form as generally considered, but is probably restricted to the north Atlantic between about 20° and 53° north latitude.

Acanthephyra haeckelii (von Martens).

Text-figs. 18-20.

Ephyra Haeckelii von Martens, 1868, p. 54, pl. 1, figs. 7a-b.

Acanthephyra agassizii Smith, 1884 (not 1882), p. 372 (part), pl. 8, fig. 1.

Acanthephyra sica Bate, 1888, p. 739, pl. 125, fig. 1.

Acanthephyra rectirostris Riggio, 1901, p. 20.

Acanthephyra purpurea var. *multispina* Coutière, 1905, p. 10.

Acanthephyra multispina Murray & Hjort, 1912, pl. 3, fig. 1 (col. fig.); Stephensen, 1923, p. 44.

Acanthephyra haeckeli Kemp, 1939, p. 575.

Diagnosis: Integument firm. Rostrum long and slender. Carapace not dorsally carinate posteriorly. Branchiostegal spine supported by a short carina. Abdomen carinate on all but the first somite and with a medium posterior spine on the third, fourth, fifth and sixth somites; telson dorsally

sulcate on proximal half and armed usually with eight to eleven pairs of lateral spines.

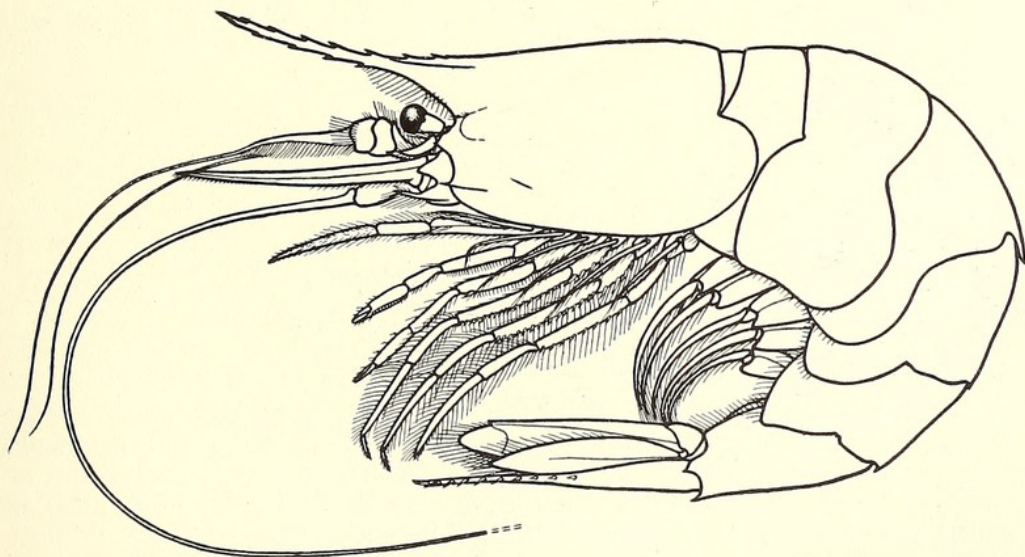
Measurements: The smallest recognizable male has a carapace length of 10.0 mm. The largest male in the collection has a carapace length of 24.0 mm., and the largest female, 24.5 mm. Of thirteen specimens in which the carapace measures 20.0 mm. or over, ten are males and three females. In the smallest specimen seen, the carapace measures 2.6 mm.

Color in Life: Body and appendages brilliant scarlet-red, with the setae somewhat lighter and with the antennae, antennal scales and proximal segments of the pleopods tinged with salmon-orange. Eyes black.

General Remarks: This species is much less common in the Bermuda area than the last. The collection contains only 217 specimens, of which 35 are males, 36 females and 146 young.

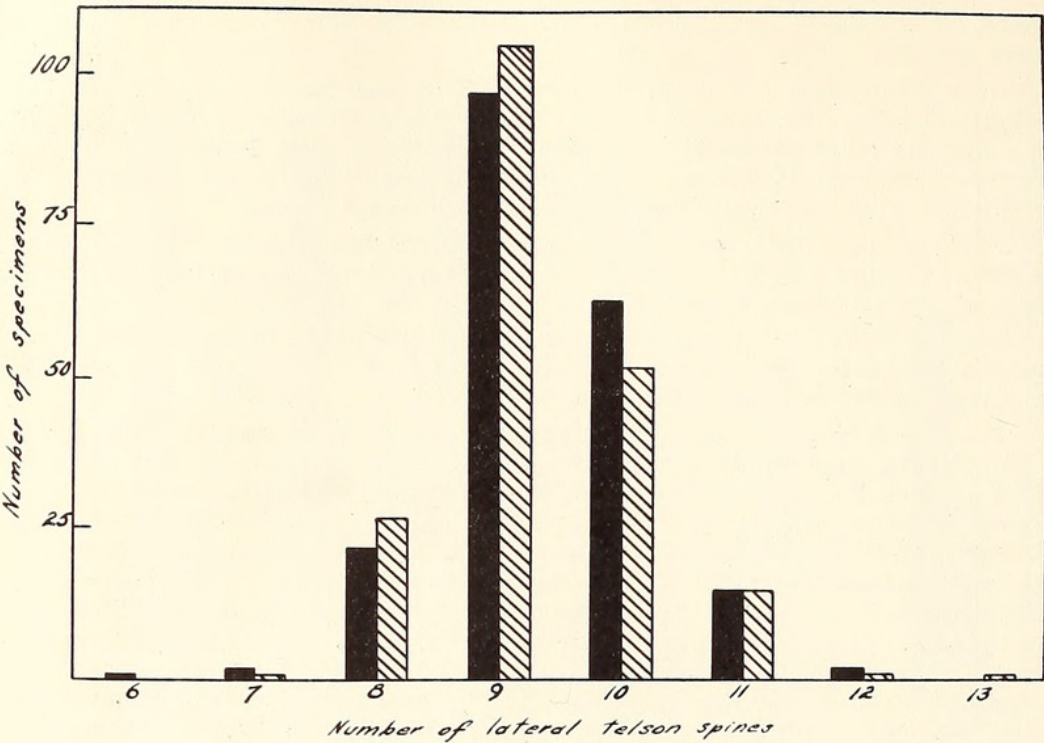
A. haeckelii can be readily distinguished from *A. purpurea* by the tooth on the fourth abdominal somite and the greater number of dorso-lateral spines on the telson. It will be seen from Text-fig. 19 that the most common number of lateral telson spines on either side is nine, followed in order by ten, eight, and eleven. Six, seven, twelve and thirteen spines occur so rarely that such a condition might well be regarded as abnormal. This species also attains a larger size than the preceding, and the rostrum is usually somewhat shorter proportionately in the Bermuda specimens. In studying the present collection, it was noticed that in the preserved specimens of *A. haeckelii* the abdomen was generally fully flexed as in the accompanying figure, whereas in those of *A. purpurea* it is usually merely bent sharply at the third somite, and the dorsal margins of the fourth and fifth somites most frequently form a straight line.

It is noteworthy that none of the females carried eggs. On the basis of the percentage of ovigerous specimens in *A. purpurea*, one would expect about twelve of the 36 females of *A. haeckelii* to be ovigerous also. The most plausible explanation would seem to be that this region is not included in the normal range of the species and that breeding does not occur due to the unfavorable conditions. There is the possibility, of course, that ovigerous females might be found during the winter months, but the apparent absence of any well defined "breeding season" in *A. purpurea* would tend to preclude



Text-figure 18.

Acanthephyra haeckelii. Male taken in September, 1929, from 900 fathoms. $\times 1.45$.



Text-figure 19.

Distribution of the lateral telson spines in *Acanthephyra haeckelii*. Solid bars represent the spines on the left side of the telson; hatched bars those on the right.

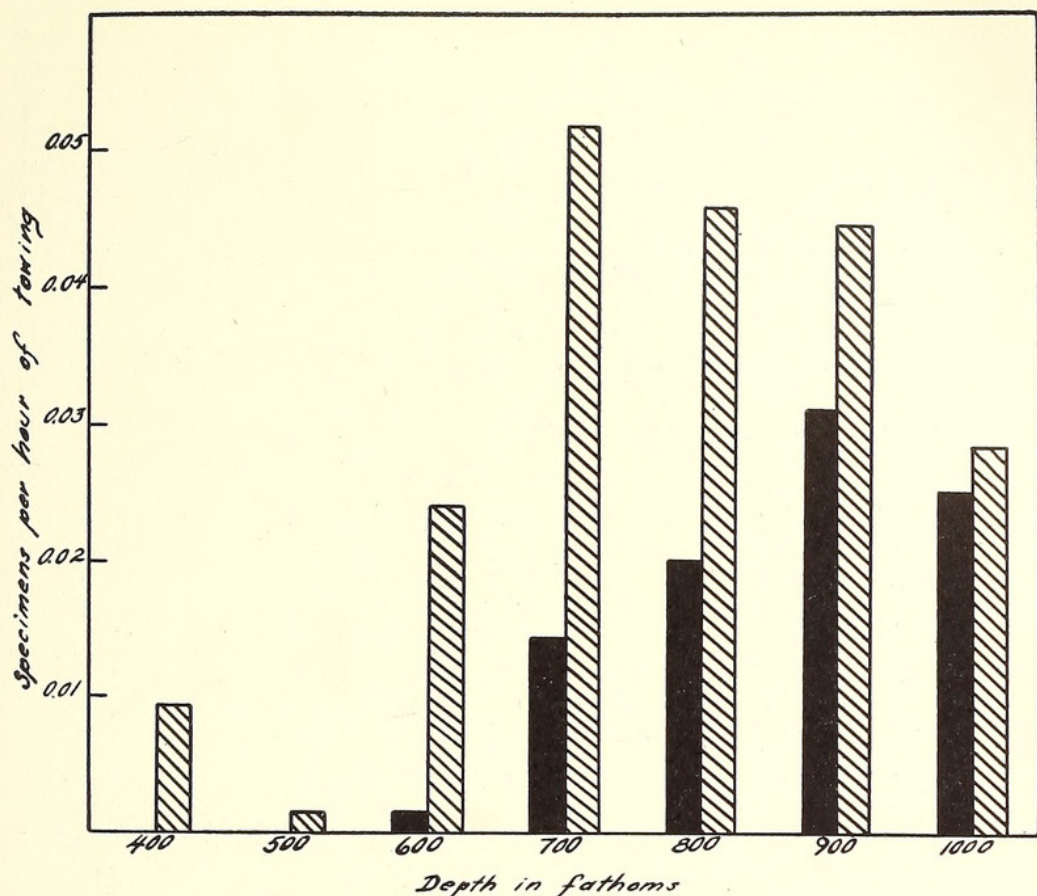
this possibility. Finally, one must not entirely disregard the chance that a greater number of females might disclose some with eggs, especially since Stephensen, 1923, reports finding only seven out of 72 females of this species carrying eggs in contrast to 17 out of 58 in the case of *A. purpurea*.

Seasonal Distribution: The number of specimens is obviously too small to give any indication of the seasonal distribution of the species. Both adults and young were taken in every month of 1929 and 1930 in which towing was done, i.e. from April to September.

Vertical Distribution: The following table shows the vertical distribution of the total catch of *A. haeckelii* from 1929 through 1935:

Fathoms	Males	Females	Young
400			2
500			1
600.....	1		16
700.....	3.....	7	36
800.....	8.....	6	32
900.....	15.....	8	33
1,000.....	8.....	15	26

When correlated with the number of hours of towing at each depth, these data are shown graphically in Text-fig. 20. All of these specimens were taken in the daytime. A comparison with the vertical distribution of *A. purpurea* leaves little doubt that *A. haeckelii* is usually found at greater depths in the area in question. In *A. purpurea* the center of the adult population was found to be between 600 and 800 fathoms, whereas in *A. haeckelii* it seems to be at about 900 fathoms. The greatest number of young, although higher in the water than the adults, were not as near the surface as those of *A. purpurea*. In the latter, the young were most numerous at from



Text-figure 20.

Vertical distribution of adults (solid bars) and young (hatched bars) of *Acantheephyra haeckelii*.

500 to 700 fathoms, while in *A. haeckelii* the center of abundance seems to be between 700 and 900 fathoms.

Geographical Distribution: This species is known from the North Atlantic as far north as Davis Strait, the Mediterranean and the South Atlantic, South Pacific and Indian Oceans. In the western North Atlantic *A. haeckelii* seems to be much commoner than *A. purpurea* west of the Gulf Stream, whereas the present collection certainly indicates that the reverse is true in the Sargasso area. Our present knowledge of the distribution of the two species in the North Atlantic would lead to the assumption that *A. haeckelii* is normally a colder water form than *A. purpurea*.

***Acantheephyra curtirostris* Wood-Mason.**

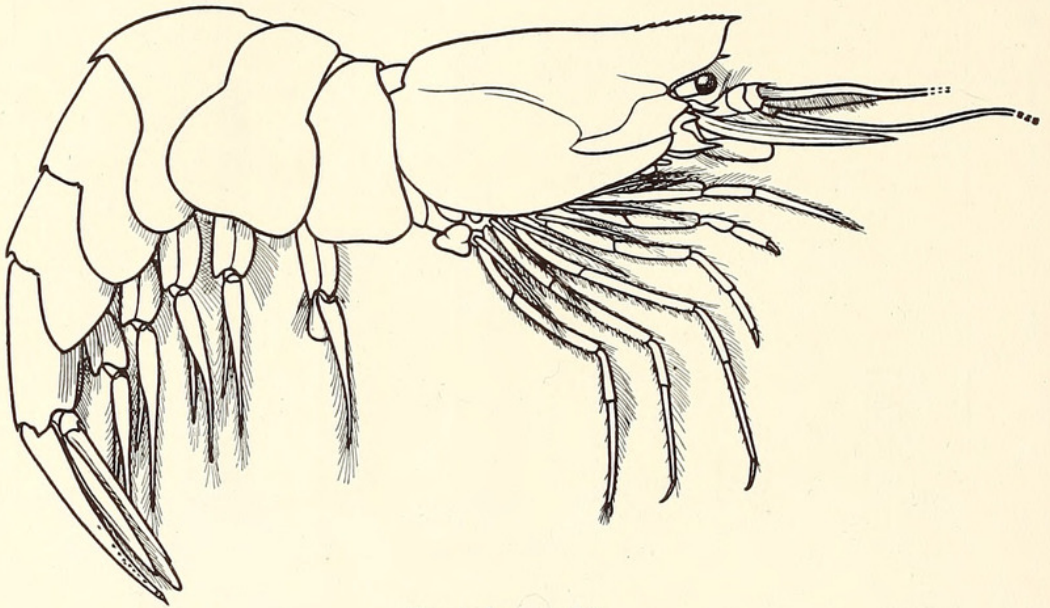
Text-fig. 21.

Acantheephyra curtirostris Wood-Mason, 1891, p. 195; Balss, 1925, p. 261, fig. 30 (mandible); Chace, 1937, p. 111.

Diagnosis: Integument firm. Rostrum not reaching beyond antennular peduncle and with a single spine on lower margin. Carapace not dorsally carinate posteriorly. Branchiostegal spine supported by a carina which extends back to posterior part of branchial region. Abdomen carinate on all but the first somite and with a median posterior spine on the third, fourth, fifth and sixth somites; telson dorsally sulcate on proximal half and armed with six to fifteen dorso-lateral spinules.

Color in Life: Crimson (Alcock, 1901). From recently preserved specimens, both from the Atlantic and the Pacific, I would infer that the general color of this species is very similar to that in *A. purpurea* and *A. haeckelii*.

Remarks: This species is represented by a single young specimen (carapace length, 4.0 mm.) from Net 1273, 1279, 1285, 1293, 1316 or 1328, September 7 to 19, 1932, from 800 fathoms. Had I not recently seen several adult specimens of this species from the West Indian region, I should have been very hesitant about the determination of this young specimen, but there is little doubt that it belongs to this species.



Text-figure 21.

Acanthephyra curtirostris. Male from Tongue of the Ocean, Bahamas. $\times 1.44$.

Geographical Distribution: *A. curtirostris* ranges from the east coast of Africa through the Indian Ocean, Malay, Philippine and Japanese regions to the Hawaiian Islands and the west coast of America from San Diego to Peru. In the Atlantic it has been known only from a specimen in the U. S. National Museum taken off British Guiana. Recently I have seen several specimens taken by the *Pawnee* in the Bahaman region and by the *Atlantis* off the north and south coasts of Cuba. Although apparently less common in the Atlantic than off the Pacific coast of America, the limits of range in both areas appear to be similar.

***Acanthephyra stylorostrata* (Bate).**

Text-fig. 22.

? *Bentheocaris exuens* Bate, 1888, p. 724, pl. 123, figs. 3-30.

Bentheocaris stylorostratis Bate, 1888, p. 726, pl. 123, figs. 4-40.

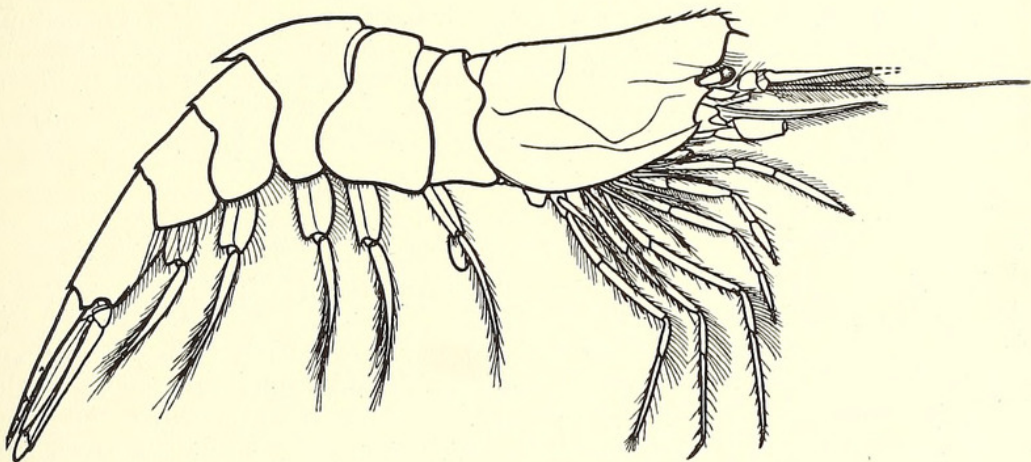
Acanthephyra stylorostratis Calman, 1925, p. 14; Chace, 1936, p. 30.

Diagnosis: Integument rather firm but by no means hard. Rostrum short and high and somewhat semicircular in outline. Carapace not dorsally carinate posteriorly. Branchiostegal spine supported by a long carina which passes back onto the posterior part of the branchial region. Abdomen carinate on all but the first somite and with a median posterior spine on the

third, fourth, fifth and sixth somites; telson dorsally sulcate and armed normally with three pairs of lateral spines.

Measurements: The smallest recognizable males have a carapace length of 8.5 mm. The largest male has a carapace length of 16.2 mm., and the largest female, 13.5 mm. In the smallest of the five ovigerous females taken, the carapace is 10.0 mm. long. The carapace of the smallest young individual measures 2.9 mm. In this and the preceding species the carapace length is shorter in relation to the abdomen than in most other species of the genus, so the total body length, exclusive of the rostrum, will be somewhat greater in these two forms than in specimens of other species of similar carapace measurements.

Color in Life: Body and appendages brilliant scarlet, with salmon-orange setae on antennae, pereopods and pleopods. Eyes golden-bronze, speckled with black. Eggs scarlet.



Text-figure 22.

Acantheephyra stylorostrata. Male taken in June, 1930, from 900 fathoms. $\times 1.74$.

General Remarks: This species is represented by 91 specimens; 17 males, 15 females, of which 5 are ovigerous, and 54 young.

The form of the rostrum distinguishes this species at a glance. It is very probable that Bate's *Bentheocaris exuens* is the same species but, inasmuch as Calman states that the type is in such condition that comparison is almost impossible and as Bate's figure is inadequate, it seems best to retain the much more suitable name, *stylorostrata*, for this form.

Practically all of the specimens in the collection have three pairs of dorso-lateral spines on the telson; I have seen but two which vary from this pattern and they have four on the left side and three on the right.

Vertical Distribution: The following table shows the depths at which this species were found:

Fathoms	Males	Females	Young
600			2
700		1 (ovig.)	6
800	2	5 (2 ovig.)	11
900	5	4 (1 ovig.)	21
1,000	10	5 (1 ovig.)	13
1,100			
1,200			1

Seasonal Distribution: There is no obvious seasonal or yearly variation in the numbers of specimens found in the Bermuda area. Of the five oviger-

ous females, two were taken in July, 1930, one either in June, July or August, 1931, one in August, 1931, and one in October, 1931. In one of the specimens taken in July, 1930, the eyes of the larvae can be seen through the egg membranes.

Obviously, *A. stylorostrata* is a deep water species usually found from 800 to 1,000 fathoms. Although the number of adults taken was small, it will be noticed that, as in *A. purpurea*, the males seem to be found at somewhat deeper levels than the females. The single female which carried eyed eggs was found at 1,000 fathoms. Even the young of this species seem to be found in considerable depths, since the greatest number came from 900 fathoms.

Geographical Distribution: *A. stylorostrata* has been recorded previously in the eastern North Atlantic in the region of Madeira, the Canaries and the Cape Verde Islands as far west as 45° west longitude. A few specimens have been seen from the region of the Gulf Stream east of New Jersey, and Calman records specimens from off Natal, South Africa. *Bentheocaris exuens*, which is probably the same species, came from the South Pacific south of the Tuamotu Archipelago.

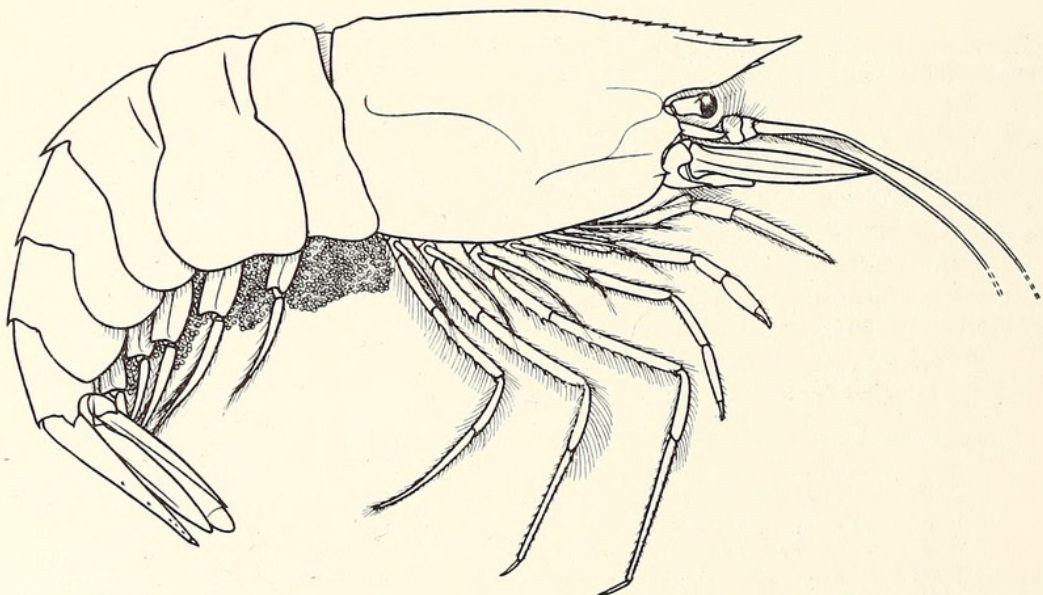
***Acanthephyra acutifrons* Bate.**

Text-fig. 23.

Acanthephyra acutifrons Bate, 1888, p. 749 (part), pl. 126, fig. 3; Kemp, 1906, p. 20; Balss, 1925, p. 261.

Diagnosis: Integument firm but not hard. Rostrum rather short and deep with a single ventral tooth. Carapace dorsally carinate for its entire length. Branchiostegal spine supported by a short, rounded ridge. Abdomen carinate on every somite and with a median posterior spine on the third, fourth, fifth and sixth somites; telson dorsally sulcate and armed with five or six pairs of lateral spinules.

Color in Life: Unknown.



Text-figure 23.

Acanthephyra acutifrons. Ovigerous female from Tongue of the Ocean, Bahamas. $\times 0.80$.

Remarks: Two young specimens (carapace lengths, 5.1 and 7.1 mm.) from Net 813, 823, 830, 839, 843, 849, 855, 861 or 866, August 28 to September 10, 1930, 700 fathoms, and Net 1272, 1278, 1284, 1292, 1297, 1315 or 1327, September 7 to 19, 1931, 700 fathoms, are assigned to this species. Although they bear a striking resemblance to *A. curtirostris*, the completely carinated dorsal margin of the carapace and the absence of a long carina supporting the branchiostegal spine eliminates that species.

Despite the fact that the *Valdivia* obtained a specimen of *A. acutifrons* in a vertical net, one would guess that adults of this heavy-bodied species are largely benthonic and it is possible that only young individuals are usually encountered in midwater.

Geographical Distribution: Only two specimens of this species are recorded in the literature: the type from the Indian Ocean (Kemp believes the other specimens included under this species by Bate to be *A. curtirostris*) and the *Valdivia* specimen collected south of Sumatra. In addition, I have examined seven specimens taken by the *Albatross*, *Pawnee* and *Atlantis* in the Gulf of Mexico and the West Indian region.

***Acantheephyra eximia* Smith.**

Text-fig. 24.

Acantheephyra eximea Smith, 1884, p. 376; Smith, 1886, pl. 14, fig. 1.

Acantheephyra angusta Bate, 1888, p. 737, pl. 124, fig. 6.

Acantheephyra edwardsii Bate, 1888, p. 747, pl. 126, fig. 1.

Acantheephyra brachytelsonis Bate, 1888, p. 753, pl. 126, fig. 7.

Acantheephyra eximia Wood-Mason & Alcock, 1892, p. 361, fig. 3.

Acantheephyra brachytelsonis Wood-Mason & Alcock, 1892, p. 362, fig. 4.

Acantheephyra eximia Kemp, 1906, p. 20.

Acantheephyra eximea Chace, 1936, p. 27.

Acantheephyra eximia Calman, 1939, p. 191.

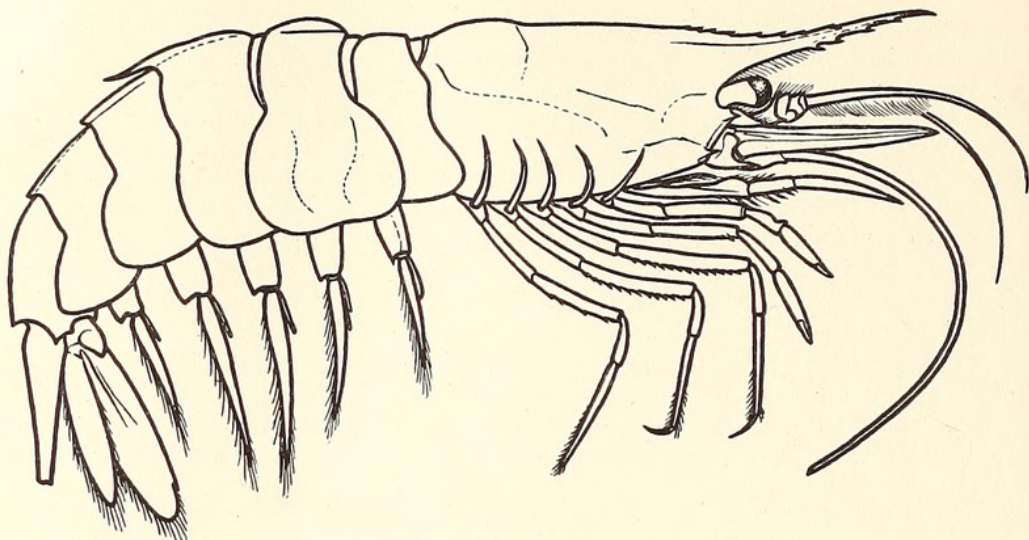
Diagnosis: Integument firm but not hard. Rostrum rather long and slender. Carapace dorsally carinate throughout its length. Branchiostegal spine not supported by a ridge. Abdomen carinate on all but the first somite and with a median posterior tooth or spine on the third, fourth, fifth and sixth somites, that of the third much the largest and those of the fourth and fifth often very small; telson faintly ridged dorsally and armed with from three to five pairs of lateral spinules.

Color in Life: Crimson (Alcock, 1901).

Remarks: Three specimens, all young, are referred to this species. One specimen with a carapace length of 8.9 mm. was taken in Net 257, 263, 269, 275, 281 or 288, July 5 to 11, 1929, from 800 fathoms; one specimen with a carapace length of 3.9 mm., from Net 427, 448, 462, 466, 467 or 476, September 5 to 13, 1929, from 900 fathoms; and one specimen with a carapace length of 5.2 mm. from Net 931, 935, 949, 962 or 969, September 22 to 30, 1930, from 800 fathoms.

This is another of that group of species which are apparently usually found on or near the bottom as adults.

There seems to be no excuse at the present time for separating *A. brachytelsonis* from this species, as the distinction between the two rests largely on the number of teeth on the lower margin of the rostrum. Apparently specimens having three teeth on the lower margin are commoner in the Pacific and those with four in the Atlantic, but the number varies from one to five, and I have seen one individual which was entirely devoid of ventral rostral teeth.



Text-figure 24.

AcanthePHYRA eximia. Holotype male (after Smith, 1886).
 × 1.03.

Calman, 1939, has pointed out that Smith, 1884, in one place in the original description used the correct form of the specific name, *eximia*, so it is probably advisable to regard the spelling, *eximea*, as a *lapsus calami*.

Geographical Distribution: This is a widely distributed species, having been found in the western Atlantic off the coasts of North and South America and in the Indian and Pacific Oceans from off Cape Natal, Africa, to the Malay Archipelago, Japan and the Hawaiian and Society Islands. A few specimens were also taken by the *Challenger* near the Kermadec Islands. *A. eximia* seems to be most prevalent in the vicinity of land and has been found off most temperate and tropical coasts with the exception of the west coasts of the Americas and the west coasts of Europe and Africa. *AcanthePHYRA pulchra* A. Milne Edwards from the Mediterranean is probably a closely related form.

