Bulletin 292

BREDIN-ARCHBOLD-SMITHSONIAN
BIOLOGICAL SURVEY OF DOMINICA

The Freshwater and Terrestrial Decapod Crustaceans of the West Indies with Special Reference to Dominica

FENNER A. CHACE, JR., AND HORTON H. HOBBS, JR.

SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM

WASHINGTON, D.C. 1969

SMITHSONIAN

INSTITUTION

MUSEUM

OF

NATURAL

HISTORY

UNITED STATES NATIONAL MUSEUM BULLETIN 292

BREDIN-ARCHBOLD-SMITHSONIAN
BIOLOGICAL SURVEY OF DOMINICA

The Freshwater and Terrestrial Decapod Crustaceans of the West Indies with Special Reference to Dominica

FENNER A. CHACE, JR., AND HORTON H. HOBBS, JR.
Senior Zoologists, Department of Invertebrate Zoology

SMITHSONIAN INSTITUTION PRESS
WASHINGTON, D.C.,
1969

Publications of the United States National Museum

The scientific publications of the United States National Museum include two series, *Proceedings of the United States National Museum* and *United States National Museum Bulletins.*

In these series are published original articles and monographs dealing with the collections and work of the Museum and setting forth newly acquired facts in the fields of anthropology, biology, geology, history, and technology. Copies of each publication are distributed to libraries and scientific organizations and to specialists and others interested in the various subjects.

The *Proceedings,* begun in 1878, are intended for the publication, in separate form, of shorter papers. These are gathered in volumes, octavo in size, with the publication date of each paper recorded in the table of contents of the volume.

In the *Bulletin* series, the first of which was issued in 1875, appear longer, separate publications consisting of monographs (occasionally in several parts) and volumes in which are collected works on related subjects. *Bulletins* are either octavo or quarto in size, depending on the needs of the presentation. Since 1902, papers relating to the botanical collections of the Museum have been published in the *Bulletin* series under the heading *Contributions from the United States National Herbarium.*

This work forms number 292 of the *Bulletin* series.

FRANK A. TAYLOR
Director, United States National Museum

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1969

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402
Price $1.75 (paper cover)

Contents

Introduction

The original objective of this study was to describe the abundant but little-known freshwater and terrestrial decapod crustaceans of Dominica. We gradually came to the realization, however, that even the intensive collecting by those who participated in the Bredin-Archbold-Smithsonian Biological Survey of Dominica hardly could be expected to reveal every species that might occur on that island at any time. In order to lend completeness to the Dominican coverage and to make the study useful to biologists interested in the faunas of other islands, we decided to include the 92 species known from all of the West Indies. We have attempted, therefore, to offer a provisional handbook of the decapods that may occur naturally in reduced salinities or above high-tide line on any of the islands from Bermuda to Trinidad and throughout the Caribbean Sea.

Previously published studies on the Dominican decapod fauna alone are limited to the brief accounts by Pocock (1889) and G. E. Verrill (1892). The freshwater and terrestrial decapods of eastern tropical America have been treated heretofore as a group in Young (1900), A. E. Verrill (1908), and Holthuis (1959), but only the first of these authors covers the true West Indian region. Certain of the families or higher groups are dealt with in Rathbun (1933), Schmitt (1935), Chace and Holthuis (1948), Hart (1961b), and Hartnoll (1964, 1965), as well as in monographic works of broader geographic coverage such as Rathbun (1905, 1906, 1918, 1930), Bouvier (1925), and Holthuis (1952).

In the present review of the fauna, illustrations showing the color patterns—prepared from notes, sketches, and color photographs made in the field—are given for the 29 species represented by adequate material in the collections from Dominica, and at least one species of each of the genera not found there is illustrated by an outline drawing. Our intent to figure the male sexual appendages of all species, those from Dominica in somewhat greater detail than the others, was not fully achieved because of the unavailability of adult males of a few of the species.

The attempt has been made, but probably not always fulfilled, to list all synonyms of each species (with type-localities) from the valid post-Linnaean literature, to indicate all combinations under which a species has been mentioned in publications, and to cite all references to Dominican records and to one or more recent works containing

figures or more complete species bibliographies. Misidentifications, except when they have become firmly established in the literature, are not listed, and the validity of the synonyms usually has not been verified by the examination of type-material.

We should emphasize that the keys and diagnoses apply only to the species covered by the study and often only to adult males; the identification of female and immature specimens of some species is frequently impossible by current criteria, except by their association with adult males or by similarities in color patterns. The italicized portions of the diagnoses denote those characters that are unique *among the species covered of each family.*

Most of the Dominican shrimps (*Macrobrachium, Atya,* and *Potimirim*) occur in two "color phases," one in which yellow, tan, and brown predominate and the other characterized by blue, gray, and black. Usually only one of the two is described in detail in the color notes presented here. The vivid colors that are displayed, almost without exception, by recently molted individuals become somewhat dull or obscured as the surface of the exoskeleton is scarred, collects silt, or serves as a substrate for the growth of bacteria, algae, and protozoans. Our color notes were recorded from animals that had not become encrusted with foreign matter. Because of the variability in the actual colors from one individual to another, color charts were not used. Seldom do two specimens have precisely the same color, and occasionally, as in *Uca,* there is little similarity in details of color pattern. Although the descriptions and illustrations of the color patterns should facilitate the field identification of the species that occur on Dominica, we trust that collectors will soon learn to recognize the relatively constant aspects of the patterns of each species and to use caution in assigning taxonomic importance to differences that may be due to factors such as immaturity, sex, light adaptation, and extraneous growth, as well as to intrinsic variation in a species.

The distributions cited indicate overall ranges and, in parentheses, the West Indian records. As mentioned below, the island records, especially of widely ranging species that have marine larvae, may be indicative only of the diversity of collecting activities. Our search for island records has not been exhaustive, but a number of new ones have been added from previously unpublished locality records in the Smithsonian collections.

The nine species listed below have been recorded, usually only once, from the West Indies, but the records have proved to be, or are believed to be, based on errors of identification or documentation, and they have therefore been excluded from consideration:

Cambarellus montezumae (De Saussure, 1857a). Rhoades (1962, p. 72) mistakenly indicated that this crayfish had been found "on both sides of the Yucatan Channel."

Guinotia (*Guinotia*) *reflexifrons* (Ortmann, 1897). This species, which was described from the Upper Amazon, was represented in the Berlin Museum by a doubtfully documented specimen from the "Antilles."

Guinotia (*Neopseudothelphusa*) *simoni* (Rathbun, 1905). The male specimen of this species from the "Antilles" received by the Smithsonian in exchange from the Kiel Museum is correctly identified, but the documentation seems doubtful, for the species is known otherwise only from Venezuela.

Sarmatium curvatum (H. Milne Edwards, 1837). It is questionable whether the unique type-specimen of *Metagrapsus pectinatus* H. Milne Edwards, 1853, a synonym of this otherwise West African grapsid crab, originated in "Martinique."

Sesarma (*Chiromantes*) *huzardi* (Desmarest, 1825). As indicated by Monod (1956), the documentation of the single specimen of this species from "Barbados" in the Paris Museum needs verification.

Uca maracoani (Latreille, 1802–03). As mentioned by Holthuis (1959), "An old record (by Sloane, 1725) of the species from Jamaica is very doubtful."

Uca pugilator (Bosc, 1801–02). The single record of this species from Jeremie, Haiti, in the Museum of Comparative Zoology at Harvard is decidedly suspect.

Uca spinicarpa Rathbun, 1900c. The specimen from Kingston Harbor, Jamaica, recorded by Rathbun (1918) as this species, proves to be *U. speciosa.*

Uca tangeri (Eydoux, 1835). The record by Miers (1881b) of material of this species from the "West Indies" in the British Museum seems questionable.

We scarcely need to call attention to the lack of completeness of this review. Most investigations of this kind generate questions that can be answered only by further study, and this one is no exception. Why do most of the freshwater shrimps on Dominica display brown and blue color phases? Are the rather distinct color patterns of both *Jonga* and *Micratya* determined by genetic or environmental causes? How does one explain the apparent difference in mean rostral length in populations of *Xiphocaris* inhabiting the same pool in different years? Is there more than one definable taxon represented by the name *Macrobrachium faustinum,* and what morphological characters can be used to distinguish immature individuals of this species from those of *M. crenulatum?* Is *Sesarma miersii* really distinct from the Brazilian *S. angustipes,* and is it as rare on Dominica as indicated by our collections? Is *S. ricordi* nowhere to be found on Dominica and, if not, why? How is color change effected in populations of *Ocypode* on black beaches? Is the third species of *Uca* in our collections undescribed, or is the single specimen an aberrant example of a known species? We hope that other students will be motivated to seek the answers to these and other questions suggested by the survey.

Most of the 7,225 specimens in the collections from Dominica (including about 350 immature individuals of *Macrobrachium* that could not be identified satisfactorily and that are therefore not listed among the material examined of any of the species) were obtained by Hobbs during two visits to that island, from January to April in both 1964 and 1966, but valuable material, as well as photographs and field notes, has been gratefully received from the following participants in the Dominican Survey: Donald M. Anderson, Dale F.

Bray, Oliver S. Flint, Jr., Horton H. Hobbs, III, Raymond B. Manning, Joseph P. Morrison, Charles F. Rhyne, Harold E. Robinson, Paul J. Spangler, Victor G. Springer, George C. Steyskal, Dieter C. Wasshausen, and Richard L. Zusi.

We also acknowledge the invaluable advice and assistance received during the course of the study from Franklin H. Barnwell of the W. C. Allee Laboratory of Animal Behavior, University of Chicago; Dorothy E. Bliss of the American Museum of Natural History; Jacques Forest of the Muséum National d'Histoire Naturelle in Paris; John S. Garth of the Allan Hancock Foundation, University of Southern California; Hermann Gisin of the Muséum d'Histoire Naturelle in Genéve; H. O. Von Hagen of Münster University, Germany; Willard D. Hartman of the Peabody Museum of Natural History, Yale University; R. G. Hartnoll of the Marine Biological Station at Port Erin, Isle of Man; L. B. Holthuis of the Rijksmuseum van Natuurlijke Historie in Leiden; Anna LaRonde of Clarke Hall, Dominica; J. J. Ochse of The Hague, Netherlands; and Alfred E. Smalley of Tulane University; as well as from our colleagues at the Smithsonian, Isabel Pérez Farfante, Henry B. Roberts, and Waldo L. Schmitt. Special thanks are due our staff artist, Carolyn Bartlett Gast, for developing the diagrammatic representation shown in figure 3 from our preliminary suggestions and for preparing figures 1 and 2 for reproduction.

At a time when systematic biological research seems to be increasingly dependent upon the larger granting agencies, especially those of the Federal Government, it is a pleasure to join other participants in the Dominica Survey in demonstrating that support from individuals who are personally interested in a particular program, like J. Bruce Bredin and John D. Archbold, can still be instrumental in advancing important knowledge. We are very grateful to Mr. Bredin and Mr. Archbold for making these studies possible.

The list that follows indicates the decapod classification employed herein and shows the species numbers referred to in the lists on pages 7 and 9 and in figure 3 (p. 41). The species marked with an asterisk (*) are known from Dominica.

List of Species

Order DECAPODA

Suborder NATANTIA
Section Penaeidea
Family PENAEIDAE
Subfamily PENAEINAE
1. *Penaeus aztecus subtilis*
2. *Penaeus brasiliensis*
3. *Penaeus duorarum notialis*
4. *Penaeus schmitti*
5. *Xiphopeneus kroyeri*

Section Caridea
Family ATYIDAE
*6. *Atya innocous*
7. *Atya lanipes*
*8. *Atya scabra*
*9. *Jonga serrei*
*10. *Micratya poeyi*
11. *Potimirim americana*
*12. *Potimirim glabra*
13. *Potimirim mexicana*
14. *Typhlatya garciai*
15. *Typhlatya monae*
*16. *Xiphocaris elongata*
Family PALAEMONIDAE
Subfamily PALAEMONINAE
*17. *Macrobrachium acanthurus*
*18. *Macrobrachium carcinus*
*19. *Macrobrachium crenulatum*
*20. *Macrobrachium faustinum*
*21. *Macrobrachium heterochirus*
22. *Macrobrachium jelskii*
23. *Palaemon (Palaemon) pandaliformis*
24. *Troglocubanus calcis*
25. *Troglocubanus eigenmanni*
26. *Troglocubanus gibarensis*
27. *Troglocubanus inermis*
28. *Troglocubanus jamaicensis*
Family HIPPOLYTIDAE
29. *Barbouria cubensis*
Suborder REPTANTIA
Section Macrura
Family ASTACIDAE
Subfamily CAMBARINAE
30. *Procambarus atkinsoni*
31. *Procambarus cubensis cubensis*
32. *Procambarus cubensis rivalis*
33. *Procambarus niveus*
Section Anomura
Family PORCELLANIDAE
*34. *Petrolisthes quadratus*
Family COENOBITIDAE
*35. *Coenobita clypeatus*
Section Brachyura
Family PORTUNIDAE
Subfamily PORTUNINAE
*36. *Callinectes bocourti*
37. *Callinectes danae*
38. *Callinectes exasperatus*
39. *Callinectes marginatus*
40. *Callinectes ornatus*
*41. *Callinectes sapidus*
Family PSEUDOTHELPHUSIDAE
Subfamily EPILOBOCERINAE
42. *Epilobocera armata*

43. *Epilobocera cubensis*
44. *Epilobocera gertraudae*
45. *Epilobocera gilmanii*
46. *Epilobocera granulata*
47. *Epilobocera haytensis*
48. *Epilobocera sinuatifrons*

Subfamily PSEUDOTHELPHUSINAE

*49. *Guinotia (Guinotia) dentata*
50. *Guinotia (Guinotia) garmani garmani*
51. *"Pseudothelphusa" affinis*
52. *Pseudothelphusa (Pseudothelphusa) americana*
53. *Pseudothelphusa (Pseudothelphusa) terrestris*

Family TRICHODACTYLIDAE

54. *Trichodactylus (Dilocarcinus) dentatus*

Family XANTHIDAE

Subfamily PANOPEINAE

55. *Eurytium limosum*
56. *Panopeus herbstii*

Family GRAPSIDAE

Subfamily GRAPSINAE

*57. *Geograpsus lividus*
*58. *Goniopsis cruentata*
*59. *Grapsus grapsus*
60. *Pachygrapsus corrugatus*
61. *Pachygrapsus gracilis*
62. *Pachygrapsus transversus*

Subfamily VARUNINAE

63. *Glyptograpsus jamaicensis*

Subfamily SESARMINAE

64. *Aratus pisonii*
*65. *Cyclograpsus integer*
66. *Metasesarma rubripes*
67. *Metopaulias depressus*
68. *Sesarma (Holometopus) americanum*
69. *Sesarma (Holometopus) hanseni*
*70. *Sesarma (Holometopus) miersii*
71. *Sesarma (Holometopus) rectum*
72. *Sesarma (Holometopus) ricordi*
*73. *Sesarma (Holometopus) roberti*
74. *Sesarma (Sesarma) bidentatum*
75. *Sesarma (Sesarma) curacaoense*
76. *Sesarma (Sesarma) jarvisi*
77. *Sesarma (Sesarma) verleyi*

Subfamily PLAGUSIINAE

*78. *Plagusia depressa*

Family GECARCINIDAE

*79. *Cardisoma guanhumi*
80. *Gecarcinus lagostoma*
*81. *Gecarcinus lateralis*
*82. *Gecarcinus ruricola*

Family OCYPODIDAE

Subfamily OCYPODINAE

*83. *Ocypode quadrata*
*84. *Uca burgersi*

85. *Uca cumulanta*
86. *Uca leptodactyla*
87. *Uca major*
88. *Uca rapax*
89. *Uca speciosa*
90. *Uca thayeri*
*91. *Uca vocator*
*92. *Ucides cordatus*

West Indian Species Records

The following list shows the species records (see "List of Species," p. 4) from each of the West Indian islands indicated in figure 1.

Bermudas
A—Bermuda Islands (2, 35, 38–41, 55–59, 61, 62, 65, 72, 78, 79, 81, 83)
Bahamas
B—Green Turtle Cay (56, 61, 81, 86)
C—Great Abaco Island (35, 59, 70, 78, 81)
D—Bimini Islands (35, 39, 40, 56, 59, 62, 84, 86–88)
E—Eleuthera Island (35, 40, 56, 58, 70, 78, 83)
F—New Providence Island (35, 39, 57–62, 64, 78, 83, 86)
G—Andros Island (17, 20, 35, 39, 40, 59, 62, 72, 79, 81, 82)
H—Green Cay (81, 83)
I—San Salvador Island (55, 59, 65, 70, 82, 83, 87)
J—Rum Cay (59, 82, 84)
K—Long Island (39, 40)
L—Water Cay (35)
M—Acklins Island (35)
Greater Antilles and Virgin Islands
N—Cuba (1–6, 8–11, 13, 14, 16–18, 20, 23–27, 29, 31–33, 35, 37–44, 51–53, 55–62, 64, 65, 70, 72, 73, 75, 78, 79, 81–84, 86–90, 92)
O—Isla de Pinos (30, 31, 45, 70)
P—Jamaica (1–3, 4, 6, 8–11, 13, 16–21, 28, 35–41, 55–59, 61–65, 67, 72–79, 81–84, 86–90, 92)
Q—Navassa Island (82)
R—Hispaniola (1–4, 6, 8, 16–21, 23, 35, 37–40, 47, 52, 55, 56, 58, 59, 62, 65, 72, 73, 78, 79, 81–84, 88, 92)
S—Isla Mona (15, 35, 81, 83)
T—Puerto Rico (1–3, 5–10, 13, 16–18, 20, 21, 23, 34–41, 48, 55–62, 64, 65, 72, 73, 75, 78, 79, 81–84, 86–88, 90, 92)
U—Isla de Vieques (17, 57, 59)
V—Saint Thomas (2–4, 7, 18, 20, 35, 37, 39, 40, 55, 57–62, 68, 72, 73, 78, 79, 81, 83, 84, 88, 92)
W—Saint John (1, 3, 59, 62, 79)
X—Saint Croix (1, 2, 6, 16–20, 23, 35–41, 48, 55–62, 64, 65, 72, 73, 78, 79, 81–84, 86–88)
Lesser Antilles (excluding Virgin Islands)
Y—Anguilla (84)
Z—Saint Martin (17, 18, 38, 40, 56, 84)
AA—Barbuda (15, 84)
BB—Saba (35, 57, 82)
CC—Sint Eustatius (40)
DD—Nevis (84)
EE—Antigua Island (1, 35, 56, 62, 64, 84, 88, 92)

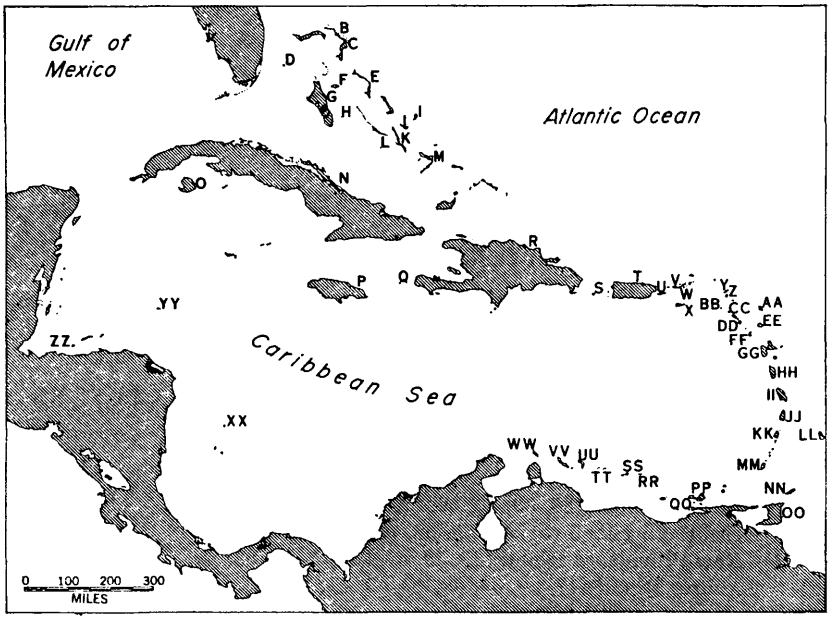


FIGURE 1.—The West Indies

Acklins Island (M)
Andros Island (G)
Anguilla (Y)
Antigua Island (EE)
Aruba (WW)
Aves, Islas de (TT)
Barbados (LL)
Barbuda (AA)
Bermuda Islands (A) [not shown]
Bimini Islands (D)
Bonaire (UU)
Cuba (N)
Cubagua, Isla (QQ)
Curaçao (VV)
Dominica (HH)
Eleuthera Island (E)
Great Abaco Island (C)
Green Cay (H)
Green Turtle Cay (B)
Grenada (MM)
Guadeloupe (GG)
Hispaniola (R)
Jamaica (P)
La Orchila (RR)
Long Island (K)
Los Roques, Islas (SS)
Margarita, Isla de (PP)
Martinique (II)
Mona, Isla (S)
Montserrat (FF)
Navassa Island (Q)
Nevis (DD)
New Providence Island (F)
Pinos, Isla de (O)
Providencia, Isla de (XX)
Puerto Rico (T)
Rum Cay (J)
Saba (BB)
Saint Croix (X)
Saint John (W)
Saint Lucia Island (JJ)
Saint Martin (Z)
Saint Thomas (V)
Saint Vincent (KK)
San Salvador Island (I)
Sint Eustatius (CC)
Swan Islands (YY)
Tobago (NN)
Trinidad (OO)
Utila, Isla de (ZZ)
Vieques, Isla de (U)
Water Cay (L)

FF—Montserrat (6, 79, 81, 82)
GG—Guadeloupe (6, 19, 21, 35, 39, 40, 49, 56, 57, 62, 64, 81, 84, 87, 88, 90)
HH—Dominica (6, 8–10, 12, 16–21, 34–36, 39, 41, 49, 57–59, 65, 70, 73, 78, 79, 81–84, 91, 92)
II—Martinique (6, 10, 17, 37, 49, 57, 59, 62, 72, 73, 78)

JJ—Saint Lucia Island (1, 16, 18, 20, 37, 40, 49, 57, 59, 73, 81, 83)
KK—Saint Vincent (6, 18, 20, 21)
LL—Barbados (9, 16, 18, 20, 23, 35, 37, 40, 56–59, 62, 73, 78, 79, 81–84)
MM—Grenada (19–21)
NN—Tobago (20, 71, 84, 91)
OO—Trinidad (1, 3, 4, 8, 11, 18, 19, 22, 35, 37, 50, 54, 56, 57, 59, 62, 66, 71–73, 78–80, 88, 91)
PP—Isla de Margarita (39, 50, 64, 83)
QQ—Isla Cubagua (34)
RR—La Orchila (81)
SS—Islas Los Roques (35, 38–40, 55–59, 64, 65, 79, 81, 83, 88)
TT—Islas de Aves (35, 84)
UU—Bonaire (18, 20, 35, 40, 56, 59, 81, 84, 88)
VV—Curaçao (18, 20, 34, 35, 39, 40, 55–59, 62, 64, 72, 75, 78, 79, 81, 82, 84, 85, 88, 90)
WW—Aruba (18, 34, 35, 39, 40, 56, 81, 83, 84)

Caribbean Islands

XX—Isla de Providencia (35, 37–39, 57–59, 72, 79, 82, 83, 88)
YY—Swan Islands (35, 59, 70, 81–84)
ZZ—Isla de Utila (37, 39, 79)

Dominican Survey Stations †

(FIGURE 2)

1 (G3) Tributary to Layou River across from Clarke Hall, 50′ (6, 8, 10, 16, 18, 19, 20, 21, 49, 73, 83)
2 (G3) Mannet's Gutter near mouth, Clarke Hall, 60′ (6, 8, 10, 16, 18, 19, 20, 21, 35, 49, 73)
3 (I4) Check Hall River at Springfield, 1,150′ (6, 10, 16*, 18*, 19, 21, 49)
4 (G3) Mannet's Gutter at upper bridge, Clarke Hall, 70′ (6, 8, 10, 18, 19, 21, 49, 73)
5 (I4) Tributary to Check Hall River, 1,500′ (6, 21, 49)
6 (G2) Coconut-banana plantation immediately S of mouth of Layou River, 1′–10′ (16, 35, 57, 59, 65, 73, 79, 81, 82, 83, 84, 92)
7 (H3) Belfast River, 75′ (6, 10, 18, 19, 21, 49)
8 (H4) Tributary to Belfast River, 1,900′ (6, 18*, 21, 49)
9 (H4) Tributary to Belfast River, 1,700′ (49)
10 (I3) Stream near Rockaway, N of Roseau, 10′ (20)
11 (G3) Layou River at Clarke Hall, 50′ (16, 18, 19, 20, 21, 49, 73)
12 (G3) Layou River just downstream from Clarke Hall, 40′ (16, 18, 19, 20, 21)
13 (G3) Layou River at lowest riffle, approximately 5′–10′ (6, 9, 10, 16, 19, 21, 73)
14 (G2) North bank of Layou River, 30 yards above mouth, sea level (6, 9, 10, 16, 17, 18, 20, 73)
15 (G2) Mouth of Layou to 200 yards upstream on S bank, sea level (6, 9, 16, 17, 20, 35, 41, 73)
16 (F2) Batali River bank, near mouth, sea level (73)
17 (F2) Batali River near mouth, sea level (6, 10, 16, 19, 20, 35, 73)
18 (H3) Mouth of Belfast River, sea level (6, 9, 10, 19, 73)
19 (G6) North Branch of Ravine Deux Dleau, to Rosalie River, 800′ (6, 10, 21, 49)
20 (H6) Tributary to North Branch of Ravine Deux Dleau, to Rosalie River, 600′ (6, 49)
21 (H7) Mill Race to Rosalie River, 50′ (6, 20, 21)

†Numbers in parentheses, etc. . . (following elevations) refer to species list (p. 4).
*Based on sight records.

22 (H7) Rosalie River between bridge and mouth, 5′–15′ (18, 19, 20, 21, 35)
23 (I7) Sarisari River near mouth, 20′–50′ (18, 19, 49)
24 (I7) Case O'Gowrie River near mouth, 10′–30′ (20, 21, 73)
25 (I7) La Ronde River near mouth, sea level to 50′ (20, 35, 49)
26 (G5) Tributary to Laurent River, to Layou River, 1,600′ (6, 12, 21)
27 (H4) Tributary to Belfast River, 2,000′ (6)
28 (I3) Mouth of Check Hall River, less than 10′ (6, 10, 19, 20)
29 (G3) Tributary to Layou River at Cassada Gardens, 500′ (6, 21, 49)
30 (F2) Macoucheri River in vicinity of bridge, 5′–15′ (6, 10, 16, 18, 19, 20, 21, 41, 73, 79)
31 (F2) Tributary to Macoucheri River, mill race, 10′ (6, 10)
32 (K5) Tributary to Stewart's River, 150′ (6, 10, 12, 19, 20, 21, 49)
33 (K5) Mouth of Stewart's River, less than 10′ (10, 19, 20, 21, 73)
34 (K4) Unnamed stream on Fond Baron Estate, 450′ (6, 49)
35 (I5) Stream near Freshwater Lake, tributary to Rosalie River, 2,500′ (6, 21)
36 (F2) Salisbury River, sea level to 20′ (16, 17, 19, 20, 36, 41, 73, 83, 84)
37 (G2) Stream immediately N of Mero, less than 10′ (17, 20, 73, 84)
38 (G2) Mero River, less than 10′ (16, 17, 36, 58*, 73, 79, 82, 84)
39 (C5) Tributary to Kasiobna River, 300′ (6, 12, 19, 49)
40 (C5) Kasiobna River above airport, 75′ (10, 20, 49)
41 (D2) Headwaters of Picard River, 1,500′ (6, 49)
42 (I7) Taberi River, 10′–20′ (19, 20, 21, 49, 73)
43 (E6) Pagua River, 650′ (18*, 19, 21*, 49)
44 (F5) River D'Or, to Layou River, 750′ (10, 16, 19, 21, 49)
45 (F5) Tributary to Layou River just S of River D'Or, 700′ (6, 19, 21, 49)
46 (F5) Tributary to Layou River just N of Dleau Manioc, 700′ (6, 19, 49)
47 (G5) Dleau Manioc, to Layou River, 650′ (21, 49)
48 (G5) Dleau Morne Laurent, to Layou River, 700′ (6, 16, 19, 21, 49)
49 (G3) Layou River at Gingerette Estate, 150′ (16, 19, 20)
50 (G3) Mannet's Gutter, to Layou River, 350′ (6, 8, 16, 18, 19, 48, 81)
51 (G3) Layou River above Gingerette Estate, 165′ (16)
52 (G3) Layou River at mouth of stream from Cassada Gardens, 175′ (16, 19, 20, 21)
53 (G3) Ravine Neiba, to Layou River, 250′ (6, 10, 49)
54 (C5) Toulaman River, 50′ (6, 9, 10, 18, 19, 20, 49, 73)
55 (B5) Hodges River, 25′ (6, 10, 12, 16, 19, 21, 49, 73)
56 (B3) Blenheim River, 10′–20′ (9, 10, 17, 19, 20, 21, 73)
57 (B3) Blenheim River, sea level to 5′ (9, 16, 17, 20)
58 (A1) Manicou River, 75′ (49)
59 (A1) Lamonthe River, 400′ (6, 10, 19, 20, 49, 73)
60 (A1) Hermitage River, 300′ (6, 10, 49)
61 (B1) Salt River, 100′–200′ (16, 19, 20, 73)
62 (B1) Swamp Ravine, less than 10′ (9, 17, 73)
63 (C1) Cario River, less than 25′ (6, 10, 12, 16, 19, 20, 21, 73)
64 (C1) Lamoins River, sea level (16, 73)
65 (G3) Ravine Neiba at mouth, to Layou River, 200′ (10, 19)
66 (G6) Fond Figues River, to Castle Bruce River, 350′ (6, 8, 10, 16, 18*, 19, 21, 49)
67 (F7) Castle Bruce River at mouth, sea level (9, 16, 20, 83)
68 (F6) Raymond Stone River, to Castle Bruce River, 100′ (10, 18, 19, 20, 73)
69 (G6) Tributary to Castle Bruce River W of Raymond Stone River, 250′ (6, 10, 21)
70 (H5) Tributary to Rosalie River near Boeri Lake, 3,050′ (6, 49)
71 (F2) North mouth of Batali River, sea level (9, 16, 20, 21)
72 (B2) Indian River, 0.5 mile above mouth, 5′–10′ (9, 10, 16, 17, 20)
73 (I5) Tributary to Roseau River below Trafalgar Falls, 1,000′ (6, 21, 49)
74 (K5) Pichelin River below Logge, to Stewart's River, 350′ (6, 8, 10, 19, 21)

*Based on sight records.

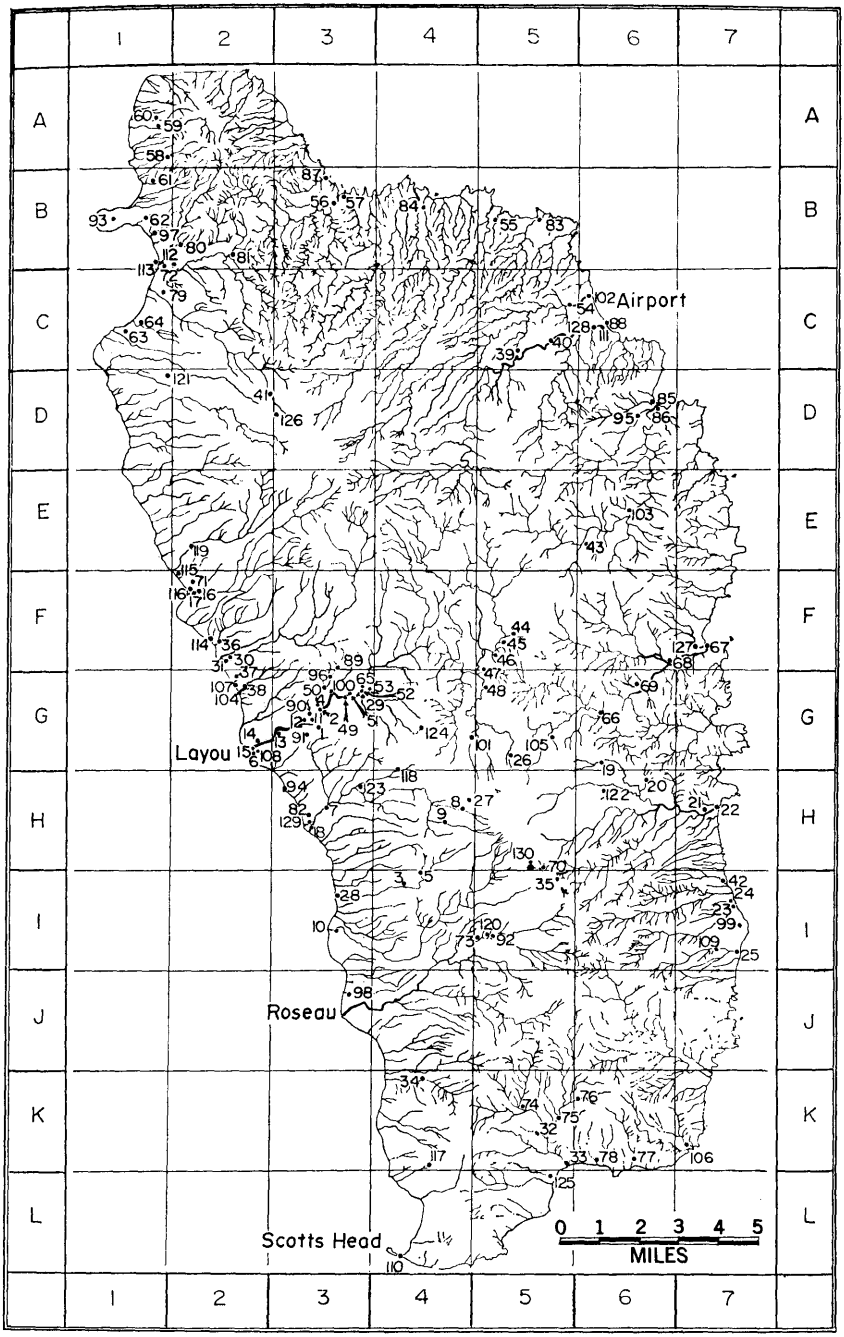


FIGURE 2.—Dominican Survey stations (see p. 9).

317-180—69——2

75 (K5) Tributary to Perdu Temps River, to Stewart's River, 350′ (6, 10, 12, 19, 20, 21 49)
76 (K6) Ravine Cacao, to Stewart's River, 400′ (6, 10, 12, 19, 21)
77 (K6) Malabuka River, 25′ (10, 20, 21, 49)
78 (K6) Ravine Irene, 50′ (6, 9, 10, 19, 21, 49)
79 (C1) Picard River S of Portsmouth, 20′–50′ (10, 16, 19, 20)
80 (B2) Barry River, to Indian River, 10′ (6, 9, 10, 16, 19, 20, 21)
81 (B2) Indian River, 150′ (9, 12, 16, 17, 19, 20)
82 (H3) Roadside just N of Mahaut, 20′ (82)
83 (B5) Woodford Hill River near Wesley, 25′ (16, 73, 79*)
84 (B4) Penton River, W of Calibishie, 25′ (9, 10, 19, 21)
85 (D6) Marechal River, S of Marigot, 100′ (10, 19, 20, 49)
86 (D6) Pagua River, near mouth, 5′ (20)
87 (B3) Thibaud River, 10′ (10, 19, 20, 21, 49)
88 (C6) Kasiobna River at mouth, sea level (10, 20, 21, 73)
89 (F3) Mannet's Gutter near top of mountain, 1,000′ (18)
90 (G3) Clarke Hall, 50′ (49)
91 (G3) Cliff across Layou River from Clarke Hall, 300′ (49)
92 (I5) Pool below Trafalgar Falls, to Roseau River, 1,000′ (6, 49)
93 (B1) Fort at Cabrits, 200′ (82)
94 (H3) Rodney's Rock, sea level (35, 59)
95 (D6) Crapaud Hall River, to Pagua River, 100′ (18, 19, 20, 49, 73)
96 (G3) Mannet's Gutter, to Layou River, 500′ (18, 19)
97 (B1) Near Gutter Ravine NW of Portsmouth, 5′–10′ (35, 79, 81, 83)
98 (J3) Goodwill, 5′–10′ (81)
99 (I7) Near Police Station N of La Plaine, 200′ (35)
100 (G3) Layou River at bridge, E of Clarke Hall, 100′ (16, 19, 20, 73)
101 (G4) Warner River, N of Pont Cassé, 1,350′ (6, 21)
102 (C6) Toulaman River, at mouth, sea level (20, 73, 83)
103 (E6) Tributary to Pagua River, 350′ (6, 10)
104 (G2) Black beach at mouth of Mero River, sea level (83)
105 (G5) Tributary to Fond Figues River, to Castle Bruce River, 1,350′ (6, 10, 12, 19, 21, 49)
106 (K7) La Riviere Nyson, Petite Savane, 500′ (49)
107 (G2) Black Beach at Mero, sea level (83)
108 (G2) Drainage ditch in coconut plantation, to Layou River, 5′ (17)
109 (I7) La Ronde River, 250′ (6, 10, 18, 19, 21, 35, 49)
110 (L4) Rocky beach, southern shore at Scotts Head, sea level (34, 57, 65)
111 (C6) Tributary to Kasiobna River near mouth, 5′ (79)
112 (B1) Mud flat S of Indian River, less than 10′ (36, 58, 70, 79, 84, 91, 92)
113 (B1) Sea wall at mouth of Indian River, sea level (59, 78)
114 (F2) Beach immediately N of Macoucheri River, sea level (57*, 59)
115 (F2) Rocky beach N of Salisbury, sea level (59)
116 (F2) Along roadside just N of Batali River, 5′ (81)
117 (K4) Ravine SE of South Chiltern, 1,200′–1,300′ (35, 49)
118 (G4) Belfast River valley, Sherwood Estates, 900′ (49)
119 (E2) Coulibistri River, 1.5 miles above mouth, 750′ (49)
120 (I5) Along trail below Trafalgar Falls, tributary to Roseau River, 1,250′ (49)
121 (D1) Along road from Portsmouth to Syndicate Estate, 1,000′ (49)
122 (H6) Terre Ferme, S of Rosalie Road, 1,100′ (49)
123 (H3) Between Forks of Belfast River, 350′ (49)
124 (G4) Southeast of Layou River, 2,000′ (49)
125 (L5) Beruka, 20′ (49)
126 (D3) Western slope of Morne Diablotin, 2,500′ (49, 73)

*Based on sight records.

127 (F7) Castle Bruce River, ⅜ mile above mouth, 30′ (49, 73)
128 (C6) Retaining wall of Kasiobna River at airport, 10′ (73)
129 (H3) Pool in abandoned bed of Belfast River, near mouth, 5′ (35, 79)
130 (H5) Boeri Lake, 2,850′ (49)

Distribution, Relationships, and Origins

While there were a number of insular masses in the Caribbean region during the Cretaceous Period (Woodring, 1954, p. 724; see also Weye, 1966)—except for a chain of volcanic islands in the area now encompassed by the island of Cuba—most, if not all of the extant islands, northern South America, and Central America were submerged. Furthermore, there is no geological evidence for assuming the continuous existence of land masses anywhere in the Antilles prior to the Eocene, and most of the islands are not known to be older than late Oligocene or early Miocene; consequently, if this be true, the ancestors of the present freshwater and terrestrial faunas on them could not have been permanently established earlier.

Since about the turn of the present century, a number of students of zoogeography (among them Ortmann, 1905; Barbour, 1914; Villalobos, 1955; Rivas, 1958; and, more recently, Hobbs and Villalobos, 1964) have postulated one or more land bridges between the Central American-Mexican region and the Greater Antilles over which various faunal elements might have reached the islands. Some have advocated another such bridge that connected the Lesser Antilles with northern South America.

Other zoogeographers (including Matthews, 1915 and 1939; Myers, 1938; Darlington, 1938 and 1957; Simpson, 1956; and Rosen and Bailey, 1963) have presented convincing arguments against the existence of such bridges. Instead, they have proposed that the Antillean faunas were derived from waifs or strays that reached the islands accidentally. Recently, Hobbs (1967) has admitted that, in light of data involving the tolerance of cambarine crayfishes to much higher salinities than formerly had been assumed possible, the necessity for a land bridge seems far less real.

The majority of the Antillean freshwater and terrestrial decapods are known either to be tolerant of salinities equivalent to that of sea water—many actually invading the ocean—or to have larval stages that typically occur in the sea. For some of these decapods, few data are available, and, in the absence of a fossil record, neither the time of arrival of their ancestors in the islands nor the routes taken by them can be postulated with any degree of certainty.

In contrast, there are a number of species that are typically freshwater inhabitants with no obviously closely related marine ancestors and that complete their life cycles in or near fresh water. For at least

some of them, conclusions concerning their probable ancestral home and the time of their reaching the islands are possible.

By whatever means or from whatever source the ancestral decapods reached the West Indies, having arrived—in the words of Simpson (1956), primarily in reference to the advent of mammalian stocks in the Antilles—they "would find in the Greater Antilles what was essentially an ecological vacuum for them. Once the hazardous trip was over, survival and expansion would be much more likely than not."

The following tabulation and the species records listed on page 7 summarize the state of our knowledge of the occurrence of the freshwater and terrestrial decapods of the Bermudas and the West Indies. The distributions indicated undoubtedly reflect, to some degree, the activities of collectors on the respective islands rather than the actual richness of their faunas. It seems probable, however, that the larger numbers of species of decapods occur on the larger islands of the Greater Antilles, where the endemic faunas also are probably much richer, than on the other islands.

Distribution of the Fauna

I. Antillean endemics (the unique types of both *Epilobocera granulata* and *Sesarma hanseni* are labeled "West Indies" and are not included in this list)

A. Lesser Antilles, excluding Virgin Islands

Guinotia dentata

B. Greater Antilles and Virgin Islands

1. Cuba

Typhlatya garciai, Troglocubanus calcis, T. eigenmanni (also Isla de Pinos), *T. gibarensis, T. inermis, Barbouria cubensis, Procambarus atkinsoni* (Isla de Pinos); *P. c. cubensis* (also Isla de Pinos), *P. c. rivalis, P. niveus, Epilobocera armata, E. cubensis, E. gertraudae, E. gilmanni, Pseudothelphusa affinis*

2. Jamaica

Troglocubanus jamaicensis, Glyptograpsus jamaicensis, Metopaulias depressus, Sesarma bidentatum, S. jarvisi, S. verleyi

3. Hispaniola

Epilobocera haytensis

4. Puerto Rico and Saint Croix

Epilobocera sinuatifrons

5. Puerto Rico and Saint Thomas

Atya lanipes

C. Lesser and Greater Antilles

?Jonga serrei, ?Micratya poeyi, Potimirim americana, Typhlatya monae, Xiphocaris elongata, Macrobrachium faustinum [2], *Pachygrapsus corrugatus* [2], *Uca burgersi*

[2]Also Bahamas.

II. Antillean fauna also represented on continental masses
  A. Lesser Antilles (including Trinidad) and—
    South America
      Guinotia g. garmani, Trichodactylus dentatus, Sesarma rectum, Gecarcinus lagostoma [3], *Uca cumulanta, U. vocator*
    Central America
      None
    South America and Central America
      Potimirim glabra [4], *Macrobrachium jelskii*
  B. Greater Antilles and—
    South America
      None
    Central America and/or Mexico
      Potimirim mexicana, Pseudothelphusa americana, P. terrestris, Sesarma americanum
    Central America and/or Mexico and North America
      Uca speciosa
  C. Lesser and Greater Antilles and—
    South America
      Sesarma miersii [2]
    South America and North America
      Macrobrachium acanthurus [2], *Sesarma curacaoense, Uca thayeri*
    Central America and/or Mexico
      Atya innocous, Petrolisthes quadratus
    Central America and/or Mexico, and North America
      Gecarcinus ruricola [2]
    South America and Central America and/or Mexico
      Penaeus aztecus subtilis, P. duorarum notialis, P. schmitti, Atya scabra, Macrobrachium crenulatum, M. heterochirus, Palaemon pandaliformis, Callinectes danae, Goniopsis cruentata [1 2 3], *Metasesarma rubripes, Sesarma roberti, Uca major* [2]
    South America and Central America and/or Mexico and North America
      Penaeus brasiliensis [1], *Xiphopeneus kroyeri, Macrobrachium carcinus, Coenobita clypeatus* [1 2], *Callinectes bocourti, C. exasperatus* [1], *C. marginatus* [1 2 3], *C. ornatus* [1 2], *C. sapidus* [1], *Eurytium limosum* [1 2], *Panopeus herbstii* [1 2], *Aratus pisonii* [2 4], *Cyclograpsus integer* [1 2 3], *Geograpsus lividus* [1 2 3 4], *Grapsus grapsus* [1 2 3 4], *Pachygrapsus gracilis* [1 2 3], *P. transversus* [1 2 3 4], *Plagusia depressa* [1 2 3], *Sesarma ricordi* [1 2], *Cardisoma guanhumi* [1 2], *Gecarcinus lateralis* [1 2], *Ocypode quadrata* [1 2], *Ucides cordatus, Uca rapax*

Whereas one might correctly conclude that the faunas of Cuba, Jamaica, and Puerto Rico are almost certainly richer than those of Dominica, he should attach little significance to the apparent disparity in numbers of species present on Dominica and the neighboring islands of Guadeloupe and Martinique (see "Species Records," p. 9).

[1] Also Bermudas.
[2] Also Bahamas.
[3] Also West Africa.
[4] Also West America.

Indeed, it is probable that instead of having one-half or less than one-half the numbers of species reported for Dominica, both islands actually have or have had richer faunas inasmuch as they offer a greater variety of habitats. To what extent some of the habitats on these French islands have been ravaged by man and perhaps the mongoose is not known to us; nevertheless, such species as *Aratus pisonii*, which is largely limited in its ecological distribution to mangrove swamps, occurs on Guadeloupe but is absent on Dominica, where no mangroves are present. Too, the larger area of low-lying land on Guadeloupe has provided for a much more extensive estuarine development than is possible on Dominica.

In assessing the significance of the numbers of species reported for the islands, one should take into account the fact that some of the records cited herein are old ones based on collections made prior to the deforestation associated with agricultural and other developments. Many of the dry arroyos that are so abundant on many of the islands were, in years past, shaded ravines with permanent streams. With water in them during only a few weeks or months of the year, many of the freshwater decapods have disappeared, apparently completely from some of the smaller islands. It is entirely possible, if not highly probable, for example, that some of the species herein reported to occur on Saint Croix and Saint Thomas, where fresh water is at such a premium, no longer exist on those islands.

We are aware that from a faunistic standpoint the decapods of at least one of the geographic regions recognized (Mexico and Central America) are probably composed of two elements, and it is regrettable that the crustaceans of this area are too little known to enable us to distinguish between the northern and southern components of this fauna. In order to avoid ambiguity resulting from our lack of knowledge, we are considering the fauna of this region as a unit, designating the area as the Central American-Mexican region, occasionally referring to it as the Central American-Mexican continental mass.

Except for Trinidad, the freshwater fauna is either so depauperate, so little known, or pan-Antillean in nature on most of the islands off the northern coast of South America that they seem to warrant no special attention in this discussion, and they are referred to infrequently, some not at all. Trinidad, although occasionally included herein as a member of the Lesser Antilles, should perhaps faunistically be considered more properly a part of South America.

As might be expected, many (24) species present in the West Indies also occur in coastal areas of *all three* neighboring continental masses, but the ranges of a majority of them are decidedly more restricted, with 33 species and subspecies endemic to one or more of the islands.

It may be noted that the number of species shared by the Lesser Antilles with South America alone is only six, and those with Central and South America, only two. No species are limited to the Central American-Mexican region *and* the Lesser Antilles.

Four species are common exclusively to the Greater Antilles and the Central American-Mexican region. A single species occurs only in the Greater Antilles, the Central American-Mexican region, and in North America.

As for the species shared in common by the Lesser and Greater Antilles, 12 occur also in South America and in the Central American-Mexican region, two in only the Central American-Mexican region, three in South America and North America, and one each in South America and in the combination of the Central American-Mexican region and North America.

Perhaps surprising is the fact that none of the Antillean species are shared with North America alone (as used in this discussion, exclusive of Mexico); furthermore, none of the endemic species occurring on the islands seem to have been derived from ancestors moving directly to them from North America. The ancestors of a majority of the endemic fauna seem to have reached the Greater Antilles from the Central American-Mexican region, and a few have undoubtedly been derived from stocks from South America. Evidence for a West Indian origin directly from salt water ancestors exists for only one species, *Barbouria cubensis*, which occurs in brackish pools in Cuba.

THE WEST INDIAN FAMILIES.—The following is a summary of the distribution of the West Indian decapod families having freshwater or terrestrial members:

	Penaeidae [1]	Atyidae	Palaemonidae	Hippolytidae [1]	Astacidae	Porcellanidae [1]	Coenobitidae	Portunidae [1]	Pseudothelphusidae	Trichodactylidae	Xanthidae [1]	Grapsidae	Gecarcinidae	Ocypodidae
Bermudas	X		X	X		X	X	X			X	X	X	X
Bahamas	X		X	X		X	X	X			X	X	X	X
Cuba	X	X	X	X	X	X	X	X	X		X	X	X	X
Jamaica	X	X	X	X		X	X	X			X	X	X	X
Hispaniola	X	X	X	X		X	X	X	X		X	X	X	X
Puerto Rico	X	X	X	X		X	X	X	X		X	X	X	X
Virgin Islands	X	X	X	X		X	X	X	X		X	X	X	X
Lesser Antilles	X	X	X	X		X	X	X	X		X	X	X	X
Trinidad	X	X	X	X		X	X	X	X	X	X	X	X	X
North America	X	X	X	X	X	X	X	X			X	X	X	X
Mexico	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Central America	X	X	X	X	X	X	X	X	X	X	X	X	X	X
South America	X	X	X	X		X	X	X	X	X	X	X	X	X

[1] Marine families, some members of which occur in the supralittoral or in estuarine habitats, occasionally invading freshwater.

Of the 14 families represented in the West Indies, 11 occur on all of the adjacent continental masses; 2, the Pseudothelphusidae and Trichodactylidae, are also in Mexico, Central America, and South America; and 1, the Astacidae, in North America, Mexico, and Central America.

Only two families occurring in the Western Hemisphere and having freshwater and terrestrial members are absent from the West Indies. The Parastacidae are found in South America, Australia, New Zealand, Tasmania, New Guinea, and Madagascar, and the Aeglidae are endemic to South America, but neither of these families occurs in the northern part of the South American continent.

Only 1 of the 14 families, the Astacidae, can be adjudged conclusively as having reached the Antilles from North America, and that via the Central American-Mexican region. Likewise, only one family, the Trichodactylidae, is unquestionably a South American one, invading the Antilles only to Trinidad. A third family, the Pseudothelphusidae, has apparently reached the Antilles from two sources, South America and the Central American-Mexican region.

THE WEST INDIAN GENERA.—Twenty-two of the 38 genera having freshwater and terrestrial representatives are also found in North and South America and in the Central American-Mexican region. Six (*Typhlatya*, *Xiphocaris*, *Troglocubanus*, *Barbouria*, *Epilobocera*, and *Metopaulias*) are endemic in the West Indies, three (*Guinotia*, *Trichodactylus*, and *Metasesarma*) are found elsewhere only in South America, and three (*Jonga*, *Micratya*, and *Glyptograpsus*) elsewhere only in the Central American-Mexican region. Three genera (*Atya*, *Potimirim*, and *Pseudothelphusa*) occur also both in South America and in the Central American-Mexican region, but only one (*Procambarus*) inhabits both North America and the latter. None of the genera are confined to the West Indies and North America.

Only one genus, *Procambarus*, is believed to have had a North American origin, and it has reached the Antilles from the Central American-Mexican region.

As to the origins of the stocks from which the West Indian genera probably arose, *Barbouria* is the only one that has possibly been derived from a marine ancestor in situ, on the Island of Cuba. The ancestors of the endemic *Epilobocera* almost certainly came from the Central American-Mexican region as have those of the West Indian representatives of *Jonga*, *Micratya*, *Typhlatya*, *Pseudothelphusa*, and *Glyptograpsus*. The West Indian representatives of the genera *Guinotia*, *Trichodactylus*, and *Metasesarma* seem unquestionably to have had a South American ancestry, while there is evidence that *Potimirim* has reached the Antilles from both South American and Central American-Mexican regions. The origins of the ancestors of the endemic *Xipho-*

caris and *Troglocubanus* cannot presently be postulated. The monotypic *Metopaulias* is believed to have had a common origin with the freshwater members of the Jamaican representatives of the genus *Sesarma*, and the stock from which they arose probably reached the island from the Central American-Mexican region.

THE WEST INDIAN SPECIES.—This discussion is devoted largely to the species that are known only from the West Indies; however, where appropriate, other more widely ranging ones are introduced. For the remaining species, either their ranges are so broad or our data so meager that nothing can be said concerning the migratory routes followed by their ancestors or the relative times of their arrivals.

The Atyidae: Of the 11 Antillean atyids, 7 are endemic to the islands: *Atya lanipes, Jonga serrei, Micratya poeyi, Potimirim americana, Typhlatya garciai, T. monae,* and *Xiphocaris elongata.* Among them are some of the most generalized and some of the most specialized members of the family. Except for the two members of the genus *Typhlatya,* all of them probably have larval stages that undergo part of their development in the sea, thus minimizing the possibility of deciphering their sources of origin. Nevertheless, postulates concerning migratory paths of the ancestors of some of them are presented with some degree of confidence.

Only one member of the genus *Atya* is endemic in the West Indies. *Atya lanipes,* one of the most primitive members of the genus, is confined to the islands of Puerto Rico and Saint Thomas, and its presence in the midst of the ranges of its relatives *A. innocous* and *A. scabra,* both of which occur on Puerto Rico, is somewhat surprising. The presumed absence of the latter two on Saint Thomas suggests the possibilities that *A. lanipes* became differentiated on Saint Thomas and that its presence on Puerto Rico represents a subsequent invasion. Perhaps, however, it had its origin on Puerto Rico and migrated to Saint Thomas, establishing a population there that has succeeded in warding off the subsequent invasions of *A. innocous* and *A. scabra,* a feat that it was not able to accomplish on the larger island of Puerto Rico. Little is known of the habits of this species; thus, an evaluation of its probable fate on Peurto Rico cannot be judged.

A lack of knowledge that would permit a postulate as to the range of the primeval *Atya* stock with its presumed marine larvae almost obviates speculation concerning the origins of the three West Indian species. It seems highly unlikely that the primitive *A. lanipes* is presently occupying the original home of the genus. Suffice it to say that *A. lanipes* is the most primitive of the three, *A. scabra* the most advanced, and that *A. innocous* is somewhat more primitive than the latter.

The monotypic *Jonga* and *Micratya* are each known with certainty from only five islands in the Antilles: both occur on Cuba, Jamaica, Puerto Rico, and Dominica; the former is found also on Barbados, and the latter on Martinique. We have several specimens of *Jonga* and a single female of *Micratya* that were collected in Costa Rica and that may be conspecific with the West Indian species; these records should not be accepted for the species, however, until additional specimens become available for comparison. In view of the apparent absence of the two from the lower islands in the Lesser Antillean chain and in South America, we are inclined to consider that they reached the Greater Antilles from the Central American-Mexican region and spread southeastward.

While three species of the genus *Potimirim* occur in the West Indies, only *P. americana* is endemic (Cuba, Jamaica, and Trinidad). *Potimirim mexicana* ranges from northeastern Mexico to Costa Rica and occurs on Cuba, Jamaica, and Puerto Rico. *Potimirim glabra* is reported here from the Antilles for the first time, having been found on Dominica; elsewhere it occurs in Central America and Brazil. The interrelationships of the members of the genus are somewhat enigmatic, and while the probably primitive branchial characters of *P. americana* and *P. glabra* bring them closer to each other than to either of the two remaining species of the genus, *P. mexicana* and *P. potimirim* (from Brazil), the characters of the appendix masculina places them at opposite extremes. Even with the apparent discontinuities in the ranges of the West Indian species and the puzzling occurrence of *P. americana* (instead of the expected *P. glabra*) on Trinidad, one is inclined to assume that the ancestors of *P. americana* arrived in the Greater Antilles from the Central American-Mexican region and subsequently migrated southward along the Lesser Antillean chain. The invasion of the Antilles by *P. mexicana* from the same region and by *P. glabra* from South America along the Lesser Antilles probably occurred at a later time. Such an assumption is supported by a comparison of the appendices masculinae of the four species: that of *P. americana* consists of a simple subcircular lobe; in *P. mexicana* it is more elongate, and the posterior border is very shallowly trilobate; in *P. potimirim* it is even more elongate, and the three lobes more distinctly delimited; and in *P. glabra* the pattern is quite similar to the latter but with a deep, rounded, naked sinus between the proximal two lobes. There can be little question, on the basis of this character, that *P. americana* has its closest affinities with *P. mexicana* and that *P. potimirim* links the latter with *P. glabra*.

The genus *Typhlatya* is represented in the Antilles by two species, *T. garciai* (Oriente Province, Cuba) and *T. monae* (Isla Mona and Barbuda) and a third species, *T. pearsei* Creaser, occurs in Yucatan.

All three are troglobitic and almost certainly represent relicts of a once much more widespread epigean stock of which no other trace is known to exist. The ancestral stock must have been a primitive one, retaining exopods on all of the pereiopods, a condition found elsewhere in the family only in *Mesocaris*, *Paratya*, and *Xiphocaris*. Perhaps the absence of epigean species signifies an inability of the surface members to compete with faunas that later invaded the ancestral range; however, it is not inconceivable that had the ancestral stock become adapted for a freshwater existence, as have their spelean descendents, one or more Pleistocene inundations of their ranges could have had effects similar to those postulated by Hobbs (1958) in considering the evolutionary history of certain troglobitic crayfishes in Florida. Were there sufficient land remaining in Yucatan, Cuba, and on Mona during such an inundation to serve as recharge areas for the subterranean streams, or if adequate underlying aquifers were available to feed them, those forms that had invaded subsurface waters could have survived, even if the epigean stock were annihilated by salt water. On the basis of the present distribution of the members of *Typhlatya*, there seems no reason to doubt that the Antillean members have been derived from stocks that reached the islands from the Central American-Mexican region, probably in Miocene or Pliocene times.

We are much puzzled by the remarkable occurrence of *T. monae* on Mona and Barbuda. This disjunct distribution of a troglobite seems almost inconceivable; however, careful comparison of specimens from the two islands reveals no differences worthy of note. That parallel evolution should have resulted in apparently identical populations on the two islands hardly seems possible, but the alternative proposal that a continuous spelean corridor exists or has existed between the islands seems ridiculous. Of course, if it could be shown that the troglobitic facies of *T. monae* are actually nothing more than ecophenotypic expressions, then the apparent parallelism is precisely what might be expected in the troglobitic adaptation of an old, stable species. The fact that *T. garciai* differs from *T. monae* in comparatively minor details lends some credence to the latter possible interpretation.

The monotypic *Xiphocaris elongata* is a near orphan in the family, retaining the most primitive branchial complement and also having the primitive characters of exopods on all of the pereiopods and untufted fingers of the chelipeds. Since it is apparently quite primitive and has no close relative anywhere, one might conclude that it represents the remnant of an old stock that has disappeared elsewhere but in this species has found a congenial habitat in the West Indies.

