

*Psalidopus:*  
The Scissor-Foot Shrimps  
(Crustacea: Decapoda: Caridea)

FENNER A. CHACE, JR.  
and  
LIPKE B. HOLTHUIS

## SERIES PUBLICATIONS OF THE SMITHSONIAN INSTITUTION

Emphasis upon publication as a means of “diffusing knowledge” was expressed by the first Secretary of the Smithsonian. In his formal plan for the Institution, Joseph Henry outlined a program that included the following statement: “It is proposed to publish a series of reports, giving an account of the new discoveries in science, and of the changes made from year to year in all branches of knowledge.” This theme of basic research has been adhered to through the years by thousands of titles issued in series publications under the Smithsonian imprint, commencing with *Smithsonian Contributions to Knowledge* in 1848 and continuing with the following active series:

*Smithsonian Contributions to Anthropology*  
*Smithsonian Contributions to Astrophysics*  
*Smithsonian Contributions to Botany*  
*Smithsonian Contributions to the Earth Sciences*  
*Smithsonian Contributions to the Marine Sciences*  
*Smithsonian Contributions to Paleobiology*  
*Smithsonian Contributions to Zoology*  
*Smithsonian Studies in Air and Space*  
*Smithsonian Studies in History and Technology*

In these series, the Institution publishes small papers and full-scale monographs that report the research and collections of its various museums and bureaux or of professional colleagues in the world of science and scholarship. The publications are distributed by mailing lists to libraries, universities, and similar institutions throughout the world.

Papers or monographs submitted for series publication are received by the Smithsonian Institution Press, subject to its own review for format and style, only through departments of the various Smithsonian museums or bureaux, where the manuscripts are given substantive review. Press requirements for manuscript and art preparation are outlined on the inside back cover.

S. Dillon Ripley  
Secretary  
Smithsonian Institution

SMITHSONIAN CONTRIBUTIONS TO ZOOLOGY • NUMBER 277

*Psalidopus:*  
The Scissor-Foot Shrimps  
(Crustacea: Decapoda: Caridea)

*Fenner A. Chace, Jr.*  
*and Lipke B. Holthuis*



SMITHSONIAN INSTITUTION PRESS

City of Washington

1978

## ABSTRACT

Chace, Fenner A., Jr., and Lipke B. Holthuis. *Psalidopus*: The Scissor-Foot Shrimps (Crustacea: Decapoda: Caridea). *Smithsonian Contributions to Zoology*, number 277, 22 pages, 14 figures, frontispiece, 1978.—The four nominal species of *Psalidopus* are reduced to two, *P. barbouri* from the western Atlantic and *P. huxleyi* from the Indo-West Pacific, and both are redescribed from 350 specimens of the former and 15 of the latter. The chelae of the first and second pereopods are described in detail and their possible function is discussed.

OFFICIAL PUBLICATION DATE is handstamped in a limited number of initial copies and is recorded in the Institution's annual report, *Smithsonian Year*. SERIES COVER DESIGN: The coral *Montastrea cavernosa* (Linnaeus).

---

### Library of Congress Cataloging in Publication Data

Chace, Fenner A.

*Psalidopus* : the scissor-foot shrimps (Crustacea, Decapoda, Caridea).

(Smithsonian contributions to zoology ; no. 277)

Bibliography: p.

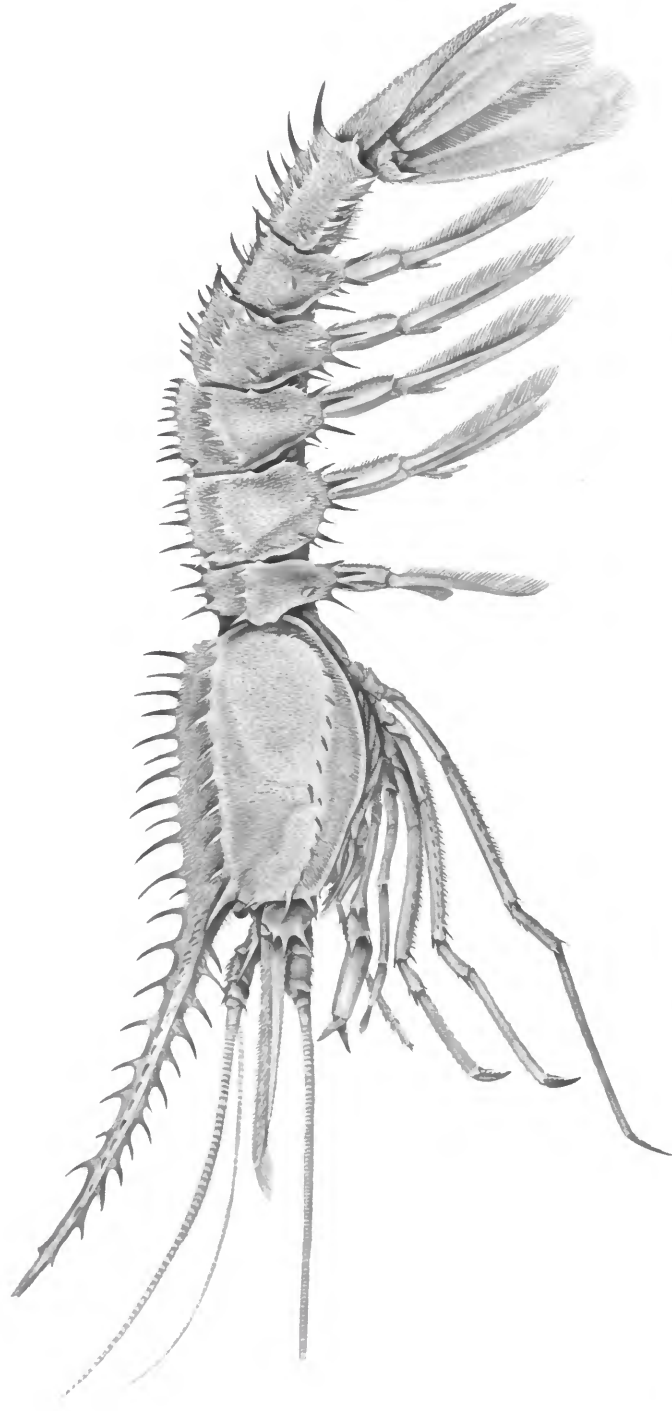
I. *Psalidopus*—Classification. 2. Crustacea—Classification. I. Holthuis, L. B., joint author.

II. Title. III. Series: Smithsonian Institution. Smithsonian contributions to zoology ; no. 277.

QL1.S54 no. 277 [QL444.M33] 591'.08s [595'.3843] 78-3711

# Contents

	<i>Page</i>
Introduction .....	1
Material .....	1
Systematic Discussion .....	1
Acknowledgments .....	2
Family PSALIDOPODIDAE Wood-Mason and Alcock, 1892 .....	2
Genus <i>Psalidopus</i> Wood-Mason and Alcock, 1892 .....	2
<i>P. barbouri</i> Chace, 1939 .....	2
<i>P. huxleyi</i> Wood-Mason and Alcock, 1892 .....	11
The Chelae of <i>Psalidopus</i> .....	19
Literature Cited .....	21



FRONTISPIECE.—*Pseudodopus barbouri*, male, carapace length 16 mm, from R/V *John Elliott Pillsbury* Station 784 off Cabo de la Aguja, Colombia. 567-715 meters. X3.6. (Illustration by Constance S. McSweeney.)



# *Psalidopus*: The Scissor-Foot Shrimps (Crustacea: Decapoda: Caridea)

Fenner A. Chace, Jr.  
and Lipke B. Holthuis

## Introduction

**MATERIAL.**—The bizarre shrimps of the genus *Psalidopus* have generally been considered to be among the rarer of carideans. Until the appearance of the list of material collected by the exploratory research vessels of the Fish and Wildlife Service (Bullis and Thompson, 1965), only 12 specimens seem to have been recorded in the literature: two assigned to a western Atlantic species, and the remaining 10 identified with three different Indo-West Pacific species.

During the preparation of a report still in progress on the caridean shrimps of the *Albatross* Philippine expedition of 1907–10, the senior author found six specimens of *Psalidopus* collected during that expedition and nine specimens taken during the northwestern Pacific cruise of the *Albatross* in 1906. Subsequently, 351 specimens of the Atlantic species were also discovered in the unidentified Smithsonian collections, all collected by United States Fish and Wildlife Service vessels. In the meantime, the junior author had identified and made preliminary studies of 24 specimens collected at Bahamian and Caribbean stations by vessels of the University of Miami, Florida.

Inasmuch as the material of the Atlantic species

available to us came from more than 70 different stations, we are surprised that no specimens of the genus were obtained by earlier investigations in the Gulf of Mexico and Caribbean Sea. Probably the more prevalent use of large otter trawls in recent years is chiefly responsible for the increased catch, but the first Atlantic specimen was taken with a 14-foot Blake trawl in 1938, and all 15 specimens of the Indo-West Pacific species collected by the *Albatross* off Japan and the Philippines from 1906 to 1909 were taken in 9- to 12-foot beam trawls.

**SYSTEMATIC DISCUSSION.**—The availability of such extensive collections from the western Atlantic has permitted a variability study of the genus that would have been impossible otherwise. As a result, we are convinced that only one of the three species described from the Indo-Pacific region is recognizably distinct, and the number of known species is therefore reduced from four to two.

In our accounts of the two species, the terminology used for the rows of spines on the carapace corresponds with that proposed for the ridges on *Glyphocrangon* A. Milne-Edwards by Holthuis (1971:272, fig. 1). The counts of the spines in these rows do not include the supraorbital, antennal, or branchiostegal spines. The postorbital carapace lengths (in mm) are shown in parentheses following most of the specimen counts in the "Material Examined" sections.

Most of the material of the two species listed below is in the Smithsonian collections, but a few lots (as indicated) have been deposited in the Rijks-

---

Fenner A. Chace, Jr., Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560. L. B. Holthuis, Rijksmuseum van Natuurlijke Historie, Postbus 9517, 2300 RA Leiden, The Netherlands.

museum van Natuurlijke Historie, Leiden, The Netherlands (RMNH) and in the Rosenstiel School of Marine and Atmospheric Science of the University of Miami, Florida (UMML).

**ACKNOWLEDGMENTS.**—Probably the most important contribution to this study was the extensive collection of the Atlantic species of *Psolidopus* transferred to the Smithsonian from the Bureau of Commercial Fisheries Biological Laboratory at Pascagoula, Mississippi, through Harvey R. Bullis, Jr., and John R. Thompson. This is just a small part of the vast and extremely valuable collections received from that source during many years. Those who are unfamiliar with the operations of the exploratory fishing vessels of the Fish and Wildlife Service (subsequently the National Marine Fisheries Service) can hardly appreciate the labor and sacrifice required to preserve these important collections for future study. It is our understanding that, unlike the earlier operations of the Bureau of Fisheries, there is no directive to save study material collected during exploratory fishing cruises, and all that is preserved must be credited to the volunteer and overtime efforts of members of the scientific parties on the various cruises. To all of them goes our profound gratitude.

We also thank John Thompson, currently with the Division of Forestry, Fisheries, and Wildlife Development of the Tennessee Valley Authority, for graciously relinquishing his prior claim to the *Psolidopus* study and Linda H. Pequegnat of the Department of Oceanography, Texas A&M University, for calling our attention to the Thompson work and for offering *Psolidopus* specimens from the Texas A&M collections. Finally we are indebted to four of our Smithsonian staff and resident colleagues: Margaret A. Daniel for sharing her expertise on the reproduction of illustrations; Horton H. Hobbs, Jr., for assistance rendered whenever requested, including review of the manuscript; Raymond B. Manning for welcome advice and, especially for calling our attention to the unidentified cache of *Psolidopus* in our midst, as well as for reading the manuscript; and Isabel Pérez Farfante for reviewing the manuscript.

**Family PSALIDOPODIDAE Wood-Mason and Alcock, 1892**

PSALIDOPODIDAE Wood-Mason and Alcock, 1892:265.—Holthuis, 1955a:11, 81.—Hemming, 1957:158, 186.

**DEFINITION.**—Rostrum longer than carapace, ascendant, armed with dorsal, lateral, and ventral series of spines. First abdominal somite with shallow lateral lobe forming secure sliding junction with submarginal ridge of carapace. Eyestalk not unusually elongate, fused proximally to floor of orbit, immovable; cornea obscurely faceted, unpigmented; dorsolateral antennular flagellum simple, not biramous. Mandible with stout molar process well separated from simple, pointed incisor process; palp 2-segmented, massive. Exopods on 3 pairs of pereopods only. Second maxilliped with distal segment applied as narrow strip to margin of penultimate segment. Third maxilliped composed of 5 segments, none expanded. First pereopod more robust than 2nd, chela with 2 movable fingers, scissorlike; ischium and merus partially fused. Second pereopod terminating in tuft of long setae arising from distal surface of imperfect chela; carpus undivided, ischium and merus partially fused. Third and 4th pereopods with ischium and merus partially fused. Fifth pereopod longer and more slender, especially propodus; ischium and merus distinct, not fused. Pleopods 2–5 with appendices internae on endopods; 2nd pleopod of male with appendix masculina. Males and nonbreeding females with slender spine in midline of posterior 1 or 2 (rarely 3) thoracic sternites and with up to 11 similar spines in ventral midline of abdomen; breeding females without ventral thoracic or abdominal spines. Gills consisting of epipods on 1st and 2nd maxillipeds only and of pleurobranch on each of somites bearing 1st to 4th pereopods.

Known only from the type-genus.

