

Synopses of the Indo-West-Pacific  
Species of *Lysiosquilla* Dana, 1852  
(Crustacea: Stomatopoda:  
Lysiosquillidae)

RAYMOND B. MANNING

## 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 259

Synopses of the Indo-West-Pacific  
Species of *Lysiosquilla* Dana, 1852  
(Crustacea: Stomatopoda: Lysiosquillidae)

*Raymond B. Manning*



SMITHSONIAN INSTITUTION PRESS

City of Washington

1978

## ABSTRACT

Manning, Raymond B. Synopses of the Indo-West-Pacific Species of *Lysiosquilla* Dana, 1852 (Crustacea: Stomatopoda: Lysiosquillidae). *Smithsonian Contributions to Zoology*, number 259, 16 pages, 13 figures, 1978.—The five species of *Lysiosquilla* from the Indo-West-Pacific region are characterized. Two previously known species, *L. maculata* (Fabricius) and *L. sulcirostris* Kemp, and a new species, *L. sulcata*, are described and illustrated. Comparative diagnoses and sketches are provided for these species as well as for *L. capensis* Hansen and *L. tredecimdentata* Holthuis.

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

Manning, Raymond B. 1934—

Synopses of the Indo-West-Pacific species of *Lysiosquilla* Dana, 1852.

(Smithsonian contributions to zoology ; no. 259)

Bibliography: p.

1. *Lysiosquilla*. 2. Crustacea—Classification. 3. Crustacea—Indian Ocean. 4. Crustacea—Pacific Ocean. I. Title. II. Series: Smithsonian Institution. Smithsonian contributions to zoology ; no. 259.

QL1.S54 no. 259 [QL444.M375] 591'08s [595'.382] 77-10934

## Contents

	<i>Page</i>
Introduction .....	1
Key to Indo-West-Pacific Species of <i>Lysiosquilla</i> .....	2
<i>Lysiosquilla capensis</i> Hansen, 1895 .....	3
<i>Lysiosquilla maculata</i> (Fabricius, 1793) .....	3
<i>Lysiosquilla sulcata</i> , new species .....	7
<i>Lysiosquilla sulcirostris</i> Kemp, 1913 .....	11
<i>Lysiosquilla tredecimdentata</i> Holthuis, 1941 .....	13
Literature Cited .....	16



# Synopses of the Indo-West-Pacific Species of *Lysiosquilla* Dana, 1852 (Crustacea: Stomatopoda: Lysiosquillidae)

*Raymond B. Manning*

## Introduction

The pantropical stomatopod genus *Lysiosquilla*, which includes the largest known stomatopods, now comprises 12 species, five of which occur only in the Indo-West-Pacific region. Two of the five, *L. capensis* Hansen and *L. tredecimdentata* Holthuis, have been redescribed in recent papers (Manning, 1969 and 1968, respectively). Two other previously known species, *L. maculata* (Fabricius) and *L. sulcirostris* Kemp, are redescribed below, and the fifth is named below.

*Lysiosquilla maculata*, the largest and the most common species in the Indo-West-Pacific region, has never been characterized adequately. The most complete account, that by Kemp (1913), was based on specimens of both *L. maculata* and *L. tredecimdentata*. It seems likely that many of the references to *L. maculata*, summarized in Holthuis (1967), apply to one or more of the other species reported herein. For this reason the ranges of most of the species included in this study cannot be determined with any precision and all references to *L. maculata* in the literature require verification. The synonymies compiled by Holthuis (1967) have not been duplicated here, but are referred to along with references to the original description and other selected ones.

Differential diagnoses and stylized comparative

outline drawings (Figures 9–13) of diagnostic features of the five Indo-West-Pacific species of *Lysiosquilla* are included, supplementing the more complete accounts of *L. maculata*, *L. sulcirostris*, and *L. sulcata*, new species. The stylized outline drawings, patterned after those introduced by Hobbs (1974) for crayfishes, should simplify identification of these members of the Indo-West-Pacific stomatopod fauna.

Several simple diagnostic characters for *Lysiosquilla* apparently have not been used in the past. The shape and pigmentation of the antennal scale can be determined readily: it is slender (Figures 11a, 12a, 13a) and outlined by dark pigment or with the surface covered with dark chromatophores in *L. capensis*, *L. sulcirostris*, and *L. tredecimdentata*, broadly oval (Figures 9a, 10a) with an irregular surface spot in *L. maculata* and *L. sulcata*, new species. In the three species with a slender antennal scale, there is a sharp, fixed anterior projection on the protopod above the articulation of the antennal peduncle (Figures 11a, 12a, 13a); those species with a broad antennal scale lack this projection. The fixed projection should not be confused with the supple antennal papillae found in all members of this genus. Finally, the presence of dark pigment on the apex of the uropodal endopod has proved to be a reliable specific character.

Sexual dimorphism, affecting primarily the size and number of teeth on the claw of adult females, has been documented for two of the Indo-West-

---

*Raymond B. Manning, Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D. C. 20560.*

Pacific species and may well occur in all species. Kemp (1913) and Bigelow (1931), among others, have reported on dimorphism in *L. maculata*, and Serène (1954) noted it on *L. sulcirostris*. In adult females the claw is smaller than in males, the size and number of teeth on the claw are reduced, and the carpus and propodus may be ornamented with numerous simple setae.

Accounts of the postlarval forms of *L. maculata* and *L. sulcirostris* from India were published by Alikunhi (1967). As noted below under the account of *L. tredecimdentata*, Alikunhi may have been dealing with that species rather than *L. maculata*. Furthermore, it is not certain from his account whether his observations were based upon *L. sulcirostris* or upon *L. sulcata*, both of which, as adults, have less than 10 teeth on the dactylus of the claw. Michel (1970) recorded the occurrence of larvae and postlarvae of three distinct species of *Lysiosquilla* from the central Pacific, one similar to *L. capensis* (not known outside of South African waters), one like *L. maculata*, and one resembling *L. sulcirostris*. It seems likely that additional species of *Lysiosquilla*, possibly from deeper water, will be found in the future in the Indo-West-Pacific region.

Measurements and terms used in the accounts have been explained in earlier papers (Manning, 1968, 1969). All measurements are in millimeters (mm). Total length (TL) is measured on the midline from the anterior margin of the rostral plate to the posterior median margin of the telson.

The following abbreviations are used to designate repositories:

BMNH	British Museum (Natural History), London
MNHNP	Muséum National d'Histoire Naturelle, Paris
NMV	Naturhistorisches Museum, Vienna
RMNH	Rijksmuseum van Natuurlijke Historie, Leiden
SMF	Natur-Museum und Forschungsinstitut Senckenberg, Frankfurt am Main

USNM	National Museum of Natural History, Smithsonian Institution, Washington (formerly United States National Museum)
ZMB	Zoologisches Museum an der Humboldt- Universität zu Berlin, Berlin
ZSI	Zoological Survey of India, Calcutta

ACKNOWLEDGMENTS.—I thank B. Campbell, Queensland Museum, Brisbane, for lending the holotype of *L. miersii* De Vis; J. Forest, Muséum National d'Histoire Naturelle, Paris, for providing working space there in 1971 and for the subsequent loan of material; H.-E. Gruner and G. Hartmann, Zoologisches Museum, Berlin, for providing working space in 1971; L. B. Holthuis, Rijksmuseum van Natuurlijke Historie, Leiden, for many kindnesses, including numerous loans, providing working space on several visits, and for discussions; R. W. Ingle, British Museum (Natural History), for loans and for arranging accommodations and access to the collections there on several visits; G. Pretzmann, Naturhistorisches Museum, Vienna, for loans and for arranging accommodations and access to the collections in 1971; K. K. Tiwari, Zoological Survey of India, for his help during a visit to Calcutta in 1972; M. Türkay and the late R. Bott, Natur-Museum und Forschungsinstitut Senckenberg, for loans and for arranging accommodations and working space in 1971; and Torben Wolff, Universitetets Zoologiske Museum, who provided working space in 1971.

Part of this study, including visits to European Museums in 1971, was supported by the Smithsonian Institution through its Research Awards Program. The visit to the Zoological Survey of India in 1972 was supported by the Foreign Currency Program of the Smithsonian. All of the illustrations were prepared by my wife Lilly.

I thank Cynthia Hemming and Anne Cohen for reading a rough draft of the manuscript and for checking references. Horton H. Hobbs, Jr., critically reviewed the manuscript.