The Palaemonidae: Twelve members of this family are found in fresh waters of the West Indies. Among them are some of the most unique of the endemic decapods, members of the troglobitic genus *Troglocubanus*, which is represented on Cuba by four species and on Jamaica by one. Their relationships to other members of the family are at best remote, and, since all are cavernicolous, they should perhaps be looked upon as relicts of a stock of the family that reached the Antilles comparatively early, perhaps as early as the Miocene, populating the freshwater systems of at least Cuba and Jamaica and gaining access to the underground water systems on both. For some reason the supposed epigean derivatives from the original stock were unsuccessful and became extinct, leaving albinistic relicts as the only evidence of their existence. Whether all six species represent independent invasions of subterranean waters can be left only to conjecture, but a conclusion that there were at least two invasions, one on each of the islands, seems inescapable. There is little likelihood that a subterranean fresh water connection has ever occurred between Jamaica and Cuba, and equally unlikely that any other type of highway, along which they might have travelled after once having become troglobitic, has ever joined the two islands. On the basis of present information, we are unable to hazard a guess as to the area from which the ancestral stock emigrated. For several reasons, however, it seems probable that the ancestors reached the islands in pre-Pleistocene times.

Of the five members of the genus, *Troglocubanus eigenmanni* (provinces of Pinar del Río and Matanzas) is probably the most generalized, and the most specialized is *T. inermis* (Provincia de La Habana). Closely related to the latter is *T. gibarensis* (Provincia de Oriente). The Jamaican *T. jamaicensis* seems to have its closest affinities with *T. calcis* (Provincia de La Habana).

The endemic *Macrobrachium faustinum* appears to be the West Indian counterpart of *M. olfersii* (Wiegmann), the range of which extends from Mexico to Brazil and includes the Florida peninsula. That the two have a recent common ancestry seems almost undebatable, and for the first half of the present century they were considered to belong to a single species that was designated *M. olfersii*. One must assume that the ancestral stock was a continental one, and a postulate of its having reached the Greater Antilles from the Central American-Mexican region rather than from South America seems more probable for the reasons that the Greater Antilles are older than the Lesser Antilles, and the stock would almost certainly be more nearly isolated than if it moved northward along the islands adjacent to the South American coast (it is now known to occur on Curaçao, Bonaire, and Tobago, which are only some 40 to 65 miles

from the continent). Once isolated in the Greater Antilles, it probably moved along the islands eastward to the Bahamas and southward through the Lesser Antilles, reaching as far southwest as Curaçao. It seems odd that the islands closest to South America have not been invaded by *M. olfersii*, and the obvious explanations are that either *M. faustinum* arrived first, lessening the chance that its close relative could become established even if it reached the islands, or that in recent times the waterway between the mainland and the islands has been a barrier to both species.

The Astacidae: All of the West Indian members of this family are endemic. Evidence that cambarine crayfishes lend themselves to having been rafted from the Central American-Mexican area to the Greater Antilles comes from several sources. Hobbs (1942b) in discussing the habits of the crayfish *Procambarus spiculifer* (LeConte) stated that "several times in removing dead limbs or logs from streams in order to use a seine or dip net I have found females, carrying young or eggs, wedged in a hollow limb or down in a crevice of a log . . . ," indicating that crayfishes do frequent a potential raft. Since then, other species have been observed in such microhabitats. Faxon (1884), Hobbs (1942b), and Penn (1943, 1956) reported that *Cambarus uhleri* Faxon, *Procambarus pycnogonopodus* Hobbs, and *Procambarus clarkii* (Girard) invade brackish habitats (the latter two, congeners of the Antillean crayfishes). Helff (1931) and Steeg (1942) demonstrated that a few *P. clarkii* can survive up to 17 ppt of NaCl for 7 days. Kendall and Schwartz (1964) also found that other freshwater crayfishes, *Cambarus b. bartonii* (Fabricius) and *Orconectes virilis* (Hagen), while intolerant of prolonged exposures (600 hours) to salinities equivalent to that of sea water (about 30 ppt), a few individuals of both species lived longer than 500 hours.

With the knowledge that crayfishes require only a high humidity to keep their gills moist for respiratory purposes, it would not be necessary to assume that they needed to be submerged in salt water at all; furthermore, were the raft (log) hollow, the crayfish therein might well have moved above the water level during the overseas voyage and remained there until the log had been lodged in an estuary on Cuba or Isla de Pinos, where the salinity was within the range of tolerance of the emigrant. Even had it received numerous salt water sprays, the gill chamber might still have maintained a low salt concentration. Thus, with the known proclivities of ovigerous crayfishes for seeking shelter in hollow logs and their tolerance to comparatively high concentrations of salt, it may be concluded that the crayfish stock reached Cuba (Isla de Pinos) by fortuitous rafting.

Probably the most primitive of the four crayfishes in the Antilles is *Procambarus atkinsoni*, which occurs only on Isla de Pinos (see

Ortmann, 1913; Hobbs and Villalobos, 1964; and Hobbs, 1967). Its closest relative, *P. cubensis rivalis,* is found, as might be expected, in western Cuba, where its range is limited to a small area in the mountainous portion of Provincia de Pinar del Río. The more advanced *P. c. cubensis* is widespread in Cuba and is also present on Isla de Pinos, and the troglobitic *P. niveus* is known from a single cave in the westernmost province on the island.

It is suggested that the invading stock, presently best represented by *P. atkinsoni,* reached Isla de Pinos in the late Miocene or Pliocene and that soon thereafter it reached the nearby Cuban coast. Once on Cuba, one portion of the stock retained the primitive facies, occupying moderately to swiftly flowing streams, and is represented today by *P. c. rivalis.* The other portion moved into sluggish streams and eventually into lentic habitats and, in adapting to such, was able to spread throughout the island. This stock gave rise to *P. c. cubensis,* which subsequently spread to the ancestral home on Isla de Pinos, passively to be sure, but as to whether or not it was introduced by man will probably never be known. *Procambarus niveus* was probably derived from the stock of *P. c rivalis,* a population that invaded subterranean waters of western Cuba, probably in the late Pliocene or early Pleistocene.

The Pseudothelphusidae: The pseudothelphusid fauna of the West Indies is composed of three genera: *Epilobocera* represented by six species, *Guinotia* by two, and *Pseudothelphusa* by three.

The Antillean endemic genus *Epilobocera* is confined to the Greater Antilles and Saint Croix, with four species (*E. armata, E. cubensis, E. gertraudae,* and *E. gilmanii*) on Cuba, one (*E. haytensis*) on Hispaniola, and one (*E. sinuatifrons*) on Puerto Rico and Saint Croix. The apparently more primitive species, *E. gilmanii* and *E. cubensis,* occur respectively on Isla de Pinos and on Cuba. The slightly more advanced *E. armata,* which has been reported from Provincia de Las Villas, tends to link the primitive Cuban species with the more specialized *E. haytensis* and *E. sinuatifrons.* Differing from both groups is *E. gertraudae,* which apparently frequents subterranean waters in the western portion of Cuba.

Epilobocera is probably the most primitive of the Antillean pseudothelphusids, possessing a well-developed exopod on the third maxillipeds and having a comparatively simple first pleopod in the males that is remarkably similar in all the species. Its absence from the Lesser Antilles suggests a Central American-Mexican origin rather than a South American one, and, inasmuch as it has undergone a greater degree of diversity than the other pseudothelphusids in the Antilles, it seems likely that the ancestral stock reached the Greater Antilles earlier, possibly Miocene or early Pliocene, than did the

ancestors of the other species. With the more primitive species occurring on Isla de Pinos and Cuba, the precursors of the modern members of the genus might well have arrived in the islands about the time that the crayfishes reached them.

The more advanced *Pseudothelphusa* is represented in the Antilles by only three species, *P. affinis*, *P. americana*, and *P. terrestris*, of which only the former is an endemic, known only from Cuba. The latter two also occur in the Central American-Mexican region, and *P. americana* has been found on Puerto Rico. Little is known about these three crabs; it is not even known whether or not they occur sympatrically on Cuba, and their phylogenetic and ecological relationships are quite obscure. Such evidence as exists, however, points to a Central American-Mexican origin. The remaining members of the genus occur in Colombia, Costa Rica, and southern Mexico.

In contrast, the two representatives of the genus *Guinotia* in the West Indies have had a South American origin. *Guinotia g. garmani* occurs in eastern Venezuela, on Trinidad, and on Isla de Margarita. Almost certainly, the ancestral stock of *G. dentata* invaded the Lesser Antillean Chain from South America and is now represented by this single species on Guadeloupe, Dominica, Martinique, and Saint Lucia. The remaining species belonging to this genus are endemic to South America.

The Trichodactylidae: This primarily South American family barely reaches the West Indies in Trinidad, where it is represented by *Trichodactylus dentatus*, a species with an extensive range in northeastern South America. A few representatives of the genus in Central America and Mexico have very probably been derived from South American ancestors. Inasmuch as the West Indian examples are conspecific with South American ones, it seems probable that the invasion of Trinidad was comparatively recent.

The Grapsidae: While almost one-fourth of the freshwater and terrestrial decapods in the West Indies are members of this family, only seven of them are endemic to the islands. Typically, the members of this family have marine larvae, but those of a few species have become adapted to fresh water.

Pachygrapsus corrugatus, a marine species, is known only from New Providence, Cuba, Puerto Rico, and Saint Croix, where its range overlaps that of *P. gracilis* and *P. transversus*. Its affinities with these and other members of the genus are not well understood, and it can only be supposed that its ancestors reached the Greater Antilles rather early and that perhaps competition with other forms occupying similar habitats has prevented it from extending its range to the nearby continental masses and neighboring islands.

Glyptograpsus jamaicensis, which is believed to have marine larvae, is a Jamaican endemic, and its closest relative, *G. impressus*, occurs on the Pacific coast of southern Mexico and Central America. Since Jamaica has been a haven for several endemic grapsids, an observer is tempted to conclude that *G. jamaicensis* is a relict of a tertiary stock that occurred in the Central American region during the submergence of the isthmus. That segment occurring on the Caribbean side became segregated from that giving rise to the Pacific stock with the development of the Panama Land Bridge during the late Tertiary or early Pleistocene (Woodring, 1966). Woodring noted, in relation to his study of Tertiary mollusks, that "The rise of the bridge also is inferred to have led to impoverishment of the present Caribbean province. . . ." The ancestors of *G. jamaicensis* could well have found a refuge on Jamaica prior to this time, whereas the remainder of the Gulf coastal stock perished along with other forms following the disappearance of the interoceanic seaways.

Three of the four Antillean endemic members of the genus *Sesarma* are also found only on Jamaica (*S. bidentatum*, *S. jarvisi*, and *S. verleyi*). A single specimen of the fourth, *S. hanseni*, is known, recorded simply from "The West Indies." Prior to Hartnoll's (1964) studies, the only crabs that have "been shown to pass their entire life cycle in fresh water are the Potamonidae [including Pseudothelphusidae]." He demonstrated that the three Jamaican endemics also complete their life cycle in fresh water as does also the closely related, bromeliad-inhabiting *Metopaulias depressus*. Almost certainly, these four Jamaican crabs had their origins on Jamaica from a common ancestor, and the diverse habitats that they occupy suggest that ecological factors have played an important role in their origins. Of the four, *S. bidentatum* probably most closely approximates both in its morphology and ecology those of the ancestral stock. That portion of the stock that gave rise to *S. jarvisi* moved to higher elevations, that leading to *S. verleyi* invaded subterranean streams, while that from which *Metopaulias depressus* arose found a niche in the lentic habitat of bromeliads. Once the necessary adaptations had been made so that the life cycle could be completed in fresh water, it is not surprising that three of the stocks invaded habitats that are unique for grapsid crabs. Therefore, with the additional evidence of morphological similarities that are not known to have been affected by a transition in habitat, there is every reason to agree with Hartnoll's (1964) conclusion that "all the freshwater crabs of Jamaica have been the result of an invasion by a single stock derived from the subgenus *Sesarma*." There still remains, however, the question as to the source of the invading stock. Only one other member of the subgenus, *S. curacaoense*, occurs in the West Indies, ranging from southern Florida to

Brazil; furthermore, along the continental coasts of the Gulf and Caribbean there is only one other member, *S. reticulatum* (Say), ranging from Texas to Massachusetts. Inasmuch as several species occur on the Pacific side of the Americas, a possible correlation might exist between the relative paucity of Caribbean marine or quasi-marine species of the subgenus and the depauperization of the Caribbean faunas following the elevation of the Panama Land Bridge in the late Tertiary or early Pleistocene.

Most of the Greater Antillean freshwater decapods apparently have had their origins from stocks originating from the Central American-Mexican region, and it is probable that the Jamaican *Sesarma* did also. In light of the range of *S. curacaoense*, one might suspect that a South American origin would seem more likely, but the latter is so remotely related to the Jamaican species that it can hardly be considered with them. It is not inconceivable that two Central American-Mexican stocks reached the Greater Antilles (both Cuba and Jamaica) and that those reaching Cuba migrated eastward and then southward along the Lesser Antillean chain and subsequently reached the South American continent. Obviously, however, too few data are available to draw any definite conclusion. If, however, *S. curacaoense* has had a South American origin, it would have had an essentially unique history among the Greater Antillean decapods.

Hartnoll (1964) posed the question as to why "the grapsid crabs evolved a population of species breeding in fresh water in Jamaica but nowhere else" and concluded that the absence of the Potamidae [Pseudothelphusidae] is certainly a contributing factor. To what extent the pseudothelphusids are actually in competition with *Sesarma* elsewhere, however, remains to be demonstrated. His correlation, nevertheless, is well taken.

Unfortunately, the interrelationships of the members of the world-wide genus *Sesarma* are poorly understood, and there are reasons for questioning the validity of the subgeneric groupings as they are presently recognized. Until a review of the entire genus has been accomplished, little progress can be made toward an understanding of the phylogeny of its members.

As to the means utilized by the ancestral grapsids in reaching the Antilles, since all of the ancestral forms probably had marine larvae, a rafting hypothesis by no means seems essential, but in view of the chance that the pseudothelphusid crabs and the crayfishes utilized such in reaching the Antilles, some of the grapsids might also have done so. The possibility that one or more stocks might have resorted to rafting is supported by the observations of Marchand (1946) on the accidental introduction of *Platychirograpsus typicus* Rathbun into Florida.

317-180—69——3

The Ocypodidae: While this family is represented in the West Indies by 10 species, only one, *Uca burgersi*, is endemic. This species is closely related to *U. mordax*, which is known with certainty to occur only along the northern coast of South America. Until the ranges of the two are better understood, no hypotheses concerning the possible origin of *U. burgersi* can be offered.

Uca cumulanta is a South American species that has become established on Curaçao but has not been reported from other islands in the Lesser Antilles or from those considered herein as the Caribbean islands. A third species, *U. speciosa*, which is known to be present in Yucatan, Cuba, Jamaica, and Florida probably had its origin in the Central American-Mexican region and migrated to the Greater Antilles and Florida. Whether or not it reached Florida by way of Jamaica and Cuba can only be left to conjecture. The homogeneity of its characters suggests a Pleistocene or recent invasion of the islands and Florida.

The remaining representatives of the family are widely spread on the adjacent continents, and there are no data to indicate from what area or areas the insular members were derived.

Other families: The following families are not treated in this discussion largely because the wide ranges of the species composing them provide little or no data concerning the origins of their members: Penaeidae, Hippolytidae, Porcellanidae, Coenobitidae, Portunidae, Xanthidae, and Gecarcinidae.

ENDEMISM AND ORIGIN.—The following is a summary of our tentative conclusions concerning the source of the several *freshwater or landlocked* decapod stocks that have invaded the West Indies, together with estimates of the probable time of their island invasion (numbers in parentheses indicate species endemic to the West Indian region):

Ancestors of—	Number of species in West Indies	Probable time of invasion
(from the Central American-Mexican Region)		
Jonga	1 (0)	Recent
Micratya	1 (0)	Recent
Potimirim	2 (0)	Pleistocene or Recent
Typhlatya	3 (2)	Tertiary
Macrobrachium	6 (1)	?
Procambarus	3 (3)	Tertiary
Epilobocera	7 (7)	Tertiary
Pseudothelphusa	3 (1)	?
Glyptograpsus	1 (1)	Tertiary
(?) *Sesarma*	3 (3)	Tertiary
(?) *Metopaulias*	1 (1)	Tertiary

Ancestors of—	Number of species in West Indies	Probable time of invasion
(from South America)		
Potimirim	1 (0)	Pleistocene or Recent
Guinotia	2 (1)	Pleistocene or Recent
Trichodactylus	1 (0)	Pleistocene or Recent
(in situ)		
Barbouria	1 (1)	?
(no evidence of source)		
Atya	3 (1)	?
Xiphocaris	1 (1)	Tertiary
Troglocubanus	5 (5)	Tertiary
Macrobrachium	6 (1)	?
Palaemon	1 (0)	?
Sesarma	1 (0)	?

Available data do not allow postulates concerning the invasions by a majority of the freshwater and terrestrial decapod crustaceans. The origins of even the two endemic genera, *Xiphocaris* and *Troglocubanus* (the former monotypic and the latter represented by five troglobitic members), and the endemic *Atya lanipes* and *Pachygrapsus corrugatus* are completely obscure. Further, all of the species classified herein as terrestrial have marine larvae and are so widespread that, while it must be assumed from a zoogeographic standpoint that all have invaded each of the islands they occupy independently, this fact has little bearing on an understanding of the relationships of the island faunas to those of the continental masses. The same is true for those forms that are widespread in estuarine habitats throughout the tropical and subtropical western Atlantic.

Nevertheless, there is evidence that seven and possibly nine stocks have reached the islands from the Central American-Mexican region. Three, possibly four, stocks have arrived from South America, one of which reaches northward only to Trinidad. No stocks appear to have attained the islands directly from North America, and only the cambarine astacids (crayfishes) are believed to have utilized North America as a center or origin, reaching the Antilles through the Central American-Mexican region. A single hippolytid, *Barbouria cubensis*, which frequents brackish pools on Cuba, appears to have had its origin from marine ancestors on the island.

Endemism among the West Indian decapods, as illustrated below, is only moderately spectacular and is largely confined to the Greater Antilles. The numbers of freshwater and terrestrial species endemic to individual islands and island groups are as follows (Isla de Pinos is included herein with Cuba, and Isla Mona with Puerto Rico):

	Jamaica	Cuba	Hispaniola	Puerto Rico	Bermudas	Bahamas	Lesser Antilles	Trinidad
Atyidae	0	1	0	2[1]	0	0	0	0
Palaemonidae	1	4	0	0	0	0	0	0
Hippolytidae	0	1	0	0	0	0	0	0
Astacidae	0	3	0	0	0	0	0	0
Pseudothelphusidae	0	5	1	1[2]	0	0	1	0
Grapsidae	5	0	0	0	0	0	0	0
Totals	6	14	1	3	0	0	1	0

[1] One also on Saint Thomas and the other also on Barbuda.
[2] Also on Saint Croix.

Two families are represented among those species restricted to Jamaica. Of these, the palaemonid genus *Troglocubanus* is found elsewhere only on Cuba. The closely related grapsid genera *Sesarma* and monotypic *Metopaulias* comprise the remaining Jamaican endemics. While the former is a subcosmopolitan genus, only on Jamaica in the West Indies is it represented by species (three) that are known to complete their life cycles in freshwater.

Five families contribute to the list of 14 Cuban endemic decapods. One species of the spelean atyid genus *Typhlatya* occurs on Cuba and another on Isla Mona (Puerto Rico) and Barbuda. The palaemonid genus *Troglocubanus* comprises four species on Cuba and a single one on Jamaica. The monotypic hippolytid genus *Barbouria* is restricted to Cuba. The astacid genus *Procambarus*, while ranging from Honduras northward into the United States, has three Cuban endemic species, one represented by two subspecies, but is not found elsewhere in the Antilles. The pseudothelphusid genera *Epilobocera* and *Pseudothelphusa* are represented by four and one endemic respectively. The endemic Antillean *Epilobocera* also occurs on Hispaniola and Puerto Rico, while *Pseudothelphusa* is restricted to Cuba, Puerto Rico, Mexico, Costa Rica, and Colombia.

Only one endemic decapod, *Epilobocera haytensis*, is known to occur on Hispaniola, the least known of the four larger Greater Antillean islands.

Puerto Rico shares with Saint Thomas the Antillean *Atya lanipes*, and the troglobitic *Typhlatya monae* occurs only on Mona Island and Barbuda. The remaining endemic is *Epilobocera sinuatifrons*.

The Bermudas, Bahamas, and Trinidad are without endemic decapods, and only one species, *Guinotia dentata*, is restricted to the Lesser Antilles. Other members of the genus occur in South America and along the coastal islands.

While there is no concrete evidence that any stock, once reaching the islands, has reinvaded the neighboring continental masses, it is tempting to postulate that the gecarcinids, and perhaps other groups, reached southern Florida from the Antilles or Bahamas, and it is not unthinkable that some few, the origins of which are highly problematical, may well have moved in the opposite direction.

It is a necessary assumption that there has been a considerable amount of "island hopping" once a stock became established in the West Indies, but here again, data are few that permit ascertaining which island or island groups were first invaded; consequently, the directions of migrations are most often undecipherable.

Almost certainly Cuba has served as the center of dispersal for the genus *Epilobocera*, from which the ancestral stock spread to Hispaniola, Puerto Rico, and Saint Croix. Cuba may well have served also as the primary insular home of the stock from which *Troglocubanus* was derived, but it is not inconceivable that the stock reaching Jamaica might have arrived first and subsequently spread to Cuba with the more primitive facies being preserved in southern Cuba. The ancestral stock of *Typhlatya monae* also very probably reached Isla Mona (Puerto Rico) from Cuba. *Guinotia dentata*, *Potimirim glabra*, and *Trichodactylus dentatus*, all three having South American ancestries, are the only decapods that can be said with little doubt to have moved northward in the Lesser Antillean chain.

One can scarcely resist posing the question as to why the crayfishes, as successful as they have been on Cuba, have not spread further through the Antilles. Inasmuch as the freshwater crab and shrimp faunas on Cuba are no poorer than on the remaining islands of the Greater Antilles, one might expect the crayfishes to have been equally successful on these islands. The obvious answer is that a crayfish stock just never got there, or, if it did, the arrival was too late to establish niches in the freshwater habitats before they were occupied by other decapods. One also wonders, with the comparatively rich freshwater grapsid (*Metopaulias* and *Sesarma*) fauna on Jamaica, why they too have not spread to the other islands. Can it be, as Hartnoll has suggested, that the absence of other freshwater crabs on Jamaica has made possible the adaptive radiation occurring in this family? From the standpoint of decapods at least, the bromeliads on all of the islands bear a vacuum awaiting the invasion of a *Metopaulias*-like crab!

The following tabulations are presented as summaries that may be of interest to students of zoogeography who are concerned with the Antillean Region.

The numbers of taxa of *freshwater and terrestrial* decapods, excluding primarily marine forms (see footnotes), occurring on some of the West

Indian islands are as follows (numbers in parentheses indicate, in addition, genera or species that are probably there but have not been reported):

	Jamaica	Cuba	Hispaniola	Puerto Rico	Bermudas	Bahamas	Lesser Antilles [4]	Trinidad
Families [1]	6	9	7	7	4	5	7	8
Genera [2]	18	22	14(4)	18	6	9(1)	17	11(3)
Species [3]	32	41	20(4)	28	6	13(1)	28	15(3)

[1] Excluding Penaeidae, Hippolytidae (except *Barbouria*), Porcellanidae, Portunidae, and Xanthidae.
[2] Excluding families indicated by "1," and *Aratus*, *Cyclograpsus*, *Grapsus*, *Metasesarma*, *Pachygrapsus*, and *Plagusia*.
[3] Excluding families and genera indicated by "1" and "2" and *Sesarma hanseni* and *S. ricordi*.
[4] Excluding Trinidad.

The numbers of *freshwater* taxa of West Indian decapods are distributed as follows (numbers in parentheses indicate, in addition, genera or species that are probably there but have not been reported):

	Jamaica	Cuba	Hispaniola	Puerto Rico	Bermudas	Bahamas	Lesser Antilles [1]	Trinidad
Families	3	5	4	4	0	2	4	5
Genera	10	13	7(4)	10	0	2	9	6
Species	20	27	12(4)	16	0	3	15	9

[1] Excluding Trinidad.

Ecological Discussion

The majority of the West Indian freshwater and terrestrial decapod crustaceans are known to be tolerant of salinities approaching that of sea water, many actually invading the ocean or having larval stages that typically occur in the sea. In sharp contrast are a number of freshwater forms that are endemic on one or more of the islands. While perhaps no broad classification can adequately depict the ecological distribution of this assemblage of crustaceans, that presented herein represents an attempt to group those species living in broadly similar habitats and requiring, insofar as known, similar ecological conditions for their larval and juvenile development.

In spite of the fact that some of the distinctions suggested are not respected by all of the species listed, the assignments are made with some degree of confidence, particularly for those species occurring on Dominica; that is, that the animals do indeed exist in the habitats

designated. We anticipate, however, that the ecological tolerances of some of them may exceed the limitations indicated.

A few of the specific names relegated to a particular category are preceded by a question mark, indicating that we are not certain that the species in question actually should be so categorized, and a few species, for which no ecological data are available, have been omitted from the list. In some instances, the assignments are made on such meager data that it is suspected that certain names should perhaps be included in more than one category, as indeed *Procambarus cubensis cubensis* has been (IVA, 2 and 3).

This ecological classification of the West Indian species is as follows:

I. Typically marine species that do not, or rarely, enter fresh water

A. Climbing on rocks or sea walls above water level

Grapsus grapsus
Plagusia depressa

B. Occurring under and among rocks and debris on beaches

Petrolisthes quadratus
Geograpsus lividus
?Pachygrapsus corrugatus
Pachygrapsus transversus
Cyclograpsus integer
Sesarma ricordi

C. Burrowing in marshes or low-lying land (M); along muddy banks of estuaries (B); or in mangrove swamps (S)

Eurytium limosum (B, S)
Panopeus herbstii (B, S)
Goniopsis cruentata (M, B, S)
Pachygrapsus gracilis (B, S)
Aratus pisonii (B, S)
?Metasesarma rubripes (M)
?Sesarma miersii (B, S)
Sesarma curacaoense (B, S)
Uca burgersi (M)
Uca cumulanta (M)
Uca leptodactyla (M)
Uca major (M)
Uca rapax (M)
Uca speciosa (M)
Uca thayeri (M)
Uca vocator (M)
Ucides cordatus (M, B)

II. Typically marine species that invade estuarine habitats

Penaeus aztecus subtilis
Penaeus brasiliensis
Penaeus duorarum notialis
Penaeus schmitti
Xiphopeneus kroyeri
Callinectes bocourti
Callinectes danae
Callinectes exasperatus
Callinectes marginatus
Callinectes ornatus
Callinectes sapidus

III. Typically freshwater species that invade marine habitats or have, or probably have, marine larvae

Atya innocous
?Atya lanipes
Atya scabra
Jonga serrei
Micratya poeyi
Potimirim americana
Potimirim glabra
Potimirim mexicana
Xiphocaris elongata
Macrobrachium acanthurus
Macrobrachium carcinus
Macrobrachium crenulatum
Macrobrachium faustinum
Macrobrachium heterochirus
Macrobrachium jelskii
Palaemon pandaliformis
?Glyptograpsus jamaicensis
?Sesarma americanum
Sesarma rectum
Sesarma roberti

IV. Typically freshwater species that complete their life cycles in fresh water and seldom, or never, invade marine habitats

A. Epigean

1. Living in bromeliads

Metopaulias depressus

2. Frequenting lakes and ponds

Procambarus cubensis cubensis *Guinotia dentata*

3. Frequenting streams

Procambarus atkinsoni *Epilobocera sinuatifrons*
Procambarus cubensis cubensis *Guinotia dentata*
Procambarus cubensis rivalis *Guinotia garmani garmani*
Epilobocera armata *Pseudothelphusa affinis*
Epilobocera cubensis *Pseudothelphusa americana*
Epilobocera gertraudae *Pseudothelphusa terrestris*
Epilobocera gilmanii *Trichodactylus dentatus*
?Epilobocera granulata *Sesarma bidentatum*
Epilobocera haytensis *Sesarma jarvisi*

B. Subterranean

Typhlatya garciai *Troglocubanus inermis*
Typhlatya monae *Troglocubanus jamaicensis*
Troglocubanus calcis *Procambarus niveus*
Troglocubanus eigenmanni *Sesarma verleyi*
Troglocubanus gibarensis

V. Typically terrestrial species that have marine larvae

A. Living in gastropod shells

Coenobita clypeatus

B. Burrowing on sandy beaches

Ocypode quadrata

C. Burrowing in coastal or subcoastal areas

Sesarma jarvisi *Gecarcinus lateralis*
Cardisoma guanhumi *Gecarcinus ruricola*
Gecarcinus lagostoma

VI. Restricted to landlocked brackish or salt water pools

Barbouria cubensis

VII. Epigean species that enter caves

Potimirim americana *Epilobocera sinuatifrons*
Xiphocaris elongata *Sesarma bidentatum*
Macrobrachium carcinus *Cardisoma guanhumi*
Macrobrachium faustinum

Since all of the West Indian decapods that are known to occur above the high-tide line are treated here, a number of strictly marine forms are unavoidably included. In the rock-strewn littoral zone of the sea, particularly in the vicinity of cliffs, *Grapsus grapsus* is frequently seen perched on the tops or sides of boulders protruding above the water line. In company with this species in such habitats and on sea walls, *Plagusia depressa* frequently emerges from the water but remains relatively close to the tide line.

Along cobble or rocky beaches (pl. 3A and B), *Geograpsus lividus* and *Cyclograpsus integer* are common, and in some areas *Petrolisthes quadratus* occurs among the rocks that are partially embedded in the

wet sand. Both *Pachygrapsus corrugatus* and *P. transversus* live along rocky shore lines and on encrusted pilings near the tide line. Even where there are comparatively few rocks, *Geograpsus* may seek cover under various sorts of debris, its preferred habitat (see Hartnoll, 1965), that receives spray from breaking waves during high tides.

In low-lying areas (pl. 4A), subject to at least occasional flooding during high tides, *Goniopsis cruentata*, the members of the genus *Uca*, and *Ucides cordatus* dig comparatively shallow burrows that reach the water table. During the day, all three species may be seen near the mouths of their burrows. When the latter two are disturbed, they quickly scurry into the excavations they have made. The usually less-abundant *Goniopsis*, however, apparently wanders farther from its burrows and, when disturbed, may race across the mud flat or seek shelter in clumps of vegetation, piles of debris, or among root tangles of nearby trees.

Among the more aquatic marine forms that venture above the high-tide line are those that live on or dig burrows in the muddy banks of estuaries and some that are characteristic inhabitants of mangrove thickets. While *Aratus pisonii* is not limited to a mangrove habitat, it is so frequently found climbing about the emergent portions of these trees that it has been designated the "mangrove crab" or "tree crab." Also frequenting the lower strata of the mangrove thickets are *Eurytium limosum*, *Panopeus herbstii*, *Goniopsis cruentata*, *Pachygrapsus gracilis*, *Sesarma miersii*, and *S. curacaoense*. The latter three, however, apparently are equally as much at home on the muddy banks of estuaries, where they are associated with litter or concealed in shallow burrows. While members of the genus *Uca* are often associated with these crabs along estuaries, larger colonies usually occur in tidal or mud flats. *Sesarma ricordi* lives among rocks and litter and sometimes wanders 100 or more yards inland (see Hartnoll, 1965).

A number of decapods in the West Indies are usually more abundant in marine habitats but invade estuaries and the lower reaches of streams; seldom, unless stranded, do they leave the water. Among these are the young of the commercial shrimp belonging to the genus *Penaeus*. Most of these shrimps undergo at least a part of their post-larval development in estuarine and even fresh waters. (On Dominica, no penaeids were observed in any of the streams, perhaps because most of our observations were made during the late winter and very early spring when the young have returned to the sea.) The swimming crabs of the genus *Callinectes* frequent most estuarine habitats and occasionally wander into fresh water. On Dominica, *C. bocourti* was found only in the polluted estuaries of two streams, and one was found in a shallow pool, apparently stranded, on a mud flat.

Of the species that are characteristic of fresh water but which invade the sea or have marine larvae, some are restricted to the comparatively sluggish waters near the mouths of streams (pl. 2B). *Jonga serrei* and *Macrobrachium acanthurus* occur in estuarine or subestuarine habitats. They are definitely tolerant of fresh water but are found to be progressively less abundant as the stream gradient increases, and on Dominica neither was found above 150 feet elevation. On that island, both are absent in those streams that reach the coast with their beds above the high tide level (pl. 2A). *Macrobrachium acanthurus* is most abundant on Dominica in sluggish streams that flow over a muddy bottom.

Juveniles of most of the remaining species, in their migrations upstream, may be found in a wide variety of habitats, but the adults seem, for the most part, to be somewhat selective in sharing the stream beds with other species. At high elevations on Dominica, *Atya innocous* shares the streams with *Guinotia dentata*, and, while it is obviously the dominant element and in some streams the sole element of the decapod fauna at altitudes above 2,500 feet, it also occurs throughout most of the streams on the island, becoming less abundant as the size of the rivers increases. Typically, it is an inhabitant of cascading waters where it is numerous in small pools and among rocks.

Below about 2,500 feet, *A. innocous* is joined by *Macrobrachium heterochirus*, which seems to be confined to riffle areas, a habitat in which it occurs almost to sea level. *Macrobrachium carcinus* ascends the streams to about 2,000 feet, and it lives in pools or under large stones in the larger rivers. In subestuarine habitats, it seeks shelter among the littoral debris. Below about 1,300 feet, *Micratya poeyi*, *Potimirim glabra*, and *M. crenulatum* join the former three, sharing the stream bed with them almost to sea level. *Macrobrachium crenulatum* inhabits pools in the smaller streams and seeks the comparatively quiet, littoral portions of shallow riffles in the larger streams. Both *Micratya* and *Potimirim* are riffle dwellers but occasionally may be found among rocks at the edges of pools. *Xiphocaris elongata* occurs from elevations of approximately 1,200 feet to sea level. Adults usually inhabit pools although they do not hesitate to move through the swiftest currents; in contrast, the young seek the margins of streams where the current is not so swift, and they occur in numbers in pools at lower elevations. On Dominica, no adults were observed below 150 to 200 foot elevations. Below 500 feet, *Atya scabra* and *Macrobrachium faustinum* join the stream fauna. The former frequents cascading reaches of small streams while the latter is largely confined to quieter waters of pools and protected littoral areas of larger streams. *Macrobrachium faustinum* invades the subestuarine habitats in which *M. acanthurus* and *Jonga* abound.

Macrobrachium jelskii and *Palaemon pandaliformis* were not found on Dominica, but elsewhere in the Antilles they occur in habitats similar to those of *Jonga serrei* and *M. acanthurus*. On other islands having larger rivers or streams with a low gradient, all four range much farther inland than do the latter two on Dominica. The habitat of *Glyptograpsus* is not known except that it was found in "fresh water" on Jamaica. Hartnoll (1965) did not encounter it during his studies of the grapsid crabs of that island.

Of the three species of the genus *Sesarma* herein classified as "freshwater species that invade marine habitats," ecological data are available for only *S. roberti*. Hartnoll (1965) presented an excellent, but brief, account of this species (= his *S. angustipes*) on Jamaica. On Dominica, this crab ranges upstream for a distance of at least two miles, where it even invades seepage areas.

There are 28 decapods in the Antilles that are believed to complete their life cycles in fresh water. Among them is the Jamaican *Metapaulias depressus*, which frequents bromeliads. This decapod is one of few that invade aerial habitats and is the only one known to be so restricted. On Jamaica it lives at elevations of 800 to 2,700 feet (Hartnoll, 1964; see also Laessle, 1961) and surpasses adaptations made by other crabs that frequent trees in that it completes its life cycle well above the surface of the ground.

Although freshwater lakes are comparatively rare in the Antilles and few have been examined for their decapod fauna, Boeri Lake—and probably Freshwater Lake—on Dominica is inhabited by *Guinotia dentata*. Freshwater swamps and pools on Cuba are frequented by the crayfish *Procambarus cubensis cubensis*, which is by no means confined to such habitats but also lives in many of the smaller streams on the island and on Isla de Pinos.

Among the stream inhabitants in the West Indies are both crayfishes belonging to the genus *Procambarus* (Cuba and Isla de Pinos) and crabs belonging to the genera *Epilobocera* (Cuba, Isla de Pinos, Hispaniola, Puerto Rico, and Saint Croix), *Guinotia* (Lesser Antilles), *Pseudothelphusa* (Cuba and Hispaniola), *Trichodactylus* (Trinidad), and *Sesarma bidentatum* (Jamaica). Little is known of the ecological distribution of most of these species, and data for *Epilobocera granulata* are totally lacking. Since all other members of the genera *Epilobocera*, *Guinotia*, and *Trichodactylus* occur in fresh water, this species also is assumed to do so. Furthermore, it is suspected that all of these occur in or in the immediate vicinity of streams. Hartnoll (1964) indicated that *Sesarma bidentatum* occurs on Jamaica at altitudes of 1,200 to 4,500 feet and is present in several river systems, where it frequents the clear waters of very small streams, small rivers, and even a stream flowing through a cave. This crab was found in pools and shallow

burrows, and at night some of the animals move to land at the water's edge.

While a number of usually epigean species occur in caves, only nine of the West Indian decapods have become so completely adapted to cave life that they probably are unable to exist elsewhere. Six of these troglobites occur on Cuba, *Typhlatya garciai, Troglocubanus calcis, T. eigenmanni, T. gibarensis, T. inermis,* and *Procambarus niveus;* one on Mona Island and Barbuda, *Typhlatya monae;* and two on Jamaica, *Troglocubanus jamaicensis* and *Sesarma verleyi.* The latter, insofar as known, is restricted to a cave environment on Jamaica (Hartnoll, 1964, p. 164). It is "pale bluish white" in color, its integument is thin, its legs longer than other West Indian species of the genus, and its eyes are markedly reduced but pigmented. It was found by Hartnoll "about 60 ft. below ground level [in] a slowly running stream with areas of finely silted bottom . . . [and] under stones in a damp area some distance from the water." In another cave he found this crab in a "wide, slow-moving river with muddy banks and bottom . . . [as well as] on the banks." Although all of these animals occur in caves, except for *S. verleyi,* details of their habitats have not been well documented.

Among the usually epigean species reported from caves are *Potimirim mexicana, Macrobrachium carcinus, M. faustinum, Epilobocera sinuatifrons,* and *Cardisoma guanhumi* (see Nicholas, 1966) and *Sesarma bidentatum* (see Hartnoll, 1964). Brother Nicholas found these decapods in caves on Puerto Rico where he also collected *Xiphocaris elongata* (in litt.). He has also indicated to us that *Macrobrachium carcinus* at times of flood was reported to him to occur in numbers in pools along Rio Camuy, presumably having been washed out of underground passages connected with Empalme Sinkhole. An unidentified member of the genus *Macrobrachium* was collected along with the troglobitic *Typhlatya monae* from a catchment basin on Mona Island.

Perhaps the most completely terrestrial decapod in the Antilles is the hermit crab, *Coenobita clypeatus,* which ranges from sea level up to 1,300 feet on Dominica. Only one very small juvenile was found in water during the period when observations were being made on that island. *Ocypode quadrata* is largely confined to sandy beaches above the high-tide line, but one juvenile specimen was collected almost two miles from the coast along a freshwater stream on Dominica. The most conspicuous element of the terrestrial decapod fauna during most of the year is *Cardisoma guanhumi.* Thousands of these crabs may be observed in the lower flood plains of rivers and in low-lying land, apparently resting but alert, near the mouths of their burrows, many, if not all, of which penetrate the water table. After dark,

large individuals frequently wander some distance from their lairs. At Tarou Cliffs (pl. 3B), numbers of young *Cardisoma* and *Gecarcinus lateralis* were found in shallow "dry" burrows along the shaded, northern talus slope. The three species of the genus *Gecarcinus* usually seek higher ground than does *C. guanhumi* but apparently do not travel as far inland as *Coenobita.* During the breeding season, they often move in large groups toward the sea.

One of the most unusual decapods in the Antilles is the endemic Cuban *Barbouria cubensis,* which frequents landlocked brackish or salt water pools.

It is obvious from the foregoing discussion that little is known of the habits and life histories of most of the freshwater and terrestrial decapods of the West Indies. Except for the careful studies of Hartnoll (1964 and 1965), Laessle (1961), and the limited observations made on the Dominican fauna recorded herein, all data are exceedingly cursory.

On Dominica (and, we suspect, on most of the smaller islands of the Antilles), ecological factors seem to have played a far more important role in the distribution of its decapod fauna than has topography. There, whether on the windward or the leeward slopes, where a particular type of habitat exists, the same assemblage of decapods was found to be present. (For example, all of the typically freshwater decapods reported from the island occur in the Layou River System.) Whereas on most continental land masses and on many larger islands species are limited in their distribution by physical barriers of one sort or another, this does not appear evident on Dominica. Despite the rugged topography, the numerous (at least 365) streams that have cut deep valleys and the relatively xeric habitats that separate the lower portions of some of the streams, barriers to the decapods if they ever existed, are no longer effective. A number of factors have made possible the crossing of potential barriers by all of the decapods present on the island:

1. In the sense that terrestrial organisms are not dependent on water except that taken internally, truly terrestrial decapods do not exist; all of them must have at least a film of water covering their branchial surfaces, and this water is acquired directly from the environment. In an atmosphere of such high humidity as that on Dominica, enhanced by frequent precipitation, such decapods as *Coenobita clypeatus* and the two species of the genus *Gecarcinus* can exist for weeks or months without having to return to standing water. Furthermore, while they are not characteristically found in bodies of fresh water, such streams as do exist on Dominica would hardly present a formidable barrier to them. Inasmuch as the so-called terrestrial crabs have marine larval stages, even if the lower reaches

of rivers should serve as barriers to the adults, the young crabs could come ashore between the mouths of most of the rivers on the island.

2. As is true for the terrestrial species, all of the freshwater decapods on Dominica except *Guinotia dentata* have or are believed to have larval stages that require a marine habitat; consequently, as larvae they can move or be transported by tides and currents around the entire island, which enables the young or late larvae to gain access to all of the streams.

3. The single decapod on Dominica that is known to complete its life cycle in and around freshwater is *Guinotia dentata.* This crab is almost as much at home in seepage areas as it is in streams, and often individuals have been observed several hundred yards from the nearest stream. With an annual rainfall of up to 400 inches on the windward slopes of the island and with the habit of this crab to wander over land, all parts of the island, except a few semixeric areas such as the Grand Savane, are accessible to this species. Even those streams flowing through the Savane have their headwaters on the forested mountainous slopes where the crabs could safely wander from one brook to another.

Although there is no necessity for postulating that stream piracy has been effective in the spread of the decapod fauna on Dominica, undoubtedly it has occurred repeatedly.

Hodge (1954), in his treatment of the flora of Dominica, presented an excellent summary of the physiography, geology, soils, and climate of the island and proposed a classification of the plant communities. For the most part, however, the decapods do not appear to be aware of the boundaries between these communities and several species invade all except the "Elfin Woodland." With one possible exception, none of the species on the island is limited to any one of Hodge's communities. *Callinectes bocourti* has been found only in the lowermost portions of two streams in the "Dry-Scrub Woodlands," but it is highly probable that this species occurs in some of the estuarine habitats along the northeast coast as well as in the Portsmouth area. Where there are streams or low-lying lands, regardless of the plant communities of the area, one or more decapods are almost certainly present.

Figure 3 depicts the major habitats of the Dominican decapods treated herein and will perhaps be helpful for the reader in visualizing the classification that follows. Basically, three types of decapod habitats exist on Dominica:

MARINE HABITATS.—Despite the steepness of the submarine shore, along many stretches of the coast boulders have eroded from the cliffs and have fallen into the water, some with parts protruding above the surface. These along with the man-made sea walls enable at

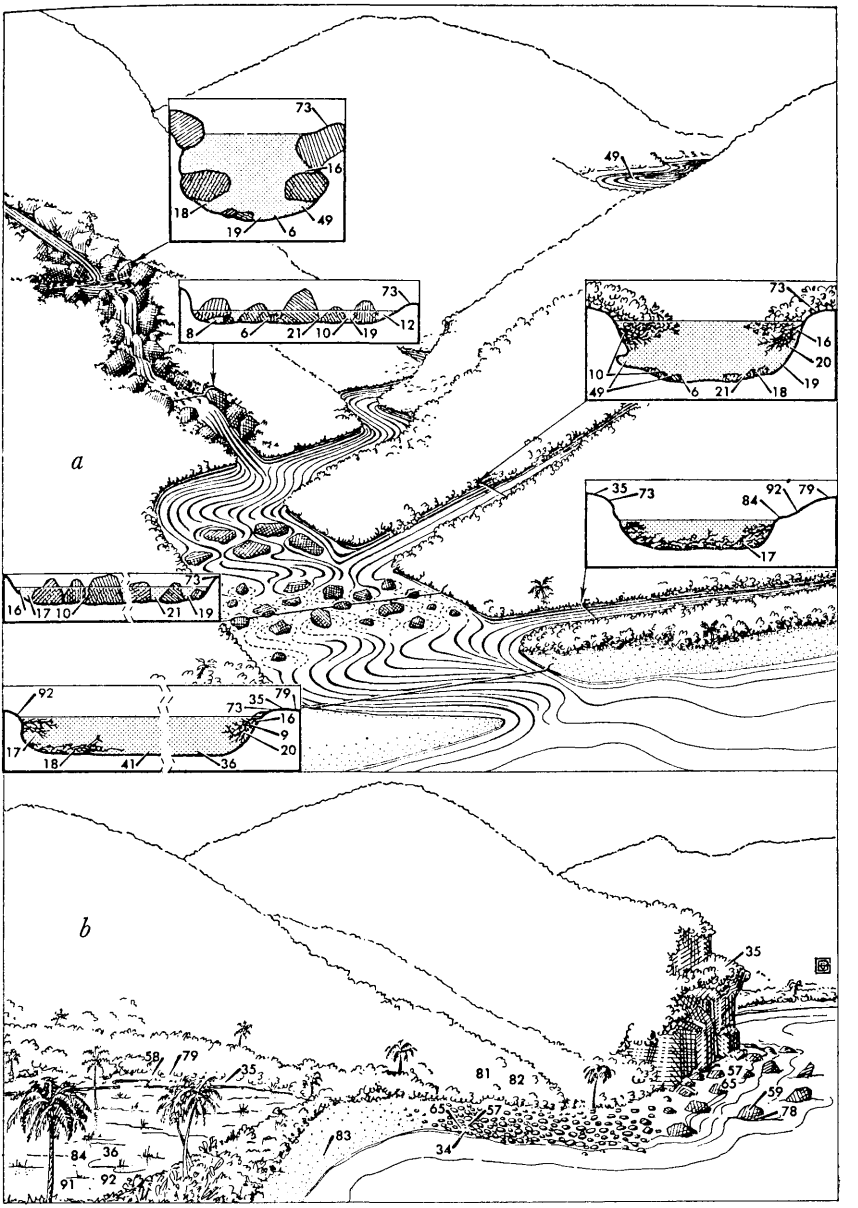


FIGURE 3.—A stylized representation of the major decapod habitats on Dominica (species inhabiting them are indicated by numbers; see "List of Species," p. 4): *a*, a river rising in a mountain lake (upper right) and receiving tributaries with a steep gradient (upper left), a moderate gradient (middle right), and a low gradient (lower right), with its mouth opening into the sea (right of middle foreground) [insets are sections through streambeds at level indicated]; *b*, lentic, shoreline, and terrestrial habitats with a mudflat (lower left) a sandy beach, a cobble beach, and a rocky beach with partially submerged boulders (below cliffs).

least two marine crabs to spend much of the time above the high-tide line.

TERRESTRIAL HABITATS.—Many of the beaches are studded with water-worn rocks and entrapped debris (pl. 3A and B). Such areas are the haunts of other crabs. Yet another crab is restricted largely to the sandy beaches, where it digs shallow burrows in the exposed sand. In the lower floodplains of rivers (pl. 4B) and on low, poorly drained land, including a few mud flats (pl. 4A) and swamps, a different assemblage of crabs excavate their burrows.

FRESHWATER HABITATS.—Probably nowhere else in the Caribbean area does there exist an island with so many comparatively unpolluted and little man-altered streams as occur on Dominica. The rugged terrain has discouraged the agricultural development that has almost denuded some of the West Indian islands, and the high annual rainfall keeps most of the stream beds flushed of garbage and other debris. Only in the leeward coastal regions, where villages and the two major ports, Roseau and Portsmouth, are densely populated, and along the north coast are some of the streams obviously polluted. The lower reaches of many of the sluggish streams on these coasts are cloudy and frequently carry a heavy load of detergents. Elsewhere, with few exceptions, the waters are clear, except after heavy rains, flowing with a swift to moderate current even in the "dry season." (With an annual rainfall as great as occurs on Dominica, perhaps one should refer to it as the "comparatively dry season.") The largest river on the island, the Layou, is usually clear from its headwaters to its mouth, and what pollution it receives along its course is scarcely evident at the coastal village of Layou. Probably responsible for the many clear streams is the combination of the steep gradient of the beds (pl. 1; see also Mitchell, 1966, pp. 90–91), the large volumes of water carried by them, and, of considerable importance, the cascades and riffles that maintain a near-saturation of the water with oxygen.[1]

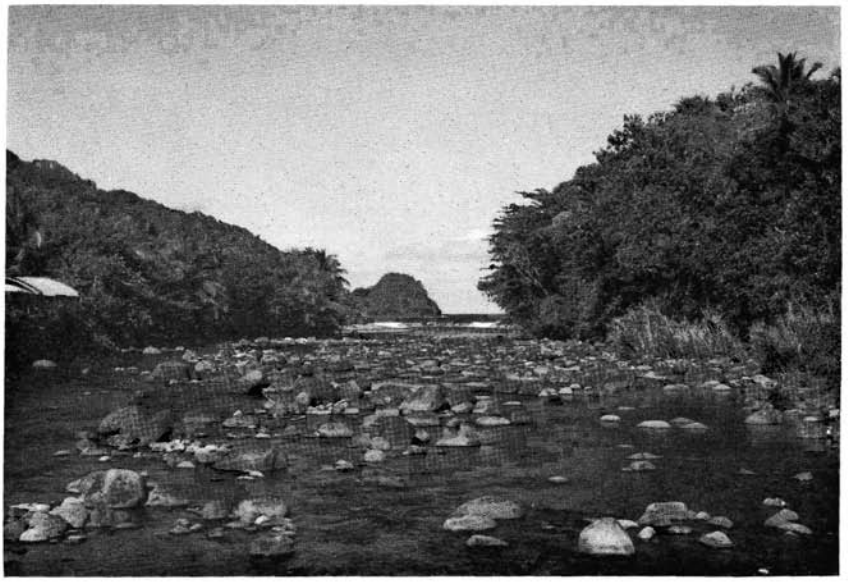
Although most of the Dominican streams are permanent, a few of them are temporary, ceasing to flow or becoming dry, particularly during the winter months. Even though the decapods disappear when the stream beds do become dry, they reappear quickly when the water begins to flow again. Probably those areas that become dry actually have headwaters where water exists in reduced quantities all year, but when there is comparatively little rain, the water percolates through the soil before reaching the mouth. With increased volume of water, the bed is refilled and drains to the sea, thus enabling decapods in the headwaters, and perhaps some from the sea, to reinvade the newly filled beds.

[1] C. W. and D. G. Hart are preparing a report on the physical and chemical characteristics of representative lakes and streams on Dominica.

A small tributary to the Castle Bruce River between the mouths of the Raymond Stone and Fond Figues rivers (station 69), a habitat in which *Atya innocous* constitutes the dominant element of the decapod fauna. The stream is very similar to Manne's Gutter, the fauna of which is discussed on pages 43 and 97. (Photo courtesy C. W. Hart, Jr.)

A. Mouth of the Rosalee River (station 22), one of the larger rivers on Dominica that flows over riffles almost to its mouth. Such river mouths support a decapod fauna that is characteristic of riffle areas elsewhere, and they lack such species as *Jonga serrei* and *Macrobrachium acanthurus*, which are associated with the subestuarine habitat of the mouths of rivers like the Layou (B). One of the densest populations of *Coenobita clypeatus* observed on the island occurred on the south side (right) of the mouth of this river; hundreds of them were feeding there on the fruit of *Terminalia catappa*. (Photo courtesy C. W. Hart, Jr.)

B. Mouth of the Layou River (stations 14 and 15). Note the sand bar that deflects the channel to the left (south). This area of the river is inhabited by *Jonga serrei*, juvenile *Xiphocaris elongata*, *Macrobrachium acanthurus*, *M. carcinus*, *M. faustinum*, and *Callinectes sapidus*, all of which seek shelter in the exposed roots of shoreline plants and in the debris trapped by roots and trunks of fallen trees. Only at night do *M. carcinus* and *C. sapidus* move far from shore over the sandy bottom. Occupying the adjoining floodplain and banks of the river are *Coenobita clypeatus*, *Sesarma roberti*, *Cardisoma guanhumi*, *Uca burgersi*, and *Ucides cordatus*. On the sandy beach at the mouth of the river, *Ocypode quadrata* is common. (Hobbs' photo.)



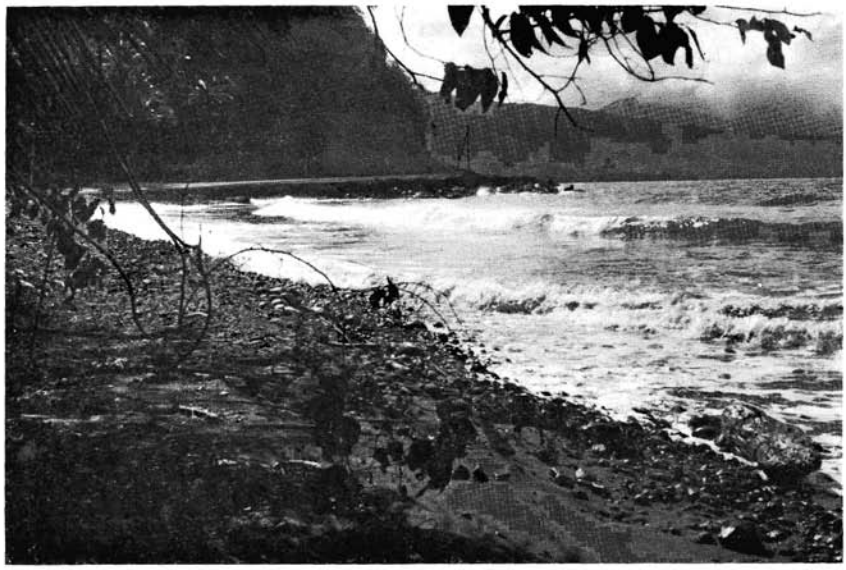
A

B

A. Cobble beach along the southern side of the isthmus at Scotts Head (station 110), where *Petrolisthes quadratus*, *Geograpsus lividus*, and *Cyclograpsus integer* are exceedingly common. (Hobbs' photo.)

B. Tarou Cliffs (southern portion of station 6) and Morne Anglais (largely covered by clouds) in the distance. The young of *Cardisoma guanhumi* and *Gecarcinus lateralis* were found in abundance on the talus slopes of the cliffs (upper left). *Petrolisthes quadratus*, *Geograpsus lividus*, *Grapsus grapsus*, and *Cyclograpsus integer* occur along the rocky shore at the foot of the cliffs. (Hobbs' photo.)

A



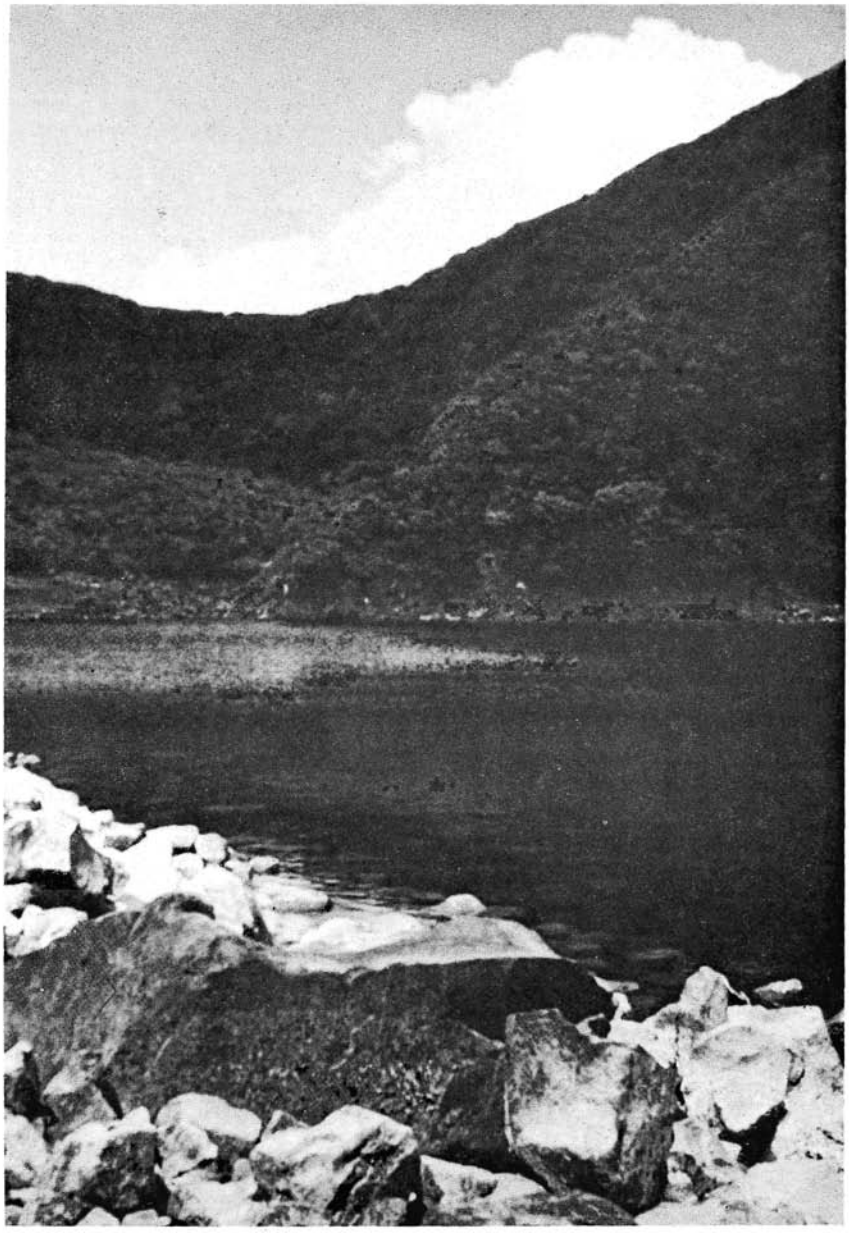
B

A. Mud flat at Portsmouth (station 112) adjoining the Indian River. *Pterocarpus officinalis* (right foreground), *Montrichardia arborescens* (right middleground), and the fern *Acrostichum daneaefolium* (left foreground and background) are among the most conspicuous elements of the flora. *Goniopsis cruentata*, at least two species of the genus *Uca*, and *Ucides cordatus* constitute the dominant components of the decaped fauna. *Callinectes bocourti* occurs in the water, and *Sesarma miersii* (?) and *Cardisoma guanhumi* inhabit the margins of the flat. (Hobbs' photo.)

B. Floodplain at the mouth of the Layou River (station 6) planted in coconuts and bananas. The better drained areas (foreground) support large colonies of *Cardisoma guanhumi*, and populations of *Uca burgersi* and *Ucides cordatus* occupy the wetter portions; *Coenobita clypeatus* and *Sesarma roberti* also are found here in abundance. (Hobbs' photo.)

A

B



Boeri Lake (station 130) where only a single decapod, *Guinotia dentata*, was found. (Hobbs' photo.)

All of the streams on the island are subject to torrential floods, and the water level in some of them, such as the Layou River, may rise 6 to 10 feet within a few hours. With the steepness of the gradients, the streams just as quickly return to their more usual levels.