**Genus *Psolidopus* Wood-Mason and Alcock, 1892**

*Psolidopus* Wood-Mason and Alcock, 1892:266 [type-species, selected by Holthuis, 1955a:81: *Psolidopus Huxleyi* Wood-Mason and Alcock, 1892:273].—Holthuis, 1955a:81.—Hemming, 1957:141, 174.

An exhaustive description of the genus has been given by Wood-Mason and Alcock (1892:266–273).

***Psolidopus barbouri* Chace, 1939**

FIGURES 1–7, 14; Frontispiece

*Psolidopus barbouri* Chace, 1939:36 [*Atlantis* Sta 2987C; Nicholas Channel between Cuba and Cay Sal Bank; 23°21'N, 79°58'W; 549–576 m; 13 Mar 1938; 14' Blake trawl: 1 ovig.



female holotype (22.6)].—Thompson, 1963:221.—Bullis and Thompson, 1965:8.

**MATERIAL EXAMINED.**—OFF EAST COAST OF UNITED STATES. 29°29'N, 79°53'W; 686 m; 7.2°C; 19 Nov 1965; 40' flat trawl; *Oregon* Sta 5753: 2 males (16.6, 25.1).

**STRAITS OF FLORIDA.** 24°13'N, 81°24'W; 595 m; 28 Oct 1960; 40' balloon trawl; *Silver Bay* Sta 2421: 2 ovig. females (27.0, 27.7).

**GULF OF MEXICO.** Northeast Quadrant. 27°33'N, 85°06'W; 501 m; 16 Jun 1969; 204' shrimp trawl; *Oregon II* Sta 10626: 1 ovig. female (27.8). 29°07.5'N, 88°09'W; 549 m; 8.5°C; 23 Oct 1962; 40' flat trawl; *Oregon* Sta 4005: 2 males (18.9, 24.8) 3 females (13.0–29.3), 2 ovig. (24.8, 29.3). Northwest Quadrant. 27°55'N, 90°28'W; 549 m; 10.0°C; 22 Feb 1964; 40' shrimp trawl; *Oregon* Sta 4703: 2 females (21.4, 24.0), 1 ovig. (24.0). 27°46'N, 92°13'W; 549 m; 10.0°C; 26 Feb 1964; 40' flat shrimp trawl; *Oregon* Sta 4729: 2 females (16.3, 26.8), 1 ovig. (26.8). 27°37.5'N, 92°23.5'W; 732 m; 6.7°C; 27 Feb 1964; 40' flat shrimp trawl; *Oregon* Sta 4730: 1 female (25.0). 27°33'N, 93°35.5'W; 549 m; 9.0°C; 30 Jan 1964; 40' shrimp trawl; *Oregon* Sta 4661: 1? (20.3). 27°25'N, 93°40'W; 732 m; 6.2°C; 30 Jan 1964; 40' shrimp trawl; *Oregon* Sta. 4662: 4 males (18.7–22.9) 5 females (14.4–25.3). 25°41'N, 96°11'W; 732 m; 6.1°C; 6 Apr 1964; 40' shrimp trawl; *Oregon* Sta 4800: 1 female (18.2). Southwest Quadrant. 23°15'N, 97°16'W; 677 m; 2 Jun 1970; 150' shrimp trawl; *Oregon II* Sta 10954: 2 males (24.1, 25.8) 3 females (24.0–28.8), 1 ovig. (28.8). 19°28'N, 92°55'W; 612 m; 9 Jun 1970; 150' universal trawl; *Oregon II* Sta 10984: 1 male (19.2) 1 ovig. female (27.1). Southeast Quadrant. 24°22'N, 87°49'W; 585 m; 13 Aug 1970; 71' shrimp trawl; *Oregon II* Sta 11147: 1 ovig. female (28.0).

**BAHAMA ISLANDS.** Tongue of the Ocean; 25°07'N, 77°22'W–25°08'N, 77°18'W; 805 m; 1 Jul 1972; 40' otter trawl; *Iselin* Sta 2: 3 males (UMML).

**LEEWARD ISLANDS.** Anegada Passage. 18°28'N, 63°23'W; 683 m; 6 Dec 1969; 70' shrimp trawl; *Oregon II* Sta 10835: 1 male (25.6) 4 females (22.1–30.2), 3 ovig. (25.9–30.2). 18°18'N, 63°23'W; 688 m; 6 Dec 1969; 70' shrimp trawl; *Oregon II* Sta 10834: 4 males (17.1–25.6). 18°18'N, 63°24'W; 658 m; 10 Dec 1969; 40' shrimp trawl; *Oregon II* Sta 10847: 3 males (19.0–24.0) 1 ovig. female (27.2). Off Ile Saint-Barthélemy. 17°46'N, 62°59'W; 649 m; 9.4°C; 18 May 1967; 40' flat net; *Oregon* Sta 6696: 1 male (18.5) 4? (20.2–25.8). Off Saba Bank. 17°38'N, 63°48'W; 651 m; 3 Dec 1969; 70' shrimp trawl; *Oregon II* Sta 10831: 3 males (21.9–23.0) 3 females (19.0–24.8), 2 ovig. (24.2, 24.8), 1 soft shelled. Off Saba. 17°38'N, 63°01'W; 717 m; 7 Dec 1969; 70' shrimp trawl; *Oregon II* Sta 10838: 1 male (21.5). 1 female (13.3). 17°37'N, 63°00'W; 658 m; 7 Dec 1969; 40' shrimp trawl; *Oregon II* Sta 10839: 1 male (16.0). Off Sint Eustatius; 17°38'N, 62°59'W; 649 m; 9 Dec 1969; 40' trawl; *Oregon II* Sta 10846: 4 males (15.0–20.8) 3 females (15.8–23.0), 1 ovig. (23.0). Off Saint Christopher. 17°14'N, 63°01'W; 704–777 m; 22 May 1967; 65' flat net; *Oregon* Sta 6705: 2 males (20.0, 23.7) 2 females (24.3, 25.7), 1 ovig. (25.7). 17°24'N, 62°28'W; 629 m; 8 Dec 1969; 40' shrimp trawl; *Oregon II* Sta 10844: 3 females (16.0–30.3), 2 ovig. (26.3, 30.3). 17°33'N, 62°46'W; 667 m; 9 Dec

1969; 40' shrimp trawl; *Oregon II* Sta 10845: 2 males (15.0, 23.0). Off Antigua Island. 16°53'N, 61°53'W; 750–841 m; 21 May 1967; 65' flat net; *Oregon* Sta 6703: 3 males (21.1–23.0) 1 female (26.0). Dominica Passage. 15°42'N, 61°08'W; 640 m; 1 Dec 1969; 71' shrimp trawl; *Oregon II* Sta 10825; 3 males (20.2–25.3) 4 females (17.2–31.8), 3 ovig. (28.0–31.8).

**OFF BELIZE.** 16°58'N, 87°53'W; 457–732 m; 10 Jun 1962; 40' shrimp trawl; *Oregon* Sta 3635: 10 males (16.1–21.2) 28 females (17.1–25.7), 18 ovig. (20.7–24.2).

**OFF HONDURAS.** 16°51'N, 82°14'W; 585 m; 9.4°C; 15 Nov 1968; 71' shrimp trawl; *Oregon II* Sta 10176: 1 male (20.0).

**OFF NICARAGUA.** 14°40'N, 81°33'W; 450–576 m; 31 Jan 1971; *Pillsbury* Sta 1355: 10 specimens (12–27), 5 ovig. (21–27) (RMNH). 14°23'N, 81°45'W; 457 m; 5 Jun 1962; 71' shrimp trawl; *Oregon* Sta 3616: 1 ovig. female (23.0). 14°10'N, 81°55'W; 439–457 m; 8.9°C; 21 May 1962; 40' shrimp trawl; *Oregon* Sta 3565: 4 females (15.9–26.2), 1 ovig. (26.2). 14°10'N, 81°50'W; 549–604 m; 6.1°C; 21 May 1962; 40' shrimp trawl; *Oregon* Sta 3571: 8 males (15.0–21.3) 11 females (21.9–26.1), 9 ovig. (22.0–26.1). 13°58'N, 81°49'W; 549 m; 14 Sep 1957; 40' shrimp trawl; *Oregon* Sta 1932: 4 females (14.7–26.0), 3 ovig. (23.7–26.0). 12°25'N, 82°15'W; 549–585 m; 23 May 1962; 40' shrimp trawl; *Oregon* Sta 3576: 1 ovig. female (25.4). 12°24'N, 82°24'W; 612 m; 8.3°C; 17 Nov 1968; 17' shrimp trawl; *Oregon II* Sta 10207; 1 male (19.7).

**OFF PANAMA.** 9°15'N, 81°32'W; 457 m; 9.4°C; 25 May 1962; 40' shrimp trawl; *Oregon* Sta 3582: 1 ovig. female (25.7). 9°00'N, 81°23'W; 457 m; 31 May 1962; 40' shrimp trawl; *Oregon* Sta 3599; 4 ovig. females (26.2–27.9). 9°03'N, 81°18'W; 549 m; 31 May 1962; 40' shrimp trawl; *Oregon* Sta 3600: 2 males (20.7, 21.9) 6 ovig. females (23.7–25.5). 9°05'N, 81°18'W; 594 m; 29 Oct 1970; 40' shrimp trawl; *Oregon II* Sta 11228: 4 males (17.6–18.9) 6? (13.9–25.0). 9°07.4'N, 81°11.8'W–9°04.0'N, 81°13.8'W; 657–673 m; 21 Jul 1966; *Pillsbury* Sta 447: 5 specimens, 2 ovig. (RMNH). 9°12'N, 81°11'W; 555 m; 28 Oct 1970; 40' shrimp trawl; *Oregon II* Sta 11227: 7 males (15.8–23.2) 5 females (22.1–26.0), 3 ovig. (22.1–26.0). 9°07'N, 81°10'W; 732 m; 6.1°C; 31 May 1962; 40' shrimp trawl; *Oregon* Sta 3601: 3 females (13.3–25.8), 1 ovig. (25.8). 9°13'N, 80°43'W; 439 m; 30 May 1962; 40' shrimp trawl; *Oregon* Sta 3592: 2 ovig. females (22.3, 22.9).

**OFF COLOMBIA.** 8°56'N, 76°53'W; 622 m; 2 Nov 1970; 71' shrimp trawl; *Oregon II* Sta 11231: 4 males (17.7–21.7) 7 females (20.1–26.8), 4 ovig. (24.7–26.8). 9°02.4'N, 76°31.5'W; 732 m; 28 May 1964; *Oregon* Sta 4902: 2 males (15.3, 21.0) 2 females (16.7, 17.2). 9°28.6'N, 76°26.3'W–9°27.4'N, 76°29.0'W; 416–634 m; 16 Jul 1966; *Pillsbury* Sta 394: 1 specimen (UMML). 9°36'N, 76°22'W; 512 m; 10.0°C; 16 Oct 1965; 65' shrimp trawl; *Oregon* Sta 5722: 2 females (21.9, 23.3), 1 ovig. (23.3). 9°57.0'N, 76°10.6'W; 434–373 m; 14 Jul 1966; *Pillsbury* Sta 374: 2 females (23, 28), 1 ovig. (28) (UMML). 10°00'N, 76°10'W; 549 m; 6 Nov 1970; 71' shrimp trawl; *Oregon II* Sta 11244: 1 female (19.7). 11°10.8'N, 74°28.5'W; 549 m; 18 May 1964; 40' flat shrimp trawl; *Oregon* Sta 4854: 2 males (21.3, 22.4) 4? (23.8–26.1). 11°13'N, 74°26'W; 631 m; 9 Nov 1970; 71' shrimp trawl; *Oregon II* Sta 11250: 4 females (21.9–25.0), 2 ovig. (22.8, 25.0). 11°26.5'N, 74°10'W–11°26.7'N, 73°57.9'W; 567–715 m; 31 Jul 1968; *Pillsbury* Sta 784: 1 male

(UMML). 12°10'N, 72°52'W; 549 m; 19 Nov 1970; 71' flat trawl; *Oregon II* Sta 11286: 4 females (19.8–28.1), 1 ovig. (28.1). 12°28'N, 72°26'W; 549 m; 2 Jun 1964; 40' flat shrimp trawl; *Oregon* Sta 4925: 1 male (20.8) 1 ovig. female (26.2).