***AcanthePHYRA brevirostris* Smith.**

Text-fig. 25.

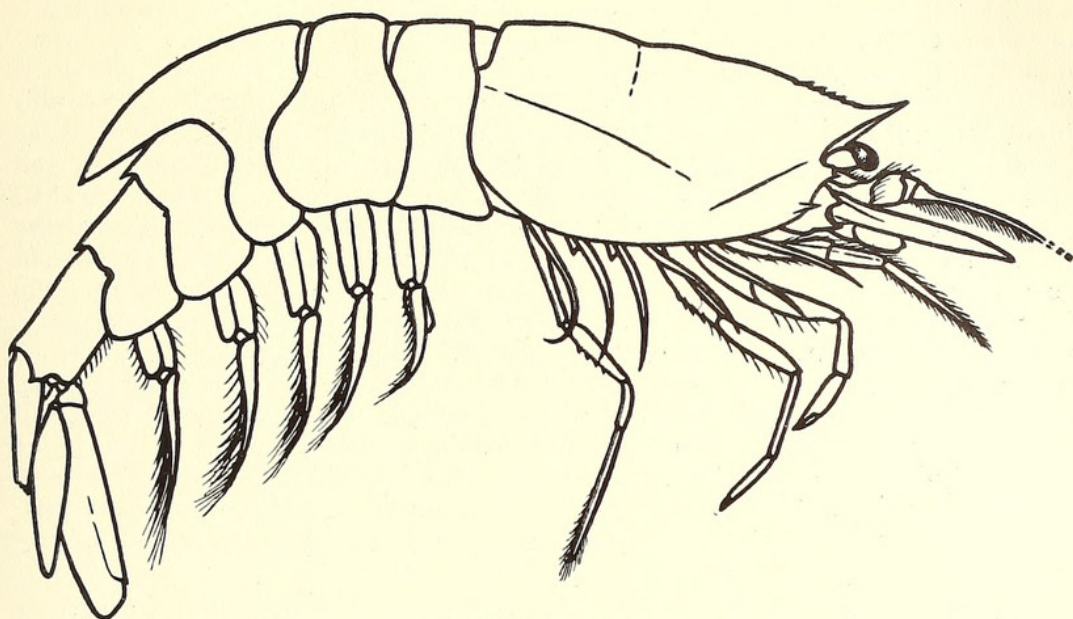
AcanthePHYRA brevirostris Smith, 1885, p. 504; Smith, 1886, p. 670 (66), pl. 14, fig. 2, pl. 15, figs. 2 and 8, pl. 16, figs. 1 and 6; Lenz & Strunck, 1914, p. 327.

Hymenodora duplex Bate, 1888, p. 843, pl. 136, fig. 3.

Diagnosis: Integument soft and almost membranous. Rostrum short. Carapace not dorsally carinate posteriorly. Branchiostegal spine not supported by a ridge. Abdomen carinate on all but the first two somites and with a median posterior tooth or spine on the third, fourth, fifth and sixth somites, that of the third extremely large and fleshy and usually overreaching the fourth somite; telson dorsally sulcate and armed with about five pairs of lateral spinules.

Color in Life: Unknown.

Remarks: This species, which is easily recognized by the large, fleshy spine on the third abdominal somite, is represented in the Bermuda collection by six specimens: a young male having a carapace length of 14.0 mm., and five young in which the carapace length varies from 5.5 to 9.0 mm. The young male was taken in June, July or August, 1931, from a depth of 1,000



Text-figure 25.

Acantheephyra brevirostris. Male from off Chesapeake Bay.
 × 1.55.

fathoms. The young were taken on the following dates: June 19, 1929, June 7, 1930, June 28 to July 4, 1930, September 13 to 19, 1930, and June 2 to August 5, 1931, in depths of 1,000, 1,000, 1,000, 700 and 900 fathoms respectively.

Examination of the mandible discloses that the incisor process is dentate throughout so that there is little doubt that this species is correctly assigned to the genus *Acantheephyra* and does not belong in the genus *Notostomus* as might be assumed from its soft integument and the fact that it has no close relatives among the species of the former genus.

It is not improbable that adults of *A. brevirostris* are usually found on, or close to, the bottom. At least it is evidently a deep-water form since no adults have been recorded from less than 1,000 fathoms.

Geographical Distribution: The majority of the recorded specimens of this species were taken off the east coast of the United States, but it has also been found in the Equatorial Atlantic, off Marion Island, southeast of the Cape of Good Hope and in the eastern Pacific off the coast of Ecuador.

***Acantheephyra gracilipes*, sp. nov.**

Text-figs. 26 and 27.

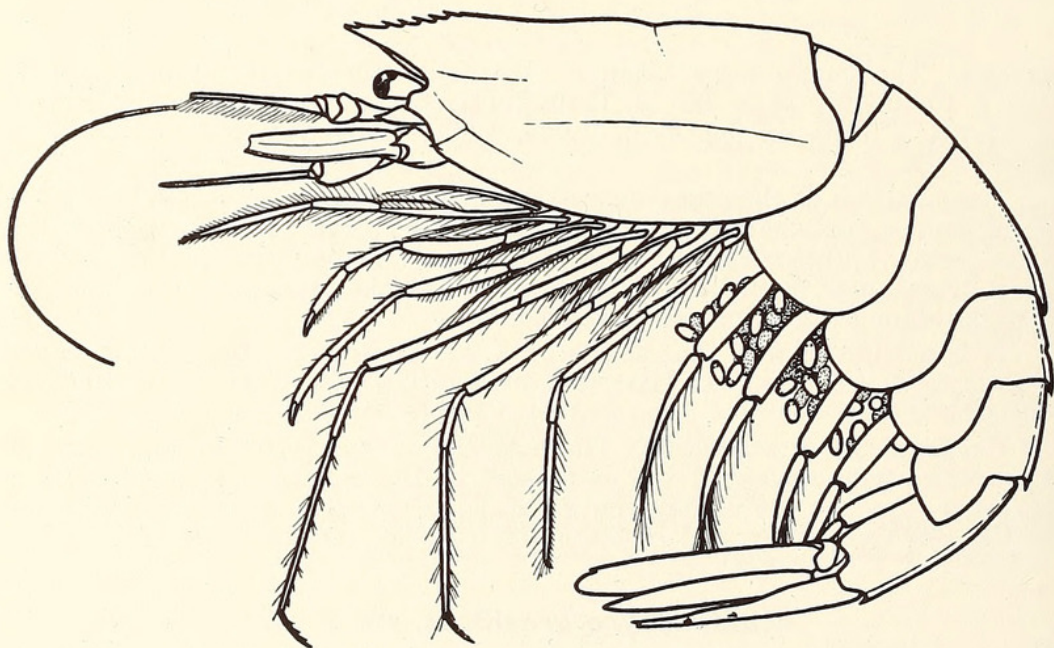
Type: Holotype ovigerous female, Cat. No. 301689 Department of Tropical Research, New York Zoological Society; Net 689 or 734; June 9 or 27, 1930; 1,000 fathoms.

Diagnosis: Integument very thin and fragile. Rostrum short. Carapace not dorsally carinate posteriorly. Branchiostegal spine not supported by a ridge or carina. Abdomen carinate on all but the first two somites and with a median posterior tooth on the third, fourth, fifth and sixth somites; telson dorsally sulcate.

Description: Carapace with a depression in the dorsal margin in the region of the cervical groove. Rostrum triangular, reaching about as far as the third segment of the antennular peduncle and armed dorsally with six

small teeth, two of which are behind the line of the orbit; there are no teeth or spines on the lower edge. The carina supporting the rostrum in the dorsal midline disappears before reaching the cervical groove. Antennal spine so minute as to be scarcely discernible. Branchiostegal spine much more prominent but without any supporting ridge or carina. The integument is so membranous that it is difficult to determine the distinctive grooves and ridges, but they apparently consist of an hepatic groove, a faint cervical groove passing over the dorsal midline and a distinct carina-like ridge above the branchial region passing backward from the hepatic region. Abdomen dorsally smoothly rounded on the first two somites, sharply carinate on the four following. Each of the latter four is provided with a prominent tooth, those of the third, fourth and fifth somites being offset to the left side of the animal as in *Notostomus compsus*. The end of the telson is missing; the remaining portion is dorsally sulcate and armed with two pairs of small spines. Eyes dark brown in alcohol and provided with a papilla on the inner surface just behind the cornea. Antennal scales broken. Third maxillipeds and all of the pereopods very long and slender; the third pereopods, which are the longest, exceed the antennal scale by the dactyl and probably nearly half of the propodus.

In the single specimen, the eggs were apparently nearly ready to hatch as evidenced by the presence of eye spots.



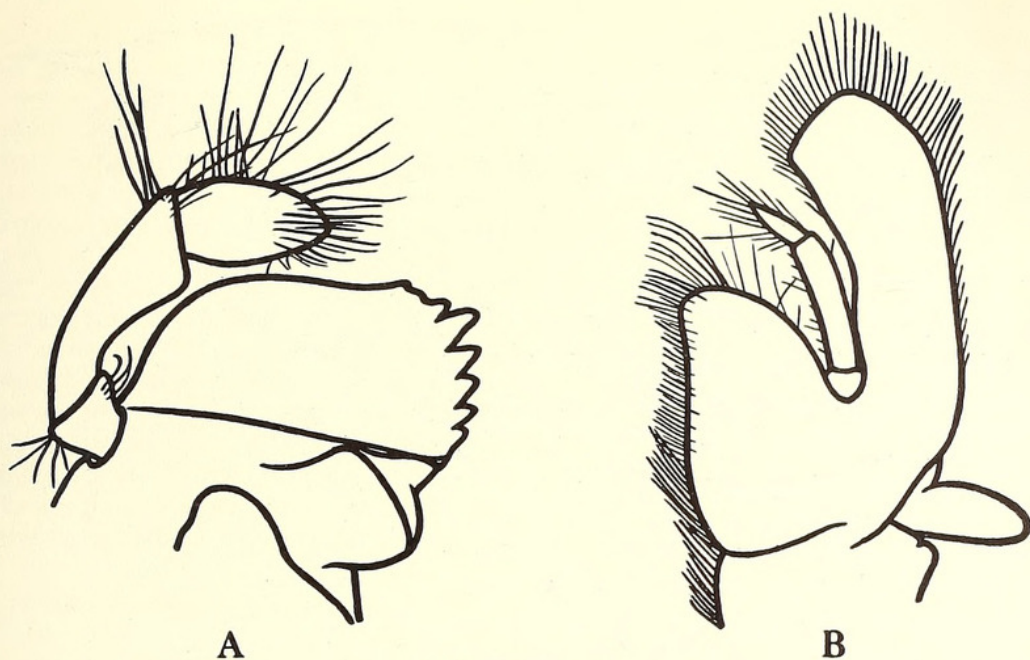
Text-figure 26.

Acantheephyra gracilipes. Holotype ovigerous female. $\times 3.49$.

Measurements: Total length about 42 mm.; length of carapace, 12.4 mm.; length of rostrum, 2.6 mm. The eggs measure about 0.8 mm. in longer diameter.

Color in Life: Unknown.

Remarks: *A. gracilipes* belongs to that group of the genus comprising *A. sibogae* de Man, 1916, *A. cucullata* Faxon, 1893, *A. tenuipes* (Bate, 1888) and *A. indica* Balss, 1925. All of the species of this group have a more or less membranous integument and closely resemble the less specialized



Text-figure 27.

Acantheephyra gracilipes. A. Mandible. B. First maxilliped.

members of the genus *Notostomus*, so much so that their generic status cannot easily be determined except by examination of the mandibles. *A. sibogae* differs from *A. gracilipes* by having the carapace dorsally carinate throughout its length, by having no antennal spine, the branchiostegal spine supported by a carina and no spine or tooth on the third abdominal somite. *A. cucullata* has a much higher and shorter rostrum, the branchiostegal spine supported by a long carina and the second abdominal somite dorsally carinate. *A. tenuipes* more closely resembles *A. gracilipes* and it is difficult from Bate's description and figure to make a very definite comparison with the present species; apparently, however, in *A. tenuipes* the rostrum is higher and somewhat more compressed laterally and (Bate's figure to the contrary) the fourth, fifth and sixth abdominal spines are less prominent than those of *A. gracilipes*. Finally, *A. indica*, which closely resembles the Bermuda species in general form, can be distinguished by the presence of a branchiostegal carina, a carina on the dorsal margin of the second abdominal somite and probably by a much shorter telson. *A. gracilipes* probably has longer and more slender pereopods than any of the other species of the group.

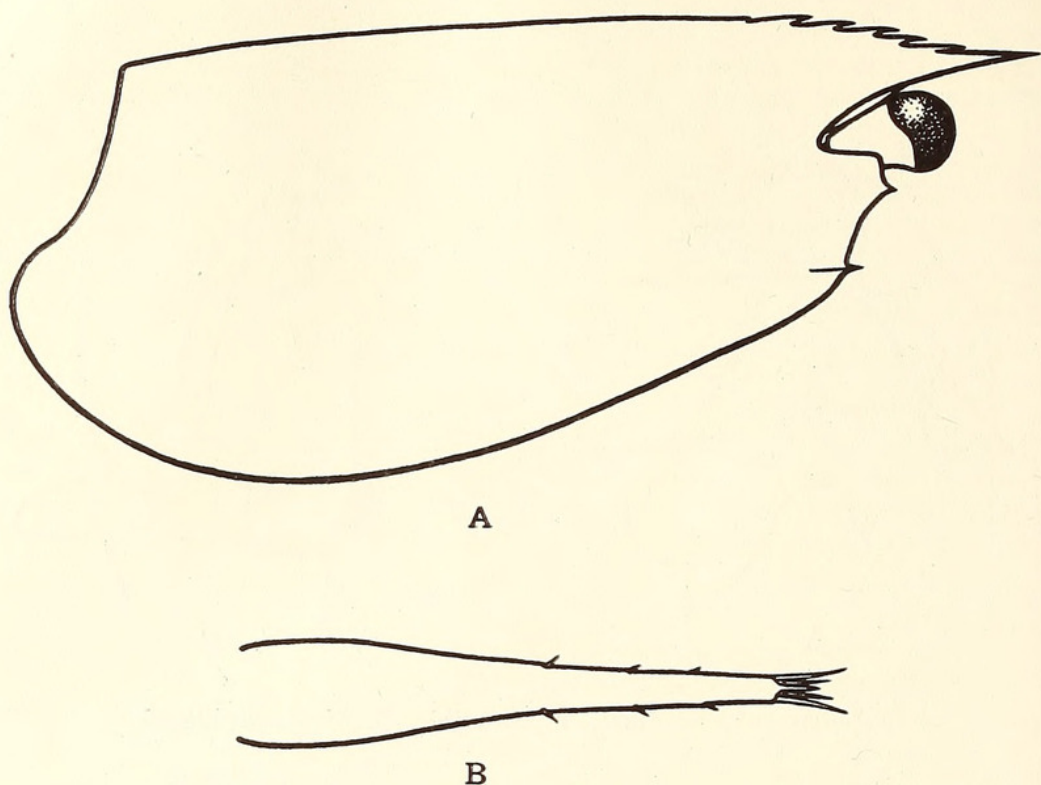
***Acantheephyra*, sp. ?**

Text-fig. 28.

Diagnosis: Integument thin and soft. Rostrum short. Carapace not dorsally carinate posteriorly. Branchiostegal spine supported by a very short carina. Abdomen carinate on all but the first two somites and with, or without, a small posterior spine on the fifth and sixth somites, telson dorsally sulcate and armed with three pairs of lateral spinules.

Color in Life: Unknown.

Remarks: Eight specimens, ranging in size from a carapace length of 3.8 to 5.8 mm., belong to this undetermined species. They were taken in



Text-figure 28.

Acanthephyra, sp. ?. **A.** Carapace of specimen taken in June, July or August, 1931, from 1,000 fathoms. **B.** Telson of same specimen.

June, 1929, June to September, 1930, and June to September, 1931, in 900 and 1,000 fathoms. Since none of the specimens are ovigerous or have an appendix masculina on the second pleopods, it is very likely that they are immature. They most closely resemble *A. rostrata* (Bate, 1888) and may prove to be the young of that species, but they differ from Bate's description and figure in that they have fewer rostral teeth and no long carina-like ridge supporting the branchiostegal spine. The fact that the larger specimens have a small tooth at the end of the sixth abdominal somite and the largest also has a small tooth on the fifth somite indicates that possibly the dentition of the abdominal somites may be further developed in adult individuals if, indeed, the present specimens are actually young.

Genus *Notostomus* A. Milne Edwards, 1881a.

Carapace with at least one straight carina running along the median lateral line from the orbital region to the hind margin, and with an oblique carina delimiting the hind margin of the hepatic furrow. Abdomen carinate on the last four somites, at least. Telson more or less truncate at the tip, not terminating in a sharply pointed end-piece laterally armed with spines. Pereiopods not abnormally broad and flattened. Exopods of third maxillipeds and pereiopods neither foliaceous nor rigid. Eyes well pigmented even when small. Outer margin of antennal scale not armed with a series of spines. Incisor process of mandible toothed for only half the length of the cutting edge.

KEY TO THE BERMUDIAN SPECIES OF *Notostomus*.

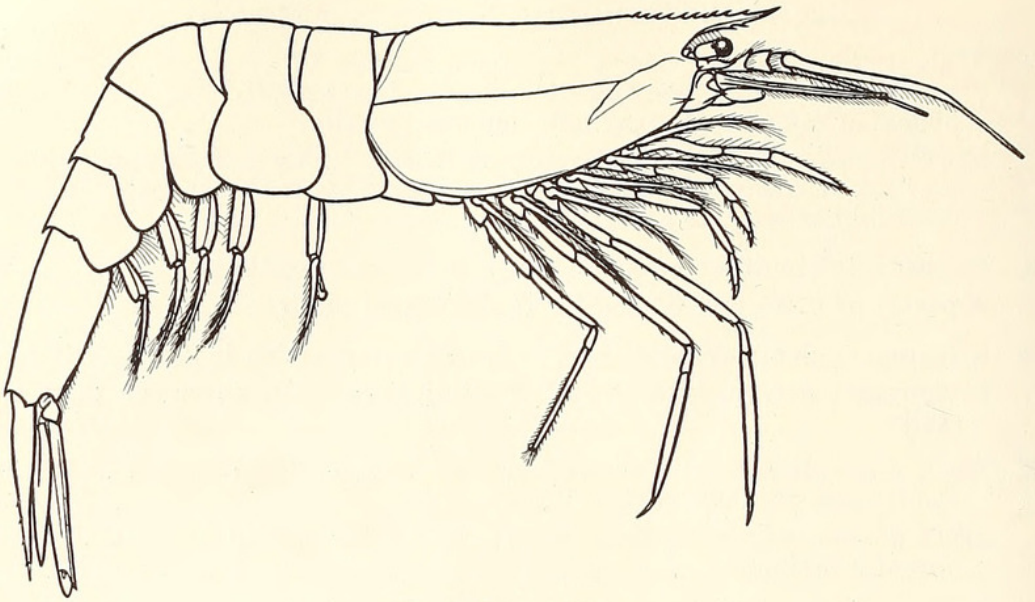
1. A single longitudinal carina on lateral surface of carapace; dorsal margin of carapace not denticulate on posterior three-fourths of its length; abdomen not dorsally carinate on first somite.....2.
More than one longitudinal carina on lateral surface of carapace; dorsal margin of carapace denticulate for nearly its entire length; abdomen dorsally carinate on every somite.....6.
2. No posterior tooth or spine on third abdominal somite.....3.
A posterior tooth or spine on third abdominal somite.....5.
3. Integument firm; eyes at least as broad as eyestalks in lateral view....4.
Integument extremely soft and fragile; eyes much narrower than eyestalks*N. mollis*
4. Sixth abdominal somite about twice as long as fifth; second abdominal somite not dorsally carinate.....*N. vescus*
Sixth abdominal somite little longer than fifth; second abdominal somite dorsally carinate.....*N. compsus*
5. Posterior tooth on third abdominal somite broad and truncate or concave distally; dactyls of chelipeds terminating in two small, blunt spines; size very small.....*N. miccylus*
Posterior tooth on third abdominal somite triangular like those on following somites; dactyls of chelipeds terminating in two long, slender spines; size moderately large.....*N. marptocheles*
6. Not more than two prominent longitudinal carinae on lateral surface of carapace.....*N. distirus*
Four or five longitudinal carinae on posterior half of lateral surface of carapace7.
7. Four longitudinal carinae on posterior half of lateral surface of carapace.....8.
Five longitudinal carinae on posterior half of lateral surface of carapace.....*N. westergreni* ?
8. Post-orbital not continuous with rostral carina.....*N. robustus*
Post-orbital continuous with rostral carina*N. perlatus* ?

***Notostomus vescus* Smith.**

Text-figs. 29 and 30.

Notostomus vescus Smith, 1886, p. 677 (72).*Acanthephyra brevirostris* Bate, 1888, p. 751, pl. 126, figs. 5-6, (Not *Acanthephyra brevirostris* Smith, 1885).*Acanthephyra batei* Faxon, 1895, p. 167.*Acanthephyra batei* Hansen, 1908, p. 77, pl. 4, fig. 2a.*Notostomus batei* Balss, 1925, p. 267.*Notostomus vescus* Chace, 1936, p. 28.

Diagnosis: Integument soft, but not so fragile that the body easily loses its shape. Carapace not inflated, dorsal margin in line with rostrum and not dentate on posterior three-fourths of its length. A single lateral carina on carapace passing from orbit to hind margin. Branchiostegal spine without a carina. Rostrum usually with one or two ventral teeth in addition



Text-figure 29.

Notostomus vescus. Male taken in June, July or August, 1931, from 700 fathoms. $\times 2.91$.

to the dorsal series. Abdomen carinate only on the third, fourth, fifth and sixth somites and with a posterior tooth on the fourth, fifth and sixth; sixth somite about twice as long as fifth. Eyes at least as broad as eye-stalks. Dactyls of first two pairs of pereipods ending in two short spines, one of which falls on either side of the fixed finger when fingers are closed.

Measurements: The smallest recognizable males have a carapace length of about 8.0 mm. The largest male has a carapace measuring 18.0 mm. The largest female gives a corresponding measurement of 16.7 mm. and the smallest ovigerous female, 13.0 mm. The youngest specimen has a carapace 4.3 mm. long.

Color in Life: Of this species, Hansen, 1908, writes, "The carapace is greenish, lighter or darker chiefly according to the colour of the tissues underneath. The dorsal aspect of the first three abdominal segments is gray-green, the lateral surfaces much lighter." Although no color notes were made upon specimens of this species in the Bermuda material, I cannot help but feel that Hansen's specimen may have attained this coloration artificially, possibly from being kept in a copper container which will often affect specimens in this way. I have seen living specimens of this species and, although no color notes were taken, my impression is that the animal was a very dark, dull crimson, the carapace being somewhat darker than the abdomen and very much darker than other bathypelagic forms commonly met with.

General Remarks: This species is represented by 152 specimens; 28 males, 50 females, of which 15 are ovigerous, and 74 young. Seven of the ovigerous specimens are carrying eggs in which the eyes are visible.

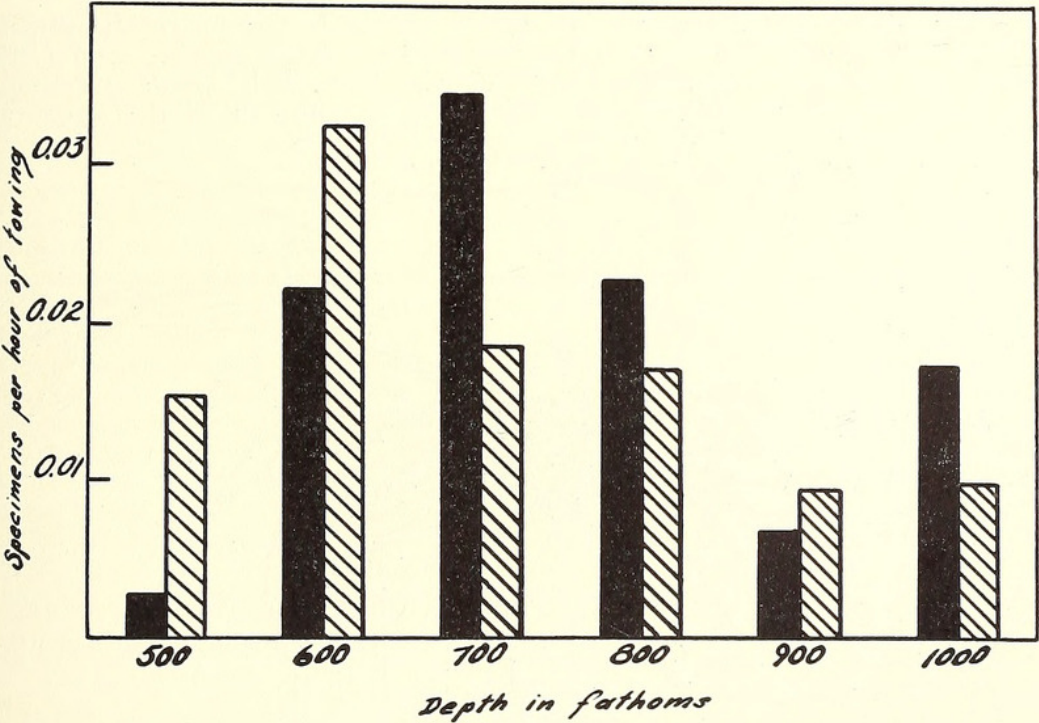
An examination of Smith's type of *Notostomus vescus* in the U. S. National Museum leaves little doubt that *Acantheephyra brevirostris* Bate (= *A. batei* Faxon) is a synonym of Smith's species.

Out of 123 of the Bermuda specimens in which the rostrum was examined, 5 have no ventral rostral teeth, 84 have one such tooth, 32 have two and 2 have three. In several of the very young specimens, the posterior spine on the fourth abdominal somite is minute and sometimes entirely absent.

Seasonal Distribution: Any conclusions as to seasonal distribution based on such a small number of specimens must be accepted with caution. Both adults and young were taken in every month from April to September in 1929 and 1930. Ovigerous females were found in April, May, June, July and August, and those in which the eggs were eyed occurred in May, June, July and August. It is of interest that of the thirteen females taken in September none were carrying eggs, whereas out of a like number taken in June six were ovigerous. If one examines the proportion of specimens carrying eyed eggs out of the number of ovigerous females taken in each month, it is found that the single ovigerous specimen taken in April did not carry eyed eggs, of four taken in May the eggs of one were eyed, of six in June three were eyed and the single ovigerous specimen taken in August carried eyed eggs. One might theorize from this that the eggs usually hatched in June or July, but much more material would have to be accumulated before such a hypothesis could be verified. It will be noted that the total catch contained nearly twice as many females as males. This dissimilarity is found to hold true for every month in which towing was done with the possible exception of September, in which month eleven of the twenty-four adults taken were males.

Vertical Distribution: The following table shows the vertical distribution of the total catch of *N. vescus*:

Fathoms	Males	Females	Young
500.....	1.....	1.....	11.....
600.....	4.....	11 (4 ovig.).....	22.....
700.....	10.....	14 (3 ovig.).....	13.....
800.....	6.....	10 (2 ovig.).....	12.....
900.....	4.....	1 (ovig.).....	7.....
1,000.....	3.....	13 (5 ovig.).....	9.....



Text-figure 30.
Vertical distribution of adults (solid bars) and young (hatched bars) of *Notostomus vescus*.

These data, correlated with the towing time at each depth, are shown in Text-fig. 30. The optimum level for adults appears to be at about 700 fathoms, and for the young at about 600 fathoms. All of these specimens were taken in the daytime. It is difficult to explain the increase in numbers of adults at 1,000 fathoms, but a smooth distribution curve is hardly to be expected with so few individuals and with the use of open nets. Ovigerous females carrying eyed eggs were taken at 600, 700, 800, 900 and 1,000 fathoms, one at each of the first four levels and three at 1,000 fathoms.

Geographical Distribution: *N. vescus* has been recorded from the North Atlantic south of Iceland, off the east coast of the United States, in mid-Atlantic near the equator and in the Bay of Bengal. I have also seen specimens from the Philippine region.

***Notostomus compsus*, sp. nov.**

Text-figs. 31 and 32.

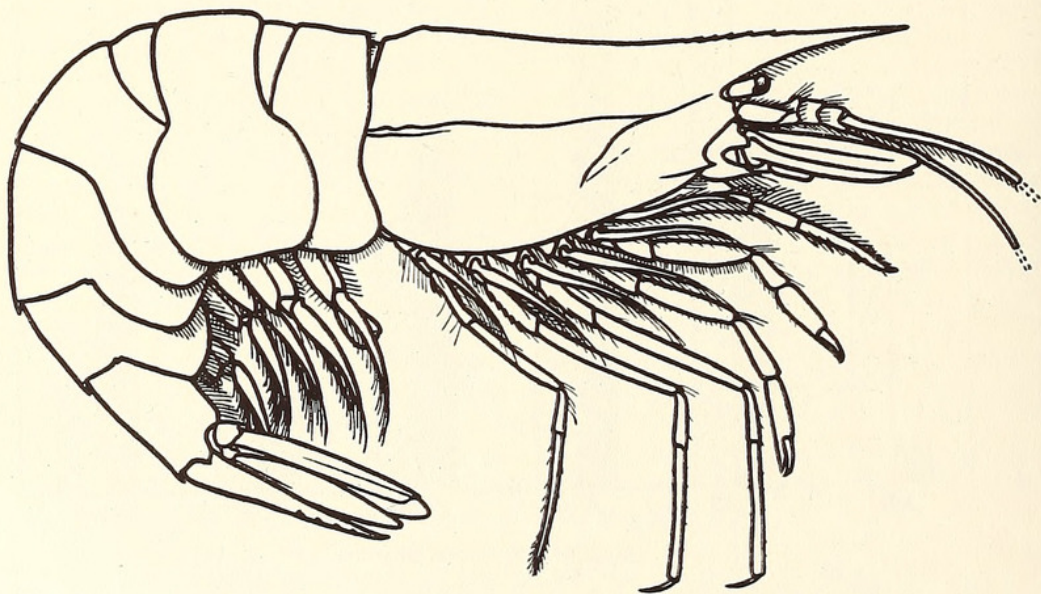
Types: Holotype male, Cat. No. 30,322, Department of Tropical Research, New York Zoological Society; Net 748; June 30, 1930; 900 fathoms.