From the standpoint of their decapod faunas, three types of permanent streams are recognizable on Dominica: (1) those in which the gradient is steep from source almost to mouth, usually with clear water, and without estuarine or subestuarine development—examples include the Belfast River, stations 7, 18, 118, 123, and the Rosalie River (pl. 2A), stations 19, 20, 21, 22, 122; (2) those in which the gradient is steep but with the lower stream bed well below sea level, usually with clear water—examples include the Layou River (pl. 2B), stations 13, 14, 15, and the Castle Bruce River, stations 66, 67, 68, 69, 127; (3) those in which the gradient is more gradual, with the lower stream bed below sea level, subestuarine, usually with cloudy water—examples include the Mero River, stations 38, 44, and the Salisbury River, Stations 37, 107 (essentially similar to the stream pictured by Mitchell, 1966, pp. 86–87).

The faunas of the three river-types differ chiefly in the lowermost portions. Those above the first riffle area in all of the permanent streams are almost identical.

There are three lakes on Dominica—Boeri, Boiling, and Freshwater—all located in the south-central part of the island. It is improbable that any decapods exist in Boiling Lake; none were found in Freshwater Lake; and only the crab *Guinotia dentata* is known to occur in Boeri Lake (pl. 5).

A number of hours were spent in observing the decapod fauna of a small pool, approximately 4 feet wide, 10 feet long, and with a maximum depth of 2 feet, on Mannet's Gutter, a mountain tributary of the Layou River on the Clarke Hall Estate in Dominica. Here, at an altitude of some 350 feet, the stream has cut a deep V-shaped valley, and boulders from the eroded walls have fallen into the stream bed, deflecting the current or obstructing the flow so that pools are interspersed between cascades and riffle areas. Except after heavy rains the water is clear, flowing over a rocky, sandy bottom overlain in the pools with a shallow layer of silt. Many of the larger trees along the 45 to 80 degree slopes have been cut and bananas have been planted between the felled trunks; as a result, during a short period in the day, the time depending upon the orientation of the adjacent slopes, full sunlight reaches the stream bed. Marginal shrubs do inhibit direct light from reaching portions of the stream. The pool referred to here received sunlight for about two hours before noon in mid-March.

The macroscopic fauna of the pool consisted of what the observer believed to be a single species of gobioid fish scarcely exceeding

317-180—69——5

40 mm in length; two atyid shrimps, *Atya innocous* and *Xiphocaris elongata;* two palaemonid shrimps, *Macrobrachium carcinus* and *M. crenulatum;* and a crab, *Guinotia dentata.* No other animals were observed. There were 1 crab, 2 *M. carcinus*, 12–15 *A. innocous*, about the same number of *M. crenulatum*, 20–25 *Xiphocaris elongata*, and approximately the same number of fish.

When the pool was first approached by observers, the fish and *X. elongata* were "resting" on the stones at the sides and bottom of the pool, only swimming occasionally for a centimeter or so to take another position on a rock. The crab was not in sight, and only the chelae of the smaller of the two *M. carcinus* could be seen protruding from beneath one of the larger rocks. In contrast, the individuals of *A. innocous* and the smaller *M. crenulatum* were scurrying back and forth across the bottom of the pool, disappearing beneath a stone and reappearing shortly thereafter. *Atya innocous* was by far the most active. Of the three or four large individuals of *M. crenulatum*, two were in view but were not moving about, and the others were concealed somewhere among the stones. Except for the almost incessant wanderings of *A. innocous* and the smaller *M. crenulatum*, there was little activity.

When an earthworm, suspended on a string, was gently lowered into the water, however, a chain reaction was initiated that set the entire population of the pool in motion. The smaller individuals of *M. crenulatum* were the first to show an awareness of the presence of the worm. Although apparently they did not see it, the rate of their random walking increased tremendously, perhaps best described as "frantic," causing them to collide with one another and with the other inhabitants; *A. innocous* joined them, the larger *M. crenulatum* began moving back and forth, and *X. elongata* left the stones on which they had been comparatively still and swam about the pool. The frenzied motion disturbed the fish and they, too, began to shift their positions on the rocks. When one of the smaller *M. crenulatum* finally located the position of the worm, the shrimp left the bottom, swam to the worm, grasped it with its chelae, and attempted to swim away with the worm. When this attempt failed, the shrimp used its abdomen to give a rapid series of strong tugs. This motion apparently attracted the attention of almost all of the shrimps in the pool. One of the larger *M. crenulatum* swam toward the worm as the smaller ones backed away, and when it had stripped the worm from the string, the shrimp sank to the bottom of the pool and scurried for the nearest cover. By this time, both individuals of *M. carcinus* had moved into the open water of the pool, and as the larger one moved about, all of the other shrimps retreated from its path, remaining beyond reach of the large chelipeds. While the commotion was going on, the crab slowly crawled from under the largest rock at the side

of the pool, and all of the occupants, including the previously dominant *M. carcinus* gave wide clearance to the newcomer. A short time after the shrimp with the worm had found cover and presumably had devoured it, the crab crawled back into its lair, the large *M. carcinus* moved into crevices, and the remainder of the population returned to its original state. A second worm introduced into the pool resulted in a similar turmoil, but this worm was successfully acquired by one of the young *M. crenulatum*, which quickly swam to the shallow down-stream end of the pool and crawled beneath a stone. Repeated introductions of worms into the pool elicited comparable responses.

Similar observations were made in other pools on several occasions, and it seems highly probable that all of the shrimps respect the crab, that the dominant shrimp in the pool is the largest *M. carcinus* inhabiting it, and that the size of the individual *M. carcinus* determines its rank in the hierarchy. Even the largest *M. crenulatum* with heavier chelipeds gives way to *M. carcinus* that are scarcely larger. In turn, the smaller *M. crenulatum* and *A. innocous* respect the larger *M. crenulatum* but join with *X. elongata* in hesitantly approaching the more dominant members of the pool, darting away when challenged. *Xiphocaris elongata*, *A. innocous*, and juvenile *M. crenulatum* seem able to vie with one another although *X. elongata* backs away from all except the smallest *M. crenulatum* and *A. innocous*.

Local Importance of Dominican Species

Of the freshwater and terrestrial decapod crustaceans utilized directly for food, perhaps none are so generally exploited as the two species of the genus *Gecarcinus*. Since most of the Dominicans make no distinction between them, they are equally acceptable for recipes ranging from "crab-back" to "calilou soup." Both *G. lateralis* and *G. ruricola* seem definitely to be preferred to *Cardisoma guanhumi* and apparently are more widely available than the latter.

While probably fewer freshwater shrimps, *Macrobrachium*, are used for food than *Gecarcinus*, all five species are eaten. Chiefly, we suspect, because of its larger size, *Macrobrachium carcinus* is favored, but *M. heterochirus* and *M. crenulatum* along with either species of *Atya* are eaten. *Macrobrachium* does provide one advantage over the crabs in that apparently its availability is not seasonal.

Following a dry spell (during the latter part of March and early April), when the rains first begin to fall or, better still, on the first evening after a good rain, the crabs emerge from their burrows and wander up and down hill. On such an evening, groups of children and adults of both sexes carry gunny sacks and torches and walk through cleared areas searching for crabs; especially productive are the roadside ditches along the coast. In a single evening, dozens of crabs

have been seen crossing the road between the mouth of the Layou River and the town of Roseau. They are especially common along the foot of the cliffs just south of the mouth of the Layou and just north of Roseau and in the Cabrits area. If gunny sacks are not available, vines are utilized to bind the chelipeds and walking legs so close to the body that the crabs are immobilized. In such a helpless condition, six or eight of them can be tied together and carried as though they were in shopping bags. Crabs thus restrained are often offered for sale in the open air market in Roseau. Since these crabs wander relatively short distances from the coast, hardly more than two miles, they are not available to those persons who live near the center of the island.

Macrobrachium carcinus is sought in several ways; perhaps the oldest technique involves explorations with the bare hands beneath rocks. It was a continued source of amazement to observe the abilities of men, women, and boys who thrust their hands in spaces beneath stones and withdrew a specimen of *Macrobrachium* or *Atya*. Since the exoskeleton of *Atya innocous* is so smooth that it is very difficult to hold a living individual even out of the water, it must take considerable experience to be able to catch the shrimp with one's bare hands.

A second technique involves tying small pieces of "coconut meat" to strings that are anchored at the shoreline of the rivers, with the coconut resting in shallow water a foot or two away from the shore. These baited lines are left until well after dark. With the aid of a torch or flashlight, the shrimp that have been attracted to the coconut are easily seen and may be caught with one's hands.

At least some of the populace catch their "crayfish" on a hook and line. The equipment is prepared as follows: to one end of a 6-foot line is tied a bent pin (the barb on a fish hook, we are told, keeps the shrimp from accepting the hook), and the other end of the line is tied close to one end of a pole some three feet long. The hooked pin should be baited with either small pieces of shrimp or earthworm, and the point of the hooked pin should be lightly stuck into the same end of the pole to which the line is tied. The opposite end of the pole should be grasped in one hand with the index finger flexed to hook around the now U-shaped slack line approximately midway between its two ends. With the hook thus lightly anchored in the end of the pole, the baited end of the pole can be carefully directed into a crevice or gently thrust beneath a rock (either one a likely hiding place for the shrimp) even in the swifter currents. If the shrimp accepts the bait, detectable by a gentle tug on the index finger hooked around the line, the finger should be extended, thus releasing the line. The pole is slowly withdrawn until the slack has been taken from the line and, within one and one-half minutes, should be drawn firmly but

gently away from the cavity under the rock. If the shrimp has swallowed the pin, then it can be pulled from its lair and placed into a container or on the ground, where the hook can be removed.

A yet more popular method of catching shrimps by the younger set involves the use of a glass face mask and spear gun. In the larger streams where there is sufficient water to enable one to look beneath and between the partially or completely submerged large rocks, the shrimps can often be seen, and where there is room to use a spear gun, they can be easily impaled. Spears with a movable barb and a line affixing the opposite end to the gun are occasionally seen, but more frequently simple shafts of sharply pointed, stiff wire are used by the children, who indiscriminately impale any member of the genus *Macrobrachium* (chiefly *M. carcinus*, *M. heterochirus*, and *M. crenulatum*), *Atya innocous*, and small fishes.

How the shrimps are prepared for consumption has not been carefully pursued. A visitor claimed to have seen a man "peeling" a small *Macrobrachium* and eating it raw. Several Dominicans were asked whether or not these animals were eaten raw, and all persons questioned indicated that never were the shrimps eaten without first being cooked. These crustaceans are usually, if not always, boiled, and are either eaten plain or, after being sautéed in butter, with spices and herbs added. The Dominicans think highly of this delicacy and serve it for breakfast and lunch as the main meat dish or at dinner as a cocktail. As delicious as it is, if it were more plentiful, it might well compete favorably with the frog *Leptodactylus fallax*, which is highly favored and known locally as the "mountain chicken" or Crapaud.

Among those whom we know who have eaten *M. carcinus*, several agree with the junior author that it is delicious and superior to most crustaceans!

The crabs are often treated like the shrimp, simply boiled and eaten without further cooking. In preparing "crab-back," the meat is removed, mixed with seasoning, onions, chives, tomatoes, butter, crumbs, and eggs, packed into the cleaned carapace of the crab, sprinkled with bread crumbs, and baked. This is quite delectable, but most of our acquaintances who know "calilou soup" would prefer to relegate the crab to the latter. This is made by adding coconut milk, boiled crab, seasoning, and dasheen leaves to freshly boiled fat pork or bacon stock. Most persons who have tasted this soup agree that it is one of the tastiest of all of the items in Dominican cookery.

With no figures on the number of the above crustaceans utilized by Dominicans, it is impossible to assess their importance in the total food consumption of the population, but suffice it to say that considerable numbers of crabs and a lesser number of freshwater shrimps are eaten every year.

More difficult to assess are the roles played by the remaining decapods in the economy of the island. Few if any of them are consumed directly, and since their positions in the various food chains are not known, only a guess, hopefully somewhat educated, can be made that at least some of the smaller shrimps add their bit to the fish protein in freshwater and to that at the mouths of the streams.

Most decapods are scavengers to some degree, and while on Dominica the streams are flushed so frequently by run-off after heavy rains that the potential job the shrimp and aquatic crabs might do is somewhat minimized, the scavenger role played by the terrestrial decapods is considerable.

On the negative side of the ledger, it seems improbable that any of the freshwater or terrestrial crabs are destructive or harmful. Perhaps in local areas *Pseudothelphusa* and *Cardisoma* might be a menace to small chickens or the very young of other domesticated animals; no report came to us, however, of their being objectionable—even in an esthetic sense!

Explanation of Measurements

The length of the carapace is measured in the midline from its posterior margin to the level of the posteriormost portion of the orbits in shrimps and crayfishes and to the margin of the front in the crablike forms.

FIGURE 4. (key)

Abd, abdomen
Ant, antennal region
antPd, antennal peduncle
antrPd, antennular peduncle
antSc, antennal scale
antSp, antennal spine
Apd, apodemal pit
Api, appendix interna
Apm, appendix masculina
artK, articular knob
artM, articular membrane
Br, branchial region
brl, branchial lobe
brSp, branchiostegal spine
Bs, basis
Car, carapace
Card, cardiac region
Crn, cornea
Crp, carpus
cvg, cervical groove
Cx, coxa
Dct, dactyl
End, endopod
epBr, epibranchial region
epGst, epigastric lobe
Epst, epistome
Exp, exopod
Eyst, eyestalk
Fgr, finger
Flg, flagellum
Ft, front
Ftl, frontal region
Gst, gastric region
Hep, hepatic region
hepSp, hepatic spine
Int, intestinal region
Isc, ischium
L, walking leg
Md, mandible
Mer, merus
msBr, mesobranchial region
msGst, mesogastric region
mtBr, metabranchial region
mtGst, metagastric region
Mxpd, maxilliped
Orb, orbit
Orbl, orbital region
Plm, palm
Plp, palp
Plpd, pleopod
Plrn, pleuron
prGst, protogastric region
Prop, propodus
Prpd, pereiopod
Prtp, protopodite
Ptrg, pterygostomian region
Ptsm, petasma
R, rostrum
Stlc, stylocerite
Stn, sternite
Tel, telson
Terg, tergum
urGst, urogastric lobe
Urpd, uropod

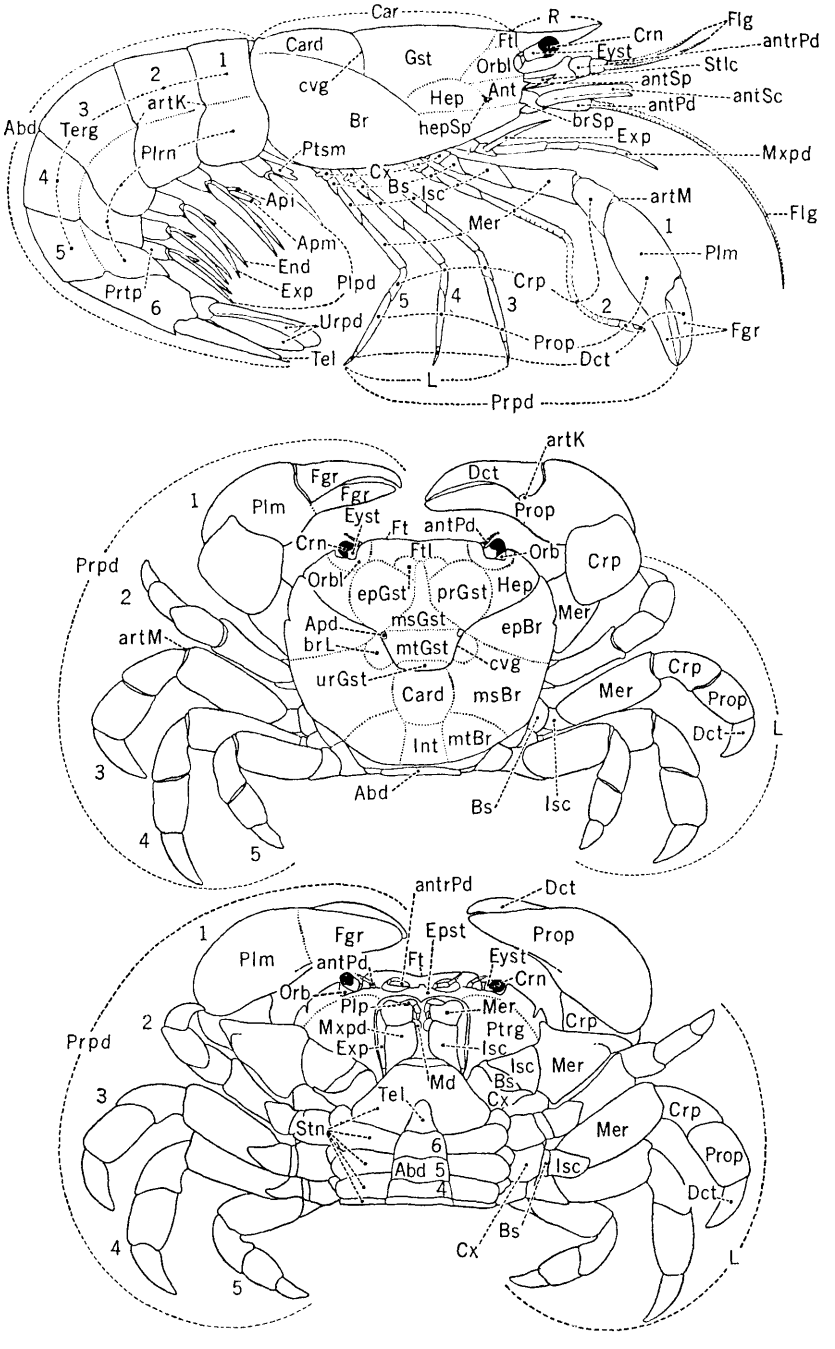


FIGURE 4.—Diagrammatic shrimp (lateral view) and crab (dorsal and ventral views), showing terms used in description (see "Glossary," p. 224).

The width of the carapace is measured in its widest plane at right angles to the midline.

The width of the front is usually measured between its lateral angles; in the fiddler crabs, *Uca*, it is measured between the levels of the posterodistal angles of the proximal segments of the eyestalks.

The fronto-orbital distance is measured from the outer angle of one orbit to the outer angle of the other.

The length of the rostrum is measured in a straight line from its tip to the level of the posteriormost portion of the orbits.

The length of each podomere of the pereiopods is measured along the extensor margin with the appendage fully extended.

The width of each podomere is measured at the widest part.

Key to the Families of West Indian Freshwater and Terrestrial Decapod Crustaceans

1. Both first and second pairs of pereiopods ending in pincers (chelate); shrimp-like or crayfish-like 2
   Second pair of pereiopods not ending in pincers (simple); crablike 6
2. First pair of pereiopods conspicuously longer and more robust than following pairs; first pair of pleopods vestigial (females) or forming exclusively reproductive organs (males), not adapted for swimming; first segment of antennular peduncle without prominent lateral spine or tooth (stylocerite). Crayfishes, fresh water . . . . . ASTACIDAE (p. 117)
   First pair of pereiopods not longer and rarely more robust than following pairs; at least outer branch (exopod) of first pair of pleopods adapted for swimming; first segment of antennular peduncle with prominent lateral spine or tooth (stylocerite). Shrimps 3
3. Lateral flaps (pleura) of first abdominal somite overlapping those of second; third pair of pereiopods ending in pincers (chelate). Marine and estuarine. PENAEIDAE (p. 51)
   Lateral flaps (pleura) of second abdominal somite overlapping those of first; third pair of pereiopods not ending in pincers (simple) 4
4. Second pair of pereiopods more slender (though longer) than first, carpus multiarticulate, chela much smaller than that of first pair. Brackish pools (Cuba) . . . . . HIPPOLYTIDAE (p. 116)
   Second pair of pereiopods at least as robust as first, carpus not subdivided, chela subequal to or larger than that of first pair 5
5. Fingers of chelae of first and second pairs of pereiopods usually with terminal brushes of long hairs; if not, all pereiopods with exopods. Fresh water. ATYIDAE (p. 56)
   Fingers of chelae of first and second pairs of pereiopods without terminal brushes of long hairs; pereiopods without exopods. Freshwater and marine. PALAEMONIDAE (p. 87)
6. Fifth pair of pereiopods much smaller than first three pairs and ending in pincers (chelate); abdomen with uropods and either loosely flexed beneath body or soft, membranous, and twisted 7
   Fifth pair of pereiopods not much smaller than other pairs and not ending in pincers (simple); abdomen without uropods and closely flexed against sternum. True crabs 8

7. Symmetrical, crablike decapods with loosely flexed abdomen. Marine and supralittoral . . . . . PORCELLANIDAE (p. 121)
   Asymmetrical hermit crabs usually found in empty gastropod shells, which protect soft, twisted abdomen. Terrestrial . . . COENOBITIDAE (p. 123)
8. Palp of third maxilliped articulating at or near distomesial angle of merus, never concealed by expanded merus; males with spermatic duct passing from coxa of fifth pereiopod to base of first pleopod; length of adult carapace in midline usually not more than two-thirds of maximum width (if more than three-fourths, anterolateral margin with 8–11 teeth) 9
   Palp of third maxilliped articulating near middle of distal margin or at distolateral angle of merus, occasionally partially or completely concealed by expanded merus; males with spermatic duct passing from opening in sternum to base of first pleopod; length of adult carapace in midline usually at least three-fourths of maximum width (if less, anterolateral margin unarmed) . 12
9. Dactyl of fifth pereiopod either greatly compressed and expanded to form swimming paddle about half as wide as long or dactyls of all walking legs armed with rows of blunt spines 10
   Dactyls of second through fifth pereiopods neither spinose nor expanded to form swimming paddles 11
10. Carapace broadly hexagonal, large spine at lateral angle; fifth pereiopods flattened and broadened to form swimming paddles. Marine and estuarine, occasionally in fresh water . . . . . PORTUNIDAE (p. 127)
    Carapace broadly oval, without large lateral spine; dactyls of second through fifth pereiopods not expanded, armed with rows of blunt spines. In and near fresh water . . . . . PSEUDOTHELPHUSIDAE (p. 136)
11. Carapace armed with five broad anterolateral teeth, first two partially and broadly fused; frontal margin unarmed. Marine and supralittoral, especially in marshes . . . . . XANTHIDAE (p. 153)
    Carapace armed with 8–11 small acute anterolateral teeth; frontal margin armed with 15 or more small sharp spines. In and near fresh water. TRICHODACTYLIDAE (p. 152)
12. Third maxillipeds not gaping, almost completely covering mouth area and concealing mandibles when closed. Supralittoral beaches and marshes. OCYPODIDAE (p. 202)
    Third maxillipeds usually gaping mesially when closed, revealing at least tips of mandibles (if not gaping, front of carapace deeply incised revealing retracted antennules in dorsal view) 13
13. Carapace with lateral margins well defined, either dentate or rather distinctly carinate. Supralittoral or near fresh water . . . . . GRAPSIDAE (p. 156)
    Carapace greatly inflated anterolaterally in adults, lateral margins not sharply defined. Supralittoral and terrestrial . . GECARCINIDAE (p. 194)

Family PENAEIDAE

Subfamily PENAEINAE

Key to the Species

1. Rostrum longer than antennal scales, without ventral teeth; dorsal antennular flagellum about six times as long as antennular peduncle; basis of second pereiopod unarmed; fourth and fifth pereiopods much longer than third, filiform; male with petasma tubular and bearing large hornlike transverse distal processes (fig. 7*e*) . . . . . **Xiphopeneus kroyeri** (p. 55)

Rostrum shorter than antennal scales, typically with ventral teeth; antennular flagella shorter than antennular peduncle; basis of second pereiopod armed with spine; fourth and fifth pereiopods shorter than third; male with petasma open, without hornlike transverse processes (figs. 7*a–d*) 2

2. Lateral rostral grooves reaching little behind posterior rostral tooth on carapace; male with petasma lacking pair of conspicuous hoodlike projections curving around distomedian margin (fig. 7*d*); female with thelycum open, not covered by heavy membranes meeting in midline.
Penaeus schmitti (p. 54)

Lateral rostral grooves reaching nearly to posterior margin of carapace; male with petasma bearing conspicuous hoodlike projections curving around distomedian margin (figs. 7*a–c*); female with thelycum covered by heavy membranes meeting in midline 3

3. Petasma of male (fig. 7*b*) with pointed tip of stiff marginal strip projecting freely at distomedian end, not attached to surrounding tissue (marginal strip not armed with spinules); membranous covers of thelycum of female produced anteriorly and tightly closed, anterior carina if present not protruding in midline . . . . . **Penaeus brasiliensis** (p. 53)

Tip of marginal strip of petasma not projecting freely at distomedian end; membranous covers of thelycum not meeting anteriorly in midline, revealing short longitudinal carina. 4

4. Posterior extensions of lateral rostral grooves narrow, each less than three-fourths as wide as median ridge separating them; distal margins of petasma of male unarmed (fig. 7*a*); anteromedian carina of thelycum of female bifurcate anteriorly. . . . . **Penaeus aztecus subtilis** (p. 52)

Posterior extensions of lateral rostral grooves broad, each usually more than three-fourths as wide as and often wider than median ridge; curved distal edge of stiff marginal strip of petasma of male bearing 2 to 12 small spinules (fig. 7*c*); anteromedian carina of thelycum of female not bifurcate anteriorly.
Penaeus duorarum notialis (p. 53)

Genus *Penaeus*

1. *Penaeus aztecus subtilis* Pérez Farfante

FIGURE 7*a*

Penaeus Brasiliensis, var. *Aztecus* Ives, 1891 [part], p. 190 [type-locality: Veracruz, Mexico].

Penaeus brasiliensis.—Many authors prior to 1939 [part].

Penaeus aztecus.—Burkenroad, 1939 [part], p. 34.—Holthuis, 1959, p. 63, fig. 6b.

Penaeus aztecus subtilis Pérez Farfante, 1967, p. 87, figs. 2, 3 [type-locality: off Punta Gallinas, Departamento de la Guajira, Colombia].

DIAGNOSIS.—Lateral rostral grooves reaching nearly to posterior margin of carapace, *narrow, each less than three-fourths as wide as median ridge*. Rostrum shorter than antennal scales, usually with ventral teeth. Antennular flagella shorter than peduncle. Basis of both first and second pereiopods armed with sharp spine. Fourth and fifth pereiopods shorter than third. Petasma open, with paired, hoodlike distomedian projections; stiff marginal strip unarmed, distomedian tip not projecting from surrounding tissue. Thelycum covered by paired membranes meeting in midline but gaping anteri-

orly; short longitudinal carina protruding from gape and produced anteriorly as *divergent paired ridges*. A large species when adult, maximum postorbital carapace length about 55 mm; estuarine specimens considerably smaller.

HABITAT.—Adults marine; juvenile and immature specimens in brackish, exceptionally in fresh water.

DISTRIBUTION.—Cuba and Yucatan to Estado do Rio de Janeiro, Brazil (Cuba, Jamaica, Hispaniola, Puerto Rico, Saint John, Saint Croix, Antigua I., Saint Lucia I., Trinidad).

2. *Penaeus brasiliensis* Latreille

FIGURE 7*b*

Penaeus brasiliensis Latreille, 1817, p. 156 [type-locality: Brazil].—Holthuis, 1959, p. 66, fig. 6c.—Boschi, 1963, p. 23, fig. 7.

DIAGNOSIS.—Lateral rostral grooves reaching nearly to posterior margin of carapace, broad, each usually more than three-fourths as wide as median ridge. Rostrum shorter than antennal scales, usually with ventral teeth. Antennular flagella shorter than peduncle. Basis of both first and second pereiopods armed with sharp spine. Fourth and fifth pereiopods shorter than third. Petasma open with paired hoodlike distomedian projections; stiff marginal strip unarmed, *distomedian tip projecting from surrounding tissue*. Thelycum covered by paired membranes produced laterally and tightly closed in midline, with *no anterior gape; anterior carina absent*. A large species when adult, maximum postorbital carapace length about 60 mm, estuarine specimens considerably smaller.

HABITAT.—Adults marine; juvenile and immature specimens in brackish, exceptionally in fresh water.

DISTRIBUTION.—Cape Hatteras, North Carolina, to Estado do Rio Grande do Sul, Brazil (Bermudas, Cuba, Jamaica, Hispaniola, Puerto Rico, Saint Thomas, Saint Croix).

3. *Penaeus duorarum notialis* Pérez Farfante

FIGURES 5, 7*c*

Penaeus brasiliensis.—Many authors prior to 1939 [part].
Penaeus duorarum Burkenroad, 1939 [part], p. 31.—Boschi, 1963, p. 20, fig. 6.
Penaeus duorarum notialis Pérez Farfante, 1967, p. 94, fig. 4 [type-locality: off Las Piedras, Gulf of Venezuela].

DIAGNOSIS.—Lateral rostral grooves reaching nearly to posterior margin of carapace, broad, each usually more than three-fourths as wide as median ridge. Rostrum shorter than antennal scales, usually with ventral teeth. Antennular flagella shorter than peduncle. Basis of both first and second pereiopods armed with sharp spine. Fourth and fifth pereiopods shorter than third. Petasma open with

paired hoodlike distomedian projections; stiff marginal strip *armed with spinules on distal curve*, distomedian tip not projecting from surrounding tissue. Thelycum covered by paired membranes meeting in midline but gaping anteriorly; short, longitudinal carina protruding from gape *not bifurcate anteriorly*. A large species when adult, maximum postorbital carapace length about 55 mm, estuarine specimens considerably smaller.

HABITAT.—Adults marine; juvenile and immature specimens in brackish, exceptionally in fresh water.

DISTRIBUTION.—Cuba and British Honduras to Estado do Rio de Janeiro, Brazil (Cuba, Jamaica, Hispaniola, Puerto Rico, Saint Thomas, Saint John, Trinidad). The typical subspecies, *P. d. duorarum*, occurs in the Bermudas.

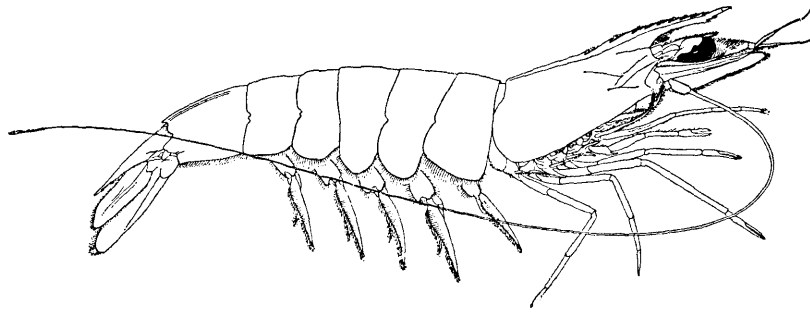


FIGURE 5.—*Penaeus duorarum notialis*, male (carapace length 22.8 mm) from south of Jamaica (*Oregon* station 5396).

4. *Penaeus schmitti* Burkenroad

FIGURE 7*d*

Penaeus setiferus.—Some authors prior to 1936 [part].

Penaeus schmitti Burkenroad, 1936, p. 315, figs. 1a, 2, 3 [type-locality: Kingston Harbour, Jamaica].—Holthuis, 1959, p. 61, fig. 6a.—Boschi, 1963, p. 17, fig. 5.

DIAGNOSIS.—Lateral rostral grooves not reaching nearly to posterior margin of carapace, ending near posterior dorsal tooth. Rostrum shorter than antennal scales, usually with ventral teeth. Antennular flagella shorter than peduncle. Basis of both first and second pereiopods armed with sharp spine. Fourth and fifth pereiopods shorter than third. Petasma open, *without hoodlike distomedian projections. Thelycum open, not covered by paired membranes meeting in midline.* A large species when adult, maximum postorbital carapace length about 50 mm, estuarine specimens considerably smaller.

HABITAT.—Adults marine; juvenile and immature specimens in brackish, exceptionally in fresh water.

DISTRIBUTION.—West Indies and Honduras to Estado de Santa Catarina, Brazil (Cuba, Jamaica, Hispaniola, Saint Thomas, Trinidad).

Genus *Xiphopeneus*

5. *Xiphopeneus kroyeri* (Heller)

FIGURES 6, 7*e*

Penaeus Kroyeri Heller, 1862a, p. 425, pl. 2: fig. 51 [type-locality: Rio de Janeiro, Brazil].

Xiphopeneus Hartlii Smith, 1869b, p. 28, figs. 1, 1a [type-locality: Caravelas, Estado da Bahia, Brazil].

Xiphopeneus Kroyeri.—Smith, 1885, p. 188.

Xiphopenaeus kroyeri.—Boschi, 1963, p. 32, fig. 10.

DIAGNOSIS.—Lateral rostral grooves not reaching nearly to posterior margin of carapace, ending near posterior dorsal tooth. *Rostrum longer than antennal scales, without ventral teeth. Dorsal antennular flagellum about six times as long as peduncle. Basis of second pereiopod unarmed.*

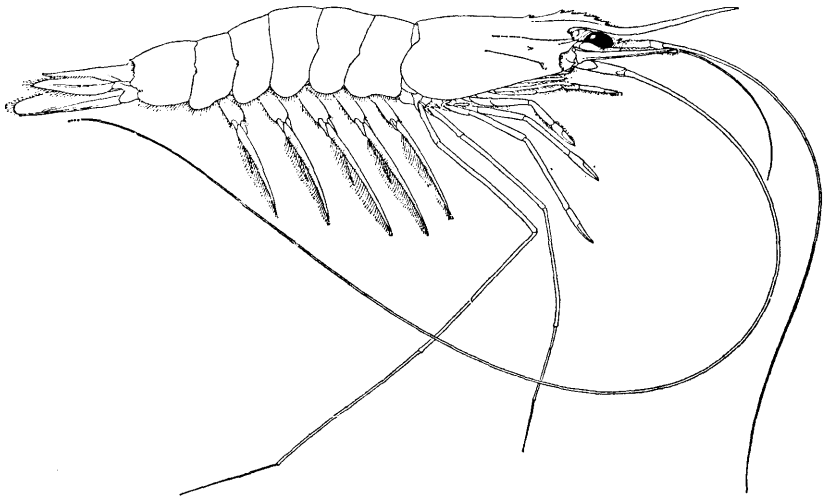


FIGURE 6.—*Xiphopeneus kroyeri*, female (carapace length 17.5 mm) from off Surinam (*Coquette* station 44).

Fourth and fifth pereiopods much longer than third, filiform. Petasma tubular with large hornlike transverse distal processes. Thelycum covered by long posterior and short anterior membranes separated by anteriorly convex transverse fissure. A moderately large species, maximum postorbital carapace length about 40 mm.

HABITAT.—Marine and brackish environment, exceptionally in fresh water.

DISTRIBUTION.—North Carolina to Estado do Paraná, Brazil (Cuba, Puerto Rico).

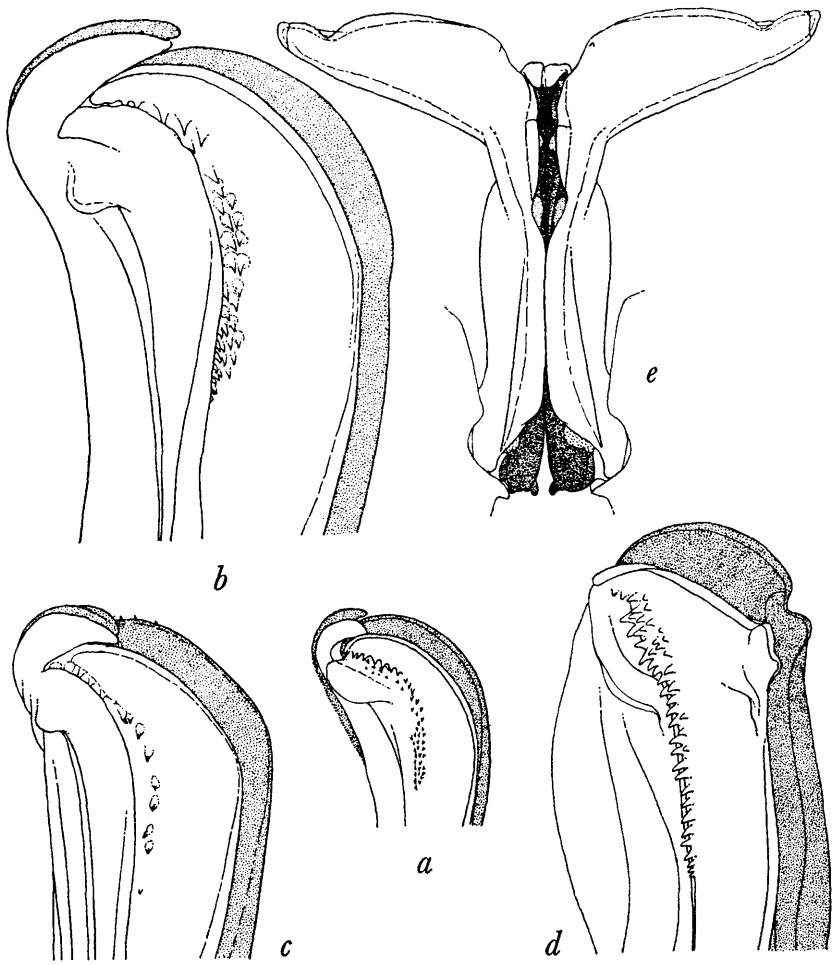


FIGURE 7.—Petasmas of shrimps of the family Penaeidae (*a–d*, distal end viewed from right side; *e*, entire structure in posterior view): *a*, *Penaeus aztecus subtilis* (carapace length 16.2 mm) from Jamaica (*Albatross*); *b*, *P. brasiliensis* (cl 27.2 mm) from Golfo de Morrosquillo, Colombia (*Oregon* station 4886); *c*, *P. duorarum notialis* (cl 21.3 mm) from Bizeton, Haiti (W. Beebe); *d*, *P. schmitti* (cl 23.5 mm), "cotype" from Kingston Bay, Jamaica; *e*, *Xiphopeneus kroyeri* (cl 13.2 mm) from Arroyo, Puerto Rico (*Fish Hawk*).

Family ATYIDAE

Key to the Species

1. Chelae of first and second pereiopods without tufts of long hairs at ends of fingers . . . . . **Xiphocaris elongata** (p. 81)
   Chelae of first and second pereiopods with tufts of long hairs at ends of fingers 2

2. Eyes reduced, cornea limited to distolateral pigment spot on eyestalk; pereiopods with exopods; subterranean species 3
   Eyes normal, cornea nearly as broad as or broader than eyestalk; pereiopods without exopods; epigean species 4
3. Exopod on fifth pereiopod nearly as well developed as those on preceding ones . . . . . **Typhlatya garciai** (p. 80)
   Exopod on fifth pereiopod greatly reduced, barely discernible. **Typhlatya monae** (p. 80)
4. Rostrum with dorsal teeth . . . . . **Micratya poeyi** (p. 70)
   Rostrum without dorsal teeth 5
5. Carpus of second pereiopod broader than long 6
   Carpus of second pereiopod much longer than broad 8
6. Adults without horizontal lateral lobe or tooth on either side of rostrum; third pereiopod not bearing horny scales or tubercles and only slightly more robust than fourth pereiopod . . . . . **Atya lanipes** (p. 62)
   Adults with distinct horizontal lateral lobe or tooth on either side of rostrum; third pereiopod bearing prominent horny scales or tubercles and considerably larger and more robust than fourth pereiopod. 7
7. Lateral lobes of adult rostrum obtuse (fig. 10*a*); pleuron of second abdominal somite without blunt marginal spines although pleura of third to fifth somites may bear acute marginal denticles (fig. 10*c*); body without transverse bands of dark color. . . . . **Atya innocous** (p. 57)
   Lateral lobes of adult rostrum subacute and directed anteriorly (fig. 10*d*); ventral margins of pleura of second to fifth abdominal somites armed with row of small blunt spines (fig. 10*f*); transverse bands of dark color at juncture of carapace and abdomen and on anterior part of sixth abdominal somite . . . . . **Atya scabra** (p. 63)
8. Orbital margin minutely serrate; appendix masculina on second pleopod of male slender, terminating in sharp point (figs. 14*f*, *g*). . **Jonga serrei** (p. 66)
   Orbital margin not serrate; appendix masculina on second pleopod of male broad, rounded distally 9
9. Appendix masculina widening distally, about three-fourths as wide as long, posterior margin slightly and evenly convex (fig. 19*a*). **Potimirim americana** (p. 76)
   Appendix masculina widest proximally, not more than half as wide as long, posterior margin sinuous 10
10. Dorsal margin of rostrum curving downward at tip; appendix masculina with deep, unarmed sinus in posterior margin (fig. 19*c*). **Potimirim glabra** (p. 76)
    Dorsal margin of rostrum nearly straight; appendix masculina without deep, unarmed sinus in posterior margin (fig. 19*d*). . **Potimirim mexicana** (p. 79)

Genus *Atya*

6. *Atya innocous* (Herbst)

FIGURES 8, 10*a–c*, 14*a*, *b*

Astacus Nasoscopus Meuschen, 1778, p. 86 [type-locality: Martinique; publication ruled invalid by Opinion 260, International Commission on Zoological Nomenclature].

Cancer (*Astacus*) *Innocous* Herbst, 1792, p. 62, pl. 28: fig. 3 [type-locality: Martinique].

Atya occidentalis Newport, 1847, p. 159 [type-locality: Jamaica].—Pocock, 1889, p. 11, pl. 2: figs. 3, 3a.—Bouvier, 1925, p. 312, figs. 700–702.
Atya robusta A. Milne-Edwards, 1864, p. 148, pl. 3: fig. 1 [type-locality: "New Caledonia" (see Holthuis, 1966, p. 237)].
Atya innocous.—Holthuis, 1966, p. 237.
Atyia occidentalis.—Vélez, 1967, p. 42.

DIAGNOSIS.—Orbital margin unarmed. Rostrum without dorsal teeth, *lateral lobes obtuse*, ventral margin virtually unarmed. Ventral margin of pleuron of second abdominal somite unarmed, *those of third through fifth somites usually bearing row of small, sharp denticles.* Eyes not reduced. Basal segment of antennular peduncle without dorsal spines proximal to series bordering distal margin. Pereiopods without exopods. Fingers of chelae of first and second pereiopods

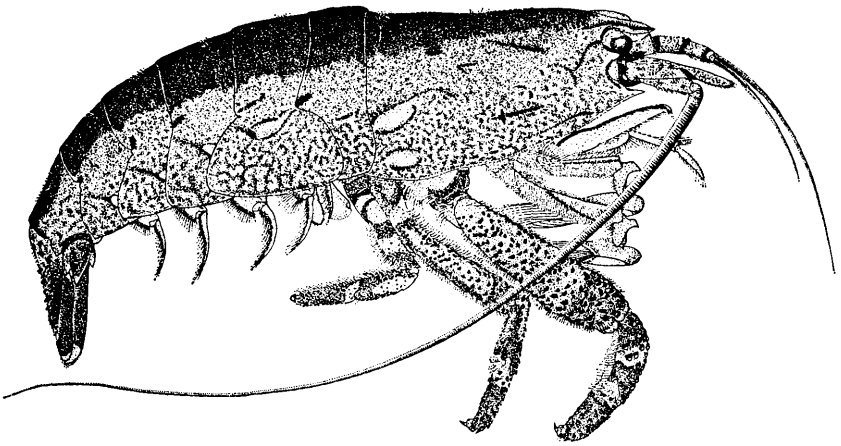


FIGURE 8.—*Atya innocous*, male (carapace length 25.8 mm) from Dominica station 46.

bearing terminal tufts of long hair. Carpus of second pereiopod broader than long. *Last three pereiopods bearing depressed horny scales.* Merus of third pereiopod noticeably broader than that of fourth pereiopod, *usually between 0.2 and 0.3 as broad as long.* Appendix masculina on second pleopod of male broad lobe bordered with slender curved spines. Body without distinct dark-colored transverse bands near anterior and posterior ends of abdomen. A moderately large species, maximum postorbital carapace length at least 34 mm.

COLOR IN LIFE.—Two phases, green and brown.

Brown Phase: Ground color of cephalothorax dark brown (brownish black chromatophores forming reticulate pattern over tan). Dorsum of carapace with dark brown longitudinal stripe extending from base of rostrum to posterior margin, becoming broader posteriorly. Stripe continuing onto abdomen but broken by very narrow

transverse tan bands across posterior margins of anterior five terga; sixth tergum tan anteriorly and dark brown posteriorly; broadest portion of stripe on first and second somites, in both becoming narrower posteriorly. Lateral surface of carapace straw brown with several obliquely directed dark brown lines, posterior and ventral ones directed posteroventrally; posterolateral area with lateral and ventrolateral pale tan spots outlined above and below by aforementioned pairs of dark brown lines. Ventrolateral portion of abdominal terga and pleura mottled straw brown with short dark brown lines (in anterior somites) or spots (in posterior somites) adjacent to articular knobs at posterior bases of pleura: second pleuron with prominent pale tan spot at base, and succeeding three pleura with similar, progressively smaller ones, all forming row with lateral spot on carapace; each spot on pleura with dark border. Ventral and posterior margins of pleura very light with dark submarginal line.

Antennular peduncle straw brown with dark brown rings, antennal peduncle straw brown with dark brown markings just proximal to, and on lateral margin of, antennal scale; flagella dark brown to tan. Third maxillipeds pale, translucent, with narrow black lateral margins on more distal podomeres. First two pereiopods translucent to straw brown with dark brown lateral line on merus; carpus straw brown with orange spot on articular surface; bases of two distal podomeres orange, followed by bluish cream throughout most of their lengths, with subterminal narrow, vivid orange band and terminal white one bearing setal tufts; setae dark gray at base fading to cream distally. Basal podomeres (coxa through ischium) of third leg cream with irregular dark brown splotches; merus light basally, becoming dark brown distally and bearing very dark brown tubercles, few with corneous tips; carpus dark brown with light tan band at midlength, propodus light tan in proximal fourth and dark brown in distal three-fourths, tubercles on carpus and propodus dark at base but with corneous (yellow) tips; dactyl mostly corneous. Fourth and fifth pereiopods with basal podomeres as in third pereiopod; merus with flexor portion, proximal and distal ends dark brown, remainder tan; carpus with proximal extensor surface tan, otherwise dark brown; propodus and dactyl as on third pereiopod.

In most young specimens, light dorsomedian stripe extending from tip of rostrum almost to, or to, distal margin of telson; on cephalothorax, stripe of uniform width; on first abdominal somite, expanded in posterior half; in succeeding three somites, narrow anteriorly and broadening posteriorly; in fifth somite narrow and of uniform width; in sixth, essentially similar to that in second through fourth; and on telson, narrower posteriorly. In older individuals, dark pigment

317-180—69——6

forming variable, mostly bilaterally symmetrical, patterns along lateral margins of dorsomedian stripe; with increasing age, patterns coalescing and infringing on stripe to extent that in individuals of intermediate size, stripe usually narrower, irregular, and interrupted, and largest individuals usually without trace of stripe.

Green Phase: Pattern essentially identical; color, however, ranges from pale bluish green to greenish black.

MATERIAL EXAMINED.—The Dominican collections contain 232 males (carapace lengths 5.0–33.7 mm), 246 females (cl 5.9–20.6 mm), including 80 with eggs (cl 8.8–20.6 mm), and 215 juveniles (cl 1.1–5.0 mm). The smallest specimens for which the sex can be determined have a carapace length of about 5.0 mm; at this size, and occasionally at a carapace length of as much as 6.2 mm, the appendix masculina on the second pleopod of males is subequal in length to the appendix interna.

ECOLOGICAL NOTES.—*Atya innocous* is probably the least ecologically and geographically restricted shrimp on the Island of Dominica. It has been found in such diverse habitats as the mouth of the Layou River, some 100 feet from the Caribbean, and in a small tributary of the Rosalie River between Boeri and Freshwater Lakes at an altitude of approximately 2,500 feet. It seems to be equally at home in the cascading reaches of mountain rivulets, in quiet upland pools, and in low-lying sluggish brooks. In an upland pool, on a stream tributary of the Layou River flowing through the Cassada Gardens Estate (station 29), some 20 or 30 individuals were observed actively crawling over the bottom at about 10:00 A.M. Sharing the pool with them were some 10 or 12 *Macrobrachium crenulatum*. Here, a large boulder projecting from the bank over the pool provided considerable shade. In their wanderings, both shrimps ventured into areas of direct sunlight but quickly returned to the shaded portion of the pool. In the edge of a riffle area just below the pool, several individuals of *M. heterochirus* occasionally emerged from beneath stones, but no *Atya* were observed except in the pool.

Along Mannet's Gutter, near Clarke Hall, *A. innocous* was equally common in the riffle areas, in the cascading reaches, and in the pools. (See the description of the decapod composition of a Dominica pool, p. 43.)

DISTRIBUTION.—Nicaragua to Panama and the West Indies (Cuba, Jamaica, Hispaniola, Puerto Rico, Saint Croix, Montserrat, Guadeloupe, Dominica, Martinique, Saint Vincent).

Dominica Stations: 1–5, 7, 8, 13–15, 17–21, 26–32, 34, 35, 39, 41, 45, 46, 48, 53–55, 59, 60, 63, 66, 69, 70, 73–76, 78, 80, 92, 101, 103, 105, 109 (0–3,050 ft.).

REMARKS.—Large males of *A. innocous* have the lateral lobes of the rostrum subrectangular, approaching the subacute form in *A. scabra*, but males of the two species can be distinguished easily by numerous other characters. In living specimens, the two can be separated by the color pattern, especially the transverse bands near either end of the abdomen in *A. scabra*, and by the different texture of the integument. *Atya innocous* is much more slippery and more difficult to hold in the hand than is the rougher *A. scabra*, even though the latter is a more slender shrimp, the carapace especially being proportionately less high than it is in the former. The antennular peduncle, on the other hand, is usually somewhat longer proportionately in *A. innocous* than it is in *A. scabra*, and it lacks the one to three dorsal spines that are usually present on the basal segment proximal to the distal circlet in *A. scabra* (figs. 10*a*, *d*). The third pereiopod of *A. innocous*, although much more robust than in *A. lanipes*, is normally more slender than in *A. scabra*, especially in males of the two species, and it is studded with appressed corneous scales, rather than with the much more erect, though flat-topped, curved spines characteristic of *A. scabra*. The appendix masculina on the second pleopod of the male is provided with longer but fewer spines, particularly on the central portion of the mesiodistal surface, in *A. innocous* than in *A. scabra*. Probably the most reliable characters for separating males of the two species are the form of the pre-anal carina (figs. 10*b*, *e*) and the armature of the ventral margins of the abdominal pleura (figs. 10*c*, *f*). In *A. innocous*, the latter consists, at most, of a short row of small, acute denticles on the third, fourth, and fifth somites, but the pleura of any or all of the somites may be unarmed, or the spinules may be almost indistinguishable from some of the stout hairs arising from the pleural margins. In *A. scabra* the pleura of the second, third, fourth, and fifth somites are armed with more extensive and more prominent series of close-set, blunt, stout spines. Female and juvenile specimens are more difficult to identify by any of these characters; it is quite possible that some of the juveniles assigned to *A. innocous* from the Dominica collections may be *A. scabra*. Females of *A. scabra* can be identified by the form of the rostrum in the series examined; the pleural armature is much as in males of *A. innocous*, but the forms of the third pereiopod and of the pre-anal carina are reliable.

Atya innocous was generally known as *A. occidentalis* until the identity of Herbst's species was demonstrated by Holthuis (1966). The western American material of *Atya* available to us is not sufficient to determine the status of *A. tenella* Smith, 1871, and we are therefore following the suggestion of Holthuis in considering it distinct from *A. innocous* for the time being.

Ovigerous specimens of *A. innocous* were collected in all months in which the species was taken: January, February, March, May, August, September, and October.

7. *Atya lanipes* Holthuis

FIGURE 14c

Atya lanipes Holthuis, 1963a, p. 61, figs. 1, 2 [type-locality: Saint Thomas].

DIAGNOSIS.—Orbital margin unarmed. Rostrum unarmed dorsally, *lateral lobes represented only by very slight broadening of proximal half of rostrum*, ventral margin armed with two or three teeth, not regularly serrate. Ventral margins of abdominal pleura unarmed. Basal segment of antennular peduncle without dorsal spines proximal to series bordering distal margin. Pereiopods without exopods. Fingers of chelae of first and second pereiopods bearing tufts of long hair. Carpus of second pereiopod broader than long. Last three pereiopods without horny scales or tubercles. Merus, carpus, and propodus of third pereiopods not swollen, only slightly more robust than those of fourth pereiopod. Appendix masculina on second pleopod of male forming broad lobe bordered with slender curved spines. A moderately large species, maximum postorbital carapace length at least 28 mm.

HABITAT.—Fresh water.

DISTRIBUTION.—Puerto Rico and Saint Thomas.

REMARKS.—This species is represented in the national collections by 10 lots from Puerto Rico containing 16 males (carapace lengths 4.2–28.0 mm) and 15 females (cl 4.9–21.8 mm), including 9 with eggs (cl 9.4–17.7 mm). The documentation with these lots is as follows:

Rio Culebrinas at Rt. 13, 1,000 m south and 300 m east of San Sebastián; June 2, 1953; H. W. Harry.

Río Maricao at Maricao; February 9, 1951; N. T. Mattox.

Freshwater streams at Jayuya; spring 1954; L. A. Costas Grana.

Río Lajas, 2,800 m east and 3,000 m south of Vega Alta; May 8, 1953; H. W. Harry.

Río Cibuco at Rt. 20, 1,500 m south and 3,500 m west of Corozal; May 5, 1953; H. W. Harry.

Corozal Río Manatí at road from Corozal to Orcovis (S54–7); November 23, 1954; C. L. Smith and H. W. Harry.

El Yunque tributary to Río Mameyes at Rt. 112, 100 m north and 1,500 m east of El Yunque summit; June 8, 1953; H. W. Harry.

El Yunque pool below dam in Río Cubuy at Rt. 112, 500 m south and 1,000 m west of El Yunque summit; June 8, 1953; H. W. Harry.

It is surprising that a species as distinctive as *A. lanipes* and as widely distributed through the length and breadth of Puerto Rico, as the above records would indicate, has escaped notice so long. The Puerto Rican material agrees well with the original description,

except that none of the specimens have the last three pereiopods clothed in hair dense enough to conceal the underlying surface. There is considerable variation in the development of the spine at the pterygostomian angle; in most of the larger males, it is longer and more attenuated than in the type from Saint Thomas, but it is far less prominent in small males and females, often being reduced to no more than a broadly acute angle.

8. *Atya scabra* (Leach)

FIGURES 9, 10*d–f*, 14*d*, *e*

Atys scaber Leach, 1815, p. 345 [type-locality: vicinity of Veracruz, Mexico; restricted by Holthuis, 1966].

Atya mexicana Wiegmann, 1836, p. 145 [type-locality: Misantla, Estado de Veracruz, Mexico].

Ataya margaritacea A. Milne-Edwards, 1864, p. 148, pl. 3: fig. 2 [type-locality: "New Caledonia" (probably in error)].

Atya punctata Kingsley, 1878b, p. 91 [type-locality: Republic of Haiti].

Atya scabra.—Bouvier, 1925, p. 314, figs. 55–67, 703–706.—Villalobos, 1943, pp. 7–67, figs. 1–22.—Holthuis, 1966, p. 234.

Atyia scabra.—Velez, 1967, p. 42.

DIAGNOSIS.—Orbital margin unarmed. Rostrum without dorsal teeth, *lateral lobes subacute*, ventral margin virtually unarmed. *Ventral margins of pleura of second through fifth abdominal somites armed with close-set series of stout, blunt spines.* Eyes not reduced. *Basal segment of antennular peduncle with one to three spines proximal to series bordering distal margin.* Pereiopods without exopods. Fingers of chela of first and second pereiopods bearing terminal tufts of long hair. Carpus of second pereiopod broader than long. *Last three pereiopods bearing flat-topped but upstanding curved spines or tubercles. Merus, carpus, and propodus of third pereiopod much more inflated than those of fourth, merus usually more than 0.3 as broad as long.* Appendix masculina on second pleopod of male forming broad lobe bordered with slender curved spines. *Body with dark-colored transverse bands at juncture of carapace and abdomen and on anterior half of sixth abdominal somite.* A moderately large species, maximum postorbital carapace length at least 31 mm.

COLOR IN LIFE.—Two phases, green and brown.

Green Phase: Ground color of cephalothorax and abdomen dark green (chromatophores forming reticulate pattern), darker dorsally, gradually fading ventrolaterally to olive interspersed with dark cream. Dorsum with broken, narrow, median, longitudinal, greenish-cream stripe extending from anterior part of rostrum to posterior margin of fifth abdominal tergum. (In some larger individuals, dorsal light stripe obliterated.) Three dorsally situated transverse bands of dark forest green as follows: (1) immediately posterior to base of rostrum and extending ventrally almost to level of antennal spine;

(2) on posterior margin of carapace, continuing onto anterior portion of first abdominal tergum, and extending ventrally on both to level of base of abdominal pleura; and (3) on anterior half of sixth abdominal tergum extending ventrally to margin. Carapace with dark green spot immediately below second band and cream one immediately anterior to spot, studded with pile of short golden setae, one to three setae in each punctation.

Antennular and antennal peduncles forest green; flagella tan to brown. Third maxillipeds and first two pairs of pereiopods lavender cream with bright green longitudinal lines on ischium and merus;

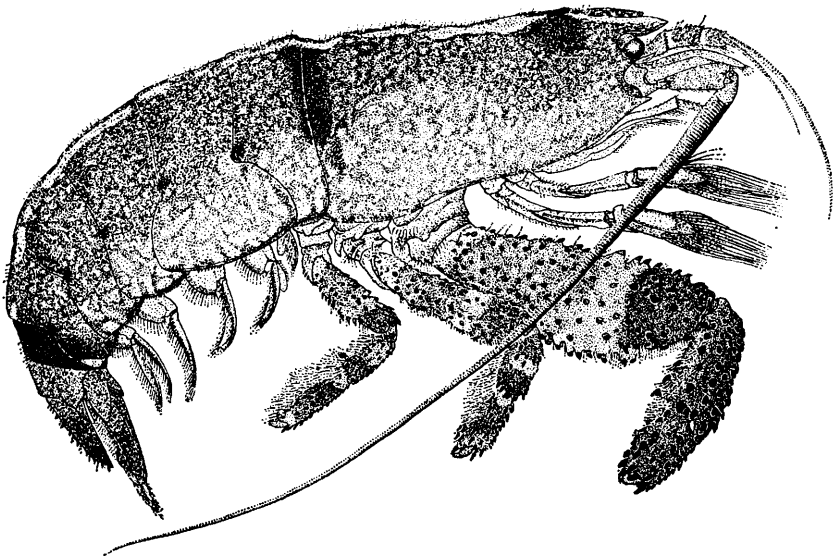


FIGURE 9.—*Atya scabra*, male (carapace length 27.8 mm) from Dominica station 50.

proximal portions of chelae of first two pereiopods lavender, distal portions vermilion; distal setal tufts dark gray proximally fading to beige distally. Proximal three podomeres of third, fourth, and fifth pereiopods cream with irregular green markings; merus with cream-colored base followed distally by broad green band, narrower cream one, and distal green one; carpus and propodus of third periopods forest green; those of fourth and fifth cream proximally and dark green distally; dactyls of three orange brown (corneous); tubercles on all three legs darker green than areas surrounding them; green bands on all three legs progressively darker from proximal to distal podomeres. Basal portions of pleopods cream with greenish-tan lateral margin; rami tan with brown borders. Uropod light green

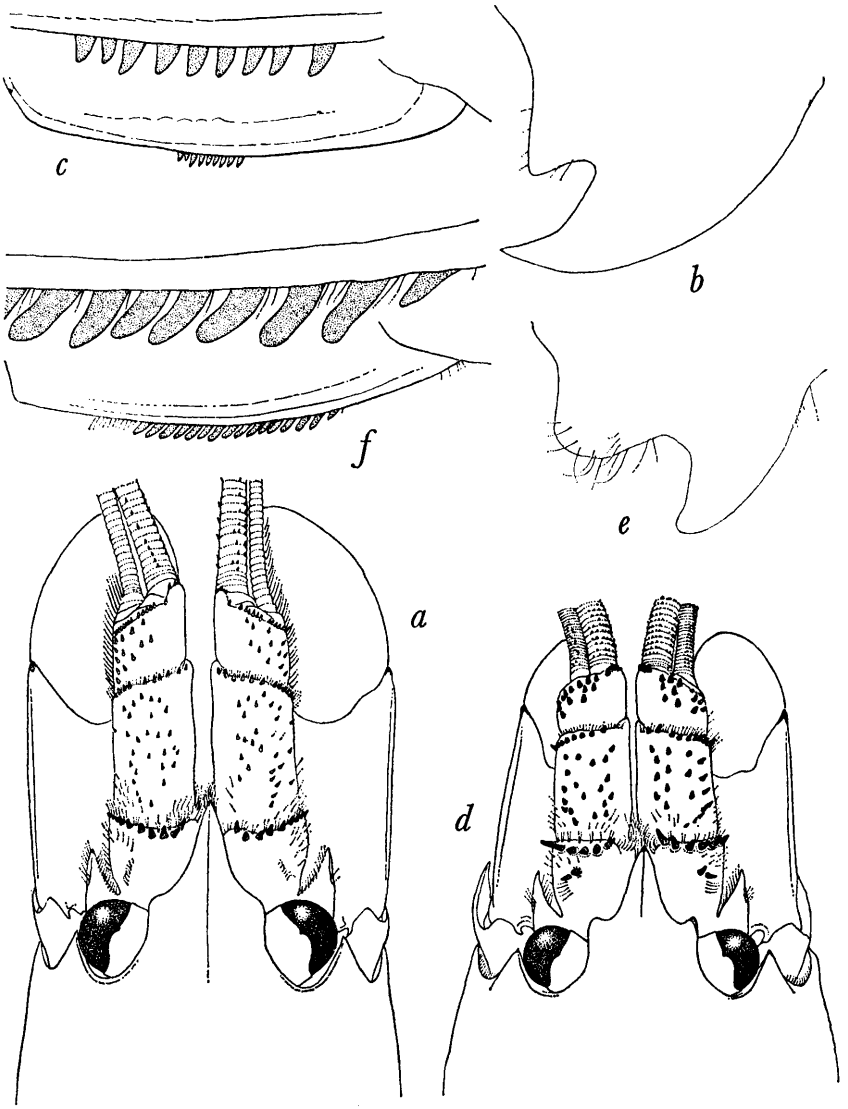


FIGURE 10.—Diagnostic characters: *a*, anterior part of body in dorsal view of male *A. innocous* shown in figure 8; *b*, pre-anal carina of same specimen viewed from right side; *c*, maximum development of denticles on margin of right third abdominal pleuron in male *A. innocous* (carapace length 23.4 mm) from Dominica station 46; *d*, anterior part of body of male *A. scabra* (cl 31.0 mm) from Dominica station 74; *e*, pre-anal carina of male *A. scabra* shown in figure 9; *f*, denticles on margin of right third abdominal pleuron of same specimen.

proximally, dark green distally with patches of brownish pigment alternating with aqua spots in distal portions of both rami; marginal setae golden. Telson light green anteriorly, dark green posteriorly with brownish spots and brown tip.