OFF VENEZUELA. 12°29'N, 72°19'W; 485 m; 9 Oct 1965; 40' shrimp trawl; *Oregon* Sta 5689: 11 females (14.0–27.5), 5 ovig. (22.7–27.5). 12°52'N, 70°43'W; 512 m; 23 Nov 1970; 71' shrimp trawl; *Oregon II* Sta 11299: 10 females (21.0–29.0), 6 ovig. (25.1–29.0). 12°38'N, 70°26'W; 549 m; 23 Nov 1970; 71' shrimp trawl; *Oregon II* Sta 11300: 1 male (23.3) 12 ovig. females (25.1–29.0). 12°52'N, 70°24'W; 603 m; 24 Nov 1970; 71' shrimp trawl; *Oregon II* Sta 11302: 1 male (21.8). 12°54'N, 70°39'W; 603 m; 25 Nov 1970; 71' shrimp trawl; *Oregon II* Sta 11303: 10 males (19.0–24.7) 1 ovig. female (26.1). 12°54'N, 70°39'W; 612 m; 26 Nov 1970; 71' shrimp trawl; *Oregon II* Sta 11310: 6 males (17.5–25.0) 8 females (15.5–28.3), 6 ovig. (27.0–28.3). 12°55'N, 70°16'W; 622 m; 26 Nov 1970; 71' shrimp trawl; *Oregon II* Sta 11307: 3 males (21.0–22.2) 6 ovig. females (26.4–29.5). 12°55'N, 70°16'W; 622 m; 26 Nov 1970; 71' shrimp trawl; *Oregon II* Sta 11308: 12 males (18.7–23.8) 2 ovig. females (26.6, 27.0). 11°49'N, 69°24'W; 549 m; 7.2°C; 3 Oct 1963; 40' flat trawl; *Oregon* Sta 4412: 1 male (16.1) 2 females (18.5, 19.3). 11°53'N, 69°25'W; 640 m; 7.8°C; 3 Oct 1963; 40' flat trawl; *Oregon* Sta 4413: 8 males (17.2–22.9) 3 females (16.0–26.3), 1 ovig. (25.5). 11°54'N, 69°23'W; 732 m; 6.7°C; 3 Oct 1963; 40' flat trawl; *Oregon* Sta 4414: 3 males (17.3–22.8) 2 females (25.8), 1 ovig. (25.8). 10°55'N, 67°56'W; 549 m; 10 Oct 1963; 40' flat trawl; *Oregon* Sta 4448: 1 female (22.8). 11°40'N, 62°33'W; 585–622 m; 24 Sep 1964; 40' shrimp trawl; *Oregon* Sta 5039: 2 males (18.7, 18.7) 5 females (18.5–28.7), 3 ovig. (26.0–28.7).

**DIAGNOSIS.**—Rostrum usually straight over most of length. Carapace with longitudinal row of spines on dorsal part of branchial region much reduced or absent and usually without spines on submarginal region (ventral to sublateral row of spines). Sixth abdominal somite with 5–9 spines in dorsal midline. Antennal scale 2.0–4.2 (average 2.8) times as long as wide.

**DESCRIPTION.**—Rostrum variably ascendant, typically nearly straight except faintly more upturned near tip (Figures 1a, 4a,d,e, Frontispiece) but often curving strongly dorsad throughout, especially in mature females (Figure 4c), armed with 6–12 (average 8.3+) dorsal spines, 10–12 (average 15.5+) ventral spines, and 5–16 (average 10.7+) lateral spines. Carapace armed with 10–17 (average 12.9+) spines in dorsal midline, usually with tubercle on gastric or frontal region and near posterior margin; 5–9 (average 6.5+) in anterior intermediate row; 3–7 (average 4.7+) in posterior intermediate row; 0–2 (average less than 1) in anterior antennal row; 0–6 (average less than 1) in posterior antennal row; 0 (rarely 1–2) on remainder of branchial region;

3–9 (average 5.1+) in anterior sublateral row; 6–13 (average 9.7) in posterior sublateral row; and 0–10 (average less than 1) on submarginal region. Abdomen armed in dorsal midline (Figure 1a, Frontispiece) with 1–5 (usually 3) spines on 1st somite; 5–10 (average 7.0+) on 2nd; 6–11 (average 8.6+) on 3rd; 6–12 (average 8.9+) on 4th, usually also with large tubercle or boss in posterior ½ of length; 0–10 (average 3.2+) on 5th (Figures 1b, 4b); and 5–9 (average 6.8+) on 6th. Telson variable, commonly with paired series of prominent dorsal spines or stout setae (Figure 4f) but often with dorsal rows of spines little more prominent than setae covering dorsolateral parts of telson (Figure 1c).

Eyes as described above in family definition.

Antennular peduncle (Figure 1d) with stylocerite abruptly constricted to long terminal spine overreaching distolateral margin of 2nd segment. Basal segment with strong spine near midlength of ventral surface. Second and 3rd segments subequal, armed with spines and stout setae, pair at distolateral angle of 3rd segment especially prominent. Dorsolateral flagellum about 1½ times as long as carapace; ventromesial flagellum more slender and slightly longer.

Antennal scale (Figure 1e) 2.0–4.2 (average 2.8) times as long as wide, usually less than 3 times as long as wide in mature individuals and more than 3 times as long as wide in juveniles (Figure 7). Basal segment of antennal peduncle armed with 3 strong lateral spines, ventralmost longest (Figure 1a). Antennal flagellum more than 10 times as long as carapace and more than twice as long as entire shrimp from tip of rostrum to end of telson.

Mandibles similar and subequal, molar process of right mandible (Figure 1f–h) apparently slightly less robust than that of left mandible (Figure 1i); incisor process very slender and tapering regularly to sharp tip. First maxilla (Figure 2a,b) with about 12 marginal spines on distal half of distal lacinia; palp slightly constricted near midlength. Second maxilla (Figure 2c) with distal lobe of scaphognathite comparatively short. First maxilliped (Figure 2d) with palp rather stout in proximal ½. Second maxilliped (Figure 2e) typical of family. Third maxilliped (Figure 2f) reaching to near level of distal ¼ of antennal scale; distal part of distal segment (Figure 2g) rather stout.

First pereopod (Figure 2h) reaching about to level of midlength of antennal scale. Second pereop-

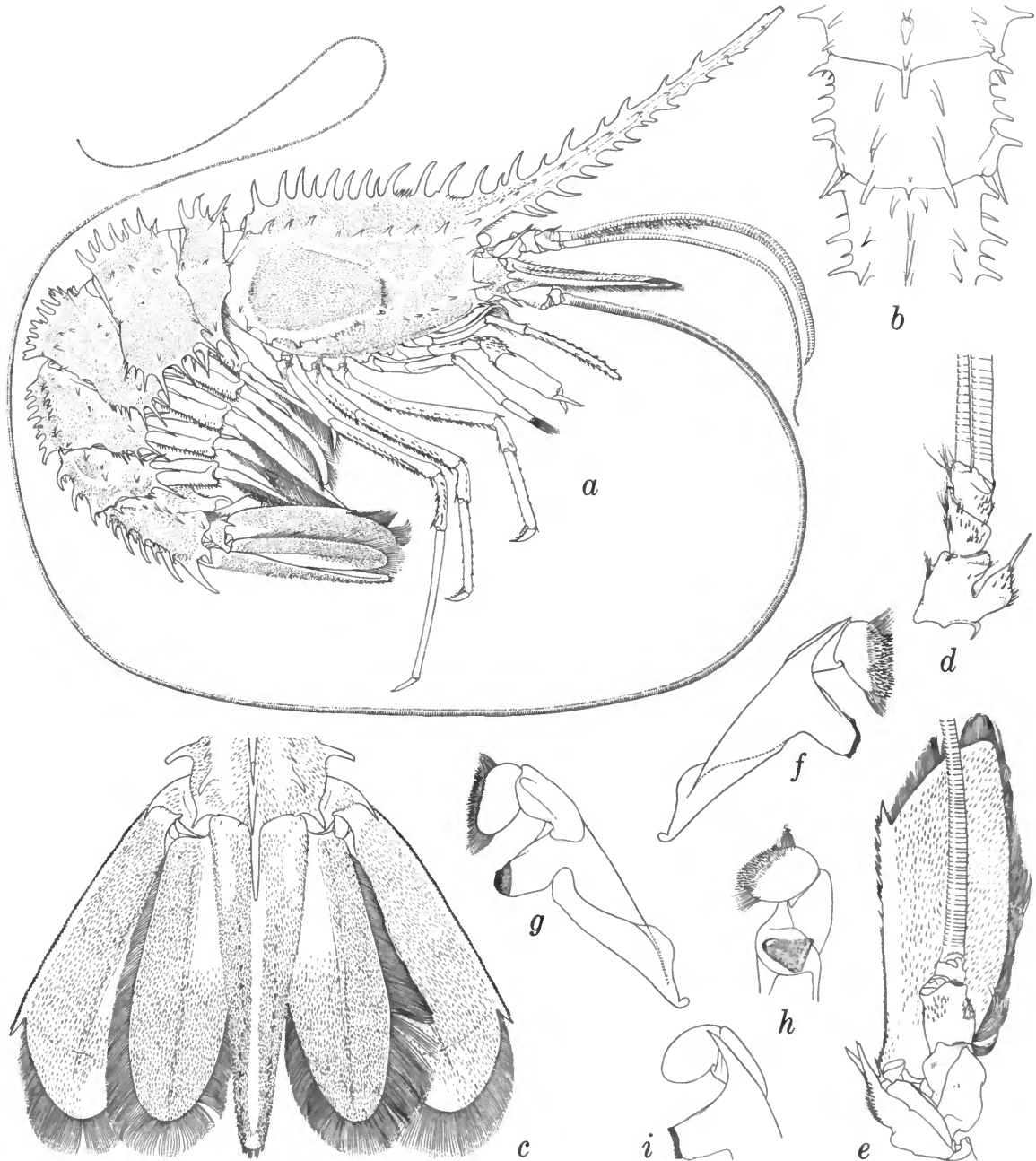


FIGURE 1.—*Psalidopus barboursi*, male from Oregon II Sta 10847, carapace length 24.0 mm: a, entire animal, right aspect; b, 5th abdominal somite, dorsal aspect; c, telson and uropods; d, right antennular peduncle and scale, dorsomesial aspect; e, right antennular peduncle and scale, ventral aspect; f, right mandible, posterior aspect; g, same, anterior aspect; h, same, mesial aspect; i, left mandible, posterior aspect. (Magnifications: a,  $\times 1.5$ ; b-e,  $\times 3$ ; f-i,  $\times 6$ .)



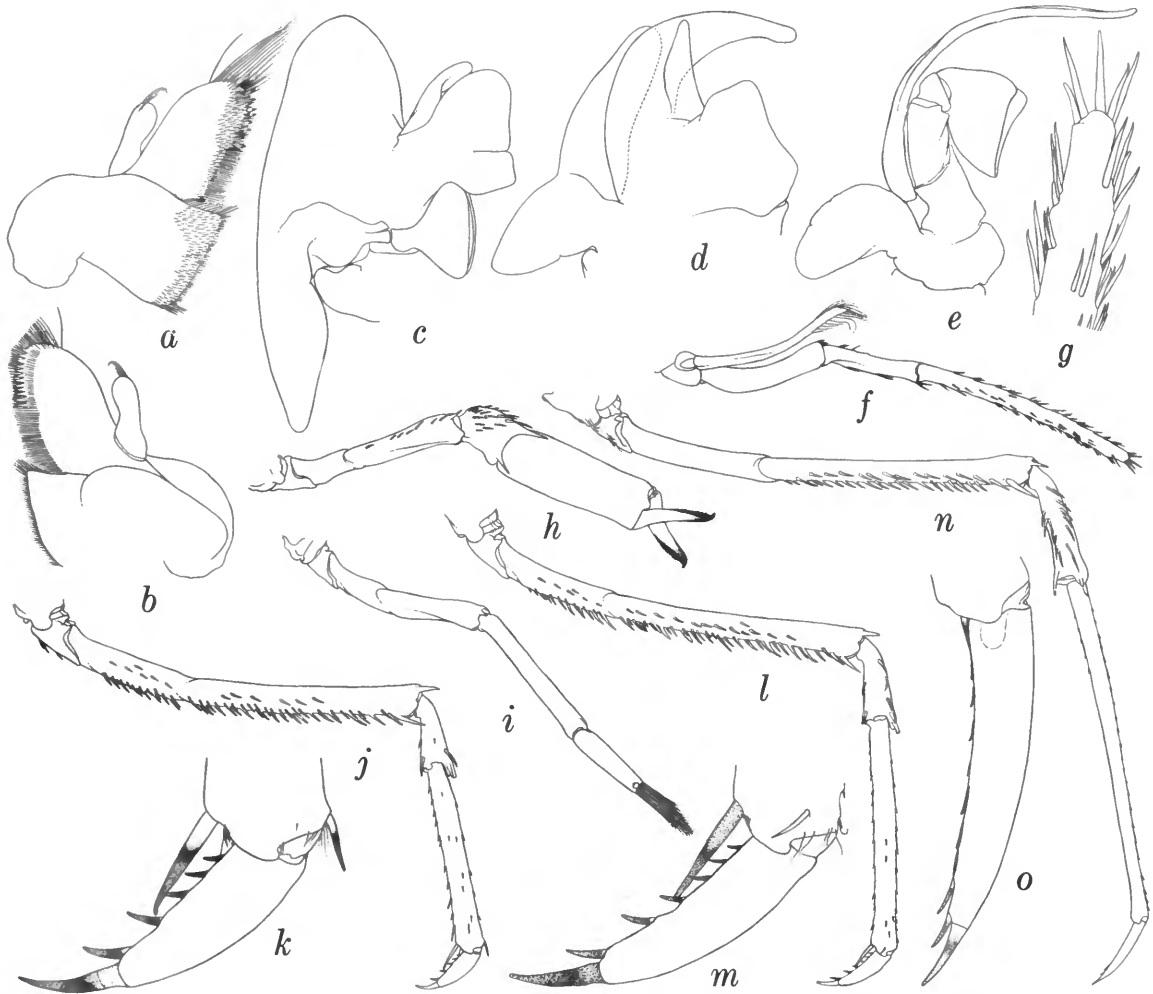


FIGURE 2.—*Psalidopus barbouri*, male from Oregon II Sta 10847, carapace length 24.0 mm: a, right 1st maxilla, aboral aspect; b, same, oral aspect; c, right 2nd maxilla; d, right 1st maxilliped; e, right 2nd maxilliped; f, right 3rd maxilliped; g, same, distal end; h, right 1st pereopod; i, right 2nd pereopod; j, right 3rd pereopod; k, same, dactyl; l, right 4th pereopod; m, same, dactyl; n, right 5th pereopod; o, same, dactyl. (Magnifications: f, h-j, l, n,  $\times 3$ ; a-e,  $\times 6$ ; g, k, m, o,  $\times 12$ .)

pod (Figure 2i) falling slightly short of distal end of 1st pereopod when both extended anteriorly. Third pereopod (Figure 2j,k) reaching level of distal margin of antennal scale. Fourth pereopod (Figure 2l,m) barely overreaching antennal scale. Fifth pereopod (Figure 2n,o) overreaching antennal scale by length of dactyl and about  $\frac{1}{3}$  of propodus.