#### Key to Indo-West-Pacific Species of *Lysiosquilla*

1. Antennal potopod with angled dorsal projection. Antennal scale slender, length 3 or more times greatest width. Ventral keel of eighth thoracic somite sharp (apex of uropodal endopod dark) ..... 2  
 Antennal protopod lacking angled dorsal projection. Antennal scale broad, length less than 3 times greatest width. Ventral keel of eighth thoracic somite rounded ..... 4
2. Rostral plate lacking median carina. Dactylus of claw with 15–17 teeth ..... *L. capensis* Hansen, 1895  
 Rostral plate with median carina. Dactylus of claw with less than 15 teeth ..... 3



Key to Indo-West-Pacific Species of *Lysiosquilla* (Con't)

3. Median carina on rostral plate flanked laterally by longitudinal grooves. Dactylus of claw with 7-8 teeth ..... *L. sulcirostris* Kemp, 1913
- Median carina on rostral plate not flanked laterally by longitudinal grooves. Dactylus of claw with 10-13 (usually 12-13) teeth ..... *L. tredecimdentata* Holthuis, 1941
4. Rostral plate with low median carina, flanked by longitudinal grooves, or with median depression. Dactylus of claw with 7-9 teeth. Apex of uropodal endopod light ..... *L. sulcata*, new species
- Rostral plate with distinct median carina, not flanked laterally by longitudinal grooves. Dactylus of claw with 8-11 (usually 10-11) teeth (fewer in large females). Apex of uropodal endopod dark ..... *L. maculata* (Fabricius, 1793)

*Lysiosquilla capensis* Hansen, 1895

## FIGURE 11

*Lysiosquilla capensis* Hansen, 1895:74.—Holthuis, 1967:15 [synonymy, including larvae].—Manning, 1969:5, fig. 1 [description and figure].

**DIAGNOSIS.**—Rostral plate (Figure 11a) cordiform, length and width subequal, median carina absent. Antennal protopod (Figure 11a) with sharp anterior projection above articulation of antennal peduncle. Antennal scale (Figure 11a) slender, length about 3 times greatest width, scale outlined by dark pigment. Dactylus of raptorial claw (Figure 11d) with 15-17 teeth. Dorsal tooth of carpus of claw not markedly deflexed mesioventrally. Ventral keel of eighth thoracic somite (Figure 11b) produced into posteriorly directed spine. Sixth abdominal somite and telson (Figure 11f) smooth or slightly wrinkled dorsally. Basal segment of uropod with strong spine ventrally at articulation of endopod (Figure 11e), apex of endopod dark.

**REMARKS.**—Although this species is not represented in the materials reported here, a diagnosis has been included to complement the comparative illustrations of this species given below (Figure 11). A more detailed description with illustrations has been given in an earlier paper (Manning, 1969).

During a visit to the Universitetets Zoologiske Museum, Copenhagen, in 1971, I found that the holotype of this species, a male, TL 59 mm, from Port Elizabeth, South Africa, was deposited there, rather than in the Musée Zoologique, Strasbourg, as reported by Holthuis (1967).

*Lysiosquilla capensis* is the only member of the genus in which the rostral plate is smooth dorsally, being neither longitudinally sulcate nor carinate. It also has more teeth on the claw, 15-17, than any other representative of the genus. Finally, the ven-

tral spine on the basal segment of the uropod is better developed in this species than in any other in the genus.

This is a relatively small species of *Lysiosquilla*. It does not approach *L. maculata* in maximum size. Males 59-104 mm long and other specimens 40-96 mm long have been recorded in the literature (Manning, 1969).

**DISTRIBUTION.**—Apparently restricted to South African waters, in relatively shallow water, from shore to 48 fathoms (88 meters).

*Lysiosquilla maculata* (Fabricius, 1793)

## FIGURES 1-3, 9

*Squilla maculata* Fabricius, 1793:511.

*Lysiosquilla Miersii* De Vis, 1883:321.

*Lysiosquilla maculata*.—Holthuis, 1967:18 [complete synonymy].—Manning, 1968:36, fig. 12 [comparison with *L. tredecimdentata*].

**MATERIAL.**—Honolulu, Oahu, Hawaiian Islands; *Albatross*, leg.; 12 Nov 1896: 1 ♂, TL 118 mm (USNM 21489). Same; *Albatross*, leg.; 1901: 1 ♀, TL 162 mm (USNM 64899). Honolulu market; *Albatross*, leg.; 26 Mar 1902: 1 ♂, TL 220 mm (USNM 64901). Lagoon, Palmyra Island, Line Islands; F. C. Sibley et al., leg.; 15 May 1966: 1 ♂, TL 140 mm (USNM 120230). Apia, Upolu Islands, Samoa Islands; D. S. Jordan, leg.; 1902: 1 ♂, TL 260 mm (USNM 64904). Data same: 2 ♀, TL 240-285 mm (USNM 64905). Samoa Islands; A. B. Steinberger, leg.: 1 ♀, TL 298 mm (USNM 5148). Tahiti, Society Islands; Mission Ranson, leg.; 1952: 1 ♂, TL 198 mm (USNM 124719). Papara, Tahiti, Society Islands; *Albatross*, leg.; 11 Nov 1899: 1 ♀, TL 190 mm (USNM 69592). Raiatea, Society Islands; J. M. Clements, leg.; 15 Aug 1927: 2 ♂, TL 255-285 mm; 1 ♀, TL 267 mm (USNM 62613). Farepiti Point, Bora Bora, Society Islands; purchased from fishermen; Smithsonian-Bredin Sta 50-57; 23 Apr 1957: 2 ♂, TL 253-317 mm; 2 ♀, both TL ca. 300 mm (USNM 105674). Nuku Hiva, Marquesas Islands; W. H. Jones, leg.; 1883: 1 ♂, TL 210 mm (USNM 6593). Toau Atoll, Tuamotu Archipelago; G. Pinchot, leg.; 5 Oct

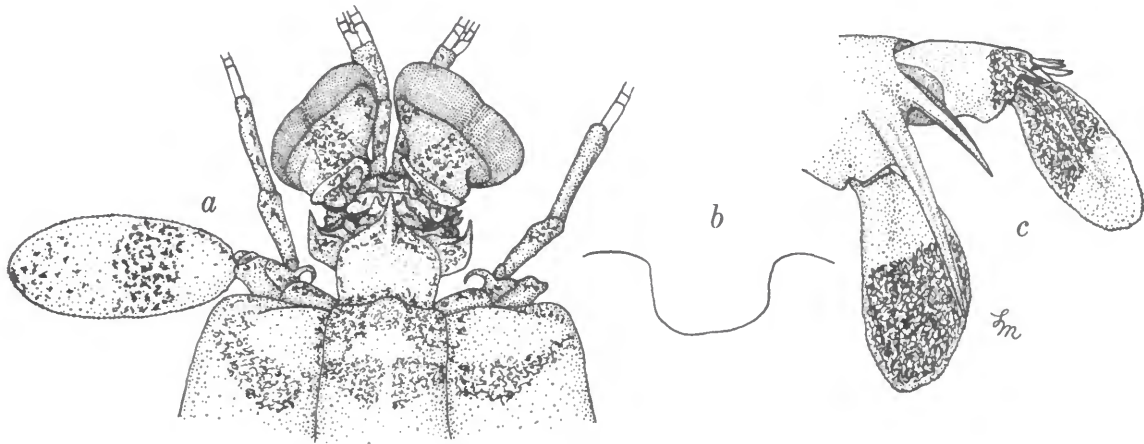


FIGURE 1.—*Lysiosquilla maculata* (Fabricius), male, TL 76 mm, Zanzibar: *a*, anterior part of body; *b*, ventral keel of eighth thoracic somite, lateral view; *c*, uropod, ventral view. Setae omitted.

1929: 1 ♂, TL 222 mm (USNM 63164). Celebes, Indonesia; M. C. Raven, leg.; 1 ♀, TL 175 mm (USNM 69595). Moreton Bay, Queensland, Australia; holotype of *L. miersii* De Vis: 1 ♀, TL ca. 225 mm (Queensland Museum). Dar es Salaam, Tanzania; Cmdr. Smart, R. N., leg.: 1 ♀, TL 120 mm (BMNH 1919.11.11.2). Zanzibar; J. D. Robinson, Peace Memorial Museum: 1 ♂, TL 76 mm (BMNH 1953.5.28.2-3). Diego Garcia Atoll, Chagos Archipelago; 07°26'S, 72°26'E; shore to 1.2 m, dipnet; H. A. Fehlmann Sta HA67-42; 12 Jul 1967: 1 ♀, TL 180 mm (USNM 168530).

**DIAGNOSIS.**—Rostral plate (Figure 9a) usually cordiform, occasionally subtriangular, width usually greater than length, with short, raised median carina anteriorly. Antennal protopod (Figure 9a) lacking anterior projection. Antennal scale (Figure 9a) broad, length less than 3 times greatest width. Scale not outlined by dark pigment but with irregular dark spot on surface. Dactylus of claw (Figure 9d) usually with 10–11 teeth, fewer and smaller in large females. Dorsal tooth of carpus of claw not deflexed mesioventrally. Sixth abdominal somite and telson (Figure 9f) smooth or slightly wrinkled dorsally. Basal segment of uropod (Figure 9c) unarmed ventrally at articulation of endopod, apex of endopod dark.

**DESCRIPTION.**—Eye (Figures 1a, 2a,b, 3a) large, cornea bilobed, set slightly obliquely on stalk. Ocular scales erect, triangular, apices inclined anteriorly.

Antennular peduncle short, about half as long as carapace. Dorsal processes of antennular somite

visible lateral to rostral plate as sharp, anteriorly directed spines.