Brown Phase: Pattern essentially identical; colors, however, range from cream through pale buff to dark brown.

MATERIAL EXAMINED.—The Dominican collections contain only 15 males (carapace lengths 11.0–31.0 mm) and 4 females (cl 12.0–17.1mm), 1 of which (cl 17.1 mm) bears eggs.

ECOLOGICAL NOTES.—*Atya scabra* is decidedly less common on Dominica and is much more restricted in its habitat distribution than is *A. innocous*. Insofar as our collections indicate, *A. scabra* frequents the cascading reaches and riffles of small streams at elevations of 50 to 350 feet, where it secretes itself among the stones over and among which water is rushing. Although it must travel through pools in moving from one congenial niche to another, it was neither observed nor collected in a pool during this study. The only specimens obtained were caught by placing a net in the cascading waters and moving the larger stones immediately upstream so that the swift current washed the shrimp sheltered under and among the rocks into the net.

DISTRIBUTION.—Mexico and the West Indies to Estado de Pernambuco, Brazil (Cuba, Jamaica, Hispaniola, Puerto Rico, Dominica, Trinidad).

Dominica Stations: 1, 2, 4, 50, 66, 74 (50–350 ft.).

REMARKS.—The differences between this species and *A. innocous* are discussed under the latter species (p. 61).

We agree with Holthuis (1966) that *A. scabra* is probably confined to eastern America, but *A. rivalis* Smith, 1871, from the Pacific drainage of the Americas has an almost identical color pattern; the minor morphological characters by which that species is distinguished may prove eventually to be of no more than subspecific importance.

The single ovigerous female of *A. innocous* from Dominica was collected on January 29.

Genus *Jonga*

9. *Jonga serrei* (Bouvier)

FIGURES 11, 14*f, g*

Ortmannia Serrei Bouvier, 1909, p. 332 [type-locality: vicinity of Havana, Cuba]; 1925, p. 279, figs. 645–654.
Ortmannia serrei.—Schmitt, 1935, p. 137.
Potimirim serrei.—Holthuis, 1954, p. 3 [by implication].
Jonga serrei.—Hart, 1961a, p. 3, figs. 1–2.

DIAGNOSIS.—*Orbital margin armed dorsally with row of denticles.* Rostrum without dorsal teeth, ventral margin dentate but not finely

serrate. Ventral margins of abdominal pleura unarmed. Eyes not reduced. Basal segment of antennular peduncle without dorsal spines proximal to series bordering distal margin. Pereiopods without exopods. Fingers of chelae of first and second pereiopods bearing terminal tufts of long hair. Carpus of second pereiopod much longer than broad. Last three pereiopods without prominent horny scales or tubercles. Merus of third pereiopod not noticeably broader than that of fourth pereiopod. *Appendix masculina on second pleopod of male forming long, slender, sharp-pointed spike.* A small species, maximum postorbital carapace length about 5 mm.

Color in life.—Male (fig. 11*a*): Translucent with pale pink suffusion; white chromatophores widely scattered but more concentrated in dorsal and dorsolateral areas (corresponding to locations of stripes and bands in females). Groups of white chromatophores at base of each pleopod and red ones scattered along courses of ventral blood vessels and nerve cord; carapace with widely scattered, red chromatophores but these rarer than white ones, and blue ones absent. Antennular peduncle orange red to yellow; tips of fingers of first and second pereiopods orange red and setae extending from them gray to buff; uropods and telson fringed with orange-tan setae.

Female: There are two somewhat distinct color patterns represented among the females of this species that vary in color from almost black, dark blue, or reddish purple to orange red, gold, or translucent.

1. One pattern (fig. 11*b*) is found among the darker individuals, dark blue or reddish purple; the blue form is described here. Carapace and abdomen dark blue with yellow or whitish translucent median longitudinal stripe from tip of rostrum through basal fifth of telson; blue becoming slightly diluted ventrally over branchiostegites and abdominal pleura. Ventral half of rostrum blue. Third abdominal tergum with median stripe expanded laterally as it approaches posterior margin of somite, maximum expansion at posterior margin of somite, there reaching ventrally more than half distance between mid-dorsal line and articular knob at junction of tergum and pleuron. Median stripe also expanded basally on telson and covering distal half of protopodite of uropod and small proximal portion of inner ramus and almost one-third of proximolateral area of outer ramus of uropod. Matching or yellowish transverse band extending across tip of telson, distal fourth of inner ramus of uropod, and distal sixth of outer ramus.

Antennular peduncle dark blue with flagella tan, inner lighter at base than outer. Antennal peduncle and antennal scale with expanded blue chromatophores, giving both a spotted appearance; flagellum dark tan, darker than flagella of antennule; sometimes antennal scale pale laterally with dark blue lamellar portion. Podomeres of first and second legs mostly translucent with dark bands or spots, tips of fingers

scarlet with tan brush; articular areas yellowish to orange; third, fourth, and fifth legs similar to first and second, but propodus and dactyl translucent. Pleopods mostly dark with translucent areas interspersed. Eggs greenish brown.

2. This pattern (fig. 11*c*) is found most frequently in individuals that are tan to dark brown with cream to yellowish-tan markings. Coloration of carapace less regular than in other pattern but generally darker dorsally than ventrally; upper half of rostrum light, lower half dark; light area extending posteriorly onto carapace to level of base of first pereiopod, posterodorsal area of carapace also light. Abdomen

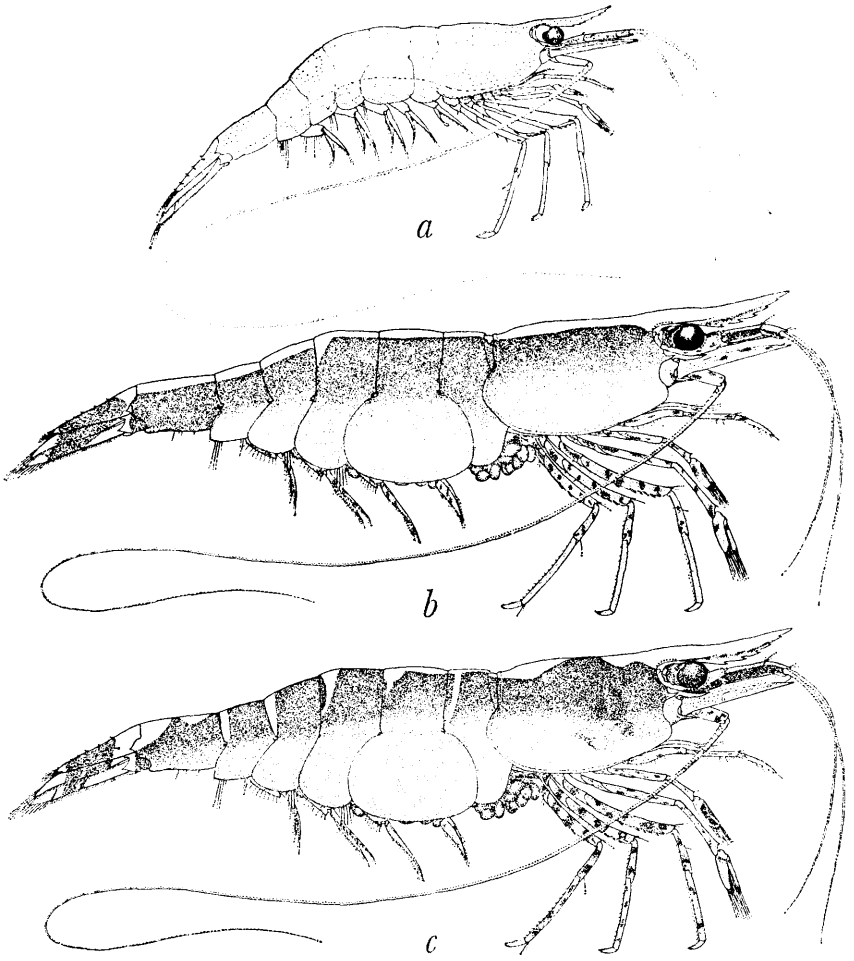


FIGURE 11.—*Jonga serrei* from Dominica station 80: *a*, male (carapace length 2.6 mm); *b*, female (cl 4.5 mm) showing median-stripe color pattern; *c*, same showing transverse-band color pattern.

like carapace, generally dark dorsally and lighter ventrolaterally with pleura distinctly lighter than terga (excluding pale markings); first two abdominal terga with median longitudinal light stripe expanded laterally in posterior portions of both, expansion on first narrower but extending to base of pleura; third, fourth, and fifth terga lacking median longitudinal band but each with transverse bands posteriorly, those on fourth and fifth extending ventrolaterally to base of pleura along posterior margins of respective terga; sixth abdominal tergum with oval light patch in anterior half and much broader light area posteriorly extending onto anterior half of telson. Telson and uropods light (yellow, cream, or translucent) anteriorly and posteriorly with dark area between; dark area on telson and inner ramus of uropod covering about one-half of each, and that on outer ramus, about one-quarter. Abdominal pleura with irregular markings, those on second and third subtriangular with apex pointed ventrally, second also with small light area anteroventrally; fourth and fifth pleura each with conspicuous light areas narrow ventrally but broadened dorsally. Appendages very similar to those of dark forms (see above) but, by contrast, bands on legs, especially fourth and fifth, more prominent. Eggs brownish red.

MATERIAL EXAMINED.—The Dominican collections contain 177 males (carapace lengths 1.6–2.7 mm), 294 females (cl 1.6–4.9 mm), including 144 with eggs (cl 2.8–4.9 mm), and 182 juveniles (cl 0.7–1.7 mm). The smallest recognizable males, in which the appendix masculina on the second pleopod varies from a barely discernible bud to twice as long as the appendix interna, have carapace lengths of 1.6 or 1.7 mm.

ECOLOGICAL NOTES.—This small shrimp seems to be restricted, at least on Dominica, to estuarine and sluggish lotic environments where it is sheltered from rapid currents among roots of littoral vegetation, in various sorts of debris, and particularly in mats of aquatic vegetation. The lower reaches of the Castle Bruce River are scarcely above sea level, and sand has effectively impounded much of the mouth, leaving only a narrow, shallow channel through which water spills into the Atlantic. In the sluggish, shallow area immediately upstream from the mouth there is a luxuriant growth of *Potamogeton*, and among the mats of this plant *Jonga serrei* occurs in large numbers.

The species is absent from those streams that have no estuarine habitat; for example, it is not in the Rosalie River (pl. 2A), the mouth of which is located only a little more than seven miles south of the mouth of the Castle Bruce River and is almost continuously scoured by a comparatively swift current. By contrast, *Jonga* has found a congenial habitat among the roots of shoreline plants and in other debris in the estuarine portion of the Layou (pl. 2B), the largest river

on the island, where the littoral areas are not continuously abraded by swift currents. In this area of the river, floating coconut husks are frequented by this shrimp, and in those husks that have been in the water for several days, a few individuals are almost always present.

DISTRIBUTION.—West Indies and Republic of Costa Rica (?) (Cuba, Jamaica, Puerto Rico, Dominica, Barbados). *Jonga* was believed to be a West Indian endemic until we received from D. P. Kelso specimens of *J. serrei* or a closely related species collected in the vicinity of Tortuguero, Costa Rica, in 1963 and 1964.

Dominica Stations: 13–15, 18, 54, 56, 57, 62, 67, 71, 72, 78, 80, 81, 84 (0–1,500 ft.).

REMARKS.—There is no doubt that this little shrimp is generically distinct from the species of *Potimirim*. It is distinguished not only by the denticulate orbital margin but also by the unique appendix masculina on the second pleopod of the male. Of all of the American atyids, it seems to resemble most closely the species of *Caridina*, which are so numerous and so widespread through most of the tropical regions of the world except the Americas.

Jonga serrei was collected on Dominica only in February, March, and April; ovigerous females were well represented in all three months.

Genus *Micratya*

10. *Micratya poeyi* (Guérin-Méneville)

FIGURES 12, 13, 14*h*, *i*

Atya Poeyi Guérin-Méneville, 1855, pl. 2: figs. 7, 7a–c [type-locality: Cuba]
Calmania Poeyi.—Bouvier, 1909, p. 335.
Micratya Poeyi.—Bouvier, 1913, p. 181; 1925, p. 325, figs. 709–716.
Micratya poeyi.—Schmitt, 1935, p. 137, fig. 11.
Micratyia poeyi.—Vélez, 1967, p. 42.
Micraitya poeyi.—Vélez, 1967, p. 42.

DIAGNOSIS.—Orbital margin unarmed. Rostrum with dorsal teeth, ventral margin with one or two teeth but not finely serrate. Ventral margins of abdominal pleura unarmed. Eyes not reduced. Basal segment of antennular peduncle without dorsal spines proximal to series bordering distal margin. Pereiopods without exopods. Fingers of chelae of first and second pereiopods bearing terminal tufts of long hair. *Carpus of second pereiopod very slightly longer than broad.* Last three pereiopods armed with sharp spines, but without horny scales or tubercles. Merus of third pereiopod not much broader than that of fourth. *Appendix masculina on second pleopod of male extending far beyond end of appendix interna and armed only with terminal cluster of long, stout spines.* A small species, maximum postorbital carapace length little more than 6 mm.

COLOR IN LIFE.—There are three distinct color patterns in both males and females of *Micratya poeyi;* sometimes, because of adaptations to light backgrounds, the patterns are not readily discernible. The three patterns are designated herein (1) vertical-band, (2) median-stripe, and (3) self.

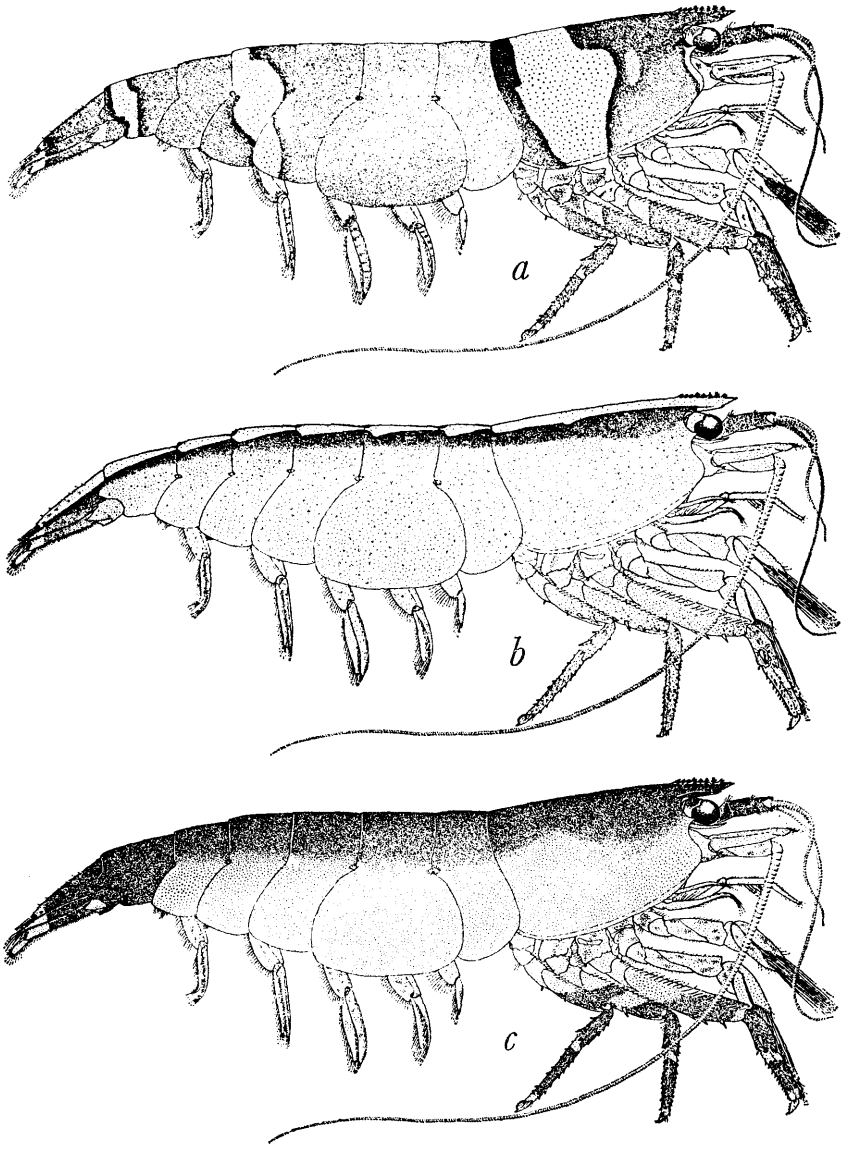


FIGURE 12.—*Micratya poeyi* from Dominica station 66: *a*, female (carapace length 5.4 mm) showing vertical-band color pattern; *b*, same showing median-stripe color pattern; *c*, same showing self color pattern.

1. Vertical-band Pattern, Blue Phase (fig. 12*a*): Anterodorsal part of carapace and rostrum mostly dark bluish gray fading ventrally to lavender cream; rostral spines corneous (yellow). Narrow vertical white band on anterior margin of carapace from antennal spine to level of lower portion of antennal peduncle. Posterior half of carapace with broad, transverse, white or cream band subtended immediately anteriorly by narrow black band fading anteriorly into bluish-gray area; immediately posterior to white band, black one reaching posterior

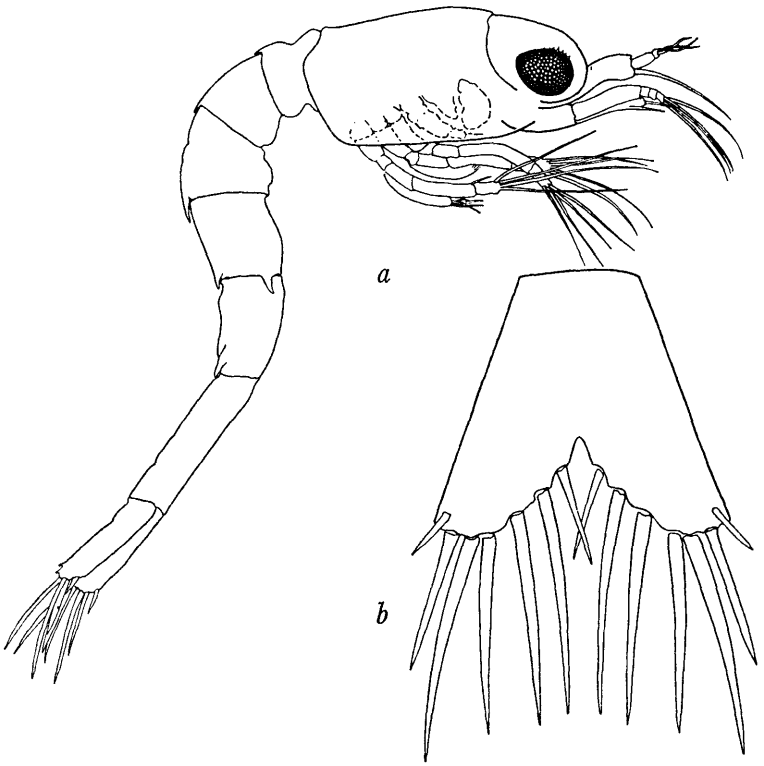


FIGURE 13.—*Micratya poeyi*: *a*, probable first larval stage in lateral view; *b*, telson of same in dorsal view.

border of carapace and fading ventrally to dark gray. Suboval pale gray spot immediately anterior to anterior black band. Abdomen mostly bluish gray with reddish-purple spots at articular knobs of segments 1 through 4. Posteroventral angle of fourth pleuron white. Fifth tergum black anteriorly with narrow white band dorsally expanding on lateral portions of tergum and narrowing on pleuron where restricted to anteroventral portion. Posterior portion of sixth tergum with narrow white or cream transverse band extending ventrally onto posterolateral part of somite. Lateral spine on base of uropod

white distally. Posterior part of telson and distal portions of both rami of uropods pale yellow with buff setae, adjacent anterior areas black fading anteriorly to dark gray.

Antennular peduncle and inner flagellum dark gray; outer flagellum pale bluish gray. Antenna pale bluish tan. First and second pereiopods

FIGURE 14.—Male second pleopods: *a*, left, posteromesial view, *Atya innocous* shown in figure 8; *c*, left, posteromesial view, *A. lanipes* (carapace length 20.6 mm) from Maricao, Puerto Rico (N. T. Mattox); *d*, right, posteromesial view, *A. scabra* shown in figure 9; *f*, right, posterior view, *Jonga serrei* shown in figure 11; *h*, right, posteromesial view, *Micratya poeyi* (cl 4.2 mm) from Dominica station 66. Left appendices masculinae, posteromesial view: *b*, *A. innocous* from Dominica; *e*, *A. scabra* from Dominica; *g*, *J. serrei* from Dominica; *i*, *M. poeyi* from Dominica.

translucent with lavender spots; terminal setal tufts dark bluish gray basally fading to pale yellow at midlength and becoming dark gray distally. Ambulatory legs translucent with blotches of bluish purple proximal to merus; distal two-thirds of merus light purple with pale pinkish distal articular area; carpus with broad light purple band extending from just distal to proximal articular area to distal end of podomere; propodus with similar purple band on distal four-fifths of podomere although with light apical band; dactyl pinkish with corneous tip. Pleopods translucent lavender with bluish to purple spots. Eggs bluish black.

Yellow Phase: Differs from blue phase in that the dark areas are brown; the blue, orange to yellow; and the white, cream or pinkish. Too, the posterior portions of the telson and uropods are bright yellow.

2. Median-stripe Pattern (fig. 12*b*): Median, longitudinal, white or cream stripe extending from tip of rostrum to posterior margin of telson; stripe broadening posteriorly in each abdominal somite but in first five narrowing suddenly just anterior to posterior borders. From level of base of eye-stalk posteriorly, median stripe subtended by bluish black bands fading quickly ventrally to translucent area bearing widely dispersed red, blue, and white chromatophores. Articular knobs at bases of pleura surrounded by purple. Uropods dark blue to gray with terminal bands of yellow.

Antennules, antennae, and pereiopods as in vertical-band pattern except banding of third through fifth pereiopods not so prominent. Pleopods translucent with very few red and blue chromatophores; with yellow setae. Eggs brown.

3. Self Pattern (fig. 12*c*): Dorsum of carapace, terga of abdomen, anterior four-fifths of telson, proximal two-thirds of inner ramus of uropod, and proximal half of outer ramus dark purple, almost black. Ventrally, purple area fading quickly to pinkish translucent on branchial region and first five abdominal pleura. Posterior area of telson, distal portions of both rami of uropods, and lateral spine on base of uropod cream or yellow.

Antennules and eyestalk purple. Antennae, first and second pereiopods, and proximal podomeres of third through fifth pereiopods translucent with red chromatophores. Merus of third and fifth pereiopods with distal half, except tip, reddish purple; that of fourth with two bands, one in proximal and other in distal half. Carpus of third through fifth pereiopods reddish purple, propodus purple except at distal extremities where pinkish translucent. Pleopods translucent with widely scattered chromatophores and yellow setae.

MATERIAL EXAMINED.—The Dominican collections contain 282 males (carapace lengths 1.8–4.6 mm), 510 females (cl 1.8–6.2 mm),

including 228 with eggs (cl 3.2–6.2 mm), and 295 juveniles (cl 1.1–1.9 mm). The smallest recognizable males, in which the appendix masculina on the second pleopod varies from a bud to twice the length of the appendix interna, have carapace lengths of 1.8 to 2.0 mm.

ECOLOGICAL NOTES.—*Micratya poeyi* has been observed in at least two quite different habitats. In the rivers and smaller cascading brooks, it frequents the riffle areas, where it is particularly abundant among concentrations of small rocks and pebbles. It is also abundant in rapidly flowing drainage ditches, among roots of shoreline plants and plants trailing in the current. Among the features that these two diverse types of habitats have in common are a swift current and a place in which the animals may gain a foothold.

In Mannet's Gutter (station 4), where an attempt was made to collect decapods by using pronox, *M. poeyi* seemed to be much more sensitive to the poison than any of the other shrimps and crabs.

DISTRIBUTION.—West Indies and Republic of Costa Rica (?) (Cuba, Jamaica, Puerto Rico, Dominica, Martinique). Like *Jonga*, *Micratya* was thought to be confined to the West Indian islands until a single ovigerous female was collected by D. P. Kelso in the Rio Agua Fria (8 miles from sawmill), Tortuguero, Costa Rica, August 25, 1964. Specific determination of this specimen must remain questionable until additional material becomes available from the mainland, but there is no doubt of the genus.

Dominica Stations: 1–4, 7, 13, 14, 17–19, 28, 30–33, 40, 44, 53–56, 59, 60, 63, 65, 66, 68, 69, 72, 74–80, 84, 85, 87, 88, 103, 105, 109 (0–1,350 ft.).

REMARKS.—In Dominican adults of this common little shrimp, the number of dorsal teeth on the rostrum varies from 5 to 9. In the smallest juveniles, with carapace lengths of 1.1 and 1.2 mm, there may be only one or two barely distinguishable teeth, but the number increases rapidly with growth. Slightly larger juveniles usually have three or four rostral teeth, and the maximum number of nine can be found at carapace lengths of 3.0 mm in males and 4.2 mm in females.

The Dominican collections indicate that all three of the color patterns described above are represented in every population. Examination of 87 specimens, some living and some preserved but still showing the dark-adapted patterns, suggest that the majority of males (22) belong to the form with vertical pale bands. Females (15) and juveniles are often similarly banded, but females seem to be most prevalent among the unbanded forms, either with (21) or without (15) the light, mid-dorsal stripe.

Inasmuch as females with eggs were collected on Dominica in January, February, March, May, and September, the species probably breeds throughout the year. Larvae obtained from one of them after

317-180—69——7

capture indicate that the young hatch as a zoea (fig. 13). It seems unlikely that such early stages could avoid being carried down to the lower reaches of the streams inhabitated by *Micratya*, and many of the larvae must be swept out to sea.

Genus *Potimirim*

11. *Potimirim americana* (Guérin-Méneville)

FIGURE 19*a*

Caridina americana Guérin-Méneville, 1855, pl. 2: figs. 13, 13a [type-locality: Cuba].

Ortmannia americana.—Bouvier, 1904, p. 136; 1925, p. 282, figs. 655–659.

Potimirim americana.—Holthuis, 1954, p. 3 [by implication].—Smalley, 1963, pp. 178–179, fig. 2.

DIAGNOSIS.—Orbital margin unarmed. Rostrum without dorsal teeth, dorsal margin slightly convex in distal half, ventral margin dentate but not finely serrate. Ventral margins of abdominal pleura unarmed. Eyes not reduced. Basal segment of antennular peduncle without dorsal spines proximal to series bordering distal margin. Pereiopods without exopods. Fingers of chelae of first and second pereiopods bearing terminal tufts of long hair. Carpus of second pereiopod much longer than broad. Last three pereiopods without prominent horny scales or tubercles. Merus of third pereiopod not noticeably broader than that of fourth. *Appendix masculina on second pleopod of male roughly disc shaped, nearly three-fourths as broad as long.* A small species, maximum postorbital carapace length about 5 mm.

HABITAT.—Freshwater streams.

DISTRIBUTION.—Cuba, Jamaica, Trinidad.

REMARKS.—See "Remarks" under *P. glabra* (p. 79) regarding the record of *Caridina americana* from Dominica in Pocock (1889).

12. *Potimirim glabra* (Kingsley)

FIGURES 15, 19*b*, *c*

Atyoida glabra Kingsley, 1878b, p. 93 [type-locality: west coast of Republic of Nicaragua].

?*Caridina americana*? Pocock, 1889, p. 16.

Potimirim glabra.—Holthuis, 1954, p. 3, fig. 1.—Smalley, 1963, pp. 177–182, fig. 1.

Potimirim brasiliana Villalobos, 1960, p. 275, pls. 1–5 [type-localtiy: Río Ariró, Angra dos Reis, Estado do Rio de Janeiro, Brazil].

DIAGNOSIS.—Orbital margin unarmed. Rostrum without dorsal teeth, dorsal margin convex distally, ventral margin obscurely dentate, not finely serrate. Ventral margins of abdominal pleura unarmed. Eyes not reduced. Basal segment of antennular peduncle without dorsal spines proximal to series bordering distal margin. Pereiopods

without exopods. Fingers of chelae of first and second pereiopods bearing terminal tufts of long hair. Carpus of second pereiopod much longer than broad. Last three pereiopods without prominent horny scales or tubercles. Merus of third pereiopod not noticeably broader than that of fourth. *Appendix masculina on second pleopod of male with deep, unarmed sinus in sinuous posterior margin.* A small species, maximum postorbital carapace length about 7 mm.

COLOR IN LIFE.—Ground color semitranslucent with pale greenish to bluish-green suffusion, and entire color pattern in shades of blue. Dorsal and dorsolateral portions of carapace with mottled blue but with clear dorsomedian longitudinal stripe extending from rostrum to telson; anterolateral area posterior to antennal spine with dark

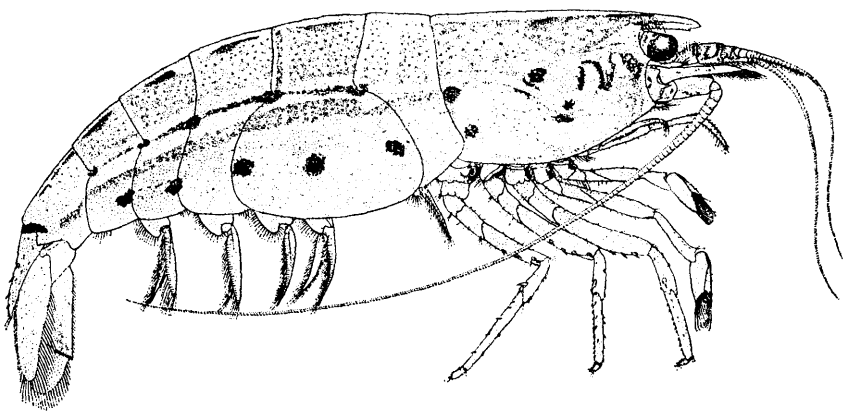


FIGURE 15.—*Potimirim glabra*, female (carapace length 5.8 mm) from Dominica station 26.

blue, M-shaped mark. Posterolateral surface of branchical region with longitudinal light stripe extending anteroventrally from level of base of abdominal pleuron and, at level of base of first pereiopod, broadening and extending anterodorsally over M-shaped mark to orbit; pair of irregular spots, one in light area and one below it at level of base of first pereiopod; pair of sublinear spots flanking lateral light band just posterior to expanded light area; larger dark spot situated anterodorsal to upper sublinear spot; posteroventral portion of branchial region with two prominent spots, more dorsal one contiguous with lower posterior margin of light band, and ventral one anteroventral to latter and situated above base of fifth leg; ventral half of branchial region mottled with faint submarginal stripe. Tergum of first abdominal somite with two subequal, paired, rectangular bands flanking dorsomedian light band and extending ventrally almost to base of pleura; second abdominal tergum with broad anterior and very

narrow posterior rectangular bands; remaining terga with single rectangular band; upper margins of bands, except those in first abdominal somite partially edged in dark blue. Translucent longitudinal band on tergopleural junction encompassing dark blue longitudinal stripe extending from articular knob between first and second abdominal segments to that between fifth and sixth, band darkest and broadest at knobs, becoming more diffuse posteriorly from each knob and progressively narrower and less distinct posteriorly. Dorsal portions of pleura crossed by longitudinal light stripe, flanked ventrally by bluish green band, and latter flanked ventrally by another pale band. Ventral half to three-fifths of pleura pale bluish green and translucent, with longitudinal row of five prominent dark blue spots on level with posteroventral spot on carapace; anterior three spots spanning second pleuron, fourth on fourth pleuron and last on fifth. Sixth abdominal somite with similarly colored spot on posterolateral margin contiguous with spot on anteromedian margin of telson.

Eyestalks, antennular and antennal peduncles, and anterolateral surfaces of coxae of pereiopods with dark blue spots; appendages otherwise translucent bluish green except for scarlet tips of chelae of first and second pereiopods bearing grayish-tan setal tufts.

Material examined.—The Dominican collections contain 7 males (carapace lengths 3.7–4.2 mm), 17 females (cl 2.2–6.9 mm), 1 of which is ovigerous (cl 6.2 mm), and 3 juveniles (cl 1.3–1.8 mm). All of the males have the appendix masculina on the second pleopod fully formed.

Ecological notes.—A rubble bottom and moderately swift to swift current typify all of the localities in which *P. glabra* was found. Only at station 105 was the collector aware that he was collecting specimens of this species at the time that he took them. Here, just below a small waterfall is a pool of clear water, some 15 to 20 feet in diameter, from which the water flows in several narrow channels over moss-covered stones and rubble. The 10 specimens taken in this locality were obtained by placing a net downstream from the beds of rubble and scouring the accumulation of small stones and sand and by thrusting a small net into the mats of submerged moss. Along with the 10 specimens of *Potimirim*, 70 specimens of *Atya innocuous* were secured, most of which were approximately the size of the *Potimirim*. This locality (see Mitchell, 1966, pp. 90–91) is on the northeastern slope of Morne Trois Pitons on a tributary to the Fond Figues River at an elevation of slightly less than 1,400 feet.

Distribution.—Dominica, republics of El Salvador, Nicaragua, and Costa Rica, and Rio de Janeiro and São Paulo states, Brazil.

Dominica Stations: 26, 32, 39, 55, 63, 75, 76, 81, 105 (25–1,350 ft.).

REMARKS.—This small shrimp superficially resembles juvenile specimens of *Atya*, but it can readily be distinguished by the elongate carpus of the second pereiopod.

As *Potimirim glabra* is the only species of the genus collected on Dominica during the present survey and as it was found in the Laurent River, a tributary of the Layou from which came the two ovigerous females questionably identified by Pocock (1889) as *Caridina americana*, it seems likely that the latter specimens may belong to this species.

All of the specimens of *P. glabra* in the present collections were taken in February and March; the single ovigerous female was found in the latter month.

13. *Potimirim mexicana* (De Saussure)

FIGURE 19*d*

Caridina mexicana De Saussure, 1857c, p. 505 [type-locality: Veracruz, Mexico].
Atyoida Mexicana.—Von Martens, 1868, p. 49.
Ortmannia potimirim.—Rathbun, 1901, p. 120 [not *Atyoida potimirim* Müller, 1881, p. 117].
Ortmannia mexicana.—Bouvier, 1904, p. 136; 1925 [part], p. 284, figs. 660–667.
Potimirim mexicana.—Holthuis, 1954 [part], p. 4.—Villalobos, 1960, p. 295, pls. 6–9.

DIAGNOSIS.—Orbital margin unarmed. Rostrum without dorsal teeth, dorsal margin nearly straight, ventral margin dentate but not finely serrate. Ventral margins of abdominal pleura unarmed. Eyes not reduced. Basal segment of antennular peduncle without dorsal spines proximal to series bordering distal margin. Pereiopods without exopods. Fingers of chelae of first and second pereiopods bearing terminal tufts of long hair. Carpus of second pereiopod much longer than broad. Last three pereiopods without prominent horny scales or tubercles. Merus of third pereiopod not noticeably broader than that of fourth. *Appendix masculina on second pleopod of male without deep, unarmed sinus in sinuous posterior margin.* A small species, maximum postorbital carapace length about 6 mm.

HABITAT.—Freshwater streams.

DISTRIBUTION.—Northeastern Mexico to Republic of Costa Rica, Cuba, Jamaica, Puerto Rico.

REMARKS.—In view of the discovery on Dominica of *Potimirim glabra*, a species known previously from the mainland of Central and South America, West Indian material identified as *P. mexicana* should be examined carefully to be sure that the closely related *P. potimirim* (Müller, 1881) is not represented. The latter species, thus far recorded only from South America, may be distinguished, according to Villalobos (1960), by the narrower appendix masculina on the second pleopod of the male.

Genus *Typhlatya*

14. *Typhlatya garciai* Chace

Typhlatya garciai Chace, 1942, p. 99, pl. 29 [type-locality: cave at Banes, Provincia de Oriente, Cuba].

DIAGNOSIS.—Orbital margin unarmed. Rostrum represented only by unarmed angular projection of frontal margin not reaching ends of eyestalks. Ventral margins of abdominal pleura unarmed. Eyes reduced, cornea limited to distolateral pigment spot on eyestalk. Basal segment of antennular peduncle without dorsal spines. All pereiopods with well-developed exopods. Fingers of chelae of first and second pereiopods bearing terminal tufts of long hair. Carpus of second pereiopod much longer than broad. Last three pereiopods without horny scales or tubercles. Merus of third pereiopod not noticeably broader than that of fourth. A small species, maximum postorbital carapace length about 5 mm.

HABITAT.—Subterranean fresh water.

DISTRIBUTION.—Known only from a cave at Banes, Provincia de Oriente, Cuba.

15. *Typhlatya monae* Chace

FIGURE 16

Typhlatya monae Chace, 1954, p. 318, fig. 1 [type-locality: well near Sardinera, Isla Mona, Puerto Rico].

DIAGNOSIS.—Orbital margin unarmed. Rostrum represented only by unarmed, angular projection of frontal margin not reaching ends of eyestalks. Ventral margins of abdominal pleura unarmed. Eyes reduced, cornea limited to distolateral pigment spot on eyestalk.

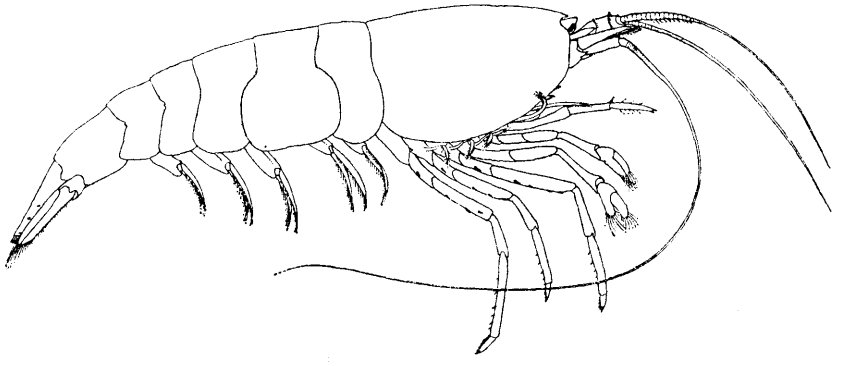


FIGURE 16.—*Typhlatya monae*, female (carapace length 4.5 mm) from Dark Cave, Barbuda (Smithsonian-Bredin Caribbean Expedition, 1959).

Basal segment of antennular peduncle without dorsal spines. First four pereiopods with well-developed exopods, *that on fifth reduced to barely discernible bud.* Fingers of chelae of first and second pereiopods bearing terminal tufts of long hair. Carpus of second pereiopod much longer than broad. Last three pereiopods without horny scales or tubercles. Merus of third pereiopod not noticeably broader than that of fourth. A small species, maximum postorbital carapace length about 5 mm.

HABITAT.—Subterranean fresh water.

DISTRIBUTION.—Isla Mona; Barbuda.

REMARKS.—Specimens collected in Dark Cave on Barbuda during the Smithsonian-Bredin Expeditions of both 1958 and 1959 appear to be indistinguishable from the type-series from Isla Mona.

Genus *Xiphocaris*

16. *Xiphocaris elongata* (Guérin-Méneville)

FIGURES 17, 18, 19*e*, *f*

Hippolyte elongatus Guérin-Méneville, 1855, pl. 2: figs. 16, 16a [type-locality: Havana, Cuba].

Oplophorus americanus De Saussure, 1858, p. 472, pl. 4: figs. 31–31b [type-locality: mouths of rivers of Republic of Haiti].

Xiphocaris elongata.—Von Martens, 1872, p. 140.—Pocock, 1889, p. 17, pl. 2: fig. 8.—Bouvier, 1925, pp. 9–20, 48–54, figs. 1–53.—Hart, 1961b, p. 76, figs. 18–19.

Xiphocaris gladiator Pocock, 1889, p. 18, pl. 2: fig. 6 [type-locality: Layou River, Dominica].

Xiphocaris gladiator, var. *intermedia* Pocock, 1889, p. 19, pl. 2: fig. 7 [type-locality: Layou River, Dominica].

Xiphocaris brevirostris Pocock, 1889, p. 20, pl. 2: figs. 5, 5a [type-locality: Dominica].

Oplophorus elongatus.—Sharp, 1893, p. 121.

Xiphocaris elongata typica.—Ortmann, 1894, p. 400.

Xiphocaris elongata intermedia.—Ortmann, 1894, p. 400.

Xiphocaris elongata gladiator.—Ortmann, 1894, p. 400.

Xiphocaris elongata brevirostris.—Ortmann, 1894, p. 400.

DIAGNOSIS.—Orbital margin unarmed. Rostrum armed with series of subequal, close-set, small teeth in basal part of dorsal margin, *ventral margin finely serrate.* Ventral margins of abdominal pleura unarmed. Eyes well developed. Basal segment of antennular peduncle without dorsal spines. All pereiopods with well-developed exopods. *Fingers of chelae of first and second pereiopods without terminal tufts of long hair.* Carpus of second pereiopod longer than broad. Last three pereiopods without horny scales or tubercles. Merus of third pereiopod not noticeably broader than that of fourth. *Appendix masculina on second pleopod of male short (not overreaching appendix*

interna), *subcylindrical, and armed distally with crown of moderately long spines.* A medium-sized species, maximum postorbital carapace length about 15 mm.

COLOR IN LIFE.—Body greenish but translucent with internal organs visible (not shown in fig. 17), subtriangular brown stomach most conspicuous, massive hepatopancreas also dark brown with narrow cream area on dorsal side of each lobe; intestine brown with pair of longitudinal light cream stripes on each side of dorsomedian line; pigmented portion of eyes matching coloration of hepatopancreas.

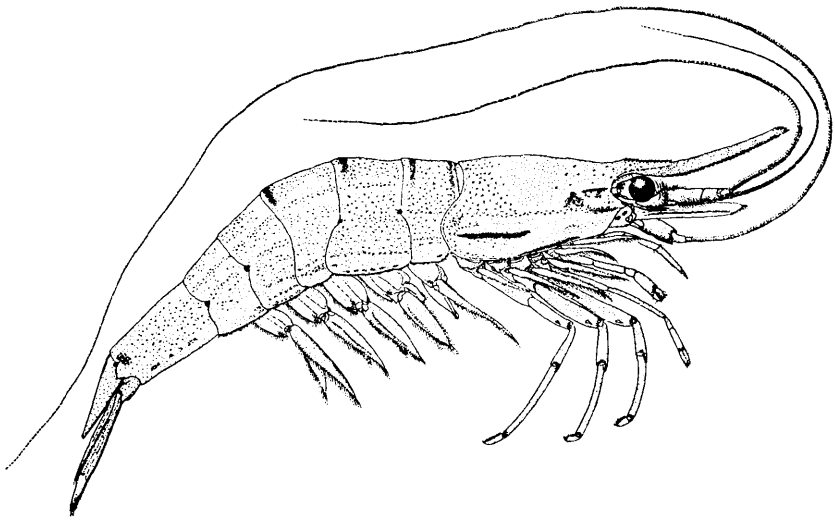


FIGURE 17.—*Xiphocaris elongata*, male (carapace length 9.6 mm) from Dominica station 48.

Carapace with short brown or purple stripe just posterior to orbit, and prominent irregular spot just posteroventral to stripe; another stripe of same color, although more diffuse and becoming reddish, extending from antennal spine posteriorly almost to posterior margin of carapace, posteriorly line continuous with broad transverse band of red chromatophores extending across carapace to line on opposite side. Posteroventral portion of branchial region with narrow white stripe extending from level of coxa of second pereiopod to level of that of fifth, subtended below by bluish-purple one; ventral margin of carapace with bluish-purple stripe extending from level of base of third maxillipeds to level of coxa of third pereiopod. Rostrum distal to posterior series of dorsal spines orange with lower margin studded with brown corneous spines. Tergum of first abdominal somite with narrow anterior and posterior transverse bands of purplish red, bands extending ventrally to base of pleuron; tergum of second and

third abdominal somites each with narrow transverse band posteriorly, neither band approaching bases of pleura. Dorsolateral portions of second through base of sixth terga with longitudinal stripe of red chromatophores; two similar ones present on pleuron of first abdominal somite, one along base of pleuron and other at level of posteroventral bluish-purple stripe on branchial region; lower row on pleuron followed on succeeding three pleura and on sixth somite by narrow longitudinal row of white chromatophores; lower margins of second, fourth, and anterior portion of fifth pleura with row of white chromatophores; bluish-purple stripe present immediately above marginal row of white chromatophores on fourth and fifth pleura, and another slightly dorsal to latter bluish-purple stripe on third and posterior portion of second pleura. Articular knobs with purple spots at anterior margins of second, third, fifth, and sixth somites. Posterolateral portion of sixth somite with irregular brown spot and brownish-purple one at dorsal base of lateral spine. Telson and uropods with brown margins, purple spots at articular knobs, and outer ramus of uropod with distal yellow area.

Lower portion of antennular peduncle and inner flagellum blue; antennal peduncle and scale with blue markings. Pereiopods translucent with orange at bases of fingers of first and second, and at bases of three distal podomeres on remaining pereiopods. Pleopods with blue spot on posterodistal end of protopodite and blue line on exopodite.

Material examined.—The Dominican collections contain 212 males (carapace lengths 3.8–9.9 mm), 204 females (cl 4.0–12.5 mm), including 1 with eggs (cl 10.9 mm), and 1,457 juveniles (cl 2.0–3.9 mm). The appendix masculina on the second pleopod of the male may not become apparent in this species until a carapace length of nearly 7.0 mm is attained (it is a minute bud in two specimens with carapace lengths of 6.1 and 6.2 mm), but the asymmetrical form of the endopod of the first male pleopod is usually noticeable at carapace lengths of between 4.0 and 5.0 mm, and it is discernible in one specimen with a carapace length of only 3.8 mm; a carapace length of 4.0 mm was therefore used as the minimum size at which sex can usually be determined.

Ecological notes.—*Xiphocaris elongata* occurs in many diverse types of habitat on Dominica, but it is not everywhere abundant, and just what factors determine its absence or presence are not known. Fully mature specimens were collected, usually from pools, in the upper reaches of streams at altitudes of 200 to 900 feet, where no juvenile specimens were encountered. Within the pools, groups of individual shrimps clung to submerged rocks, frequently on those exposed to full sunlight. In the Laurent River (station 48), on the

other hand, large specimens were observed in the swift current, as well as in the quiet pools. For several miles up the Layou River from its mouth, juvenile and small subadult *Xiphocaris* were present in the littoral portions of the river, but were never seen far from the shoreline. Here, too, they were frequently found clinging to the lee

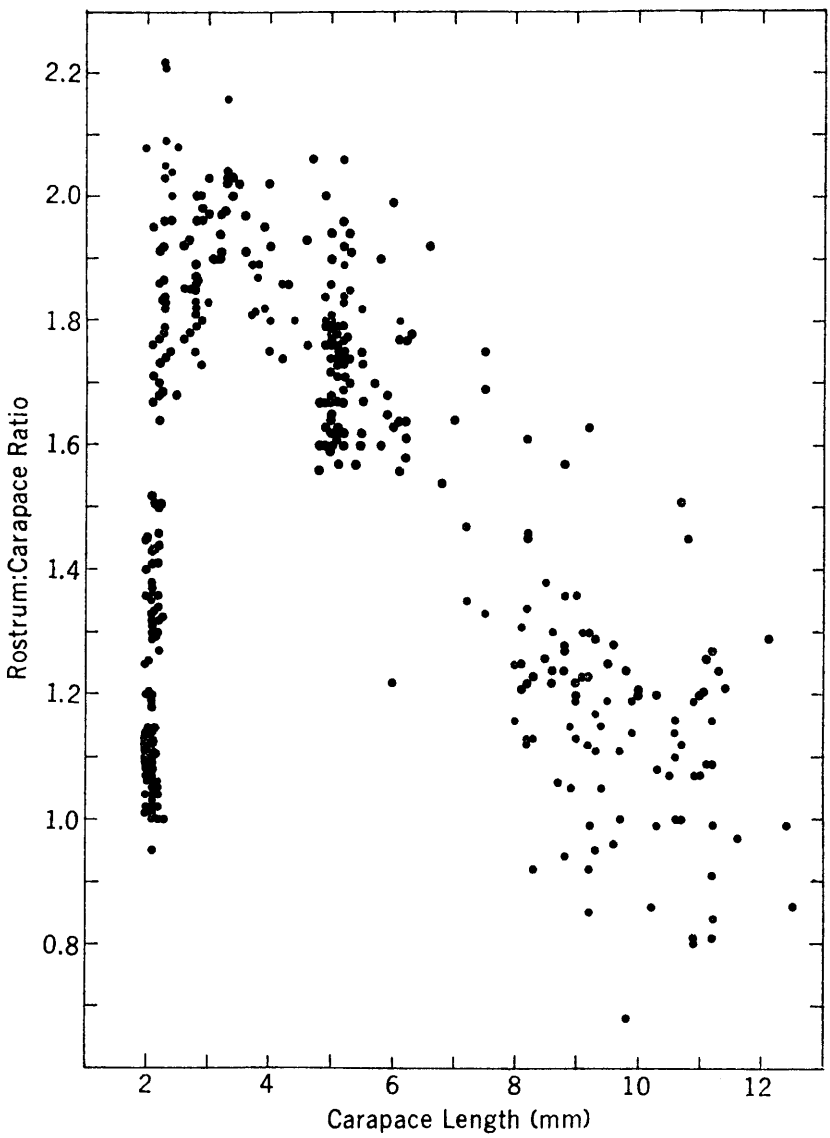


FIGURE 18.—Scatter diagram showing correlation of the proportionate length of the rostrum with growth in specimens of *Xiphocaris elongata* collected on Dominica in 1964.

side of a rock in the current or, in greater numbers, clinging to rocks in a sluggish current or in a quiet backwater, often no more than a few inches from a swiftly flowing part of the stream. The smallest juveniles (carapace lengths 2.0–2.2 mm) were often abundant along the shore in the lower reaches of the Layou. On February 12, 1964, vast numbers of these juveniles were observed in shallow water near the shore of a small, freshwater (sometimes brackish) embayment near the mouth of the Layou. For yards along the shore there was a continuous, densely packed school not more than one to one and one-half feet wide and seldom more than six shrimps deep.

Xiphocaris, as noted by other observers, is a very active shrimp. When pursued with a net, individuals quickly jump above the surface of the water and swim rapidly away from the point at which they land. Apparently, their most effective retreat can be made by a sudden flexion of the abdomen that carries them out of the water. It soon became apparent that they could be collected most readily by thrusting a net on top of them rather than by approaching in the conventional manner from the side or below. They are such strong swimmers that they can probably negotiate low cascades in their presumed upstream migrations. Even when a sudden inopportune jump lands them on dry sand or among rocks above the water line, they rather startle an observer by rapidly, although not very gracefully, crawling back to the water. Several erratic jumps may precede the methodical crawl, and frequently the first jump carries the shrimp back into the stream. When being pursued, they seem to orient themselves so that the first jump takes them into the current and away.

Even the juvenile specimens in the lower reaches of the river have similar escape reactions. When the observer approached the extensive school in the lower Layou, mentioned above, the shrimps in the shallowest water jumped an inch or so above the surface in an apparent attempt to reach deeper water as quickly as possible. In this way the entire segment of the school moved offshore a foot or so. When the observer ceased all motion, the school moved back inshore, following the contour of the water line. The orientation of the individuals in the school seemed to be controlled by the direction of the local wind currents: when the water moved toward the mouth of the river, the shrimps faced upstream and remained nearly stationary relative to the shore; when the current was reversed, they responded accordingly, facing the river mouth, but maintaining their original relative positions. While the school was being watched, a 5- or 6-inch fish attacked, breaching the ranks, but the school quickly reassembled after the sudden attack. A group of "tri-tri" (larval fishes) swimming slightly deeper and offshore from the shrimps seemed not to affect

the formation. Five days later, the school had apparently disappeared, and far fewer *Xiphocaris* were to be found in the area.

DISTRIBUTION.—Known only from the West Indian islands (Cuba, Jamaica, Hispaniola, Puerto Rico, Saint Croix, Dominica, Saint Lucia I., Barbados).

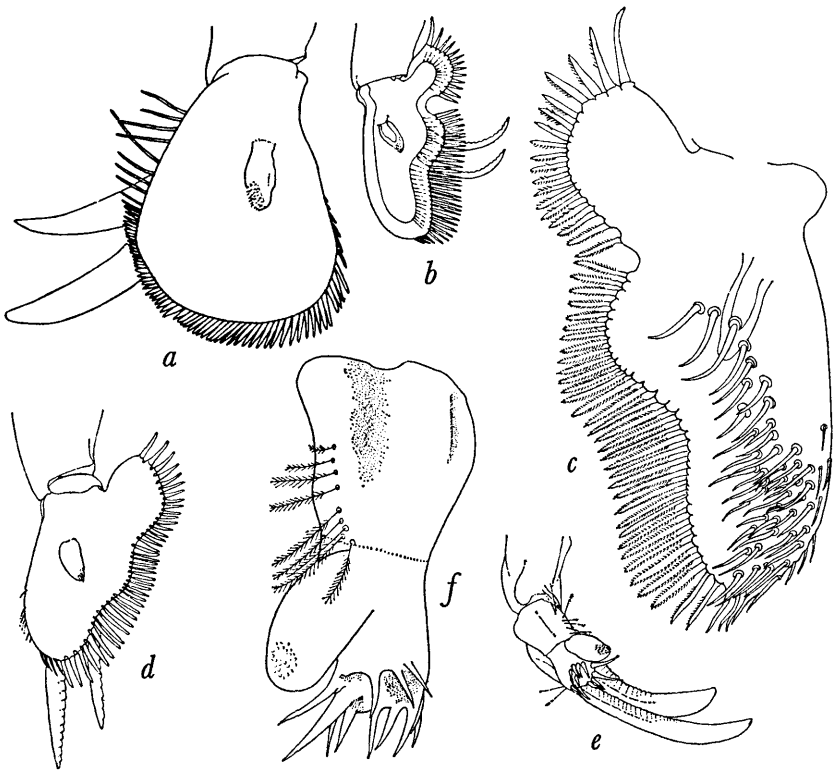


FIGURE 19.—Male second pleopods: *a*, left, posteromesial view, *Potimirim americana* (after Smalley, 1963); *b*, right, mesial view, *P. glabra* (carapace length 4.2 mm), Dominica station 26; *d*, right, mesial view, *P. mexicana* (cl 2.7 mm), near Nequabo, Puerto Rico (H. W. Harry); *e*, right, mesial view, *Xiphocaris elongata* (fig. 17). Appendices masculinae: *c*, right, lateral view, *P. glabra*, Dominica; *f*, left, mesial view, *X. elongata*, Dominica.

Dominica Stations: 1–3, 6, 11–15, 17, 30, 36, 38, 44, 48–52, 55, 57, 61, 63, 64, 66, 67, 71, 72, 79, 80, 81, 83, 100 (0–1,150 ft.).

REMARKS.—The reason for the variability in the relative length of the rostrum in this species, which led Pocock (1889) to propose, with reservations, three distinct species and a variety, cannot be fully explained by the material collected during the present Dominican Survey. Statistical analysis of this character in the Dominican series demonstrates that growth changes are responsible for some of the

differences, as suspected by Pocock and others. Contrary to the statement made by that author, the rostrum of many shrimps increases rapidly in relative length in the youngest juveniles, then gradually decreases in proportion as the body lengthens and broadens. This pattern is followed very closely in *Xiphocaris* (fig. 18). In the collections made on Dominica in 1964, the rostrum-carapace ratio usually varies from 1.0 to 1.3 in the smallest juveniles with a carapace length of 2.0 mm. The highest ratio, i.e., the greatest proportionate rostral length, varies from about 1.7 to 2.2 and is attained at a carapace length of about 2.3 mm. From that maximum the ratio decreases rather rapidly and regularly to a generally observed range of 0.8 to 1.3 in mature shrimps with carapace lengths of 8 to 12 mm. With one exception (a male in which the rostrum may have regenerated), the ratios in the largest specimens taken in 1964 did not fall below 0.8, and the rostrum is longer than the carapace in most of the specimens, which are therefore referable to typical *X. elongata* as restricted by Pocock; in only five specimens does the rostrum fall short of the end of the antennal scale, as in Pocock's *X. gladiator gladiator*. Much to our surprise, therefore, specimens collected in Mannet's Gutter (station 50) in 1966 have the rostrum rather consistently shorter than those taken at the same season of the year from the same locality two years earlier. Seven of the 12 specimens with carapace lengths greater than 8.0 mm taken in 1966 have rostrum-carapace ratios as low as 0.47 to 0.55, which would refer them to or near Pocock's *X. brevirostris*. We are at a loss to explain this striking difference between the Mannet's Gutter populations of 1964 and 1966.

The only ovigerous female in the collection was found in Mannet's Gutter on March 21, 1964, and other specimens with eggs were seen but not collected at that time. This was the latest date on which mature specimens were collected, and the absence of egg-bearing specimens among the numerous mature females collected earlier would suggest a breeding season starting in late March. On the other hand, the innumerable small juvenile specimens schooling in the lower reaches of the Layou on February 12 would suggest a hatch in late fall or early winter and, therefore, an extended or multiple breeding season, unless the eggs are retained for a very long period or the larvae are unusually long lived.