Endopod of 1st pleopod of male elongate quadrangular, faintly emarginate distally, with retinacula at distomesial angle (Figure 3a,b), of female bluntly subtriangular, curved mesiad, and fringed with long setae (Figure 3e,f). Appendix masculina (Figure 3c,d) sparsely spinose.

Uropods (Figure 1c) not overreaching telson.

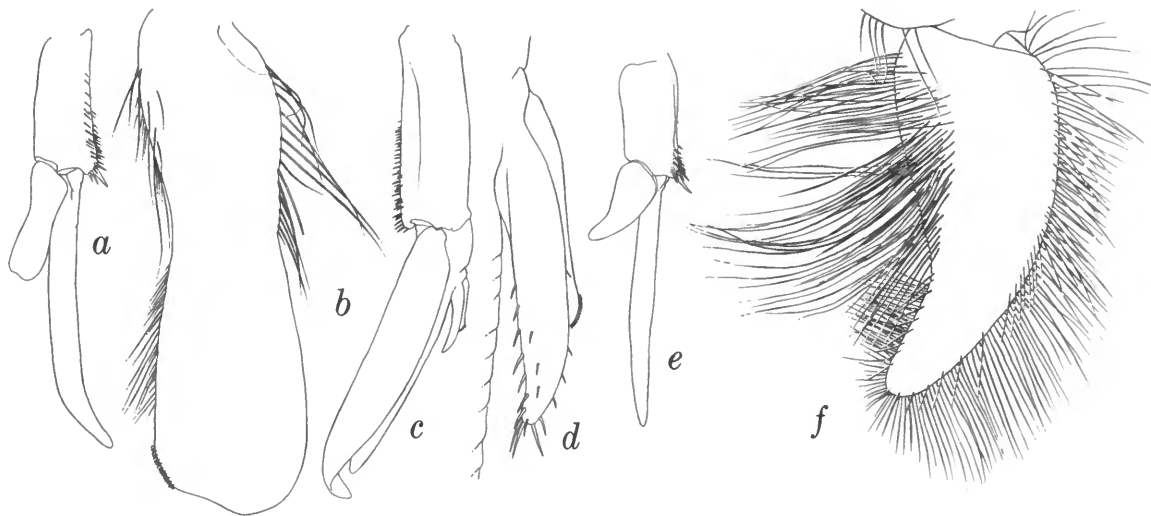


FIGURE 3.—*Psalidopus barbouri*, male from Oregon II Sta 10847, carapace length 24.0 mm: a, right 1st pleopod, posterior aspect; b, same, endopod; c, right 2nd pleopod, anterior aspect; d, same, appendices masculina and interna. Female from Oregon Sta 3635, carapace length 22.3 mm: e, right 1st pleopod, posterior aspect; f, same, endopod. (Magnifications: a, c, e,  $\times 3$ ; b, d, f,  $\times 12$ .)

Ovigerous females bearing as many as 43 eggs measuring from  $2.9 \times 2.5$  mm when freshly laid to  $5.3 \times 4.0$  mm before hatching.

**COLOR.**—The following description was made from the two female specimens immediately after capture at Pillsbury Station 374 off Colombia. The general impression is that of a delicate pink shrimp. The pink color extends over the entire dorsal surface of the body, from the rostrum to the posterior end of the tailfan. The color is quite uniform, only the spines and the margins of the segments may be slightly darker than the rest. The anterolateral part of the carapace is also pink, but the posterolateral portion of the ventral parts of the pleura of the 1st to 4th abdominal somites are practically colorless transparent. The tip of the rostrum and the antennular and antennal flagella likewise are colorless transparent, as are also the tips of some of the longer spines. The eyes are dull white with a slightly pink tinge. The antennular and antennal peduncles, including the antennal scales, are pink. The 1st pair of chelipeds are pink, but the finger tips are of a dark horn color; this horn color becomes lighter proximally and finally merges with the pink of the palm. The following 3 pairs of

pereopods are uniformly pink or have the extreme proximal part colorless transparent. The 5th pair of pereopods differ from the others in being largely colorless transparent, with only the merus and the distal part of the propodus pink. The pleopods are completely colorless. The uropods, like the rest of the tailfan, are pink.

**SIZE.**—Carapace lengths of males, 14.2–25.8 mm; of females without eggs, 13.0–30.1 mm; of ovigerous females, 20.7–31.8. Total length, from tip of rostrum to end of telson, about 5 times carapace length in mature females, up to  $5\frac{1}{2}$  times in males.

**SEXUAL DIFFERENCES.**—Apart from the different form of the endopod of the 1st pleopod (Figure 3a,b,e,f) and the presence of the appendix masculina on the endopod of the 2nd pleopod of the male (Figure 3c,d), the adult male and female differ from each other chiefly in rather subtle distinctions in the form of the carapace and rostrum. The carapace is usually proportionately larger and the dorsal profile more convex in the female (Figure 4a versus Figures 1a and 4d and Frontispiece). Also, the rostrum is sometimes curved more strongly dorsad in that sex (Figure 4c).

**VARIATION.**—The variability in the curvature and



spination of the rostrum and the fluctuation in the number of spines in each of the three principal longitudinal series on the carapace has been alluded to above. In addition, the tubercle in the dorsal midline of the anterior gastric or frontal region is not constant in distinctness or position relative to the spines in the dorsal median series; usually it is situated at the posterior base of the spine next posterior to the spine nearly in line with the margin of the orbit but it may lie midway between this spine and the one following posteriorly, or even at the posterior base of the latter spine. The variation in the number of dorsal abdominal spines is further compounded by the variable position of the boss in the dorsal midline of the 4th somite; sometimes it

is isolated between spines, sometimes surmounted posteriorly by a spine of variable length, and sometimes situated at the posterior base of a larger spine. The spination of the telson has been mentioned previously. The antennal scales are often slightly dissimilar and unequal even if not obviously injured. The chela of the 1st pereopod may or may not be armed with spines near the proximal end of the palm, and the merus of the 2nd pereopod may have a few spines on the extensor surface. In males and nonbreeding females, the abdomen is typically armed with a slender ventral spine on each somite, but this spine may be lacking on any somite or it may be double or, occasionally, triple.

**BATHYMETRIC RANGE.**—*Psalidopus barbouri* lives

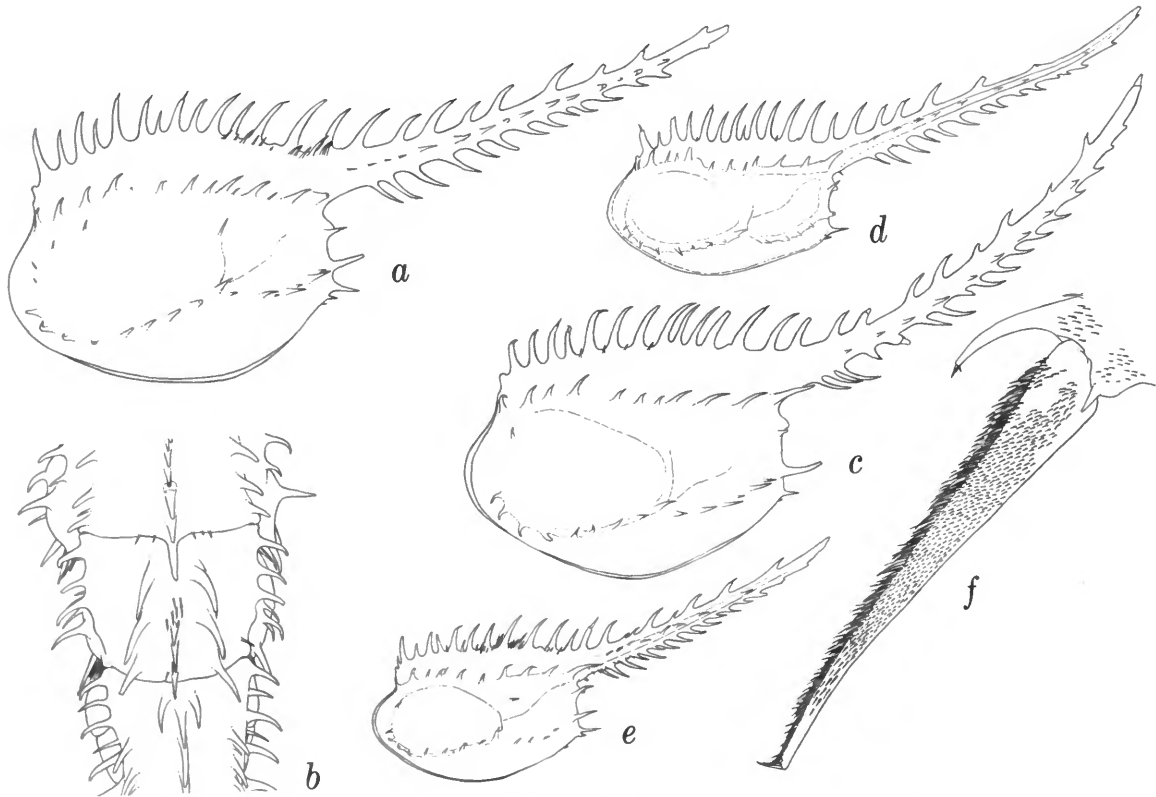


FIGURE 4.—*Psalidopus barbouri*, variation in rostrum and in spination of 5th abdominal somite and telson: *a*, ovigerous female from Oregon Sta 3635, carapace length 22.8 mm; *b*, same specimen, 5th abdominal somite, dorsal aspect; *c*, ovigerous female from same station, carapace length 21.9 mm; *d*, male from Oregon II Sta 11227, carapace length 16.2 mm; *e*, female from Oregon Sta 1932, carapace length 14.7 mm; *f*, same specimen, telson, right aspect. (Magnifications: *a*, *c*–*e*,  $\times 1.5$ ; *b*,  $\times 3$ ; *f*,  $\times 6$ .)

on the continental or insular slopes in depths of 412 to more than 750 meters. Most of the specimens (72 per cent) collected by the Fish and Wildlife Service vessels came from between 540 and 660 meters. Analysis of those collections engendered the belief that females may be found in shallower depths than males. No less than 36 females, all but 2 of them mature and 22 of them ovigerous, were taken in less than 540 meters at 9 different stations,

whereas all males in the material available to us were found below that depth. On the other hand, of the 5 males recorded by Thompson (1963:221), 1 was taken at 412 meters, 1 at 503, and 1 at 512; only 2 came from below 540 meters, so the seemingly significant data originally available to us were apparently insufficient.

**GEOGRAPHIC RANGE.**—Available records indicate that the western Atlantic species of *Psalidopus*

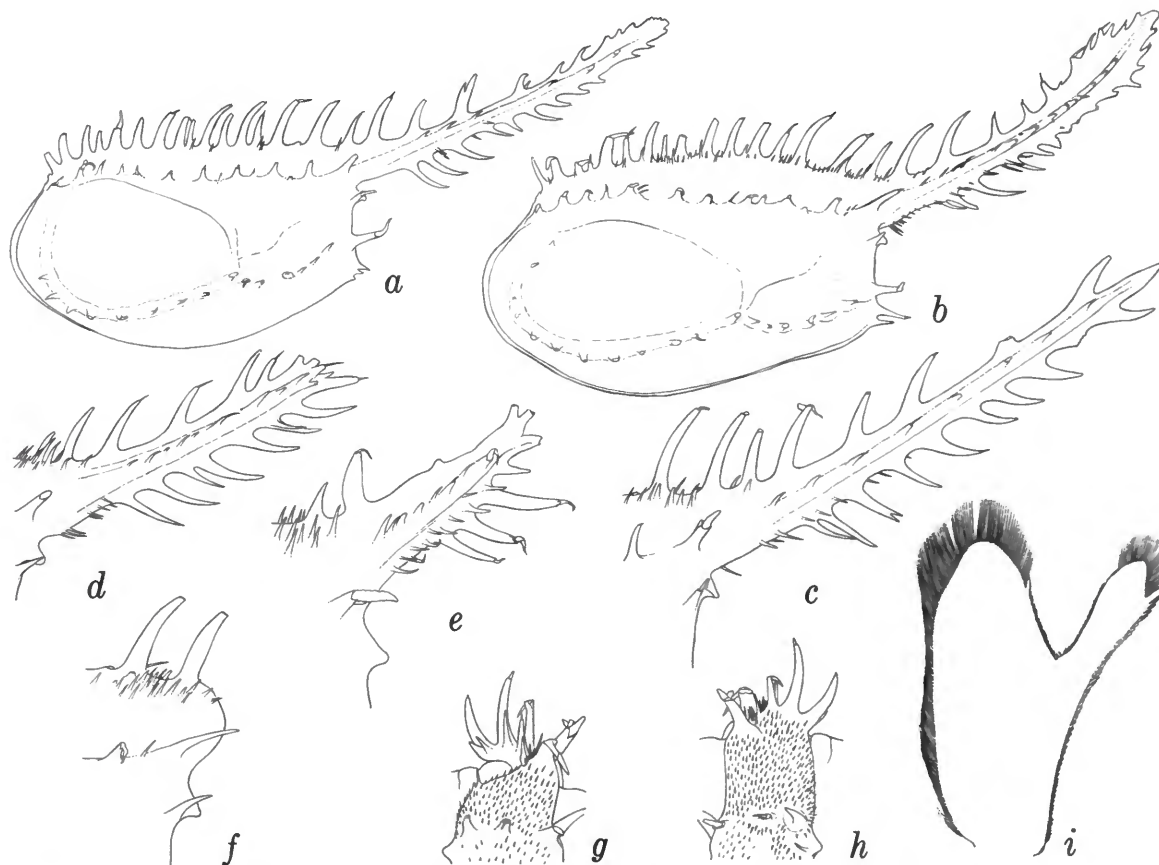


FIGURE 5.—Representative probable responses to injuries in *Psalidopus barbouri*: a, carapace and slightly deformed rostrum of male from Oregon II Sta 11303, carapace length 24.7 mm; b, carapace and deformed rostrum of ovigerous female from Oregon II Sta 11307, carapace length 27.8 mm; c, slightly foreshortened rostrum of male from Oregon II Sta 11303, carapace length 23.0; d, foreshortened rostrum of male from Oregon Sta 3635, carapace length 19.0 mm; e, stump of rostrum of ovigerous female from Oregon II Sta 11300, carapace length 29.0 mm; f, healed rostral base of ovigerous female from Oregon II Sta 11300, carapace length 26.0 mm; g, dorsum of 1st abdominal somite, right aspect, of male from Oregon Sta 4413, carapace length 22.9 mm; h, same, left aspect; i, right antennal scale, dorsal aspect, of female from Oregon Sta 3635, carapace length 25.7 mm. (Magnifications: a, b,  $\times 1.5$ ; c-i,  $\times 3$ .)