Antennal scale (Figures 1a, 2a, 3a) broad, curved, length about 2.5 times greatest width. Scale with large dark spot on surface. Antennal peduncle not extending beyond eye. Antennal protopod lacking triangular anterior projection, 1 mesial and 2 ventral papillae present.

Rostral plate usually cordiform (Figures 1a, 2a), occasionally subtriangular (Figure 3a), width usually greater than length. Short median carina present on anterior half or third of plate, carina not flanked laterally by deep longitudinal grooves; carina low, broad, less distinct, and with apex blunter in large specimens.

Dactylus of raptorial claw with 8–11 teeth, usually 10–11; number and size of teeth reduced in large females (TL 186–200 mm or larger); outer margin of dactylus sinuate. Propodus of claw longer than carapace except in large females in which it may be shorter. Propodus and carpus comparatively more inflated in large females and males; in large females, complement of proximal movable teeth on opposable margin of carpus reduced and carpus and propodus ornamented with hairs. Dorsal tooth of carpus not deflexed mesioventrally.

Mandibular palp and 5 epipods present.

Ventral keel of eighth thoracic somite rounded (Figures 1b, 2c).

Abdomen smooth, unarmed. Sixth somite smooth

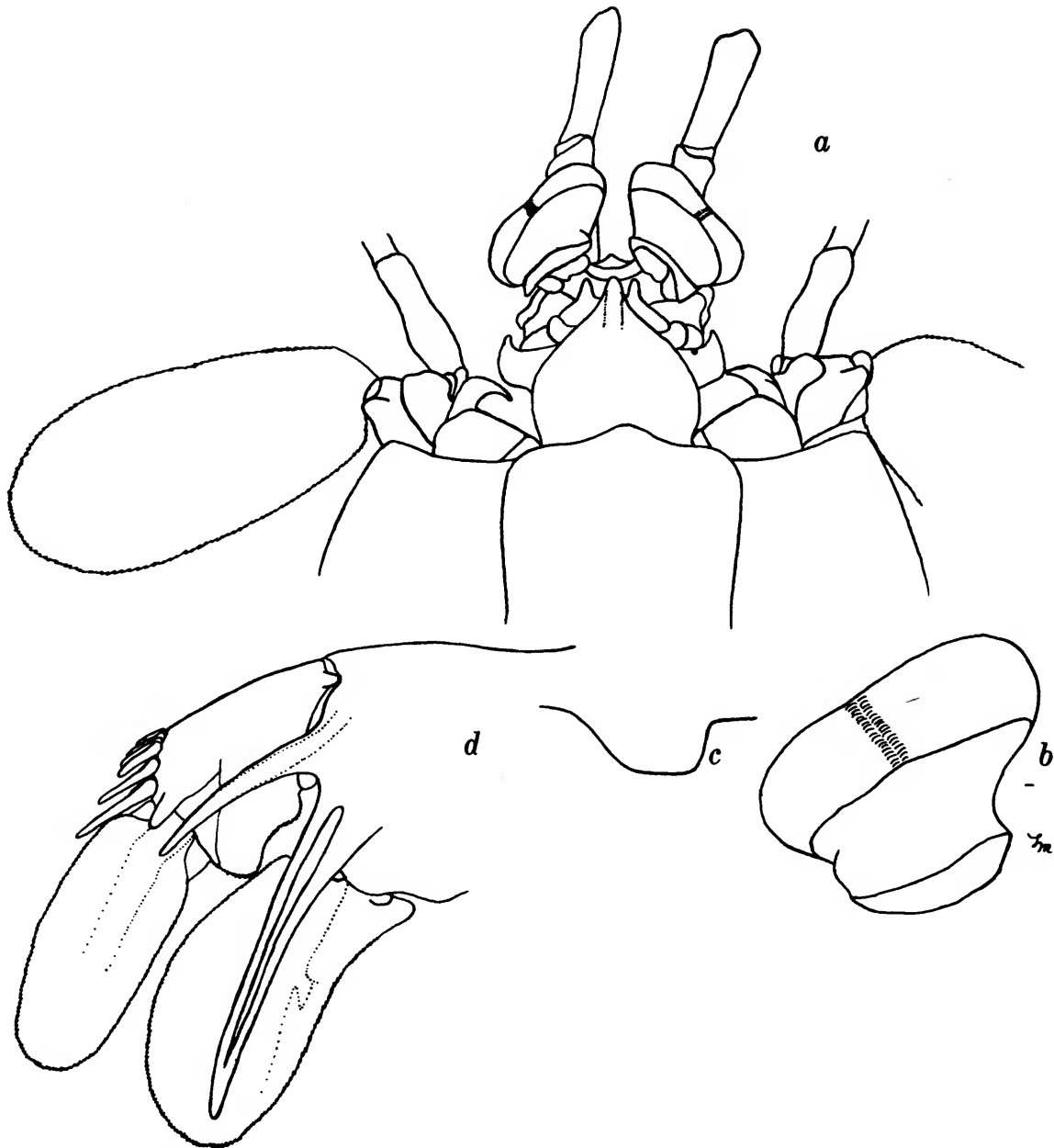


FIGURE 2.—*Lysiosquilla maculata* (Fabricius), holotype of *Lysiosquilla miersii* De Vis, female, TL ca. 225 mm, Queensland: *a*, anterior part of body; *b*, eye; *c*, ventral keel of eighth thoracic somite, lateral view; *d*, uropod, ventral view. Setae omitted.

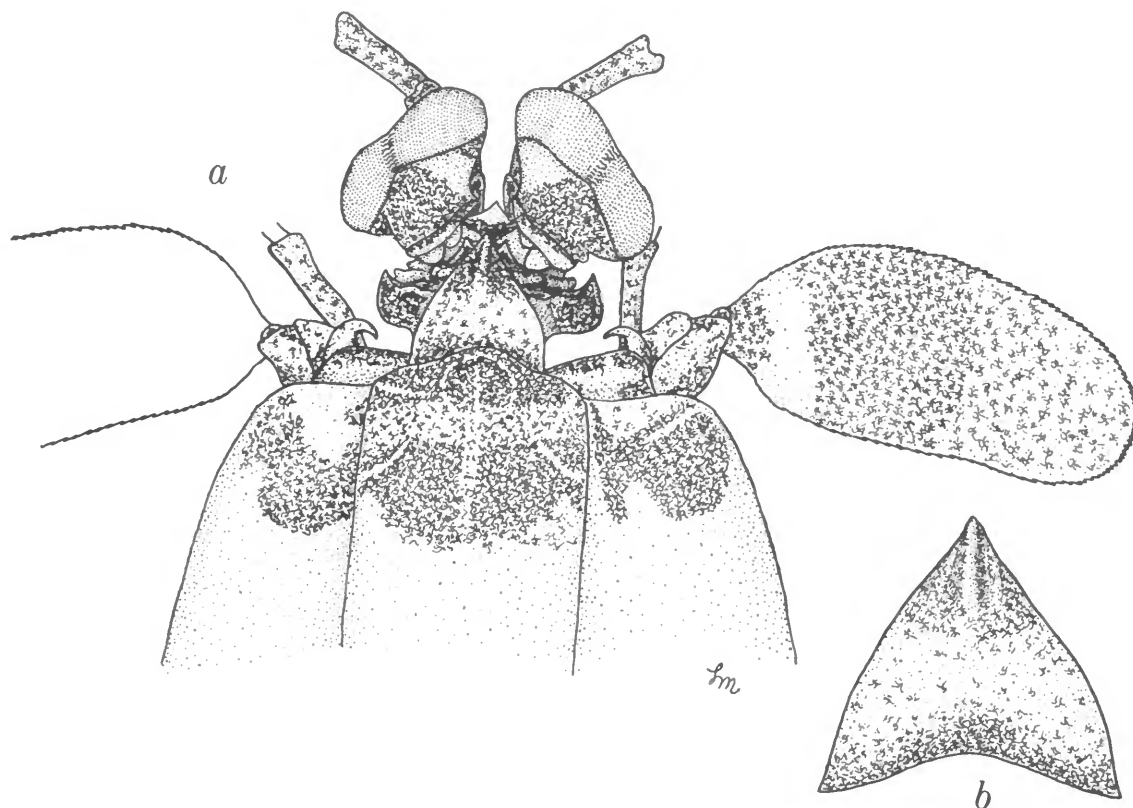


FIGURE 3.—*Lysiosquilla maculata* (Fabricius), female, TL 180 mm, Diego Garcia Atoll: *a*, anterior part of body; *b*, rostral plate. Setae omitted.

medially, with low, broad lateral boss flanked mesially by shallow longitudinal groove. Sixth somite with triangular lobe ventrolaterally anterior to articulation of each uropod.

Telson much broader than long, smooth or slightly wrinkled, with broad, shallow pits dorsally, with raised, smooth, subtriangular or ovate median boss and lower submedian bosses on dorsal surface. Lateral margin of telson lacking lateral carina in large specimens, with low lateral carina on proximal fourth in smaller ones (male, TL 76 mm). Posterior margin of telson with 3-4 pairs of fixed projections, inner indistinct, outer sharpest.