One ovigerous female; Net 421; September 4, 1929; 1,000 fathoms.

One ovigerous female; Net 552; May 9, 1930; 600 fathoms.

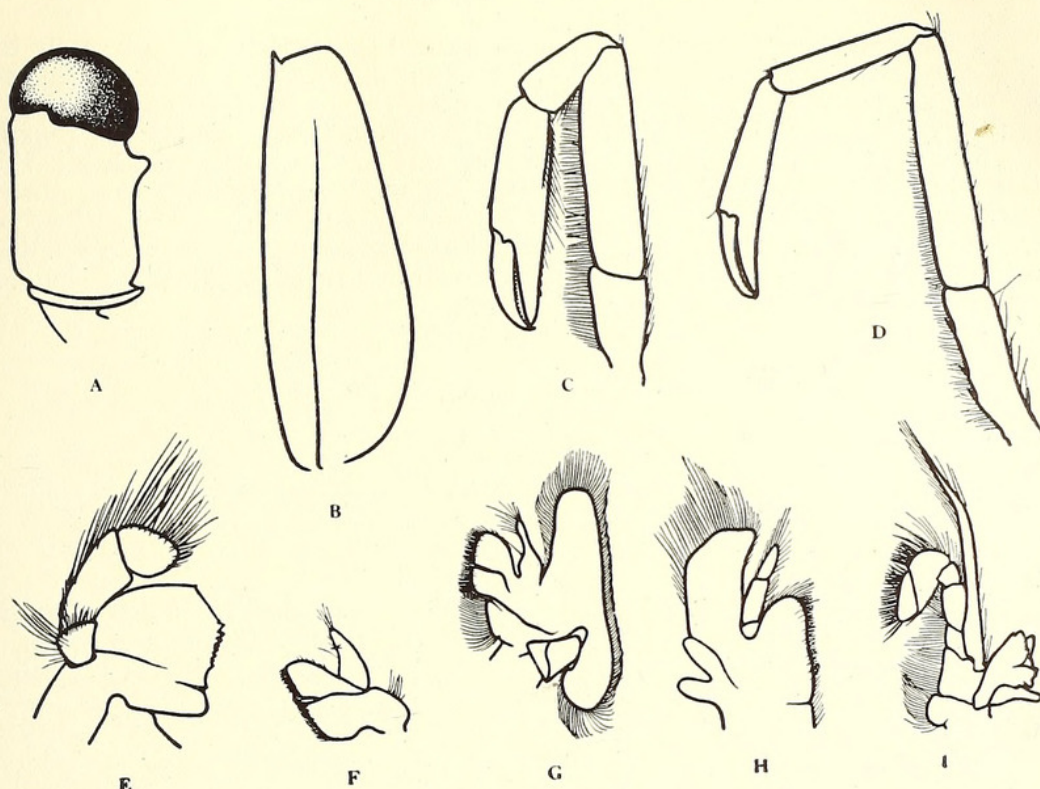
Diagnosis: Integument firm but not hard. Carapace not inflated; dorsal margin in line with rostrum and not dentate on posterior three-fourths of its length. A single lateral carina on carapace passing from orbit to hind margin. Branchiostegal spine supported by a short ridge. Rostrum without teeth or spines on lower margin. Abdomen carinate on all but the first somite, but that of the second is indistinct; a posterior spine on the fourth, fifth and sixth somites; sixth somite little longer than fifth. Eyes as broad as eyestalks, dactyl of first two pairs of pereopods with a minute spine far back from the tip.

Description: Carapace dorsally sharply carinate for nearly its entire length; this carina is somewhat concave in the central portion and rises slightly anteriorly to an acutely triangular rostrum which reaches beyond the antennular peduncles but not quite as far as the tips of the antennal



Text-figure 31.

Notostomus compsus. Holotype male. $\times 1.32$.



Text-figure 32.

Notostomus compsus. **A.** Left eye from above. **B.** Antennal scale. **C.** First pereopod. **D.** Second pereopod. **E.** Mandible. **F.** First maxilla. **G.** Second maxilla. **H.** First maxilliped. **I.** Second maxilliped.

scales. There is a series of about six minute teeth at the base of the rostrum, two of them being behind the line of the orbit, but the anterior third of the rostrum is unarmed. There is no armature on the lower margin. A single lateral carina passes back from the orbit to the hind margin and the usual carina marking the posterior limit of the hepatic furrow is present. Branchiostegal spine supported by a short ridge which disappears before reaching the hepatic furrow. First somite of abdomen smoothly rounded dorsally; second somite with a very faint carina, and this carina increases in importance on each succeeding somite. Third somite unarmed; fourth, fifth and sixth somites with a median posterior spine, those on the fourth and fifth offset to the left side of the mid-line. Sixth somite about one-fifth again as long as the fifth. Telson slightly shorter than the combined lengths of the fifth and sixth somites, deeply sulcate dorsally, armed with four or five pairs of lateral spinules and truncate at the end. Eyes brown in alcohol and about as broad as the stalks; there is a small papilla on the inner side of the stalk. Stylocerite reaches to the end of the first segment of the antennular peduncle. Antennal scale broad with a broad, truncate tip, the inner angle of which overreaches the outer spines. Third maxillipeds extend about to the end of the antennal scales. The fingers of the first two pairs of pereopods close normally, although there is a minute tooth back of the terminal spine of the movable finger. The eggs are proportionately very small, about 1.0 mm. in diameter, nearly spherical and very numerous.

Measurements: Total length of holotype about 112 mm.; length of carapace 28.7 mm.; length of rostrum 15.6 mm.

The ovigerous female from Net 421 has a carapace length of 27.0 mm., and the one from Net 552, 32.2 mm.

Color in Life: Unknown.

Remarks: Except for its much larger size, this species might easily be confused with *N. vescus*. It differs from that species by apparently never having any ventral spines or teeth on the rostrum, by having the branchiostegal spine buttressed by a sharp ridge, by having the spines of the fourth and fifth abdominal somites offset to the left and, finally, by having the sixth abdominal somite very little longer than the fifth, rather than about twice as long as in *N. vescus*. *N. compsus* may be readily separated from *N. mollis*, the only other described species of the genus which lacks a spine on the third abdominal somite, by its much firmer integument, more slender carapace, longer rostrum and larger eyes.

***Notostomus marptocheles*, sp. nov.**

Text-figs. 33 and 34.

Types: Holotype female, Cat. No. 1060, Bingham Oceanographic Collection, Yale University; *Atlantis* Station 1478; lat. 25° 29' N., long. 77° 18' W.; N. E. Providence Channel, Bahamas; February 20, 1933; 875 fathoms of wire.

One young; *Pawnee* Station 46; lat. 21° 46' N., long. 72° 50' W.; north of Little Inagua Island, Bahamas; April 4, 1927; 1,667 fathoms of wire.

One ovigerous female, one young; *Pawnee* Station 48; lat. 21° 44' N., long. 72° 43' W.; north of Little Inagua Island, Bahamas; April 6, 1927; 1,167 fathoms of wire.

One young; D.T.R. Net 81; May 8, 1929; 900 fathoms.

One young; Net 138 (?), 143, 149, 154, 161, 167, 173, 179, 185 (?), 190 or 196; May 30 to June 20, 1929; 800 fathoms.

One young; Net 247; July 1, 1929; 1,000 fathoms.

One ovigerous female; Net 365; August 10, 1929; 1,000 fathoms.

Two young; Net 496 (?) or 516; September 23 or 27, 1929; 1,000 fathoms.

One young; Net 716, 740 or 761; June 17 to July 2, 1930; 900 fathoms.

One young male; Net 726 (?), 733 or 771; June 26 to July 4, 1930; 900 fathoms.

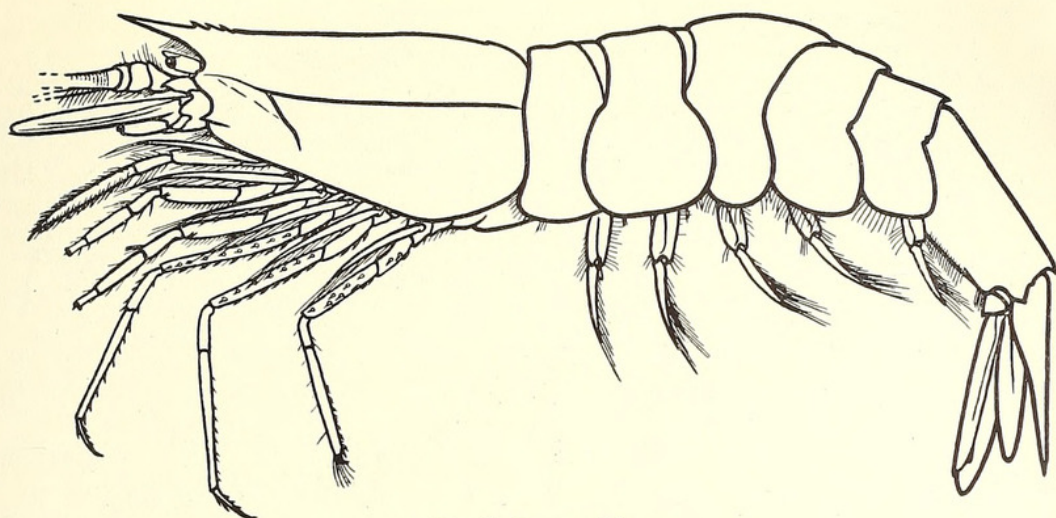
One young; Net 827 or 858; September 1 or 6, 1930; 1,000 fathoms.

One young male; Net 983 (?), 993, 1001, 1007, 1024, 1025, 1105, 1114 (?), 1116, 1124 or 1134; June 2 to August 5, 1931; 800 fathoms.

One female; Net 1165, 1166, 1171, 1178, 1185, 1190, 1203, 1204, 1207, 1208, 1213, 1219, 1230, 1239, 1245, 1251, 1258 or 1264; August 11 to September 4, 1931; 900 fathoms.

Diagnosis: Integument firm but not hard. Carapace not inflated, dorsal margin in line with rostrum and not dentate on posterior three-fourths of its length. A single lateral carina on carapace passing from orbit to hind margin. Branchiostegal spine supported by a very short carina. Rostrum without teeth or spines on lower margin. Abdomen carinate on all but the first somite, but the carina of the second is extremely indistinct; a posterior spine on the third, fourth, fifth and sixth somites; sixth somite more than twice as long as fifth. Eyes nearly as broad as eyestalks. Dactyls of first two pairs of pereopods ending in two long spines, one of which falls on either side of the fixed finger when fingers are closed.

Description: Carapace dorsally sharply carinate for its entire length; this carina is nearly straight throughout and in line with the dorsal margin of the rostrum. The latter is acutely triangular and reaches just beyond the end of the antennular peduncle; it is armed with two to five, usually three or four, dorsal spines at the base, one or two being placed behind the line of



Text-figure 33.

Notostomus marptocheles. Holotype female. $\times 2.03$.

the orbit, but the distal third, at least, is unarmed dorsally and there are no teeth or spines on the lower margin. A single lateral carina passes from the orbit to the hind margin, and the usual carina delimiting the hepatic furrow posteriorly is present. Branchiostegal spine supported by a sharp carina which is only three or four times as long as the spine, itself. First somite of abdomen smoothly rounded dorsally. Second somite with an almost invisible line representing a dorsal carina. Succeeding four somites with a sharp dorsal carina ending posteriorly in a prominent tooth, those of the third, fourth and fifth folded over to the left (Text-fig. 34A). Sixth somite slightly more than twice as long as the fifth. Telson about as long as the sixth somite, dorsally sulcate on the distal half, armed with four pairs of lateral spines along the margin of the sulcus and more or less truncate at the tip, with three spines on either side of a median one. Eyes nearly as wide as the dorso-ventral diameter of the stalk; there is a prominent papilla arising from the inner surface of the stalk and extending at least as far as the tip of the cornea. Stylocerite does not reach the end of the first segment of the antennular peduncle. Antennal scale tapering to a rounded end which is slightly surpassed by the outer spine. Third maxillipeds extend about as far as the antennal scales. Dactyls of chelae of first two pereopods terminate in two long, curved spines, between which the fixed finger fits when the fingers are closed (Text-fig. 34E-F). Meri of last three pereopods spiny. Eggs proportionately small, about 1.1 mm. in longer diameter, broadly oval and numerous.

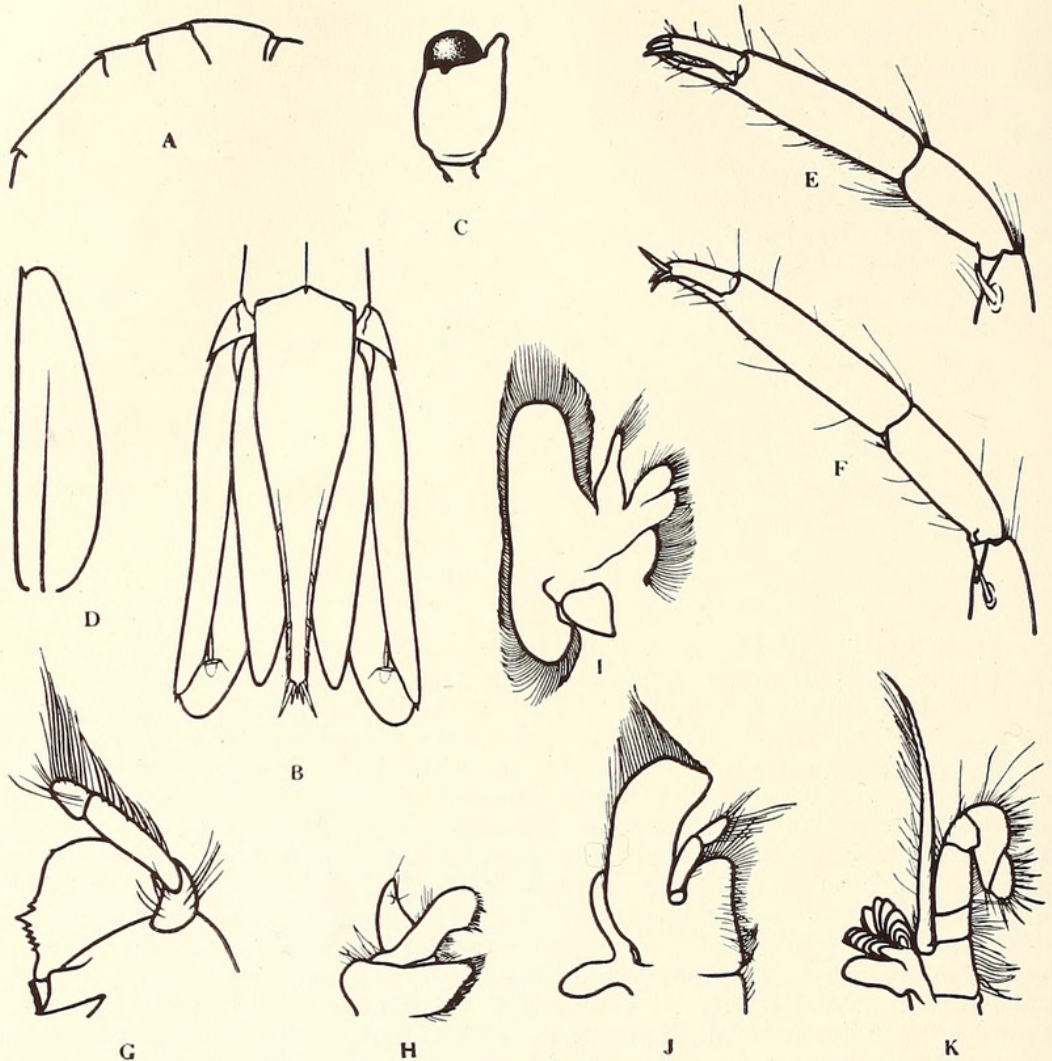
Measurements: Total length of holotype about 62 mm.; length of carapace 17.2 mm.; length of rostrum 4.9 mm.

The two young males, in which the appendix masculina is shorter than the other stylet, have the carapace 17.0 mm. long in each. The two ovigerous females have a carapace length of 20.1 and 22.8 mm., and the latter is the largest specimen examined. The smallest specimen has a carapace length of 5.5 mm.

Color in Life: Deep scarlet—nearly black. Rostrum and mouth parts bright red.

Remarks: Inasmuch as the specimens from the Bingham Oceanographic Collection were sent for identification before the Bermuda collection, Dr. Beebe has kindly consented to the selection of the holotype from that series.

It will be seen from the net data that *N. marptocheles* was found at



Text-figure 34.

Notostomus marptocheles. **A.** Dorsal margins of third, fourth, fifth and sixth abdominal somites viewed from the right side. **B.** Telson and uropods. **C.** Left eye from above. **D.** Antennal scale. **E.** Carpus and hand of first pereopod. **F.** Carpus and hand of second pereopod. **G.** Mandible. **H.** First maxilla. **I.** Second maxilla. **J.** First maxilliped. **K.** Second maxilliped.

Bermuda in every month of the year in which towing was done with the exception of April. Apparently it is a relatively deep water species, since two specimens were taken in 800 fathoms, four in 900 and five in 1,000. The eggs on the ovigerous female from *Pawnee* Station 48 were eyed, whereas those on the Bermuda specimen from Net 365 were not.

Although this species bears a close resemblance to *N. compsus*, it may be readily distinguished by the presence of a spine on the third abdominal somite, the much longer sixth somite, differently formed eyes and antennal scales and the long terminal spines on the movable fingers of the chelipeds.

Apparently most, if not all, of the species of Oplophoridae have the dactyls of the chelipeds more or less split at the end for the reception of the fixed finger when the fingers are closed, but in no others that I have seen are these terminal spines so long as to be easily visible to the naked eye.

***Notostomus miccylus*, sp. nov.**

Text-figs. 35-37.

Types: Holotype female, Cat. No. 1061, Bingham Oceanographic Collection, Yale University; *Pawnee* Station 48; lat. $21^{\circ} 44' N.$, long. $72^{\circ} 43' W.$; north of Little Inagua Island, Bahamas; April 4, 1927; 1,167 fathoms of wire.

Two males: *Pawnee* Station 11; lat. $23^{\circ} 58' N.$, long. $77^{\circ} 26' W.$; Tongue of the Ocean, Bahamas; March 2, 1927; 1,167 fathoms of wire.

One female: *Pawnee* Station 25; lat. $24^{\circ} 51' N.$, long. $76^{\circ} 37' W.$; Exuma Sound, Bahamas; March 17, 1927; 1,333 fathoms of wire.

Two females (one ovigerous): *Pawnee* Station 52; lat. $21^{\circ} 30' N.$, long. $71^{\circ} 11' W.$; Turks Island Passage; Bahamas; April 11, 1927; 1,333 fathoms of wire.

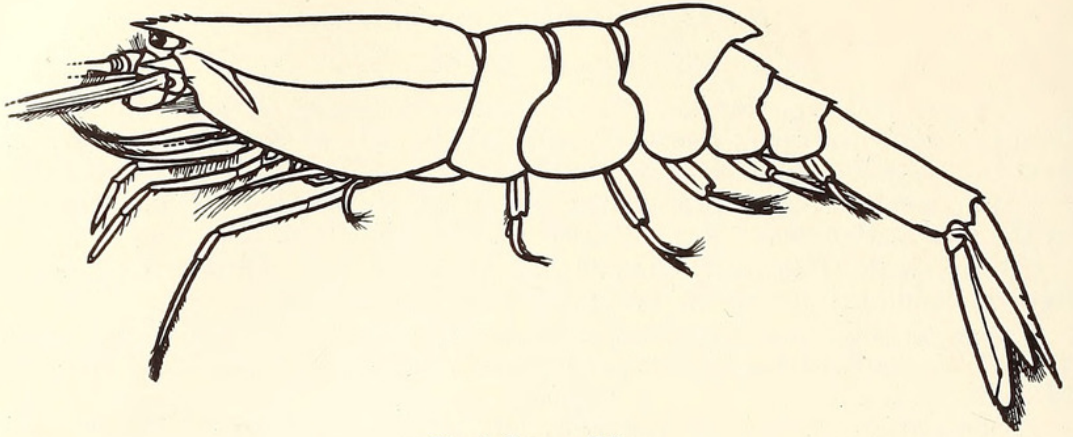
One female: *Pawnee* Station 58; lat. $32^{\circ} 24' N.$, long. $64^{\circ} 29' W.$; off Bermuda; April 20, 1927; 833 or 1,667 fathoms of wire.

Two females: *Atlantis* Station 1478; lat. $25^{\circ} 29' N.$, long. $77^{\circ} 18' W.$; N.E. Providence Channel, Bahamas; February 20, 1933; 875 fathoms of wire.

47 males, 73 females (4 ovigerous), 25 young; D.T.R. Bermuda Expeditions; 1929 to 1931; 500 to 1,000 fathoms.

Diagnosis: Integument thin but not membranous. Carapace not inflated, dorsal margin in line with rostrum and not dentate on posterior nine-tenths of its length. A single lateral carina on carapace passing from orbit to hind margin. Branchiostegal spine not supported by a carina. Rostrum without teeth or spines on lower margin. Abdomen carinate on all but first somite but the carina of the second is hardly visible; a posterior spine on third, fourth, fifth and sixth somites, that on the third being very broad with a concave distal margin; sixth somite more than two and one-half times as long as fifth. Eyes as broad as eye-stalks. Dactyl of first two pairs of pereopods ending in two small, blunt spines.

Description: Carapace dorsally sharply carinate for its entire length; the carina is nearly straight and continuous with the dorsal margin of the rostrum. Rostrum acutely triangular and not reaching beyond the second segment of the antennular peduncle; it is armed with from two to six, usually three to five, dorsal spines at the base, one sometimes being placed behind the line of the orbit; there are no teeth or spines on the lower margin. Of 135 specimens in which the rostrum is undamaged, one specimen has two dorsal rostral spines, 19 have three, 71 have four, 40 have five and four have six. A single lateral carina runs from the orbit to the hind margin of the carapace, and there is the usual carina delimiting the hepatic furrow posteriorly. Branchiostegal spine outstanding but not supported by any carina or sharp ridge. First abdominal somite smoothly rounded dorsally. Second somite with a faint line representing a dorsal carina. The next four somites are sharply carinate. The third somite is provided with a distinctive broad tooth which is truncate or concave distally. Fourth, fifth and sixth somites end in a small, sharp spine. Sixth somite more than two and one-half times as long as the fifth. Telson slightly longer than the sixth somite, deeply sulcate dorsally, armed with three or four pairs of dorso-lateral spinules and with a more or less truncate tip which bears three spines on either side of a central one. Eyes nearly black and about as wide as the dorso-ventral width of the stalk; in dorsal view, the stalk is much wider than the cornea and bears a small, rounded papilla on the inner margin. Stylocerite narrow and drawn out to a slender point which reaches just beyond the first segment of the antennular peduncle. Antennal scale narrow, sharply concave along its external margin and truncate distally, the outer spine extending beyond the blade. Third maxillipeds extend about as far as the antennal scales. All of the pereopods are normal. The eggs are small.



Text-figure 35.

Notostomus miccylus. Holotype female. $\times 3.38$.

Measurements: Total length of holotype about 33 mm.; length of carapace 9.2 mm.; length of rostrum 2.0 mm.

The smallest recognizable male has a carapace length of 4.9 mm. The ovigerous females have carapace lengths ranging from 7.2 to 9.5 mm. In this species the female apparently attains a larger size than the male; females reach a carapace length of 10.0 mm., whereas the largest male examined had a carapace measurement of only 8.1 mm. The smallest specimens seen have the carapace 3.2 mm. long.

Color in Life: Abdomen solid scarlet; cephalothorax and telson heavily dotted with scarlet. Eyes dark brown.

General Remarks: Inasmuch as the specimens from the Bingham Oceanographic Collection were sent for identification before the Bermuda collection, Dr. Beebe has kindly consented to the selection of the holotype from that series.

Although this species might be confused with *N. vescus* because of the similarity in size, *N. miccylus* is even smaller than *N. vescus* and can be distinguished from it and all other known species of the genus by the characteristic shape of the tooth on the third abdominal somite.

Seasonal Distribution: The seasonal distribution of the population of *N. miccylus* over the months in which tows were made in 1929 and 1930 is shown in the following table:

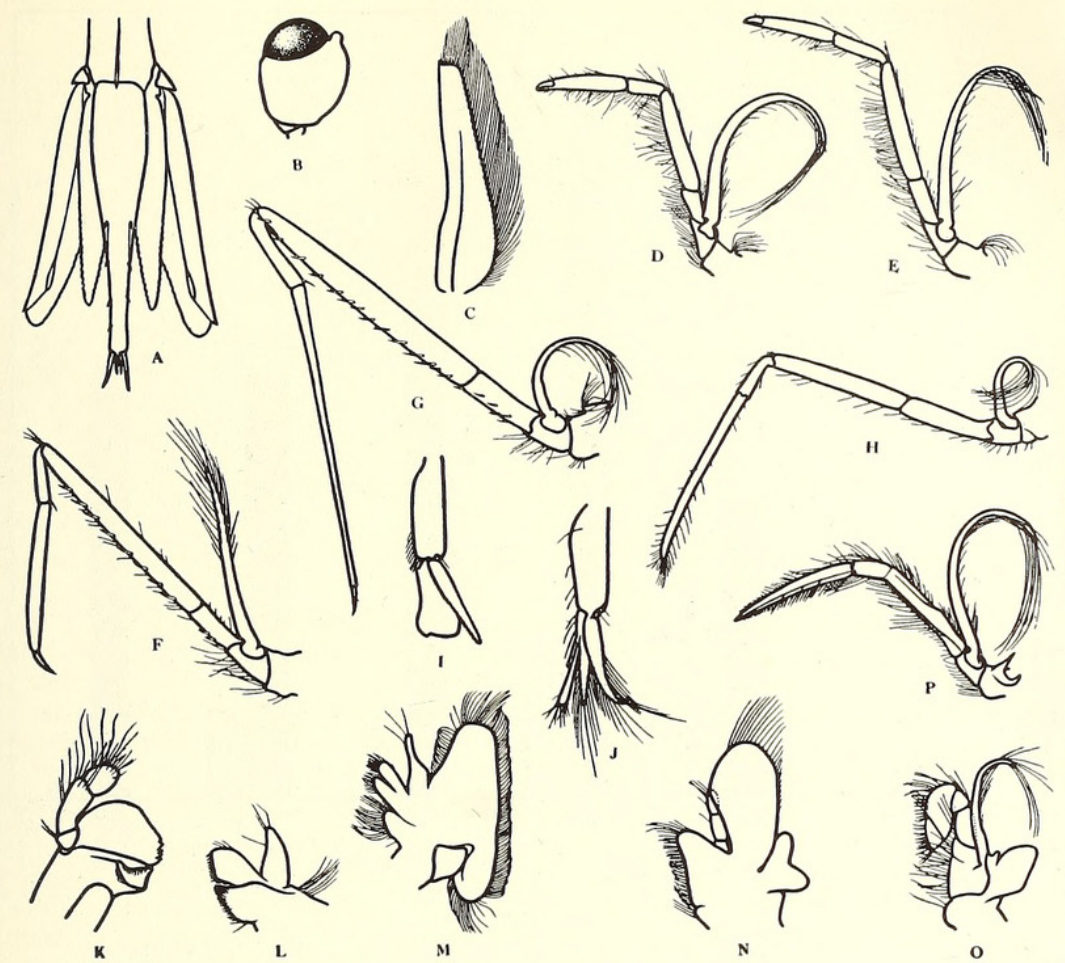
1929

April	.....	3 females (1 ovig.), 2 young
May	.....	1 male, 2 females, 1 young
June	.....	1 male, 12 females, 1 young
July	.....	6 males, 14 females (2 ovig.), 3 young
August	.....	1 male, 3 females, 1 young
September	.....	8 males, 9 females, 2 young

1930

May	.....	4 males, 1 female, 1 young
June	.....	6 males, 5 females, 3 young
July	.....	3 males, 4 females, 2 young
August	.....	1 male
September	.....	4 males, 8 females (1 ovig.), 1 young

It will be noted that the distribution over these months is reasonably uniform and that ovigerous females were taken in April, July and September. Curiously, each of the four ovigerous specimens carried but one egg and there was evidence that the remaining eggs had recently hatched;



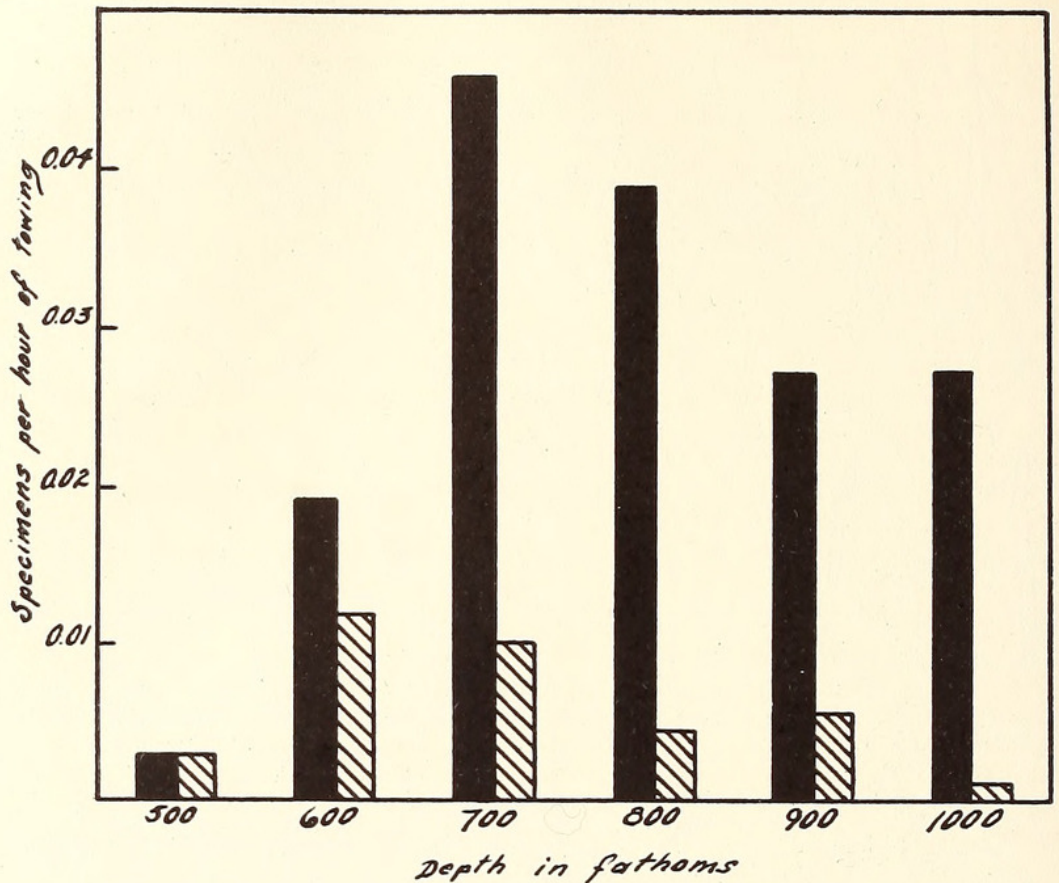
Text-figure 36.