occurs on continental and insular slopes from off the east coast of Florida and the Bahamas, through the Gulf of Mexico, to the western and southern slopes of the Caribbean Sea, as well as in the Leeward Islands and perhaps southward to off Surinam (Figure 6). It seems to be especially abundant in the southwestern Caribbean from off Belize (where 38 specimens were taken in a single haul) to off western Venezuela. Thompson (1963:227) indicated that the species had been collected in Bahía de Cochinos on the south coast of Cuba and off Saint Lucia Island in the Windward Islands, but we have been unable to verify those records. Thompson also (1963:226) suggested that the record from off Surinam (*Oregon* Sta 2011) was "questionable," but that station was included without reservation in the compilation by Bullis and Thompson (1965:8).

**HABITAT AND ASSOCIATIONS.**—The available evidence suggests that *P. barbouri* lives on an often steeply sloping soft mud bottom, sometimes mixed with sand. The temperature of this environment ranges from 6.1° to 10.0° C.

Thompson (1963:237) noted that fishes of the genera *Argentina* Linnaeus, 1758; *Bembrops* Steindachner, 1877; *Chaunax* Lowe, 1846; *Chlorophthalmus* Bonaparte, 1840; *Dibranchius* Peters, 1876; and *Galeus* Rafinesque, 1810, as well as those of the families Macrouridae and Brotulidae, were commonly associated with *P. barbouri*, as were also the isopod *Bathynomus giganteus* A. Milne-Edwards, 1879; the caridean shrimps *Acanthephyra armata* A. Milne-Edwards, 1881; *Glyphocrangon alispina* Chace, 1939; and *G. spinicauda* A. Milne-Edwards, 1881; the eryonoid *Stereomastis sculpta* (Smith,

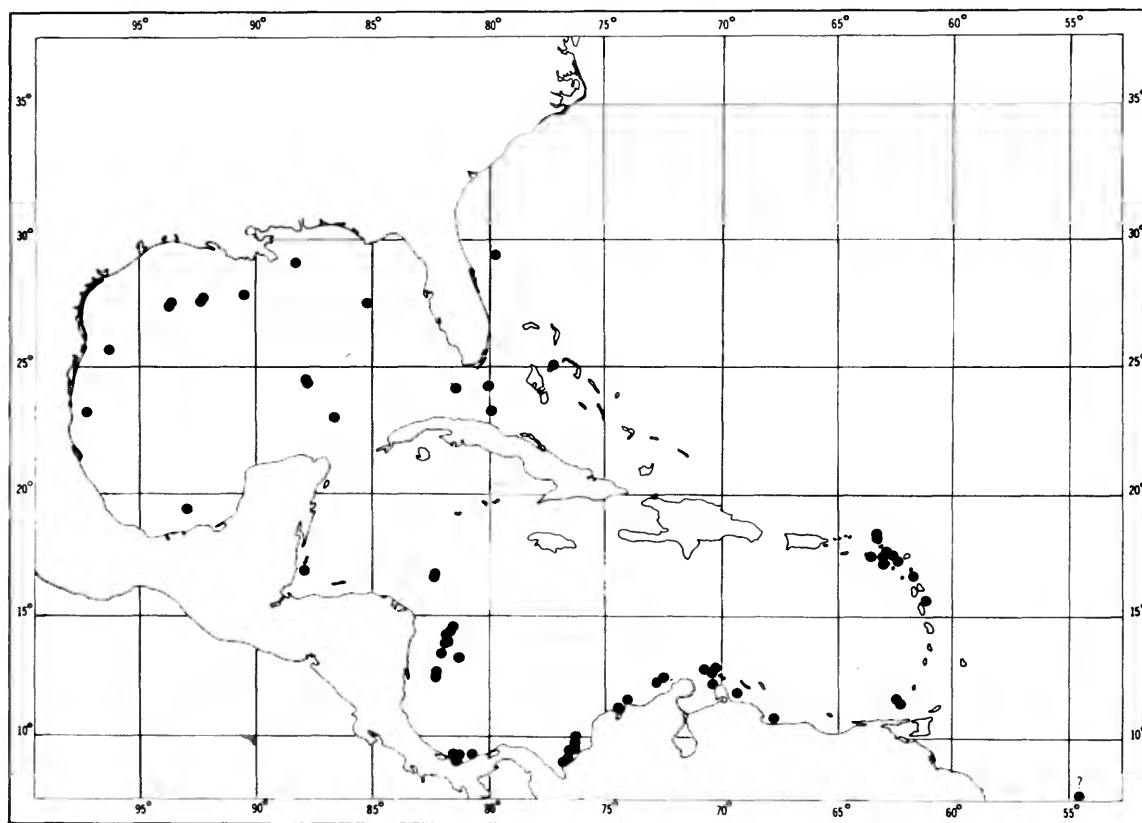


FIGURE 6.—Geographic distribution of *Psalidopus barbouri* based on material examined and other sources.

1880); and the nephropid lobster *Metanephrops binghami* (Boone, 1927).

**INJURIES AND PARASITES.**—A rather surprising number of the specimens examined display scars of battle. The most frequent point of attack seems to be the rostrum (Figures 5a-f), followed by the antennal scales (Figure 5i). There is some indication that the repair of such damage may involve a proliferation of spines (Figure 5g,h).

No obvious parasites, either branchial or abdominal were noticed on any of the specimens.

**REPRODUCTION.**—Removal of a presumably late embryo from the egg membrane revealed a larva with well-developed pleopods, but with pereopodal exopods and a deeply incised telson. It is probably referable to an advanced mysis stage. Even if this represents the larval stage at the time of hatching (and there is no certainty that it does), the species must be considered to be only slightly metamorphic, and development to the adult form is probably brief.

Documentation of the material at our disposal shows *P. barbouri* was taken by Fish and Wildlife Service vessels in every month of the year except March and July, and ovigerous females are present in collections made in each of the remaining months except January and April. Breeding-size females were taken in each of nine months, and the percentage of ovigerous specimens among them varied as follows (total number of mature females shown in parentheses): January, 0% (3); February, 50% (4); May, 79% (33); June, 70% (33); August, 80% (5); September, 86% (7); October, 60% (25); November, 77% (52); December, 93% (14). There is obviously little evidence of a breeding season in these data.

**TAXONOMY.**—It is hardly surprising that such a variable species as *P. barbouri* is not clearly distinct from its Indo-Pacific congener, *P. huxleyi*, in every instance. Nearly every character by which the species can usually be distinguished becomes less significant as more and more specimens are compared, but there is little doubt that *P. barbouri* is specifically different from the type-species of the genus. In general, the spines on the carapace and abdomen are shorter and therefore slightly stouter in Atlantic specimens, and the rostrum is usually straighter in that species. Probably the best character is the smaller number of spines (normally 0-3) in the posterior half of the antennal row in *P. barbouri*

(even though 1 specimen has 5 spines and another 6) compared with 5 to more than 10 in *P. huxleyi*. Likewise, there are few, if any, spines on the ventrolateral (submarginal) region of the carapace in *P. barbouri*, compared with 2 to more than 20 in *P. huxleyi*. The anterior and posterior tubercles in the dorsal midline of the carapace are usually less prominent in *P. barbouri*. There are generally more spines in the dorsal midline of the abdomen (5-9 on the 6th somite of *P. barbouri*, compared with 4-5 in *P. huxleyi*). In many specimens, the proportions of the antennal scale (Figure 7) provide a very useful character, the length to width ratio being generally lower in *P. barbouri*, but this ratio must be correlated with the size of the shrimp, and even then, it is not always reliable.

***Psalidopus huxleyi* Wood-Mason and  
Alcock, 1892**

FIGURES 7-13

- Psalidopus Huxleyi* Wood-Mason and Alcock, 1892:273, pl. 14: figs. 1, 2, 7 [12 km E of N Cinque Island, Andaman Sea, 896 m, 12 Apr 1888 (*Investigator* Sta 10, Agassiz trawl; see Anonymous, 1914:1): 1 ovig. female holotype (28.5)].—Alcock, 1899:31; 1901:112.—De Man, 1920:85, pl. 16: fig. 47.—Holthuis, 1955a:81.
- Psalidopus spiniventris* Wood-Mason and Alcock, 1892:274, pl. 14: figs. 3-6a, 8; pl. 15 [Andaman Sea, 11°25'05"N, 90°47'06"E (*Investigator* Sta 116, green mud, 8.3°C, 9 Dec 1890, Agassiz trawl): 1 male, 1 female, 1 juvenile, syntypes; 13 km E of Cinque Island, Andaman Sea (*Investigator* Sta 5, 914 m, 8 Dec 1887, Blake trawl): 1 male, 1 female, syntypes].—Alcock and Anderson, 1894:153.—Alcock, 1899:31; 1901:113; 1902:150, 259, 264, fig. 21.
- Psalidopus huxleyi*.—Alcock and McArdle, 1901: pl. 51: fig. 5.—Balss, 1940:113, 148, 154, fig. 197; 1955:1300.—Holthuis, 1955a: fig. 55; 1955b:215, 220.—Balss, 1957a:1540, fig. 1143; 1957b:1744.—Hemming, 1957:141, 148, 174, 179.
- Psalidopus japonensis* Kubo, 1952:91, figs. 1, 2, pl. 5 [off Daiō-zaki, Kii Hantō, 530 m, 25 Apr 1943: 1 male paratype (23), 1 female holotype (29)].

**MATERIAL EXAMINED.**—OFF SOUTHERN JAPAN. Off Shiono Misaki; 33°25'20"N, 135°36'20"E; 530-446 m; brown mud, sand, Foraminifera; 6.7°C; 29 Aug 1906; 9' Agassiz beam trawl; *Albatross* Sta 4966: 1 male (19.0) 5 females (27.2-30.5), 4 ovig. (27.2-30.5). Southwest of Koshiki Rettō; 31°39'N, 129°20'30"E; (675-743 m); 11 Aug 1906; 12' Tanner beam trawl; *Albatross* Sta 4906: 1 ovig. female (25.7). 31°39'30"N, 129°24'E; 743 m; gray *Globigerina* ooze; 5.9°C; 11 Aug 1906; 12' Tanner beam trawl; *Albatross* Sta 4907: 1 male (19.0). 31°31'N, 129°25'30"E; (780 m; gray *Globigerina* ooze, broken shells); 12 Aug 1906; 9' Agassiz beam trawl; *Albatross* Sta 4915: 1? (14.0, dry).



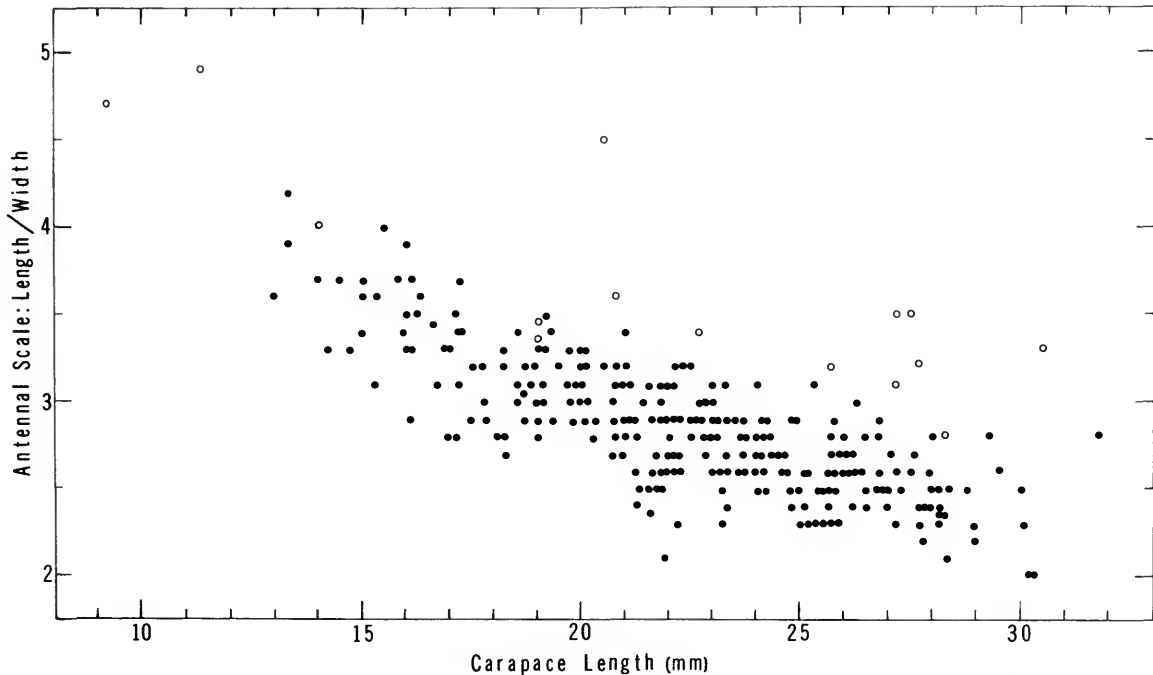


FIGURE 7.—Variability of proportions of antennal scale in *Psalidopus barbouri* (dots) and *P. huxleyi* (circles).