Basal segment of uropod with slender dorsal spine. Proximal segment of exopod shorter than distal, with 8 movable spines, distalmost not exceeding midlength of distal segment. Endopod broad, length about or less than twice greatest

width; apex of endopod dark. Basal prolongation consisting of 2 spines, trefoil in cross section, inner longer. Ventral surface of uropodal protopod unarmed at articulation of endopod (Figure 2*d*).

COLOR.—Eystalks with scattered dark chromatophores. Anterior half of rostral plate with dark spot. Anterior margin of antennal protopod and dorsal surface of antennal peduncle with scattered dark chromatophores; scale (Figures 1*a*, 3*a*) with large, irregular dark spot on surface, margin not outlined by dark pigment. Claw, when folded, with 3 broad bands of dark pigment, propodus without separate distal vertical dark bar. Carapace with 3 broad, dark bands. Posterior 3 thoracic and all abdominal somites with diffuse anterior and more concentrated posterior dark bars, posterior bar on margin. Sixth abdominal somite with dark lateral patch extending onto basal segment of uropod.

Telson with median and 2 submedian dark spots on posterior half, spots distinct or coalesced anteriorly. Basal segment of uropod dark proximally. Uropodal exopod with dark spot overlapping segments, apex of distal segment light (Figure 1c). Distal two-thirds of endopod dark (Figure 1c).

MEASUREMENTS.—Males, TL 76–317 mm; females, TL 120–300 + mm. Other measurements of a male, TL 317 mm: carapace length 52.9; cornea width 11.4; antennal scale length 36.6, width 17.3; raptorial propodus length 81.2; fifth abdominal somite width 64.2. Other measurements of a female, TL 300 + mm: carapace length 56.2; cornea width 9.4; antennal scale length 28.4, width 16.2; raptorial propodus length 49.3; fifth abdominal somite width 71.3.

This is the largest known stomatopod. Females as long as 385 mm have been recorded in the literature; specimens longer than 250 mm are not uncommon in either sex.

REMARKS.—*Lysiosquilla maculata* is the largest, the most common, and the most widely distributed species of the genus in the Indo-West-Pacific region. It resembles *L. sulcata*, new species, described below, and differs from the other species in that region in having a broad antennal scale, a rounded ventral keel on the eighth thoracic somite and in lacking an angled dorsal projection on the antennal protopod. It differs from *L. sulcata* in having more teeth on the claw (usually 10–11 rather than 7–9), a broader rostral plate lacking longitudinal grooves along the median carina, and a dark apex on the uropodal endopod.

In general, the rostral plate in *L. maculata* is cordiform, with a short anterior carina that may be very low in large specimens. In some specimens, however, the plate is subtriangular (Figure 3a) or even pentagonal, approaching that of *L. sulcata* in shape. Variation in the shape of the plate is not unusual in this species.

Through the kindness of Dr. Bruce Campbell, Queensland Museum, I was able to examine the holotype of *Lysiosquilla miersii* De Vis. As suggested by Stephenson (1953), it can be identified with *L. maculata*. Sketches of the holotype are shown in Figure 2.

Most of the references included in Holthuis' (1967) complete synonymy for *L. maculata* require verification, which can be accomplished only by examining the specimens on which they are based.

Certainly the earlier records are not reliable and may apply to any member of the genus occurring in the Indo-West-Pacific region.

SEXUAL DIMORPHISM.—Several authors, including Kemp (1913), Bigelow (1931), and Holthuis (1941), have reported that large females of this species, about 186 mm in total length or larger, exhibit marked secondary sexual characters. In such specimens the eye size is reduced and the propodus of the raptorial claw is comparatively smaller than in smaller specimens. In addition, the propodus is dilated, the proximal movable spines on the propodus are reduced and some may be absent, the propodus and carpus may be ornamented with numerous hairs, and the teeth on the dactylus of the claw are reduced in number as well as in size. The reduction in number of teeth in large females of *L. maculata* has led to some confusion in the past, for such females may have the same number of teeth on the claw as *L. sulcirostris* Kemp, 1913 (and *L. sulcata*, new species). *Lysiosquilla maculata* var. *sulcirostris* was described by Kemp from a male, 113.5 mm long, with a narrow, grooved rostral plate and 8 teeth on the dactylus of the claw. The similarity in number of teeth on the claw in large females of *L. maculata* and in *L. sulcirostris* led Monod (1925) and Bigelow (1931) to question the validity of Kemp's variety and further induced Chopra (1934) to publish a long discussion of these characters based on specimens identified with *L. maculata* in the collection of the Indian Museum. Monod and Bigelow were basing their observations on highly modified females of *L. maculata*.

The specimen from Mauritania that Monod (1925) identified with *L. sulcirostris* represents a new species, the description of which is in press (Manning).

DISTRIBUTION.—Widely distributed in the Indo-West-Pacific region, from Japan to the western Indian Ocean, usually in shallow water. Most literature records require verification.

### *Lysiosquilla sulcata*, new species

FIGURES 4–6, 10

*Lysiosquilla sulcirostris*.—Manning, 1970:1438, fig. 3 [not *Lysiosquilla sulcirostris* Kemp, 1913].

MATERIAL.—Saipan, Marianna Islands; S. Hofer, leg.; 1918; paratype: 1 ♂, TL 150 mm (SMF). Pacific Ocean; no other

data; paratype: 1 ♀, TL 92 mm (USNM 124770). Konori Island, Mios Wendi, Padaido Group, West New Guinea (West Irian); National Science Foundation sta 464; 28 Jan 1956; paratype: 1 ♂, TL 122 mm (RMNH). Amboina, Indonesia; Strubell, leg.; paratype: 1 ♀, TL 75 mm (SMF). Rasdu Atoll, near Weligandu Island (04°18'N, 73°00'E), Maldives Islands; sand zone with coral; Klauswitz, leg.; 19 Mar 1958; paratype: 1 ♀, TL 98 mm (SMF). Between Mafleferi and Mara Islands, Fadiffolu Atoll, Maldives Islands; 05°21'30"N, 73°25'15"E; J. S. Garth, R. Robertson, F. C. Ziesenhenné, leg.; IIOE, Sta GA 64-25; 23-24 Mar 1964; holotype: 1 ♂, TL 99 mm (USNM 156253). Grand Recif, Tulear, Madagascar; between buoys; coarse sand, plants, in shallow water; R. Derijard, leg.; 25 Apr 1967; paratype: 1 ♂, TL 41 mm (MNHN). Zanzibar; no other data; paratype: 1 ♂, TL 129 mm (BMNH 1935.5.28.2-3).

**DIAGNOSIS.**—Rostral plate (Figure 10a) subtriangular or subpentagonal, length and width subequal or length slightly greater, with median longitudinal depression anteriorly, median carina reduced or absent. Antennal protopod (Figure 10a)

lacking anterior projection. Antennal scale (Figure 10a) broad, length less than 3 times greatest width. Scale not outlined by dark pigment but with scattered dark spots on surface. Dactylus of raptorial claw (Figure 10d) with 7-8 teeth, dorsal tooth of carpus of claw not deflexed mesioventrally. Ventral keel of eighth thoracic somite (Figure 10b) rounded. Sixth abdominal somite and telson (Figure 10f) smooth or with shallow pits dorsally. Basal segment of uropod (Figure 10e) unarmed ventrally at articulation of endopod, apex of endopod light.

**DESCRIPTION.**—Eye (Figures 4a,b, 5a, 6) large, cornea bilobed, set slightly obliquely on stalk. Ocular scales erect, triangular, apices inclined anteriorly.

Antennular peduncle short, about half as long as carapace. Dorsal processes of antennular somite visible lateral to rostral plate as broad, anteriorly directed spines.