Family PALAEMONIDAE

Subfamily PALAEMONINAE

Key to the Species

1. Carapace with two spines on anterolateral margin, antennal and branchiostegal . . . . . **Palaemon (Palaemon) pandaliformis** (p. 111)

Carapace with no more than one spine on anterolateral margin, branchiostegal and rarely antennal spines absent 2

2. Carapace with hepatic spine on lateral surface; rostrum with ventral teeth; eyes not reduced, cornea wider than eyestalk and densely pigmented; epigean species 3

Carapace without hepatic spine; rostrum without ventral teeth; eyes reduced, cornea not pigmented; subterranean species 8

3. Rostrum long, usually reaching beyond end of antennal scale, with 5–11 dorsal teeth, no more than 2 of which originate on carapace posterior to level of orbital margin; second pereiopods of adult male slender, chela more than eight times as long as broad 4

Rostrum short, reaching at most slightly beyond end of antennular peduncle, with 10–15 dorsal teeth, at least 4 of which originate on carapace posterior to level of orbital margin; second pereiopods of adult male robust, chela less than seven times as long as broad 5

4. Rostrum armed throughout dorsal length, posterior tooth usually separated from second by distance greater than that between second and third; second pereiopod of adult male spinulose, carpus shorter than chela, fingers densely furred . . . . . **Macrobrachium acanthurus** (p. 89)

Rostrum unarmed in distal half or third of dorsal margin except for two subapical teeth, proximal teeth subequally spaced; second pereiopod of adult male smooth, carpus longer than chela, fingers bare.

Macrobrachium jelskii (p. 109)

5. Rostrum with sinuous dorsal margin, tip slightly upturned; second pereiopods of adult male subequal in form if not in size, with short pubescence and short spines along outer margin of fixed finger and continued onto palm, but spines not forming distinct crest and not hidden by pubescence 6

Rostrum with nearly straight dorsal margin, tip not upturned; second pereiopods of adult male unequal in both form and size with dense long fur partially concealing crestlike row of long spines on margin of palm . . 7

6. Posterior teeth of dorsal rostral series not especially erect or noticeably more widely spaced than others; second pereiopods of adult male subequal, carpus shorter than merus and about half as long as palm, fingers only slightly shorter than palm, prominent tooth near end of proximal third of opposable margin of fixed finger; abdomen longitudinally striped in life . . . . . **Macrobrachium carcinus** (p. 93)

Three or four posterior teeth of dorsal rostral series more erect and more widely spaced than anterior ones; second pereiopods of adult male usually unequal in length, major one with carpus about as long as merus and about three-fourths as long as palm, fingers about two-thirds as long as palm, none of teeth on opposable margin of fixed finger greatly enlarged; abdomen transversely banded in life . . . . **Machrobrachium heterochirus** (p. 106)

7. Major second pereiopod of adult male with carpus usually longer than merus and fingers distinctly longer than palm, row of spines along mesial margin of palm and fixed finger rather long on proximal portion of palm, becoming shorter near middle of palm, longer near base of finger, and decreasing again distally on finger . . . . . **Macrobrachium faustinum** (p. 102)

Major second pereiopod of adult male with carpus shorter than merus and fingers slightly longer or slightly shorter than palm, row of spines along mesial margin of palm and fixed finger forming regular series, not decreasing in length along middle portion of palm.

Macrobrachium crenulatum (p. 99)

8. Rostrum with two or more teeth on dorsal margin 9
   Rostrum with single dorsal tooth or unarmed 10
9. Rostrum reaching at least as far as end of antennal scale, armed with six to eight dorsal teeth . . . . . **Troglocubanus eigenmanni** (p. 113)
   Rostrum not reaching beyond end of antennular peduncle, armed with two or three dorsal teeth . . . . . **Troglocubanus gibarensis** (p. 113)
10. No antennal spine on carapace . . . . . **Troglocubanus inermis** (p. 114)
    Antennal spine present, even if inconspicuous 11
11. Rostrum with ventral margin straight or concave throughout; third and fourth pereiopods with propodus more than three times as long as dactyl. **Troglocubanus calcis** (p. 112)
    Rostrum with ventral margin convex in proximal two-thirds; third and fourth pereiopods with propodus not more than two and one-half times as long as dactyl . . . . . **Troglocubanus jamaicensis** (p. 115)

Genus *Macrobrachium*

17. *Macrobrachium acanthurus* (Wiegmann)

FIGURES 20, 25*a*, *g*

Palaemon acanthurus Wiegmann, 1836, p. 150 [type-locality: "Brazilian coast"].
Palaemon forceps H. Milne Edwards, 1837, p. 397 [type-locality: Rio de Janeiro].
Palaemon Swainsonii (Leach ms) White, 1847, p. 78.
Palaemon mexicanus De Saussure, 1857c, p. 504 [type-localities: Cuba and Mexico].
Macrobrachium longidigitum Bate, 1868, p. 365, pl. 31: fig. 2 [type-locality unknown].
Palaemon dasydactylus Streets, 1871, p. 225, pl. 2: figs. 3, 3a [type-locality: tidewater of the Río Coatzacoalcos, Estado de Veracruz, Mexico].
Palaemon sexdentatus Streets, 1871, p. 226, pl. 2: figs. 4, 4a [type-locality: tidewater of the Río Coatzacoalcos, Estado de Veracruz, Mexico].
Palaemon Potieté Müller, 1892, p. 181 [type-locality: Itajaí, Estado de Santa Catarina, Brazil].
Bithynis acanthurus.—Rathbun, 1900b, p. 154.
Bithynis forceps.—Young, 1900, p. 487.
Macrobrachium acanthurus.—Pearse, 1911, p. 111.—Holthuis, 1952, p. 45, pl. 8; pl. 9: figs. a, b.

DIAGNOSIS.—Carapace with antennal and hepatic spines, without branchiostegal spine. Rostrum usually reaching beyond end of antennal scale, nearly straight in large specimens (fig. 20*b*), upcurved in young adults (fig. 20*a*); armed with 9 to 11 dorsal and 4 to 7 ventral teeth; posterior two teeth of dorsal series on carapace behind level of orbital margin, first usually separated from second by interval longer than that between second and third. Eyes large, cornea well pigmented. Second pereiopods of adult male subequal, slender (for the genus); fingers nearly as long as palm, meeting throughout their length, covered with dense, short fur, opposable margin of each armed near base with distinct tooth; palm subcylindrical, four and one-half to five and one-half times as long as wide, with several

longitudinal rows of spinules; carpus longer than either palm or merus. Third pereiopod with propodus about two and one-half times as long as dactyl. Color pattern dominated, especially in immature specimens, by three prominent stripes on ventral half of carapace: *oblique, slightly sinuous stripe from above base of second pereiopod to antennal spine; sharply sinuous stripe resembling figure "3" above base of fourth pereiopod; and anteriorly convex stripe extending dorsally above base of fifth pereiopod.* A large species, maximum postorbital carapace length about 45 mm.

COLOR IN LIFE.—Dominant elements of color pattern most obvious in very small shrimp. Body translucent bluish green with reddish-purple stripes and spots, and yellow at articulations of podomeres. Rostrum with longitudinal stripe extending almost from apex to slightly behind orbit; two V-shaped spots immediately behind posterior portion of stripe and below second dorsal tooth of rostral series. Four prominent and three less conspicuous, obliquely vertical stripes on branchial region: anteriormost slender, extending from level of base of first pereiopod anterodorsally but not reaching base of antenna; second longest and most prominent, extending from immediately above base of second pereiopod to ventral base of antennal spine; third very slender, short, situated above base of third pereiopod; fourth prominent, resembling figure "3," lying above base of fourth pereiopod, convex anteriorly with dorsalmost extremity reaching level of antennal spine; fifth very slender, shorter than third, extending anterodorsally between dorsal and ventral extremities of fourth stripe; sixth almost as conspicuous as fourth, slightly convex anteriorly but extending almost directly dorsally above base of fifth pereiopod and reaching level of antennal spine; seventh also conspicuous, extending dorsally along posterior margin of carapace from base of fifth pereiopod to point slightly dorsal to dorsal extremity of fifth stripe. Irregular horizontal stripe posterior to antennal spine and situated dorsal to second oblique stripe; small spot below it with diffuse reddish-purple pigment radiating ventrally to second oblique stripe; additional horizontal stripe, posterior to that over second oblique stripe, extending over third and fourth oblique stripes. Abdomen with purple spots at articular knobs at anterior margins of first, second, and third somites. Narrow continuous band of purple at level of base of pleura from midlength of fourth abdominal somite to telson; ventral margin of sixth somite with narrow purple band. Single dorsomedian spot on anterior margin of first and on posterior margins of second and third somites; third somite with small paired spots just lateral to median one. Pleuron of first abdominal somite with short vertical purple stripe. Telson with two pairs of small purple spots.

Antennule with mesial margin of peduncle and inner flagellum dark bluish purple; antennal scale with longitudinal dark line separating lamella from outer heavy portion. First and second pereiopods translucent with corneous tipped fingers. Coxa, basis, and proximal

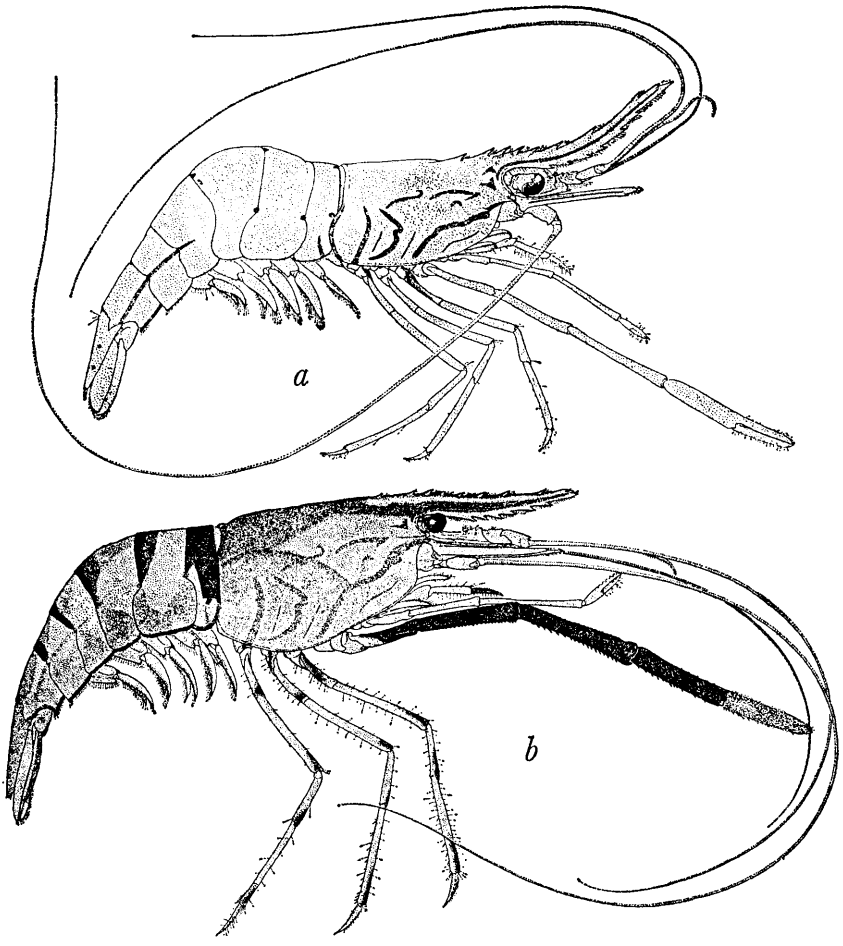


FIGURE 20.—*Macrobrachium acanthurus: a*, male (carapace length 16.5 mm) from Dominica station 14; *b*, male (cl 33.6 mm) from Dominica station 108.

portion of ischium of third and fifth pereiopods with dark pigment. Gnathal podomeres so pigmented that in ventral aspect two dark lines converge from first oblique stripes on carapace across epistome to bases of antennules.

Larger shrimp with most elements of color pattern described above present but subdued by additional coloration. Carapace reddish

brown dorsally, fading ventrally to lavender, with posteriorly directed wedge of bluish green from orbital area to level of fourth obliquely vertical stripe; stripe on rostrum often olive brown instead of purple. Tergum of first abdominal somite reddish brown with small triangular area of bluish green posteriorly; tergum of second abdominal somite with broad posterior triangle of reddish brown fading apically (anteriorly) to reddish tan near midlength of tergum, remainder of tergum pale bluish green; tergum of third through sixth abdominal somites similar to second, but reddish-tan apical portion of triangle extending to anterior margin of each somite. Pleura of abdominal somites mostly lavender with reddish-brown ventral borders and wedges of pale bluish green. Telson and uropods reddish brown with inner ramus of latter slightly lighter, and extremities of both rami bright red.

Eyestalk reddish tan above. Inner flagellum of antennule purple and outer pale tan; peduncle of antenna lavender tan, flagellum pale tan; antennal scale with lavender lamellar area separated from thicker, cream, lateral portion by purple band. Third maxilliped pinkish tan with purple dactyl; first pereiopod pinkish tan with light chela; second pereiopod brownish purple with olive fingers tipped with orange; remaining pereiopods pinkish tan with upper distal portion of each podomere, except dactyl, reddish purple; dactyl tipped with cream; uropods cream and pale lavender.

MATERIAL EXAMINED.—The Dominican collections contain 48 males (carapace lengths 4.0–36.5 mm), 35 females (cl 4.0–20.6 mm), including 1 with eggs (cl 16.2 mm), and 6 juveniles (cl 1.9–3.9 mm). A carapace length of 4.0 mm was rather arbitrarily selected as the smallest size at which sex can be determined. In one male with a carapace length of 4.2 mm the appendix masculina on the second pleopod is subequal to the appendix interna, but it is slightly longer in specimens having carapace lengths of 4.0 to 5.2 mm.

ECOLOGICAL NOTES.—This shrimp characteristically frequents the comparatively quiet waters near the mouths of those streams that enter the Caribbean over a bed that is below sea level or does not have riffles at its junction with the sea. Only at one station (81, on the Indian River, at 150 ft. elevation) was it found more than 10 feet above sea level.

During the day, the shrimps are found among the debris and roots of shoreline plants that are exposed in the water. After dark, they move to the tops of debris accumulations or into open water. During the daylight hours, no *M. acanthurus* can be seen in the Layou River mouth (station 15), but at night thousands of young and many adults may be observed swimming and crawling about the surface of the debris or on the river bottom.

In only one locality were large individuals of this species found to be comparatively abundant—in a drainage ditch in a coconut grove on the south side of the mouth of the Layou River (station 108). As in the river, the shrimp appeared in the open only after dark. Even though the water in the ditch was nowhere more than six inches in depth, scores of these shrimp could be seen within an area of 120 square feet (14 square meters).

DISTRIBUTION.—North Carolina, U.S.A., to Estado do Rio Grande do Sul, Brazil (Andros I., Cuba, Jamaica, Hispaniola, Puerto Rico, Isla de Vieques, Saint Croix, Saint Martin, Dominica, Martinique).

Dominica Stations: 14, 15, 36, 37, 38, 56, 57, 62, 72, 81, 108 (0–150 ft.).

REMARKS.—The single ovigerous female of this species was collected on February 26.

18. *Macrobrachium carcinus* (Linnaeus)

FIGURES 21, 25*b*, *h*

Cancer Carcinus Linnaeus, 1758, p. 631 [type-locality: "*in* Americae *fluviis*" (restricted to Jamaica by Holthuis, 1952)].

Cancer 44 Linnaeus, 1759, p. 203.

Squilla, Crangon, Americana, major Seba, 1761, p. 54, pl. 21: fig. 4 [locality: Surinam].

Astacus minor chelis denticulatis Gronovius, 1764, p. 231.

Astacus major.—Fermin, 1765, p. 74.

Astacus carcinus.—Fabricius, 1775, p. 414.

Astacus 2 Browne, 1789, p. 424 [locality: Jamaica].

Cancer (*Astacus*) *Jamaicensis* Herbst, 1792, p. 57, pl. 27: fig. 2 [type-locality: Jamaica].

Palaemon carcinus.—Weber, 1795, p. 94.

Palaemon jamaicensis.—Olivier, 1811, p. 659.—Verrill, 1892, p. 353.

Astacus (*Palaemon*) *jamaicensis.*—Voigt, 1836, p. 184.

Palaemon brachydactylus Wiegmann, 1836, p. 148 [type-locality: east coast of Mexico].

Palemon punctatus Randall, 1840, p. 146 [type-locality: "East Indies"?, West Indies].

Palemon brevicarpus De Haan, 1849, p. 172 [type-locality?].

Palaemon aztecus De Saussure, 1857c, p. 504 [type-locality: Veracruz, Mexico].

?*Palaemon Montezumae* De Saussure, 1857c, p. 504 [type-locality: Veracruz, Mexico].

Palaemon laminatus (Gollmer ms) Von Martens, 1869, p. 24 [type-locality: Caracas].

Palaemon (*Macrobrachion*) *Jamaicensis.*—Von Martens, 1872, p. 137.

Bithynis jamaicensis.—Pocock, 1889, p. 10.

Bithynis aztecus.—Young, 1900, p. 486.

?*Bithynis montezumae.*—Young, 1900, p. 486.

Macrobrachium jamaicense.—Pearse, 1915, p. 551.

Palemon ornatus (Forns ms) Torralbas, 1917, p. 616, figs. 56, 57 [type-locality: Cuba; not *Palaemon ornatus* Olivier, 1811].

Palaemon (*Macroterocheir*) *jamaicensis.*—De Man, 1925, p. 51, figs. 13a–d.

Palaemon jamaicensis f. *aztecus*.—Pesta, 1931, p. 177.
Periclimenes portoricensis Schmitt, 1933b, p. 3, fig. 2 [type-locality: Puerto Rico].
Macrobrachium carcinus.—Hedgpeth, 1949, p. 31, figs. 1b, 3, 5.—Holthuis, 1952, p. 114, pl. 30; pl. 31: figs. a-c.—Lewis, Ward, and McIver, 1966, p. 48.
Macrobrachium carinus.—Geijskes, 1954, p. 69.

DIAGNOSIS.—Carapace with antennal and hepatic spines, without branchiostegal spine. Rostrum usually reaching to or slightly beyond end of antennular peduncle, dorsal margin sinuous, tip slightly upturned; armed with 11 to 16 rather regularly spaced dorsal and 3 or 4 ventral teeth; posterior 4 to 6 teeth of dorsal series placed on carapace behind level of orbital margin. Eyes large, cornea well

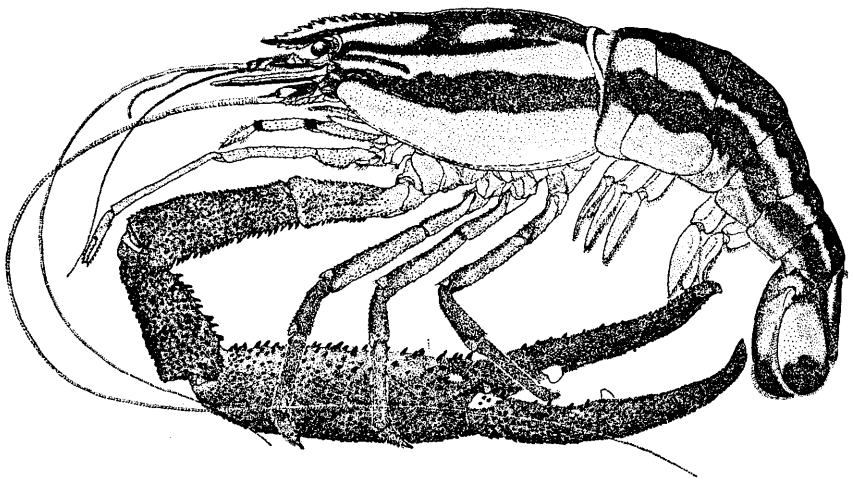


FIGURE 21.—*Macrobrachium carcinus*, male (carapace length 63.8 mm) from Dominica station 96.

pigmented. Second pereiopods of adult male subequal, robust; fingers slender, very slightly shorter than palm, gaping in proximal part, strongly crossing at tips, opposable margin of each armed near midlength (dactyl) and near end of proximal third (fixed finger) with large tooth, fixed finger partially pubescent; palm slightly compressed, more than three but less than four times as long as wide, armed with scattered spines, spines longer and less numerous near margin continuing onto fixed finger but not forming crestlike row; *carpus about half as long as palm* and slightly shorter than merus. Third pereiopod with propodus slightly more than twice as long as dactyl. *Color pattern characterized by longitudinal dark and light stripes on carapace and abdomen.* A very large species, maximum postorbital carapace length more than 90 mm.

COLOR IN LIFE.—*Macrobrachium carcinus* is the only species of the genus on Dominica that exhibits longitudinal stripes on the carapace and abdomen; while there is considerable variation in actual color and in minor details of the color pattern, there is remarkable uniformity in the major pattern. The dark colors vary from blue black to brown; the lighter areas may be gray, pinkish tan, cream, lavender, or various shades of yellow. One of the darker, almost black-striped individuals is described below.

Rostrum with longitudinal stripe of dark blue extending from apex posterodorsally to broad transverse bluish-black band a short distance posterior to posteriormost rostral tooth, and continuing posteriorly to ridge bordering posterior margin of carapace; second transverse band extending ventrally from longitudinal stripe at level of base of fourth pereiopod; both bands ending ventrally in dorsolateral longitudinal black stripe, latter stripe extending posteriorly from orbit to level of base of fifth pereiopod; areas between stripes and bars yellow. Yellowish-tan longitudinal stripe present ventral to dorsolateral dark stripe made bifid anteriorly by short narrow black stripe extending posteriorly from orbit to level of anterior transverse band. Fourth longitudinal blackish stripe ventral to yellowish-tan one and extending from base of antenna to ridge on posterior margin of carapace; latter stripe followed ventrally by yellowish-cream one, and it, in turn, by broad grayish-blue marginal one; posterior ridge on carapace cream to yellow. Abdomen with broad gray dorsomedian longitudinal stripe extending from posterior half of first abdominal somite to tip of telson; stripe, margined in black, broadest in third abdominal somite and narrowing posteriorly; tannish-cream longitudinal stripe flanking median dorsal stripe along almost entire length; broad black stripe ventral to tannish-cream one and extending along tergopleural junctions to telson, there fusing with dorsomedian stripe; pleura mostly pinkish tan but with pale yellow spots, spots becoming contiguous on fourth, fifth, and sixth pleura forming narrow light yellow longitudinal stripe. Protopodite of uropod black with lateral lunar-shaped yellow spot, outer ramus mostly black with median yellow spot in proximal section, distal section black; inner ramus with proximal three-fourths yellow to light brown and with black distal fourth.

Antennule with black markings on distal portions of segments of peduncle and lateral area of proximal segment; undivided ramus dark tan and divided one light tan. Antenna with black markings on peduncular portion; antennal scale with black lateral border, yellowish beige thickened lateral portion, and bright blue lamellar portion; flagellum light tan. Third maxilliped mostly white with dark bands at distal two articulations. First pereiopod lavender with cream

fingers; distal portion of merus in some specimens dark blue with maroon articulating membrane at distal end. Second pereiopod with proximal two podomeres and lower proximal portion of ischium lavender, otherwise mostly purplish black except distal portions of merus and carpus, and proximal portions of carpus and propodus with bands of bright, almost iridescent, blue; lower surface of palm with distal white spot, and upper and lower surface of dactyl with proximal white spot; large tubercles on opposable margins of fingers white; upper surfaces of carpus and palmar portion of propodus with broad cream-tan band. Third, fourth, and fifth pereiopods lavender basally with upper margins of ischium and merus purple; carpus purple, propodus and dactyl bluish purple, latter with corneous tan tip. Distal surfaces of merus and carpus with yellow spots. Pleopods pinkish tan.

The most conspicuous variation in coloration is in the chela which may be olive brown with black tubercles. In observing the animal in the water, the most conspicuous areas are the white or cream distal segments of the third maxilliped and the white spot at the opposable base of the dactyl when the fingers are slightly gaping.

MATERIAL EXAMINED.—The Dominican collections contain 26 males (carapace lengths 10.9–92.0 mm) and 31 females (cl 12.2–64.2 mm), including 3 with eggs (cl 13.7–44.2 mm). Inasmuch as none of the numerous juvenile specimens of *Macrobrachium* in the collections could be positively assigned to *M. carcinus*, the smallest size at which sex can be recognized could not be determined.

ECOLOGICAL NOTES.—*Macrobrachium carcinus* was observed on Dominica in the comparatively quiet mouth of the Layou River, in rapidly flowing drainage ditches, beneath large stones in swift portions of streams, and under stones at the margins of pools along even the smallest creeks. It was seen or collected from sea level to 1,900 feet. In streams where there is suitable cover, this shrimp probably attains even higher altitudes.

Like most, if not all, of the shrimps on Dominica, the members of this species are more active at night than during the day. In the pools, after dark, they leave the cover of the overhanging rock under which they are secluded during the day and move freely about the bottoms, and it is reasonable to assume that it is during the night that they migrate across riffle areas in moving from one pool to another. In repeated observations in riffle areas during the day, this shrimp was never observed in open water and has never been seen in shallow riffles between pools.

Our observations suggest that there exists a correlation between the size of the pool and the number of *M. carcinus* populating it. In several small pools (under 15 square feet in surface area and

scarcely more than 1 foot in depth) along Mannet's Gutter on the Clarke Hall Estate, where regular visits were made over a period of several weeks, not once was more than one *M. carcinus* observed. On three occasions, the single *M. carcinus* in the pool was collected during the day and on the following days the pool was re-examined to determine whether or not another individual had moved into it. In one of the three pools, another shrimp moved into it during the night; the other two were repopulated two days later. In yet another pool, two shrimp were taken from beneath the same stone three days apart, and for the next three days, unsuccessful attempts were made to find a third one under the rock. There are no data available, to our knowledge, to indicate what factors promote or discourage migrations of individuals along the course of a stream or to determine whether or not they migrate in both directions.

In contrast to the smaller pools, the larger ones, those with surface areas of at least 20 square feet, may harbor more than one individual of *M. carcinus*. In one such pool (surface area of approximately 100 square feet) on Mannet's Gutter, the better parts of several days were spent observing the composition of the decapod population. At one time there were four *M. carcinus*, one large one and three that were considerably smaller. Whether or not these four shrimp had divided the pool among themselves is not know, but when an earthworm was dangled into the water, the three smaller ones came toward it from different directions; a short time thereafter, the fourth shrimp, by far the largest, appeared from under the largest overhanging stone in the pool and from the same direction from which one of the smaller ones had come. There was no question, on any of the occasions during which this group was being observed, that the largest shrimp, while tolerating the presence of the other three in its pool, was the master of it. The smaller ones swam or backed quickly away when the largest one approached.

DISTRIBUTION.—Florida and Texas, U.S.A., to Estado de Santa Catarina, Brazil (Cuba, Jamaica, Hispaniola, Puerto Rico, Saint Thomas, Saint Croix, Saint Martin, Dominica, Saint Lucia I., Saint Vincent, Barbados, Trinidad, Bonaire, Curaçao, Aruba).

Dominica Stations: 1–4, 7, 8, 11, 12, 14, 22, 23, 30, 43, 50, 54, 66, 68, 89, 95, 96, 109 (0–1,900 ft.).

REMARKS.—Of the 31 females collected on Dominica, the majority (20) were taken in January, February, and March. Egg-bearing specimens, however, were found only on October 25, 1964 (2 of 6 females) and May 13, 1966 (1 of 3 females). This suggestion of a breeding season is in agreement with the observations of Lewis, Ward, and McIver (1966) on Barbados, where ovigerous specimens were collected in every month from May through October, but none of

the more than 400 females taken during the remaining six months carried eggs.

During the second author's visits to Dominica *M. carcinus* was spied upon, fished for, purchased, and consumed on numerous occasions, but two specific encounters with this largest species of American shrimps are frequently recalled as highlights of the study. Early in the course of the field work, inquiry had been made as to how large specimens of *M. carcinus* might best be obtained, and a demonstration had been provided by a local police officer, Mr. Courette, in the Sari Sari River north of La Plaine. The technique, described on page 46, had been tried unsuccessfully in many likely looking crevices and beneath rocks along Mannet's Gutter, and one small specimen had finally been taken in the large pool mentioned above.

Upstream from this pool the creek flowed sluggishly around and under a tremendous rock. As this rock was approached one day, the largest *Macrobrachium* heretofore encountered was seen partially exposed. As it quickly retreated under the rock, the baited hook was thrust gently after it and, within seconds, the shrimp had taken the bait and in minutes was being pulled from beneath the rock, its long chelipeds and walking legs widely braced against the sandy bottom of the pool. Under water, the animal appeared at least twice as large as it actually is—even so, it is a fine specimen with a carapace length of 64 mm, a total body length of 191 mm, and a leg span of nearly 20 inches (about 500 mm). After pulling the animal to shore, the highly excited fisherman was faced with the problem of removing the hook. The wild thrashing of the huge chelipeds and four additional pairs of legs and the violent flexing of the abdomen seemed to offer no safe way of accomplishing this. Finally, by covering the entire shrimp with a plastic bag and grasping all of the appendages firmly, the fisherman extricated the pin, and the shrimp, uninjured, was consigned to a container. This is the specimen shown in figure 21.

The other memorable encounter with the species occurred at the mouth of the Layou after nine o'clock in the evening, when Dr. R. B. Manning and the same author were searching from a dugout canoe for signs of penaeid shrimps in the lower reaches of the river. The eyes of literally thousands of *Xiphocaris elongata* and *Macrobrachium acanthurus* (perhaps also *Jonga serrei*) shone in the rays of our lantern in the extreme littoral areas. As the boat moved away from the shore and over a clump of submerged tree limbs resting on the bottom, a large *M. carcinus* came into view. It was not too wary; however, equipment was not available to work with ease in more than three feet of water, and attempts to catch the animal were unsuccessful. Later, three additional and apparently gigantic individuals, alerted by the light from our lantern and headlamp, crawled rapidly away;

on being startled by nets lowered to capture them, they swam off rapidly and gracefully, abdomen first, their appendages trailing. It was nothing short of thrilling for the observers to watch these large, ghostlike, striped animals gliding across the sandy bottom of the river mouth.

19. *Macrobrachium crenulatum* Holthuis

FIGURES 22, 25*c*, *i*

Palaemon olfersii.—Sharp, 1893 [part], p. 123.
Bithynis olfersii.—Rathbun, 1901 [part], p. 124.
Macrobrachium olfersii.—Schmitt, 1933a [part], p. 315.
Macrobrachium crenulatum Holthuis, 1950a, p. 95 [type-locality: Río Peje Bobo, Panama]; 1952, p. 107, pl. 27a–d; pl. 28.

DIAGNOSIS.—Carapace with antennal and hepatic spines, without branchiostegal spine. Rostrum reaching about as far as end of antennular peduncle, dorsal margin faintly convex, tip not upturned; armed with 11 to 14 rather regularly spaced dorsal and 3 or 4 ventral teeth; posterior 4 to 6 teeth of dorsal series placed on carapace behind level of orbital margin. Eyes large, cornea well pigmented. Second pereiopods of adult male very dissimilar and unequal; major cheliped with fingers slightly longer or shorter than palm, curved dactyl forming wide gape, one large tooth on proximal part of opposable margin of each finger, each finger densely covered with nonaligned spinules on both surfaces and bearing numerous tufts of long, stiff hairs along cutting edges; palm distinctly compressed, about twice as long as wide, armed with longitudinal rows of strong spines, those on mesial margin forming spiny crest diminishing rather abruptly at base of fixed finger but *not near midlength of palm*, spines of upper and mesial surfaces partially concealed by hairs; carpus shorter than either palm or merus but much more than half as long as palm. Third pereiopod with propodus two and one-half to three times as long as dactyl. Color pattern usually characterized by light transverse patch on posterior part of third abdominal tergum; fingers of second pereiopod and distal podomeres of third to fifth pereiopods not conspicuously banded; second pereiopods dark colored. A medium-sized species, maximum postorbital carapace length about 30 mm.

COLOR IN LIFE.—At least a part of the tremendous variation in color in this species is due to adaptations to different backgrounds. In comparison with this variation in actual color, the color pattern is not nearly so variable. Since most of the animals observed in the field were adapted to a dark background, this phase is described in detail.

Carapace of males mostly reddish purple to bright blue above but with reddish-black longitudinal stripe on rostrum and irregular, similarly colored blotch ventrolateral to posterior rostral spine.

Dorsum of carapace generally darker than branchial area, and with lighter area just posterior to hepatic spine; anteroventral portion of branchial area with submarginal reddish-black stripe. Terga of first and second abdominal somites reddish black dorsally fading to purplish red, and both provided with lighter purplish-red spots lateral to median line. Tergum of third abdominal somite as dark as those anterior to it but with broad subrectangular yellow area in posterior half. Fourth and fifth terga purplish red, each with narrow yellow transverse band flecked with red near posterior margins. Sixth tergum purplish red. All pleura purplish red but progressively darker posteriorly. Articular knobs at bases of pleura ringed in black. Telson scarlet with darker red patches and black rings around bases of spines. Uropods variable

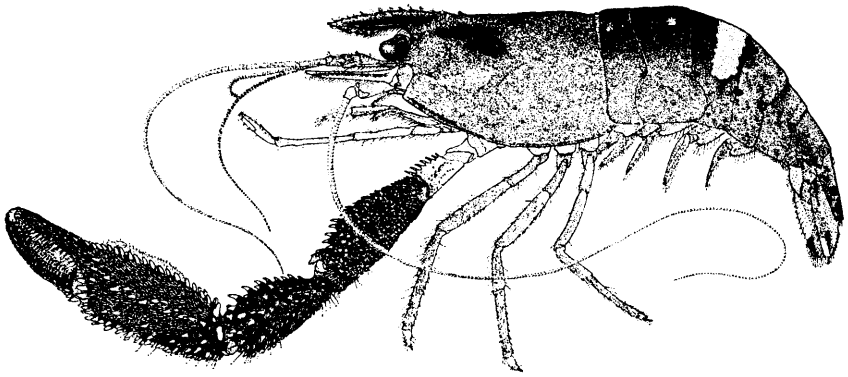


FIGURE 22.—*Macrobrachium crenulatum*, male (carapace length 24.0 mm) from Dominica station 22.

but lateral margin of lateral ramus and laterodistal part of mesial ramus sulfur yellow; remainder of both scarlet with darker red blotches.

Eyestalks purple with cornea almost black. Antennules purplish basally; inner flagellum dark tan and outer two pale tan. Antennal peduncle lavender red, antennal scale with dark lateral margin and purplish lamella, and flagellum pale tan. First pereiopod dark grayish blue except for chela, latter creamy translucent with dark blue stripe along palm and dark band across fingers. Second pereiopod with gray coxa and pinkish basis and ischium; distal podomeres black with white translucent tubercles; base of dactyl orange, tips of both fingers white. Coxa of walking legs gray, remaining podomeres red except for pale pinkish distal extremities of propodus and proximal extremities of merus and dactyl. Pleopods red with bluish setae; distolateral angles of protopodites of posterior three pairs with sulfur yellow spot.

In some males, the colors are predominantly blue and yellow with the red areas described above replaced by shades of yellow. In those shrimp adapted to light backgrounds, the color is mostly pale tan with pale yellow and light brown. The second pereiopod is lavender below, olive green above with purple tubercles and fingers, the latter with white tips; the basal portion of the dactyl is bright orange. The second through the fifth pereiopods are bluish with pink bands.

Most females are not so richly colored, nearly always lacking the strong contrasts between the shining black and brilliant reds and yellows, and seldom do they exhibit the rich blue-to-purple coloration of the males.

Three male shrimp that had been collected during the morning were retained throughout the remainder of the day and evening in a light blue plastic bucket. At approximately 10:00 P.M., about an hour before the light was extinguished, two of them were placed in a dark purplish red bucket. At 7:00 A.M. on the following morning (still almost dark where the shrimp were maintained), the two that had been moved to the dark bucket were very dark purplish red with little yellow evident, but the one in the light blue bucket was translucent pale tan. This seems of particular interest because the shrimp were able to become adapted to their respective backgrounds after a very short exposure to very dim light.

MATERIAL EXAMINED.—The Dominican collections contain 149 males (carapace lengths 2.9–29.7 mm), 106 females (cl 3.0–25.3 mm) including 19 with eggs (cl 8.7–19.0 mm), and 22 juveniles (cl 2.0–2.8 mm). The smallest recognizable male, in which the appendix masculina on the second pleopod is no more than a bud, has a carapace length of 2.9 mm, but that appendix may be less than fully developed at a carapace length of more than 6 mm.

ECOLOGICAL NOTES.—*Macrobrachium crenulatum* occurs most abundantly in pools in the small feeder streams cascading from the mountains but is also at home in small, flowing drainage ditches and in the shallow rocky areas of larger streams. In the pools, this shrimp may be seen moving from place to place at almost any time of the day. If a person slowly approaches a pool, the shrimp may often be seen moving about apparently aimlessly or resting in the open with their antennae gently waving to and fro. The larger individuals, however, are for the most part at least partially concealed beneath a stone or under debris. In and immediately upstream and downstream from pools in Mannet's Gutter, this is undoubtedly the most abundant shrimp. Unlike *M. carcinus*, a single small pool may support a dozen or more *M. crenulatum*. In the smaller pools there may be only a single large male; however, in the larger ones, there are often three or four of them.

Apparently members of this species are always hungry, and the introduction of a small piece of meat or an earthworm into a pool will set them into frantic motion—meeting one another they "flash" their chelae, and usually one large male, obviously the dominant member of the *crenulatum* population of the pool, will temporarily drive the smaller shrimps and other members of its species away. Should a small shrimp get to the food before the larger ones find it, the small one grasps the morsel in its chelae and races for shallow water; if, as it races away, other shrimps are encountered on the bottom of the pool, it immediately rises above the animals it encounters and swims for cover.

DISTRIBUTION.—West Indies, Panama, and Venezuela (Jamaica, Hispaniola, Saint Croix, Guadeloupe, Dominica, Grenada, Trinidad).

Dominica Stations: 1–4, 7, 11–13, 17, 18, 22, 23, 28, 30, 32, 33, 36, 39, 42–46, 48, 49, 50, 52, 54–56, 59, 61, 63, 65, 66, 68, 74–76, 78–81, 84, 85, 87, 95, 96, 100, 105, 109 (0–1,350 ft.).

REMARKS.—In the absence of color after preservation, this species is often difficult to distinguish from *M. faustinum;* this is especially true of young specimens and even adults that have lost the major second pereiopod.

Females with eggs were collected in February, March, April, May, August, and September. The absence of ovigerous specimens among the 23 females taken in January and the fact that only 4 of 34 females were carrying eggs in February, coupled with the evidence that 4 of the 5 females taken from April through September bore eggs, suggest that *M. crenulatum* may have a prolonged breeding season, beginning in February; the species was not collected in June, October, November, and December.

20. *Macrobrachium faustinum* (De Saussure)

FIGURES 23, 25*d, j*

Palaemon spinimanus H. Milne Edwards, 1837 [part], p. 399 [type-locality: Antilles and Brazil; not *Palaemon spinimanus* Latreille, 1818].

Palaemon Faustinus De Saussure, 1857c, p. 505 [type-locality: near Jacmel, Haiti].

Palaemon (Macrobrachion) Faustinus—Von Martens, 1872, p. 137.

Bithynis spinimanus.—Pocock, 1889, p. 10.

Palaemon Olfersii.—Pocock, 1893, p. 408 [not *Palaemon Olfersii* Wiegmann, 1836].

Palaemon cubanus (Guérin ms) Sharp, 1893, p. 124 [type-locality: Cuba].

Bithynis faustinus.—Rathbun, 1897c, p. 45.

Bithynis olfersii.—Rathbun, 1901 [part], p. 124.

Macrobrachium faustinum.—Chace and Holthuis, 1948, p. 23.—Holthuis, 1952, p. 88, pl. 22; pl. 23a-c.

DIAGNOSIS.—Carapace with antennal and hepatic spines, without branchiostegal spine. Rostrum reaching nearly or quite as far as

end of antennular peduncle, dorsal margin faintly convex, tip not upturned; armed with 13 to 15 small rather regularly spaced dorsal and 2 or 3 ventral teeth; posterior 5 or 6 teeth of dorsal series placed on carapace behind level of orbital margin. Eyes large, cornea well pigmented. Second pereiopods of adult male very dissimilar and unequal; major cheliped with fingers slightly longer than palm, widely gaping, with one large tooth on proximal part of opposable margin of each finger, each finger bearing several longitudinal rows of small spinules on exterior surfaces and long, stiff hairs along cutting edges; palm strongly compressed, about two or two and one-half times as long as wide, armed with longitudinal rows of spines, those on mesial margin forming spiny crest continued in reduced form on

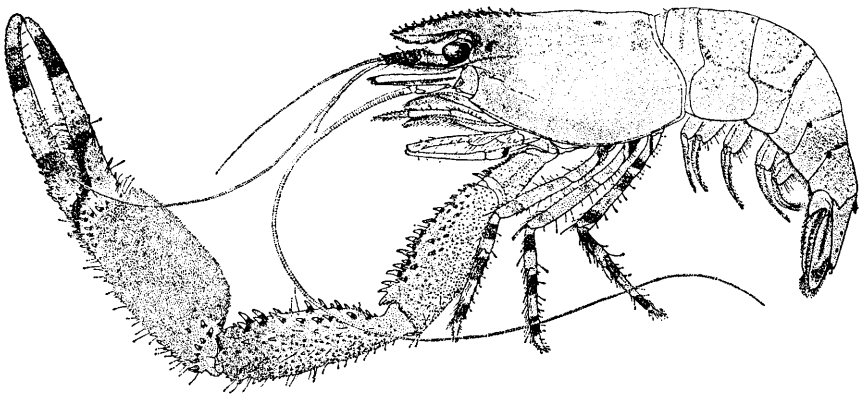


FIGURE 23.—*Macrobrachium faustinum*, male (carapace length 18.2 mm) from Dominica station 24.

fixed finger and *reduced also near midlength, becoming strong in proximal and distal parts of palm, all spines on lateral and inner surfaces almost completely concealed by dense, soft fur;* carpus usually as long as or slightly longer than palm and distinctly longer than merus. Third pereiopod with propodus two and one-half to three times as long as dactyl. Color pattern usually characterized by light transverse patch on posterior part of third abdominal tergum; fingers of second pereiopod and distal podomeres of third to fifth pereiopods often conspicuously banded; second pereiopod light colored, except for bands on fingers. A medium-sized species, maximum postorbital carapace length about 18 mm.

COLOR IN LIFE.—Body of male almost translucent with pale yellowish or pinkish suffusion produced by widely scattered orange-red chromatophores. Rostrum with reddish-brown stripe along lower basal half extending ventrolaterally along margin of orbit almost

to antennal spine; similarly colored spot immediately posterior to submarginal orbital stripe and two others dorsolaterally in cardiac region, larger of two almost at posterior margin of carapace with smaller one anterior to larger and on level with dorsal margin of orbit; oblique pale stripe, with short anteriorly directed branches in hepatic region, extending from large posterior spot to anterior margin of carapace immediately above antennal spine; shorter similarly colored stripe extending posterodorsally between antennal and hepatic spines, ending at base of latter; branchial region slightly darker than dorsal and anterolateral portions of carapace. Tergum of first abdominal somite with reddish-brown mid-dorsal spot spanning posterior half of tergum with narrow similarly colored band extending ventrally from midlength of spot to base of pleuron, area anterior to band tannish cream. Second abdominal tergum with narrow dark bands anteriorly and posteriorly, anterior band continuing posteriorly at base of pleuron to join posterior band, anterior band with dorsomedian gap, and posterior one with anterolateral notch, narrow cream-colored band immediately anterior to posterior dark one extending from just below level of notch across tergum to corresponding level on other side. Third abdominal tergum with very prominent U-shaped cream-colored bar extending across posterior portion of segment between bases of pleura; bar delimited by reddish-brown border circumscribing it. Fourth and fifth abdominal terga with narrow transverse band along posterior margin joining dark spots at articular knobs at bases of pleura. Pleuron of third abdominal somite darker than other pinkish-tan pleura and same color extending along tergopleural junctions of fourth and fifth somites. Telson and uropods mostly pinkish tan; both rami of uropod with dark submedian longitudinal stripe, and inner ramus with transverse band distally.

Antennules with reddish-brown stripe on lateral surface of basal segment, and distal two segments entirely reddish brown; antennal scale with lateral reddish-brown stripe. First pereiopod with red spot at base of dactyl, otherwise pinkish. Second pereiopod mostly pinkish translucent with tubercles brown basally and pale distally; carpus with darker distal band; setal tuft on palm buff; naked portion of palm pink with narrow black band extending across area at base of dactyl, continuing along opposable margin of immovable finger and crossing finger at end of proximal fourth; second broader black band at base of distal third; distalmost portion of finger pink fading to cream distally and with corneous tip; color of dactyl replica of that of immovable finger except lacking black areas along basal opposable surface. Third through fifth pereiopods pinkish with red to brown bands; one or two on ischium, two on merus, one on carpus, and

two on propodus; dactyl translucent pink with corneous tip. Pleopods translucent pink.

Female with essentially same coloring and similar basic patterns; however, carapace with three to nine additional dark, irregular spots laterally and dorsolaterally, chiefly in branchiostegal area.

Juveniles with coxa and basis of second and third pereiopods deeply pigmented.

MATERIAL EXAMINED.—The Dominican collections contain 247 males (carapace lengths 2.8–18.2 mm), 294 females (cl 2.8–12.5 mm), including 69 with eggs (cl 5.1–12.5 mm), and 413 juveniles (cl 1.8–3.2 mm). The smallest recognizable males, in which the appendix masculina on the second pleopod is no more than a bud, have carapace lengths of 2.8 and 2.9 mm, but that appendix may not be fully developed at a carapace length of 4.6 mm.

ECOLOGICAL NOTES.—*Macrobrachium faustinum* is primarily an inhabitant of the lower reaches of streams on Dominica, and even here it is much more abundant in the quieter portions of the streams where it seeks shelter beneath stones, trunks of water-logged trees that rest submerged on the bottom of the stream bed, palm fronds, and coconut husks that also lie on the bottom of shallow parts of the stream. Seldom does it venture into riffle areas where the water is rushing but it is frequently found close to the shore in such areas if the littoral waters are not swift.

What these shrimp do during flood stages of the lower portions of the streams, when the latter are converted to torrents, rising some six or eight feet, is not known, but shortly after the river has subsided to its former level, *M. faustinum* is back in its old haunts.

At Clarke Hall, this shrimp frequents the lee side of a bend of the Layou River, where coarse sand has accumulated and the bottom gently slopes downward to a depth of some 12 feet, thus providing a splendid beach for swimming and bathing. On a number of occasions, bathers there have been "nipped" on the feet and legs by small individuals of this shrimp. Fortunate for the bathers, the larger individuals are much more retiring. The population on this sand bar is a rather sparse one, but some shrimp are always there, and the place lends itself to making obervations on the shrimp with the use of a face mask. The area close to the shore, and just below the riffles, seems always to be populated by a number of juveniles that actively wander over the bottom with their chelae outstretched, apparently giving consideration to every object that invades the area, whether it be a tiny fragment of a leaf or something as large as the feet and legs of a man. Here on the lee side of the river, a moderately strong eddy current occasionally arrests objects that are comparatively heavy and they become temporarily imbedded in the sand. Almost certainly, it is the

eddy current that makes the sandy area so attractive to the *M. faustinum* population, and as temporarily anchored as these broken limbs, portions of palm fronds, or coconut husks may be, adult individuals of this shrimp are always present among the debris. Without a face mask to ascertain where the disturbed shrimp are wandering or swimming, the observer finds catching them in open water to be somewhat difficult. The shrimp are so palely translucent they are almost indistinguishable from the underlying sand. At night, when all of the shrimp venture from their lairs, the ruby-colored light reflected from their eyes when a beam of light is trained upon them renders the animals utterly conspicuous.

This species apparently never ascends cascades and has been taken consistently at comparatively low elevations (mostly under 200 feet, but up to 400 feet) where the gradient of the stream bed is quite low.

DISTRIBUTION.—West Indies (Andros I., Cuba, Jamaica, Hispaniola, Puerto Rico, Saint Thomas, Saint Croix, Dominica, Saint Lucia I., Saint Vincent, Barbados, Grenada, Tobago, Bonaire, Curaçao).

Dominica Stations: 1, 2, 10–12, 14, 15, 17, 21, 22, 24, 25, 28, 30, 32, 33, 36, 37, 40, 42, 49, 52, 54, 56, 57, 59, 61, 63, 67, 68, 71, 72, 75, 77, 79–81, 85–88, 95, 100, 102 (0–400 ft.).

REMARKS.—*Macrobrachium faustinum* is a highly variable species. For some time, it appeared that two species were among the Dominican specimens that were being assigned to it. One of them is drab buff in color with the carpus of the major chela shorter than the merus and the chela comparatively heavy; the other is darker, with prominent bands on the legs, the carpus of the second pereiopod longer than the merus, and the chela quite slender. When series of the two are compared, however, it appears that the combinations of characters are not consistent, and at least some of the differences in color are due to adaptations to light and dark backgrounds. The relative lengths of the carpus and merus of the second pereiopods cannot be correlated with any of the other differences, and in some specimens their lengths are subequal.

Ovigerous females were collected in January, February, March, April, July, and October, suggesting that this species may breed throughout the year. In the first four months, the only period during which significant numbers of specimens were collected, about 40 percent of the females with carapace lengths of more than 5 mm have eggs.

21. *Macrobrachium heterochirus* (Wiegmann)

FIGURES 24, 25*e*, *k*

Palaemon heterochirus Wiegmann, 1836, p. 149 [type-locality: "east coast of Mexico"].

Palaemon Appuni Von Martens, 1869, p. 31, pl. 2: fig. 5 [type-locality: Puerto Cabello, Venezuela].
Palaemon heterocheirus.—Kingsley, 1878a, p. 68.
Bithynis appuni?—Pocock, 1889, p. 10, pl. 2: fig. 2.
Macrobrachium heterochirus.—Holthuis, 1950b, p. 14; 1952, p. 69, pl. 15: figs. a, b; pl. 16: figs. a–c.

DIAGNOSIS.—Carapace with antennal and hepatic spines, without branchiostegal spine. Rostrum reaching anteriorly nearly or just as far as end of antennular peduncle, dorsal margin sinuous, tip slightly upturned; armed with 10 to 13 dorsal and 2 to 4 ventral teeth; posterior 4 to 6 teeth of dorsal series placed on carapace behind level of orbital margin, *posterior 3 or 4 more erect and more widely spaced*

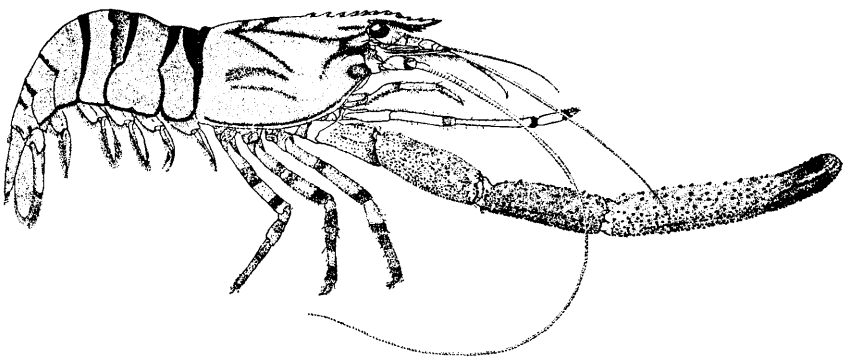


FIGURE 24.—*Macrobrachium heterochirus*, male (carapace length 31.9 mm) from Dominica station 47.

than others. Eyes large, cornea well pigmented. Second pereiopods of adult male similar in form but unequal in length; fingers about two-thirds as long as palm, meeting throughout their length, without noticeably large teeth on opposable margins, each finger bearing numerous scattered spinules on exterior surface and short pubescence along cutting edge; palm only slightly compressed, three or more times as long as wide, provided with scattered spinules protruding from short pubescence, but without spiny crest along margin continuing from fixed finger; carpus about three-fourths as long as palm and as long as or longer than merus. Third pereiopod with propodus two to three times as long as dactyl. Color pattern characterized by dark transverse bands on abdominal tergites and dark borders on pleura. A medium-sized species, maximum postorbital carapace length about 34 mm.

COLOR IN LIFE.—*Macrobrachium heterochirus* is the most strikingly transversely banded shrimp on Dominica. Like all *Macrobrachium* and like most of the freshwater shrimps, the basic colors of this species

are either brown and yellow or black and blue. The latter is described below.

Carapace generally bluish straw with blue-black to purple markings: longitudinal stripe on lower half of rostrum; very short longitudinal one extending from posterior to eye to level of third rostral tooth from base; long longitudinal one extending posteroventrally from orbit almost to level of posterior extremity of short stripe, there turning gently posterodorsally and terminating short distance from posterior margin of carapace; short vertical bar over hepatic spine joining aforementioned long stripe to short arclike stripe extending posteroventrally from base of antenna between antennal and hepatic spines; posterior portion of long stripe with one or two branches extending anterodorsally and one anteroventrally; branchial region with two subparallel, almost horizontal, stripes; large spot on anterolateral surface at base of antenna with submarginal stripe extending posteriorly to level behind coxa of fifth pereiopod; posterior margin of carapace with narrow transverse band. (Latter band with those on abdomen constituting conspicuous banded elements in this shrimp). First abdominal somite margined in black with bands on tergum much broader than black rim on pleuron, remainder bluish gray. Second abdominal somite with bluish-black band on free margins of pleuron and posterior border of tergum; remainder of somite bluish gray with pair of pale yellow spots adjacent to ventral marginal bluish-black edging. Third abdominal somite with broad, royal blue band anteriorly and narrow bluish-black band posteriorly, separated by broad bright yellow one; ventral margin of pleuron with bluish-black border. Tergum of fourth and fifth somites with narrow rust-colored bands across posterior margins between articular knobs; ventral borders of pleura with narrow bluish-black bands. Sixth abdominal tergum with narrow transverse, rust-colored band just anterior to midlength; similarly colored spot at base of uropod and another laterally at posterior margin. Telson bluish gray with dark spines and dark terminal setae. Uropods translucent, especially lateral ramus, with greenish-blue areas highly variable in shape; distal portion of inner ramus usually with light translucent area.

Peduncle of antennules purplish, inner flagellum dark blue, lateral one paler. Antenna with dark spots on basal segment; antennal scale with longitudinal stripe laterally and along lateral portion of lamella; flagellum pale bluish straw. First pereiopod translucent blue with dark blue band at distal end of merus, carpus, and at base of fingers. Basal segment of second pereiopod pale bluish lavender; merus through palmar area of propodus olive green with dark purple tubercles and golden setal clusters; fingers dark blue with pale tan tips. Third, fourth, and fifth pereiopods pale bluish lavender with pink

bands on proximal podomeres becoming red at distal end of merus; bands on carpus and propodus slate blue. Pleopods translucent pale pinkish blue.

MATERIAL EXAMINED.—The Dominican collections contain 72 males (carapace lengths 6.8–33.3 mm), 49 females (cl 5.2–24.0 mm), including 9 with eggs (cl 10.0–24.0 mm), and 4 juveniles (cl 3.1–4.2 mm). None of the males has the appendix masculina on the second pleopod rudimentary, and a carapace length of 5 mm was, therefore, rather arbitrarily chosen as the size separating juveniles from sexually recognizable individuals.

ECOLOGICAL NOTES.—Both the adults and young of this species appear to be restricted to riffle areas and low cascades that are shared with the local species of *Atya*. Perhaps its absence in some of the streams at higher elevations (above 2,500 feet) is due to the lack of water except during rainy periods. It seems highly improbable that a member of this species, with its ungainly major cheliped, could construct any kind of burrow in which it might seclude itself should the riffle become dry. This shrimp is a rapid swimmer, speeding either up or downstream with considerable grace. Even though much more widespread along the stream gradients (frequenting almost all riffles) than any of the shrimps on Dominica except the two species of *Atya*, it apparently is as limited ecologically as are those (*M. acanthurus* and *Jonga serrei*) that seem to be restricted to the lowermost portions of streams.

DISTRIBUTION.—Estado de Puebla, Mexico, to Estado de São Paulo, Brazil (Jamaica, Hispaniola, Puerto Rico, Guadeloupe, Dominica, Saint Vincent, Grenada).

Dominica Stations: 1–5, 7, 8, 11–13, 19, 21, 22, 24, 26, 29, 30, 32, 33, 35, 42–45, 47, 48, 52, 55, 56, 63, 66, 69, 71, 73–78, 80, 84, 87, 88, 101, 105, 109 (0–2,500 ft.).

REMARKS.—The Dominican collections are not sufficiently large to furnish reliable information on the presence of a breeding season in this species. Ovigerous females were found in February, March, July, and November, but it may be significant that none of the six females with a carapace length of more than 10 mm taken in January bore eggs, and only 1 of 15 had eggs in February, whereas 6 of the 15 collected in March were ovigerous.

22. *Macrobrachium jelskii* (Miers)

FIGURE 25*f*

Palaemon jelskii Miers, 1877, p. 661, pl. 67: fig. 1 [type-locality: Saint-Georges (Oyapock), French Guiana].

Bithynis jelskii.—Young, 1900, p. 489.

Macrobrachium amazonicus.—Schmitt, 1936, p. 373 [not *Palaemon amazonicus* Heller, 1862].

Macrobrachium jelskii.—Chace and Holthuis, 1948, p. 23.—Holthuis, 1952, p. 26, pl. 4: figs. a–d.

DIAGNOSIS.—Carapace with antennal and hepatic spines, without branchiostegal spine. Rostrum reaching beyond end of antennal

FIGURE 25.—Appendices masculinae (*a-f*, right second pleopods in mesial view; *g-k*, left appendices masculinae of Dominica specimens in anterior view): *a*, *Macrobrachium acanthurus*, specimen shown in figure 20*b*; *b*, *M. carcinus*, specimen shown in figure 21; *c*, *M. crenulatum*, specimen shown in figure 22; *d*, *M. faustinum*, specimen shown in figure 23; *e*, *M. heterochirus*, specimen shown in figure 24; *f*, *M. jelskii*, male (carapace length 8.8 mm) from Paramaribo, Surinam (A. Reyne); *g*, *M. acanthurus*; *h*, *M. carcinus*; *i*, *M. crenulatum*; *j*, *M. faustinum*; *k*, *M. heterochirus*.

scale, dorsal margin shallowly sinuous, tip directed slightly upward; armed with 7 to 10 dorsal and 5 or 6 ventral teeth; posterior tooth of dorsal series placed on carapace behind level of orbital margin, distal two teeth subapical, separated from posterior group of evenly spaced teeth by unarmed interval amounting to about one-third of rostral length. Eyes large, cornea well pigmented. Second pereiopods of adult male subequal, very slender, fingers about three-fourths as long as palm, meeting throughout their length, smooth and bare, with single small tooth near proximal end of each opposable margin; palm subcylindrical, more than three and one-half times as long as wide, smooth and bare; carpus longer than either chela or merus. Third pereiopod with propodus slightly more than twice as long as dactyl. A medium-sized species, maximum postorbital carapace length about 15 mm.

HABITAT.—Fresh, occasionally brackish water.

DISTRIBUTION.—Republics of Costa Rica and Venezuela to Brazil (Trinidad).