Notostomus miccyllus. A. Telson and uropods. B. Left eye from above. C. Antennal scale. D. First pereopod. E. Second pereopod. F. Third pereopod. G. Fourth pereopod. H. Fifth pereopod. I. First pleopod of male. J. Second pleopod of male. K. Mandible. L. First maxilla. M. Second maxilla. N. First maxilliped. O. Second maxilliped. P. Third maxilliped.

the remaining egg was eyed and obviously ready to hatch in three of the specimens and in the other, taken in September, 1930, the egg was not eyed and was possibly infertile. Whether the fact that only about 5 per cent. of the adult females carried eggs and in those few most of the eggs were missing indicates that the Bermuda area is not included in the normal "breeding range" is problematical. The table also discloses the anomaly that in 1929 only about 28 per cent. of the adult specimens were males, while in 1930 there were like numbers of each sex.

Vertical Distribution: The vertical distribution of the total catch of *N. miccyllus* is shown in the following table:

Fathoms	Males	Females	Young
500.....	1.....	1.....	2.....
600.....	6.....	7 (1 ovig.).....	8.....
700.....	15.....	17 (1 ovig.).....	7.....
800.....	7.....	20.....	3.....
900.....	8.....	12 (1 ovig.).....	4.....
1,000.....	9.....	16 (1 ovig.).....	1.....



Text-figure 37.

Vertical distribution of adults (solid bars) and young (hatched bars) of *Notostomus miccylus*.

These data, correlated with the towing times, are shown in Text-fig. 37. All of these specimens were taken in the daytime. A close parallelism between the vertical range of this species and that of the other small species of the genus, *N. vesicus*, will be noted.

***Notostomus mollis* (Smith).**

Text-fig. 38.

Meningodora mollis Smith, 1882, p. 74, pl. 11, figs. 8-9, pl. 12, figs. 5-9.

Hymenodora mollis Bate, 1888, p. 841, pl. 136, fig. 5.

Notostomus fragilis Faxon, 1893, p. 207; 1895, p. 170, pl. 44, figs. 2-2b.

Notostomus mollis Balss, 1925, p. 266, fig. 37 (mandible).

Diagnosis: Integument extremely soft and fragile. Carapace somewhat inflated, dorsal margin evenly convex from rostrum to hind margin and not dentate on posterior nine-tenths of its length. A single lateral carina on carapace passing from orbit nearly to hind margin. Branchiostegal spine supported by a short sharp ridge or carina. Rostrum without spines on lower margin. Abdomen carinate on third, fourth, fifth and sixth somites only, and with a posterior tooth on fourth, fifth and sixth; sixth somite about one and two-thirds times as long as fifth. Eyes narrower than eyestalks. Dactyls of first two pairs of pereopods ending in two small, blunt, unequal teeth between which the fixed finger lies when the fingers are closed.

Measurements: A young male, in which the appendix masculina of the second pleopods is rudimentary, has a carapace length of 17.0 mm. The largest male has the carapace 23.0 mm. long, the largest female 24.2 mm. and the single ovigerous female 23.4 mm. The smallest specimen has a carapace length of 4.2 mm. The eggs are 0.9 mm. in greater diameter.

Color in Life: Cephalothorax maroon-tinged black shading to nopal red on the abdomen. Antennae, thoracic epipods and pleopods all nopal red. Thoracic legs dark maroon shading to lighter toward their tips. Eyes blackish.

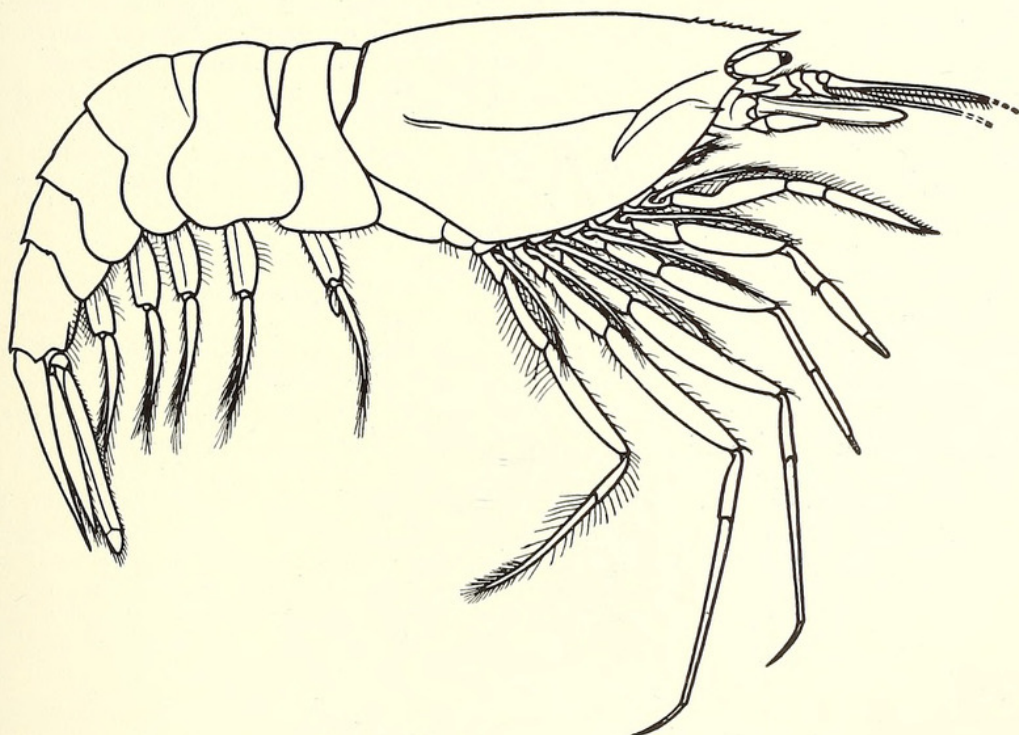
General Remarks: The collection contains 56 specimens of this species; 2 males, 10 females, of which 1 is ovigerous, and 44 young. The eyes are visible in the eggs of the single ovigerous specimen.

N. mollis may be distinguished from the other members of the genus in which the carapace is not markedly inflated and the first abdominal somite uncarinated by its much more membranous integument. It differs from all members of the genus in having the eyes noticeably smaller in diameter than the somewhat swollen eyestalks.

An examination of the types of *Meningodora mollis* Smith and *Notostomus fragilis* Faxon discloses no points of difference between the Atlantic and Pacific specimens.

N. mollis forms a connecting link between the primitive members of the genus belonging to the *N. vescus* group and the typical forms of the *N. robustus* group.

Seasonal Distribution: Specimens were found in every month of 1929 and 1930 in which tows were made, and the numbers taken are more or less evenly distributed over these periods. The single ovigerous female was taken in May, 1930.



Text-figure 38.

Notostomus mollis. Female taken in June, 1931, from 900 fathoms. $\times 1.64$.

Vertical Distribution: The vertical distribution is shown in the following table:

Fathoms	Males	Females	Young
500			2
600			3
700		1	13
800.....	2.....	3 (1 ovig.)	7
900.....		3	8
1,000.....		3	11

Geographical Distribution: *N. mollis* has been found off the east coast of the United States, off the coast of Brazil, in the Bay of Biscay, the Indian Ocean, north of the Philippine Islands (specimen in the U. S. National Museum) and off the west coast of Central America between Panama and the Galápagos Islands.

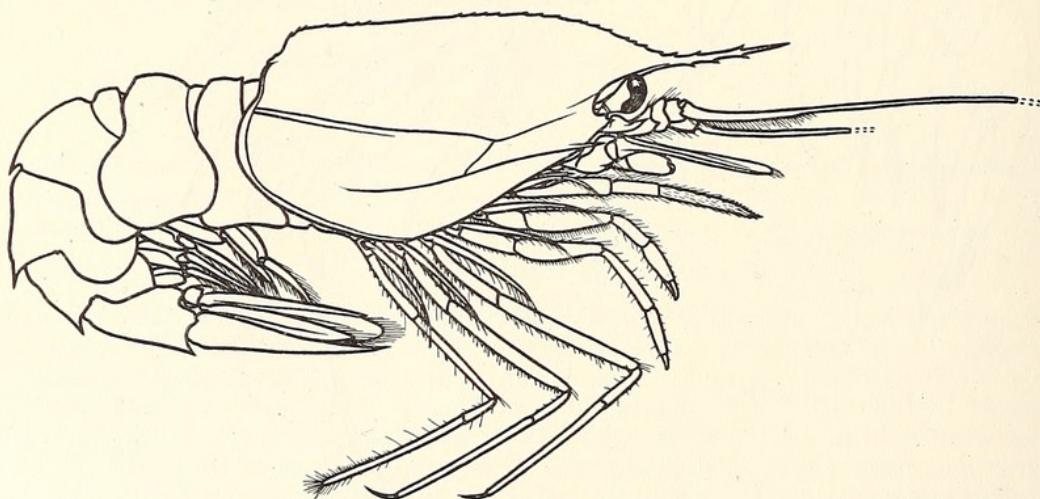
***Notostomus distirus*, sp. nov.**

Text-figs. 39 and 40.

Types: Holotype female, Cat. No. 311915, Department of Tropical Research, New York Zoological Society; Net 1281; August 9, 1931; 1,000 fathoms.

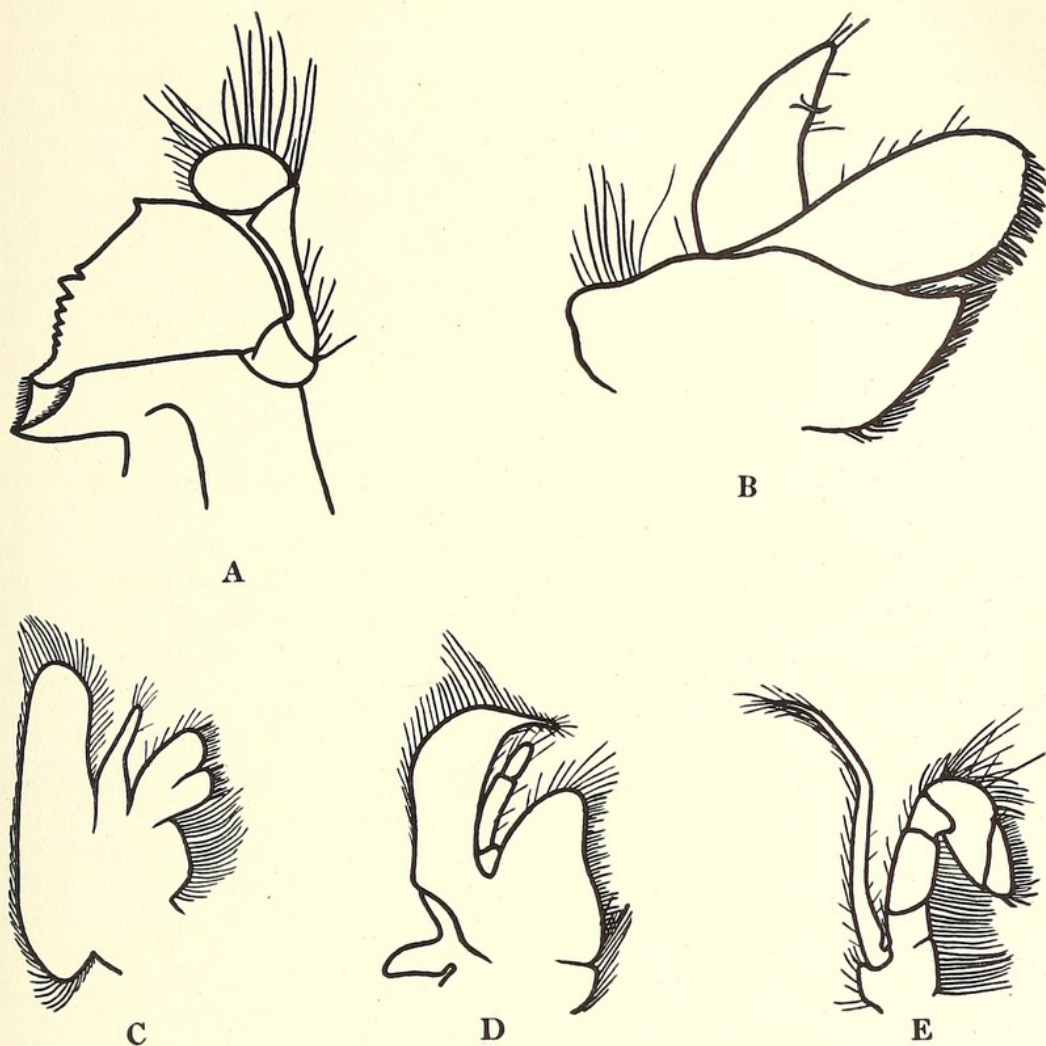
One female; Net 684; June 7, 1930; 1,000 fathoms.

Diagnosis: Integument soft. Carpace inflated, dorsal margin elevated somewhat above level of rostrum but nearly straight and denticulate for the greater part of its length. Only two prominent lateral carinae on carapace, the semi-carina below post-orbital represented by a deep sulcus and the sub-marginal carina not prominent; post-orbital and post-antennal carinae relatively close to each other and not markedly divergent behind hepatic region; post-orbital not continuous with rostral carina; no median lateral carina at base of rostrum. Rostrum with three spines on lower margin. Abdomen carinate on every somite and with a posterior tooth on third, fourth, fifth and sixth; sixth somite about one and one-third times as long as fifth. Eyes very large and black. Dactyls of first two pairs of pereopods ending in two small teeth or spines between which the fixed finger lies when the fingers are closed.



Text-figure 39.

Notostomus distirus. Holotype female. $\times 1.45$.



Text-figure 40.

Notostomus distirus. A. Mandible. B. First maxilla. C. Second maxilla. D. First maxilliped. E. Second maxilliped.

Description: Carapace moderately inflated, although not as much so as in some of the more typical members of this group. Dorsal margin sharply carinate, sparsely denticulate for its entire length, nearly straight for the greater part of its extent and somewhat, but not greatly, elevated above the level of the rostrum. Rostrum slender, reaching about as far as the tips of the antennal scales and armed on the slender portion with two dorsal and three ventral teeth. There is no median lateral carina on the rostrum. The ventral rostral carina is not continuous with the post-orbital. The latter forms an obtuse angle at the junction with the post-hepatic carina and passes backward and somewhat upward to the posterior margin. Immediately below the posterior half of this carina is a narrow longitudinal sulcus but no prominent semi-carina. The post-antennal carina rather closely approximates the post-orbital on the hepatic region and then passes backward and disappears at about the middle of the posterior branchial region. These two main carinae diverge slightly behind the hepatic region but not as much so as in *N. robustus*. The submarginal carina passing from the dorsal surface around to the hepatic region is no more prominent than in the species of other genera. Abdomen carinate on every somite, although the carina on the

first is very low. The third, fourth, fifth and sixth somites are armed with large posterior teeth. Sixth somite about one and one-third times as long as the fifth. Telson about as long as the outer branches of the uropods, deeply sulcate dorsally and armed with three pairs of minute dorso-lateral spinules and three terminal spines on either side of a median one. Eyes very large with a minute papilla on the inner side of the stalk just back of the cornea. Stylocerite reaches nearly to the end of the first segment of the antennular peduncle. Antennal scale tapering to a very bluntly angular end which reaches about as far as the outer spine. Third maxillipeds extend about as far as the antennal scales. Movable fingers of both pairs of chelipeds terminating in two inconspicuous spines which lie on either side of the fixed finger when the fingers are closed.

Color in Life: Unknown.

Measurements: Total length of holotype about 87 mm.; length of carapace 26 mm.; length of rostrum 14 mm.

The paratype is somewhat smaller, having a carapace length of about 20.5 mm.

Since there are no males or ovigerous females, there is naturally no way of determining whether these specimens are females or immature specimens.

Remarks: *N. distirus* is apparently one of the more primitive members of the *robustus* group of the genus as evidenced by the relatively slightly inflated carapace and few lateral carapacic carinae. It most closely resembles *N. murrayi* Bate, 1888, and *N. japonicus* Bate, 1888. The former was very possibly described from an immature specimen, but it apparently differs from *N. distirus* in the much greater number of teeth on the lower margin of the rostrum and the prolongation of the post-antennal carina nearly to the posterior margin of the carapace. *N. japonicus* agrees very well with the present species except that the post-orbital and post-antennal carinae are farther apart and the telson is shorter than the inner branch of the uropods.

For the possible presence of young of this species in the collection see the remarks under *N. robustus*.

***Notostomus robustus* Smith.**

Text-fig. 41

Notostomus robustus Smith, 1884, p. 377, pl. 7, fig. 2.

Notostomus beebei Boone, 1930, p. 39, fig. 6.

Notostomus robustus Chace, 1936, p. 28.

Diagnosis: Integument soft. Carapace greatly inflated, dorsal margin highly arched above level of rostrum and minutely dentate for its entire length in the adult. Four lateral carinae on posterior half of carapace including the semi-carina just below post-orbital and the submarginal carina below post-antennal; post-orbital and post-antennal carinae distinctly divergent behind hepatic region; post-orbital not continuous with rostral carina; no median lateral carina at base of rostrum. Rostrum usually with two or three spines on lower margin. Abdomen carinate on every somite and with a posterior tooth on third, fourth, fifth and sixth; sixth somite about one and one-half times as long as fifth in adult. Eyes very large and black. Dactyls of first two pairs of pereopods ending in two small, blunt, unequal teeth between which the fixed finger lies when the fingers are closed.

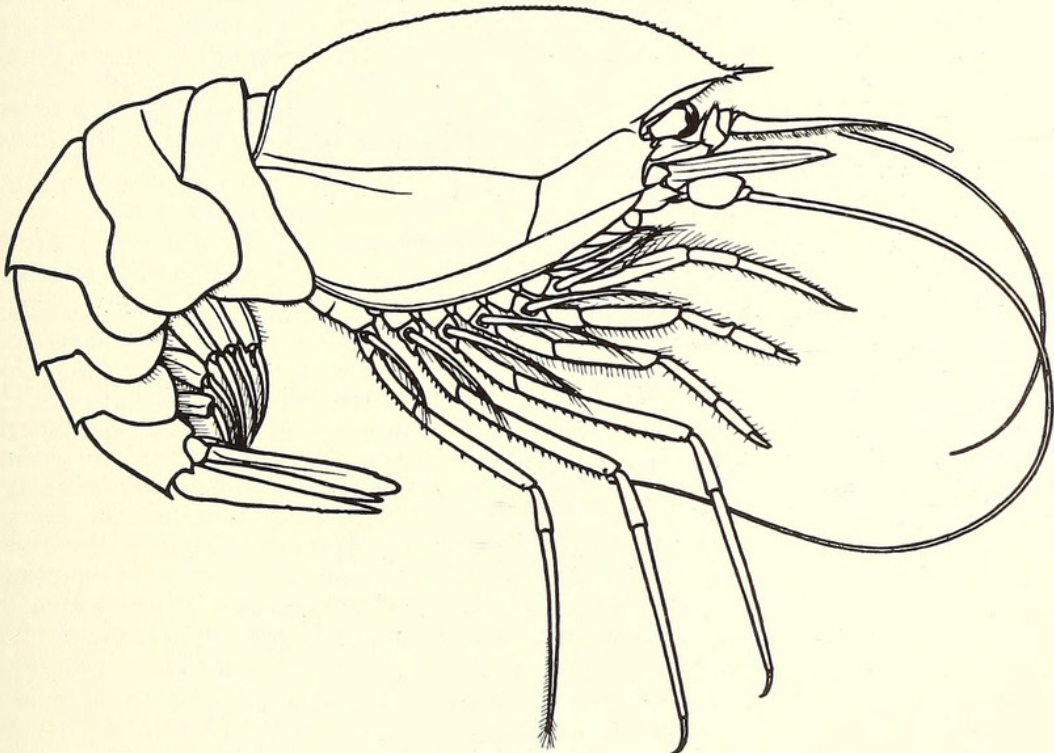
Measurements: There is no young male in the collection to determine the minimum size of adults. The only male has the carapace 49.0 mm. long. The largest female is the type of *Notostomus beebei* in which the carapace measures 45.0 mm. There are seven specimens in which the carapace is

from 19.0 to 34.0 mm. long, and the remaining 31 specimens are obviously young, the carapace measuring 3.7 to 14.8 mm.

Color in Life: Scarlet.

General Remarks: The collection contains 20 specimens which undoubtedly belong to this species; one male, one female, seven specimens which may be either females or young and eleven young. There are 20 other specimens in which the carapace is less than 7 mm. long which may belong either to *N. robustus* or to *N. distirus*. These young individuals closely resemble the adults of the *N. vescus* group in that the carapace is not greatly inflated, the dorsal carina of the carapace is not denticulate posteriorly, the lateral carinae are inconspicuous, the teeth on the third, fourth and fifth abdominal somites may be absent and the sixth abdominal somite is more than twice as long as the fifth. They can always be distinguished from the species of the *vescus* group, however, by the very large eyes.

There is little doubt in my mind that *N. beebei* Boone is a synonym of *N. robustus*. An examination of the type specimens of both species fails to disclose any differences between the two except for the presence or absence of the curious excavation in the dorsal carina at the base of the rostrum. If this character was found in but a single specimen one would readily assume that it was caused by an injury but, curiously enough, the female cotype of *N. robustus* has almost exactly the same kind of excavation armed anteriorly with a "quadrispine." Smith failed to mention this abnormality in his description and apparently assumed that it was the result of an injury. Since only four positively adult specimens of this species are known, two males and two females, and since both females have this curious depression in the dorsal carina, the possibility that this is a sexual character cannot be entirely disregarded.



Text-figure 41.

Notostomus robustus. Young female taken in August, 1930, from 800 fathoms. $\times 1.32$.

Seasonal Distribution: The adult male was taken June 19, 1929, and the type female of *N. beebei* on May 25, 1929. Other specimens with a carapace length exceeding 19 mm. were taken in June and July, 1929, and in August and September, 1930. Specimens with a carapace length of 7 to 15 mm. were found in June, July and September, 1929, and in May and September, 1930.

Vertical Distribution: The adult male was taken in 1,000 fathoms and the adult female in 900. Of the intermediate group in which the carapace measures from 19 to 34 mm., three were found at 800, one at 900 and two at 1,000 fathoms. Of the smallest specimens with a carapace length of 7 to 15 mm., one was taken in 600 fathoms, three in 700, one in 800, four in 900 and one in 1,000.

Geographical Distribution: *N. robustus* is known only from the western North Atlantic between 42° north latitude and Bermuda.

***Notostomus perlatus* Bate ?**

Text-fig. 42.

- ? *Notostomus perlatus* Bate, 1888, p. 831, pl. 134, fig. 2.
- ? *Notostomus brevirostris* Bate, 1888, p. 832, pl. 134, fig. 3.
- ? *Notostomus perlatus* Balss, 1925, p. 268.

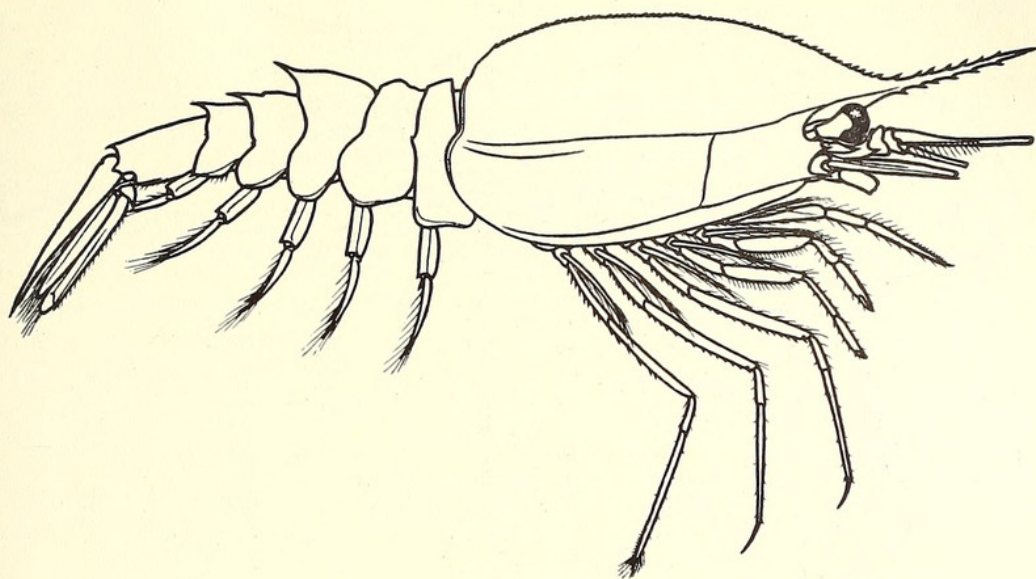
Diagnosis: Integument soft. Carapace greatly inflated, dorsal margin highly arched above level of rostrum and minutely dentate for its entire length. Four lateral carinae on posterior half of carapace, including the semi-carina just below the post-orbital and the submarginal carina below the post-antennal; post-orbital and post-antennal carinae not markedly divergent behind hepatic region; post-orbital continuous with rostral carina; no median lateral carina at base of rostrum. Rostrum with six teeth on lower margin. Abdomen carinate on every somite and with a posterior tooth on third, fourth, fifth and sixth; sixth somite about and one three-fourths times as long as fifth. Eyes very large and black. Dactyls of first two pairs of pereopods ending in two small unequal teeth between which the fixed finger lies when the fingers are closed.

Color in Life: Unknown.

Remarks: A single young specimen (carapace length 14.6 mm.) from Net 999; June 5, 1931; 700 fathoms, is tentatively assigned to this species.

The only apparent difference between this specimen and *N. perlatus* lies in the length of the rostrum. There are two adult male specimens (carapace lengths 51 and 52 mm.) in the U. S. National Museum which were taken by the *Albatross* in the Gulf of Mexico southeast of the Mississippi delta which almost certainly belong to the same species as this young Bermuda specimen. These two specimens differ from all other known specimens of *N. perlatus* in having the rostrum reaching as far as the ends of the antennal scales rather than no more than half that distance. Since the rostrum is usually longer in immature specimens in this genus, its greater length in the Bermuda example is by no means unexpected. Since these three specimens agree with *N. perlatus* in all other particulars, it does not seem desirable at present to separate them merely on the basis of the rostral length.

Another possibility is that this form is really *N. gibbosus* A. Milne Edwards, 1881, which was taken by the *Blake* off Grenada. It corresponds reasonably well with the figure of that species (A. Milne Edwards, 1883) except for the absence of a semi-carina below the posterior portion of the post-orbital carina. Another discrepancy is the fact that Milne Edwards describes the telson as being distinctly shorter than the outer branch of the uropods. The type of *N. gibbosus* cannot be found in the Museum of Com-



Text-figure 42.

Notostomus perlatus ?. Young taken in June, 1931, from 700 fathoms. $\times 2.56$.

parative Zoology. It is to be hoped that it is in the Paris Museum, for it is only by examination of this type specimen that the correct status of the species can be determined.

Geographical Distribution: All of the recorded specimens of *N. perlatus* have been taken within ten degrees of the equator; off the coast of Brazil, off the west coast of Africa, off the east coast of Africa, in the Indian Ocean and south of the Philippines. I have also seen a typical specimen of *N. perlatus* in the U. S. National Museum which was taken east of the Marquesas Islands, also within ten degrees of the equator. The only records from outside of this equatorial belt in addition to the present specimen are the two males, mentioned above, from the Gulf of Mexico.

***Notostomus westergreni* Faxon ?**

Text-fig. 43.

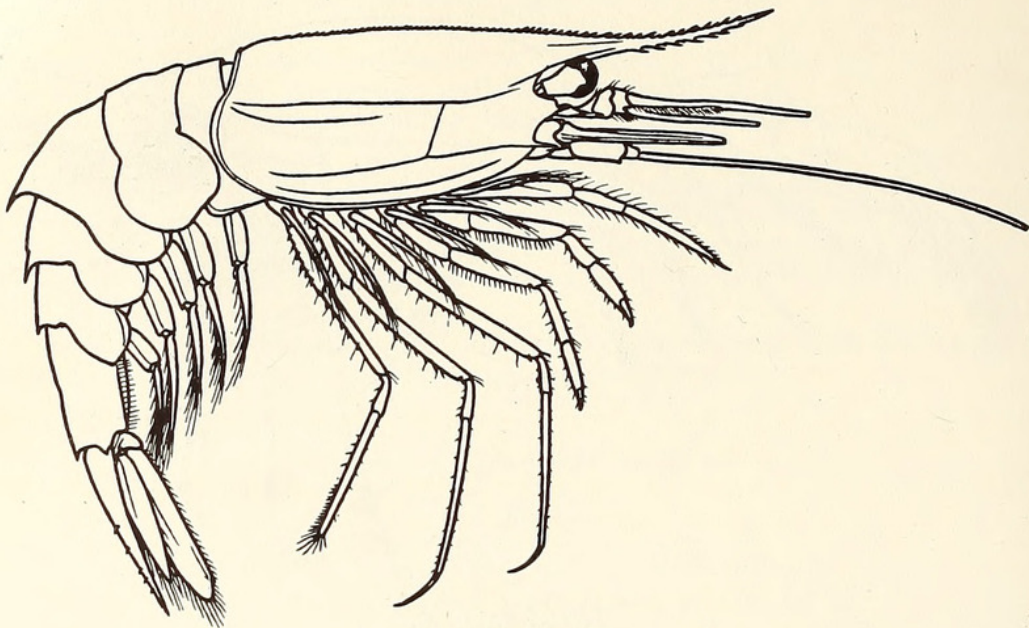
? *Notostomus westergreni* Faxon, 1893, p. 208; 1895, p. 171, pl. F.