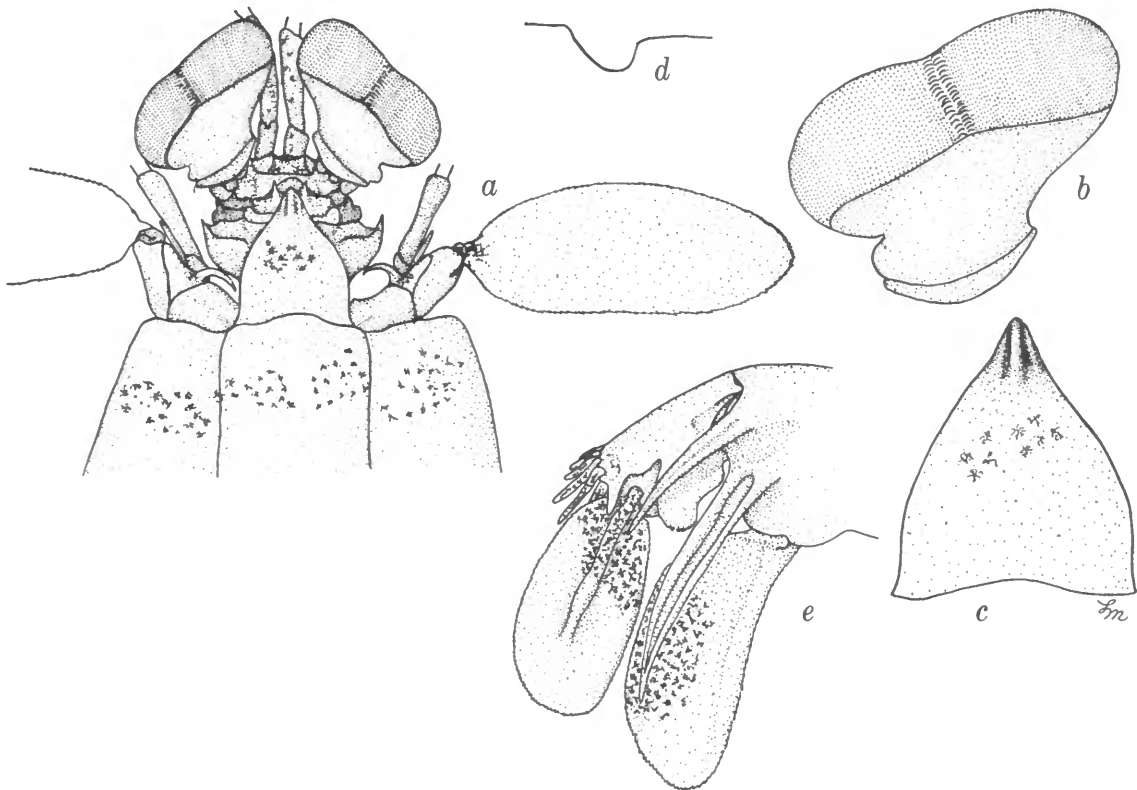


FIGURE 4.—*Lysiosquilla sulcata*, new species, male holotype, TL 99 mm, Maldives Islands: a, anterior part of body; b, eye; c, rostral plate; d, ventral keel of eighth thoracic somite, lateral view; e, uropod, ventral view. Setae omitted.

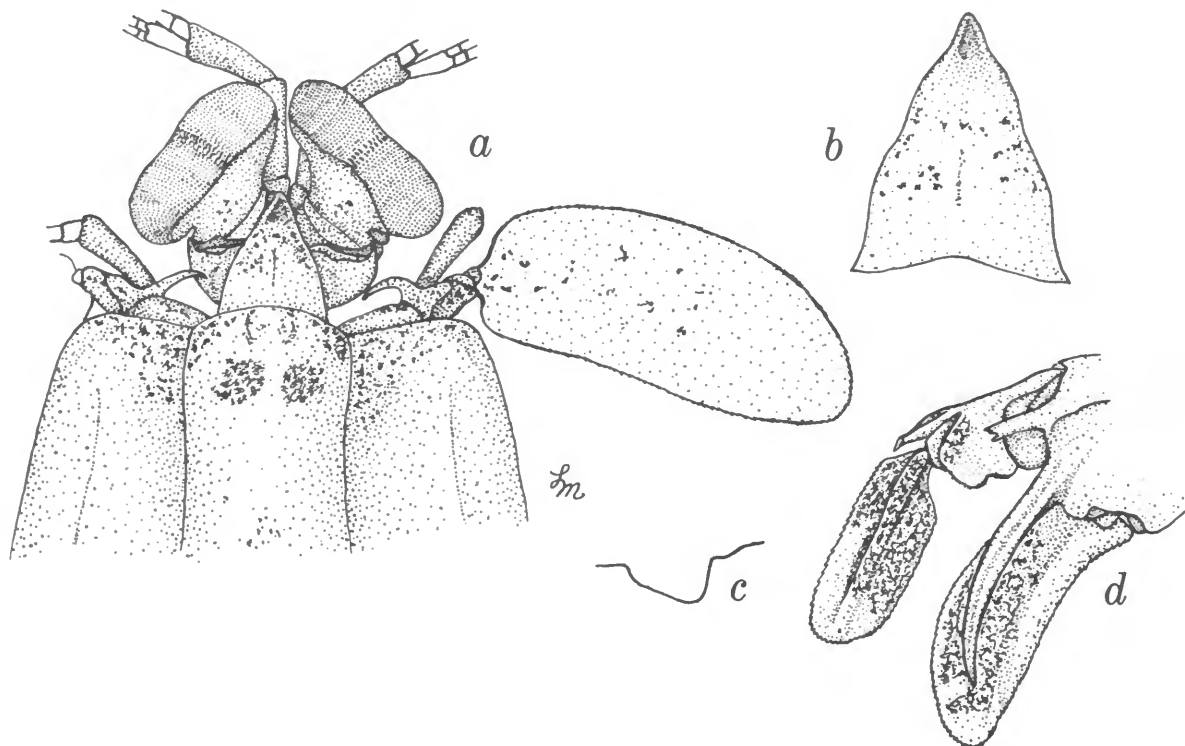


FIGURE 5.—*Lysiosquilla sulcata*, new species, male paratype, TL 129 mm, Zanzibar: *a*, anterior part of body; *b*, rostral plate; *c*, ventral keel of eighth thoracic somite, lateral view; *d*, uropod, ventral view (outer spine of basal prolongation broken). Setae omitted.

Antennal scale broad (Figures 4*a*, 5*a*, 6), length about 2.5 times greatest width. Scale not outlined by dark pigment, with dark spots on surface. Antennal peduncle not extending beyond eye. Antennal protopod (Figures 4*a*, 5*a*, 6) lacking anterior projection, with 1 mesial and 2 ventral papillae.

Rostral plate (Figures 4*a*, 5*a*, 6) subtriangular or subpentagonal, length and width subequal or length greater, apex deflexed. Plate longitudinally sulcate anteriorly, occasionally with obscure, low carina in channel (Figures 4*a*, 6).

Dactylus of raptorial claw with 7–9 teeth, outer margin of dactylus sinuate. Teeth of claw not markedly reduced in large females available for study. Propodus of claw longer than carapace in males, slightly shorter than carapace and ornamented with simple hairs in female. Dorsal tooth of carpus of claw not deflexed mesioventrally.

Mandibular palp and 5 epipods present.

Ventral keel of eighth thoracic somite rounded (Figures 4*d*, 5*c*).

Abdomen smooth, unarmed. Sixth somite with smooth lateral boss on each side, flanked mesially by shallow, longitudinal groove. Sixth somite with blunt triangular projection ventrolaterally anterior to articulation of each uropod.

Telson broader than long, pitted dorsally, with low, triangular, smooth median boss and 2 lower submedian bosses on dorsal surface. Lateral margin of telson not distinctly carinate. Posterior margin of telson with 3 pairs of fixed, blunt projections, outer sharpest.

Basal segment of uropod with dorsal spine. Proximal segment of exopod shorter than distal, with 8 slender movable spines, distalmost extending to midlength of distal segment. Endopod broad, length about twice greatest width. Apex of endopod light in color (Figures 4*e*, 5*d*). Basal prolongation

of uropod consisting of 2 spines, trefoil in cross section. Ventral surface of basal segment of uropod unarmed at articulation of endopod (Figures 4e, 5d).

**COLOR.**—Largely faded on all specimens. Rostral plate and antennal scale each with diffuse dark spot, appearing speckled. Carapace with 3 dark bands. Posterior 3 thoracic and all abdominal somites with posterior margin outlined by dark pigment. Telson with 3 dark spots dorsally. Uropod with dark spot dorsally on basal segment and dark spot on exopod at articulation of distal segment; endopod with dark spot on outer surface, inner margin and apex light (Figures 4e, 5d).

**MEASUREMENTS.**—Males, TL 41–150 mm; females, TL 75–98 mm. Other measurements of male holotype, TL 99 mm: carapace length 17.3; cornea width 5.7; antennal scale length 12.7, width 5.3; raptorial propodus length 24.1; fifth abdominal somite with 18.7.

**REMARKS.**—*Lysiosquilla sulcata*, new species, resembles *L. maculata* and differs from the other Indo-West-Pacific species of the genus in lacking an anterior projection on the antennal protopod, and in having a rounded ventral keel on the eighth thoracic somite as well as a broad rather than slender antennal scale. It differs from *L. maculata*

in having fewer teeth on the claw, a light apex on the uropodal endopod, and in the structure of the rostral plate. In *L. sulcata* the plate is either longitudinally sulcate or bears a short anterior carina flanked laterally by longitudinal grooves. The rostral plate of *L. sulcata* resembles that of *L. sulcirostris* (see below), but Kemp's species has a slender antennal scale, a projection on the antennal protopod, an angled ventral keel on the eighth thoracic somite, and a dark apex on the uropodal endopod.

The shape of the rostral plate in the small male from Tulear, the specimen which I (Manning, 1970) had identified with *L. sulcirostris*, is quite different from that illustrated here and is reproduced for comparison (Figure 6). Apparently in this species, as in *L. maculata*, the shape of the plate is variable. In some specimens the anterior carina is so poorly developed that the plate appears to have a single median, longitudinal groove.

**ETYMOLOGY.**—The name is from *sulcatus* (Latin, = grooved), alluding to the structure of the rostral plate.

**DISTRIBUTION.**—Indo-West-Pacific region, from scattered localities between Saipan and Zanzibar. It apparently lives in shallow water.