Genus *Palaemon*

23. *Palaemon (Palaemon) pandaliformis* (Stimpson)

FIGURES 26, 28*a*

Leander pandaliformis Stimpson, 1871, p. 130 [type-locality: Barbados or Trinidad].
Leander Potitinga Müller, 1892, p. 181 [type-locality: Blumenau, Estado de Santa Catarina, Brazil].
Palaemon (Leander) pandaliformis.—Thallwitz, 1892, p. 12.
Palaemon (Leander) potitinga.—Thallwitz, 1892, p. 12.
Leander petitinga.—Rankin, 1898, p. 246.
Palaemonetes cubensis Hay, 1903, p. 433, fig. 3 [type-locality: "Palacio" (probably Los Palacios, Provincia de Pinar del Rio), Cuba].
Leander cubensis.—Kemp, 1925, p. 291.
Palaemon cubensis.—Schmitt, 1935, p. 160.
Palaemon (Palaemon) pandaliformis.—Holthuis, 1950b, p. 7; 1952, p. 187, pl. 46: figs. g–l.—Alves Coelho, 1966, pp. 69–71.

DIAGNOSIS.—*Carapace with antennal and branchiostegal spines, without hepatic spine.* Rostrum reaching beyond end of antennal scale, dorsal margin nearly straight or slightly concave, tip directed upward; armed with 6 to 10 dorsal and 5 to 9 ventral teeth; posterior tooth of dorsal series small, placed on carapace behind level of orbital margin, distal 1 to 3 teeth subapical, separated from posterior group of rather evenly spaced teeth by unarmed interval amounting to about one-third of rostral length. Eyes large, cornea well pigmented. Second pereiopods of adult male subequal, very slender, fingers two-thirds to three-fifths as long as palm, meeting throughout their length, smooth and bare, with single small tooth at end of proximal third of opposable margin of dactyl, none on immovable finger; palm sub-

cylindrical, about four times as long as wide, smooth and bare; *carpus more than one and one-half times as long as either chela or merus.* Third pereiopod with propodus more than twice as long as dactyl. A small species, maximum postorbital carapace length about 7 mm.

HABITAT.—Fresh and brackish water.

DISTRIBUTION.—West Indies and Republic of Guatemala to Estado de Santa Catarina, Brazil (Cuba, Hispaniola, Puerto Rico, Saint Croix, Barbados).

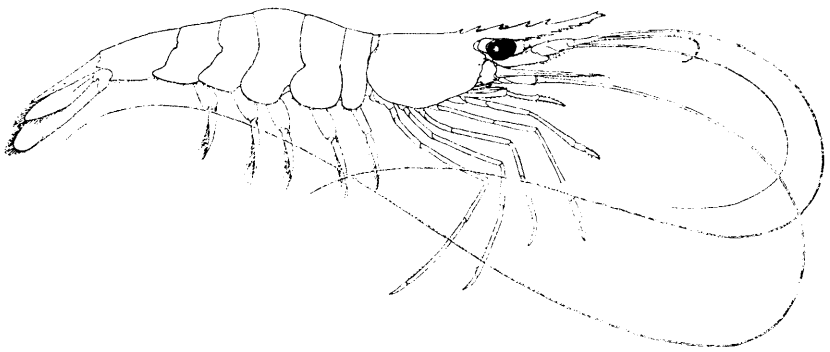


FIGURE 26.—*Palaemon (Palaemon) pandaliformis*, male (carapace length 6.8 mm) from East Luquillo, Puerto Rico (D. S. Erdman).

Genus *Troglocubanus*

24. *Troglocubanus calcis* (Rathbun)

FIGURE 28*b*

Palaemonetes calcis Rathbun, 1912 [part], p. 451, pl. 1: figs. 1–3, 5 [type-locality: cave between Madruga and Aguacate, Provincia de La Habana, Cuba].
Troglocubanus calcis—Holthuis, 1950b, p. 11; 1952, p. 144, pl. 36.

DIAGNOSIS.—Carapace with antennal spine arising from anterior margin, without branchiostegal or hepatic spines. Rostrum reaching beyond end of antennular peduncle, but not to end of antennal scale, tapering gradually to terminal point, slightly convex dorsally, *straight or slightly concave ventrally;* armed with single dorsal tooth placed on carapace slightly behind level of orbital margin. Eyes reduced, cornea without pigment. Second pereiopods subequal, slender, fingers about one and one-half times as long as palm, meeting throughout their length, smooth and bare, with single small tooth in extreme proximal part of opposable margin of dactyl, immovable finger unarmed; palm subcylindrical, swollen in proximal two-thirds, about two and one-half to three times as long as wide, smooth and bare; carpus distinctly longer than palm and slightly longer than merus.

Third pereiopod with propodus about four times as long as dactyl. A small species, maximum postorbital carapace length about 9 mm.

HABITAT.—Subterranean fresh water.

DISTRIBUTION.—Known only from the type-locality, a cave in Provincia de La Habana, Cuba.

25. *Troglocubanus eigenmanni* (Hay)

FIGURE 28*c*

Palaemonetes eigenmanni Hay, 1903, p. 431, fig. 2 [type-locality: cave near Ashton, southwest of Alquízar, Provincia de Pinar del Río, Cuba].
Troglocubanus eigenmanni.—Holthuis, 1950b, p. 11; 1952, p. 146, pl. 37.

DIAGNOSIS.—Carapace with antennal spine placed behind anterior margin, without branchiostegal or hepatic spines. Rostrum reaching to or slightly beyond end of antennal scale, tapering gradually to terminal point, faintly concave dorsally, slightly convex ventrally; armed with 6 to 8 dorsal teeth, unarmed ventrally; posterior 3 teeth placed on carapace behind level of orbital margin. Eyes reduced, cornea without pigment. Second pereiopods subequal, slender, fingers about one and one-half times as long as palm, meeting throughout their length, smooth and bare, with single small tooth in proximal part of opposable margin of dactyl, immovable finger unarmed; palm subcylindrical, about three times as long as wide, smooth and bare; carpus about as long as chela and longer than merus. Third pereiopod with propodus about three and one-half times as long as dactyl. A small species, maximum postorbital carapace length about 8 mm.

HABITAT.—Subterranean fresh water.

DISTRIBUTION.—Caves in Pinar del Río, La Habana, and Matanzas provinces, Cuba.

26. *Troglocubanus gibarensis* (Chace)

FIGURE 27

Palaemonetes gibarensis Chace, 1943, p. 28, pl. 7 [type-locality: well supplied by underground stream, Aguada del Montañes, en el Jobal, Barrio de Cupeysillo, Termino de Gibara, Provincia de Oriente, Cuba].
Troglocubanus gibarensis.—Holthuis, 1950b, p. 11.

DIAGNOSIS.—Carapace with small antennal spine arising from anterior margin, without branchiostegal or hepatic spines. Rostrum reaching nearly as far as end of antennular peduncle, with subparallel margins tapering to terminal point distally; armed with 2 or 3 dorsal teeth, unarmed ventrally; posterior tooth placed on carapace behind level of orbital margin. Eyes reduced, cornea without pigment. Second pereiopods subequal, slender, fingers not quite twice as long as palm, meeting throughout their length, smooth and bare, without teeth on opposable margins; palm subcylindrical, slightly more than

twice as long as wide, smooth and bare; carpus nearly twice as long as palm and slightly longer than merus. Third pereiopod with propodus more than three and one-half times as long as dactyl. A small species, maximum postorbital carapace length about 9 mm.

HABITAT.—Subterranean fresh water.

DISTRIBUTION.—Known only from the type-locality, an underground stream in Provincia de Oriente, Cuba.

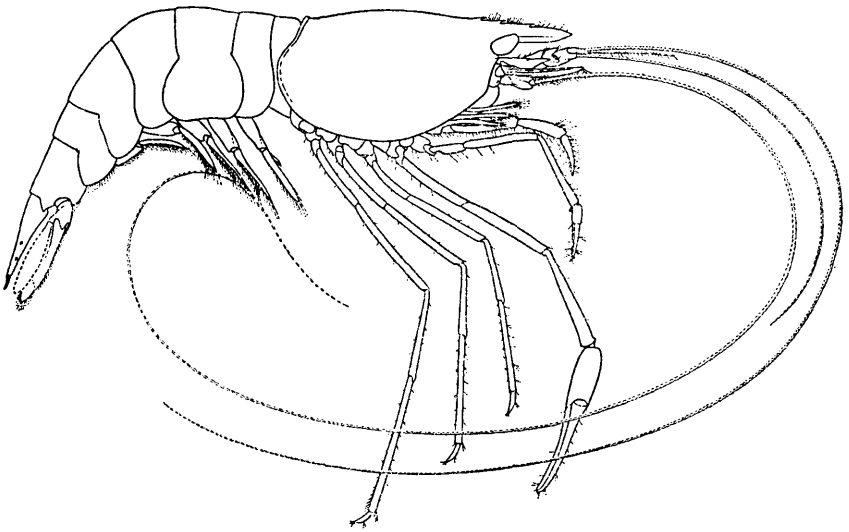


FIGURE 27.—*Troglocubanus gibarensis*, male holotype (carapace length 6.8 mm) from Termino de Gibara, Oriente Province, Cuba (from Chace, 1943).

27. *Troglocubanus inermis* (Chace)

FIGURE 28*d*

Palaemonetes calcis Rathbun, 1912 [part], p. 451, pl. 1: fig. 4.
Palaemonetes inermis Chace, 1943, p. 26, pl. 6 [type-locality: cave between Madruga and Aguacate, Provincia de La Habana, Cuba].
Troglocubanus inermis.—Holthuis, 1950b, p. 11; 1952, p. 150, pl. 39.

DIAGNOSIS.—*Carapace unarmed, without antennal, branchiostegal, or hepatic spines.* Rostrum reaching nearly as far as end of antennular peduncle, both margins subparallel proximally, strongly convex distally; unarmed or with small dorsal tooth near distal end. Eyes reduced, cornea without pigment. Second pereiopods subequal, slender *fingers about three times as long as palm*, meeting throughout their length, smooth and bare, without teeth on opposable margins; *palm subquadrangular, little longer than wide*, smooth and bare; carpus about as long as fingers and half of palm and approximately as long as merus.

Third pereiopod with propodus slightly more than three times as long as dactyl. A small species, maximum postorbital carapace length about 6 mm.

HABITAT.—Subterranean fresh water.

DISTRIBUTION.—Known only from the type-locality, a cave in Provincia de La Habana, Cuba.

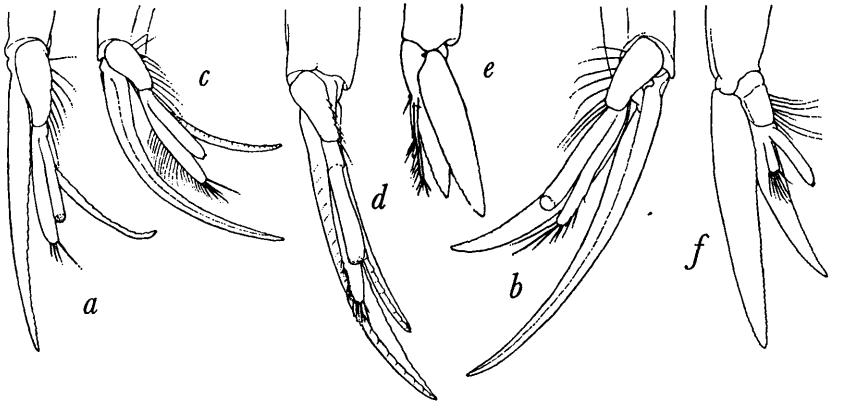


FIGURE 28.—Second pleopods, males: *a*, right, mesial view, *Palaemon* (*Palaemon*) *pandaliformis* shown in figure 26; *b*, left, mesial view, paratype, *Troglocubanus calcis* from cave between Madruga and Aguacate, La Habana Province, Cuba (T. Barbour); *c*, right, mesial view, *T. eigenmanni* from cave near Guira de Melena, La Habana Province, Cuba (P. Perdigon); *d*, right, mesial view, topotype, *T. inermis* from cave between Madruga and Aguacate, La Habana Province, Cuba (T. Barbour); *e*, left, anterior view, holotype, *T. jamaicensis* from cave near Goshen, Jamaica (modified from Holthuis, 1963a); *f*, right, anteromesial view, *Barbouria cubensis* shown in figure 29.

28. *Troglocubanus jamaicensis* Holthuis

FIGURE 28*e*

Troglocubanus jamaicensis Holthuis, 1963a, p. 67, fig. 3 [type-locality: stream in limestone cave near Lucky Hill Cooperative Farm near Goshen, Jamaica].

DIAGNOSIS.—Carapace with minute antennal spine arising from anterior margin, without branchiostegal or hepatic spines. *Rostrum not reaching beyond second segment of antennular peduncle,* convex dorsally, sinuous ventrally; unarmed or with small dorsal tooth above posterior margin of orbit. Eyes reduced, cornea without pigment. Second pereiopods subequal, slender, less than one and one-half times as long as palm, meeting throughout their length, smooth and bare, without teeth on opposable margins; palm subcylindrical, slightly swollen, slightly more than two and one-half times as long as wide, smooth and bare; carpus three-fourths as long as chela and about

as long as merus. Third pereiopod with propodus only about twice as long as dactyl. A small species, maximum postorbital carapace length 9 mm.

HABITAT.—Subterranean fresh water.

DISTRIBUTION.—Known only from the type-locality, a cave near Goshen, Jamaica.

Family HIPPOLYTIDAE

Genus *Barbouria*

29. *Barbouria cubensis* (Von Martens)

FIGURES 28*f*, 29

Hippolyte Cubensis Von Martens, 1872, p. 136, pl. 5: fig. 14 [type-locality: Cuba].
Hippolysmata cubensis.—Kingsley, 1878b, p. 89.
Barbouria poeyi Rathbun, 1912, p. 455, pls. 2–5 [type-locality: open cave (now destroyed) near seashore between Castillo del Morro and Cojímar, Provincia de La Habana, Cuba].
Barbouria poegi.—Spandl, 1926, p. 89.
Barbouria poey.—Spandl, 1926, p. 140.
Barbouria cubensis.—Holthuis, 1947, pp. 7, 33; 1963b, p. 272, fig. 2.

DIAGNOSIS.—Carapace armed with antennal and branchiostegal spines, each originating behind anterior margin and each supported by carina. Rostrum not reaching as far as end of second segment of antennular peduncle, armed with 4 or 5 dorsal and 2 or 3 ventral

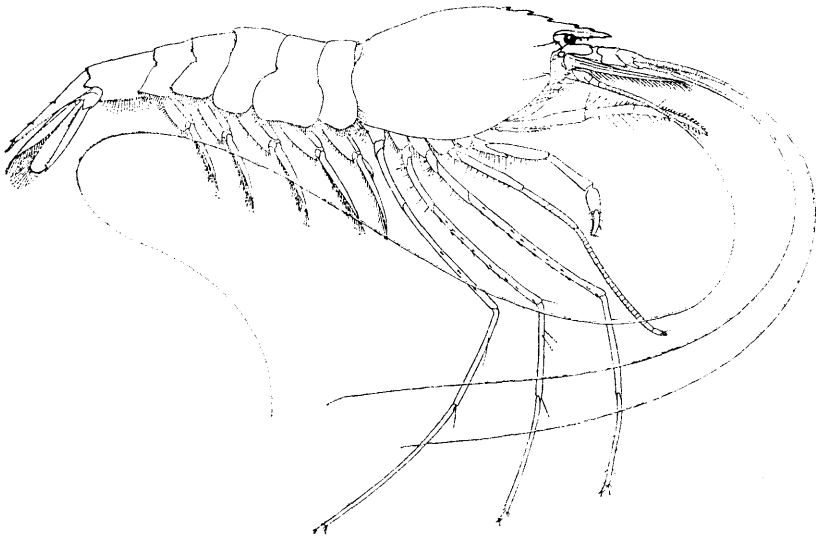


FIGURE 29.—*Barbouria cubensis*, male (carapace length 11.8 mm) from Cojimar, La Habana Province, Cuba (M. L. Jaume).

teeth; posterior 3 teeth of dorsal series placed on carapace behind level of orbital margin. Eyes with cornea noticeably narrower than eyestalk but well pigmented. Second pereiopods subequal, very slender, with carpus and distal part of merus multi-articulate, chela very small, little longer than distal article of carpus. Third pereiopod with propodus six or seven times as long as dactyl. Color translucent crimson, with antennular and antennal flagella, first pereiopods, and extreme distal portions of third to fifth pereiopods white. A rather small species, maximum postorbital carapace length about 12 mm.

HABITAT.—Marine or brackish water in sinks or roofless caves.

DISTRIBUTION.—Several marine or brackish pools near the coast of Cuba.

REMARKS.—All of the more than 100 specimens examined of *Barbouria cubensis* have an appendix masculina on the second pleopod. It is possible that the female of this shrimp is still unknown.

Family ASTACIDAE

Subfamily CAMBARINAE

Genus *Procambarus*

Key to the Species

1. Eyes reduced, body without pigment; spelean . . **Procambarus niveus** (p. 120)
   Eyes well developed, body with pigment; epigean 2
2. Posteromesial surface of first pleopod of first form male not strongly convex (fig. 31*a*) . . . . . **Procambarus atkinsoni** (p. 117)
   Posteromesial surface of first pleopod of first form male strongly convex (figs. 31*b*, *c*) 3
3. Areola usually more than 3.5 times longer than wide; distolateral tooth of first pleopod of first form male usually rounded.
   Procambarus cubensis cubensis (p. 118)
   Areola usually less than 3.5 times longer than wide; distolateral tooth of first pleopod of first form male usually acuminate.
   Procambarus cubensis rivalis (p. 118)

30. *Procambarus atkinsoni* (Ortmann)

FIGURE 31*a*

Cambarus (*Procambarus*) *atkinsoni* Ortmann, 1913, p. 414 [type-locality: tributaries of Río Los Indios, Isla de Pinos].

Procambarus atkinsoni.—Hobbs, 1942a, p. 342 [by implication].—Hobbs and Villalobos, 1964, p. 346, pls. 7–8.

DIAGNOSIS.—Body with pigment. Areola 2.5–3.1 times longer than broad and constituting 24–26.7 percent of entire length of cephalothorax. Eyes well developed. First pleopod of first form male with subangular to rounded shoulder on anterodistal surface; posteromesial surface not strongly convex (as compared with *P. cubensis cubensis* and

P. cubensis rivalis); distolateral tooth (caudal process) slender and acute. A medium-sized species, maximum postorbital carapace length about 15 mm.

HABITAT.—Freshwater streams.

DISTRIBUTION.—Isla de Pinos, Cuba.

31. *Procambarus cubensis cubensis* (Erichson)

FIGURES 30, 31*b*

Astacus (Cambarus) cubensis Erichson, 1846, p. 100 [type-locality: Cuba].
Cambarus cubensis.—Girard, 1852, p. 87 [by implication].
Cambarus consobrinus Saussure, 1857a, p. 101 [type-locality: "le mares de la partie centrale de l'ile de Cuba"].
Cambarus (Cambarus) cubensis.—Ortmann, 1905a, p. 101.
Cambarus (Procambarus) cubensis.—Ortmann, 1905b, p. 437.
Cambarus cubensis cubensis.—Faxon *in* Rathbun, 1912, p. 458 [by implication].
Cambarus cubensis consobrinus.—Faxon *in* Rathbun, 1912, p. 458.
Cambarellus cubensis.—Creaser, 1933, p. 21.—Rhoades, 1962, p. 72.
Procambarus cubensis cubensis.—Hobbs, 1942a, p. 342 [by implication].—Hobbs and Villalobos, 1964, p. 319, pls. 1, 2.
Procambarus cubensis consobrinus.—Hobbs, 1942a, p. 342 [by implication].
Procambarus consobrinus.—Villalobos, 1954, p. 303.

DIAGNOSIS.—Body pigmented. Areola 3.1–7.6 (usually more than 3.5) times longer than broad and constituting 26–35.1 percent of entire length of cephalothorax. Eyes well developed. First pleopod of first form male with angular shoulder on anterodistal surface; posteromesial surface strongly convex; distolateral tooth (caudal process) usually rounded. A medium-sized species, maximum postorbital carapace length about 18 mm.

HABITAT.—Freshwater ponds and streams.

DISTRIBUTION.—Widespread in Cuba and Isla de Pinos.

32. *Procambarus cubensis rivalis* (Faxon)

FIGURE 31*c*

Cambarus cubensis rivalis Faxon, 1912, p. 459 [type-locality: San Diego de Los Baños, Provincia de Pinar del Río, Cuba].
Procambarus cubensis rivalis.—Hobbs, 1942a, p. 342 [by implication].—Hobbs and Villalobos, 1964, p. 335, pls. 3–4.

DIAGNOSIS.—Body pigmented. Areola 2.1–3.7 (usually less than 3.5) times longer than broad and constituting 25.2–30.5 percent of entire length of cephalothorax. Eyes well developed. First pleopod of first form male with *subacute angular shoulder on anterodistal surface;* posteromesial surface strongly convex; distolateral tooth (caudal process) usually acuminate. A medium-sized species, maximum postorbital carapace length about 14 mm.

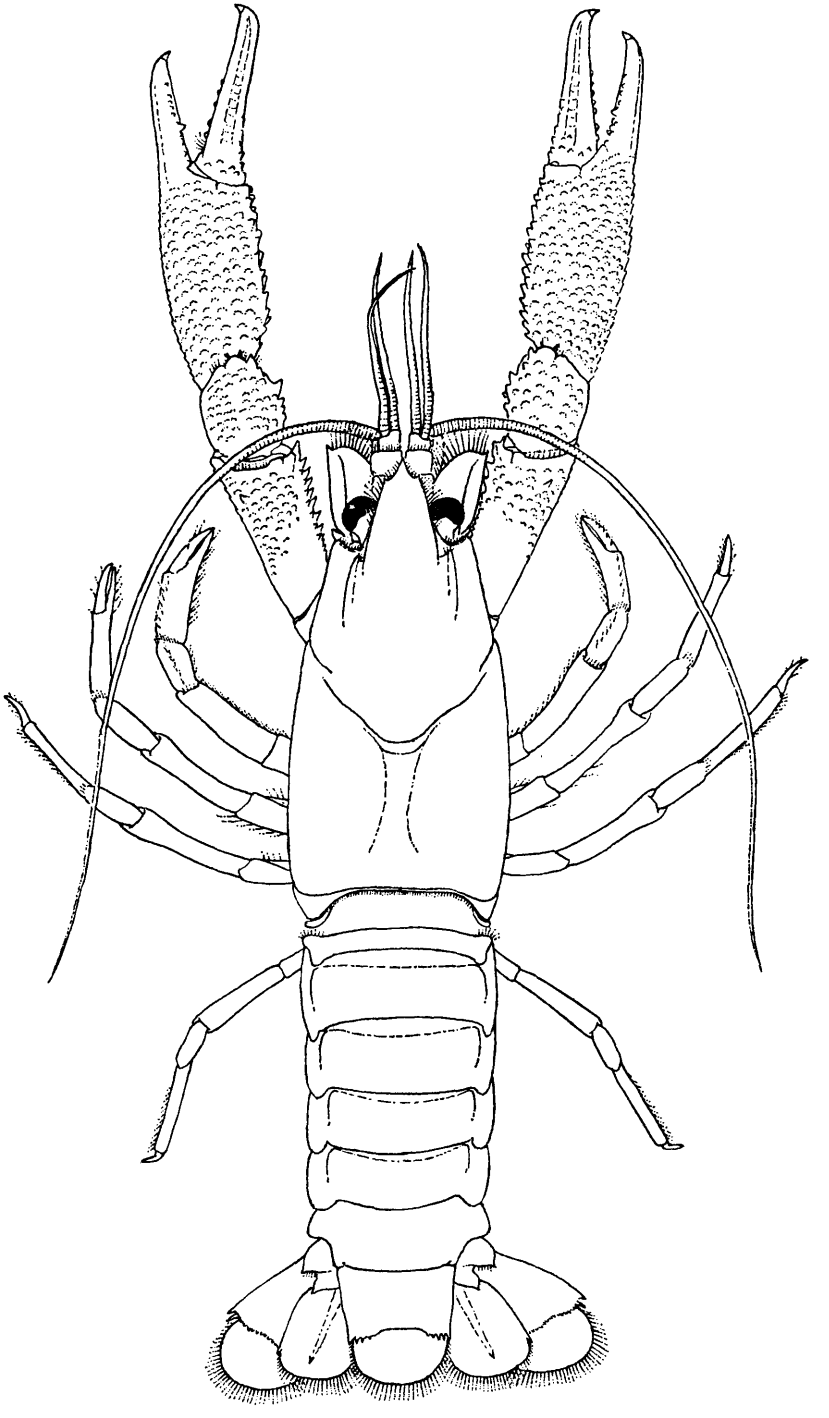


FIGURE 30.—*Procambarus cubensis cubensis*, first form male (carapace length 23.9 mm) from Guane, Pinar del Rio Province, Cuba.

HABITAT.—Mountain streams.

DISTRIBUTION.—Provincia de Pinar del Río, Cuba.

33. *Procambarus niveus* Hobbs and Villalobos

FIGURE 31*d*

Procambarus niveus Hobbs and Villalobos, 1964, p. 342, pls. 5–6 [type-locality: Cuevas de Santo Tomás, Sierra de los Organos, near Ponce, Provincia de Pinar del Río, Cuba].

DIAGNOSIS.—*Body without pigment.* Areola 3.8–4.0 times longer than broad and constituting 32–33 percent of entire length of cephalothorax. *Eyes small.* First pleopod of first form male with broadly rounded shoulder on anterodistal surface; posteromesial surface not strongly convex (as compared with *P. cubensis cubensis* and *P. cubensis rivalis*); *distolateral "tooth" (caudal process) broad, low, and rounded.* A medium-sized species, maximum postorbital carapace length about 20 mm.

HABITAT.—Subterranean fresh water.

DISTRIBUTION.—Known only from the type-locality in Provincia de Pinar del Río, Cuba.

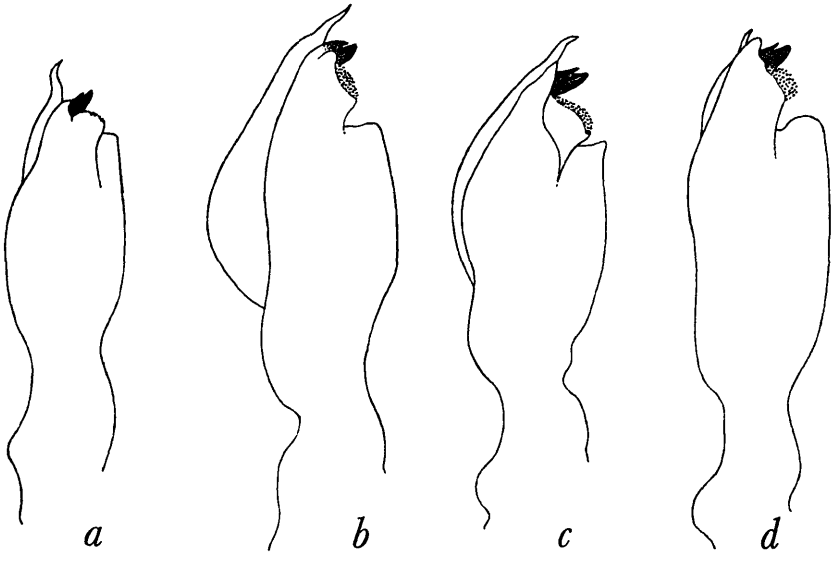


FIGURE 31.—Left first pleopods in lateral view of first form males: *a, Procambarus atkinsoni; b, P. cubensis cubensis; c, P. cubensis rivalis; d, P. niveus.* (Modified from Hobbs and Villalobos, 1963.)

Family PORCELLANIDAE

Genus *Petrolisthes*

34. *Petrolisthes quadratus* Benedict

FIGURES 32, 34*a*

Petrolisthes quadratus Benedict, 1901, p. 134, pl. 3: fig. 4 [type-locality: reefs at Ponce, Puerto Rico].—Haig, 1956, p. 18.

DIAGNOSIS.—Carapace broader than long, smooth (not rugose), lateral wall entire (not formed of two or more pieces separated by membranous interspaces). Front broadly triangular, without lobiform teeth at inner angles of orbit. Movable portion of antennal peduncle not excluded from orbit. Chelipeds of adult male similar, slightly unequal, depressed, smooth; carpus with flexor margin entire (not lobate or dentate), distal extremity of extensor margin blunt, not spinose. A small species, maximum carapace length in midline about 8 mm.

COLOR IN LIFE.—Carapace tan with greenish-brown anterior and lateral areas; greenish color extending from anterior border posteromesially along postorbital grooves to level of base of cheliped; pair of light tan spots between inner pair of postorbital grooves. Lateral wall of carapace with long upper and short lower triangular areas of olive brown. Abdomen tan with very narrow brownish band on posterior margin of each somite.

Second segment of antennal peduncle olive brown above fading to tan below; flagellum tan with distal margin of each unit olive brown. Third maxilliped with extensor margins of podomeres olive brown, remaining surface cream with tan mottling; merus with extensor margin olive brown and remaining surface pale tan with greenish splotches; carpus olive brown; propodus and dactyl pinkish tan on flexor portions, greenish brown on extensor portions. Chela of first pereiopod olive brown above with opposable margin of fixed finger cream, distal portion of extensor margin of dactyl and lower surface tan; merus and carpus olive brown above, tan below. Second through fourth pereiopods having merus tan with olive-brown extensor and flexor margins; carpus tan with longitudinal olive-brown stripes; propodus with two transverse bands; and dactyl with triangular mark proximally. Lower surfaces of remaining pereiopods, and all of fifth, cream to pinkish tan.

MATERIAL EXAMINED.—The material of *Petrolisthes quadratus* collected on Dominica at station 110 consists of 62 males (carapace lengths 2.2–5.1 mm), 44 females (cl 2.1–4.2 mm), including 34 with eggs (cl 2.7–4.2 mm), and 1 juvenile (cl 1.2 mm).

ECOLOGICAL NOTES.—Undoubtedly this small anomuran crab is much more abundant on Dominica than indicated by our single record on the south side of the isthmus that adjoins Scotts Head to the mainland (pl. 3A). Here, above the high-tide line on February 27,

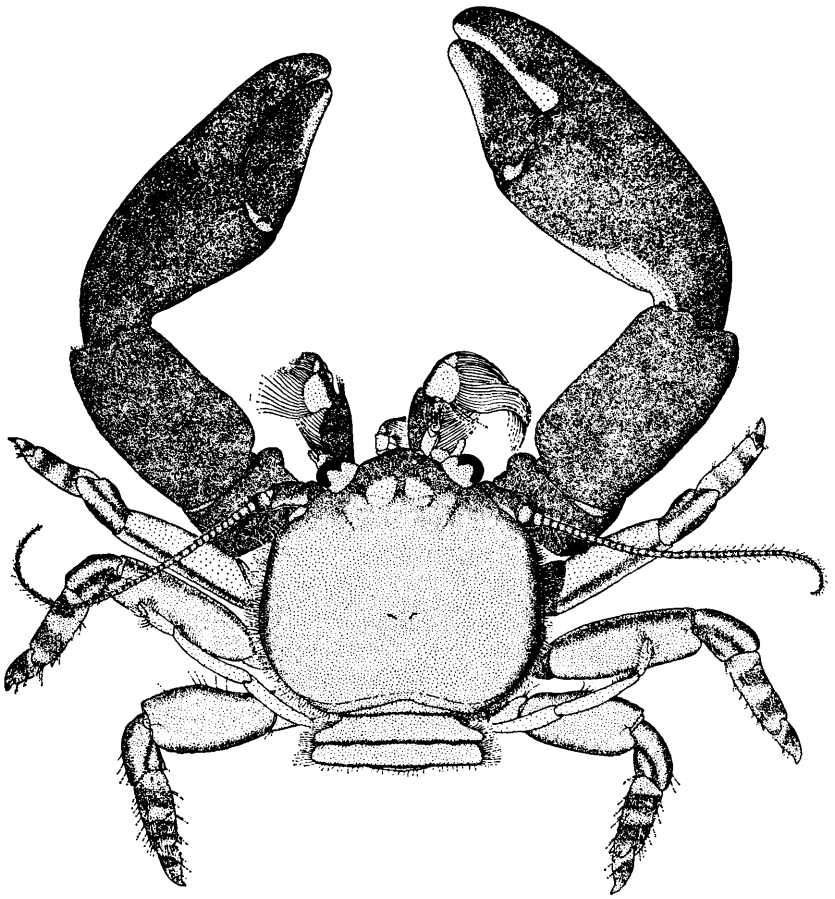


FIGURE 32.—*Petrolisthes quadratus*, male (carapace length 4.7 mm) from Dominica station 110.

1966, Dr. R. B. Manning and Hobbs were collecting along the cobble beach searching for *Geograpsus lividus* and *Cyclograpsus integer*. In this area, the rocks, 1 to 10 inches in diameter, are piled upon one another to a depth of one foot. In the splash zone, near and at the sand level, *Petrolisthes quadratus* was common, outnumbering *Geograpsus* by far and as abundant as *Cyclograpsus*, if not more so. A foot or so up the beach from where *Petrolisthes* was most numerous, *Cyclograpsus*

occurs in larger numbers than below, and yet higher, *Geograpsus* is the dominant crab. Both of the latter invade the zone inhabited by *Petrolisthes*, but the porcellanid does not wander so far from the water as does *Cyclograpsus*, and the latter not so high as does *Geograpsus*.

DISTRIBUTION.—Puerto Rico, Dominica, Isla Cubagua, Curaçao, Aruba, Panama.

Dominica Station: 110.

REMARKS.—The holotype of *Petrolisthes quadratus*, figured by Benedict (1901), is a female; in that sex, the chelipeds differ from those of the male in having the carpus marked by slightly rugose ridges and the chela less swollen, with sharper fingers. The detached walking legs associated with the holotype are very different from those of all other specimens subsequently assigned to the species; it seems unlikely that they belong to the type-specimen.

All of the Dominican specimens of *P. quadratus* were collected on February 27.

Family COENOBITIDAE

Genus *Coenobita*

35. *Coenobita clypeatus* (Herbst)

FIGURES 33, 34*b*, *c*

Cancer clypeatus Herbst, 1791, p. 22, pl. 23: figs. 2a–b [type-locality: "East Indies" (Hilgendorf, 1869, p. 98, noted that Herbst's type specimen—at that time in the Berlin Museum but probably subsequently destroyed—belonged to the West Indian species then called *Coenobita diogenes*)].

Pagurus Diogenes.—Latreille, 1818, p. 2, pl. 284: figs. 2, 3 [not *Cancer diogenes* Linnaeus, 1758].

Cenobita Diogenes.—H. Milne Edwards, 1837, p. 240.

Cenobita diogenes.—Pocock, 1889, p. 6.—Verrill, 1892, p. 353.

Coenobita clypeatus.—Rathbun, 1920, p. 329.—Provenzano, 1959, p. 359, fig. 3; 1962, p. 207, figs. 1–12.

DIAGNOSIS.—Eyestalks flattened on mesial surface. Antennular peduncle five times as long as eyestalks, flagellum blunt tipped. Antennal peduncle originating below eyestalk. Chelipeds unequal, left much larger than right, studded with closely appressed, dark-tipped spines. Third left pereiopod (second walking leg) with propodus and dactyl very broad, flattened, and smooth, with flexor margins rather sharp and obscurely serrate. Hermit crab usually occupying gastropod shells. A medium-sized to large species, maximum carapace length in midline at least 50 mm.

COLOR IN LIFE.—Carapace mauve dorsally, white dorsolaterally, lavender laterally, and white anteroventrally and ventrally. Three leathery terga of abdomen white with transverse ridges between terga

cream to flesh colored. Soft parts bluish dorsally, pinkish anterolaterally and ventrally, fading to white posteriorly; tubercles orange. Tubercular patches of uropods chocolate brown, terga purple with dark red patches of melanophores. Telson with anterolateral areas lavender, and median and posterior areas white.

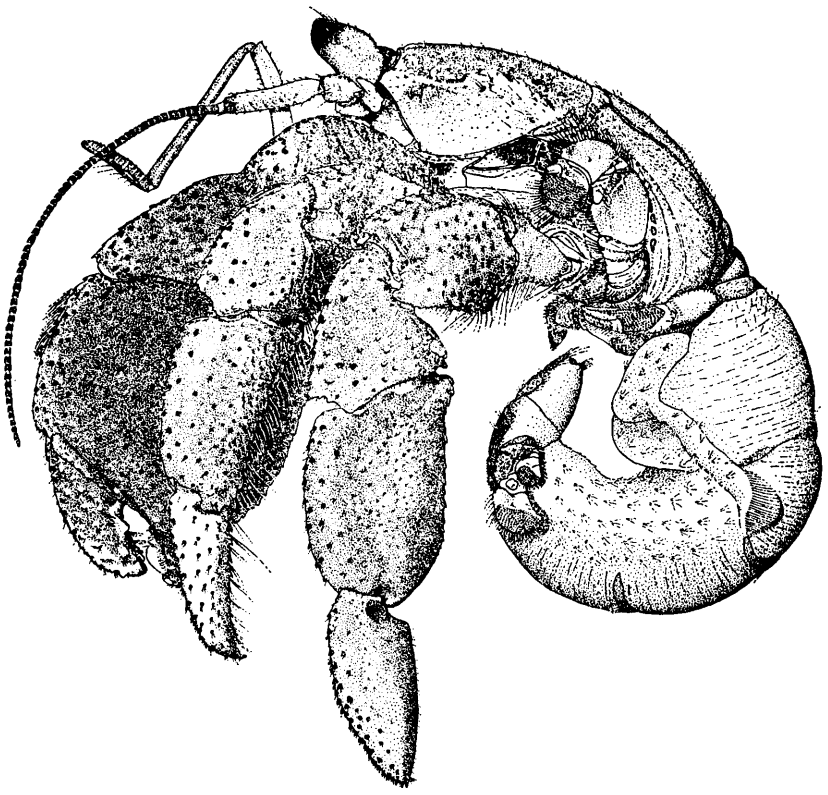


FIGURE 33.—*Coenobita clypeatus*, male (carapace length 19.2 mm) from Dominica station 17.

Eyestalks reddish orange, cornea brick red. Antennules lavender to bluish gray; flagellum vermilion with purple articular lines and dorsal margin. Antennal peduncle white basally, ultimate podomere lavender, tipped with vermilion; flagellum black with cream articulations. Third maxilliped white with terminal setal tufts brown. Cheliped with basal segments pale lavender; merus mauve; carpus dark brick red, purplish distolaterally; palm purple; fingers purple basally fading to apical white area; upper tubercles on merus through propodus very dark red, those on lower surface of propodus and distal portions of fingers lavender to white. Second pereiopod with basal podomeres

through merus lavender to mauve; carpus and extensor part of propodus brick red; flexor part of lateral surface red with lavender wash, small laterodistal area vermilion; proximal portion of extensor surface of dactyl vermilion fading to white distally, proximolateral area with lavender wash, mesial surface lavender fading to white; apical claw (spine) black. Basal segments of third pereiopod cream to lavender; merus mauve laterally and lavender mesially; carpus purplish red laterally, lavender mesially; propodus brick red laterally, lavender with longitudinal red ridge mesially; dactyl brick red laterally fading to white distally, mesial surface lavender, fading to white

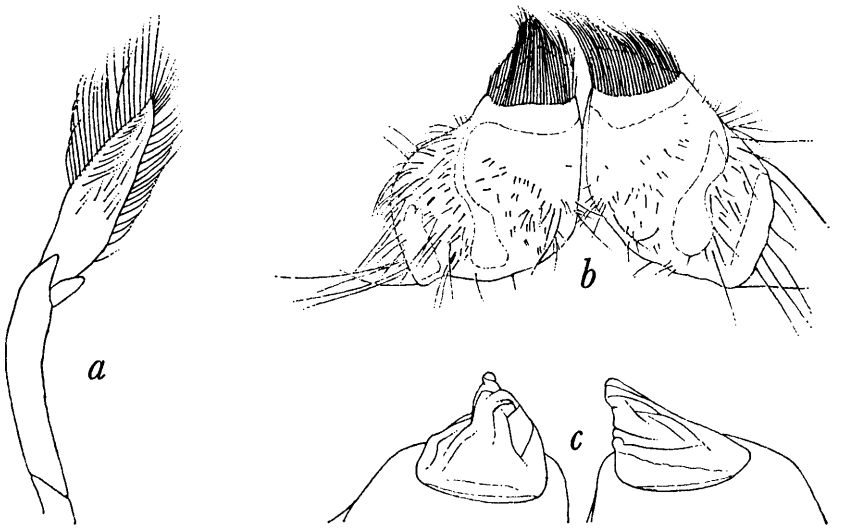


FIGURE 34.—Sexual characters: *a*, right first pleopod in anterior view of male *Petrolisthes quadratus* shown in figure 32; *b*, coxae of fifth pereiopods in anterior view of male *Coenobita clypeatus* shown in figure 33; *c*, same denuded.

distally, apical spine black; all lateral tubercles on leg dark red. Fourth and fifth pereiopods lavender to white, tubercular patch on fourth black, that on fifth dark chocolate.

MATERIAL EXAMINED.—The Dominican collections contain 26 males (total carapace lengths in midline 4.3–26.8 mm), 25 females (cl 4.1–22.0 mm), and 5 juveniles (cl 2.1–3.6 mm). The sexual pores on the coxae of the fifth pereiopods in the males and the third pereiopods in the females are usually not discernible in specimens with a carapace length of less than 4.0 mm.

ECOLOGICAL NOTES.—This terrestrial hermit crab occurs throughout all of the coastal parts of Dominica that were visited by the observers, even on cliffs that rise as much as 100 feet above the ocean. Occasional

individuals were observed approximately two miles from the coast. One small crab was found occupying a shell of the snail *Neritina punctulata* at the water's edge of the Layou River (fresh water) at Clarke Hall. Dr. J. P. E. Morrison found two specimens at South Chiltern (station 117) at an altitude of 1,300 feet.

There is some indication that these crabs are highly gregarious. The largest number of individuals observed at one time was immediately south of the mouth of the Rosalie River in a triangular area between a banana plantation, the river, and the ocean. Here among the shaded but dry litter, hundreds of individuals were observed, most of them crawling about the forest floor, but a number of them were feeding on the fruits of *Terminalia catappa*. As many as five or six small ones were within an area of one square foot, and under some of the stones a dozen or more had congregated. This population was observed shortly after noon on February 14, 1964.

Although such large numbers were not observed wandering about the north slope of Tarou Cliffs, just south of the mouth of the Layou River, 19 individuals were collected at about 2:00 P.M. within a few minutes; of the 19, however, 14 were found in a small pile of rocks less than a square foot in area. In this locality, burrows of small individuals of *Gecarcinus lateralis* and *Cardisoma guanhumi* were present in the immediate vicinity, and within 15 feet there were the burrows of large individuals of *C. guanhumi*.

Usually *Coenobita* is much more active at night near the mouth of the Layou than during the day, and dozens of specimens may be collected at night along the foot of the Cliff; however, they were never observed in the adjacent marshy area near the burrows of *Ucides cordatus*.

DISTRIBUTION.—Southern Florida to Venezuela (Bermudas, Great Abaco I., Bimini Is., Eleuthera I., New Providence I., Andros I., Water Cay, Acklins I., Cuba, Jamaica, Hispaniola, Isla Mona, Puerto Rico, Saint Thomas, Saint Croix, Saba, Antigua I., Guadeloupe, Dominica, Barbados, Trinidad, Isla Los Roques, Isla de Aves, Bonaire, Curaçao, Aruba, Isla de Providencia, Swan Is.). Brazilian records of this species in the older literature need verification.

Dominica Stations: 2, 6, 15, 17, 22, 25, 94, 97, 99, 109, 117, 129 (0–1,300 ft.).

REMARKS.—It may be noteworthy that none of the 25 females of this species from Dominica are ovigerous; they were collected in January, February, March, and June.

Family PORTUNIDAE

Subfamily PORTUNINAE

Genus *Callinectes*

Key to the Species

1. Central trapezoidal (metagastric) area on carapace nearly or quite three times as wide anteriorly as long . . . . . **Callinectes ornatus** (p. 132)
   Central trapezoidal (metagastric) area on carapace little more than twice as wide anteriorly as long 2
2. Submedian pair of frontal teeth large, reaching nearly as far forward as lateral pair . . . . . **Callinectes bocourti** (p. 127)
   Submedian pair of frontal teeth small or absent 3
3. Teeth on anterolateral margin of carapace directed outward, not curving noticeably forward; lateral spine often considerably more than twice as long as posterior margin of preceding tooth 4
   Anterolateral teeth of carapace curving forward; lateral spine less or little more than twice as long as posterior margin of preceding tooth 5
4. Submedian pair of frontal teeth small but distinct; first pleopods of adult male (fig. 37*b*) reaching about to suture between sternites supporting third and fourth pereiopods . . . . . **Callinectes danae** (p. 130)
   Submedian pair of frontal teeth rudimentary or absent; first pleopods of adult male (fig. 37*f*) reaching beyond suture between sternites supporting first and second pereiopods . . . . . **Callinectes sapidus** (p. 133)
5. Anterolateral margin of carapace strongly arched; first pleopods of adult male (fig. 37*c*) reaching about to suture between sternites supporting third and fourth pereiopods, tips curving mesially . . **Callinectes exasperatus** (p. 131)
   Anterolateral margin of carapace not strongly arched; first pleopods of adult male (fig. 37*d*) falling far short of suture between sternites supporting third and fourth pereiopods, tips divergent . . **Callinectes marginatus** (p. 131)

36. *Callinectes bocourti* A. Milne-Edwards

FIGURES 35, 37*a*

Callinectes Bocourti A. Milne-Edwards, 1879, p. 226 [type-locality: Mullins River, 20 miles south of Belize, British Honduras].

Callinectes Cayennensis A. Milne-Edwards, 1879, p. 226 [type-locality: (French) Guiana].

Callinectes bocourti.—Rathbun, 1930, p. 128, text-figs. 15g, 16e, 17h, 18f, pl. 55.—Holthuis, 1959, p. 201, text-fig. 47, pl. 5: fig. 2.

Callinectes Boucorti—Vélez, 1967, p. 42.

DIAGNOSIS.—Carapace with central trapezoidal (metagastric) area nearly half as long as anterior width; anterolateral margins moderately arched; anterolateral teeth curving slightly forward; lateral spine usually less than twice as long as posterior margin of preceding tooth. *Submedian pair of frontal teeth large, reaching nearly as far forward as lateral pair.* First pleopods of adult male diverging, then recurving mesially in distal half, reaching beyond suture between sternites supporting first and second pereiopods; distal portion armed laterally

with row of large and small, sharp spinules; extreme tip directed somewhat lateral to axis of shaft. A large species, maximum carapace length in midline about 75 mm.

COLOR IN LIFE.—Carapace olive to forest green with purplish red markings: paired oblique elongate bars present in protogastric and lateral epibranchial regions, small spot in branchial lobe; two spots in anteromesial portion and two bars in posterolateral portion of mesobranchial region; more anterior bar extending posterolaterally from lateral spot, posterior one irregular and almost transverse; some

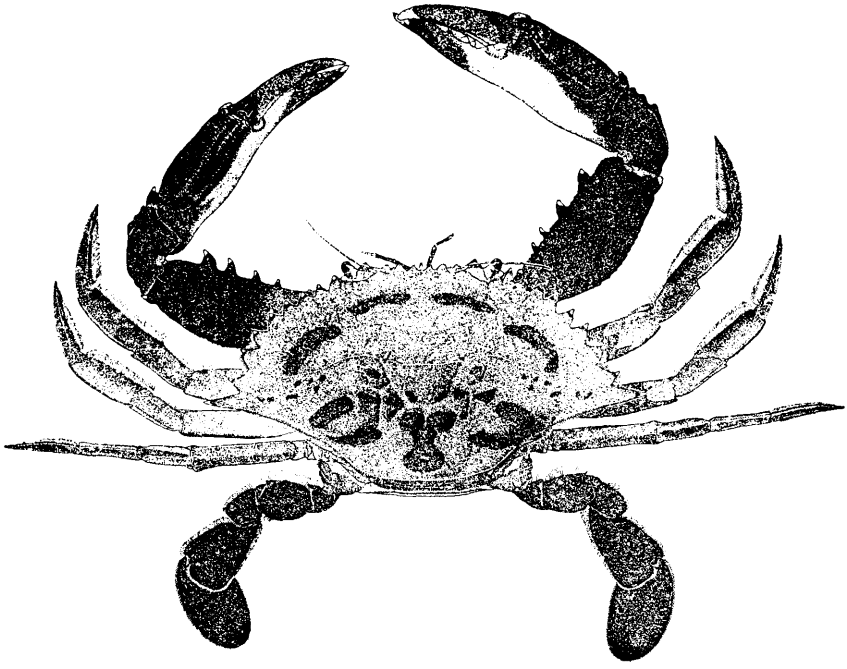


FIGURE 35.—*Callinectes bocourti*, male (carapace length 72.0 mm) from Dominica station 36.

half dozen very small spots scattered across anterolateral portion of mesobranchial region; urogastric lobe with pair of spots in posterolateral angles; cardiac and intestinal area with prominent median dumbbell-shaped blotch with pair of anterolaterally projecting auriform lobes, posteromedian portion of dumbbell with circular light spot. Anterolateral teeth with red bands immediately adjacent to yellowish-cream tips.

Eyestalks green basally, yellowish tan more distally, with reddish-black cornea. Antennules reddish brown with gray terminal setae. Third maxillipeds white with bluish suffusion distally. Chelipeds

mostly brick to scarlet red but growths of algae furnishing upper distal portion of merus and upper surface of carpus with greenish tinge. Lower mesial and lateral surfaces of palmar area of propodus, proximoventral portion of dactyl, and proximodorsal portions of immovable finger bluish cream; tubercles, tips of fingers, and all spines on all podomeres cream; remainder of fingers mostly bright red with small dark red areas. Second and third pereiopods with proximal portions of merus mostly orange red becoming more scarlet distally. Fourth pereiopod lighter red on coxa and darker but bright red on more distal podomeres; distal extremity of dactyl very dark red. Fifth pereiopod dark red with upper surface of basis white and with distal portions of distal three podomeres bearing overlay of dark olive. Setae on all legs olive tan.

Ventral surface of cephalothorax white to cream with lower surface of carapace blue marginally; first abdominal segment reddish tan with white epimera, remainder mostly white to light cream.

MATERIAL EXAMINED.—The Dominican collections contain 6 males (carapace lengths in midline 42.0–72.0 mm) and 8 females (cl 32.5–62.4 mm). The two smallest males (cl 42.9 and 43.3 mm) have the abdomen sealed to the sternum, but the first pleopods are fully formed. Only the largest female has the abdomen fully formed; it is subtriangular in those with a carapace length of 51.2 mm or less.

ECOLOGICAL NOTES.—Relatively few of the streams on Dominica provide a habitat suitable to support populations of the two species of *Callinectes*. As has been pointed out above, so many of the streams enter the Caribbean or Atlantic over riffles, with no estuarine habitats at their mouths, that these crabs are not everywhere present and appear to be rare except in a few streams such as the Mero and Salisbury Rivers, both of which lack any noticeable current during much of the drier seasons of the year.

Callinectes bocourti was observed to be abundant only in the area of the mouth of the Mero River. This stream is hardly more than a trickle during the drier seasons, and never was it observed discharging much water at its mouth. About 40 to 50 yards from its mouth, it reaches sea level, broadens from 15 to 25 feet, and in some areas is as much as 3 feet deep. Much of the bottom is rock strewn and elsewhere there is sand with a shallow coat of silt. Considerable amounts of garbage thrown into the area, together with the sluggish current, are probably responsible for the brownish tinge of the water. The outlet is usually blocked by dark sand, and the water that escapes from the stream bed must seep through the sand. A small tributary, longer than the lagoonal area just described, but no more than 10 feet wide, joins the Mero within 30 feet of its mouth. It is stagnant and much debris has accumulated within it. In this heavily polluted

stream, *C. bocourti* may be seen wandering about among the rocks, struggling with one another over a bit of debris (viscera of a chicken, small chunks of suet, or similar discarded refuse), or pressing close to the bottom against a stone. The crabs were not observed after dark; however, it would be surprising were they much more active at night than during the day.

A single specimen of this crab was found close to the shore in a small pocket of water in the mud flat adjacent to the mouth of the Indian River at Portsmouth, and large specimens were collected near the mouth of the Salisbury River. In all three of these areas, the water was dark, presumably somewhat stagnant; both the Mero and Salisbury Rivers are distinctly polluted, and none of the three was in direct communication with the Caribbean when collections were made.

No intensive search was made in other streams on the island to locate this crab, but many collections were made in the lower reaches of the Layou both during the day and at night, and not one individual was seen there, whereas a number of *Callinectes sapidus* were observed. In sharp contrast to the Mero and Salisbury Rivers, this stream is always flowing and, although perhaps slightly polluted, does not have a debris-littered bed, and any materials in the nature of garbage would be quickly washed to sea. Perhaps the relatively clean bed of the stream is responsible for the apparent absence of this crab in it.

DISTRIBUTION.—Southern Florida to Estado de Santa Catarina, Brazil (Jamaica, Puerto Rico, Saint Croix, Dominica).

Dominica Stations: 36, 38, 112 (0–5 ft.)

37. *Callinectes danae* Smith

FIGURE 37*b*

Lupa dicantha.—Dana, 1852, p. 272 [not *Lupea dicantha* H. Milne Edwards, 1834].

Callinectes diacanthus.—Ordway, 1863, p. 575.

Callinectes Danae Smith, 1869b, p. 7 [type-localities: Recife (Pernambuco), Salvador (Bahia), and Rio de Janeiro, Brazil (restricted to Recife, Estado de Pernambuco, Brazil by Rathbun, 1930)].

Callinectes danae.—Rathbun, 1930, p. 118, text-figs. 15d, 16b, 17b, 18d, pl. 51.—Williams, 1966, p. 86, figs. 2, 4c, D.

DIAGNOSIS.—Carapace with central trapezoidal (metagastric) area nearly half as long as anterior width; anterolateral margins rather feebly arched; anterolateral teeth directed outward, not curving noticeably forward; lateral spine as much as three or four times as long as posterior margin of preceding tooth. Submedian pair of frontal teeth small but distinct. First pleopods of adult male nearly straight, sometimes overlapping, reaching about to suture between somites supporting third and fourth pereiopods; *distal portion usually appear-*

ing unarmed under low magnification; tip usually directed laterad and toward sternum. A large species, maximum carapace length in midline about 55 mm.

HABITAT.—Marine and estuarine, perhaps occasionally in fresh water.

DISTRIBUTION.—West Indies and British Honduras to Estado de Santa Catarina, Brazil (Cuba, Jamaica, Hispaniola, Puerto Rico, Saint Thomas, Saint Croix, Martinique, Saint Lucia I., Barbados, Trinidad, Isla de Providencia, Isla de Utila).

38. *Callinectes exasperatus* (Gerstaecker)

FIGURE 37*c*

Lupea exasperata Gerstaecker, 1856, p. 129 [type-locality: Puerto Cabello, Venezuela].

Callinectes tumidus Ordway, 1863, p. 574 [type-localities: Key West, Florida, and Haiti].

Callinectes exasperatus.—Rathbun, 1897b, p. 150; 1930, p. 130, text-figs. 15f, 16f, 17e, 18e, pl. 56.

DIAGNOSIS.—Carapace with central trapezoidal (metagastric) area nearly half as long as anterior width; anterolateral margins strongly arched; anterolateral teeth curved forward; lateral spine usually less than twice as long as posterior margin of preceding tooth. Submedian pair of frontal teeth small but distinct. First pleopods of adult male slightly overlapping proximally, diverging, and then abruptly recurved mesially in distal half, reaching about to suture between sternites supporting third and fourth pereiopods; distal portion provided with scattered minute spinules; *extreme tip broadening slightly and obliquely truncate.* A large species, maximum carapace length in midline about 63 mm.

HABITAT.—Marine and estuarine, perhaps occasionally in fresh water.

DISTRIBUTION.—Southern Florida to Estado do Parana, Brazil (Bermudas, Cuba, Jamaica, Hispaniola, Puerto Rico, Saint Croix, Saint Martin, Islas Los Roques, Isla de Providencia).

39. *Callinectes marginatus* (A. Milne-Edwards)

FIGURE 37*d*

Neptunus marginatus A. Milne-Edwards, 1861, p. 318; pl. 30: fig. 2 [type-locality: Gabon, West Africa].

Callinectes larvatus Ordway, 1863, p. 573 [type-localities: Key West and Dry Tortugas, Florida, Bahamas, Haiti].

Callinectes africanus A. Milne-Edwards, 1879, p. 229 [type-locality: Cape Verde Islands].

Callinectes larvatus var. *africanus*?—Benedict, 1893, p. 537.

Callinectes marginatus.—Rathbun, 1897b, p. 149; 1930, p. 123, text-figs. 15e, 16d, 17d, 18c, pl. 53.—Monod, 1956, p. 208, figs. 238–239.

Callinectes marginatus var. *larvatus*.—Verrill, 1908, p. 368, text-fig. 22b, pl. 18: fig. 1.

DIAGNOSIS.—Carapace with central trapezoidal (metagastric) area nearly half as long as anterior width; anterolateral margins not strongly arched; anterolateral teeth curved forward; lateral spine slightly more than twice as long as posterior margin of preceding tooth. Submedian pair of frontal teeth very small but distinct. First pleopods of adult male not overlapping, *distal portion curved sharply laterally, not reaching beyond middle of sternite supporting fourth pereiopods;* terminal portion provided with scattered, extremely minute spinules and tapering gradually to rather sharp tip. A moderately large species, maximum carapace length in midline about 50 mm.

HABITAT.—Marine and estuarine, perhaps occasionally in fresh water.

DISTRIBUTION.—Western Atlantic from Florida to Estado de São Paulo, Brazil (Bermudas, Bimini Is., New Providence I., Andros I., Long I., Cuba, Jamaica, Hispaniola, Puerto Rico, Saint Thomas, Saint Croix, Guadeloupe, Dominica, Isla de Margarita, Islas Los Roques, Curaçao, Aruba, Isla de Providencia, Isla de Utila); eastern Atlantic from Mauritania and Cape Verde Islands to northern Angola.

40. *Callinectes ornatus* Ordway

FIGURE 37*e*

Callinectes ornatus Ordway, 1863, p. 57 [type-localities: Cumaná (Venezuela), Haiti, Bahamas, Dry Tortugas, and Charleston Harbor (South Carolina)].—Rathbun, 1930, p. 114, text-figs. 15b, 16a, 17a, 18b, pl. 50.—Williams, 1966, p. 84, figs. 1, 4A, B.

DIAGNOSIS.—Carapace with *central trapezoidal (metagastric) area little more than one-third as long as anterior width;* anterolateral margins not strongly arched; anterolateral teeth curved forward; lateral spine two and one-half to three times as long as posterior margin of preceding tooth. Submedian pair of frontal teeth very small, almost rudimentary. First pleopods of adult male nearly straight, overlapping proximally, reaching nearly to suture between sternites supporting third and fourth pereiopods; provided with scattered, small spinules becoming more numerous subdistally; extreme tip bluntly lanceolate. A large species, maximum length of carapace in midline about 60 mm.

HABITAT.—Marine and estuarine, occasionally in fresh water.

DISTRIBUTION.—New Jersey to Estado de São Paulo, Brazil (Bermudas, Bimini Is., Eleuthera I., Andros I., Long I., Cuba, Jamaica, Hispaniola, Puerto Rico, Saint Thomas, Saint Croix, Saint Martin, Saint Eustatius, Guadeloupe, Saint Lucia I., Barbados, Islas Los Roques, Bonaire, Curaçao, Aruba).

41. *Callinectes sapidus* Rathbun

FIGURES 36, 37*f*

Portunus diacantha Latreille, 1825b [part], p. 190 [type-localities: North America, Antilles, Brazil, etc. (restricted to Philadelphia, Penn., by Holthuis, 1962, p. 232); name suppressed for purposes of Law of Priority by International Commission on Zoological Nomenclature, Opinion 712 (1964, p. 336)].

?*Lupea dicantha*.—H. Milne Edwards, 1834, [part] p. 451.

Lupa dicantha.—Gould, 1841, p. 324.

Callinectes sapidus Rathbun, 1896a, p. 352, pl. 12; pl. 24: fig. 1; pl. 25: fig. 1; pl. 26: fig. 1; pl. 27: fig. 1 [type-locality restricted to "east coast of United States" by Williams, 1965].—Williams, 1965, p. 168, fig. 151.