? *Notostomus westergreni* Balss, 1925, p. 269.

Diagnosis: Integument soft. Carapace moderately inflated, dorsal margin arched but slightly above level of rostrum and denticulate for its entire length. Five lateral carinae on posterior half of carapace, including the semi-carina just below post-orbital and the submarginal carina along lower edge; post-orbital and post-antennal carinae nearly parallel; post-orbital not continuous with rostral carina; a median lateral carina at base of rostrum. Rostrum with eight or nine teeth on lower margin. Abdomen carinate on every somite and with a posterior tooth on third, fourth, fifth and sixth; sixth somite nearly twice as long as fifth in the young. Eyes very large and black. Dactyls of first two pairs of pereopods ending in two small spines between which the fixed finger lies when the fingers are closed.

Color in Life: The type specimen of *N. westergreni* was bright red. No color notes were taken on the Bermuda specimens.

Remarks: Two immature specimens are referred to *N. westergreni*



Text-figure 43.

Notostomus westergreni ?. Young taken in July or August, 1929, from 900 fathoms. $\times 3.70$.

with some hesitation. One specimen, with a carapace length of 9.0 mm., was taken in Net 325, 330, 362 or 382; July 24 to August 16, 1929; 900 fathoms. The other, with a carapace length of 7.8 mm., is from Net 613 or 614; May 21, 1930; 600 fathoms.

These specimens differ from the male type of *N. westergreni* as follows; the dorsal margin of the carapace is less elevated, there are fewer teeth on the lower margin of the rostrum and the sixth abdominal somite is proportionately longer. All of these characters might well be attributed to the obvious immaturity of the specimens. Although Faxon described this species as having a posterior tooth on the "third, fourth and fifth" somites of the abdomen, the type has a well developed tooth on the sixth somite as well, as shown in Faxon's figure. I have also seen a specimen in the U. S. National Museum in which the carapace is 12.5 mm. long, which corresponds in every particular with these Bermuda specimens except that the semi-carina fuses anteriorly with the post-orbital. This specimen was taken by the *Albatross* off the coast of Peru not far from the type locality of *N. westergreni*.

It is obviously impossible at present to determine with certainty young specimens of *Notostomus* due to the comparative scarcity of material, but of the three known species of the genus which have five lateral carinae on the posterior half of the carapace, *N. westergreni*, *N. patentissimus* Bate, 1888, and *N. longirostris* Bate, 1888, the present specimens are much nearer the first than to the other two.

Geographical Distribution: There are but three recorded specimens of *N. westergreni*; the type from off the coast of Ecuador, a specimen from near the Keeling Islands in the Indian Ocean and the third from off Cape Point, South Africa.

Genus *Ephyrina* Smith, 1885.

Carapace with a blunt ridge running along the median lateral line from the orbital region to the hind margin, and with an oblique ridge delimiting the hind margin of the hepatic furrow. Abdomen smoothly rounded, not

carinate, throughout its length. Telson more or less truncate, not terminating in a sharply pointed end-piece laterally armed with spines. Ischial and meral joints of the pereopods abnormally broad and flattened. Exopods of third maxillipeds and pereopods neither foliaceous nor rigid. Eyes well pigmented. Outer margin of antennal scale not armed with a series of spines. Incisor process of mandible toothed for only half the length of the cutting edge.

KEY TO THE KNOWN SPECIES OF *Ephyrina*.

1. A posterior tooth or spine on third abdominal somite..... 2.
No posterior tooth or spine on third abdominal somite; ten to thirteen pairs of lateral spines on telson.....*E. hoskynii*.
2. Posterior tooth on third abdominal somite triangular; twenty to twenty-five pairs of lateral spines on telson.....*E. benedicti*
Posterior tooth on third abdominal somite broad and bifid at the end; five to eight pairs of lateral spines on telson.....*E. bifida*.

***Ephyrina hoskynii* Wood-Mason.**

Text-fig. 44.

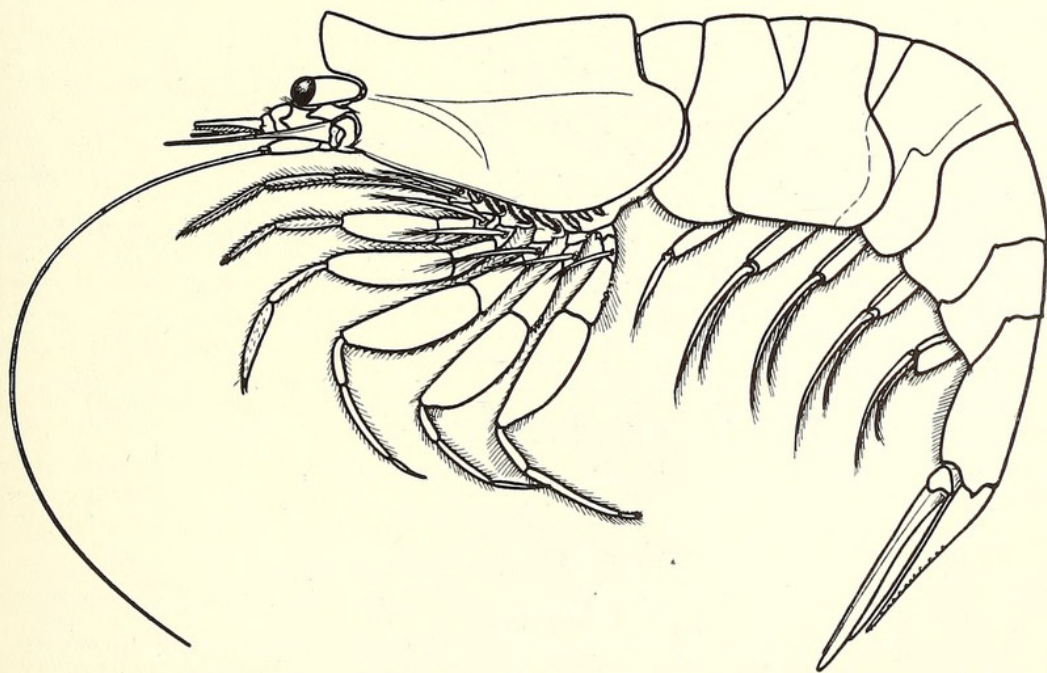
Ephyrina hoskynii Wood-Mason & Alcock, 1891, p. 194.

Ephyrina hoskynii Kemp, 1910, p. 68, pl. 7, figs. 1-6.

Ephyrina benedicti Chace, 1936, p. 29 (part).

Diagnosis: Abdomen without dorsal teeth or spines on any somite; telson armed with ten to thirteen pairs of lateral spinules. Eyes not broader than eyestalks.

Color in Life: Dark red, according to Alcock, 1901. No color notes were taken on the Bermuda specimen.



Text-figure 44.

Ephyrina hoskynii. Female (after Kemp, 1910). $\times 1.19$.

Remarks: This species is represented by a single young specimen having a carapace length of 6.8 mm. taken in Net 896; September 16, 1930; 700 fathoms.

The large number of specimens of various sizes with bifid spines on the third abdominal somite in the present collection have forced me to the conclusion that there are in reality three known species of *Ephyrina* rather than one variable one. There appears to be no difficulty in separating these forms since they differ, not only as regards the teeth on the third and fourth abdominal somites, but also in the number of lateral telson spines and the size of the cornea of the eye. There is probably little in the form of the rostrum that is of taxonomic importance since all of the described forms may be found among the various age groups of a single species.

Geographical Distribution: *E. hoskynii* is known from off the southwest coast of Ireland, the Bay of Biscay, off the coast of Spain or Portugal, the Arabian Sea in the vicinity of the Laccadive Islands and the Bay off Bengal off Ceylon.

***Ephyrina bifida* Stephensen.**

Text-fig. 45.

Ephyrina bifida Stephensen, 1923, p. 58, fig. 18.

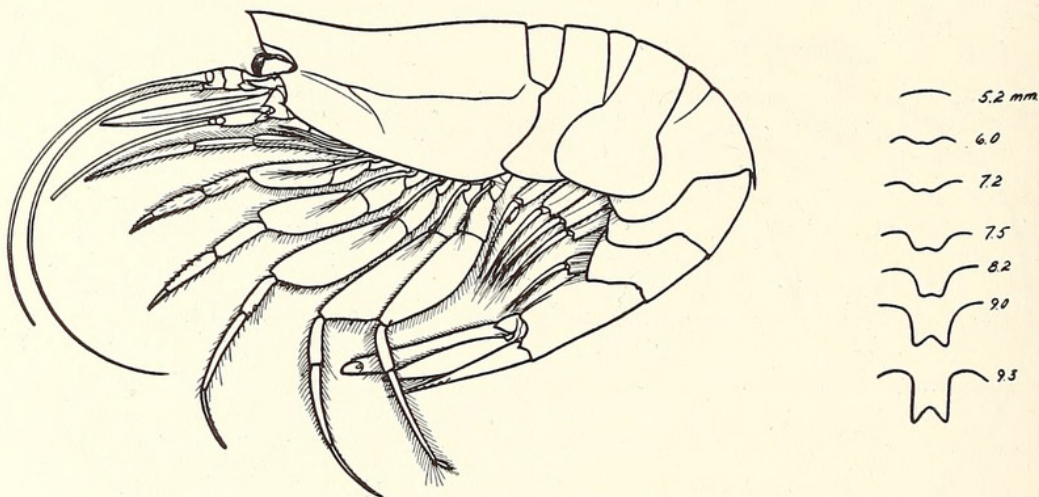
Ephyrina benedicti Balss, 1925, p. 269, figs. 38 and 39.

Ephyrina benedicti Chace, 1936, p. 29 (part).

Diagnosis: Abdomen with a broad, bifid tooth on third somite and a small triangular tooth on fourth somite in the adult; telson armed with five to eight pairs of lateral spinules. Eyes distinctly broader than eyestalks.

Measurements: The collection contains no adult male or ovigerous female specimens by which the size of adults might be gauged. The largest specimen, apparently a female, has a carapace length of 21.3 mm. In the smallest specimen the carapace measures 3.9 mm., but in this specimen, as in several others slightly larger, the telson still retains its larval form.

Color in Life: Unknown.



Text-figure 45.

Ephyrina bifida. Female taken in September, 1931, from 1,000 fathoms. $\times 1.19$. On the right is shown the development of the tooth on the third abdominal somite in this species with the carapace lengths in mm.

General Remarks: The collection contains 70 specimens, five of which have a carapace length exceeding 15 mm. and are tentatively designated as females.

In specimens of *E. bifida* having a carapace length of 5 mm. or less there are no teeth on any of the abdominal somites. At about 6 mm. the tooth on the third somite is represented by a broad, shallow lobe which becomes faintly notched at about 7 mm. From this stage on, the tooth gradually increases in length and becomes more distinctly bifid, the mature condition being reached in specimens having a carapace length of about 9 mm. The small tooth on the fourth somite first appears in specimens having a carapace length of 8 or 9 mm. Young specimens lacking either of these spines may be distinguished from those of *E. hoskynii* by the smaller number of lateral spines on the telson.

One young specimen of this species was found in the stomach of the fish, *Gonostoma elongatum*.

Seasonal Distribution: Specimens were taken in every month of 1929 and 1930 in which towing was done, with the largest numbers appearing in September of each year. Specimens of various sizes were scattered at random over these months and individuals having carapace lengths between 4 and 5 mm. were taken in every month.

Vertical Distribution: This species was taken in depths ranging from 400 to 1,000 fathoms, but only one specimen was found above 600 fathoms and no specimens having a carapace length greater than 5.5 mm. were taken in less than 800 fathoms. The largest number of specimens were found at 800 fathoms, but in none of these did the carapace exceed 10 mm. in length; only at 900 and 1,000 fathoms were possibly adult specimens collected.

Geographical Distribution: Only four specimens of this species have been recorded previously. These came from the Bay of Biscay, the Gulf of Guinea off the west coast of Africa, the Indian Ocean east of the Maldiv Islands and the southern Indian Ocean west of Australia.

Genus *Hymenodora* G.O. Sars, 1877.

Carapace with no ridge or carina running the entire length of the median lateral line from the orbital region to the hind margin, and without an oblique ridge or carina delimiting the hind margin of the hepatic furrow. Abdomen smoothly rounded throughout, without a dorsal carina on any somite. Telson truncate at the tip, not terminating in a sharply pointed end-piece laterally armed with spines. Pereiopods slender. Exopods of third maxillipeds and pereiopods neither foliaceous nor rigid. Eyes small and very slightly pigmented. Outer margin of antennal scale not armed with a series of spines. Incisor process of mandible toothed for the entire length of its cutting edge.

Only one species is known from the Bermuda area.

Hymenodora gracilis Smith.

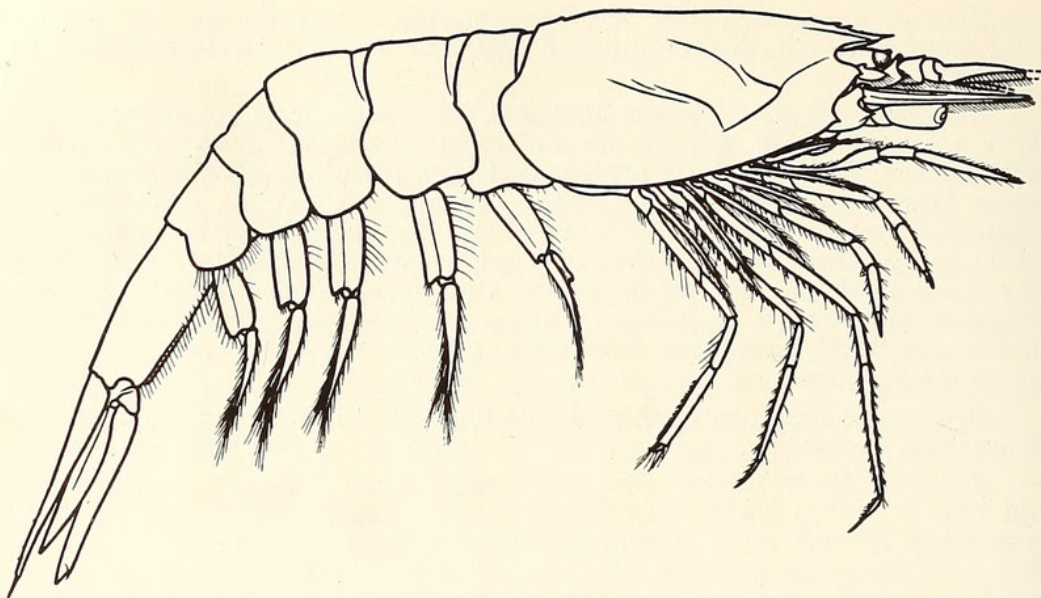
Text-figs. 46-49.

Hymenodora gracilis Smith, 1886, p. 681, pl. 12, fig. 6.

Hymenodora gracilis Stephensen, 1923, p. 60.

Hymenodora glacialis Chace, 1936, p. 29 (part).

Diagnosis: Integument extremely soft and fragile, rostrum reaching about as far as tips of eyes, a groove passing upward and backward from



Text-figure 46.

Hymenodora gracilis. Male taken in August or September, 1931, from 900 fathoms. $\times 2.66$.

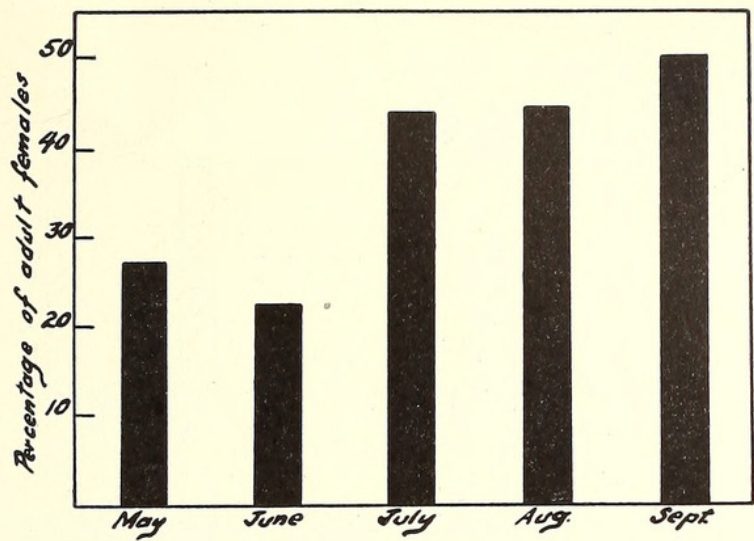
the middle of the hepatic furrow but no similar groove converging toward the first from the supra-branchial groove, end of squamous portion of antennal scale truncate and not reaching beyond base of outer spine.

Measurements: The smallest recognizable males have a carapace length of 9.0 mm. The largest males have the carapace about 13.0 mm. long. The smallest ovigerous females are about the same size as the smallest males or even slightly smaller. The male appears to attain a somewhat larger size than the female in this species; if, as seems likely, the females mature at a smaller size than the males there is no way of distinguishing these small, non-ovigerous females from immature specimens. The smallest specimens seen have a carapace length of 3.0 mm. Since specimens of this species are usually in poor condition due to the extremely fragile integument, it is often difficult to obtain accurate measurements. The eggs are very large in comparison with the size of the animal, measuring 2.3 by 2.0 mm.

Color in Life: Two slightly different shades of color were noted in Bermuda specimens of this species. In two ovigerous females taken in Net 1099 the body and appendages were bright scarlet with a faintly yellowish tinge to the tips of the appendages and to the setae. The eyes were buffish, with the facets outlined in brownish-black. The eggs were pansy-purple with the developing embryo pale peach-colored. In another ovigerous specimen taken in Net 1106 the body and appendages were grenadine red with the scarlet red heart showing through the dorsal part of the carapace. The eyes were as in the above specimens. The eggs, which were not well-developed in this specimen, were spectrum red.

General Remarks: The collection contains 1,829 specimens; 73 males, 206 females, of which 78 are ovigerous, and 1,550 young.

Dr. Stanley Kemp has convinced me that *H. gracilis* is distinct from *H. glacialis* with which it has often been confused. I believe that Dr. Kemp will clarify the differences in a forthcoming paper; the diagnosis given above is sufficient to recognize the species, the only one I have seen from the Bermuda area. The only additional point of taxonomic interest is the fact



Text-figure 47.
Seasonal distribution of ovigerous females of *Hymenodora gracilis* computed from specimens taken in 1929 and 1930.

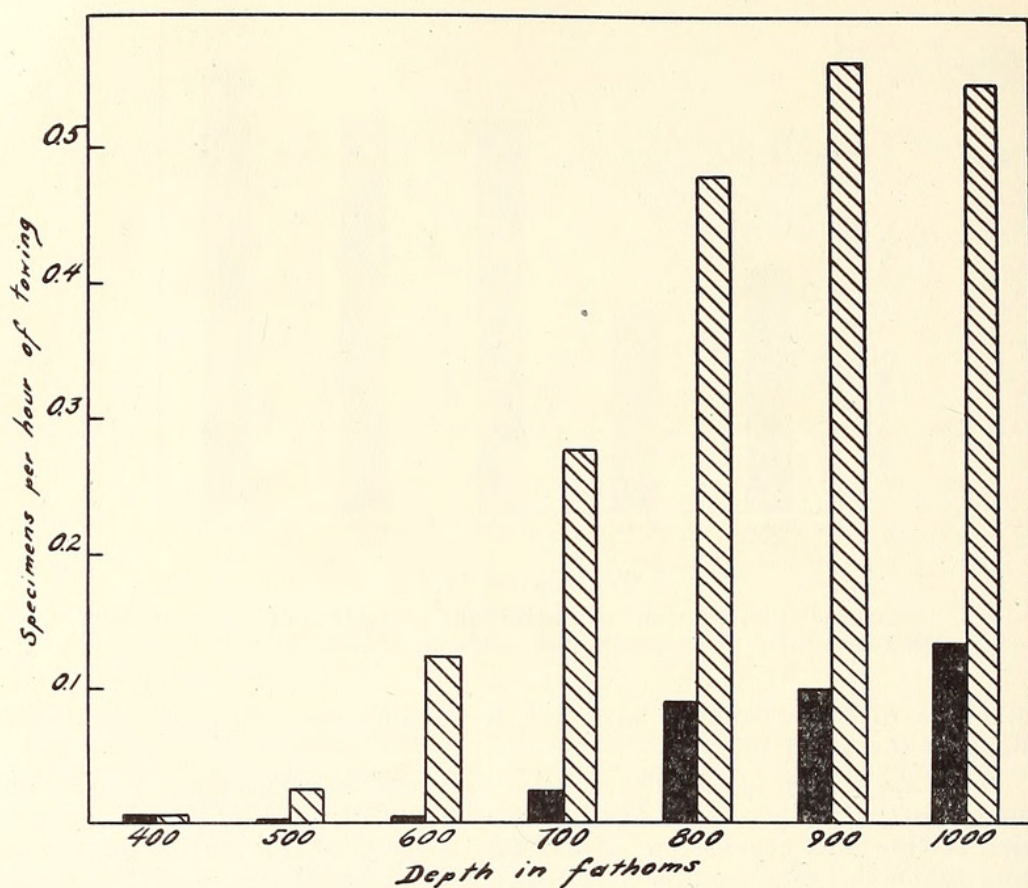
that a few of the specimens have five or six terminal spines on the telson instead of the usual four.

Seasonal Distribution: There is no apparent monthly fluctuation in the numbers of either adults or young taken during that part of the year in which towing was carried on. Naturally, there were proportionately more young taken in those months in which a large part of the tows were made above 900 or 1,000 fathoms and conversely, a greater percentage of adults were taken during the months when more of the deeper tows were made, but when all of these factors are taken into consideration there are no striking disclosures regarding the seasonal distribution of the population of *H. gracilis*. In contrast to the results obtained with *Acantheephyra purpurea*, however, there appears to be an increase in the numbers of ovigerous females during the latter part of the summer as shown in Text-fig. 47. Although these results may be entirely due to chance, it is difficult to suppose that the percentage error would be great enough to account for the fact that out of forty females taken in June only nine were ovigerous, whereas out of forty-two females in September twenty-one were carrying eggs.

Vertical Distribution: The vertical distribution of the entire catch of *H. gracilis* is shown in the following table:

Fathoms	Males	Females	Young
400.....		1	1
500.....	1		17
600.....	1	1	83
700.....	1	14 (5 ovig.)	193
800.....	10	51 (21 ovig.)	334
900.....	15	59 (24 ovig.)	417
1,000.....	45	78 (28 ovig.)	503
1,100.....		1	2
1,200.....		1	

The distribution of the adult and young when reduced to the number of specimens taken in an average hour of towing at each depth is shown in Text-fig. 48. All of these specimens were taken in the daytime. This distribution naturally suggests that a large part of the adult portion of the popula-

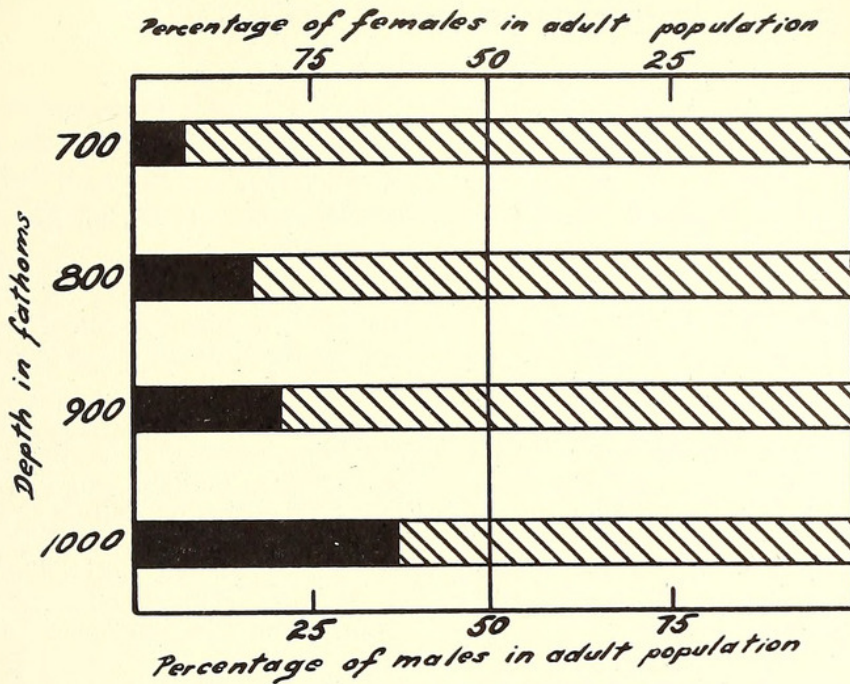


Text-figure 48.

Vertical distribution of adults (solid bars) and young (hatched bars) of *Hymenodora gracilis*.

tion is usually found at depths exceeding 1,000 fathoms. That they were not taken in greater numbers at 1,100 and 1,200 fathoms may be due to the fact that these depths are too near the bottom in the area investigated. It is not unlikely that additional towing at greater depths in this general region might reveal a much greater proportion of adults. An increase in the proportionate number of males as the depth becomes greater, similar to the vertical distribution of the sexes in *Acantheephyra purpurea*, is apparent in this species as shown in Text-fig. 49. Since the females are more numerous at every haul, it is probable that this sex is normally more abundant than the males in this species, but one cannot entirely ignore the possibility that if the increase in the male component of the population continues with increase in depth to 2,000 fathoms or over this sex ratio might be more nearly equalized; if, in the case of *Acantheephyra purpurea*, only specimens from 600 fathoms and above had been seen, one would assume that the females were distinctly in the majority, but when the deeper hauls are considered just the reverse proves to be true. It will be noticed from the table that the ovigerous females were fairly well scattered from 700 to 1,000 fathoms, varying from 35 to 42 per cent. of the adult females at those levels.

Geographical Distribution: Since *H. gracilis* has so frequently been confused with *H. glacialis*, its distribution is very imperfectly known. All of the specimens which I have seen from the temperate North Atlantic, with the exception of a single specimen taken southeast of Georges Bank, appear



Text-figure 49.

Relative abundance of males and females of *Hymenodora gracilis* from 700 to 1,000 fathoms. Solid bars represent the male fraction of the adult population; hatched bars the female.

to belong to *H. gracilis*; possibly *H. glacialis* is usually confined to the arctic and subarctic regions in the North Atlantic. However, the specimens from the Gulf of Panama referred to this species by Faxon (1895, p. 168) prove to be typical specimens of *H. glacialis*.

Genus **Systellaspis** Bate, 1888.

Carapace without a straight ridge or carina running along the median lateral line from the orbit to the hind margin, and without an oblique ridge or carina delimiting the hind margin of the hepatic furrow. Abdomen never dorsally carinate on the sixth somite. Telson not truncate at the tip but terminating in a sharply pointed end-piece laterally armed with spines. Pereiopods not abnormally broad and flattened. Exopods of third maxillipeds and pereiopods neither foliaceous nor rigid. Eyes well pigmented and usually large. Outer margin of antennal scale not armed with a series of spines. Incisor process of mandible toothed for the entire length of its cutting edge.

KEY TO THE BERMUDIAN SPECIES OF *Systellaspis*.

- Rostrum triangular and less than half as long as carapace; hind margins of fourth and fifth abdominal somites not denticulate; sixth somite at least twice as long as fifth.....*S. braueri*.
- Rostrum slender and longer than carapace; hind margins of fourth and fifth abdominal somites denticulate; sixth somite less than twice as long as fifth*S. debilis*.

***Systellaspis braueri* (Balss).**

Text-fig. 50.

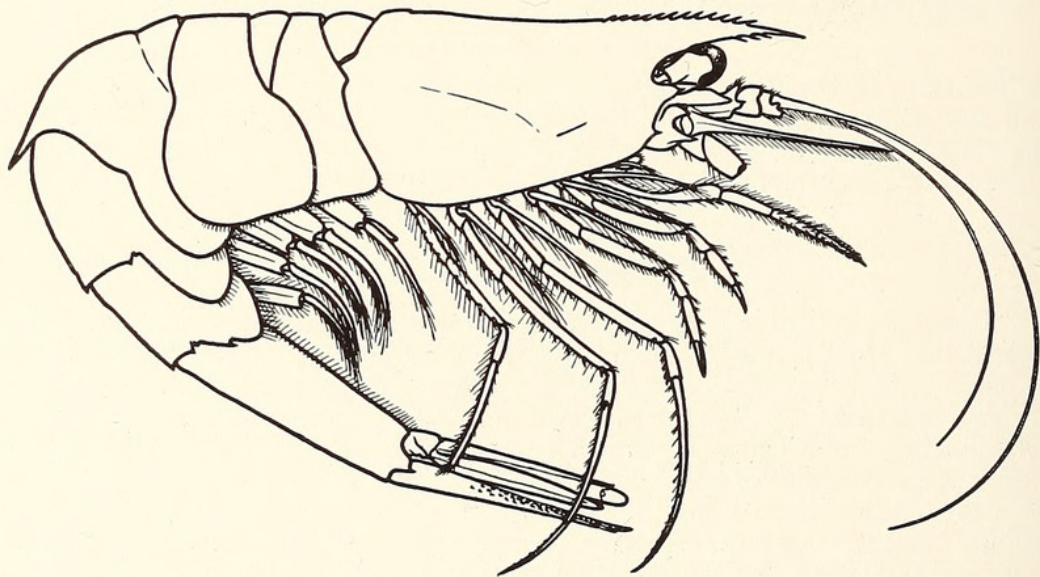
? Systellaspis echinurus Coutière, 1911, p. 158.*Acanthephyra braueri* Balss, 1914, p. 594.*Systellaspis densispina* Stephensen, 1923, p. 57, fig. 17.*Systellaspis braueri* Balss, 1925, p. 245, text-figs. 17-20, pl. 21.