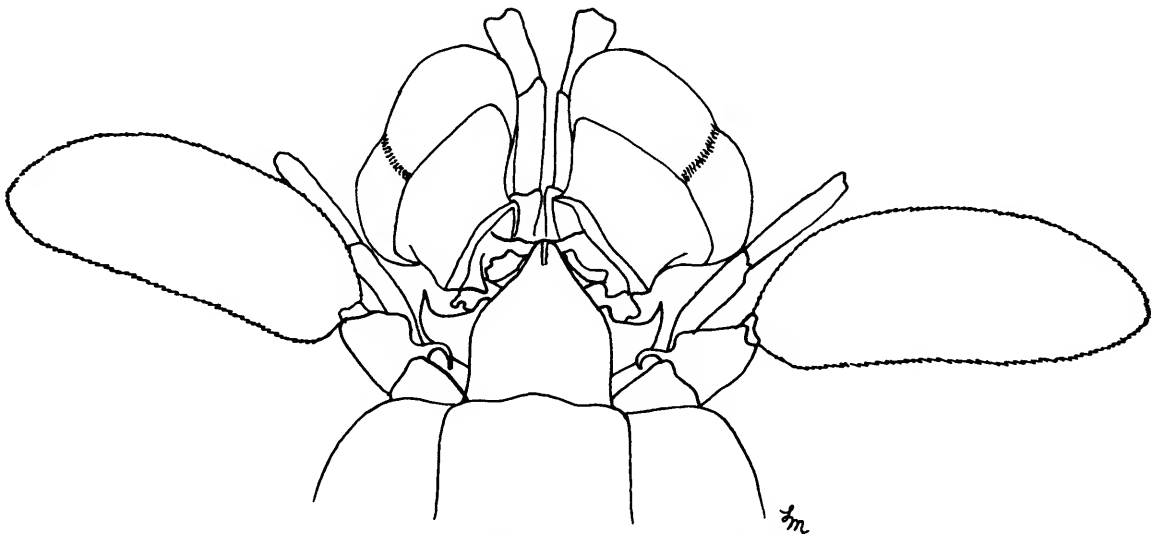


FIGURE 6.—*Lysiosquilla sulcata*, new species, male paratype, TL 41 mm, Tulear: anterior part of body. Setae omitted.



*Lysiosquilla sulcirostris* Kemp, 1913

FIGURES 7-8, 12

*Squilla maculata*.—De Haan, 1849:221 [not *Squilla maculata* Fabricius, 1793].

*Lysiosquilla maculata* var. *sulcirostris* Kemp, 1913:116, pl. 8: figs. 92-93.—Holthuis, 1941:272.—Serène, 1954:6, 7, 8, 11, 13, 70, figs. 1, 3, pl. 5: figs. 3-4, pl. 6: figs. 3-4.

*Lysiosquilla sulcirostris*.—Holthuis, 1967:23 [complete synonymy].

**MATERIAL.**—Japan; P. F. Von Siebold, leg.: 1 ♂, TL 58 mm (RMNH 12S). Insel Lombussa (Jesus-Maria), Admiralty Group; H. Schroede, leg.: 3 Mar 1910: 1 ♂, TL 325 mm (ex ZMB 13774). Lembah Strait, N. Celebes, Indonesia; Oct 1941: 1 postlarva, TL 20 mm (RMNH 264S). Celebes, Indonesia; 29 Jan 1894: 1 ♂, TL 134 mm (NMV). Batavia (Djakarta), Indonesia; Bleeker, leg.: 1 ♂, TL 105 mm (MNHN). Andaman Islands; Homfray and Tytler, don.; holotype: 1 ♂, TL 113.5 mm (ZSI 7564/10). Tany Kely, NW coast of Madagascar (Malagasy Republic); 20 m; P. Laboute, leg.; 14 Jan 1971: 1 ♂, TL 115 mm (USNM 168531).

**DIAGNOSIS.**—Rostral plate (Figure 12a) subtriangular, appearing elongate, usually slightly broader

than long, median carina on anterior part flanked laterally by deep longitudinal groove. Antennal protopod (Figure 12a) with blunt triangular anterior projection above articulation of antennal peduncle. Antennal scale (Figure 12a) slender, length about 3 times greatest width. Scale covered with dark pigment. Dactylus of raptorial claw (Figure 12d) with 7-8 teeth. Dorsal tooth of carpus of claw not deflexed mesioventrally. Ventral keel of eighth thoracic somite (Figure 12b) produced into angled lobe or sharp, posteriorly directed spine. Sixth abdominal somite and telson (Figure 12f) smooth or slightly pitted dorsally. Basal segment of uropod unarmed ventrally at articulation of endopod (Figure 12e), apex of endopod dark.

**DESCRIPTION.**—Eye (Figures 7, 8a,b) large, cornea bilobed, set slightly obliquely on stalk. Ocular scales erect, sharp, apices inclined anteriorly.

Antennular peduncle short, slightly more than half as long as carapace. Dorsal processes of antennular somite visible lateral to rostral plate as sharp, anterolaterally directed spines.

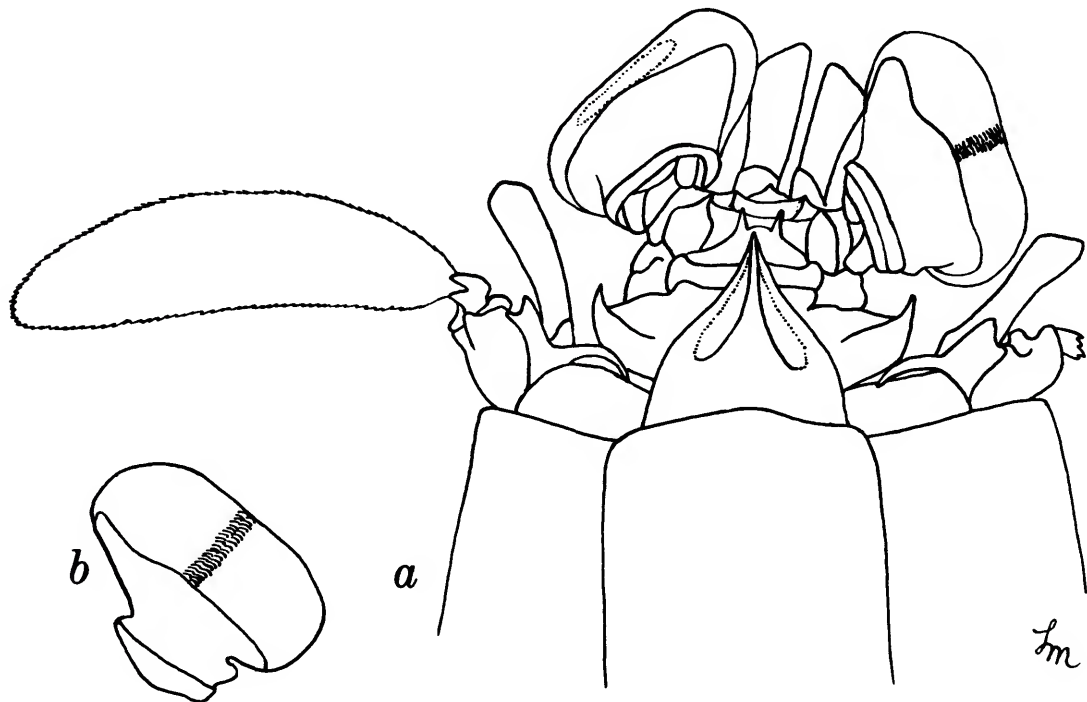


FIGURE 7.—*Lysiosquilla sulcirostris* Kemp, male holotype, Andaman Islands, TL 113.5 mm: a, anterior part of body; b, eye. Setae omitted.

Antennal scale (Figures 7a, 8a) slender, curved, length more than 3 times greatest width; scale with dark pigment scattered over surface. Antennal propod with triangular projection dorsally (Figures 7a, 8a) and with 1 mesial and 2 ventral papillae.

Rostral plate (Figures 7a, 8a,c) triangular, appearing elongate but usually slightly broader than long; median carina on anterior half flanked on each side by deep longitudinal groove.

Dactylus of claw with 7-8 teeth, outer margin of dactylus straight or slightly sinuate. Propodus of claw longer than carapace [except perhaps in adult females (Serène, 1954)]. Dorsal tooth of carpus not deflexed mesioventrally.

Mandibular palp and 5 epipods present.

Ventral keel of eighth thoracic somite produced posteriorly into angled lobe or sharp spine (Figure 8d).

Abdomen smooth, unarmed. Sixth somite with broad lateral boss flanked mesially by shallow groove and with triangular lobe ventrolaterally anterior to articulation of each uropod.

Telson much broader than long, slightly pitted dorsally, with low, smooth, triangular median boss and 2 lower submedian bosses on dorsal surface. Lateral margin of telson not distinctly carinate.

Posterior margin of telson with 4 pairs of fixed projections, outer 2 sharpest.