Callinectes sapidus acutidens Rathbun, 1896a, p. 354, pl. 13; pl. 24: fig. 2 [type-locality: Santa Cruz, Estado da Bahia, Brazil]; 1930, p. 111, text-fig. 15c, pl. 48.

DIAGNOSIS.—Carapace with central trapezoidal (metagastric) area nearly half as long as anterior width; anterolateral margins not strongly arched; anterolateral teeth directed outward, not curving noticeably forward; lateral spine two to four times as long as posterior margin of preceding tooth. *Submedian pair of frontal teeth rudimentary or absent.* First pleopods of adult male diverging, then recurving mesially in distal half, reaching beyond suture between sternites supporting first and second pereiopods; distal portion armed laterally with row of large and small, *blunt-tipped* spinules; extreme tip continuing axis of shaft, not directed laterad. A very large species, maximum carapace length in midline about 94 mm.

COLOR IN LIFE.—Carapace mostly olive green with frontal, orbital, and anterior gastric regions with dark brown suffusion; tubercles over gastric, epibranchial, hepatic, and anterolateral portions of mesobranchial regions tipped with cream; anterolateral teeth with subterminal orange bands fading to cream tips. Posterolateral portion of mesobranchial area with pale tan spot.

Antennules mottled brown on cream; antennae pale straw. Third maxillipeds cream and somewhat tan distally. Chelipeds with upper surface of merus dark olive brown anteriorly, fading to cream tan proximally and posteriorly; spines cream basally with vermilion tips (basal one entirely cream colored), and cream spot at upper distal articular knob; carpus dark olive brown above with proximal articular membrane gray; palm with two dark olive-brown stripes along upper border, one nearest flexor margin fading ventrally to olive tan and then blue with faint olive suffusion, extensor surface greenish blue, immovable finger blue fading to tan distally with cream tip and lavender teeth subtended by bright blue stripe; inner articular knob of propodus at base of dactyl white; dactyl with dark olive triangular area proximally, mostly greenish above and blue toward lavender teeth, tip white with dark brown band immediately proximal to it.

Second, third, and fourth pereiopods olive above, blue below with vermilion spots at distal ends of merus and propodus, dactyls with yellow corneous tips. Fifth pereiopod mostly olive with cream to tan setae; bright vermilion spots on distal portions of basis, merus, and propodus; posterior portion of merus white; proximal portions of carpus and propodus with bright blue areas, distal margin of carpus and proximal margin of propodus rimmed with vermilion with cream membrane between.

First abdominal tergum green. Thoracic sterna, remainder of abdomen, and all coxae, white to cream with telson bluish cream.

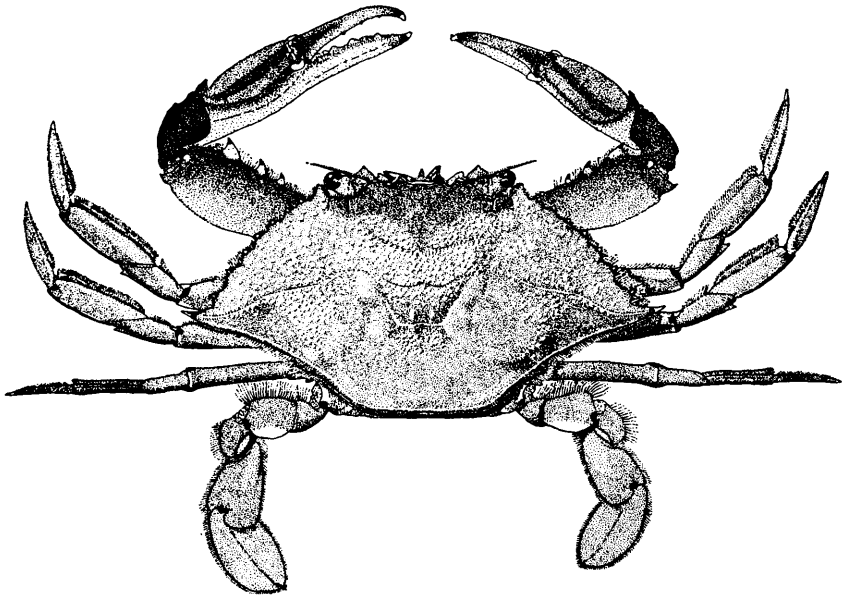


FIGURE 36.—*Callinectes sapidus*, male (carapace length 53.2 mm) from Dominica station 36.

MATERIAL EXAMINED.—The Dominican collections contain 3 males (carapace lengths in midline 19.3–53.2 mm), 2 females (cl 46.8 and 51.4 mm), and 1 juvenile (cl 6.2 mm). In the two smaller males (cl 19.3 and 22.4 mm), the abdomen is sealed to the sternum; the first pleopods are nearly straight in both, reaching to the middle of the sternite supporting the third pereiopods in the smaller specimen and nearly to the suture anterior to that sternite in the larger. Only the larger of the two females has the abdomen fully formed; it is subtriangular in the smaller female.

ECOLOGICAL NOTES.—*Callinectes sapidus* has been collected from only two streams on Dominica, the Layou and Salisbury Rivers, and a single large individual was observed in the Lamoins River south of Portsmouth. Observations, therefore, on its habits on Dominica are so limited as to be worthy of little note.

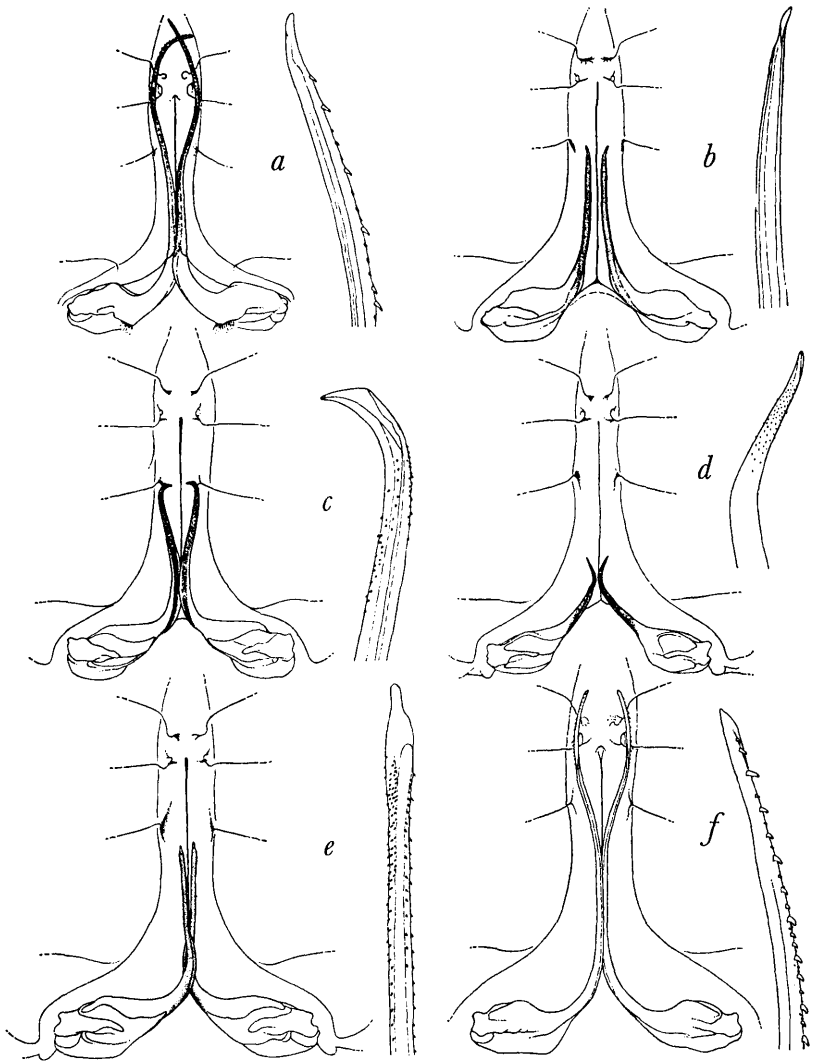


FIGURE 37.—Male first pleopods in flexed position in sternal groove and enlarged tips of left first pleopods in posterior view: *a*, *Callinectes bocourti*, specimen shown in figure 35; *b*, *C. danae* (carapace length 48.2 mm) from Cayo Punta Colorado, Cuba (*Tomas Barrera*); *c*, *C. exasperatus* (cl 51.0 mm) from Jamaica (*Albatross*); *d*, *C. marginatus* (cl 47.0 mm) from Montego Bay, Jamaica (E. A. Andrews); *e*, *C. ornatus* (cl 54.0 mm) from Tarpum Bay, Eleuthera (B. A. Bean); *f*, *C. sapidus*, specimen shown in figure 36.

In none of the three localities was it found to be abundant. In the highly polluted Mero River, where *C. bocourti* was most abundant (see "Ecological Notes" for that species), no individuals of this species were seen; however, near the mouth of the Salisbury River, a less polluted stream, several individuals were collected or observed within 50 to 75 feet from the mouth. In the clear Layou River, a number of individuals were seen near the mouth of the river, and a few were collected.

Its occurrence in the localities cited above and its absence in the Mero River suggests that this species is less tolerant of high pollution and muddy water than is *C. bocourti*.

DISTRIBUTION.—Nova Soctia to Uruguay (Bermudas, Bahamas, Cuba, Jamaica, Puerto Rico, Saint Croix, Dominica), introduced into coastal waters of Denmark, Netherlands, France, Italy, Greece, Turkey, and Israel.

Dominica Stations: 15, 30, 36 (sea level).

REMARKS.—The extreme variants of *Callinectes sapidus* in the West Indies are so different from each other that they could easily be interpreted as distinct species. In adequate series of specimens, however, there seems to be no point of demarcation between the typical form, which is prevalent along the east and south coasts of the United States, and the sharp-spined tropical variety with rudimentary submedian frontal teeth, which Rathbun called *C. sapidus acutidens*. The two forms are apparently sympatric in the West Indies, they intergrade almost completely, and the first pleopods of adult males seem identical.

The species identified as *Callinectes acutidens* by Boschi (1964, p. 45, pl. 2e–g, pl. 12) is almost certainly a different species, as indicated by the presence of discrete, even if small, submedian frontal teeth and by the straight first pleopods of presumably adult males. The holotype of *C. sapidus acutidens* has long, sinuous first pleopods, which agree very well with those of typical *C. sapidus*. Boschi's species seems to be most closely related to the variable *C. danae*, but it may represent an undescribed species.

Family PSEUDOTHELPHUSIDAE

The classification used herein is based principally on that of Pretzmann (1965). After our manuscript was submitted for publication, Bott (1968, pp. 47–49) proposed a different arrangement and demonstrated that older names are available for some of Pretzmann's new genera. Until the works of these two specialists are reconciled, the classification of the Pseudothelphusidae will remain uncertain.

Key to the Species

Some of the general morphological characters used in this key (e.g., curvature of cervical groove, dentition and contour of anterolateral margin, development of postfrontal crest) are rather variable. The most reliable character is the form of the male first pleopod; it should be examined whenever possible before a final determination is made.

1. Third maxilliped with exopod overreaching ischium; first pleopod of adult male armed distally with scattered short stout spines (fig. 39). Subfamily EPILOBOCERINAE 2
   Third maxilliped with exopod not reaching distal margin of ischium; first pleopod of adult male with group of slender spines near aperture of sperm duct but without scattered short stout spines elsewhere (fig. 43.) Subfamily PSEUDOTHELPHUSINAE 8
2. Front delimited dorsally by transverse crest or ridge, usually concealing part of true frontal margin from dorsal view 3
   Front curving gradually downward, frontal margin entirely visible in dorsal view 7
3. Postfrontal crest represented by low, obscurely tuberculate ridge; all pereiopods unusually long and slender . . . . . **Epilobocera gertraudae** (p. 139)
   Postfrontal crest well developed, tuberculate; pereiopods not unusually long 4
4. Third maxilliped with merus broad, distolateral margin rather regularly convex 5
   Third maxilliped with merus narrow, subquadrate, distal margin slightly concave 6
5. Carapace about three-fifths as long as wide . . **Epilobocera armata** (p. 138)
   Carapace less than three-fifths as long as wide . **Epilobocera granulata** (p. 140)
6. Submedian lobes of true frontal margin visible in dorsal view. **Epilobocera haytensis** (p. 141)
   True frontal margin entirely concealed from dorsal view by postfrontal crest . . . . . **Epilobocera sinuatifrons** (p. 141)
7. Third maxilliped with merus slightly concave along distal margin. **Epilobocera cubensis** (p. 138)
   Third maxilliped with merus rather regularly convex along entire distolateral margin . . . . . **Epilobocera gilmanii** (p. 140)
8. Front delimited dorsally by strong, tuberculate transverse crest; third maxilliped with exopod less than one-third as long as lateral margin of ischium . 9
   Front curving gradually downward, not delimited dorsally by transverse crest; third maxilliped with exopod more than half as long as lateral margin of ischium 11
9. Chela with prominent, swollen protuberance on outer surface at base of fingers; third maxilliped with merus rather regularly convex along entire distolateral margin . . . . . **Guinotia garmani garmani** (p. 147)
   Chela without prominent protuberance on outer surface; third maxilliped with merus concave distally 10
10. Cervical groove nearly straight . . . . . **Guinotia dentata** (p. 143)
    Cervical groove curving posteriorly near anterolateral margin. **"Pseudothelphusa" affinis** (p. 148)
11. First pleopod of adult male with distal margin appearing sinuous and transversely truncate in posterior view (fig. 43*e*). **Pseudothelphusa americana** (p. 149)
    First pleopod of adult male with distal margin appearing concave and obliquely truncate in posterior view (fig. 43*f*) . . . **Pseudothelphusa terrestris** (p. 150)

Subfamily EPILOBOCERINAE

Genus *Epilobocera*

42. *Epilobocera armata* Smith

FIGURE 39*a*

Epilobocera armata Smith, 1870, p. 151, pl. 5: figs. 2–2b [type-locality: Cuba (probably Baracoa, Provincia de Oriente)].—Rathbun, 1905, p. 316, pl. 18 (XVI): figs. 1, 6.

DIAGNOSIS.—Carapace strongly convex longitudinally and transversely, especially branchial regions, rather broad, about three-fifths as long as wide; cervical groove nearly obliterated, concave anteriorly; anterolateral margin armed with several prominent, sharp teeth anteriorly, decreasing in size posteriorly and disappearing at about widest part of carapace, no distinct notches at end of cervical groove or near outer orbital angle; front delimited dorsally by strong, tuberculate, transverse crest, true margin barely visible in dorsal view. Third maxilliped with merus broad, distolateral margin regularly convex; exopod extending beyond ischiomeral articulation. Pereiopods not unusually long or slender. Chela without prominent, swollen protuberance on outer surface at base of fingers. First pleopod of adult male armed distally with scattered, short stout spines; elongate lobe directed posteriorly in situ. A fairly large species, maximum carapace length in midline about 45 mm.

HABITAT.—In and near fresh water.

DISTRIBUTION.—Cuba.

43. *Epilobocera cubensis* Stimpson

FIGURES 38, 39*b*

Epilobocera cubensis Stimpson, 1860, p. 234 [type-locality: upper Río Yateras, Provincia de Oriente, Cuba].—Rathbun, 1905, p. 315, text-fig. 103, pl. 18 (XVI): fig. 7.

DIAGNOSIS.—Carapace strongly convex longitudinally and transversely, about two-thirds as long as wide; cervical groove nearly obliterated, somewhat sinuous, strongly concave anteriorly toward center of carapace, straight or curving slightly posteriorly near anterolateral margin; anterolateral margin nearly entire, anterior part with few very low, elongate tubercles, no notch at end of cervical groove, margin concave near outer orbital angle; front curving downward very gradually, not delimited dorsally by transverse crest. Third maxilliped with merus broad, lateral margin regularly convex, distal margin slightly concave; exopod extending beyond ischiomeral articulation. Pereiopods rather slender, not unusually long. Chela without prominent, swollen protuberance on outer surface at base

of fingers. First pleopod of adult male armed distally with scattered, short, stout spines; elongate lobe directed laterally in situ. A large species, maximum carapace length in midline about 52 mm.

HABITAT.—In and near fresh water.

DISTRIBUTION.—Cuba.

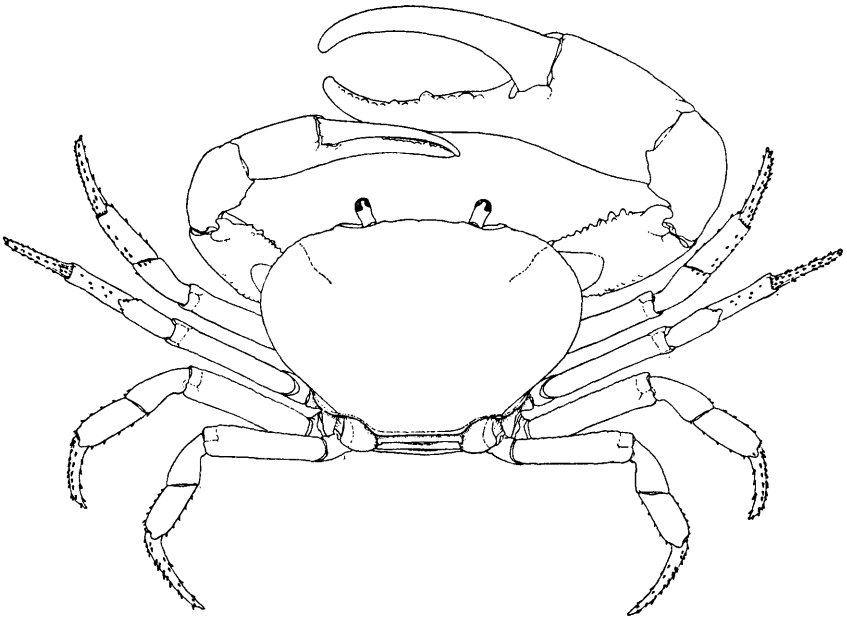


FIGURE 38.—*Epilobocera cubensis*, based on male (carapace length 37.4 mm) from near Alquizar, Pinar del Rio Province, Cuba (C. H. Eigenmann).

44. *Epilobocera gertraudae* Pretzmann

FIGURE 39*c*

Epilobacera gertraudae Pretzmann, 1965, p. 9 [type-locality: "mouth of Cane, Las Banas, Cuba" (mouth of cave at Los Baños, ca. 4 mi. north of Viñales, Provincia de Pinar del Río, Cuba)].

DIAGNOSIS.—Carapace moderately convex laterally and anteriorly, flattened posteriorly, very broad, less than three-fifths as long as wide; cervical groove shallow but distinct, slightly concave anteriorly; anterolateral margin finely and sparsely denticulate, slightly produced in broadly obtuse projection just lateral to cervical groove and with shallow indentation near outer orbital angle; front very short, delimited dorsally by low ridge, true margin retracted, barely visible in dorsal view. Third maxilliped with merus only moderately broad, lateral margin convex, distal margin faintly convex or nearly straight;

exopod extending slightly beyond ischiomeral articulation. *All pereiopods unusually long and slender.* Chela without prominent, swollen protuberance on outer surface at base of fingers. First pleopod of adult male armed distally with scattered, short, stout spines; elongate lobe directed posteriorly in situ. A medium-sized species, carapace length in midline about 25 mm.

HABITAT.—Presumably in or near fresh water.

DISTRIBUTION.—Known only from the type-locality in Provincia de Pinar del Río, Cuba.

45. *Epilobocera gilmanii* (Smith)

Opisthocera Gilmanii Smith, 1870, p. 149, pl. 5: figs. 1–1d [type-locality: small stream near center of Isla de Pinos].
Epilobocera gilmanii.—Rathbun, 1898, pp. 529, 531, 536.
Epilobocera Gilmanii.—Rathbun, 1905, p. 314, pl. 18 (XVI): figs. 2, 5.

DIAGNOSIS.—Carapace strongly convex longitudinally and transversely, about two-thirds as long as wide; cervical groove nearly obliterated, almost straight or very slightly sinuous; anterolateral margin slightly and obtusely denticulate anteriorly, entire posteriorly, without notch at end of cervical groove, broadly indented near outer orbital angle; front curving downward very gradually, not delimited dorsally by transverse crest. Third maxilliped with merus broad, distolateral margin regularly convex; exopod extending beyond ischiomeral articulation. Pereiopods not unusually long or slender. Chela without prominent, swollen protuberance on outer surface at base of fingers. A medium-sized species, carapace length in midline about 40 mm.

HABITAT.—Fresh-water stream.

DISTRIBUTION.—Known only from the unique male holotype from Isla de Pinos.

46. *Epilobocera granulata* Rathbun

Epilobocera granulata Rathbun, 1893, p. 659, pl. 77: fig. 6 [type-locality: "West Indies."]; 1905, p. 317, pl. 18 (XVI): fig. 9.

DIAGNOSIS.—Carapace rather flat and broad, less than three-fifths as long as wide; cervical groove distinct, slightly concave anteriorly near midlength; anterolateral margin grossly denticulate anteriorly, not obviously notched at end of cervical groove or near outer orbital angle; front delimited dorsally by strong, tuberculate, transverse crest, but most of true margin visible beyond it. Third maxilliped with merus broad, distolateral margin regularly convex; exopod extending beyond ischiomeral articulation. Pereiopods not unusually long. Chela without prominent, swollen protuberance on outer surface at base of fingers. Probably a medium-sized to large species.

HABITAT.—Unknown, presumably in or near fresh water.

DISTRIBUTION.—Known only from the type-series labeled "West Indies."

REMARKS.—The type-series of *E. granulata*, consisting of four immature specimens, was described by Rathbun in 1893 as "all more or less mutilated." Unfortunately, the specimens have apparently deteriorated even more with time; all of the material is now virtually macerated, except for the imperfect and extremely fragile remains of one carapace and one sternum. In view of the immaturity of these specimens and the lack of a specific type-locality, the species may remain a species inquirenda indefinitely unless it can be shown to be a synonym of *E. armata.*

47. *Epilobocera haytensis* Rathbun

FIGURE 39*d*

Epilobocera haytensis Rathbun, 1893, p. 658, pl. 77: figs. 4–5 [type-locality: Republic of Haiti]; 1905, p. 319, pl. 18 (XVI): fig. 8.

DIAGNOSIS.—Carapace not very convex longitudinally or transversely, rather broad, about three-fifths as long as wide; cervical groove distinct, sinuous, convex forward mesially, concave forward laterally; anterolateral margin denticulate throughout, even onto posterolateral margin, and marked by two broad, shallow indentations, one at end of cervical groove, one near outer orbital angle; front delimited dorsally by strong, tuberculate, transverse crest, hiding all but submedian lobes of true frontal margin from dorsal view. Third maxilliped with merus subquadrate, lateral margin feebly convex, distal margin somewhat concave; exopod extending beyond ischiomeral articulation. Pereiopods not unusually long or slender. Chela without prominent, swollen protuberance on outer surface at base of fingers. First pleopod of adult male armed distally with scattered, short, stout spines; elongate lobe directed laterally in situ. A large species, maximum carapace length in midline about 64 mm.

HABITAT.—In and near fresh water.

DISTRIBUTION.—Hispaniola.

48. *Epilobocera sinuatifrons* (A. Milne-Edwards)

FIGURE 39*e*

Boscia sinuatifrons A. Milne-Edwards, 1866, p. 205 [type-locality unknown].

Pseudothelphusa sinutifrons.—Smith, 1870, p. 147.

Pseudothelphusa sinuatifrons.—Pocock, 1889, p. 10.

Boscia Portoricensis (Von Martens ms) Rathbun, 1905, p. 318 [type-locality: Puerto Rico].

Epilobocera sinuatifrons.—Rathbun, 1898, pp. 529, 531, 536; 1905, p. 318, pl. 18 (XVI): fig. 3.

DIAGNOSIS.—Carapace not very convex longitudinally or transversely, broad, less than three-fifths as long as wide; cervical groove distinct, concave forward; anterolateral margin denticulate, marked

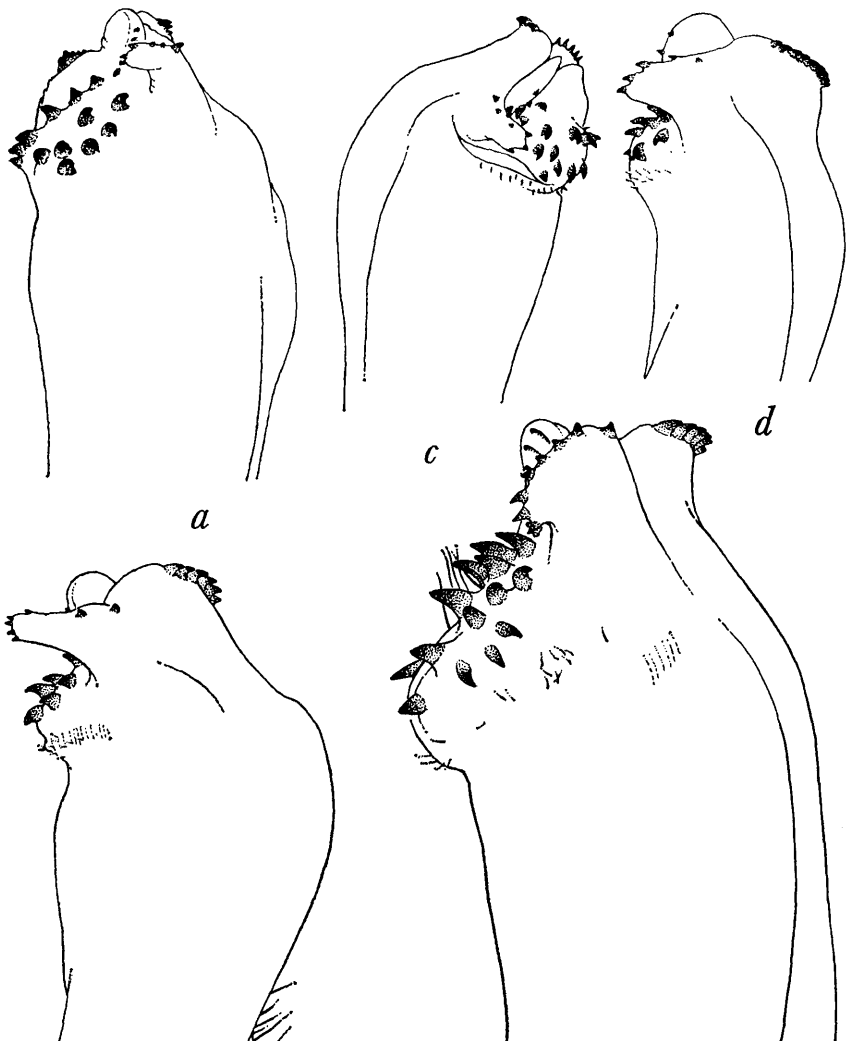


FIGURE 39.—Terminal portions in posterior view of male right first pleopods (left in *c*): *a*, *Epilobocera armata* (carapace length 45.0 mm) from Baracoa, Oriente Province, Cuba (W. Palmer); *b*, *E. cubensis* (cl 36.2 mm) from San Diego de los Baños, Pinar del Rio Province, Cuba (W. Palmer and J. H. Riley); *c*, *E. gertraudae*, holotype (cl 25.0 mm) from Baños Viñales, Pinar del Rio Province, Cuba (*Tomas Barrera*); *d*, *E. haytensis* (cl 41.5 mm) from Moline, Haiti (W. L. Abbott); *e*, *E. sinuatifrons* (cl 54.5 mm) from Caguas, Puerto Rico (*Fish Hawk*).

by two obscure notches, one at end of cervical groove, one near outer orbital angle; front delimited dorsally by strong transverse crest hiding entire true frontal margin from dorsal view. Third maxilliped with merus subquadrate, lateral margin feebly convex, distal margin somewhat concave; exopod extending beyond ischiomeral articulation. Pereiopods not unusually long or slender. Chela without prominent, swollen protuberance on outer surface near base of fingers. First pleopod of adult male armed distally with scattered, short, stout spines; elongate lobe directed posteriorly in situ. A large species, maximum carapace length in midline about 60 mm.

HABITAT.—In and near fresh water.

DISTRIBUTION.—Puerto Rico; Saint Croix.

Subfamily PSEUDOTHELPHUSINAE

Genus *Guinotia*

49. *Guinotia (Guinotia) dentata* (Latreille)

FIGURES 40, 41, 43*a–c*

Telphusa dentata Latreille, 1825c, p. 564 [type-locality: Martinique].
Potamia dentata.—Latreille, 1831, p. 338.
Cancer (Thelphusa)? dentatus.—De Haan, 1833, p. 23.
Boscia dentata.—H. Milne Edwards, 1837, p. 15, pl. 18: figs. 14–16.
Pseudothelphusa dentata.—Smith, 1870, p. 147.—Rathbun, 1905, p. 300, text-fig. 93, pl. 16 (XIV): fig. 4.
?Pseudotelphusa tenuipes Pocock, 1889, p. 7, pl. 2: figs. 1, 1a [type-locality: Laudat, Dominica].
Pseudotelphusa dentata.—Pocock, 1889, p. 9.
Potamocarcinus dentatus.—Ortmann, 1897 [part], pp. 317, 318.
Guinotia (Guinotia) dentata.—Pretzmann, 1965, p. 3 [by implication].
?Guinotia (Neopseudothelphusa) tenuipes.—Pretzmann, 1965, p. 3 [by implication].
Guinotia dentata.—Mitchell, 1966, p. 89 [color photograph].

DIAGNOSIS.—Carapace not very convex longitudinally or transversely, rather broad, about three-fifths as long as wide; cervical groove very distinct, nearly straight; anterolateral margin denticulate, denticles extending well onto posterolateral margin, very shallow emargination near outer orbital angle and occasionally a second near end of cervical groove; front delimited dorsally by strong, tuberculate, transverse crest hiding all but extreme lateral portions of true frontal margin from dorsal view. Third maxilliped with merus narrowing distally, lateral margin slightly convex, distal margin concave or broadly notched lateral to insertion of palp; exopod not reaching midlength of lateral margin of ischium. Pereiopods not unusually long or slender. Chela without prominent, swollen protuberance on outer surface near base of fingers. First pleopod of adult male not armed

distally with scattered, short, stout spines; terminating in long, strong spine *with sharp spiral tip* and armed mesially with sharp, straight spine directed mesiodistally. A large species, maximum carapace length in midline nearly 60 mm.

COLOR IN LIFE.—Carapace chocolate brown and yellow, or orange; anterior and anterolateral margins with narrow band of yellow; protogastric, mesogastric, most of anterior two-thirds of cardiac, and anteromesial portions of branchial regions also yellow; central yellow area with pair of chocolate-brown spots lateral to anterior

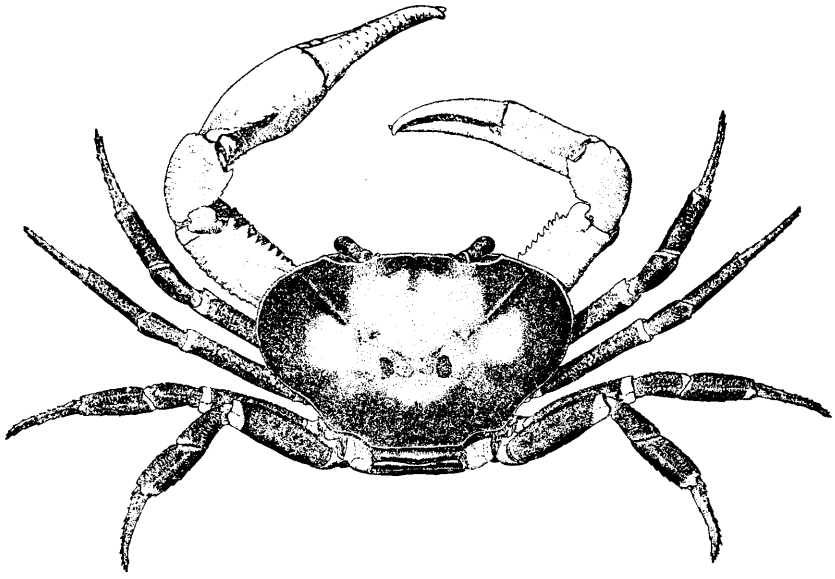


FIGURE 40.—*Guinotia* (*Guinotia*) *dentata*, male (carapace length 45.0 mm) from Dominica station 66.

portion of cardiac region. In some individuals, almost entire dorsal surface of carapace yellow with submarginal brown area and anterolateral pair of brown lobes extending posteromesially along cervical grooves; in such yellow individuals, spots characteristically present in yellow area greatly reduced in size and bleached to very poorly defined, slightly brownish areas. Lower surface of carapace chocolate brown, slightly lighter just dorsal to bases of legs; pterygostomian region very dark brown, almost black.

Eyestalks yellow to yellowish tan with black cornea, sometimes vermilion at base. Third maxillipeds with distal podomeres chocolate brown, a little lighter at articulations and along mesial border; smaller basal podomeres yellow. Cheliped with coxa yellowish tan,

basis and ischium only slightly darker; merus yellow above, brown below but distal portion entirely yellow. Carpus yellow except dorsally where brown but with yellow dorsomesial and distal margins; propodus with upper proximomesial and proximolateral surfaces brown, remainder of palm yellow; both fingers yellow proximally and white distally with white tubercles on opposable surfaces. (In some individuals, distal four podomeres yellow and white with only lower surface of merus and lower proximomesial surface of carpus brown.) Remaining pereiopods with coxae yellowish tan, basis and ischium slightly darker; merus brown except for distal yellowish-green band; distal podomeres mostly brown with greenish-yellow areas adjacent to articulations.

Sternum pale yellowish tan with pale yellow lines marking sternal sutures. Abdomen brown at base fading to tan toward telson.

MATERIAL EXAMINED.—The Dominican collections contain 50 males (carapace lengths in midline 7.2–55.8 mm), 57 females (cl 7.2–58.8 mm), including 3 with eggs (cl 44.1–55.5 mm) and 7 with young (cl 48.3–58.8 mm), and 102 juveniles (cl 3.6–8.2 mm). As indicated below, the first rudiments of pleopods may appear in both males and females at a carapace length of 7.2 mm, but other specimens as much as a millimeter longer show no sign of abdominal appendages.

ECOLOGICAL NOTES.—Except for its apparent absence in the lowermost portions of those streams with flooded mouths, *Guinotia dentata* frequents most parts of the island where fresh water is readily accessible in streams, ditches, ponds, lakes, seepage areas, or burrows. In fact, this crab was the first crustacean observed on Dominica by Hobbs. On his trip from the airport to Clarke Hall in November 1963, he saw a large male of this species crossing the road at about 9:00 A.M. just south of the bridge at Deux Branches, a tributary to the Pagua River on the windward side of the island.

In the Layou River drainage, it occurs from just above the lowermost bridge well onto the slopes of Morne Trois Pitons, and one individual was seen in Boeri Lake at an altitude of 2,850 feet. It is a denizen of seepage areas, where it constructs burrows. In streams, it is by no means confined to pools; however, almost every pool more than a few feet in diameter is frequented by one of these crabs. Often it digs shallow excavations under large stones that are surrounded by water, and many stones embedded in the bank of a stream have crab excavations beneath them that extend for a foot or more into the bank. While burrows are common in seepage areas, this crab has been found neither in low-lying areas with *Cardisoma* nor in the drier areas with the two species of *Gecarcinus*.

On the morning of February 19, 1966, Hobbs was observing a large pool on Mannet's Gutter. Using a line baited with an earth-

worm, he twice snared a large *Guinotia*, pulling it from the water only to have it drop back into the pool. After the second time, the crab disappeared into the deeper area of the pool. A short time later a crab that was believed to be the same individual because of its not-too-common pale color was observed on the opposite bank, approximately 12 feet away. It was facing the observer with its eyes erect, chelae gaping, and it remained motionless for some 10 minutes until the observer made a sudden move at which the crab quickly crawled into the edge of the water, in clear view and just barely beneath the surface. It remained there for some 15 minutes,

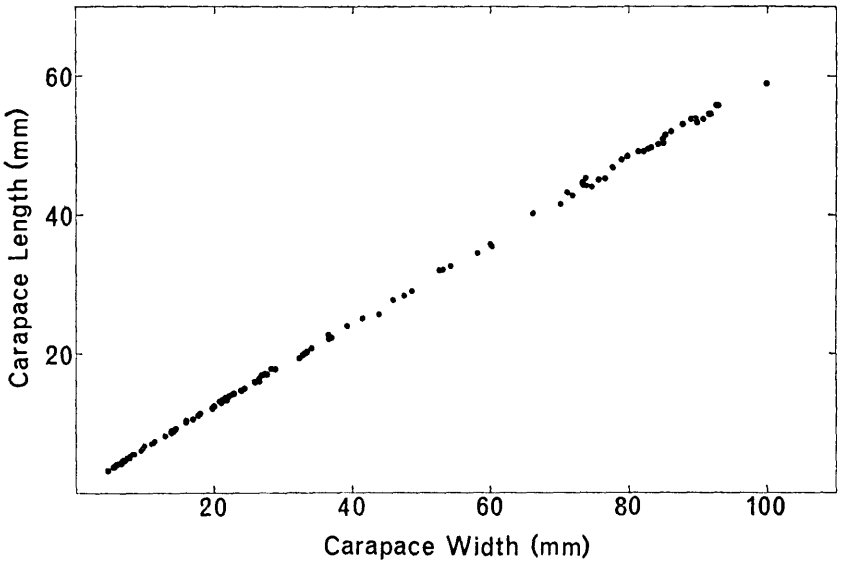


FIGURE 41.—Scatter diagram showing correlation of the dimensions of the carapace with growth in Dominican specimens of *Guinotia* (*Guinotia*) *dentata*.

moved farther into the pool to a depth of about a foot, again stopping for another 10 minutes before disappearing into the deeper part of the pool.

DISTRIBUTION.—Guadeloupe, Dominica, Martinique, Saint Lucia I. It seems safe to assume that an error of documentation is indicated by the lot of three specimens recorded by Rathbun (1905) as having been collected in "Mexico" by Bocourt. The remaining 11 species now recognized in *Guinotia* are known only from South America (and Trinidad), and it is highly unlikely that *G. dentata*, which is otherwise restricted to the central Lesser Antilles, could have a discontinuous distribution of more than 1,500 miles (in the wrong direction).

Dominica Stations: 1–5, 7–9, 11, 19, 20, 23, 25, 29, 32, 34, 39–48, 53–55, 58–60, 66, 70, 73, 75, 77, 78, 85, 87, 90–92, 95, 105, 106, 109, 117–127, 130 (0–2,850 ft.).

REMARKS.—Comparison of material available to us from Dominica and Martinique, including a male from the type-series of *Pseudotelphusa tenuipes* from Dominica and a female from the type-series of *Telphusa dentata* from Martinique, discloses no differences between the two populations. Pretzmann has informed us that the male holotype of *P. tenuipes* in the British Museum has pleopods different from those of Martinique specimens, which led him to assign that species to the subgenus *Neopseudothelphusa* of *Guinotia*, but he suggested that an error of documentation might be involved. On the basis of the evidence available to us, it would appear that *Guinotia dentata* is the only pseudothelphusid on Dominica.

The series of this species collected during the Dominican Survey displays a rather remarkable uniformity in the proportions of the carapace (fig. 41). Although the carapace is slightly narrower in juvenile specimens (average length 0.64 of average width) than it is in large adults (average length 0.60 of average width), there seems to be a very regular transition from the juvenile proportions to those of the adults. Even recently hatched young, still held in the brood pouch formed by the abdomen of the mother, have the carapace of similar proportions, although of rather different form. In the presumably first instar, the carapace is about 3.2 mm long and it is considerably swollen and apparently foreshortened by contained yolk material; it resembles the carapace of the true land crabs, such as *Cardisoma*, but the front is so produced that it compensates for the reduction in postfrontal length. The numbers of immature with carapace lengths of 13–14, 16–17, and 19–21 mm suggests that these sizes may represent common instar intervals.

Females with eggs were taken in January and February, and those with young were found in February, October, and November. Inasmuch as most large adult specimens were collected in those four months, there is no satisfactory evidence for or against the existence of a restricted breeding season in this species, nor is there any evidence of monthly size classes, which might indicate such a breeding season. One female with a carapace length of 44.1 mm carried 152 eggs; another, 55.5 mm long, had the same number of eggs; and a third of 51.8 mm harbored 202 young.

50. *Guinotia (Guinotia) garmani garmani* (Rathbun)

FIGURE 43*d*

Pseudothelphusa garmani Rathbun, 1898 [part], p. 522, figs. 14a, b, f, g [type-locality: Trinidad]; 1905, p. 298, fig. 91.

Guinotia (Guinotia) garmani.—Pretzmann, 1965, p. 3 [by implication].
Pseudothelphusa garmani garmani.—Rodriguez, 1966, p. 123, text-fig. 6, pl. 5.

DIAGNOSIS.—Carapace not very convex longitudinally or transversely, rather broad, about three-fifths as long as wide; cervical groove distinct, nearly straight; anterolateral margin denticulate, denticles extending onto posterolateral margin, not emarginate either near outer orbital angle or near end of cervical groove; front delimited dorsally by strong, tuberculate, transverse crest concealing true frontal margin from dorsal view. Third maxilliped with merus rather evenly convex along distolateral margin; exopod much reduced, not reaching end of basal fourth of lateral margin of ischium. Pereiopods not unusually long and slender. *Chela with prominent, swollen protuberance on outer surface near base of fingers.* First pleopod of adult male not armed distally with scattered, short, stout spines; *terminating in long, blunt, finger-like projection* and armed mesially with sharp, subtriangular tooth directed mesially. A large species, maximum carapace length in midline about 57 mm.

HABITAT.—In and near fresh water.

DISTRIBUTION.—Trinidad; Isla de Margarita; eastern Venezuela.

Genus *Pseudothelphusa*

51. "*Pseudothelphusa*" *affinis* Rathbun

Pseudothelphusa affinis Rathbun, 1898, p. 524 [type-locality: Cuba]; 1905, p. 301.
Potamocarcinus (Pseudothelphusa) affinis.—Ortmann, 1902, p. 309 [by implication].
"Pseudothelphusa" affinis.—Pretzmann, 1965, p. 10.

DIAGNOSIS.—Carapace not very convex longitudinally or transversely, broad, less than three-fifths as long as wide; cervical groove curving slightly posteriorly near anterolateral margin; anterolateral margin denticulate, without emarginations; front delimited dorsally by strong, tuberculate, transverse crest. Third maxilliped with merus slightly convex laterally, concave distally; exopod not reaching midlength of lateral margin of ischium. Pereiopods not unusually long or slender. Chela without prominent, swollen protuberance on outer surface near base of fingers. A medium-sized species, carapace length in midline about 23 mm.

HABITAT.—Presumably in or near fresh water.

DISTRIBUTION.—Known only from the unique specimen from Cuba.

REMARKS.—The generic status of this species, which is known only from the dry female holotype, must remain in doubt until the male is discovered. Ortmann (1902) notes that even the type-locality needs confirmation.

52. *Pseudothelphusa* (*Pseudothelphusa*) *americana* De Saussure

FIGURES 42, 43*e*

Pseudo-Thelphusa americana De Saussure, 1857b, p. 305 [type-locality; Haiti].
Potamia americana.—De Saussure, 1858, p. 436, pl. 2: fig. 12.
Pseudothelphusa Americana.—Smith, 1870, p. 146.
Pseudotelphusa americana.—Pocock, 1889, p. 10.
Pseudothelphusa dugesi Rathbun, 1893, p. 651, pl. 74: figs. 4, 5 [type-locality: Cuernavaca, Estado de Morelos, Mexico].
Potamocarcinus americanus.—Ortmann, 1897, p. 317.
Potamocarcinus dugesi.—Ortmann, 1897, p. 318.
Pseudothelphusa americana.—Rathbun, 1898, pp. 533, 537; 1905, p. 283.
Pseudothelphusa (*Pseudothelphusa*) *americana.*—Pretzmann, 1965, p. 4 [by implication].

DIAGNOSIS.—Carapace not very convex longitudinally or transversely, between three-fifths and two-thirds as long as wide; cervical groove distinct, concave anteriorly; anterolateral margin very obscurely denticulate, with shallow notch near outer orbital angle; front

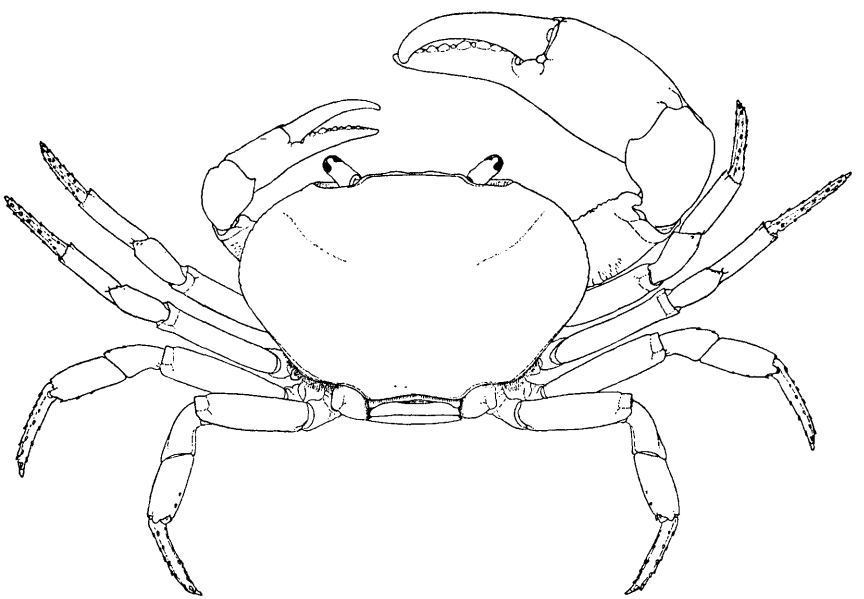


FIGURE 42.—*Pseudothelphusa* (*Pseudothelphusa*) *americana*, based on male syntype of *P. dugesi* (carapace length 20.0 mm) from Cuernavaca, Morelos State, Mexico (P. L. Jouy).

not delimited dorsally by transverse crest. Third maxilliped with merus narrowing distally, distolateral margin convex; exopod rather long, falling only slightly short of distal end of ischium. Pereiopods slender but not unusually long. Chela without prominent, swollen

protuberance on outer surface near base of fingers. First pleopod of adult male not armed distally with scattered, short, stout spines; *terminating, in posterior view, in transverse, slightly sinuous distal margin,* with broad, spine-tipped lobe on lateral margin and proximally directed spinelike tooth mesially. A medium-sized species, maximum carapace length in midline about 30 mm.

HABITAT.—In or near fresh water.

DISTRIBUTION.—Central and southwestern Mexico, Cuba, Hispaniola.

REMARKS.—Inasmuch as no West Indian material of this species was available to us, the figures were prepared from a syntype of *Pseudothelphusa dugesi,* a Mexican species that is presumed to be a synonym of *P. americana.* This synonymy needs verification by a careful comparison of the male pleopods of West Indian and Mexican specimens; the figures herein, especially figure 43*e*, should therefore be used with caution.

53. *Pseudothelphusa* (*Pseudothelphusa*) *terrestris* Rathbun

FIGURE 43*f*

Pseudothelphusa terrestris Rathbun, 1893, p. 651, pl. 74: figs. 6, 7 [type-locality: Atamajac, 3 miles west of Guadalajara, Estado de Jalisco, Mexico]; 1905, p. 283.

Potamocarcinus terrestris.—Ortmann, 1897, p. 318.

Pseudothelphusa (*Pseudothelphusa*) *terrestris.*—Pretzmann, 1965, p. 4 [by implication].

DIAGNOSIS.—Carapace not very convex longitudinally or transversely, about three-fifths as long as wide; cervical groove distinct, concave anteriorly; anterolateral margin very obscurely denticulate, with shallow emarginations near end of cervical groove and near outer orbital angle; front not delimited dorsally by transverse crest. Third maxilliped with merus narrowing distally, distolateral margin convex; exopod reaching nearly to distal fourth of outer margin of ischium. Pereiopods slender but not unusually long. Chela without prominent, swollen protuberance on outer surface near base of fingers. First pleopod of adult male not armed distally with scattered short, stout spines; *terminating, in posterior view, in oblique, concave distal margin,* with spine-tipped lobe on anterolateral margin and proximally directed spinelike tooth mesially. A medium-sized species, maximum carapace length in midline about 25 mm.

HABITAT.—In or near fresh water.

DISTRIBUTION.—West central Mexico; Cuba.

REMARKS.—The identity of Cuban specimens with this otherwise Mexican species should be verified in the light of the importance

now assigned to characters of the male pleopod. The figure of that appendage presented here should be accepted only provisionally for West Indian material until such verification is forthcoming.

FIGURE 43.—Male right first pleopods: *a*, pleopod in posterior view of *Guinotia* (*Guinotia*) *dentata* shown in figure 40; *b*, same in lateral view; *c*, same in anterior view; *d*, terminal portion of pleopod in posterior view of *G.* (*G.*) *garmani garmani* (carapace length 42.5 mm) from Isla de Margarita (P. W. Hummelinck); *e*, terminal portion of pleopod in posterior view of *Pseudothelphusa* (*Pseudothelphusa*) *americana* shown in figure 42; *f*, terminal portion of pleopod in posterior view of syntype of *P.* (*P.*) *terrestris* (cl 20.7 mm) from Atamajac, Jalisco State, Mexico (P. L. Jouy).

Family TRICHODACTYLIDAE

Genus *Trichodactylus*

54. *Trichodactylus* (*Dilocarcinus*) *dentatus* (Randall)

FIGURES 44, 46*a*

Orthostoma dentata Randall, 1840, p. 122 [type-locality: Paramaribo, Surinam (restricted by Holthuis, 1959)].

Dilocarcinus multidentatus Von Martens, 1869, p. 5, pl. 1: fig. 2 [type-locality: Salvador, Estado da Bahia, Brazil].

Dilocarcinus dentatus.—Young, 1900, pp. 231, 234, pls. 5, 6.

Trichodactylus (*Dilocarcinus*) *dentatus*.—Rathbun, 1905, pl. 20 (XVIII): fig. 4; 1906, p. 65.—Holthuis, 1959, p. 214, figs. 50b, 51.

Gerastus denticulatus (Kröyer ms) Rathbun, 1906, p. 65 [type-locality: Cayenne, French Guiana?].

DIAGNOSIS.—Carapace subcircular, about five-sixths as long as wide, strongly convex both longitudinally and transversely, without transverse ridge across branchial regions; anterolateral margin armed with 8–11 small, acute, subequal teeth; front bearing 15–19 small

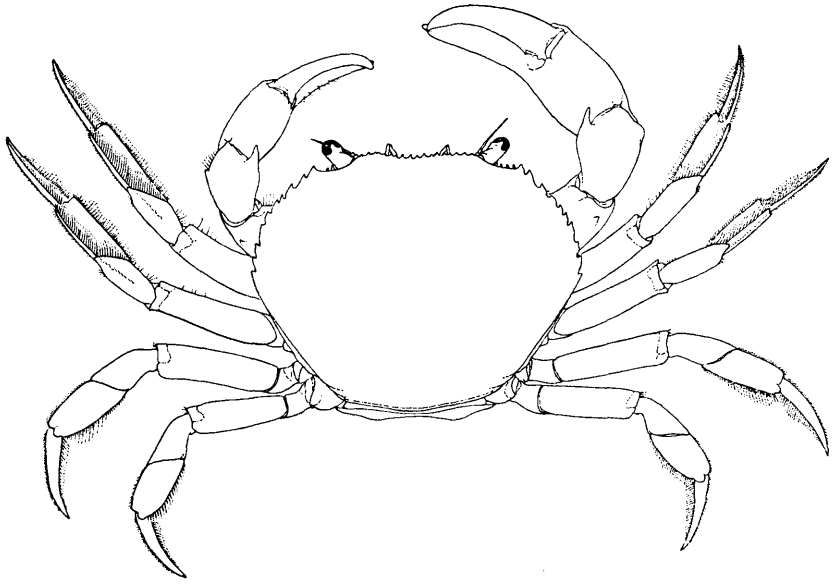


FIGURE 44.—*Trichodactylus* (*Dilocarcinus*) *dentatus*, male (carapace length 29.0 mm) from near Apartaderos, Cojedes State, Venezuela (A. Fernandez Y. and C. Ciferri).

spines. Abdomen with somites 4–6 fused in male, 3–6 in female. Eyes with cornea as wide as stalk, not reduced. Third maxilliped with merus distinctly longer than wide. Walking legs with dactyls broadly lanceolate. First pleopod of male with extreme distal portion tapering regularly to tip, provided with scattered small sharp spinules.

A fairly large species, maximum carapace length in midline about 45 mm.

HABITAT.—In and near fresh water.

DISTRIBUTION.—Venezuela to Estado da Bahia, Brazil; Trinidad.

Family XANTHIDAE

Subfamily PANOPEINAE

Key to the Species

Carapace widest posterior to tips of lateral teeth; fingers of cheliped white.
Eurytium limosum (p. 153)

Carapace widest between tips of posterior lateral teeth; fingers of cheliped dark.
Panopeus herbstii (p. 154)

Genus *Eurytium*

55. *Eurytium limosum* (Say)

FIGURES 45, 46*b*

Cancer limosa Say, 1818, p. 446 [type-locality: "shores of the northern states"].
Panopeus limosus.—H. Milne Edwards, 1834, p. 404.
Eurytium limosum.—Stimpson, 1859, p. 56.—Rathbun, 1930, p. 423, pl. 176: figs. 1, 2.—Williams, 1965, p. 199, figs. 182, 1830.

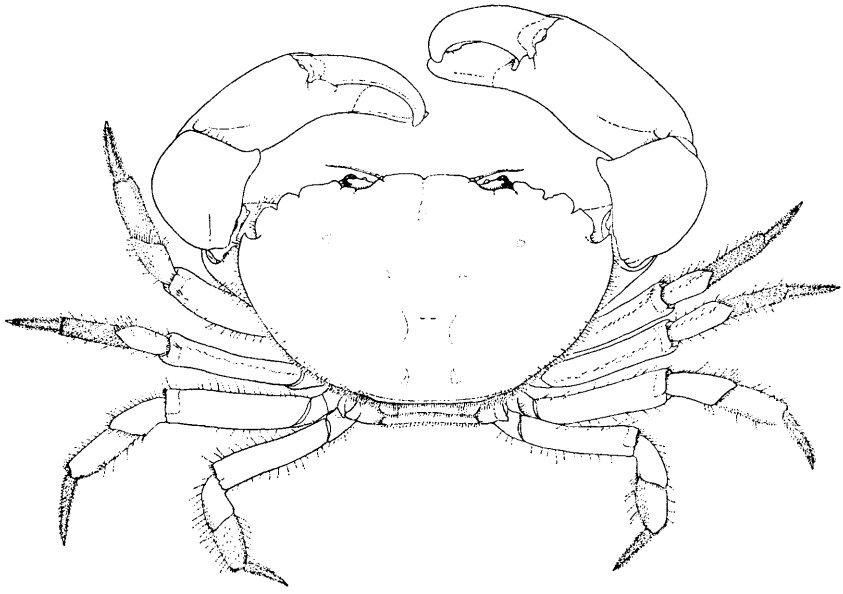


FIGURE 45.—*Eurytium limosum*, male (carapace length 26.3 mm) from Baie de Bigie, Haiti (W. M. Parish).

DIAGNOSIS.—Carapace strongly convex longitudinally, very broad, distinctly less than two-thirds as long as wide, widest posterior to tips of lateral teeth; posterolateral margin unusually convex; frontal lobes feebly convex, not produced anterolaterally. Fingers of chelipeds white, white portion of fixed finger not extending proximally to base of finger. A medium-sized species, maximum carapace length in midline about 27 mm.

HABITAT.—Muddy shores, especially among mangroves and burrowing in banks of tidal streams.

DISTRIBUTION.—New York to Estado de São Paulo, Brazil (Bermudas, San Salvador I., Cuba, Jamaica, Hispaniola, Puerto Rico, Saint Thomas, Saint Croix, Islas Los Roques, Curaçao).

Genus *Panopeus*

56. *Panopeus herbstii* H. Milne Edwards

FIGURES 46*c*, 47

Panopeus Herbstii H. Milne Edwards, 1834, p. 403 [type-locality: North America].
Panopeus lacustris Desbonne in Schramm, 1867, p. 28 [type-locality: Guadeloupe].
Panopeus Herbstii var. *obesus* Smith, 1869a, p. 278 [type-localities: Egmont Key, Florida, and Aspinwall (Colon, Panama)].
Panopeus Herbstii granulosus A. Milne-Edwards, 1880, p. 309 [type-locality: Bahia (Salvador, Brazil)].
Panopeus crassus A. Milne-Edwards, 1880, p. 313, pl. 57: figs. 1, 1a [type-localities: Bahia (Salvador) and Desterro (Florianopolis), Brazil].
Panopeus Herbstii, var. or subsp. *minax* Verrill, 1908, p. 348, text-fig. 15, pl. 15: fig. 2 [type-locality: Harrington Sound, Bermuda Islands].
Panopeus herbstii.—Rathbun, 1930, p. 335, text-figs. 52, 53, pls. 156, 157.—Williams, 1965, p. 196, figs. 180, 183M.
Panopeus herbstii f. *obesa*.—Rathbun, 1930, p. 336, pl. 156: fig. 3.
Panopeus herbstii f. *crassa*.—Rathbun, 1930, p. 336, pl. 157: fig. 3.
Panopeus herbstii f. *simpsoni* Rathbun, 1930, p. 337, pl. 157: figs. 1, 2 [type-locality: Apalachicola, Florida].

DIAGNOSIS.—Carapace moderately convex longitudinally, moderately broad, two-thirds or more as long as wide, widest between tips of posterior lateral teeth; posterolateral margin nearly straight; frontal lobes sinuous, with anterolateral lobules. Fingers of cheliped dark brown, color on fixed finger extending proximally slightly onto palm. A medium-sized species, maximum carapace length in midline about 39 mm.

HABITAT.—Marine and estuarine, frequently among mangroves and burrowing in banks of tidal streams.

DISTRIBUTION.—Massachusetts to Uruguay (Bermudas, Green Turtle Cay, Bimini Is., Eleuthera I., Cuba, Jamaica, Hispaniola, Puerto Rico, Saint Croix, Saint Martin, Antigua I., Guadeloupe, Barbados, Trinidad, Islas Los Roques, Bonaire, Curaçao, Aruba); Oahu, Hawaii (probably introduced).

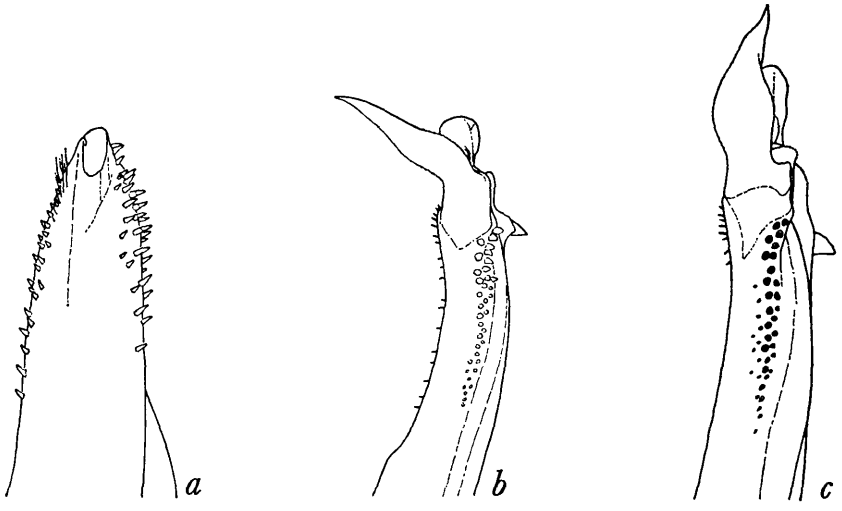


FIGURE 46.—Terminal portions of male right first pleopods in posterior view: *a, Trichodactylus* (*Dilocarcinus*) *dentatus*, specimen shown in figure 44; *b, Eurytium limosum*, specimen shown in figure 45; *c, Panopeus herbstii*, specimen shown in figure 47.