Diagnosis: Rostrum triangular and less than half as long as carapace. No sharp dorsal carina on any abdominal somite; hind margins of fourth and fifth somites not denticulate; a blunt lobe on anterior margin of first abdominal somite overlapping carapace; a deep notch in hind margin of fifth pleuron; sixth somite at least twice as long as fifth.

Color in Life: Unknown.

Remarks: The collection contains thirteen specimens of this species, ranging in size from 4.2 to 14.3 mm. in carapace length. All but two of these specimens are obviously young. The two largest specimens, possibly mature females, were taken in June and September, 1929, and the others were scattered from May to September of 1929, 1930 and 1931. The depths in which they were found varied from 700 to 1,000 fathoms, only the smaller specimens being taken in the shallower depths and the two largest in 1,000 fathoms.

As Stephensen has pointed out, it is very likely that *S. echinurus* Coutière belongs to this species, but the description is much too inadequate to permit recognition of the earlier name. Balss is probably correct in combining *S. densispina* Stephensen with this species.



Text-figure 50.

Systellaspis braueri. Female taken in September, 1929, from 1,000 fathoms. $\times 2.13$.

Geographical Distribution: Only five or six specimens of *S. braueri* have been recorded heretofore. They were found in the Bay of Biscay, in the Gulf of Guinea off the west coast of Africa and in the Bay of Bengal off Ceylon. There is one additional specimen in the U. S. National Museum which was taken by the *Albatross* off Los Angeles, California, and a large female has recently been acquired by the Museum of Comparative Zoology from southeast of Georges Bank.

***Systellaspis debilis* (A. Milne Edwards).**

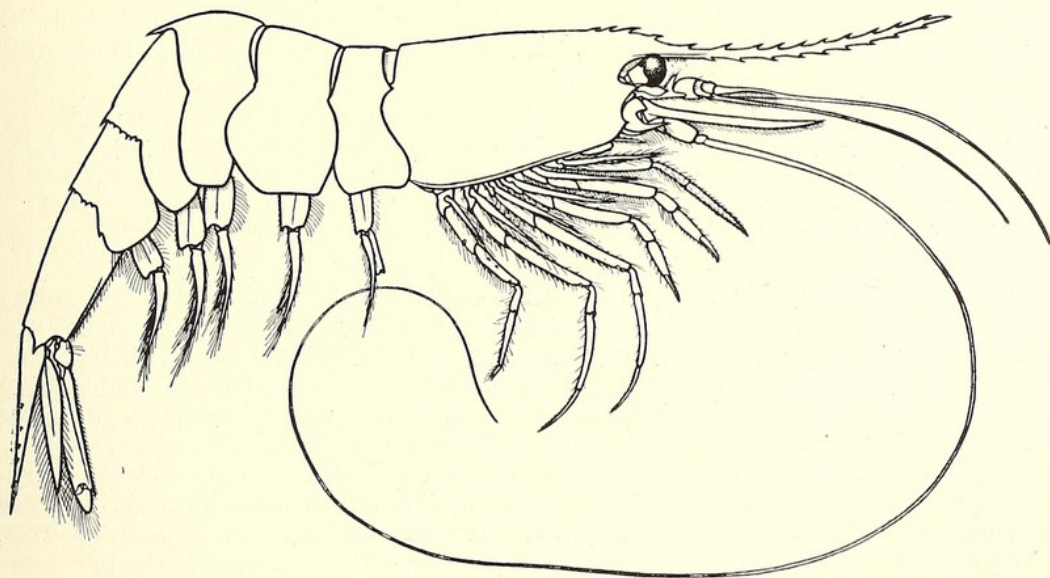
Text-figs. 51-53.

Acanthephyra debilis A. Milne Edwards, 1881a, p. 13.*Miersia gracilis* Smith, 1882, p. 70, pl. 11, figs. 4-4d.*Acanthephyra debilis* var. *Europoea* A. Milne Edwards, 1883.*Acanthephyra gracilis* Smith, 1886, p. 672.*Systellaspis debilis* Coutière, 1905, p. 5, fig. 2.*Systellaspis bouvieri* Coutière, 1905, p. 8, fig. 3.*Systellaspis debilis* var. *indica* de Man, 1920, p. 51, pl. 6, figs. 11-11f.*Systellaspis debilis* Balss, 1925, p. 242.

Diagnosis: Rostrum slender and usually longer than carapace. Abdomen dorsally carinate on most of third and posterior portion of fourth somites; hind margins of fourth and fifth somites denticulate either side of median spine; an acute lobe on anterior margin of first abdominal somite overlapping carapace; a notch in hind margin of fifth pleuron, sixth somite less than twice as long as fifth.

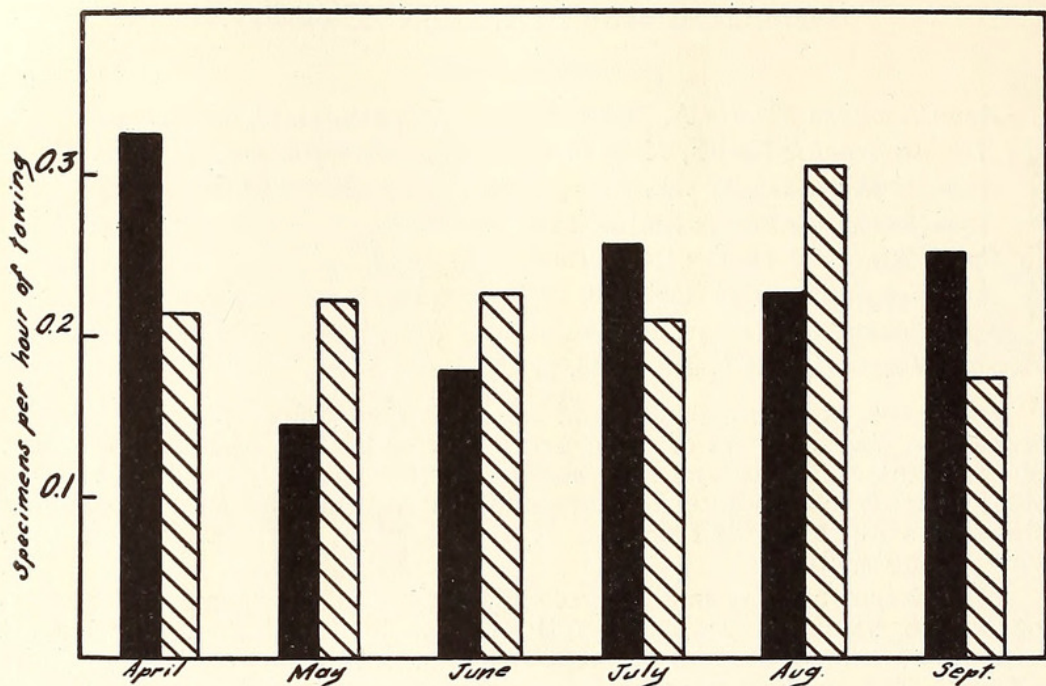
Measurements: The smallest recognizable males show some slight variation in size, having a carapace length of from 7.2 to 7.8 mm. The largest males have a carapace length of about 14.0 mm. and the largest females about 14.2 mm. The smallest ovigerous females examined had a carapace length of 10.9 mm. The youngest specimens have the carapace 2.8 mm. long. The eggs vary somewhat in size depending on their degree of development and state of preservation, but their average measurements are about 3.7 by 1.9 mm.

Color in Life: The largest adult specimens have the entire body and appendages, except for the eyes and light organs, scarlet-red, with the antennal scales, antennae, pleopods and uropods tinged with salmon-orange. The eyes are dark brown; the light organs have deep bluish-purple centers and dark red reflectors. The eggs are spectrum red. In somewhat smaller individuals the body color varies from scarlet-red to white spotted with



Text-figure 51.

Systellaspis debilis. Male taken in June, 1929, from 600 fathoms. $\times 2.12$.



Text-figure 52.

Seasonal distribution of adults (solid bars) and young (hatched bars) of *Systellaspis debilis* computed from specimens taken in 1929 and 1930.

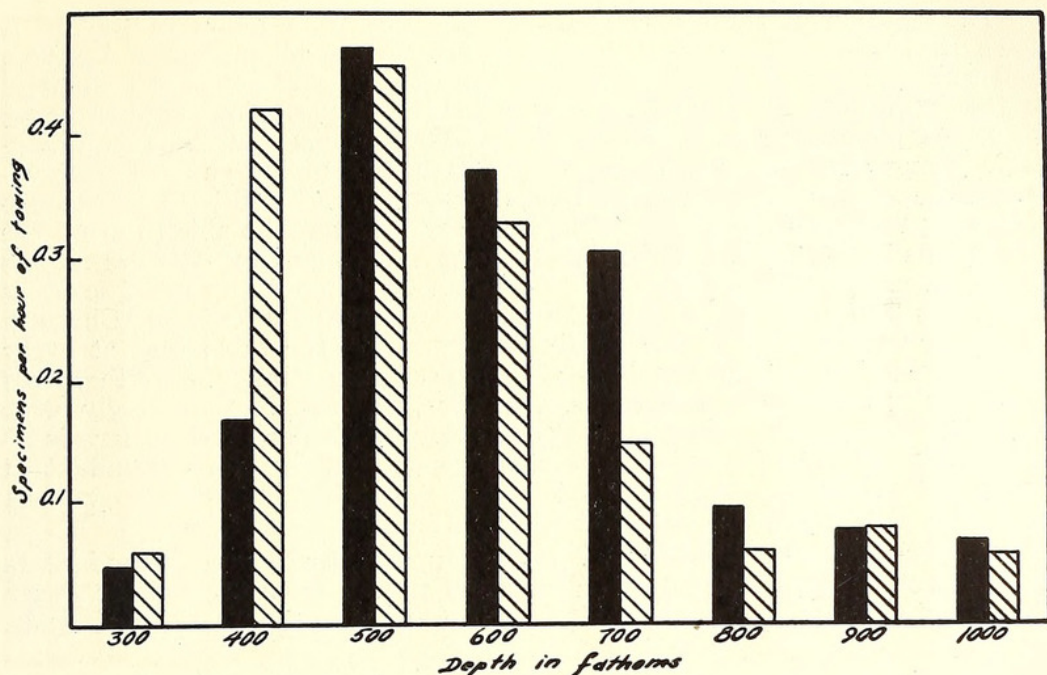
scarlet, the abdomen frequently showing considerable white in young specimens; in those specimens which are not of maximum size the tips of the antennae, rostrum, pleopods, uropods and telson are nearly white.

General Remarks: The collection contains 1,949 specimens of this species; 470 males, 567 females, of which 327 are ovigerous, and 912 young. Of the ovigerous specimens, 66 carry eggs in which the eyes are visible.

S. debilis can be distinguished from all other members of the genus by the denticulate hind margins of the terga of the fourth and fifth abdominal somites.

Luminescence: The position of the photophores in *S. debilis* is given by Kemp, 1919 (p. 64). Harvey, 1931, discusses the chemistry of the luminescence in this form and also reports that specimens can be stimulated to emit "a cloud of bluish luminescent secretion . . . from glands near the mouth." Observations on the luminescence of living specimens will be found on page 204 of the present paper.

Seasonal Distribution: The monthly distribution of the adults and young of this species in 1929 and 1930 is shown in Text-fig. 52. Obviously, the fluctuation in the population does not appear to follow any definite plan. Curiously enough, the young population seems to remain more stable than the adult. The seasonal distribution of ovigerous females similarly discloses little of significance; in each month of 1929 and 1930 in which towing was done, with the exception of April, more than half of the females were carrying eggs and more than six per cent. of the female population carried eggs in which the eyes are visible. When one examines the yearly hauls for 1929, 1930 and 1931, it is found that in 1929 the yield of this species per hour of towing was 0.249 adults and 0.224 young, whereas in 1930 and 1931 this figure was 0.190 for the adults in each year and 0.200 and 0.114 respectively for the young. However, it is found that the numbers of ovigerous females per hour of towing in 1929 and 1930 were nearly the same, 0.075 and 0.073



Text-figure 53.

Vertical distribution of adults (solid bars) and young (hatched bars) of *Systellaspis debilis*.

respectively. Of course, this also reveals a dissimilarity in the proportion of adult females which were ovigerous in the two years; in 1929 only 58.2 per cent. were ovigerous, while in 1930 75.5 per cent. were carrying eggs, and these proportions remain fairly uniform when these years are analyzed month by month. It is evident from an examination of the collection that practically all of the females in which the carapace is more than about 11.5 mm. long were ovigerous, so the explanation of the smaller proportion of ovigerous specimens in 1929 must be that young females with a carapace length of from 7.5 to 11.5 mm. were more abundant in that year than in 1930. On the other hand, although adult specimens seemed to be just as abundant in 1931 as in 1930, only 0.048 ovigerous females were taken per hour of towing and only 43.6 per cent. of the adult females were carrying eggs. Since towing in 1931 was carried on from July to October, while in 1930 it was done from May to September, it is somewhat hazardous to compare these two years in this manner. However, it would appear that young females were even more abundant in 1931 than in 1929.

Vertical Distribution: The vertical distribution of the total catch is as follows:

Fathoms	Males	Females	Young
100	.....	.....	1
200	.....	.....	.....
300	2	9 (3 ovig.)	14
400	13	23 (3 ovig.)	90
500	153	186 (102 ovig.)	329
600	127	125 (73 ovig.)	222
700	92	120 (80 ovig.)	103
800	34	32 (21 ovig.)	41
900	28	29 (20 ovig.)	59
1,000	21	42 (24 ovig.)	52
1,100	.....	.....	.....
1,200	.....	.....	1

The relation of these specimens to the number of hours of towing is shown in Text-fig. 53. All of these specimens were taken in the daytime. Apparently the center of distribution of this species is at 500 or 600 fathoms for the adults and 400 fathoms or above for the young. The rapid thinning out of the population of *S. debilis* above 500 fathoms and the fact that a single young specimen was found at 100 fathoms tend to support observations made in the bathysphere by Beebe (1934, pp. 303 and 340) that specimens are present in the upper levels, but that they may be able to avoid the nets in this better lighted zone. From night hauls made by *Atlantis* in this general area, it is known that *S. debilis* can be taken at levels at least as shallow as 220 fathoms during the hours of darkness (Welsh, Chace & Nunnemacher, 1937, p. 190). It will be seen from the table that at every depth at which significant numbers of this species were taken more than half of the adult females were ovigerous. Likewise, there was no strikingly large proportion of those carrying eyed eggs at any particular level. There is no evidence in this species that males are proportionately more abundant at deeper levels as was noted in *Acanthephyra purpurea*; in fact, the greatest proportion of females was found at 1,000 fathoms.

Geographical Distribution: *S. debilis* appears to be most abundant in the North Atlantic, but it has been recorded as well from the eastern South Atlantic, the Indian Ocean, the Malay Archipelago and the Hawaiian Islands.

Genus **Oplophorus** H. Milne Edwards, 1837.

Carapace without a straight ridge or carina running along the median lateral line, and without an oblique ridge or carina delimiting the hind margin of the hepatic furrow. Abdomen armed with remarkably long spines on either the second, third and fourth or the third, fourth and fifth somites; it is usually carinate on those somites provided with spines and not on the others. Telson terminating in a sharp point which may or may not be armed with lateral spines. Pereiopods short and slender. Exopods of third maxillipeds and pereiopods foliaceous and usually rigid. Eyes large and well pigmented. Outer margin of antennal scale usually armed with a series of spines. Incisor process of mandible toothed for the entire length of its cutting edge.

KEY TO THE BERMUDIAN BATHYPELAGIC SPECIES OF *Oplophorus*.

- | | |
|---|------------------------|
| Abdomen armed with long spines on second, third and fourth somites..... | <i>O. spinicauda</i> . |
| Abdomen armed with long spines on third, fourth and fifth somites..... | <i>O. grimaldii</i> . |

Oplophorus spinicauda A. Milne Edwards.

Text-fig. 54.

Oplophorus spinicauda A. Milne Edwards, 1883.

Oplophorus foliaceus Rathbun, 1906, p. 922, pl. 20, fig. 8.

Hoplophorus foliaceus Balss, 1925, p. 249.

Acanthephyra anomala Boone, 1927, p. 104, fig. 21 (holotype only).

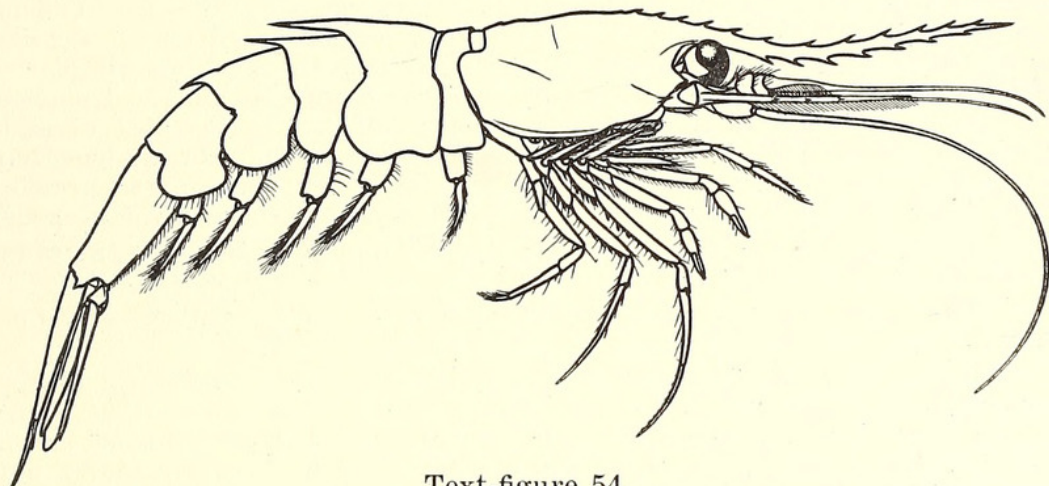
Oplophorus spinicauda Chace, 1936, p. 30.

Diagnosis: Second, third and fourth abdominal somites terminating in a long spine. No spine at postero-lateral angle of carapace. Outer margin of antennal scale spinose. Exopods of all pereiopods foliaceous but not rigid. Telson terminating in an end-piece armed with lateral spines.

Color in Life: Entire integument transparent with scarlet chromatophores scattered over the antennal peduncles, the mouth parts, the pereopods, the basal segment of the pleopods and the sides of the abdomen. The anterior internal thoracic organs scarlet, with a more posterior mass of spectrum red. Eyes blackish-brown.

Remarks: There are nine specimens of this species in the collection; one with a carapace length of 6.2 mm. that is possibly a young male, and the rest, apparently young, with a carapace length of from 4.0 to 5.2 mm. The young male was taken September 15 to 29, 1930, in 600 fathoms, and the young were found in August or September, 1929, July and September, 1930, June and July, 1931, and July, 1934, in depths ranging from 300 to 800 fathoms.

O. spinicauda shows a relationship to members of the genus *Systellaspis* in the form of the telson, the non-rigid exopods of the pereiopods and its relatively soft integument. In other characters as well, such as the presence of spines on the second, third, and fourth abdominal somites rather than on the third, fourth and fifth, the very much reduced molar process of the mandible and the third segment of the endopod of the second maxillipeds vestigial, this species differs strikingly from all other known members of *Oplophorus*.



Text-figure 54.

Oplophorus spinicauda. Young male taken in September, 1930, from 600 fathoms. $\times 3.39$.

Examination of larger series of the species from other localities indicates that there is no appendix masculina on the second pleopod in this form and the endopod of the first pleopod fails to disclose any prominent sexual differences. The sexes can apparently be distinguished, however, by the presence in the male of a broad, shallow indentation in the lower margin of the first abdominal pleuron; in the male, then, the lower margin of this somite is more or less sinuous in outline, whereas in the female and young it is more evenly convex.

There is little doubt in my mind, after examining the type of *O. foliaceus* Rathbun, that these species are identical. Miss Rathbun has informed me that at the time she described the species Milne Edwards' "Recueil de Figures" was not available. The holotype of *Acantheephyra anomala* Boone is a young specimen of *O. spinicauda*, while the paratype mentioned in the description is apparently a young specimen of *O. grimaldii* Coutière.

The following remarks were made by Miss Crane on a specimen of this species:

"The shrimp showed a great deal of spasmodic activity both on the ice and off until placed in formalin twenty-eight hours after it was brought in; at all times it kept up a continuous and vigorous kicking of its pleopods."

Luminescence: The following description of the distribution of photophores in an immature specimen of this species is taken from notes taken from fresh material by Miss Crane.

There is an elongate scarlet patch on a background of pale violet blue situated on the anteroventral surface of the eye, while on the posterior side is another, much larger, scarlet patch. One or both of these may be luminescent. On the thorax, light organs are found on the third maxilliped and the third, fourth and fifth pairs of walking legs. Those on the maxilliped are in two series at the proximal and distal ends of the dactyl, and consist of six and three minute organs respectively; they are posteriorly directed and of a golden color set in scarlet cups. Both the series arrangement and the general appearance bear a striking resemblance to the photophores of *Argyropelecus*. At the proximal end of the carpus of the third walking leg is situated a much larger organ, gold set in scarlet as above, but perfectly round and directed only very slightly downward and forward. On the fourth walking leg are two similar organs, one in a corresponding position and the other at the proximal end of the propodus. Three such organs are present on the fifth leg, two arranged as on the preceding, and the third (much longer—about four times as long as broad) is located on the distal end of the propodus. In addition to the pereopodal organs, an elongate scarlet patch, without any gold visible and possibly glandular in nature, is placed at the base of the last pair of legs beneath the carapace. On the abdomen there is a photophore directed forward and downward at the base of each pleopod; these are of about the same size as those on the thoracic legs, but the scarlet reflector is more prominent than the golden inner part. Finally, there is a smaller, similarly designed light at the inferior base of the uropods.

The following remarks are taken directly from notes made on the same specimen by Dr. Beebe.

"This small shrimp was taken alive in the big wire net at 5-7 knots on June 12th.

"It was invisible in the dark-room until the glass was tapped or the water stirred when a solid luminous spot of pale, bluish-white light shone out steadily. If the shrimp was disturbed further this light vanished and a squirt of luminosity appeared, bright at the source and rapidly fading out as it shot into the water. The visible length seemed about three times the length of the shrimp, and once at least the direction was at right angles downward from the body (about 5:30 P.M.). This phenomenon was repeated four times and it had been noticed before once. This first time (noticed by Miss Crane) there was the steady glow for a moment, then a greater amount of fire shot out than at any of the later times. The last time I saw it, it was as strong as the first. After dark (8 P.M.) the shrimp gave out no light whatever, but the water had a considerable amount of flocculent material on the bottom. This showed no especial structure under the lens."

Geographical Distribution: *O. spinicauda* has been recorded from off the coast of British Honduras, off the coast of Morocco, the Indian Ocean north of Madagascar and south of India and the Hawaiian Islands. In addition, I have seen specimens in the U. S. National Museum from off the east coast of Florida, the West Indies and the Philippine region. In the North Atlantic this species seems to be much more abundant in the West Indian region than in the Bermuda area.

***Oplophorus grimaldii* Coutière.**

Text-fig. 55.

Hoplophorus grimaldii Coutière, 1905a, p. 1114; 1905b, p. 1, fig. 1.*Hoplophorus grimaldii* Coutière, 1925, p. 249, fig. 24.

Diagnosis: Third, fourth and fifth abdominal somites terminating in a long spine. Usually no spine at postero-lateral angle of carapace. Outer margin of antennal scale spinose, and inner margin usually with a barb near the tip. Exopods of all pereopods foliaceous and more or less rigid. Telson terminating in a long spine, but not an end-piece armed with lateral spines.

Measurements: Immature males in which the appendix masculina is shorter than the usual appendix interna have a carapace length varying from 7.3 to 8.0 mm. The largest male in the collection has the carapace 12.2 mm. long and the largest female, 14.2 mm. In the smallest ovigerous female the carapace measures 11.2 mm., and all females exceeding this size are carrying eggs. The smallest specimen has a carapace length of 2.7 mm. In the three specimens in the collection in which the carapace measures less than 3.0 mm. the spine on the third abdominal somite and the rostrum are extremely long, the latter being from two and two-thirds to three times as long as the carapace. The eggs measure 2.8 by 1.8 mm.

Color in Life: Thorax and abdomen white with a heavy wash of scarlet-red chromatophores on the sides; since these are confined on the abdomen to the central part of each somite, a banded appearance is produced. There are golden reflections along the smooth, shiny sides of the carapace. Frequently the abdominal pleura are tinted pale violet. The antennae are transparent except for scarlet-red chromatophores scattered at their bases. Mouth parts brilliant spectrum-red. Pereiopods somewhat lighter, shading to almost transparent scarlet. Pleopods salmon-orange proximally with the exopods and endopods translucent white. Uropods, telson and abdominal spines transparent. Eye dark-brown, the central portion gleaming with reddish gold and orange. Eggs carmine to scarlet-red.

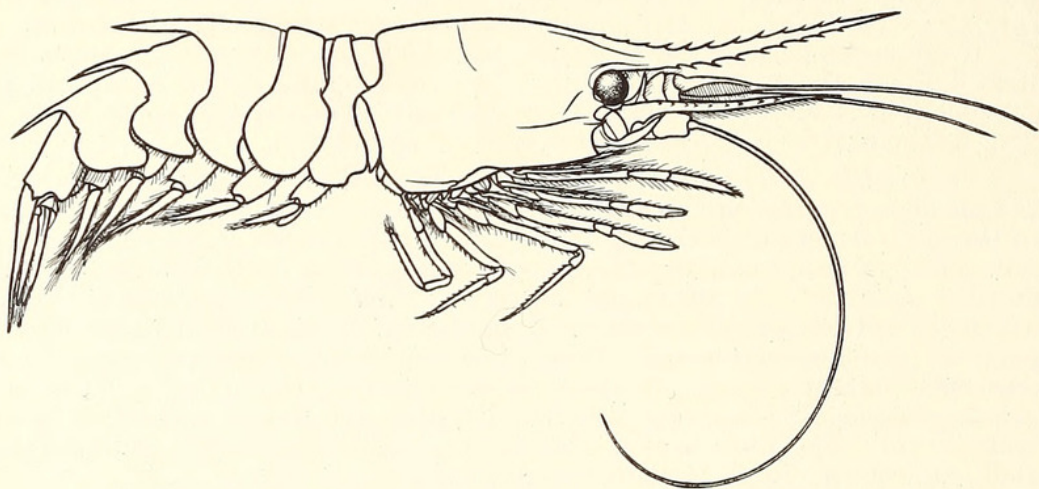
Luminescence: The following notes on the distribution of light organs in this species were made from living material by Miss Crane.

"Behind the eye is a translucent scarlet-red projection from the eye itself enclosing a darker oblong organ; in front a similar but lighter structure is found. One or both are possibly luminescent. On the distal segment of the last maxilliped, extending the entire length of the posterior border (ventral when flexed), is a row of about 45 minute, spectrum-red organs above a long, unbroken line of blue violet which probably acts as a reflector. The two organs, with their segment of the blue line, at the extreme tip are isolated somewhat from the others. A large silvery or golden organ set in purplish-blue occupies most of the interior of the short carpus on the third, fourth and fifth legs. The last (fifth) leg has in addition two organs on the long hand—an elongated oval one proximally about the size of that in the carpal segment, and a much elongated one distally. These leg organs are visible from both the outer and inner side through clear, window-like transparencies in the cuticula. From the inside, though, they appear brilliant scarlet-red as if seen through shiny red cellophane. They cannot be said to be directed in any special direction, except perhaps slightly backwards. Behind the last leg is an elongated transverse bar, the outer half spectrum-red, the inner deep violet-blue. A series of five peculiar tri-colored spots is strung in a broad arc along the carapace, cutting off the lower posterior corner.

On close examination it appears that each spot consists of an upper, upwardly directed bright red light with a violet-blue half-moon reflector placed below it, the interval between light and reflector being white. The abdominal organs consist of six pairs of deep bluish-purple lights set in scarlet-red sockets and placed beneath the epimera on the anterior outer side of the first segment of each pleopod and uropod. They are directed forwards and downwards."

No luminescence was produced in this species by stimulation of live specimens. However, Miss Crane has noted the following of one specimen placed in preservative while still alive:

"Immediately after being placed in alcohol a large quantity of white flocculent material was exuded, apparently chiefly from the posterior part of the ventral side of the thorax, perhaps from the elongated, transverse, violet and red bar previously described."



Text-figure 55.

Oplophorus grimaldii. Male taken in June, 1931, from 300 fathoms. $\times 2.71$.

General Remarks: There are 48 specimens in the collection; 8 males, 19 females, of which 8 are ovigerous, and 21 young.

O. grimaldii can be readily distinguished from the preceding species by the different arrangement of the abdominal spines, but it is more difficult to separate it from *O. gracilirostris* A. Milne Edwards (1881). In general, *O. grimaldii* has the end of the antennal scale barbed on the inner margin and no tooth or spine at the postero-lateral angle of the carapace, whereas *O. gracilirostris* has no barb on the antennal scale and bears a prominent spine at the postero-lateral angle of the carapace. However, four of the present specimens lack the barb on the scale, possibly due to injury, and three of the ovigerous females have a blunt tooth at the postero-lateral angle of the carapace. Fortunately neither of these conditions occurs in the same individual of the present series, but it is not improbable that specimens may be found which might be assigned to either species.