Basal segment of uropod with dorsal spine. Proximal segment of exopod shorter than distal, with 7-8 slender, movable spines, distalmost extending about to midlength of distal segment. Endopod broad, apex dark (Figure 8e). Basal prolongation consisting of 2 slender spines, trefoil in cross section, inner longer. Ventral surface of uropodal propod unarmed at articulation of endopod (Figure 8e).

COLOR.—Antennal scale with scattered dark chromatophores on surface, not forming dark spot. Carapace with 3 dark bands. Posterior 3 thoracic and anterior 5 abdominal somites with anterior and posterior dark bars, posterior margins outlined in black. Telson with dark bar across midlength, darkest laterally. Basal segment of uropod with dark anterior patch. Dark spot at articulation of segments of uropodal exopod covering proximal portion of distal segment. All but proximal fifth or less of uropodal endopod dark (Figure 8e).

MEASUREMENTS.—Males, TL 58-325 mm; no females examined; postlarva, TL 20 mm. Other measurements of male holotype, TL 113.5 mm: carapace length 19.7; cornea width 6.0; antennal

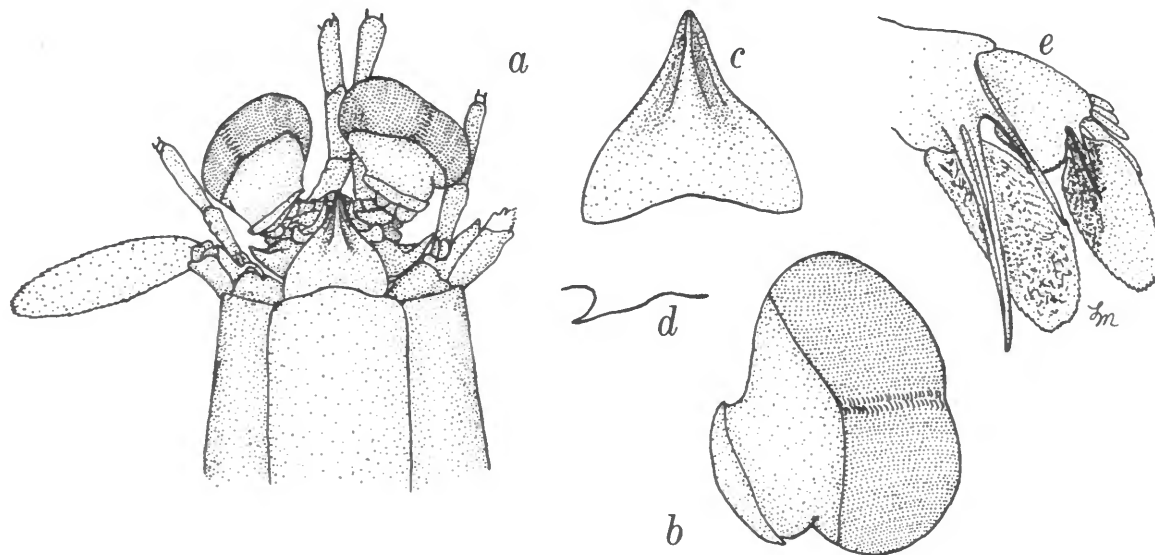


FIGURE 8.—*Lysiosquilla sulcirostris* Kemp, male, TL 58 mm, Japan: a, anterior part of body; b, eye; c, rostral plate; d, ventral keel of eighth thoracic somite, lateral view; e, uropod, ventral view. Setae omitted.

scale length 11.0, width 3.6; raptorial propodus length 28.1; fifth abdominal somite width 22.6.

REMARKS.—*Lysiosquilla sulcirostris* resembles *L. capensis* Hansen and *L. tredecimdentata* Holthuis and differs from *L. maculata* (Fabricius) and *L. sulcata*, new species, in having an anterior projection on the antennal protopod, a slender antennal scale, and a posteriorly sharp ventral projection on the eighth thoracic somite. It differs from *L. capensis* and *L. tredecimdentata* in having fewer teeth on the claw (7–8 rather than 15–17 or 10–13) and a rostral plate in which the carina is flanked laterally by deep longitudinal grooves.

*Lysiosquilla sulcirostris* also resembles an undescribed West African species (Manning, in press) that Monod (1925) reported as *L. maculata* var. *sulcirostris*. The West African species differs in having a spine on the ventral surface of the uropodal protopod at the articulation of the endopod. In other respects they are very similar.

The largest male recorded here, total length 325 mm, was in a lot with several specimens of *L. maculata* of similar size; it is the largest known specimen of the species.

Marked sexual dimorphism, similar to that observed for *L. maculata*, has been recorded for this species by Serène (1954). In a female 143 mm long, Serène noted a reduction in size of the eye and the number of teeth on the claw (5 rather than 8), an enlargement of the propodus of the claw, and the presence of tufts of hairs on the propodus and carpus. He pointed out that in this species eye size increased until specimens had attained a length of 70 to 90 mm; in larger specimens, the eye size of females decreased with increasing total length. No reduction in length of the propodus of the claw was reported by Serène. These data indicate that *L. sulcirostris* matures at a much smaller size than does *L. maculata*.

DISTRIBUTION.—Indo-West-Pacific region, from scattered localities between Japan and Madagascar. All previous records (see Holthuis, 1967) require verification.

#### *Lysiosquilla tredecimdentata* Holthuis, 1941

FIGURE 13

*Lysiosquilla maculata*.—Kemp, 1913:111, pl. 8: figs. 87–89 [part].—Chopra, 1934:28 [part ?; material not listed] [not *L. maculata* (Fabricius, 1793)].

*Lysiosquilla maculata* var. *tredecimdentata* Holthuis, 1941: 273, fig. 6.

*Lysiosquilla tredecimdentata*.—Holthuis, 1967:23 [synonymy].—Manning, 1968:38, fig. 13 [description]; 1969:6.

?*Lysiosquilla maculata*.—Alikunhi, 1967:904, figs. 158–167 [postlarval development] [not *L. maculata* (Fabricius, 1793)].

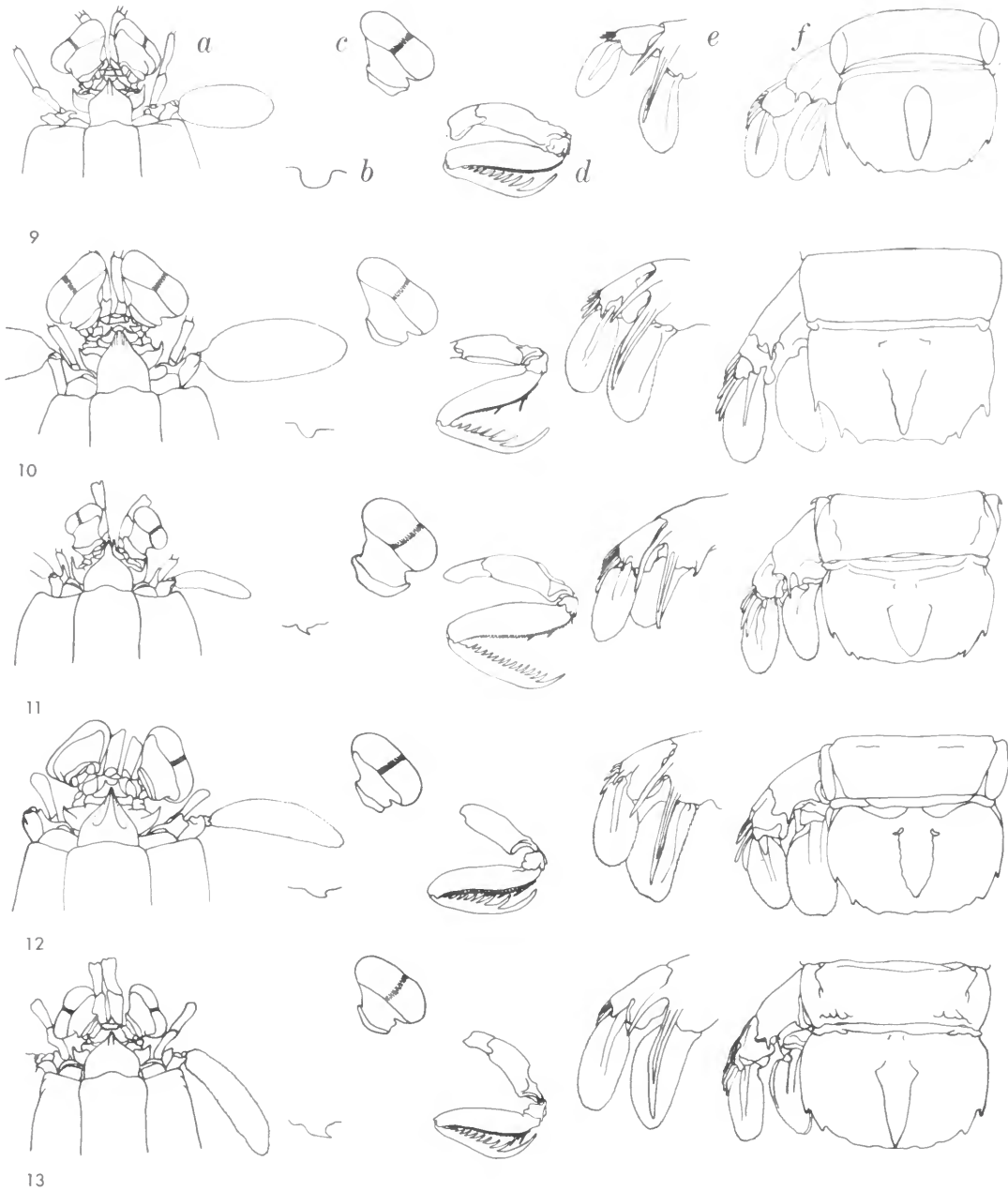
MATERIAL.—Coconada, South India; G. W. Wicks, don.: 5 ♂, TL 72–132.5 mm; 3 ♀, TL 106–186 mm (ZSI 3517–19/7 and 3528–31/7). Madras, India; 2 ♂, TL 138–144 mm (ZSI 3630–31/7). Andaman Islands: 1 fragmented ♀ (ZSI 3044/5). No data: 1 ♀, TL 91 mm (ZSI 3037/5).