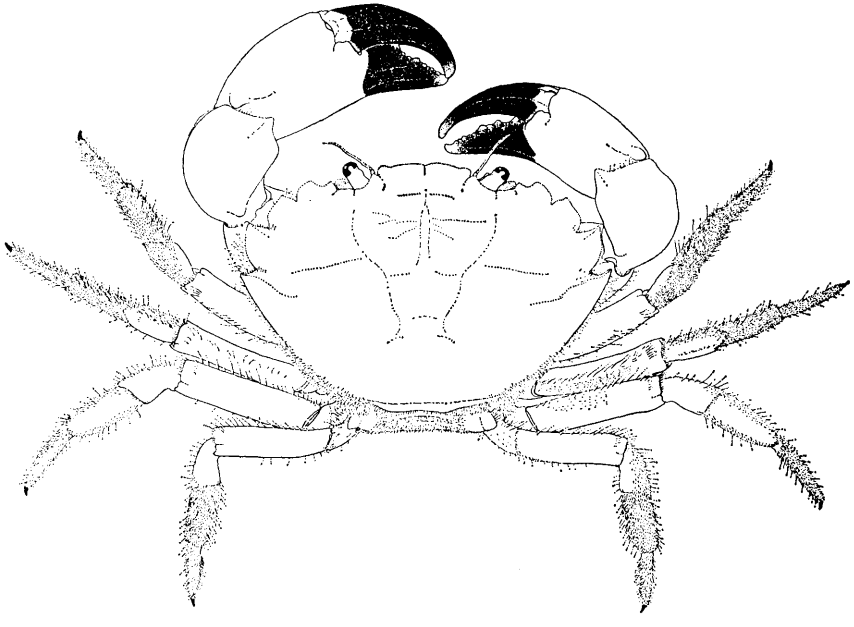


FIGURE 47.—*Panopeus herbstii*, based on male (carapace length 36.7 mm) from Montego Bay, Jamaica (E. A. Andrews).

Family GRAPSIDAE

Key to the Species

1. Front divided into three lobes by deep notches; antennules visible in dorsal view even when folded. Subfamily PLAGUSIINAE.
   Plagusia depressa (p. 192)
   Front entire; antennules hidden from dorsal view when folded 2
2. Third maxilliped without oblique hairy ridge on exposed surface of merus . 3
   Third maxilliped with oblique hairy ridge on exposed surface of merus. Subfamily SESARMINAE 9
3. Ventral margin of orbit incomplete, paralleled ventrally by deep groove and strong transverse crest; chelipeds very dissimilar. Subfamily VARUNINAE.
   Glyptograpsus jamaicensis (p. 171)
   Ventral margin of orbit entire, usually sharply produced, not paralleled by deep groove and supplementary crest; chelipeds similar. Subfamily GRAPSINAE 4
4. Front abruptly deflexed at postfrontal lobes 5
   Front strongly depressed, not sharply deflexed at postfrontal lobes . . . 6
5. Carapace broadly subquadrate, front more than half as wide as carapace; carpus of chelipeds armed with two or three small sharp teeth on flexor margin, fingers narrowly and inconspicuously spoon tipped.
   Goniopsis cruentata (p. 160)
   Carapace subcircular in adults, front less than half as wide as carapace; carpus of chelipeds armed with broad subspatulate spine-tipped tooth on flexor margin, fingers broadly and conspicuously spoon tipped.
   Grapsus grapsus (p. 163)
6. Carapace with lateral margins subparallel or converging anteriorly . . . 7
   Carapace with lateral margins converging strongly posteriorly 8
7. Carapace with subrectangular tooth on lateral margin posterior to outer orbital angle, transverse striations on branchial regions only; chelipeds with fingers pointed, indistinctly spoon tipped. **Geograpsus lividus** (p. 157)

   Carapace without tooth on lateral margin posterior to outer orbital angle, strong transverse striations extending entirely across carapace; chelipeds with fingers blunt, narrowly spoon tipped. . **Pachygrapsus corrugatus** (p. 167)
8. Chelipeds with movable finger tuberculate on extensor margin; first pleopod of male broad, terminating in very short corneous tip.
   Pachygrapsus gracilis (p. 167)
   Chelipeds with movable finger smooth; first pleopod of male slender, terminating in long corneous obliquely T-shaped endpiece.
   Pachygrapsus transversus (p. 169)
9. Carapace without tooth on lateral margin posterior to outer orbital angle . 10
   Carapace with tooth on lateral margin posterior to outer orbital angle . . 18
10. Carapace with lateral margins converging strongly posteriorly 11
    Carapace with lateral margins subparallel or diverging posteriorly, rarely converging slightly 12
11. Walking legs with dactyl not more than one-fourth as long as extensor margin of propodus . . . . . **Aratus pisonii** (p. 172)
    Walking legs with dactyl only slightly shorter than extensor margin of propodus . . . . . **Metasesarma rubripes** (p. 175)
12. Carapace arcuate anteriorly, fronto-orbital distance considerably less than maximum width of carapace . . . . . **Cyclograpsus integer** (p. 173)

Carapace subquadrate, fronto-orbital distance nearly or quite equaling maximum width of carapace 13

13. Front widening distally 14
Front with lateral margins subparallel 15

14. Denuded first pleopod of male terminating in posterior view in subquadrate endpiece directed distolaterally (fig. 62*g*) . . . . **Sesarma miersii** (p. 180)
Denuded first pleopod of male terminating in posterior view in small bluntly triangular endpiece arising from midline of appendage and directed slightly laterally (fig. 62*k*) . . . . . **Sesarma ricordi** (p. 183)

15. Walking legs with merus broad, that of third pereiopod more than half as wide as long . . . . . **Sesarma rectum** (p. 182)
Walking legs with merus less broad, that of third pereiopod less than half as wide as long 16

16. Carapace broad, about four-fifths as long as wide . **Sesarma hanseni** (p. 179)
Carapace at least nine-tenths as long as wide 17

17. Front with very shallow median emargination in dorsal view; denuded first pleopod of male terminating in posterior view in very small narrow endpiece directed distomesially (fig. 62*a*) . . . . **Sesarma americanum** (p. 178)
Front with pronounced emargination in dorsal view; denuded first pleopod of male terminating in posterior view in broad depressed endpiece with lateral margins converging distally and distal margin very broadly V-shaped (fig. 62*l*) . . . . . **Sesarma roberti** (p. 184)

18. Carapace unusually flat longitudinally and transversely; postfrontal lobes sharply produced anteriorly . . . . . **Metopaulias depressus** (p. 177)
Carapace convex, especially longitudinally; postfrontal lobes not sharply produced 19

19. Front not abruptly deflexed, postfrontal lobes obsolescent, frontal margin with shallow median sinus in dorsal view; walking legs robust, merus of third pereiopod distinctly more than two-fifths as wide as long.
Sesarma curacaoense (p. 188)
Front abruptly deflexed at postfrontal lobes, margin with rather deep median sinus in dorsal view; walking legs rather long and slender, merus of third pereiopod less or slightly more than one-third as wide as long 20

20. Integument without pigment; eyestalks tapering distally, cornea reduced; subterranean species . . . . . **Sesarma verleyi** (p. 191)
Integument pigmented; eyestalks subcylindrical, cornea well developed; epigean species 21

21. Walking legs moderately long, dactyl of third pereiopod slightly longer than extensor margin of propodus . . . . . **Sesarma bidentatum** (p. 187)
Walking legs very long, dactyl of third pereiopod at least one-third again as long as extensor margin of propodus . . . . . **Sesarma jarvisi** (p. 189)

Subfamily GRAPSINAE

Genus *Geograpsus*

57. *Geograpsus lividus* (H. Milne Edwards)

FIGURES 48, 52*a–c*

Grapsus lividus H. Milne Edwards, 1837, p. 85 [type-locality: Antilles].
Grapsus brevipes H. Milne Edwards, 1853, p. 170 [type-locality unknown].
Geograpsus lividus.—Stimpson, 1858, p. 101.—Rathbun, 1918, p. 232, pl. 55.—Monod, 1956, p. 410, figs. 562, 563.

Geograpsus occidentalis Stimpson, 1860, p. 230 [type-locality: Cabo San Lucas, Estado de Baja California, Mexico].

Grapsus (Orthograpsus) hillii [by implication] Kingsley, 1880, p. 194 [type-localities: West Indies and Key West, Florida].

DIAGNOSIS.—Carapace subrectangular, about four-fifths as long as wide (females slightly broader), flat centrally and posteriorly, curving downward anteriorly and laterally, striations distinct laterally and anteriorly, absent on most of mesogastric region and on cardiac, intestinal, and mesial portions of branchial regions; lateral margins converging anteriorly, with subrectangular tooth posterior to outer orbital angle, fronto-orbital distance less than nine-tenths of maximum width of carapace; front strongly depressed but not sharply deflexed at postfrontal lobes, about two-fifths as wide as carapace,

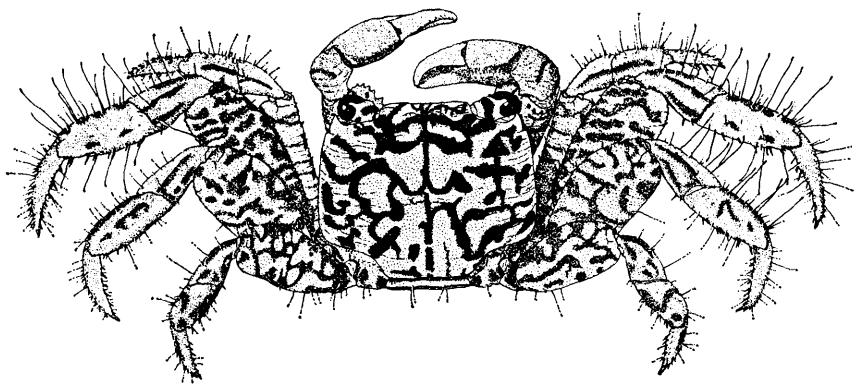


FIGURE 48.—*Geograpsus lividus*, male (carapace length 12.9 mm) from Dominica station 6.

margin nearly straight in dorsal view. Eyes well developed, cornea slightly wider than eyestalk. Ventral margin of orbit sharply produced, denticulate, curving ventrally to anterolateral angle of mouth area. Third maxillipeds without oblique hairy ridge, widely gaping, exposing mandibles. Chelipeds subequal, carpus armed with blunt triangular tooth on flexor margin; palm tuberculate dorsally; fingers pointed, not distinctly spoon tipped, extensor margin of movable finger finely and irregularly tuberculate. Walking legs broad and flattened, merus of third pereiopod, about half as wide as long, with small obscure subdistal tooth on extensor margin; dactyl slightly longer than extensor margin of propodus; carpus and propodus of third pereiopod bearing long stout *clubbed* hairs. Denuded first pleopod of male terminating, in posterior view, in subtruncate flattened endpiece notched in lateral half (fig. 52*a*). *Color pattern characterized by large dark irregularly anastomosing patches* on light background.

A medium-sized species, maximum carapace length in midline about 28 mm.

COLOR IN LIFE.—Ground color light yellowish or bluish green with highly variable, bold, anastomosing, maroon pattern interspersed with solitary spots of irregular and variable shapes.

Eyestalks greenish with maroon markings. Third maxillipeds orange tan. Chelipeds cream basally; merus becoming orange tan distally, and bearing brown markings; carpus orange tan with transverse brown bar; propodus tan; upper proximal articular knob and articular membrane at base of dactyl bright orange, almost vermilion; both fingers orange. Pereiopods from base through merus greenish with greenish brown markings; distal podomeres pale orange tan with variable brown markings, but those on carpus and propodus somewhat linearly arranged. Lower surface of proximal podomeres cream to coral, those from carpus to dactyl orange tan.

MATERIAL EXAMINED.—The Dominican collections contain 19 males (carapace lengths 6.0–13.0 mm) and 10 females (cl 5.7–14.3 mm). None of the males have juvenile gonopods. The larger females have the abdomen fully formed, but it is triangular in those with a carapace length of 9–10 mm.

ECOLOGICAL NOTES.—This agile little crab has been observed or collected on Dominica only along rocky and cobble beaches, where it ventures among the rocks high above the high-tide line and often seeks shelter among litter and debris wedged between and under the rocks. It does not shun wetter areas of the rocks and frequently when individuals were pursued they would crawl rapidly into the surf. It ventures several feet above the levels occupied by *Petrolisthes quadratus* and *Cyclograpsus integer* (see ecological discussion of former). Below Tarou Cliffs (pl. 3B), a retaining wall has been constructed along the road, and in windy weather the splash from the surf reaches the wall and often wets the macadam road. The base of the retaining wall is often quite dry and frequently accumulations of coconut husks, logs, and fronds of the coconut palm are wedged against the wall. Seepage from the swampy area across the road almost certainly passes through the fill, for earthworms were found under one log that was wedged against the wall. Here among the debris, *Geograpsus lividus* is abundant and lives some 6 to 8 feet from the accumulation of rocks but never more than 12 to 15 feet away from the surf.

DISTRIBUTION.—Bermudas and the Florida Keys to Estado de São Paulo, Brazil (Bermudas, New Providence I., Cuba, Jamaica, Puerto Rico, Isla de Vieques, Saint Thomas, Saint Croix, Saba, Guadeloupe, Dominica, Martinique, Saint Lucia I., Barbados, Trinidad, Islas Los Roques, Curaçao, Isla de Providencia); eastern

Atlantic from Senegal to northern Angola; eastern Pacific from southern Baja California to northern Chile; Hawaii.

Dominica Stations: 6, 110, 114 (0–5 ft.).

Genus *Goniopsis*

58. *Goniopsis cruentata* (Latreille)

FIGURES 49, 52*d–f*

Grapsus cruentatus Latreille, 1802, p. 70 [type-locality: the islands of South America].

Grapsus (*Goniopsis*) *cruentatus*.—De Haan, 1835, p. 33.

Grapsus longipes Randall, 1840, p. 125 [type-locality: Surinam].

Grapsus pelii Herklots, 1851, p. 8, pl. 1: figs. 6, 7 [type-locality: "prope Boutry" (Ghana, according to Monod, 1956)].

Grapsus simplex Herklots, 1851, p. 9, pl. 1: fig. 8 [type-locality: "prope Boutry" (Ghana)].

Goniograpsus cruentatus.—Dana, 1852, p. 342.

Goniopsis cruentatus.—H. Milne Edwards, 1853, p. 164, pl. 7: figs. 2–2b.

Goniopsis cruentata.—Rathbun, 1901, p. 15, pl. 1 [colored]; 1918, p. 237, pl. 57.—Monod, 1956, p. 412, figs. 564–567.—Holthuis, 1959, p. 235, figs. 59, 60.

DIAGNOSIS.—Carapace subrectangular, more than four-fifths as long as broad, rather flat anteriorly, noticeably inflated in large specimens on mesial portions of branchial regions bordering cardiac and intestinal regions, striations distinct laterally and anteriorly, absent on most of gastric, cardiac, and intestinal regions; lateral margins converging slightly anteriorly, with acute tooth posterior to outer orbital angle, fronto-orbital distance more than nine-tenths of maximum width of carapace; front sharply deflexed at postfrontal lobes, about half as wide as carapace, margin nearly straight in dorsal view. Eyes well developed, cornea about as wide as eyestalk. Ventral margin of orbit sharply produced, bluntly denticulate and somewhat concave in median portion, curving ventrally to anterolateral angle of mouth area. Third maxillipeds without oblique hairy ridge, widely gaping, exposing mandibles. Chelipeds subequal, carpus armed with few short spines on flexor margin; palm roughened dorsally by scattered spiniform tubercles arranged roughly in oblique rows; fingers rather pointed, inconspicuously spoon tipped, extensor margin of movable finger bearing large, sharp, irregular tubercles. Walking legs broad and flattened, merus of third pereiopod about half as wide as long, with distinct acute subdistal tooth on extensor margin; dactyl slightly shorter than extensor margin of propodus. Denuded first pleopod of male terminating, in posterior view, in *rounded end overreaching broad, notched chitinous endpiece* projecting only slightly from lateral surface of appendage (fig. 52*d*). Color pattern charac-

terized by fine dark marbling on light background on most of carapace and *large, often ocellated spots on lateral portions of carapace and meri of walking legs.* A fairly large species, maximum carapace length in midline nearly 50 mm.

COLOR IN LIFE.—Carapace yellowish tan to golden with purple markings consisting of horizontal and oblique lines, tiny dendritic spots, and large posterolateral splotches; lateral and posterolateral areas with circular to oblong white spots; posterior area with 2 to 10 white spots.

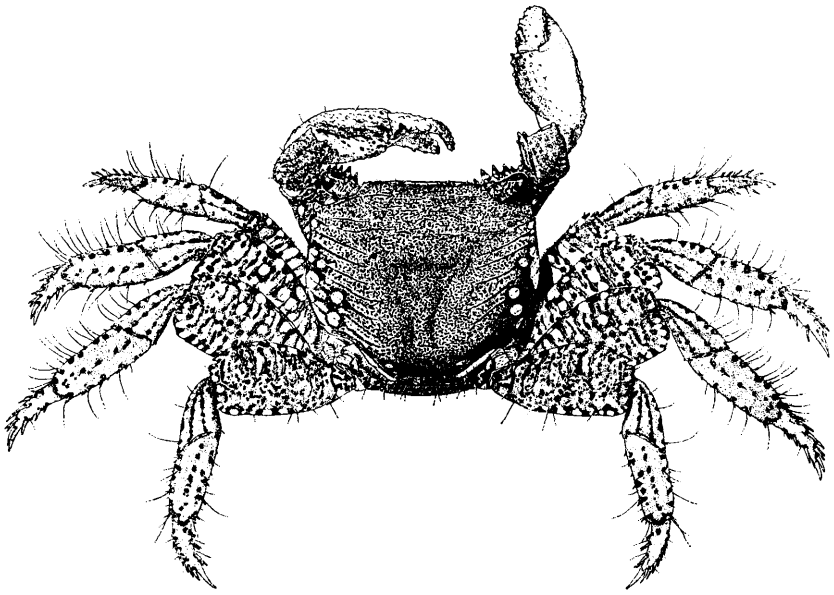


FIGURE 49.—*Goniopsis cruentata,* male (carapace length 36.2 mm) from Dominica station 112.

Eyestalks purplish with black cornea. Third maxillipeds with ischium white, proximal portion of merus bluish, and distal portion of merus and entire carpus and dactyl purple, propodus cream; exopod white with mesial margin purple. Cheliped with coxa, basis, and ischium cream to white and with purple band across distal articulations of coxa and purple spots along anterior margin of basis; merus mostly dark purplish red with purple splotches and lines and white spots along upper lateral surface; carpus scarlet with purple lines, more proximal ones undulating; propodus with inner surface of palm red and bearing purple tubercles, proximal outer surface yellow, and distal outer surface, including finger, white, inner upper surface orange red; dactyl white with purple on upper base and along

upper margin. Upper surfaces of remaining pereiopods orange tan with white spots and purplish-black markings; meri conspicuously marked with transverse dark lines and large white spots, particularly abundant on second, third, and fourth pereiopods; white spots on merus of fifth largely confined to marginal area; distal podomeres with linear arrangement of purplish-black spots at bases of setal tufts. Lower surface of legs orange-red anteriorly fading rapidly posteriorly through yellow, with most of lower surface of basal podomeres white; those distal to merus mostly orange to yellow; lower distal area of meri lavender to mauve. Sternum white with median purple band having undulating and angular lateral borders. Abdomen mostly white; basal somites lavender and remaining ones and telson with paired pale lavender markings.

MATERIAL EXAMINED.—The Dominican collections contain 7 males (carapace lengths 15.2–35.2 mm) and 3 females (cl 19.0–30.4 mm).

ECOLOGICAL NOTES.—*Goniopsis cruentata* was observed at only two localities on Dominica. The first place it was seen was in a low, somewhat muddy area near the mouth of the Mero River, where one crab was standing motionless by the side of the stump of a felled tree. Some few minutes were spent in chasing it from one side of the stump to another until it sought refuge in a hole, perhaps its own, that descended beneath the stump. Repeated visits to the same stump and the area for several weeks failed to reveal this or other members of the species. Burrows of *Cardisoma guanhumi* and *Uca burgersi* were numerous in the area, and, at almost any time, scores of the former could be seen at or near the mouths of their burrows, but no *Goniopsis* was evident.

At a marsh adjacent to the Indian River at Portsmouth (pl. 4A), a number of individuals were seen along its margin. Here, on being disturbed, they scurried into holes or ran out onto the marsh, where they were lost from view among the bordering aeroids and lianas. They would permit a person to approach them within 6 to 10 feet if the approach was a slow one, and it was found that a "squirt" of formalin directed upon them (a plastic "squeeze bottle" was used) would cause them to rush into a nearby burrow; shortly they would reappear at the surface—more quickly if additional formalin was poured into the burrow. After such treatment, they were much more easily caught; even so, many of them came out of the burrows that they had entered at such a rate of speed that it was exceedingly difficult to grasp them, and most rushed out onto the marsh or disappeared into another hole close by. Most of the burrows that they were seen to enter were horizontal ones close to *Pterocarpus* or under stumps or large trunks of trees partially embedded in the mud. Several young *Goniopsis* were seen running about in the arum (*Montrichardia arborescens*) thickets.

Here, it was exceedingly difficult for a person even to crawl, and there was little chance of overtaking a swiftly running crab. Clumps of the fern, *Acrostichum daneaefolium*, also provided refuges for this crab. In and along this marsh there are numerous burrows of fiddler crabs and of *Cardisoma guanhumi* and *Ucides cordatus*.

While *Goniopsis* was observed only at these two localities, it should occur in most of the low swampy areas immediately adjacent to the coast; however, it seems improbable that it is very common anywhere except in the area around the large Portsmouth marsh; otherwise, it would have at least been seen more frequently.

DISTRIBUTION.—Bermudas to Estado de São Paulo, Brazil (Bermudas, Eleuthera I., New Providence I., Cuba, Jamaica, Hispaniola, Puerto Rico, Saint Thomas, Saint Croix, Dominica, Barbados, Islas Los Roques, Curaçao, Isla de Providencia); eastern Atlantic from Senegal to northern Angola.

Dominica Stations: 38, 112 (0–5 ft.).

Genus *Grapsus*

59. *Grapsus grapsus* (Linnaeus)

FIGURES 50, 52*g–i*

Cancer Grapsus Linnaeus, 1758, p. 630 [type-localities: America and Ascension Island].

Grapsus pictus Lamarck, 1801, p. 150 [type-locality?].

Grapsus (Goniopsis) pictus.—De Haan, 1835, p. 33.

Grapsus maculatus H. Milne Edwards, 1853, p. 167, pl. 6: figs. 1–1n [type-locality: Antilles].

Grapsus Webbi H. Milne Edwards, 1853, p. 167 [Type-locality: Canary Islands].

Grapsus ornatus H. Milne Edwards, 1853, p. 168 [Type-locality: Chile].

Grapsus altifrons Stimpson, 1860, p. 230 [type-locailty: Cabo San Lucas, Estado de Baja California, Mexico].

Grapsus grapsus.—Ives, 1891, p. 190.—Rathbun, 1918, p. 227, pls. 53, 54.—Monod, 1956, p. 407, fig. 561.

Grapsus Kingsleyi De Man, 1900, p. 46, pl. 2: fig. 8 [type-locality: Lobito, Angola].

Cancer jumpibus Swire, 1938, p. 30 [type-locality: Saint Thomas].—Holthuis, 1960, p. 373.

DIAGNOSIS.—Carapace nearly subcircular in adults, more than nine-tenths as long as broad, moderately convex but depressed on hepatic and posterior mesogastric regions, striations distinct laterally, especially on branchial region, anterior gastric regions tuberculate; lateral margins converging both anteriorly and posteriorly with acute tooth posterior to outer orbital angle, fronto-orbital distance less than three-fourths of maximum width of carapace in adults; front sharply deflexed at postfrontal lobes, less than two-fifths as wide as carapace, margin slightly convex in dorsal view. Eyes well developed, cornea

slightly wider than eyestalk. Ventral margin of orbit sharply produced, obscurely denticulate in median portion, rather regularly arched between suborbital notch and anterolateral angle of mouth area. Third maxillipeds without oblique hairy ridge, widely gaping, exposing mandibles. Chelipeds subequal, *carpus armed with broad flattened sharp-tipped spine on flexor margin;* palm with few rounded dorsal tubercles; fingers rounded and distinctly spooned distally, extensor margin of movable finger bearing few large sharp tubercles. Walking legs moderately broad and flattened, merus of third pereiopod less than half as wide as long, with prominent acute subdistal tooth on extensor margin; dactyl slightly more than three-fourths as long

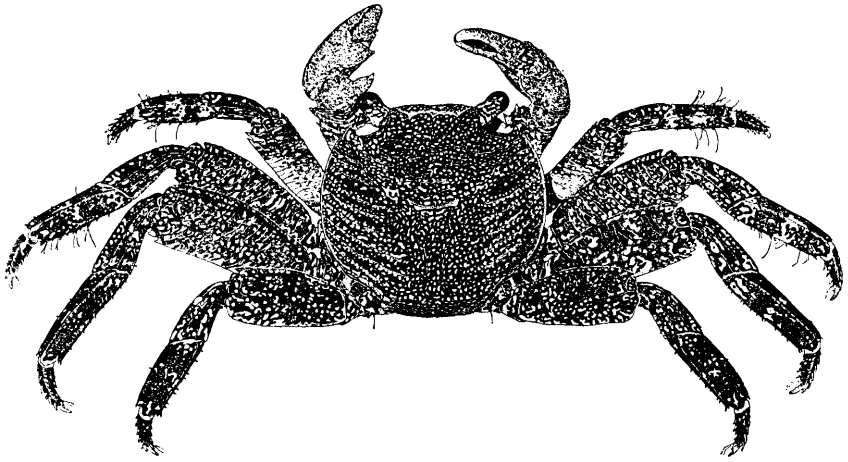


FIGURE 50.—*Grapsus grapsus,* male (carapace length 44.0 mm) from Dominica station 114.

as extensor margin of propodus. Denuded first pleopod of male terminating, in posterior view, in rather long slender chitinous distally notched endpiece directed anteriorly and slightly laterally (fig. 52*g*). Color pattern of adults characterized by numerous irregular light spots and splotches on darker background. A large species, maximum carapace length in midline about 77 mm.

COLOR IN LIFE.—Ground color of carapace maroon brown to black with pale blue markings (in young crabs, dark chromatophores not overlapping to extent in larger animals, thus more blue). Orbits pale blue. Except for urogastric, cardiac, and intestinal areas, pattern of light blue spots and bands extending across carapace in posteriorly convex arcs; although less well defined in gastric regions, similar arrangement of spots present posteriorly. Posterior portion of protogastric region with larger blue areas than elsewhere, and in some

specimens cardiac region with narrow transverse blue band flanking cervical groove; remainder of cardiac area with splotches mostly arranged in irregular longitudinal series although transverse pattern suggested in extreme anterior and posterior portions. Lateral margins blue.

Eyestalks bluish cream below with maroon lines and spots above, cornea green to black. Third maxillipeds pale blue with rust margins. Chelipeds with coxa through ischium pale blue, coxa and basis with few rust markings; from distal portion of merus distally, podomeres blue with conspicuous maroon blotches and stripes; both fingers with longitudinal stripe on outer surfaces, and dactyl with broad transverse band in proximal half to three-fourths; palm with irregular massive blotches mesially and longitudinal stripe laterally; in larger specimens blotches and stripes often irregularly fused to make majority of chela maroon; distal portions of both fingers pale blue to white; lower surfaces of palm and fingers lavender.

Remaining pereiopods with lower surfaces of coxa through merus bluish, those of distal podomeres bluish green to yellowish green, and all articular areas and spines scarlet to straw brown; upper surfaces of proximal podomeres of pereiopods mostly black to maroon with pale blue spots and lines. Merus of second pereiopod mostly blue proximally with maroon to black markings becoming more numerous distally. Propodus and base of dactyl with prominent blue splotches giving leg banded appearance; distal podomeres of third through fifth legs with same pattern repeated although banded condition progressively less conspicuous posteriorly; ischium also with hints of banding but not so obvious as on propodus and dactyl. Merus of each pereiopod differently marked but essentially with longitudinal submarginal row of spots above and with scattered spots and blotches occasionally arranged in irregular transverse bands. Sternum corresponding to chelipeds with conspicuous pair of large rusty spots. Abdomen blue to bluish cream with articular membranes rust.

MATERIAL EXAMINED.—The Dominican collections contain 4 males (carapace lengths 25.7–47.2 mm), 4 females (cl 20.9–35.2 mm), including 1 with eggs (cl 33.7 mm), and 1 juvenile (cl 10.1 mm).

ECOLOGICAL NOTES.—This crab is abundant on both the leeward and windward sides of the island, where it may be seen perched on exposed rocks being washed by the surf or among the stones along rocky beaches within splash distance of the waves or swells. Large numbers of them are usually clinging to the seawall at the mouth of the Indian River at Portsmouth, where they may crawl 6 to 10 feet above the water surface.

Regardless of where this crab occurs, it responds rapidly to moving objects but apparently totally ignores the pounding and rushing water that may completely cover it. On some of the algae-covered rocks that are exposed, one or more crabs will climb to the higher areas and there, after raising the anterior parts of their bodies, remain motionless. If disturbed, they quickly disappear to the opposite side of the rock from the source of the disturbance, where they wait, sometimes less than a minute, before returning to their original position. If the disturbing element does not approach too closely, the crabs will repeat their retreat and resumption of their positions several times before scurrying beneath the water. These crabs are not easy to catch; on the seawall it was comparatively simple to get them with a long-handled net, but attempts to snare them from an exposed rock or among the boulders and stones along a rocky beach often proved frustrating or futile if the person was alone. Their habit, on retreating, of wedging themselves into crevices or between stones does permit an easier capture than if they continue to move, for when they become wedged, they seem little concerned that a part of the carapace and one or more legs may be exposed, and because of this, they can be pinned with a small stick and so manipulated with one's fingers that the crabs can be dislodged and withdrawn. Two persons coordinating their efforts, moreover, are much more effective than one.

In March 1966, near the mouth of the Macoucheri River, Dr. R. B. Manning and Hobbs saw one of these crabs on an uprooted, partially submerged tree trunk, and on nearing it discovered that there were several *G. grapsus* on the trunk. By approaching the trunk from different directions, the two observers kept the crabs moving from one side of the log to the other and eventually pinned them in crevices or under the observers' hands as the crabs raced by.

DISTRIBUTION.—Rocky shores from the Bermudas and southern Florida to Estado de Pernambuco, Brazil (Bermudas, Great Abaco I., Bimini Is., New Providence I., Andros I., San Salvador I., Rum Cay, Cuba, Jamaica, Hispaniola, Puerto Rico, Isla de Vieques, Saint Thomas, Saint John, Saint Croix, Dominica, Martinique, Saint Lucia I., Barbados, Trinidad, Islas Los Roques, Bonaire, Curaçao, Isla de Providencia, Swan Is.); eastern Atlantic from southern Portugal to northern Angola; eastern Pacific from central Baja California to central Chile.

Dominica Stations: 6, 94, 113–115 (0–15 ft.).

REMARKS.—The only ovigerous female in the Dominican collections was taken in late February.

Genus *Pachygrapsus*

60. *Pachygrapsus corrugatus* (Von Martens)

Grapsus (*Leptograpsus*) *corrugatus* Von Martens, 1872, p. 107, pl. 4: figs. 8, 8b [type-locality: Cuba].

Pachygrapsus corrugatus.—Kingsley, 1880, p. 200.

DIAGNOSIS.—Carapace subrectangular, somewhat more than four-fifths as long in midline as wide, rather strongly convex longitudinally and transversely, *prominently striate everywhere, at least five striations extending entirely across carapace;* lateral margins subparallel, converging slightly anteriorly, without tooth posterior to outer orbital angle, fronto-orbital distance only slightly less than maximum width of carapace; front moderately depressed, not sharply deflexed at postfrontal lobes, about half as wide as carapace, margin nearly straight in dorsal view. Eyes well developed, cornea about as wide as eyestalk. Ventral margin of orbit produced, bluntly denticulate, curving abruptly to anterolateral angle of mouth area. Third maxillipeds without oblique hairy ridge, widely gaping, exposing mandibles. Chelipeds subequal, carpus armed with strong sharp curved spine on flexor margin; palm sharply tuberculate dorsally; fingers broadly rounded, prominently spoon tipped, extensor margin of movable finger bearing few sharp spines. Walking legs broad and flattened, merus of third pereiopod fully half as wide as long, with sharp subdistal tooth on extensor margin; dactyl more than four-fifths as long as extensor margin of propodus. A small species, maximum carapace length in midline about 13 mm.

HABITAT.—The only specimen of this species available to us is a female found on "coastal rocks" at Saint Croix.

DISTRIBUTION.—Salt Cay (New Providence I.), Cuba, Puerto Rico, Saint Croix.

61. *Pachygrapsus gracilis* (De Saussure)

FIGURES 51, 52*j*

Metopograpsus gracilis De Saussure, 1858, p. 443, pl. 2: fig. 15 [type-locality: Saint Thomas].

Grapsus guadalupensis Desbonne in Schramm, 1867, p. 48 [type-locality: Guadeloupe].

Pachygrapsus gracilis.—Stimpson, 1871, p. 113.—Rathbun, 1918, p. 249, pl. 60: fig. 3; pl. 61: fig. 1.—Monod, 1956, p. 419, figs. 569, 571, 574–577.—Holthuis, 1959, p. 239, pl. 10: fig. 3.—Hartnoll, 1965, pp. 114, 115, 116, 117, 136, 137, 141, 144, 145, 146, fig. 13D.

DIAGNOSIS.—Carapace trapezoidal, about three-fourths as long in midline as wide, rather strongly convex longitudinally and transversely, distinctly striate on branchial regions, faintly so on gastric

region, smooth elsewhere; lateral margins strongly converging posteriorly, slightly concave, with acute tooth posterior to outer orbital angle, fronto-orbital distance only slightly less than maximum width of carapace; front curving gradually downward, neither distinctly depressed nor deflexed at weak postfrontal lobes, slightly more than three-fifths as wide as carapace, margin usually faintly bilobed in dorsal view. Eyes well developed, cornea nearly as wide as eyestalk. Ventral margin of orbit sharply produced, especially in mesial half, obscurely denticulate laterally, curving abruptly to anterolateral angle of mouth area. Third maxillipeds without oblique hairy ridge,

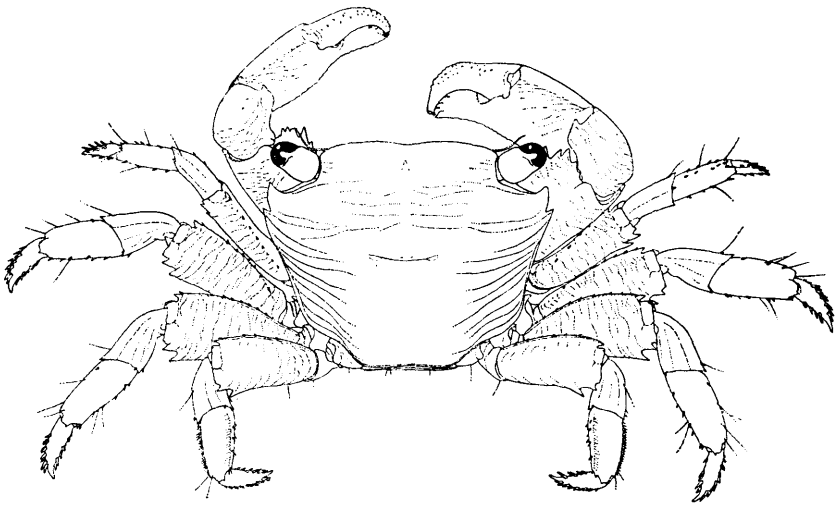


FIGURE 51.—*Pachygrapsus gracilis*, male (carapace length 14.0 mm) from Saint Croix (H. A. Beatty).

gaping, exposing mandibles. Chelipeds subequal, carpus armed with acute distally directed tooth on flexor margin; palm with low longitudinal dorsal ridge or carina; fingers narrowly rounded distally, spoon-tipped, movable finger compressed, rather strongly arched, sharply tuberculate on extensor margin. Walking legs moderately broad and flattened, merus of third pereiopod fully half as wide as long, with sharp subdistal tooth on extensor margin; dactyl about as long as extensor margin of propodus. Denuded first pleopod of male stout, terminating in posterior view in very short broadly triangular corneous tip (fig. 52*j*). A small species, maximum carapace length in midline about 15 mm.

HABITAT.—Among mangrove roots and on river banks near the ea.

DISTRIBUTION.—Bermudas and Florida to Estado da Paraíba, Brazil (Bermudas, Green Turtle Cay, New Providence I., Cuba, Jamaica, Puerto Rico, Saint Thomas, Saint Croix); eastern Atlantic from Senegal to the Congo.

62. *Pachygrapsus transversus* (Gibbes)

FIGURE 52*k*

Grapsus transversus Gibbes, 1850, p. 181 [type-locality: Key West, Florida].
Pachygrapsus transversus.—Gibbes, 1850, p. 182 [by implication].—Rathbun, 1918, p. 244, pl. 61: figs. 2, 3.—Monod, 1956, p. 415, figs. 568, 570, 572, 573.—Hartnoll, 1965, pp. 114, 135, 141, 144, 146, figs. 13A-C.
Goniograpsus innotatus Dana, 1951, p. 249 [type-locality: coast of South America?].
Leptograpsus rugulosus H. Milne Edwards, 1853, p. 172 [type-locality: Brazil].
Metopograpsus dubius De Saussure, 1858, p. 445, pl. 2: fig. 16 [type-locality: Saint Thomas].
Metopograpsus miniatus De Saussure, 1858, p. 444, pl. 2: fig. 17 [type-locality: Saint Thomas].
Pachygrapsus intermedius Heller, 1862b, p. 521 [type-locality: Rio de Janeiro, Brazil].
Grapsus declivifrons Heller, 1862b, p. 521 [type-locality: Rio de Janeiro, Brazil].
Pachygrapsus socius Stimpson, 1871, p. 114 [type-localities: Cabo San Lucas and Manzanillo, Mexico; Republic of El Salvador; Panama; Peru].

DIAGNOSIS.—Carapace trapezoidal, about three-fourths as long in midline as wide, convex longitudinally and transversely, striate anteriorly and laterally, smooth on cardiac and intestinal regions; lateral margins strongly converging posteriorly, straight or faintly convex, with acute tooth posterior to outer orbital angle, fronto-orbital distance only slightly less than maximum width of carapace; front slightly depressed but not deflexed at postfrontal lobes, less than three-fifths as wide as carapace, margin slightly bilobed or sinuous in dorsal view. Eyes well developed, cornea about as wide as eyestalks. Ventral margin of orbit strongly produced, especially in mesial half, denticulate, curving to anterolateral angle of mouth area. Third maxillipeds without oblique hairy ridge, gaping, exposing mandibles. Chelipeds subequal, carpus armed with acute distally directed tooth on flexor margin; palm with low longitudinal dorsal ridge or carina; fingers narrowly rounded distally, spoon tipped, movable finger rounded, smooth, not tuberculate on extensor margin. Walking legs moderately broad and flattened, merus of third pereiopod nearly half as wide as long, with sharp subdistal tooth on extensor margin; dactyl nearly as long as extensor margin of propodus. First pleopod of male slender, angulated, *terminating in posterior view in long corneous obliquely* T*-shaped endpiece* (fig. 52*k*). A small species, maximum carapace length in midline about 14 mm.

HABITAT.—Beneath stones and on encrusted rocks and pilings near tide line.

DISTRIBUTION.—North Carolina to Uruguay (Bermudas, Bimini Is., New Providence I., Andros I., Cuba, Jamaica, Hispaniola, Puerto

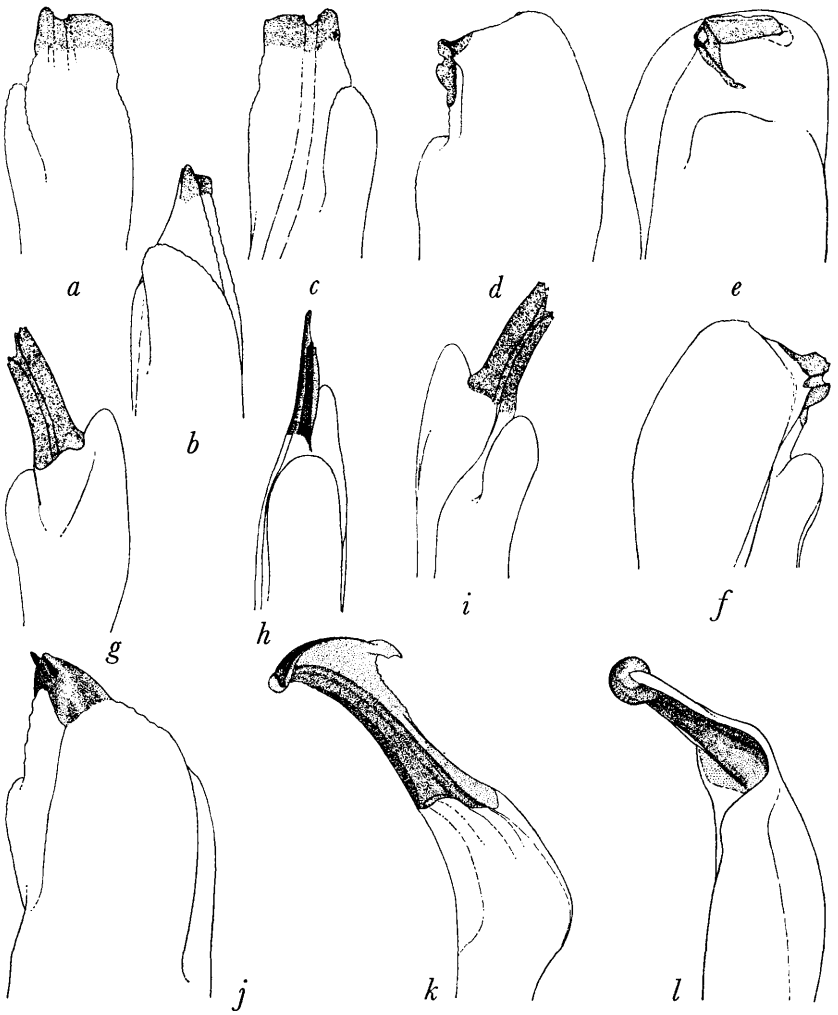


FIGURE 52.—Denuded terminal portions of male right first pleopods: *a*, *Geograpsus lividus*, specimen shown in figure 48, posterior view; *b*, same, lateral view; *c*, same, anterior view; *d*, *Goniopsis cruentata*, specimen shown in figure 49, posterior view, *e*, same, lateral view; *f*, same, anterior view; *g*, *Grapsus grapsus*, specimen shown in figure 50, posterior view; *h*, same, lateral view; *i*, same, anterior view; *j*, *Pachygrapsus gracilis*, specimen shown in figure 51, posterior view; *k*, *P. transversus* (carapace length 11.0 mm) from Saint Thomas (C. R. Shoemaker), posterior view; *l*, *Glyptograpsus jamaicensis*, specimen shown in figure 53, posterior view.

Rico, Saint Thomas, Saint John, Saint Croix, Antigua I., Guadeloupe, Martinique, Barbados, Trinidad, Curaçao); eastern Atlantic from the Mediterranean to northern Angola; eastern Pacific from California to Peru.

Subfamily VARUNINAE

Genus *Glyptograpsus*

63. *Glyptograpsus jamaicensis* (Benedict)

FIGURES 52*l*, 53

Areograpsus jamaicensis Benedict, 1892, p. 77 [type-locality: Jamaica].
Glyptograpsus jamaicensis.—Rathbun, 1897c, p. 29; 1918, p. 277, text-fig. 140, pl. 72: fig. 3.

DIAGNOSIS.—Carapace subcircular, about four-fifths as long in midline as broad, moderately convex, sloping rather abruptly ventrally in extreme posterolateral part of branchial region, surface tuberculate, especially anteriorly; lateral margins converging strongly

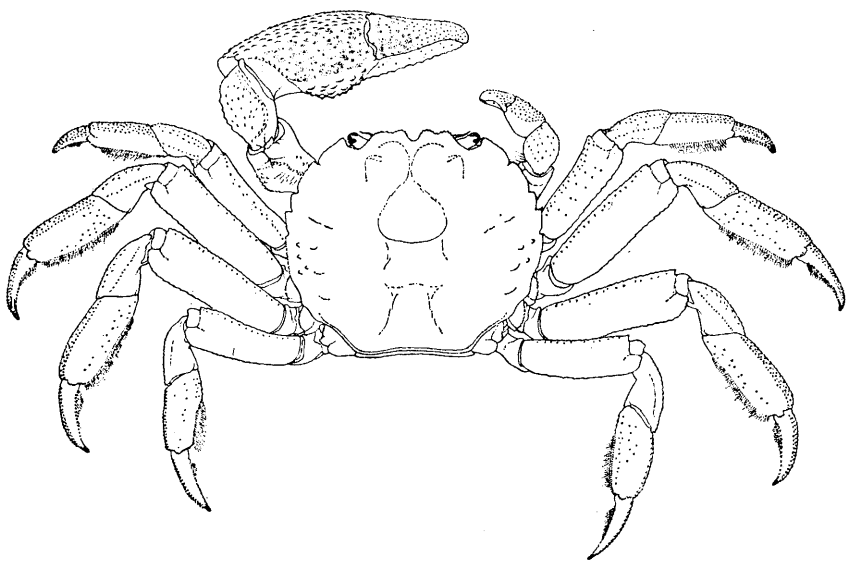


FIGURE 53.—*Glyptograpsus jamaicensis*, based on male (carapace length 39.0 mm) from Montego Bay River, Jamaica (C. B. Wilson).

anteriorly, *armed with four subrectangular teeth (last rudimentary) in addition to outer orbital angle, fronto-orbital distance little more than half maximum width of carapace;* front abruptly depressed at postfrontal lobes but not deflexed, slightly more than one-fourth as wide

as carapace, margin with deep median sinus, obscurely quadrilobate in dorsal view. Eyes well developed but rather small, cornea narrower than basal portion of eyestalk. Ventral margin of orbit denticulate, paralleled by longer row of denticles ventral to first, but not sharply produced and not curving ventrally to anterolateral angle of mouth area. Third maxillipeds without oblique hairy ridge, narrowly gaping, exposing tips of mandibles. *Chelipeds very unequal*, carpus unarmed on flexor margin; palm tuberculate dorsally; fingers of major chela very narrowly spoon tipped, of minor chela broadly spoon tipped, extensor margins of movable fingers tuberculate. Walking legs not broad and flattened, merus of third pereiopod less than one-third as wide as long, with subrectangular subdistal tooth on extensor margin; dactyl slightly shorter than extensor margin of propodus. First pleopod of male terminating in posterior view in long chitinous endpiece directed anterolaterally (fig. 52*l*). A fairly large species, maximum carapace length in midline about 40 mm.

HABITAT.—Fresh water.

DISTRIBUTION.—Known only from Jamaica.

Subfamily SESARMINAE

Genus *Aratus*

64. *Aratus pisonii* (H. Milne Edwards)

FIGURES 54, 58*a*

Sesarma Pisonii H. Milne Edwards, 1837, p. 76, pl. 19: figs. 4, 5 [type-locality: Antilles].

Aratus Pisonii.—H. Milne Edwards, 1853, p. 187.

Aratus pisonii.—Rathbun, 1918, p. 323, pl. 96.—Hartnoll, 1965, pp. 115–131, 140, 141, 143, 144, 145, figs. 1–9, tables 1–5.

DIAGNOSIS.—Carapace trapezoidal, more than nine-tenths as long in midline as wide (appearing longer than wide), slightly convex longitudinally, markedly so transversely, striations on lateral portions only; lateral margins strongly converging posteriorly, unarmed posterior to outer orbital angle, fronto-orbital distance representing maximum width of carapace; front strongly deflexed, about seven-tenths as wide as carapace, margin slanting slightly posteriorly toward midline in dorsal view. Eyes very well developed, cornea wider than eyestalk. Ventral margin of orbit sharply produced, minutely denticulate, curving to anterolateral angle of mouth area. Third maxillipeds with oblique hairy ridge on merus, widely gaping, exposing mandibles. Chelipeds subequal, carpus virtually unarmed, few denticles on flexor margin; palm sharply tuberculate dorsally; fingers subacutely spoon tipped, extensor margin of movable finger

bearing scattered tubercles. Walking legs broad and flattened, merus of third pereiopod about two-fifths as wide as long, with sharp subdistal tooth on extensor margin; *dactyl less than one-fourth as long as extensor margin of propodus.* Denuded first pleopod of male terminating in posterior view in short truncately subtriangular endpiece directed laterally (fig. 58*a*). A medium-sized species, maximum carapace length in midline about 22 mm.

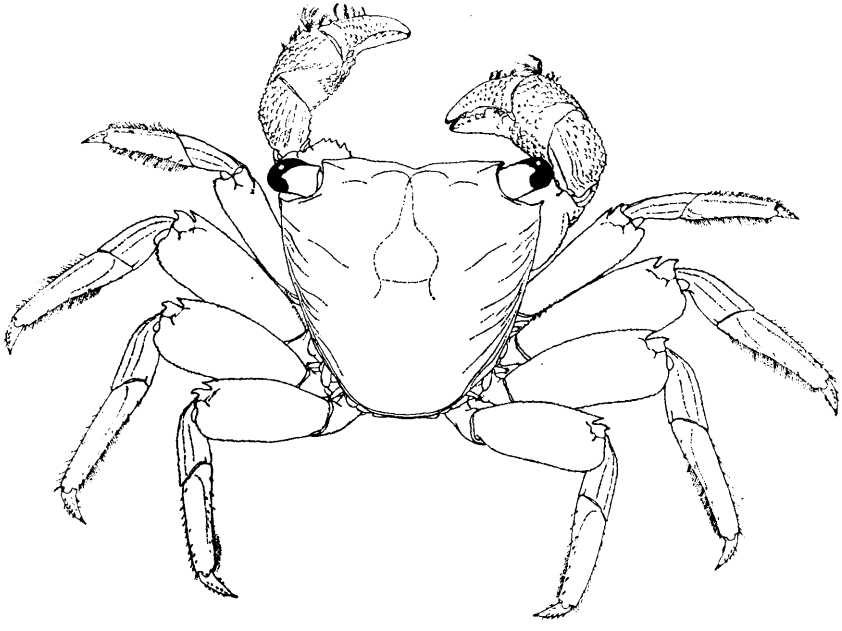


FIGURE 54.—*Aratus pisonii*, male (carapace length 23.8 mm) from Jamaica (T. H. Morgan).

HABITAT.—Among mangroves, especially on branches, and along shores of estuaries.

DISTRIBUTION.—Florida to Estado de São Paulo, Brazil (New Providence I., Cuba, Jamaica, Puerto Rico, Saint Croix, Antigua I., Guadeloupe, Isla de Margarita, Islas Los Roques, Curaçao); eastern Pacific from Nicaragua to Peru.

Genus *Cyclograpsus*

65. *Cyclograpsus integer* H. Milne Edwards

FIGURES 55, 58*b–d*

Cyclograpsus integer H. Milne Edwards, 1837, p. 79 [type-locality: Brazil].—Rathbun, 1918, p. 326, pl. 97: figs. 1, 2.—Monod, 1956, p. 451, figs. 609–612.—Hartnoll, 1965, pp. 115, 116, 137, 138, 141, 143, 144.

Grapsus integer (Latreille ms).—H. Milne Edwards, 1837, p. 79.
Cyclograpsus occidentalis A. Milne-Edwards, 1878 bis, p. 228 [type-locality: Cape Verde Islands].

DIAGNOSIS.—Carapace subrectangular, broad, less than four-fifths as long as wide, longitudinally convex anteriorly, flat posteriorly, nearly smooth except for single minutely crenulate ridge on posterior branchial region; lateral margins subparallel posteriorly, curving strongly mesially anteriorly, unarmed posterior to outer orbital angle, fronto-orbital distance slightly more than seven-tenths of maximum width of carapace; front curving ventrally, becoming perpendicular near margin, but not abruptly deflexed, slightly more than one-third as wide as carapace, margin very faintly bilobed, nearly straight, in dorsal view. Eyes rather small but fully formed, cornea narrower than basal portion of eyestalk. Ventral margin of

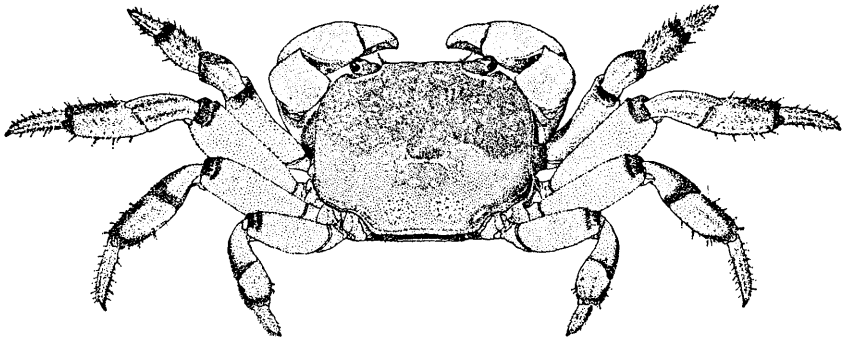


FIGURE 55.—*Cyclograpsus integer*, male (carapace length 7.1 mm) from Dominica station 6.

orbit not produced, paralleled ventrally by longer sinuous carina curving mesially to anterolateral angle of mouth area. Third maxillipeds with oblique hairy ridge crossing merus and distolateral angle of ischium, widely gaping, exposing mandibles. Chelipeds subequal, carpus unarmed, produced as rounded lobe on flexor margin; palm with low longitudinal dorsal ridge on proximal portion, otherwise smooth; fingers pointed, not spoon tipped, smooth. Walking legs not broad and flat, merus of third pereiopod less than one-third as wide as long, with obscure blunt subdistal tooth on extensor margin; dactyl considerably longer than extensor margin of propodus. Denuded first pleopod of male terminating in posterior view in subquadrate endpiece directed distolaterally (fig. 58*b*). A small species, maximum carapace length in midline about 13 mm.

COLOR IN LIFE.—Entire crab orange tan with some areas slightly darker than others. Anterior half of carapace dark with pale orbital margins and cream-colored spots as follows: one pair of elongate ones

along anterior margin of epigastric lobes, two or three small ones in anterolateral portions of protogastric regions, and one pair in mesial hepatic region. Posterior portion of carapace with two pairs of spots in anterior branchial region; an elongate, horizontal, symmetrical, laterally trifoil spot along anterior margin of cardiac area; a pair of small ones in posterior cardiac area; a small pair in branchial region at end of horizontal spot, and prominent pair of round ones in posteromesial branchial region. Appendages uniformly tan except for following darker bands: second pereiopod with bands on distal portions of merus, carpus, and propodus; third pereiopods with bands on distal portions of merus and propodus and upper distal stripe on latter; fourth and fifth pereiopods with distal band on merus, carpus, and propodus and stripe on upper margins of latter two podomeres. Lower surfaces also orange tan but slightly lighter in color than upper. Some individuals with greenish suffusion underlying tan, thus greenish tan rather than orange tan.

MATERIAL EXAMINED.—The Dominican collections contain 6 males (carapace lengths 3.7–7.1 mm) and 6 females (cl 4.1–7.2 mm), including 2 with eggs (cl 5.6 and 6.9 mm).

ECOLOGICAL NOTES.—This small crab is known from only two localities on Dominica but it is almost certainly widely dispersed along the high tide and intertidal zones around the Island. At Tarou Cliffs (pl. 3B) it is found in the splash area along the rocky beach, and a number of individuals were seen on a cobble beach on the windward side of the isthmus at Scotts Head. In the latter locality, it was found along with *Petrolisthes quadratus* and *Geograpsus lividus* (see "Ecological Notes" for *P. quadratus*).

DISTRIBUTION.—Bermudas and southern Florida to Brazil (Bermudas, San Salvador I., Cuba, Jamaica, Hispaniola, Puerto Rico, Saint Croix, Dominica, Islas Los Roques); eastern Atlantic from Senegal to the Congo.

Dominica Stations: 6, 110 (0–3 ft.).

REMARKS.—One of the four females collected at Tarou Cliffs in January and one of the two females from Scotts Head in February are ovigerous. All of those from the latter locality are smaller than the smallest one taken at Tarou Cliffs, but even the smallest female, with a carapace length of only 4.1 mm, has the abdomen fully formed.

Genus *Metasesarma*

66. *Metasesarma rubripes* (Rathbun)

FIGURES 56, 58*e*

Sesarma (*Holometopus*) *rubripes* Rathbun, 1897a, p. 90 [type-locality: Salvador, Estado da Bahia, Brazil].

Metasesarma rubripes.—Rathbun, 1918, p. 319, pl. 94.
Metopograpsus brasiliensis (A. Milne-Edwards ms.) Rathbun, 1918, p. 319 [type-locality: Florianopolis, Estado de Santa Catarina, Brazil?].

DIAGNOSIS.—Carapace trapezoidal, about four-fifths as long in midline as wide, slightly convex both longitudinally and transversely, distinctly striate laterally, nearly smooth elsewhere; lateral margins somewhat concave, converging strongly posteriorly, unarmed posterior to outer orbital angle, fronto-orbital distance representing maximum width of carapace; front sharply deflexed at postfrontal lobes, widening distally, about seven-tenths as wide as carapace, margin with

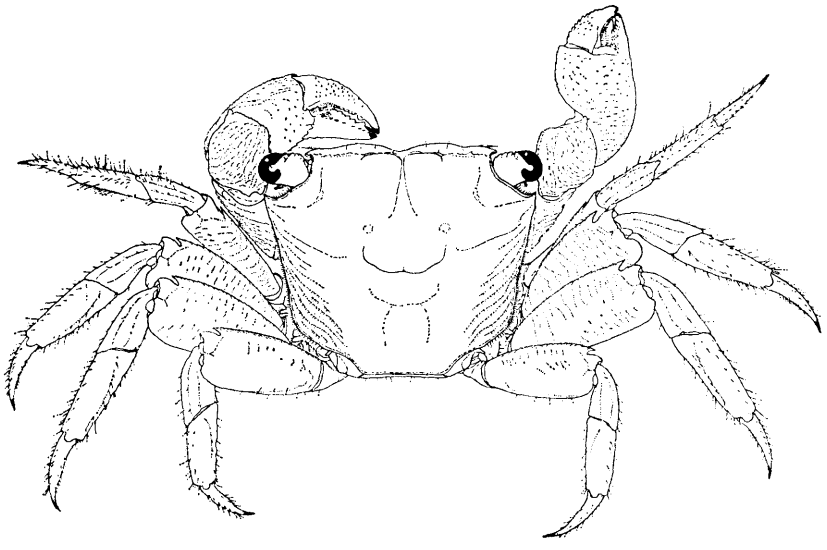


FIGURE 56.—*Metasesarma rubripes*, male (carapace length 16.0 mm) from Paparo, Venezuela (H. Pittier).

shallow median sinus, faintly quadrilobate, in dorsal view. Eyes well developed, cornea about as wide as eyestalk. Ventral margin of orbit not well defined, produced at mesial end into large lamellate lobe nearly touching frontal margin, paralleled ventrally by two sharp minutely denticulate carinae, dorsal one longer and curving mesially to anterolateral angle of mouth area. Third maxillipeds with oblique hairy ridge on merus, gaping widely, exposing mandibles. Chelipeds subequal, carpus unarmed except for few denticles on flexor margin; palm with few low oblique crenulate ridges dorsally; fingers pointed, very narrowly spoon tipped, movable finger bearing scattered sharp granules on extensor margin. Walking legs broad and flat, merus of third pereiopod nearly half as wide as long, with sharp subdistal