Although there is a well developed appendix masculina in the adult males of this species, there is also a sexual distinction involving the first abdominal pleuron as in the preceding species; in the male, the lower anterior angle of this pleuron is deeply incised so that the angle formed approaches a right angle, while in the female this angle, if present at all, is very obtuse.

One specimen of this species was found in the stomach of the rock fish, *Mycteroperca bowersi*, caught off Challenger Bank, July 30, 1930.

Seasonal Distribution: By far the largest number of specimens of both adults and young were taken in June and July of 1929, 1930 and 1931. Since there was no great concentration of 300 to 500 fathoms tows during these months, it is possible that the species really is most abundant in the Bermuda area in mid-summer. The largest numbers of shallow hauls were made in May, but only one young specimen was found in that month of any year. However, at least one specimen was taken in every month from April to September and ovigerous females occurred in June, July, August and September, the only specimen in which the eggs were eyed being taken in August, 1929.

Vertical Distribution: The largest number of specimens were found at 300, 400 and 500 fathoms, although two or more specimens were taken at every level from 300 to 1,000 fathoms. As this species has been taken at night in the South Atlantic in some numbers only ten meters below the surface, it is possible that a large part of the population occurs above 300 fathoms.

Geographical Distribution: *O. grimaldii* has been recorded from the North Atlantic west of the Madeira Islands, the South Atlantic north of Tristan da Cunha and the Indian Ocean west of Australia. I have also seen specimens from off the east coast of the United States, the Bahamas, south of Japan and northeast of Easter Island in the eastern Pacific.

Family Bresiliidae.

Rostrum well developed. First two pairs of pereopods chelate, shorter than the last three pairs and with an undivided carpus. Last three pairs not abnormally long. Exopods present on the maxillipeds and some or all of the pereopods. Terminal joint of second maxilliped normal, not applied as a strip to the end of the preceding joint. Mandible distinctly, but not deeply cleft.

One genus only is known from the Bermuda area.

Genus *Lucaya* Chace, 1939.

Carapace without a branchiostegal spine. Rostrum unarmed on the lower margin. All five pairs of pereopods provided with exopods, and the last three pairs decrease in length posteriorly. Eyes well pigmented.

There is but one known species.

Lucaya bigelowi Chace.

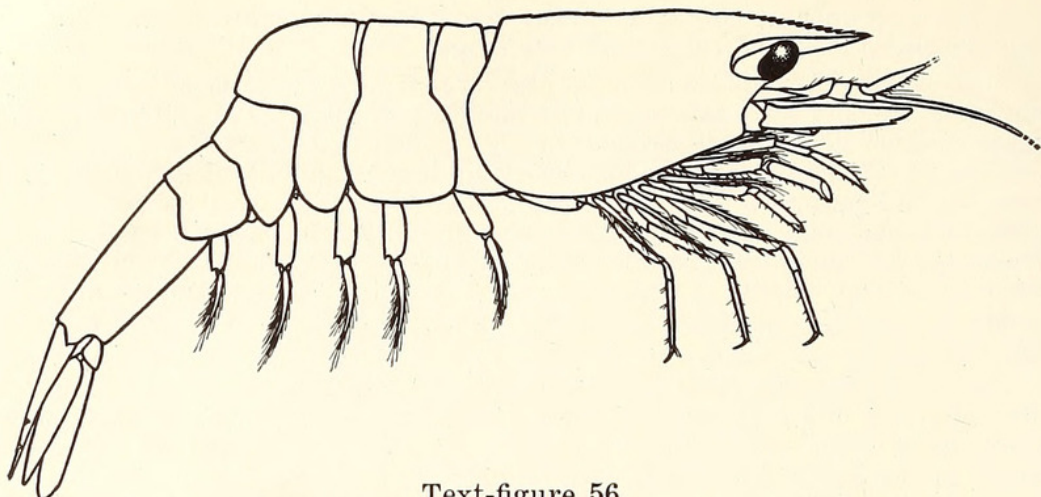
Text-fig. 56.

Lucaya bigelowi Chace, 1939, p. 34.

Diagnosis: Rostrum subquadrate in cross section. Abdomen without carina or armature of any kind; telson with two pairs of dorso-lateral spinules. Antennal scale broad with the blade extending far beyond the outer spine.

Color in Life: Entire animal pale salmon except for the rostrum, antennae and antennal scales which were scarlet.

Remarks: Two males in the present collection bring the total number of recorded specimens of this species to three. One male, with a carapace length of 4.2 mm., was taken in Net 18, April 12, 1929, in 700 fathoms; the other, with a carapace length of 4.7 mm., came from Net 940, September 24, 1930, 1,000 fathoms.



Text-figure 56.

Lucaya bigelowi. Holotype male from the Bahamas. $\times 6.02$.

More complete figures of this species are to be included in the final report on the Crustacea of the *Atlantis* Expeditions to the West Indies.

Geographical Distribution: The holotype came from east of Great Abaco Island in the Bahamas.

Family Pandalidae.

Rostrum prominent and dentate. First pair of pereopods simple or microscopically chelate. Second pair of pereopods with the carpus segmented. No exopods on any of the pereopods. Terminal joint of the second maxillipeds usually applied as a strip to the end of the preceding joint. Mandibles deeply cleft, with a three-jointed palp.

KEY TO THE BERMUDIAN BATHYPELAGIC GENERA OF PANDALIDAE.

Epipods present on all but the last pair of pereopods.....*Plesionika*.
No epipods on any of the pereopods.....*Parapandalus*.

Genus *Plesionika* Bate, 1888.

Carapace without lateral longitudinal carinae. Rostrum immovable and armed dorsally with fixed spines and sometimes with movable spines also. Eyes much wider than eyestalks. Stylocerite pointed. Third maxillipeds with an exopod. Epipods present on all but the last pair of pereopods. Carpus of second pereopods composed of more than three segments.

One bathypelagic species is known from the Bermuda area.

Plesionika martia (A. Milne Edwards).

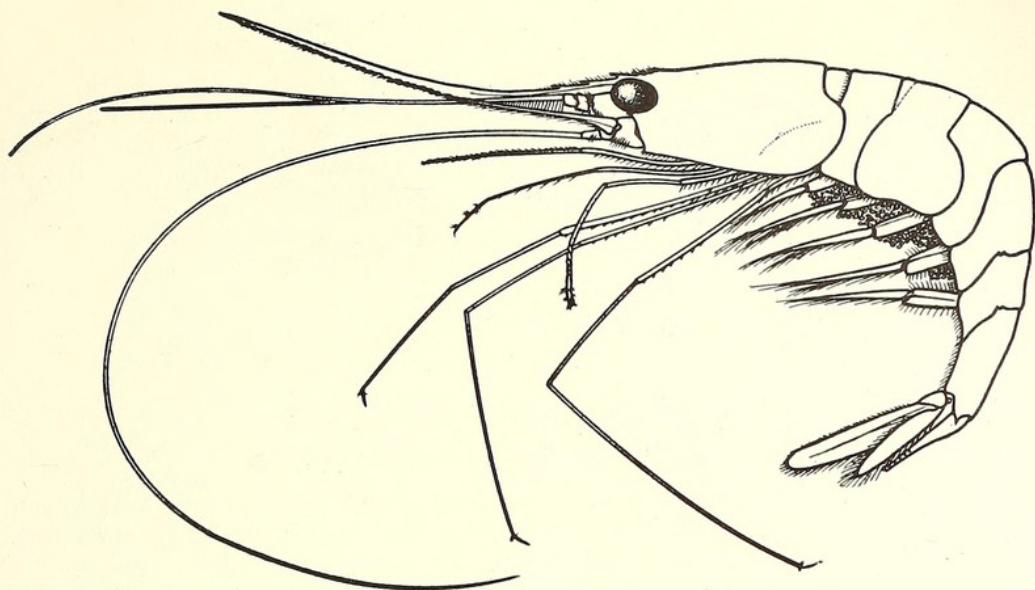
Text-fig. 57.

Pandalus martius A. Milne Edwards, 1883, pl. 21.

Plesionika semilaevis Bate, 1888, p. 644, pl. 113, fig. 3.

Plesionika martia Kemp, 1910, p. 93, pl. 12, figs. 1-4.

Plesionika martia Balss, 1925, p. 278.



Text-figure 57.

Plesionika martia. Ovigerous female (after Kemp, 1910). $\times 0.64$.

Diagnosis: Rostrum longer than antennal scale, dorsally smooth beyond antennular peduncle and regularly serrate below. Hind margin of third abdominal somite rounded. Second pereopods subequal in length.

Color in Life: The Bermuda specimen was pink and white. The following more complete color notes are quoted from Kemp, 1910 (p. 95):

"The carapace and abdomen are thickly sprinkled with bright red chromatophores; the former is dorsally of a dark purple tint, while in the latter the red pigmentation is darker on the posterior portions of each somite. The rostrum is bright red distally, less deeply coloured proximally. The eyes are black, with golden reflections; the antennules are red, and the antenna and antennal scale are more sparsely pigmented with the same colour. The outer maxillipeds and pereopods are more or less thickly spotted with red; the pleopods, telson and uropods are light red. All the fringes of the setae are golden in colour."

Remarks: A single young specimen, having a carapace length of 7.0 mm., was taken in Net 860, September 8, 1930, in 600 fathoms.

This is the first record for this species in the western Atlantic and one of the very few specimens ever taken with a mid-water net. Apparently *P. martia* generally remains on or near the bottom as indicated by the long, slender pereopods, since most of the known specimens have been taken with a dredge or trawl. However, Balss records an ovigerous female captured by the *Valdivia* in the Gulf of Guinea with a vertical net between 437 fathoms and the surface.

Geographical Distribution: *P. martia*, including its varieties, has been found off Ireland, in the Bay of Biscay, the Mediterranean Sea, the Gulf of Guinea off the west coast of Africa, off the Cape of Good Hope, off the east coast of Africa from Tanganyika to Italian Somaliland, in the Arabian Sea, the Andaman Sea, the Malay Archipelago, Sagami Bay, Japan, the Fiji Islands, off Sydney, Australia, the Kermadec Islands and the Hawaiian Islands.

Genus **Parapandalus** Borradaile, 1900.

Carapace without lateral longitudinal carinae. Rostrum immovable and armed dorsally with fixed spines and sometimes with movable spines as well. Eyes much wider than eyestalks. Stylocerite pointed. Third maxillipeds with an exopod. No epipods on any of the pereopods. Carpus of second pereopods composed of more than three segments.

Only one bathypelagic species is known from the Bermuda area.

Parapandalus richardi (Coutière).

Text-figs. 58-61.

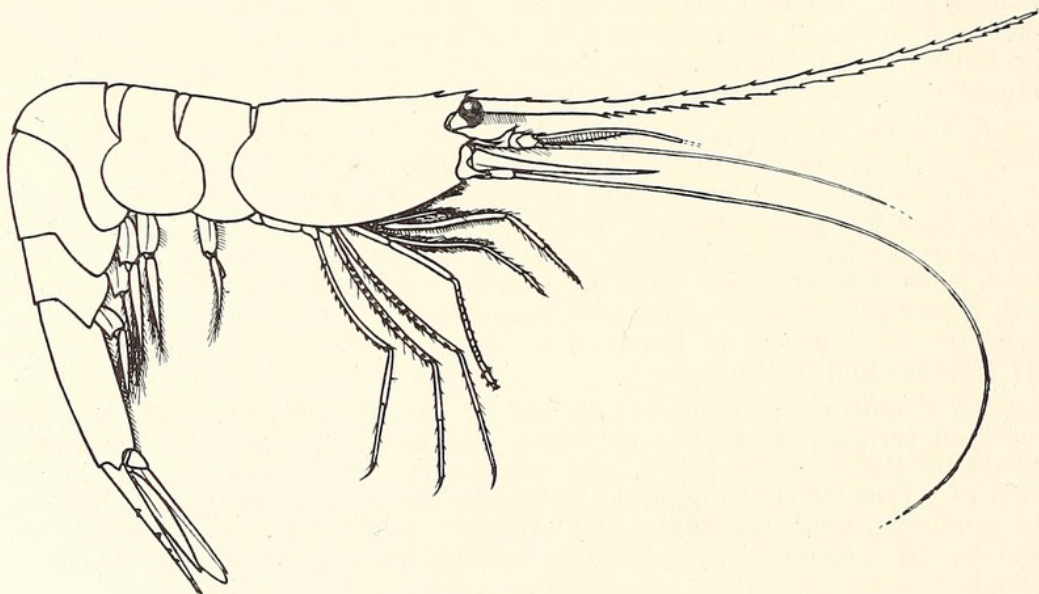
Pandalus (*Stylopandalus*) *Richardi* Coutière, 1905b, p. 18, fig. 6.

Parapandalus Richardi de Man, 1920, pp. 108 and 140.

Diagnosis: Rostrum about three times as long as carapace and armed with more or less widely spaced teeth along the entire length of its dorsal margin, including two larger teeth above the eye. Third abdominal somite at middle of its posterior margin with a slender, movable spine. Sixth abdominal somite at least three times as long as high and about two and two-thirds times as long as fifth somite.

Measurements: The smallest recognizable males in which the appendix masculina is no more than a bud have a carapace length of 4.2 mm., and the smallest ovigerous females have the carapace 5.8 mm. long. In ovigerous females in which the eggs are not eyed, the average carapace length is 6.7 mm., whereas in those in which the eggs are eyed this figure is 6.5 mm.; this may be due to a slight shrinking of the integument prior to the moult following the hatching of the eggs. The carapace of the largest male measures 7.2 mm., and of the largest female 7.5 mm. In the smallest specimen seen the carapace is 2.9 mm. long, but in most of the young specimens this measurement exceeds 3.5 mm.

Color in Life: In mature individuals, the entire prawn is bright scarlet, though paler on the abdomen where the color is resolvable into individual



Text-figure 58.

Parapandalus richardi. Male taken in June, July or August, 1931, from 500 fathoms. $\times 3.05$.

chromatophores on a white background. In young specimens, the anterior part of the body as far back as the third abdominal somite dorsally and the fourth pereopod ventrally is bright scarlet including the appendages; behind this the prawn is white, with the line of demarcation between the two regions yellowish sprinkled with scarlet chromatophores; there is a faint sprinkling of chromatophores along the sides of the abdomen also. Eyes brownish-black. Eggs pomegranate purple.

General Remarks: There are 404 specimens of this species in the collection; 166 males, 195 females, of which 105 are ovigerous, and 43 young. Of the ovigerous females, 30 carry eggs in which the eyes are developed.

TABLE 1.
SEASONAL DISTRIBUTION OF *P. richardi* IN 1929.

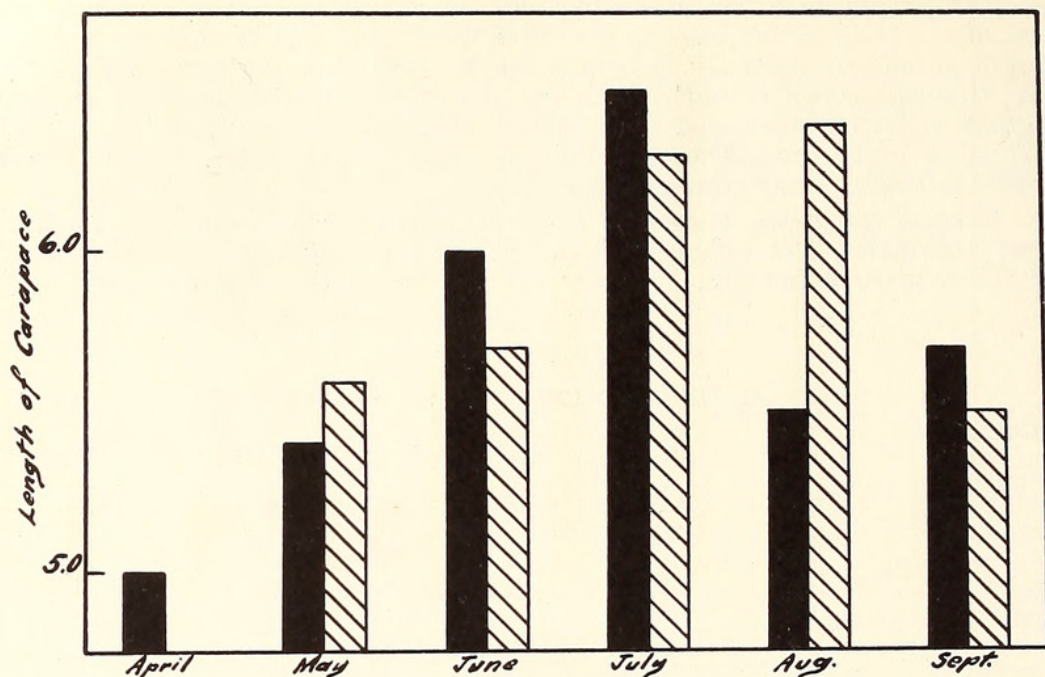
Carapace Length (mm.)	April	May	June	July	Aug.	Sept.
3.0	—	—	—	—	—	—
3.5	—	1	—	1	4	1
4.0	4	—	4	—	4	6
4.5	7	1	2	—	1	4
5.0	12	3	5	1	1	2
5.5	6	4	—	1	1	—
6.0	4	7	20	6	3	8
6.5	1	—	21	20	4	5
7.0	—	—	3	17	5	7
7.5	—	—	—	—	1	1

TABLE 2.
SEASONAL DISTRIBUTION OF *P. richardi* IN 1930.

Length Carapace (mm.)	April	May	June	July	Aug.	Sept.
3.0	No tows made in April	—	—	—	—	1
3.5		1	—	—	—	2
4.0		—	1	—	—	7
4.5		4	1	1	—	2
5.0		10	3	1	1	4
5.5		8	2	—	—	4
6.0		7	8	11	—	3
6.5		2	3	12	3	4
7.0		1	—	7	—	10
7.5		—	—	—	1	1

TABLE 3.
VERTICAL DISTRIBUTION OF *P. richardi*.

Carapace Length (mm.)	Fathoms							
	300	400	500	600	700	800	900	1,000
3.0	—	1	—	—	—	1	—	—
3.5	—	1	3	—	—	3	1	2
4.0	3	2	12	2	1	1	1	2
4.5	—	4	10	1	—	—	1	5
5.0	1	8	16	10	3	4	1	3
5.5	1	1	11	4	7	1	2	1
6.0	—	3	25	19	11	6	9	9
6.5	3	4	31	25	14	5	6	9
7.0	3	6	34	10	14	5	1	4
7.5	—	—	3	3	1	—	—	—

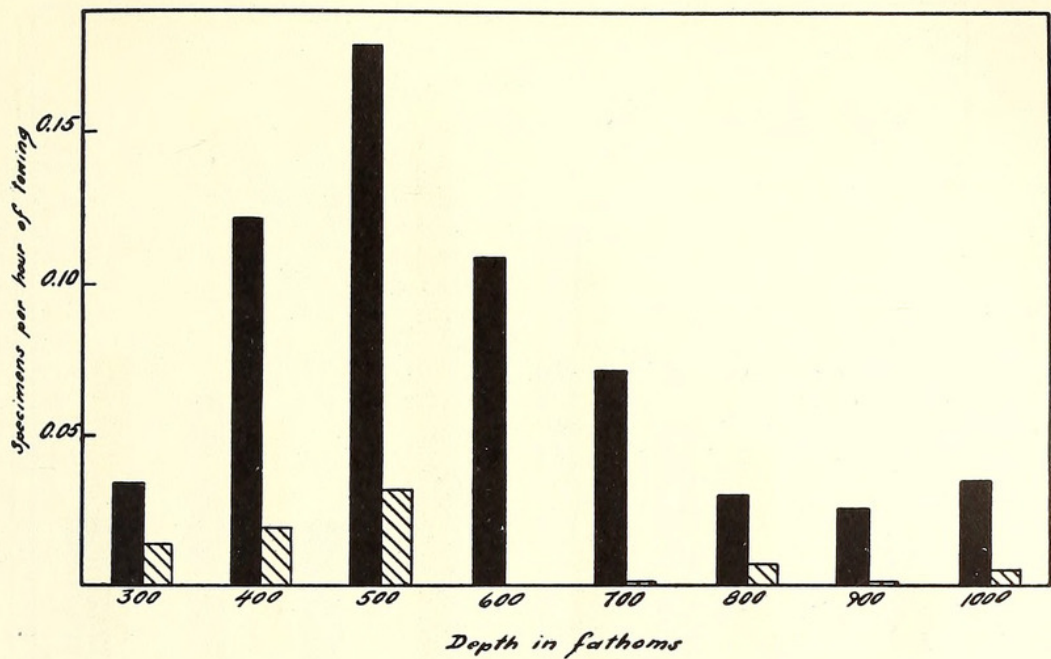


Text-figure 59.

Average carapace lengths of specimens of *Parapandalus richardi* taken in 1929 (solid bars) and 1930 (hatched bars).

This species is very similar to *P. zurstrasseni* Balss (1914) from the Indo-Pacific region. Whether or not they are identical can be determined only when more specimens of the latter species are discovered. *P. zurstrasseni* apparently lacks the slender spine on the third abdominal somite, but this is frequently broken off in specimens of *P. richardi*.

Seasonal Distribution: Analysis of the tows made in 1929 and 1930 reveals a very definite increase in the proportion of ovigerous females from about 10 per cent. of all females in April and May to 70 or 80 per cent. in July, August and September. However, as shown in Tables 1 and 2 and in Text-fig. 59, this is largely due to the fact that most of the females present in the spring are too young to bear eggs. If only those females in which the carapace exceeds 6.0 mm. are considered, it is found that from 60 to 100 per cent. are ovigerous and 15 to 30 per cent. are carrying eggs in which the eyes are visible in every month in which towing was done. The seasonal distribution of the size groups shown in Text-fig. 59 indicates that one group matures in July or August and that another group of younger individuals appears at this time. Study of the tables, however, shows that this lowering of the average carapace length is due fully as much to the decrease in the numbers of large specimens as to the increase of the small. The graph might lead to the assumption that the season was retarded somewhat in 1930 over that of 1929, but this is due largely to the increase in average size in August, 1930, and in this month only five specimens were taken, certainly not enough to yield significant results. It is difficult to account for this seasonal distribution and, except for the fact that a similar trend was found in both 1929 and 1930, little importance would be laid on results gained from such a comparatively small number of specimens. Whether this trend is caused simply by the migration of fully mature individuals through the towing area in greatest numbers in June and July or whether it is due to the normal growth of more than one age class can hardly be determined from these data. There is evidence that swarming occurs to some extent in this species since 65 of



Text-figure 60.
Vertical distribution of adults (solid bars) and young (hatched bars) of *Parapandalus richardi*.

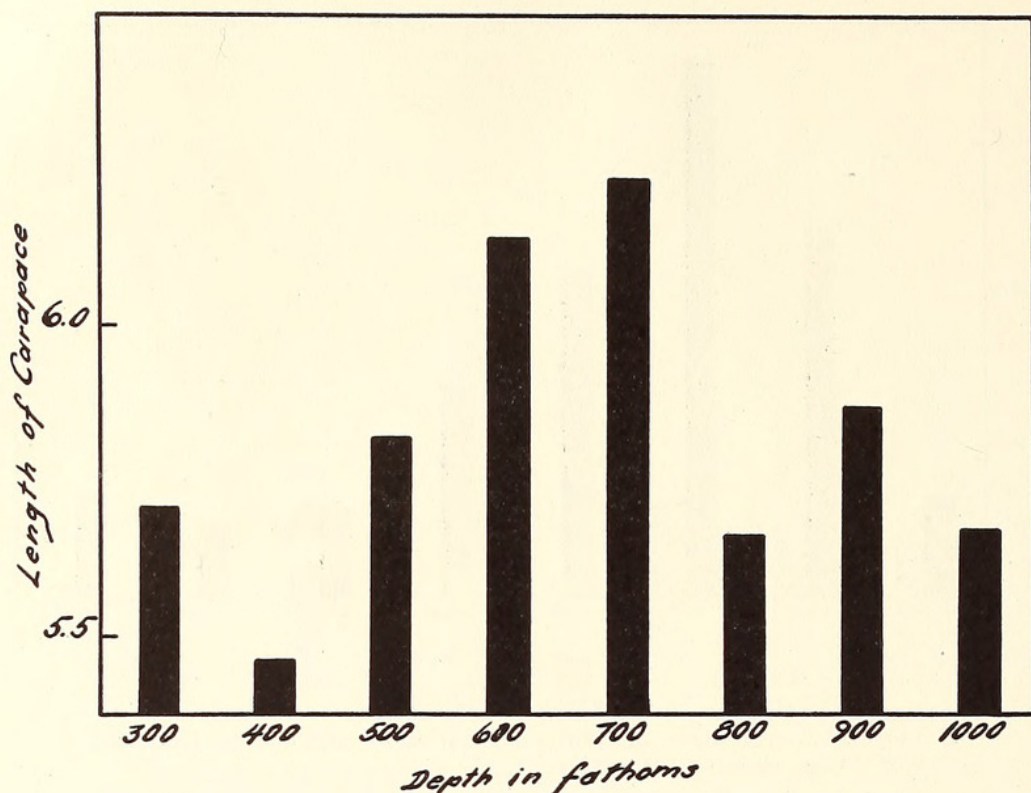
the specimens were taken in only seven nets; one in May, two in June and four in July. This, of course, may be due merely to a general increase in the number of individuals for a short period rather than actual swarming, but it has a definite effect on the results.

Vertical Distribution: The vertical distribution of the total catch is given in the following table:

Fathoms	Males	Females	Young
300.....	4.....	4 (3 ovig.)	3
400.....	12.....	14 (3 ovig.)	4
500.....	59.....	69 (40 ovig.)	23
600.....	34.....	40 (20 ovig.)	
700.....	22.....	28 (17 ovig.)	1
800.....	11.....	10 (4 ovig.)	5
900.....	8.....	11 (5 ovig.)	1
1,000.....	14.....	18 (11 ovig.)	5

Reduced to the number of specimens per towing hour, these data produce the graph shown in Text-fig. 60, and the average carapace length of the specimens at each depth is shown in Table 3 and Text-fig. 61. The optimum level for the species is at about 500 fathoms and, since open nets were employed, it might be assumed that specimens taken in over 800 fathoms were captured actually at higher levels as the nets were taken in; the unexpectedly large proportion of young specimens at these deep levels would point to the some conclusion. However, this question can be settled only by the use of closing nets. As will be seen from the table, ovigerous females were dispersed fairly uniformly from 300 to 1,000 fathoms, and the same applies to those carrying eyed eggs. As in *Systellaspis debilis*, there is no indication that males are proportionately more abundant at the deeper levels.

Geographical Distribution: The species has been previously recorded only from the Canary Islands and west of the Madeira Islands. Since it has not been taken by any of the expeditions in the northern part of the North Atlantic, *P. richardi* is probably a warm water form.



Text-figure 61.

Variation in the average carapace length of catches of *Parapandalus richardi* made at 100 fathom intervals.

Family Physetocaridae, fam. nov.

Rostrum present as a broad prolongation of the carapace. First pereopods simple. Second pereopods chelate, with the carpus segmented. No exopods on the third maxillipeds or any of the pereopods. Terminal joint of the second maxillipeds not applied as a strip to the end of the preceding joint. Mandible without an incisor process or palp.

Genus *Physetocaris*, gen. nov.

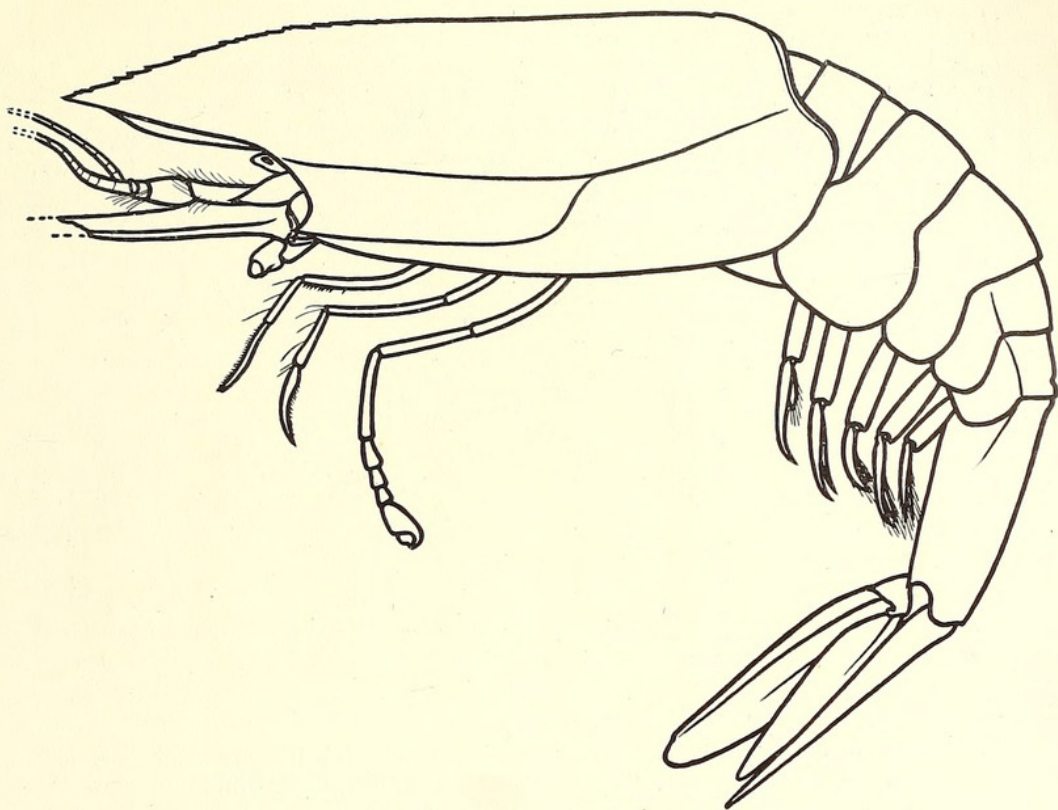
Carapace greatly inflated. Carpus of second pereopods consisting of four segments; chela flattened with a very short, broad dactyl. Branchial formula as follows:

	VII	VIII	IX	X	XI	XII	XIII	XIV
Podobranchiae	ep.	ep.	ep.	ep.	ep.	ep.		
Arthrobranchiae								
Pleurobranchiae				1	1	1	1	1

Physetocaris microphthalmia, sp. nov.