PHILIPPINES. Off San Bernardino Strait; 12°44'42"N, 124°59'50"E; 700 m; green mud, sand; 6.8°C; 3 Jun 1909; 12' Agassiz beam trawl; *Albatross* Sta 5445: 1 male (22.7). Palawan Passage; 10°57'45"N, 118°38'15"E; 686 m; coral, sand; 13.6°C; 27 Dec 1908; 12' Tanner beam trawl, mud bag; *Albatross* Sta 5348: 1 male (20.5) (RMNH). Sulu Sea off Cagayan Islands; 9°38'30"N, 121°11'E; 929 m; gray mud, coral sand; 9.9°C; 31 Mar 1909; 12' Agassiz beam trawl, mud bag; *Albatross* Sta 5423: 1 male (9.2) 1 female (10.3). 9°37'45"N, 121°11'E; 905 m; gray mud, coral sand; 9.7°C; 31 Mar 1909; 12' Agassiz beam trawl, mud bag; *Albatross* Sta 5425: 1 ovig. female (20.8) (RMNH).

CELEBES SEA OFF BORNEO. 4°06'50"N, 118°47'20"E; 635 m; gray mud; 6.7°C; 28 Sep 1909; 9' Tanner beam trawl, mud bag; *Albatross* Sta 5586: 1 ovig. female (27.7).

DIAGNOSIS.—Rostrum curved dorsad. Carapace with longitudinal row of spines on dorsal part of branchial region conspicuous and with numerous spines on submarginal region (ventral to sublateral row of spines). Sixth abdominal somite with 4 or 5 spines in dorsal midline. Antennal scale 2.8–4.9 (average 3.6) times as long as wide.

DESCRIPTION.—Rostrum variably ascendant, curving dorsad throughout (Figures 8a 10a, 12a,c,f,) armed with 9–15 (average 10.1+) dorsal spines,

7+–16+ (average 10.5+) ventral spines, and 10–22 (average 16.3+) lateral spines. Carapace armed with 10–14 (average 11.3) spines in dorsal midline, usually with tubercle on gastric or frontal region and near posterior margin; 5–9 (average 7.0) in anterior intermediate row; 4–8 (average 5.6) in posterior intermediate row; 1–3 (average 1.4) in anterior antennal row; 5–10+ (average 6.9) in posterior antennal row; 0–7 (average 5.1) on remainder of branchial region; 3–6 (average 4.5) in anterior sublateral row; 7–12 (average 9.3) in posterior sublateral row; and 7–36 (average 8.5) on submarginal region. Abdomen armed in dorsal midline with 2–4 (usually 3) spines on 1st somite; 4–7 (average 5.2) on 2nd; 5–8 (average 6.7) on 3rd; 5–8 (average 6.6) on 4th; 2–4 (average 2.6) on 5th; and 4–5 (average 4.5) on 6th. Telson commonly with paired series of strong dorsal spines (Figure 10c,d) but sometimes with dorsal spines little larger than setae covering dorsolateral parts of telson (Figure 8c,d).

Eyes as described above in family definition.

Antennular peduncle with stylocerite abruptly constricted to long terminal spine overreaching





FIGURE 8.—*Psalidopus huxleyi*, male from *Albatross* Sta 5445, carapace length 22.7 mm: a, carapace and rostrum, right aspect; b, 5th abdominal somite, dorsal aspect; c, telson and uropods; d, telson, right aspect; e, right antennular peduncle, dorsomesial aspect; f, right antennal peduncle and scale, ventral aspect; g, right mandible, posterior aspect; h, left 1st maxilla, oral aspect; i, right 2nd maxilla; j, right 1st maxilliped; k, right 2nd maxilliped; l, right 3rd maxilliped; m, same, distal end. (Magnifications: a,  $\times 1.5$ ; b-f, l,  $\times 3$ ; h-k,  $\times 6$ ; g, m,  $\times 12$ .)

distolateral margin of 2nd segment. Basal segment with strong spine near midlength of ventral surface, rarely with spine (Figure 8e) but usually unarmed (Figure 10e) at distolateral angle. Second and 3rd

segments subequal, armed with spines and stout setae, pair at distolateral angle of 3rd segment especially prominent. Dorsolateral flagellum about  $1\frac{2}{3}$  times as long as carapace; ventromesial flagel-



FIGURE 9.—*Psalidopus huxleyi*, male from Albatross Sta 5445, carapace length 22.7 mm: *a*, right 1st pereopod; *b*, same, fingers; *c*, right 2nd pereopod; *d*, right 3rd pereopod; *e*, same, dactyl; *f*, right 4th pereopod; *g*, same, dactyl; *h*, right 5th pereopod; *i*, same, dactyl; *j*, right 1st pleopod, posterior aspect; *k*, same, endopod; *l*, right 2nd pleopod, anterior aspect; *m*, same, appendices masculina and interna. (Magnifications: *a*, *c*, *d*, *f*, *h*, *j*, *l*,  $\times 3$ ; *b*, *e*, *g*, *i*, *k*, *m*,  $\times 12$ .)

lum more slender and nearly twice as long as carapace.

Antennal scale (Figures 8*f*, 10*f*) 2.8–5.0 times as long as wide, rarely more than 3 times as long as wide in mature individuals and more than 4 times as long as wide in juveniles (Figure 7). Basal segment of antennal peduncle armed with 3 lateral spines, dorsal one much shorter than other 2. Antennal flagellum about 15 times as long as carapace and about  $2\frac{2}{3}$  times as long as entire shrimp from tip of rostrum to end of telson.

Mandible (Figures 8*g*, 10*g*, 12*b,d,g*) with incisor process somewhat variable in width, curvature, and taper. First maxilla (Figures 8*h*, 10*h*) with about 13 marginal spines on distal  $\frac{1}{2}$  of distal lacinia; palp somewhat constricted near midlength. Second maxilla with scaphognathite slightly variable (Figures 8*i*, 10*i*, 12*e*). First maxilliped with palp varying slightly in width (Figure 8*j*, 10*j*). Second maxilliped (Figures 8*k*, 10*k*) typical of family. Third maxilliped (Figures 8*l*, 10*l*) reaching level of distal  $\frac{1}{3}$  or  $\frac{1}{4}$  of antennal scale; distal part of terminal segment



FIGURE 10.—*Psalidopus huxleyi*, male from *Albatross Sta 4966*, carapace length 19.0 mm: *a*, carapace and rostrum, right aspect; *b*, 5th abdominal somite, dorsal aspect; *c*, telson and uropods (posterior margin of telson deformed); *d*, telson, right aspect; *e*, right antennular peduncle, dorsomesial aspect; *f*, right antennal peduncle and scale, ventral aspect; *g*, right mandible, posterior aspect; *h*, right 1st maxilla, oral aspect; *i*, right 2nd maxilla; *j*, right 1st maxilliped; *k*, right 2nd maxilliped; *l*, right 3rd maxilliped; *m*, same, distal end. (Magnifications: *a*,  $\times 1.5$ ; *b-f*, *l*,  $\times 3$ ; *h-k*,  $\times 6$ ; *g*, *m*,  $\times 12$ .)

(Figures 8*m*, 10*m*) not very stout.

First pereopod (Figures 9*a,b*, 11*a*) overreaching antennal peduncle by length of fingers or slightly more. Second pereopod (Figures 9*c*, 11*b*) overreaching antennal peduncle by slightly more or less than  $\frac{1}{2}$  length of chela, not including terminal setae. Third pereopod (Figures 9*d,e*, 11*c,d*) barely reaching level of distal margin of antennal scale. Fourth pereopod (Figures 9*f,g*, 11*e,f*) reaching about as far anteriorly as 3rd pereopod. Fifth pereopod (Figures 9*h,i*, 11*g,h*) overreaching antennal scale by length of dactyl or slightly more.

Endopod of 1st pleopod of male (Figures 9*j,k*, 11*i,j*) obscurely notched but not clearly emarginate

distally. Appendix masculina (Figures 9*l,m*, 11*k,l*) rather densely spinose.

Uropods (Figures 8*c*, 10*c*) not overreaching telson. Ovigerous females bearing 45 or more eggs measuring  $3.3 \times 2.7$  mm to  $4.5 \times 3.6$  mm.

COLOR.—The fine ovigerous female from the Celebes Sea off Borneo (*Albatross Sta 5586*) is accompanied by the following label: "Antennae & last pair of legs white—rostral spine & all upward directed spinules, telson & head plates [antennal scales?] pink; eggs, swimmerets & downward directed spines pale."

The original description of *P. spiniventris* (Wood-Mason and Alcock, 1892:274) contains the follow-

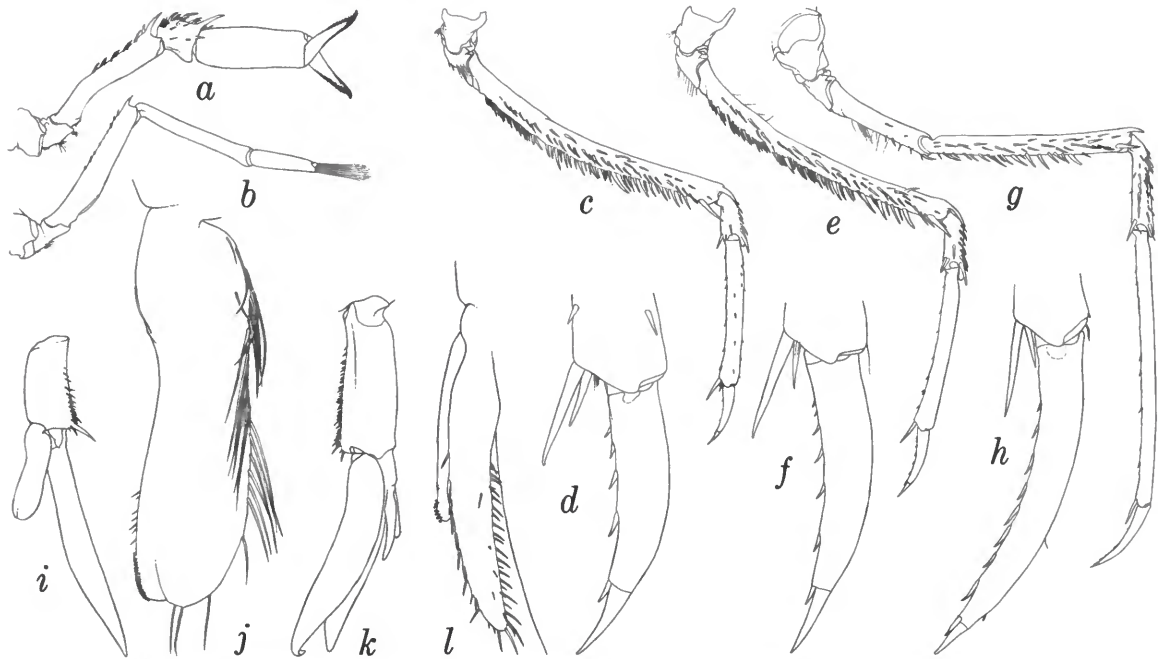


FIGURE 11.—*Psalidopus huxleyi*, male from *Albatross Sta 4966*, carapace length 19.0 mm: a, right 1st pereopod; b, right 2nd pereopod; c, right 3rd pereopod; d, same, dactyl; e, right 4th pereopod; f, same, dactyl; g, right 5th pereopod; h, same, dactyl; i, right 1st pleopod, posterior aspect; j, same, endopod; k, right 2nd pleopod, anterior aspect; l, left 2nd pleopod, appendices masculina and interna, anterior aspect. (Magnifications: a-c, e, g, i, k,  $\times 3$ ; d, f, h, j, l,  $\times 12$ .)

ing: "Colour in life 'more of a boiled lobster tint' [i.e., than other crustaceans obtained at the same time and described in the same notes as pink and blood-red], 'deepest on the spines' (*G. M. Giles*)." Yet Alcock (1901:113) stated about *P. spiniventris*, "Colour in life, pink with white points," a description more easily reconciled with that of the *Albatross* specimen.

**SIZE.**—Carapace lengths of males, 9.2–22.7 mm; of females without eggs, 10.3–28.5 mm; of ovigerous females, 20.8–30.5 mm.