All of these specimens were identified as *L. maculata* by Kemp (1913).

DIAGNOSIS.—Rostral plate (Figure 13a) cordiform, broader than long, with median carina on anterior third. Antennal protopod (Figure 13a) with triangular anterior projection above articulation of antennal peduncle. Antennal scale (Figure 13a) slender, length at least 3 times greatest width. Scale outlined by dark pigment. Dactylus of raptorial claw (Figure 13d) with 10–13, usually 12–13, teeth. Dorsal tooth of carpus of claw deflexed mesioventrally. Ventral keel of eighth thoracic somite (Figure 13b) produced into posteriorly directed spine. Sixth abdominal somite and telson (Figure 13f) smooth or slightly wrinkled dorsally. Basal segment of uropod occasionally armed with small spinule ventrally at articulation of endopod (unarmed in Figure 13e), apex of endopod dark.

REMARKS.—*Lysiosquilla tredecimdentata* is a distinctive species that resembles *L. capensis* and *L. sulcirostris* and differs from *L. maculata* and *L. sulcata*, new species, in having a slender antennal scale, outlined in dark pigment, an anterior projection on the antennal protopod, and a posterior spine on the ventral keel of the eighth thoracic somite. It differs from *L. capensis* in having a broader rostral plate with a distinct dorsal carina and 10–13 rather than 15–17 teeth on the claw. *Lysiosquilla tredecimdentata* differs from *L. sulcirostris* in having a broader rostral plate that lacks deep grooves flanking the median carina and in having 10–13 rather than 7–8 teeth on the dactylus of the claw.

This is a relatively large species. Males ranging in length from 120 to 259 mm and females 116 to 246 mm long have been recorded in the literature. In the Indo-West-Pacific region, only *L. maculata* and *L. sulcirostris*, both of which may exceed 300 mm in total length, may attain a larger size.



FIGURES 9-13.—Indo-West-Pacific species of *Lysiosquilla*: 9, *L. maculata* (Fabricius); 10, *L. sulcata*, new species; 11, *L. capensis* Hansen; 12, *L. sulcirostris* Kemp; 13, *L. tredecimdentata* Holthuis. (Figures 9-13: a, anterior part of body; b, ventral keel of eighth thoracic somite, lateral view; c, eye; d, claw; e, uropod, ventral view; f, sixth abdominal somite, telson, and uropod.)

Alikhunhi (1967) published a detailed account of the postlarval development of two species of *Lysiosquilla* from Madras, India. These he identified as *L. maculata* and *L. sulcirostris*. As I pointed out earlier (Manning, 1970), the features listed by Alikhunhi as characteristic of his young specimens of *L. maculata* (10–12 teeth on the claw, a slender antennal scale outlined by dark pigment) actually are diagnostic for *L. tredecimdentata*, raising the possibility that he was dealing with specimens of both *L. maculata* and *L. tredecimdentata* or with the latter species only. His material should be reexamined.

All of the material reported here was identified by Kemp (1913) as *L. maculata*. If his illustrations (pl. 8: figs. 87–89) are accurate, the specimens illustrated also are referable to *L. tredecimdentata* rather than to *L. maculata*; the broad dark bands on the body and the slender antennal scales are characteristic of the former species.

DISTRIBUTION.—Now known with certainty from localities in the western Indian Ocean, from the Red Sea southward to South Africa, eastward to southern India and the Andaman Islands. It may be expected to have a much wider distribution than now recognized.

## Literature Cited

- Alikunhi, K. H.  
 1967. An Account of the Post-larval Development, Moulting, and Growth of the Common Stomatopods of the Madras Coast. Pages 824-939 in Part II in *Proceedings of the Symposium on Crustacea, Marine Biological Association of India*, figures 1-194, plates 1-3.
- Bigelow, R. P.  
 1931. Stomatopoda of the Southern and Eastern Pacific Ocean and the Hawaiian Islands. *Bulletin of the Museum of Comparative Zoology, Harvard University*, 72(4):105-191, figures 1-10, plates 1-2.
- Chopra, B.  
 1934. On the Stomatopod Crustacea Collected by the Bengal Pilot Service off the Mouth of the River Hughli, Together with Notes on Some Other Forms. *Records of the Indian Museum*, 36:17-43, figures 1-5.
- De Vis, C. W.  
 1883. Description of a Species of Squill from Moreton Bay. *Proceedings of the Linnean Society of New South Wales*, 7:321-322.
- Fabricius, J. C.  
 1793. *Entomologia systematica emendata et aucta, secundum classes, ordines, genera, species, adjectis synonymis, locis, observationibus, descriptionibus*. Volume 2, pages i-viii + 1-519.
- Haan, W. De  
 1833-1850. Crustacea. Pages i-xvii, i-xxxii, ix-xvi, 1-243 in Von Siebold, *Fauna Japonica sive descriptio Animalium, quae in itinere per Japoniam, jussu et Auspiciis Superiorum, qui Summum in India Batava Imperium Tenent, suscepto, annis 1823-1930 collegit, notis observationibus, et adumbrationibus illustravit*. Plates A-J, L-Q, 1-55, circ. tab. 2. Lugduni-Batavorum: A. Arnz.
- Hansen, H. J.  
 1895. Isopoden, Cumaceen und Stomatopoden der Plankton-Expedition. Pages 1-105 in volume 2 (Gc) in *Ergebnisse der Plankton-Expedition der Humboldt-Stiftung*. Plates 1-8.
- Hobbs, Horton H., Jr.  
 1974. A Checklist of the North and Middle American Crayfishes (Decapoda: Astacidae and Cambaridae). *Smithsonian Contributions to Zoology*, 166:1-161, figures 1-294.
- Holthuis, L. B.  
 1941. The Stomatopoda of the Snellius Expedition. In *Biological Results of the Snellius Expedition, XII. Temminckia*, 6:241-294, figures 1-9.  
 1967. Fam. Lysiosquillidae et Bathysquillidae: Stomatopoda I. Pages 1-28 in volume 1 in Gruner and Holthuis, editors, *Crustaceorum Catalogus*. The Hague: W. Junk.
- Kemp, S.  
 1913. An Account of the Crustacea Stomatopoda of the Indo-Pacific Region, Based on the Collection in the Indian Museum. *Memoirs of the Indian Museum*, 4(1):1-217, 10 figures, plates 1-10.
- Manning, Raymond, B.  
 1968. Stomatopod Crustacea from Madagascar. *Proceedings of the United States National Museum*, 124 (3641):1-61, figures 1-16.  
 1969. Notes on Some Stomatopod Crustacea from Southern Africa. *Smithsonian Contributions to Zoology*, 1:1-17, figures 1-4.  
 1970. Some Stomatopod Crustaceans from Tuléar, Madagascar. *Bulletin du Muséum National d'Histoire Naturelle*, (2)41(6)(1969):1429-1441, figures 1-3.  
 In press. A Monograph of the West African Stomatopod Crustaceans. *Atlantide Reports* (Copenhagen).
- Michel, A.  
 1970. Larves Pélagiques et Post-Larves du Genre *Lysiosquilla* (Crustacés Stomatopodes) dans le Pacifique Tropical Sud et Equatorial. *Cahiers ORSTOM, Série Océanographique, France*, 8(3):53-75, figures 1-10.
- Monod, Th.  
 1925. Sur les Stomatopodes de la Cote Occidentale d'Afrique. *Bulletin de la Société des Sciences Naturelles du Maroc*, 5(3):86-93, plates 20-21.
- Serène, R.  
 1954. Observations Biologiques sur les Stomatopodes. *Mémoires de l'Institut Océanographique de Nhatrang*, 8:1-93, figures 1-15, plates 1-10.
- Stephenson, W.  
 1953. Notes on the Australian Stomatopoda (Crustacea) in the Collections of the Queensland Museum. *Memoirs of the Queensland Museum*, 13(1):40-49.

## 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 1 $\frac{1}{4}$ " 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 $\underline{b}$ ." 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 $\underline{b}$ ." 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.