Text-figs. 62 and 63.

Types: Holotype female (?) Cat. No. 30,523, Department of Tropical Research, New York Zoological Society; Net 798; July 15, 1930; 600 fathoms.



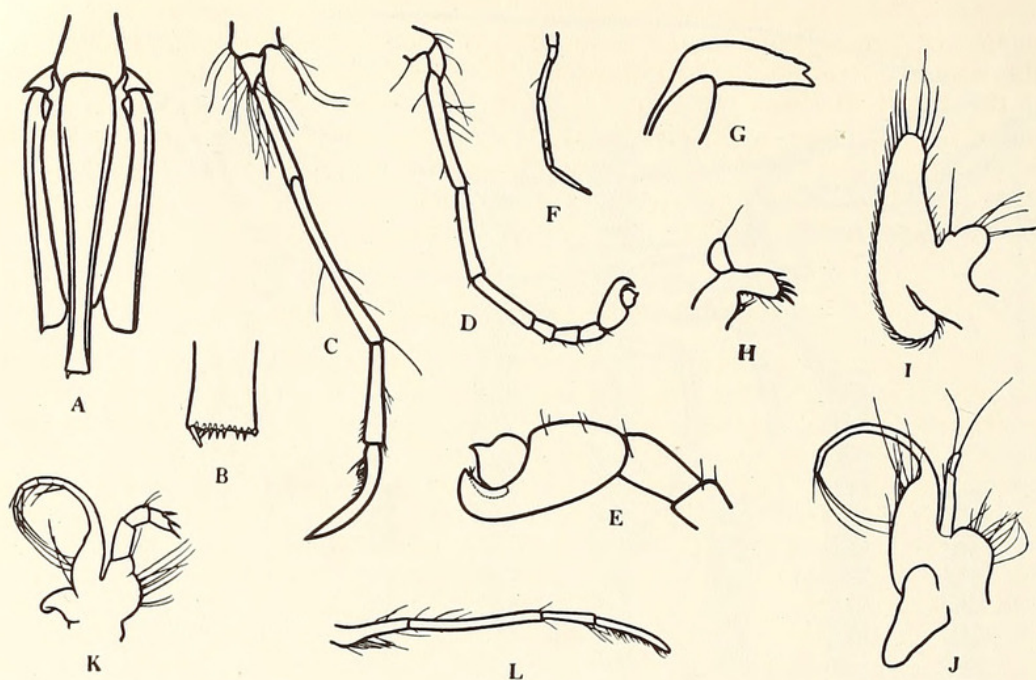
Text-figure 62.

Physetocaris microphthalma. Holotype. $\times 6.00$.

One female (?); Net 983, 990, 997, 1003, 1014, 1015, 1016, 1102, 1108, 1115, 1121, 1131, 1137 (?), 1138 (?), 1144, 1149 or 1150; June 2 to August 8, 1931; 500 fathoms.

Diagnosis: Carapace with two lateral carinae. Abdomen without any dorsal carinae or spines. Telson deeply sulcate dorsally and broadly truncate at the tip. Eyes very small and set on outside of stalks.

Description: Integument extremely thin and fragile. Carapace markedly inflated dorsally and anteriorly to form a very broad, inflated rostrum. The dorsal margin is carinate for its entire length and minutely denticulate on the anterior third of its length. In addition to the dorsal carinae there is a lateral carina originating behind the eye, which passes backward and slightly downward for about three-fifths of its length and then turns upward and terminates just before reaching the hind margin of the carapace. A second lateral carina starts at the branchiostegal spine, runs backward nearly parallel with the first for about half the length of the carapace, then turns upward and joins the first carina at the point where the latter bends upward. Orbit not defined, the raised line bordering the lower lateral margin of the rostrum forming a smooth curve and terminating in the prominent branchiostegal spine. Abdomen without any dorsal carina or spine on any somite, the only ornamentation being a raised ridge at the junction of the terga and pleura on the fourth and fifth somites; this ridge also extends onto the anterior part of the sixth somite. The sixth somite is about three and one-half times as long as the fifth. Telson longer than the sixth somite, deeply sulcate dorsally and broadly truncate at the tip where it is armed with a row of ten small spines, the outermost pair being about twice as long as the eight central ones. In the holotype, the tip of the telson is slightly concave rather



Text-figure 63.

Phisetocaris microphthalmma. **A.** Telson and uropods. **B.** Tip of telson. **C.** First pereiopod. **D.** Second pereiopod. **E.** Chela of second pereiopod. **F.** Fifth pereiopod. **G.** Mandible. **H.** First maxilla. **I.** Second maxilla. **J.** First maxilliped. **K.** Second maxilliped. **L.** Third maxilliped.

than nearly straight as in the paratype (Text-fig. 63 B). Eyes small and nearly hidden beneath the rostrum; the minute cornea is set at the antero-external angle of the stalk so that the latter extends beyond the cornea. Stylocerite is a broad, fleshy lobe of the first segment of the antennular peduncle and its outer spine reaches about to the distal third of that segment. Antennal scales damaged in both specimens; there is a small spine on the peduncle at the base of the scale. First pereiopod with a sickle-shaped dactyl. Second pereiopod with the carpus divided into four joints, the first of which is nearly as long as the combined length of the other three; chela flattened and provided with a curious, broad dactyl (Text-fig. 63 E). Third and fourth pereiopods missing. Fifth pereiopod reduced and simple (Text-fig. 63 F). The mouth parts are shown in Text-fig. 63 G-L. The mandible lacks both an incisor process and a palp and the remaining mouth parts are correspondingly reduced. The first three segments of the second maxilliped are more or less fused and the terminal segment bears three prominent spines and is applied normally to the end of the preceding joint.

Measurements: Carapace of holotype, measured from the base of the eyestalk, measures 9.2 mm. The paratype is somewhat smaller, having a carapace length of only 6.2 mm.

Color in Life: Carapace translucent white over a deep red organ (possibly ovaries). Abdomen scarlet with red at the base of the pleopods.

Remarks: In the absence of adult males or ovigerous females it is, of course, possible that this prawn may be a larval form. The fully developed appendages and lack of exopods do not bear out this possibility, however. Whether it is a larval stage or not, its systematic position is extremely obscure. It has been impossible to accommodate it in any known caridean family and even its relative position among the established families is un-

certain. There is little doubt that it is one of the most specialized bathypelagic carideans known, and it apparently shows affinities with the Processidae and the Cragonidae as evidenced by the reduced gill structure, the form of the mandibles and other mouth parts, the simple first pereopods (as in one of the first legs in *Processa*) and the multiarticulate carpus of the second pereopods. The chela of the second pereopod is unlike that found in any other caridean except possibly that on the first pereopod in the genus *Discias*; obviously, however, its relation to *Discias* is remote.

GENERAL DISCUSSION AND SUMMARY.

Taxonomy: The name of the family to which the largest number of bathypelagic carideans belong has been the cause of considerable confusion; at various times it has been known as the *Oplophoridae*, *Ephyridae*, *Miersiidae* and *Acantheephyridae*. Although the latter name, which I have employed previously, seems the more suitable, it now appears advisable to use the name *Oplophoridae* since Kingsley's use of the subfamily name *Oplophorinae*, in 1878 and 1879, antedates all others and logically proposes *Oplophorus* as the type genus, even though Kingsley originally erected the subfamily to include *Oplophorus elongata* (= *Xiphocaris elongata*, an atyid). In 1879 (p. 416) he proposed *Ephyrinae* as a subfamily of the *Atyidae*, whereas his *Oplophorinae* (p. 426) was included in the *Palaemonidae*. *Ephyra*, the type genus of the *Ephyrinae*, was proposed by Roux, 1831, for the type species, *Alpheus pelagicus* Risso, 1816, and later replaced with *Miersia* by Kingsley, 1879, since Roux's name was preoccupied. *Miersia pelagica* is apparently unknown to modern carcinologists, but it seems not unlikely that Risso's species may be the same as the form now known as *Acantheephyra pulchra* A. Milne Edwards, 1890. Risso's crude figure is obviously incorrect as regards the form of the rostrum, and there is nothing in the description which would not apply equally well to *A. pulchra* except that all of the abdominal somites are said to be sharply carinate and no mention is made of the presence of exopods on any of the pereopods. Even if these discrepancies are overlooked, however, Risso's description can never be used with any certainty and, since the type is probably not extant, the best procedure seems to be to discard *Ephyra* and *Miersia* entirely and use the name *Oplophoridae* for the family as it is known today.

There has also been some difference of opinion as to the proper spelling of the name of the type genus. The correct transliteration is, of course, *Hoplophorus*, but even though the aspirate is seldom if ever used in modern French and so might well have been overlooked by Milne Edwards, there is no choice under the present rules of nomenclature but to preserve the original orthography, *Oplophorus*, as proposed by the original author.

It is likely that future investigations will reveal that the systematics of the *Oplophoridae* as known at present are very inadequate. *Systellaspis* and *Oplophorus* are more or less well defined genera and there is little likelihood of confusing the species of those genera with any other. Likewise, the more typical members of *Acantheephyra* cause little trouble, but the line of division between *Acantheephyra* and the three other genera, *Hymenodora*, *Notostomus* and *Ephyrina*, is not sharply defined. Although there is little chance of confusing the species of *Hymenodora* with those of *Acantheephyra*, it is difficult to find any character of systematic importance for distinguishing the two groups. The reverse is true of the division between *Acantheephyra* and *Notostomus*; it is almost impossible to assign species like *Acantheephyra gracilipes* and *Notostomus compsus* to the proper genera at a glance, but the form of the mandible reveals a good diagnostic character. The genus *Notostomus*, as here defined, is a very heterogeneous group. It may be necessary at some future date to split off the species of the *N.*

vescus group under the inappropriate name, *Meningodora*. Possibly this group, even as known at present, deserved at least subgeneric recognition, but I have not made this distinction because of the way in which the gap between the two groups is filled by such species as *N. mollis* and *N. distirus*. *Ephyrina* is another easily recognizable genus which exhibits no character of great systematic importance to separate it from *Notostomus*; the form of the mandibles and the presence of a lateral ridge on the carapace ally it so closely to *Notostomus* that the broadened form of the pereopods is the only distinctive character separating it from that genus. *Notostomus*, then, is the genus which causes the greatest trouble; it is made up of about fifteen species at present and more are being found by nearly every expedition. Until our knowledge of this genus is more nearly complete, it is probably advisable to follow the systematic scheme already established for the family.

Since so many of the bathypelagic Caridea belong to relatively primitive groups, it is surprising to find such a highly evolved new form as *Physetocaris* in such a habitat. Although this animal appears to be one of the most specialized carideans known, as evidenced by the absence of exopods, the reduced gill series, the simplified mouth parts and the jointed carpus and complex chela of the second pereopods, it has apparently been able to assume a pelagic mode of life by adding to its buoyancy by means of a membranous integument and an inflated carapace.

Summary of Quantitative Results: The following table lists the species taken during the expeditions, arranged according to the number of adult specimens procured.

Species	Adults	Young
<i>Acantheephyra purpurea</i>	1705	2867
<i>Systellaspis debilis</i>	1037	912
<i>Parapandalus richardi</i>	361	43
<i>Hymenodora gracilis</i>	279	1550
<i>Notostomus miccylus</i>	120	25
<i>Notostomus vescus</i>	78	74
<i>Acantheephyra haeckelii</i>	71	146
<i>Parapasiphaë sulcatifrons</i>	36	461
<i>Acantheephyra stylostrata</i>	32	54
<i>Oplophorus grimaldii</i>	27	21
<i>Notostomus mollis</i>	12	44
<i>Notostomus robustus</i>	9	11
<i>Leptochela bermudensis</i>	8	8
<i>Notostomus marptocheles</i>	6	9
<i>Ephyrina bifida</i>	5	65
<i>Notostomus compsus</i>	3	—
<i>Parapasiphaë macrodactyla</i>	2	28
<i>Systellaspis braueri</i>	2	11
<i>Pasiphaea hoplocerca</i>	2	5
<i>Notostomus distirus</i>	2	—
<i>Lucaya bigelowi</i>	2	—
<i>Physetocaris microphthalma</i>	2	—
<i>Oplophorus spinicauda</i>	1	8
<i>Acantheephyra brevirostris</i>	1	5
<i>Pasiphaea liocerca</i>	1	—
<i>Acantheephyra gracilipes</i>	1	—
<i>Acantheephyra</i> , sp. ?	—	8
<i>Acantheephyra eximia</i>	—	3
<i>Parapasiphaë</i> , sp. b.	—	2
<i>Acantheephyra acutifrons</i>	—	2
<i>Notostomus westergreni</i> ?	—	2
<i>Parapasiphaë</i> , sp. a.	—	1
<i>Acantheephyra curtirostris</i>	—	1
<i>Notostomus perlatus</i> ?	—	1
<i>Ephyrina hoskynii</i>	—	1
<i>Plesionika martia</i>	—	1

Acantheephyra purpurea and *Systellaspis debilis* are by far the commonest species in this area but even these species, at the levels at which each was most abundant, were captured at the average rate of only one adult for every 1.7 and 2.1 hours of towing respectively. In the case of the tenth species in the list, *Oplophorus grimaldii*, 39 hours of towing were required for every adult specimen taken at 300 fathoms, the optimum level for that species in the daytime. A one meter net is far from being perfectly efficient in straining a one meter column of water, but if the assumption of 100 per cent. efficiency is allowed and if the nets are drawn through the water at the rate of one knot, which is probably conservative, these results would indicate an average concentration of the commonest caridean, *Acantheephyra purpurea*, of one adult in every 88,269 cubic feet of water at 700 fathoms which is the optimum level for that species. This gives some indication of the rarity of many of the species toward the end of the above list. Several are probably only accidental strays into this region from some other oceanic area, but the total results of all past expeditions seem to indicate that certain bathypelagic species are everywhere very rare. It is unwise, however, to make such general statements when one realizes how little of the volume of the sea has been investigated. Many species, now considered rare, may prove to be relatively common when their center of concentration is discovered. This point is clearly emphasized by the fact that the fifth species in order of abundance in the Bermuda area, *Notostomus miccylus*, was previously unknown.

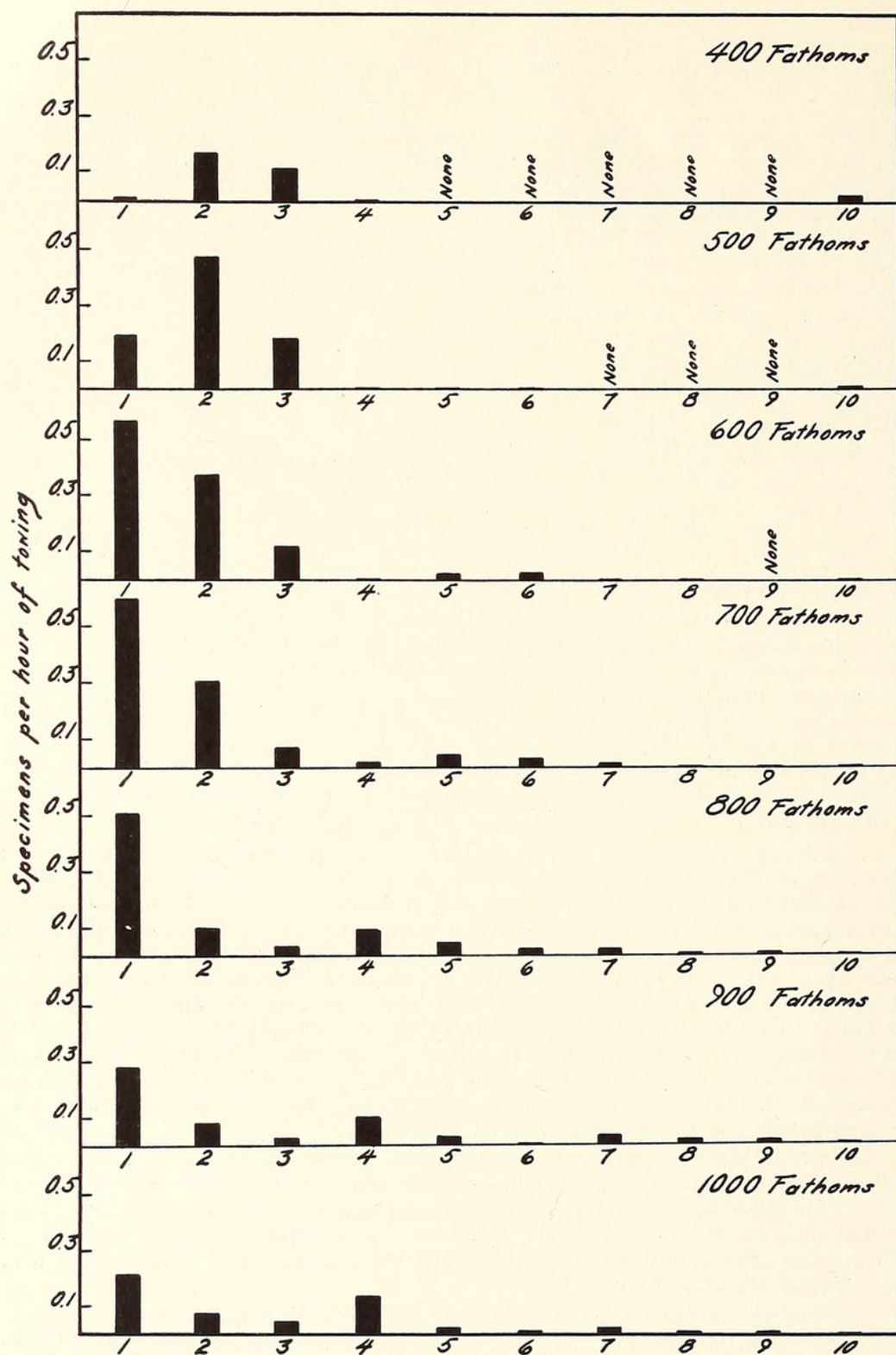
Text-fig. 64 may be useful in picturing the relative abundance of adults of the ten commonest species in the Bermuda area at each level from 400 to 1,000 fathoms. The fact cannot be stressed too strongly that this graph is applicable only to the particular region in which this work was done, or at most to the Sargasso Sea. During the course of several cruises of *Atlantis* of the Woods Hole Oceanographic Institution to the Sargasso Sea and to waters off the continental shelf to the west and north of the Gulf Stream, species common to both areas were found in much greater depths in the Sargasso area than on the coastal side of the Stream.

One of the interesting but unexplainable points brought to light by the collection is the change in the ratio between the sexes of certain species with an increase in depth. In both *Acantheephyra purpurea* and *Hymenodora gracilis*, males were proportionately more numerous near the lower limits of their range than they were nearer the surface. On the other hand, in two other species which were represented by an equally large number of specimens, *Systellaspis debilis* and *Parapandalus richardi*, no such change in the sex ratio was found. Whether the females of the first two species are for some reason more buoyant than the males or whether the phenomenon has some more involved explanation can hardly be decided at present. The logical conclusion that females with eggs are found nearer the surface is not confirmed by this material.

As practically all of the tows were made in the daytime, the collection fails to increase our knowledge of the diurnal vertical migration of these forms. Only in the case of *Leptochela bermudensis* was there evidence of diurnal migration. Although the number of specimens involved was small, this species was found at the surface in the evening but only at 400 and 700 fathoms during the daytime.

No definite evidence of any seasonal distribution could be discovered, with the exception of *Parapandalus richardi* (see remarks on seasonal distribution under that species). In all other cases where significant numbers of specimens were available, no seasonal fluctuation of any sort could be detected over the period in which towing was done. Ovigerous females of most species were taken in every month from April to September.

Geographical Distribution: As noted above, that portion of the sea through which nets have been drawn is extremely small and our knowledge



Text-figure 64.

The vertical distribution of adults of the ten commonest species of bathypelagic Caridea in the Bermuda area during the daytime. 1. *Acantheephyra purpurea*. 2. *Systellaspis debilis*. 3. *Parapandalus richardi*. 4. *Hymenodora gracilis*. 5. *Notostomus miccylus*. 6. *Notostomus vascus*. 7. *Acantheephyra haeckelii*. 8. *Parapasiphaë sulcatifrons*. 9. *Acantheephyra stylorostrata*. 10. *Oplophorus grimaldii*.

of oceanic barriers to the dispersal of bathypelagic organisms is correspondingly inadequate. From such distributional data as are available at present, it is obvious that the temperature and chemical composition of the sea have a much greater effect on the dispersal of such species than have any land barriers. Probably, then, oceanic currents will be found to delimit faunistic zones in the ocean depths much as do mountain ranges, deserts and bodies of water on land. In most cases, it is certainly misleading to define the limits of pelagic organisms on the basis of parallels of latitude and longitude. In reviewing the known distributions of the species of Caridea found off Bermuda, I have been forced to employ the more or less arbitrary regions listed below. These areas are actually regions in which more or less extensive investigations of the bathypelagic fauna have been carried on and if any of them also represent definite oceanic faunistic regions it is largely accidental. The following is a list of the zones from which species taken by the Bermuda Expeditions have been recorded previously, with the figures in parenthesis representing the numbers of species common to both those areas and to Bermuda.

- Sargasso Sea (4)
- North Atlantic (north and west of the Gulf Stream) (6)
- Off the coasts of Ireland (5)
- Eastern North Atlantic (Bay of Biscay to Cape Verde Ids.) (11)
- Mediterranean Sea (2)
- Bahamas and the West Indies (9)
- Equatorial Atlantic (11)
- South Atlantic (2)
- Off the Cape of Good Hope (6)
- Indian Ocean (15)
- Malay Archipelago and Philippine Ids. to Japan (9)
- South Pacific (4)
- Hawaiian Islands (5)
- Eastern Pacific (California to Peru) (6)

In many instances this list is no more than a key to the amount of exploration carried on in each of these zones; there is little doubt that additional towing in the West Indian region and in the equatorial Atlantic will reveal more forms found also at Bermuda. The small number of species previously known from the Sargasso Sea is due entirely to the lack of reports on that area, but there is an indication that the Sargasso fauna extends well to the east in the region of the Bay of Biscay and off the coast of Africa; several forms found both in that area and off Bermuda have not been recorded from north and west of the Gulf Stream or off the coasts of Ireland. The one striking fact illustrated by the list is the unimportance of distance or land barriers when dealing with the distribution of pelagic animals; even though the number of species may have been proportionately increased by the amount of deep-sea work carried on there, the fact that no less than fifteen of the twenty-five species from Bermuda, which had been described heretofore, are also found in the Indian Ocean should be of particular interest to the student of zoögeography.

Color of Bathypelagic Caridea: So much has been written on the color of deep-sea Crustacea that there is little necessity for reviewing the subject here. The excellent color notes on the Bermuda material supplied by Miss Crane reaffirms the well established fact that most bathypelagic prawns are of some shade of red in life. All of the species of *Acantheephyra* in which the color was noted, as well as *Pasiphaea liocerca*, *Parapasiphaë sulcatifrons*, *Notostomus robustus*, *Hymenodora gracilis* and *Systellaspis debilis*, have the body entirely scarlet or scarlet-red. Certain of the species of *Notostomus* of the *N. vascus* group have the abdomen scarlet but the carapace much deeper in color, at times nearly black. *Lucaya bigelowi* is unique in being pale salmon in life. There is another group of species, many of which are found relatively near the surface, in which the scarlet coloring

is reduced to patches or even to isolated chromatophores. This tendency is noted in *Notostomus miccylus* and *Parapandalus richardi* which have the carapace evenly scarlet but the abdomen, especially in immature specimens which frequent shallower depths, heavily splotched with scarlet. The same condition is noted in young specimens of *Systellaspis debilis*, and even in mature specimens of this species which have not attained their maximum size the uropods are often transparent. In *Leptochela bermudensis*, *Oplophorus spinicauda*, *Oplophorus grimaldii* and *Plesionika martia*, all of which may be found relatively near the surface, the entire animal is more or less transparent with scattered scarlet markings or dots. Specimens of *Leptochela bermudensis* which were kept alive for some time after their capture showed a slight deepening of color after several hours; it is not inconceivable that some species undergo a certain amount of color change depending upon the amount of light to which they are exposed.

Luminescence: Four of the bathypelagic Caridea of the Bermuda area are shown to be luminescent from notes made on living material; these species are *Leptochela bermudensis*, *Systellaspis debilis*, *Oplophorus spinicauda* and *O. grimaldi*. All of these forms apparently possess photophores, or dermal light organs of a definite structure, although this conclusion could not be substantiated in *Leptochela bermudensis*. Only from this latter species, however, could luminescence of the photophore type be produced. To my knowledge, the photophores of captured specimens of *Systellaspis debilis* have never been seen to emit light, but that such is their function can hardly be doubted, and Beebe (1934, p. 304) records the following observation made from the bathysphere, "Again, one good-sized shrimp at 1300 feet had six or eight scattered lights, and one long, slit-like light near the center of its body, which identified it with almost complete certainty as *Systellaspis debilis*." Although the presence of a transverse, slit-like organ does not necessarily prove that the species observed was *S. debilis* since several oplophorids have similar photophores behind the fifth pereopods and those in *Oplophorus grimaldii* are very like the comparable organs in *S. debilis*, these observations lend further assurance that these types of photophores are functional light organs. During one of the cruises of *Atlantis* to the Sargasso Sea, *S. debilis* was obtained in considerable numbers and it was possible to keep them alive for at least a week by refrigeration, but all attempts to shock them into producing light were futile. Similar experiments tried on living material of *Oplophorus spinicauda* and *Oplophorus grimaldii* from the present collection were likewise negative. One of the theories advanced to explain the function of these light organs suggests that they are used as specific recognition signs to enable individuals to find specimens of the opposite sex of the same species. Is it not possible, if such is the explanation, that the ability to produce light may be controlled by the ripening of the eggs and sperm? This would greatly reduce the likelihood of seeing the photophores light up in any given specimen. Since these animals can be obtained in considerable numbers in the Bermuda area and since they can be kept alive and apparently healthy for some length of time by regulating the temperature of the water, it is to be hoped that this theory may be checked in the near future.

Another type of luminescence noted in bathypelagic Caridea is the production of the so-called "luminous cloud." This appears to be a purely defensive mechanism whereby a prawn, when startled, can emit a cloud of luminous material from some internal gland. This spectacle was seen in *Systellaspis debilis* and *Oplophorus spinicauda* (see notes under that species) among the Bermuda material. Dr. Beebe assures me that this phenomenon was repeatedly observed in specimens of the former species and has very kindly provided me with a photograph of a specimen which had been seen to emit such a cloud; there is no doubt that it belongs to this species. Miss Crane has also observed that on many occasions when specimens of this species were placed in alcohol, a mass of flocculent material was immediately

ejected. On several occasions this was tested in the dark-room and found to be fluorescent. Curiously enough, Miss Crane has also noted the presence of this flocculent material when specimens of *Acantheephyra* were put in preservative.

Dr. Beebe (1934, p. 304) records as follows the results of his observations on this subject made during descents of the bathysphere: "Whereas the photophore-like organs of euphausiids may serve chiefly as recognition marks, or other non-defensive capacities, the luminous matter [of large, *Acantheephyra*-like shrimps] was obviously discharged only when a shrimp was startled, as when it bumped against the bathysphere window. When this happened, a rocket-like burst of fluid was emitted with such violence that the psychological effect was that of a sudden explosion. This occurred time and again at the lower levels, and I learned to distinguish two separate types of discharge, one uniformly luminous, the other dimmer but interspersed with dozens of brilliant stars and pinheads. For an instant the shrimp would be outlined in its own light—vivid scarlet body, black eyes, long rostrum—and then would vanish, leaving behind it the confusing glow of fluid. The light died out gradually, but the discharge disappeared even more slowly. It was not until one of my last dives that I learned that certain grayish bodies which I had been reporting as unlighted fishes were in reality these burnt-out masses of fluid."

Dr. Harvey (1931) has discussed the chemistry of luminescence in *Systellaspis*.

Among the Oplophoridae, luminescence apparently is found in but two genera, *Systellaspis* and *Oplophorus*, where both photophores and luminous glands may be found in the same species, but the possibility can not be entirely ruled out that luminous glands may be found in other genera as well. More observations made directly from living material should be encouraged to increase our knowledge of the number of species which are luminescent. It is also helpful to preserve some of each species in formalin, for photophores which disappear in a few days in alcohol, will be distinct several years later in material put up in formalin. This recommendation is made with some reservation, however, for alcohol is much to be preferred to formalin as a general preservative.

Food of Bathypelagic Caridea: The following remarks on the food of *Acantheephyra purpurea* and *Systellaspis debilis* are based on such incomplete data that they are included here merely in the hope that other workers may be induced to investigate the problem more thoroughly. Miss Jocelyn Crane dissected out the stomachs of a dozen specimens of *Acantheephyra purpurea* and found them usually crammed with well digested food containing a few identifiable animals. Very much the same type of stomach contents were found in a few specimens of *Systellaspis debilis* which I dissected. In all but one or two cases, surprisingly large fragments of at least one blackish fish were found. Also present were various crustaceans ranging from copepods to comparatively large shrimp-like forms several species of pteropods; worms, some of which may have been parasitic; and radiolarians. The most striking point about these stomach contents was the size of the fragments. In some cases one fish apparently took up the entire space within the stomach and it was often so well preserved as to permit its generic determination. Several of the crustaceans could likewise be determined from the available pieces. Apparently, then, the mandibles do not necessarily crush the food into an amorphous mass before it is passed into the stomach.

One can only guess whether these prawns are able to capture their prey alive or whether they are purely scavengers which feed upon dead or dying organisms. It is very possible that much of the material found in the stomachs of these specimens was consumed after the specimens were in the net. When the contents of a net have been dumped into a tank of water immediately after being taken aboard ship, I have observed specimens of

Systellaspis debilis feeding with apparent enthusiasm upon dead fish as well as dead specimens of their own species. The fact that the stomachs of these prawns were usually distended with food when examined may be entirely due to the plentiful meal provided by the contents of the net and one cannot be certain that this food is representative of their normal diet.

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