**SEXUAL DIFFERENCES.**—The distinctions noted in *P. barbouri* seem generally to hold true also for *P. huxleyi*.

**VARIATIONS.**—This species, like *P. barbouri*, is so variable that serious consideration was given to the possibility of recognizing more than 1 Indo-West Pacific species. The form depicted in Figures 8 and 9 seemed to be distinguished from the one illus-

trated in Figures 10 and 11 by the absence of enlarged spinules on the branchial region, the absence of paired rows of prominent dorsal spines on the telson, a distinct lateral spine on the basal antennular segment at its articulation with the 2nd segment, the incisor process of the mandible more slender and without any indication of a subdistal lobe, and the scaphognathite of the 2nd maxilla differently shaped. Subsequent study, however, revealed that there is no correlation between the absence of spines on the branchial region and any of the other characters; there is considerable disparity in the development of the dorsal spines on the telson, a variability that is reflected in *P. barbouri*; the antennular spine is present only on the right side of the specimen shown in Figure 8, although it occurs on both sides of two other specimens (unlike *P. barbouri*, in which it has not been seen); and the differences in the mandible and 2nd



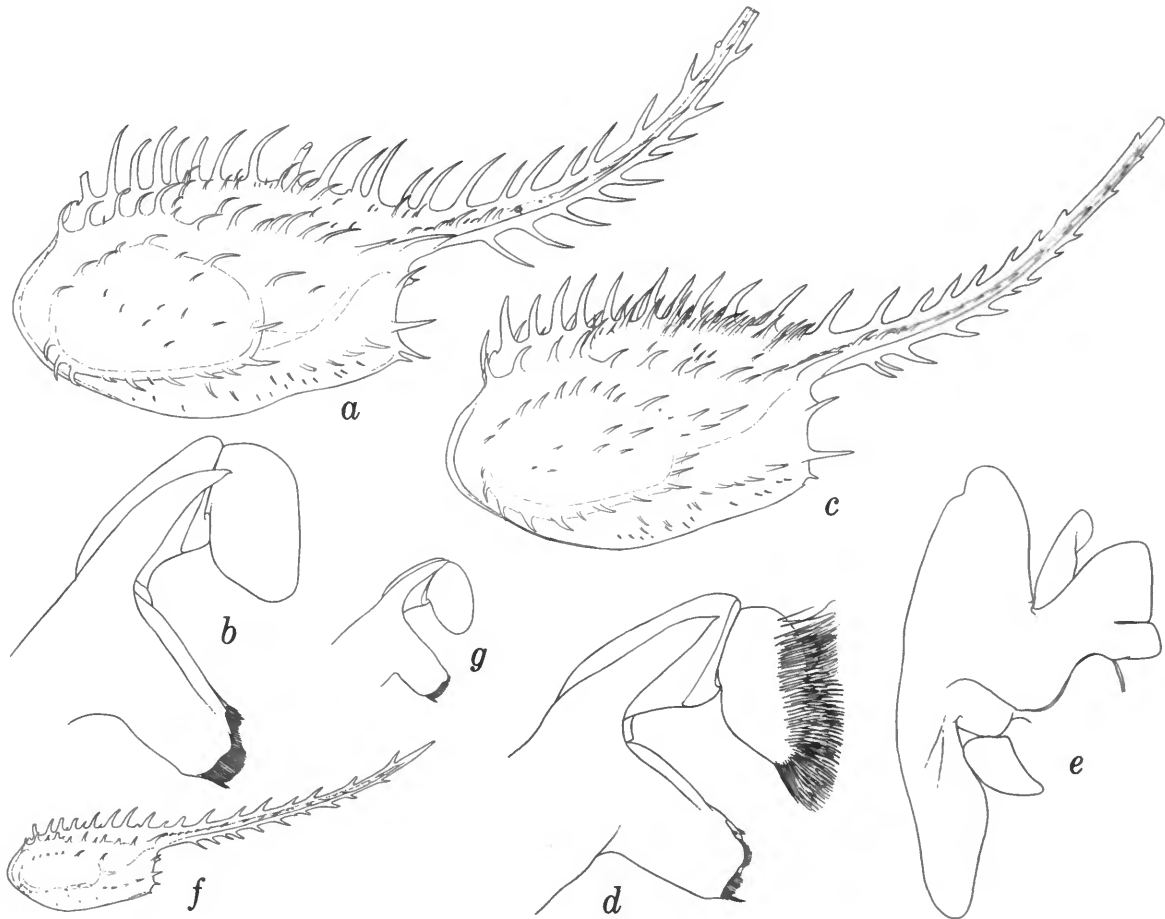


FIGURE 12.—*Psalidopus huxleyi*, representative examples showing lack of correlation between spination on carapace and configuration of mouthparts (cf. Figure 8): *a*, ovigerous female from Albatross Sta 5586, carapace length 27.7 mm; *b*, same specimen, right mandible, posterior aspect; *c*, ovigerous female from Albatross Sta 4906, carapace length 25.7 mm; *d*, same specimen, right mandible, posterior aspect; *e*, same specimen, right 2nd maxilla; *f*, female from Albatross Sta 5423, carapace length 10.3 mm; *g*, same specimen, right mandible, posterior aspect. (Magnifications: *a*, *c*, *f*,  $\times 1.5$ ; *e*,  $\times 6$ ; *b*, *d*, *g*,  $\times 12$ .)

maxilla seem to fall within the limits of variability of 1 species.

**BATHYMETRIC RANGE.**—Like *P. barbouri*, *P. huxleyi* frequents continental and insular slopes but often at greater depths than does the Atlantic species. The material recorded here and that reported previously was taken at reasonably regular intervals from less than 530 to 929 meters, with 1 record of 1,163 meters. There seems to be no correlation of sex with depth in any of these collections.

**GEOGRAPHIC RANGE.**—Records now available indicate that *P. huxleyi* occurs in rather widely separated localities of the Indian Ocean: the Laccadive Sea, off southern India, the Andaman Sea, and the Timor Sea. It has also been found in the western North Pacific Ocean from off southern Japan to the Philippines, the Sulu Sea, and the Celebes Sea (Figure 13). Although there are far fewer records of *P. huxleyi* than of *P. barbouri*, the range of the Indo-Pacific species (nearly 45° of latitude and more



than  $62^{\circ}$  of longitude) is considerably greater than that of the Atlantic one (less than  $22^{\circ}$  of latitude and  $43^{\circ}$  of longitude).

**HABITAT AND ASSOCIATIONS.**—The *Albatross* records suggest that the species frequents sometimes steeply sloping bottoms of various compositions and consistencies, such as brown, green, and gray mud or *Globigerina* ooze, occasionally mixed with coral, coral sand, Foraminifera, or broken shells, at bottom temperatures of  $5.9^{\circ}$  to  $13.6^{\circ}$  C.

No information on the associated fauna is readily available.

**INJURIES AND PARASITES.**—In the small male from *Albatross* Station 5423, the rostrum is foreshortened because of injury, but none of the other specimens examined display any of the malformations that were rather frequent in the collections of *P. barbouri*.

No parasites were noticed on any of the specimens.

**REPRODUCTION.**—The size and number of eggs is comparable with those of the western Atlantic species. It seems probable, therefore, that *P. huxleyi* is only slightly metamorphic and that the larval period is brief.

The ovigerous female holotype of the species was taken in April, and the *Albatross* obtained ovigerous specimens in March, August, and September. Five of the 7 egg-bearing specimens were taken in August off southern Japan; it was also in that month that the only mature female without eggs was found.

**TAXONOMY.**—As noted under "Variation," we weighed the possibility that *P. spiniventris*, *P. japonensis*, or even an undescribed species might be represented in the Japanese and Philippine material available to us, but there seemed to be no taxonomic significance to the variability encountered. The evidence offered by the series of *P. barbouri* showed quite convincingly that the presence

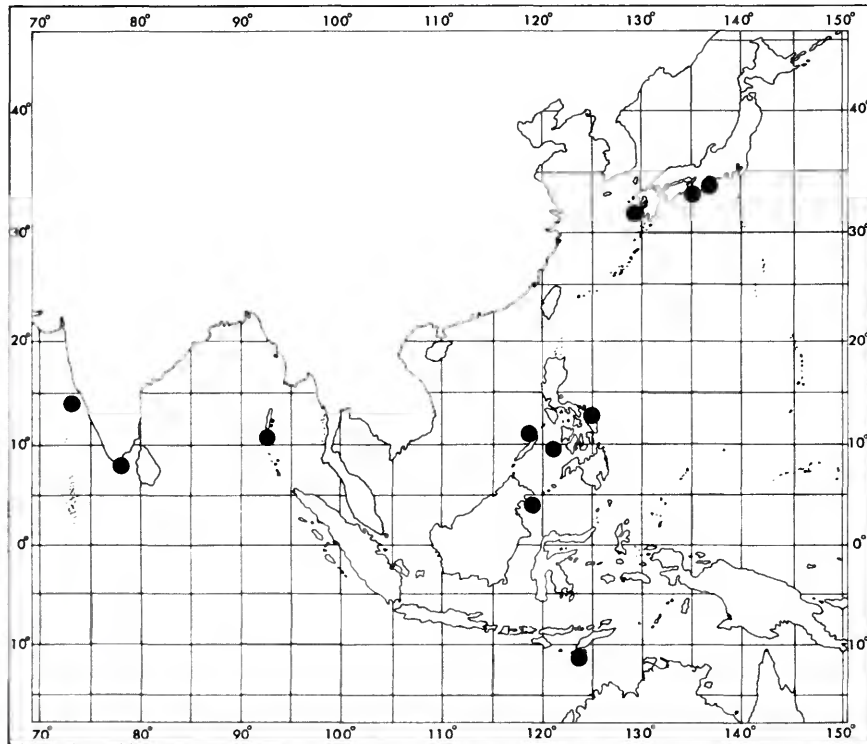


FIGURE 13.—Geographic distribution of *Psalidopus huxleyi* based on material examined and other records.

of ventral abdominal spines—the principal diagnostic character of *P. spiniventris*—is confined to males and nonbreeding females in this genus. The curvature of the rostrum, the number of median spines on the carapace, and the spination of the telson—supposedly distinctive features of *P. japonensis* according to Kubo (1952:96)—are variable, and Kubo's photograph (Plate 5) suggests the possibility that the telson of the holotype of that species is deformed, which might account for its shortness relative to the uropods.

For comments on the relationship between *P. huxleyi* and *P. barbouri*, see "Taxonomy" under the latter species.

#### The Chelae of *Psalidopus*

Few major animal groups display more diverse features of interest to students of evolutionary principles than the Crustacea, and perhaps none are more challenging than is the development of the claw borne on the 1st pereopod of *Psalidopus*. The

palm of this chela is filled with a massive combination of muscles attached to the adductor tendon (Figure 14a). The latter consists of a broad, transversely sinuous fin set perpendicular to the plane of action of the fingers, with a secondary fin arising at right angles, but in different planes, from each surface of the primary fin (Figure 14e). The broad distal end of the primary fin (Figure 14d) is attached to the proximal opposable angles of both the conventionally articulated dactyl and what would normally be the propodal extension that forms the immovable finger in a typical chela. In *Psalidopus*, the latter is hinged at the juncture with the palm opposite the attachment of the tendon; it lacks the lateral condyles by which the dactyl is articulated to the propodus and is attached to the palm by only a rather extensive articulating membrane (Figure 14c). There is a single, abductor tendon attached to the base of the dactyl peripheral to the condyles. Inasmuch as both fingers are attached to the adductor tendon, abduction of the dactyl similarly activates the other finger. Possibly because of the complex coupling between the ad-

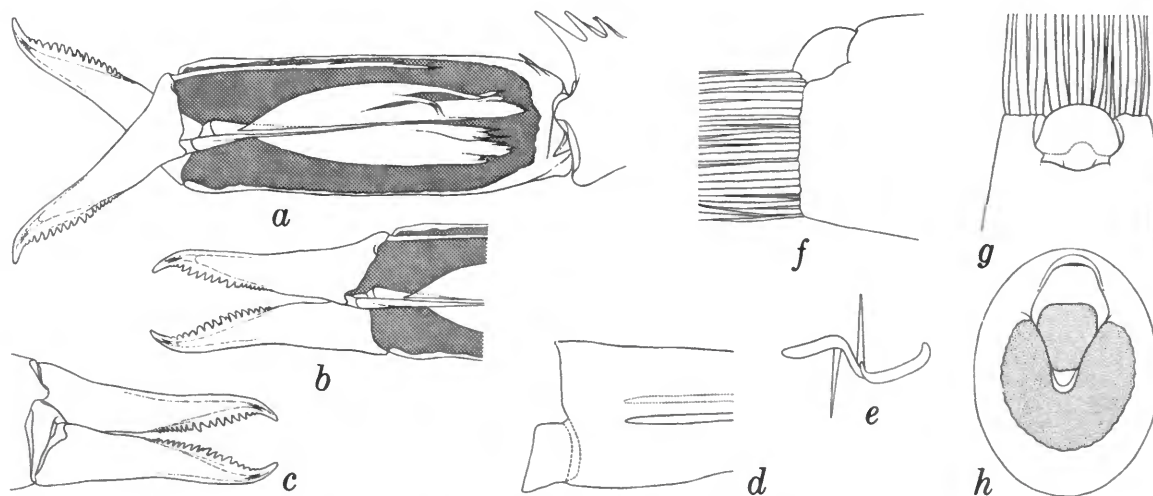


FIGURE 14.—Structure of chelae of 2 anterior pairs of pereopods in *Psalidopus barbouri*: a, lateral aspect of tendons, with fingers closed, in palm of chela of 1st pereopod of ovigerous female from Oregon II Sta 10825, carapace length 31.8 mm; b, same, fingers opened nearly to maximum limit; c, same, mesial aspect; d, same, "dorsal" aspect of distal end of adductor tendon; e, semi-diagrammatic aspect from distal end of adductor tendon, showing median "dorsal" and offset "ventral" fins; f, distal end of chela of left 2nd pereopod of same specimen, lateral aspect; g, same, dorsal aspect; h, same, distal surface, stippling denotes areas from which long setae were removed. (Magnifications: a-c,  $\times 6$ ; d, e,  $\times 12$ ; f-h,  $\times 25$ .)

ductor tendon and the 2 fingers, the latter appear to move proportional distances through identical arcs (Figure 14*b*), even though the position of the fulcrum is different for each finger.

The degenerate chela of the 2nd pereopod (Figure 14*f-h*) departs perhaps even farther from the conventional prototype claw but its evolutionary development can be conjectured more confidently than can that of the 1st pereopod. The dactyl is reduced to a vestige that is apparently no longer able to function as a movable finger. The distal ends of both the dactyl and the prolongation of the propodus that usually forms the fixed finger are squared off to form a transverse, common, flat plane from which arise numerous long, wiry setae.

As taxonomists and descriptive zoologists, we feel no obligation to speculate about the functions of the unique appendicular equipment of *Psalidopus* but we cannot resist the temptation to suggest a possible interpretation. Inasmuch as the fingers of the 1st pereopod cannot be opened widely and as the maximum muscular force would seem to be available when the fingers are crossed, is it possible that this appendage may not be used as a conventional grasping tool? As an alternative, is there a possibility that the chela is used to probe tubes or burrows or even the apparently undisturbed substrate with the fingers nearly extended and is then withdrawn with the fingers flexed, thereby producing a "sawing action" that might assist in dislodging the shrimp's prey? The 2nd pereopod would seem to serve better as a brush, as proposed by Thompson (1963:236), then as a sensory organ

to compensate in part for the degenerate eyes, as suggested by Alcock (1902:150), but it may perform a more specialized function than as a mere whisk to remove mud from the shrimp or its food. Might not this appendage be used to gather particulate matter, possibly made available by the action of the 1st pereopod, and the setal tufts then cleaned by the mouthparts, much as are the setae of filter-feeding decapods?

If the discovery by Thompson (1963:229) of "bits of muscular tissue, apparently from large organisms . . . in the stomach cavity and oral cavity" of *Psalidopus barbouri* is indicative of the normal diet of this shrimp, our explanation is probably incorrect. We are not sure, however, that food obtained from the smorgasbord contained in a trawl necessarily reflects customary feeding habits. On the other hand, Thompson's mention of "several unidentifiable crustacean eggs" in the stomach of one specimen engenders fanciful thoughts about how well equipped *Psalidopus* is to tear apart and retrieve the resulting fragments of egg masses attached to some of its caridean associates!

Such idle conjecture can hardly be defended except as cerebral stimulation or to make possible an "I told you so award" for the eventual deductive champion. Now that *Psalidopus* is known to be more common than previously believed, there should be comparatively little further delay in observing these shrimps, either in their natural habitat or in the laboratory, and watching them manipulate their extraordinary implements as only they now know how to do.

## Literature Cited

- Alcock, A.  
 1899. A Summary of the Deep-sea Zoological Work of the Royal Indian Marine Survey Ship *Investigator* from 1884 to 1897. *Scientific Memoirs by Officers of the Medical and Sanitary Departments of the Government of India*, 11:1-49.  
 1901. *A Descriptive Catalogue of the Indian Deep-sea Crustacea Decapoda Macrura and Anomala, in the Indian Museum: Being a Revised Account of the Deep-sea Species Collected by the Royal Indian Marine Survey Ship Investigator*. Pages 1-286, i-iv, plates 1-3. Calcutta: Indian Museum.  
 1902. *A Naturalist in Indian Seas or, Four Years with the Royal Indian Marine Survey Ship "Investigator."* xxiv + 329 pages, 98 figures, 1 map. London: John Murray.
- Alcock, A., and A. R. Anderson  
 1894. An Account of a Recent Collection of Deep Sea Crustacea from the Bay of Bengal and Laccadive Sea, Series II: No. 14 of Natural History Notes from H. M. Indian Marine Survey Steamer 'Investigator,' Commander C. F. Oldham, R. N., Commanding. *Journal, Asiatic Society of Bengal*, 63(II,3):141-185, plate 9.
- Alcock, A., and A. F. McArdle  
 1901. *Illustrations of the Zoology of the Royal Indian Marine Survey Ship Investigator, under the Command of Commander T. H. Heming, R. N.: Crustacea*. Volume 9, plates 49-55.
- Anonymous  
 1914. *Biological Collections of the R.I.M.S. "Investigator." List of Stations, 1884-1913*. 2 unnumbered + 35 pages. Calcutta: Indian Museum.
- Balss, H.  
 1940. Decapoda, III: Morphologischer Teil. Pages 22-160 in book 7 in part 1 in volume 5 in H. G. Bronn's *Klassen und Ordnungen des Tierreichs*. Figures 7-205.  
 1955. Decapoda, VI: Ökologie. Pages 1285-1367 in number 10 in book 7 in part 1 in volume 5 in H. G. Bronn's *Klassen und Ordnungen des Tierreichs*. Figures 1043-1069.  
 1957a. Decapoda, VIII: Systematik. Pages 1505-1672 in number 12 in book 7 in part 1 in volume 5 in H. G. Bronn's *Klassen und Ordnungen Tierreichs*. Figures 1131-1199.  
 1957b. Decapoda, IX: Geographische Verbreitung. Pages 1673-1770 in number 13 in book 7 in part 1 in volume 5 in H. G. Bronn's *Klassen und Ordnungen des Tierreichs*. Figures 1200-1212.
- Bullis, H. R., Jr., and J. R. Thompson  
 1965. Collections by the Exploratory Fishing Vessels *Oregon, Silver Bay, Combat, and Pelican Made* during 1956 to 1960 in the Southwestern North Atlantic. *United States Fish and Wildlife Service Special Scientific Report—Fisheries*, 510: 130 pages.
- Chace, F. A., Jr.  
 1939. Preliminary Descriptions of One New Genus and Seventeen New Species of Decapod and Stomatopod Crustacea. In Reports on the Scientific Results of the First *Atlantis* Expedition to the West Indies, under the Joint Auspices of the University of Havana and Harvard University. *Memorias de la Sociedad Cubana de Historia Natural*, 13(1):31-54.
- Hemming, F.  
 1957. Opinion 470: Addition to the "Official List of Generic Names in Zoology" of the Names of One Hundred and Two Genera of Caridea (Class Crustacea, Order Decapoda) and Use of the Plenary Powers for Various Purposes in Connection Therewith. *Opinions and Declarations Rendered by the International Commission on Zoological Nomenclature*, 16(9):129-202.
- Holthuis, L. B.  
 1955a. The Recent Genera of the Caridean and Stenopodidean Shrimps (Class Crustacea, Order Decapoda, Supersection Natantia) with Keys for Their Determination. *Zoologische Verhandelingen Uitgegeven door het Rijksmuseum van Natuurlijke Historie te Leiden*, 26: 157 pages, 105 figures.  
 1955b. Proposed Addition to the "Official List of Generic Names in Zoology" of the Names of One Hundred and Two Genera of Caridea (Class Crustacea, Order Decapoda), Including Proposals for the Use of the Plenary Powers (a) to Validate the Emendation to "Gnathophyllum" of the Generic Name "Gnathophyllum" Latreille, 1814, and (b) to Validate the Family-Group Names "Hippolytidae" Bate, 1888 and "Eugonatonotidae" Chace, 1937. *Bulletin of Zoological Nomenclature*, 11(7):204-228.  
 1971. The Atlantic Shrimps of the Deep-sea Genus *Glyphocrangon* A. Milne Edwards, 1881. *Bulletin of Marine Science*, 21(1):267-373, figures 1-15.
- Kubo, I.  
 1952. On Two Rare Species of Psalidopodidae and Ne-phropsidae. *Journal of the Tokyo University of Fisheries*, 39(1):91-100, 3 figures, 2 plates.
- Man, J. G., de  
 1920. The Decapoda of the *Siboga* Expedition, VI: Families Pasiphaeidae, Stylodactylidae, Hoplophoridae, Nematocarcinidae, Thalassocaridae, Pandalidae, Psalidopodidae, Gnathophyllidae, Processidae, Glyphocrangonidae and Crangonidae. *Siboga-Expeditie*, 39a:1-318, plates 1-25.

Thompson, J. R.

1963. *The Bathyalbenthic Caridean Shrimps of the Southwestern North Atlantic*. xii + 502 pages. Unpublished dissertation, Duke University.

Wood-Mason, J., and A. Alcock.

1892. On the Results of Deep-sea Dredging during the

Season 1890-91. Series II, No. 1 of Natural History Notes from H. M. Indian Marine Survey Steamer 'Investigator,' Commander R. F. Hoskyn, R. N., Commanding. *Annals and Magazine of Natural History*, (6)9:265-275, plates 14, 15.







## REQUIREMENTS FOR SMITHSONIAN SERIES PUBLICATION

**Manuscripts** intended for series publication receive substantive review within their originating Smithsonian museums or offices and are submitted to the Smithsonian Institution Press with approval of the appropriate museum authority on Form SI-36. Requests for special treatment—use of color, foldouts, casebound covers, etc.—require, on the same form, the added approval of designated committees or museum directors.

**Review** of manuscripts and art by the Press for requirements of series format and style, completeness and clarity of copy, and arrangement of all material, as outlined below, will govern, within the judgment of the Press, acceptance or rejection of the manuscripts and art.

**Copy** must be typewritten, double-spaced, on one side of standard white bond paper, with 1¼" margins, submitted as ribbon copy (not carbon or xerox), in loose sheets (not stapled or bound), and accompanied by original art. Minimum acceptable length is 30 pages.

**Front matter** (preceding the text) should include: title page with only title and author and no other information, **abstract page** with author/title/series/etc., following the established format, **table of contents** with indents reflecting the heads and structure of the paper.

**First page of text** should carry the title and author at the top of the page and an unnumbered footnote at the bottom consisting of author's name and professional mailing address.

**Center heads** of whatever level should be typed with initial caps of major words, with extra space above and below the head, but with no other preparation (such as all caps or underline). Run-in paragraph heads should use period/dashes or colons as necessary.

**Tabulations** within text (lists of data, often in parallel columns) can be typed on the text page where they occur, but they should not contain rules or formal, numbered table heads.

**Formal tables** (numbered, with table heads, boxheads, stubs, rules) should be submitted as camera copy, but the author must contact the series section of the Press for editorial attention and preparation assistance before final typing of this matter.

**Taxonomic keys** in natural history papers should use the aligned-couplet form in the zoology and paleobiology series and the multi-level indent form in the botany series. If cross-referencing is required between key and text, do not include page references within the key, but number the keyed-out taxa with their corresponding heads in the text.

**Synonymy** in the zoology and paleobiology series must use the short form (taxon, author, year:page), with a full reference at the end of the paper under "Literature Cited." For the botany series, the long form (taxon, author, abbreviated journal or book title, volume, page, year, with no reference in the "Literature Cited") is optional.

**Footnotes**, when few in number, whether annotative or bibliographic, should be typed at the bottom of the text page on which the reference occurs. Extensive notes must appear at the end of the text in a notes section. If bibliographic footnotes are required, use the short form (author/brief title/page) with the full reference in the bibliography.

**Text-reference system** (author/year/page within the text, with the full reference in a "Literature Cited" at the end of the text) must be used in place of bibliographic footnotes in all scientific series and is strongly recommended in the history and technology series: "(Jones, 1910:122)" or ". . . Jones (1910:122)."

**Bibliography**, depending upon use, is termed "References," "Selected References," or "Literature Cited." Spell out book, journal, and article titles, using initial caps in all major words. For capitalization of titles in foreign languages, follow the national practice of each language. Underline (for italics) book and journal titles. Use the colon-parentheses system for volume/number/page citations: "10(2):5-9." For alinement and arrangement of elements, follow the format of the series for which the manuscript is intended.

**Legends** for illustrations must not be attached to the art nor included within the text but must be submitted at the end of the manuscript—with as many legends typed, double-spaced, to a page as convenient.

**Illustrations** must not be included within the manuscript but must be submitted separately as original art (not copies). All illustrations (photographs, line drawings, maps, etc.) can be intermixed throughout the printed text. They should be termed **Figures** and should be numbered consecutively. If several "figures" are treated as components of a single larger figure, they should be designated by lowercase italic letters (underlined in copy) on the illustration, in the legend, and in text references: "Figure 9<sub>b</sub>." If illustrations are intended to be printed separately on coated stock following the text, they should be termed **Plates** and any components should be lettered as in figures: "Plate 9<sub>b</sub>." Keys to any symbols within an illustration should appear on the art and not in the legend.

**A few points of style:** (1) Do not use periods after such abbreviations as "mm, ft, yds, USNM, NNE, AM, BC." (2) Use hyphens in spelled-out fractions: "two-thirds." (3) Spell out numbers "one" through "nine" in expository text, but use numerals in all other cases if possible. (4) Use the metric system of measurement, where possible, instead of the English system. (5) Use the decimal system, where possible, in place of fractions. (6) Use day/month/year sequence for dates: "9 April 1976." (7) For months in tabular listings or data sections, use three-letter abbreviations with no periods: "Jan, Mar, Jun," etc.

**Arrange and paginate sequentially EVERY sheet** of manuscript—including ALL front matter and ALL legends, etc., at the back of the text—in the following order: (1) title page, (2) abstract, (3) table of contents, (4) foreword and/or preface, (5) text, (6) appendixes, (7) notes, (8) glossary, (9) bibliography, (10) index, (11) legends.



