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Investigational Report No. 58

The Penaeoidea of southeast Africa
II — The Family Penaeidae (excluding Genus *Penaeus*)

by
A.J. de Freitas

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THE PENAEOIDEA OF SOUTHEAST AFRICA:
III. The Family Penaeidae (excluding Genus *Penaeus*)

by
A.J. DE FREITAS

ABSTRACT

This is the third monograph of a series of five on the Penaeoidea of southeast Africa and, together with monograph four, deals with the family Penaeidae.

The family is represented by nine genera of which eight, with a total of 15 species, are dealt with in this article. These are *Funchalia villosa*, *Metapenaeopsis hilarulus*, *M. mogiensis*, *M. philippii*, *Macropetasma africanus*, *Parapenaeus fissurus*, *P. investigatoris*, *Trachypenaeus curvirostris*, *T. sedili*, *Parapenaeopsis acclivirostris*, *P. atlantica*, *Penaeopsis balssi*, *Metapenaeus monoceros* and *M. stebbingi*.

The last two species together form a considerable component of the commercial catches. Because of this, the biology of *M. monoceros* and *M. stebbingi* in Maputo Bay was studied in some detail and the fishery is briefly discussed.

INTRODUCTION

The family Penaeidae is the largest of the superfamily Penaeoidea. Along the African coast between the Rovuma River in northern Mozambique and the Kei River in the south, nine genera have been identified. The majority are found on the continental shelf and therefore form the bulk of the commercial catches worldwide.

This monograph deals with eight genera and constitutes the third in a series of five monographs on the penaeoids of southeast Africa. The material is part of a thesis presented to the University of the Witwatersrand for the degree of Doctor of Philosophy.

FAMILY PENAEIDAE Rafinesque, 1815

In this section, eight genera are dealt with, namely *Funchalia*, *Macropetasma*, *Metapenaeopsis*, *Parapenaeus*, *Trachypenaeus*, *Parapenaeopsis*, *Penaeopsis* and *Metapenaeus*.

Funchalia, *Parapenaeus* and *Penaeopsis* are deep-water species, while the other genera may be considered as shelf penaeids. The genera dealt with here are Penaeidae with no ventral rostral teeth.

They are small to medium sized animals with well developed and foliaceous prosartema. The cervical groove seldom reaches beyond half the distance between the hepatic spine and dorsum of the carapace. Maxilliped III has no epipodite and the exopodites are long, usually reaching to or beyond merus of endopodite. Appendix masculina does not contain an appendix interna.

Genus *Funchalia* Johnson, 1867

Funchalia Johnson, 1867: 895; Bouvier, 1908: 91; Balss, 1925: 227; Calman, 1925: 10; Burkenroad, 1934b: 76; Burkenroad, 1936: 126; Barnard, 1950: 608; Kensley, 1977: 29.
Aristeus Bate, 1888: 309 (Part).
Hemipenaeus Bouvier, 1905: 981.

The genus *Funchalia* was established by Johnson in 1867 to accommodate *Funchalia woodwardi*. Burkenroad (1934b, 1936) suggested that the genus should be subdivided into two subgenera, *Funchalia s.s.* and *Pelagopenaeus* based on the fact that although the branchial formulae of both these groups are identical, they differ in that the former lacks ventral rostral teeth. Also, *Pelagopenaeus* has no antennal spine as found in *Funchalia s.s.* and the former subgenus has an "... elongation of the branchiostegal carina of its carpace; and the occurrence of a prominent dorsal longitudinal carina of which no complete equivalent exists in *Funchalia s.s.* ...". Although Burkenroad (1934b, p.128) states that the petasma of the adult *Funchalia s.s.* is unknown, and Barnard (1950, p.609) states that "... Petasma asymmetrical (*Funchalia s.s.* ...) or symmetrical (*Pelagopenaeus*), simple, open."

I believe that the differences between the above two subgenera as given by Burkenroad (1934b, 1936) coupled now with the symmetry or asymmetry of the petasma are sufficient reasons for elevating these subgenera to genera.

Thus, the genus *Funchalia* consists of small to medium sized animals; rostrum with no ventral teeth; mandible with long, scythe-like incisor process; maxilliped III with epipodite; exopodites on all pereopods; pterygostomial angle spinose; basal and ischial spines on first two pairs of pereopods; distinct, continuous lateral cicatrices on fifth and sixth abdominal segments; telson with three or more pairs of small, at times inconspicuous, fixed lateral spines; petasma asymmetrical.

There are apparently two species to this genus, *F. woodwardi* and *F. villosa*. The former has, as yet, not been found in southeast African waters.

Funchalia villosa (Bouvier, 1905)

(Fig. III-1)

Hemipenaeopsis villosus Bouvier, 1905: 981 (part).

Grimaldiella richardi Bouvier, 1905: 982 (part).

Funchalia woodwardi Bouvier, 1908: 91.

Funchalia vanhoeffeni Lenz & Strunch, 1914: 261.

Funchalia villosa Burkenroad, 1936: 129; Crosnier & Forest, 1973: 296; Kensley, 1977: 29.

Material examined

South Africa: Off Natal (300-600 m), 3 ♀♀, 9.15 mm - 17.2 mm; 4 ♂♂, 10.7 mm - 16.0 mm.

Description

Rostrum: Surface rough and pubescent; straight; short, reaching just beyond eye; rostral formula 5-6/0; epigastric and one other tooth behind orbital margin of carapace; adrostral carina short, extending from between epigastric and first rostral teeth to below fourth tooth; postrostral carina distinct almost reaching posterior margin of carpace; no median sulcus.

Carapace: Irregularly pubescent; pubescence easily rubbed off; setae fairly long and stout; gastrofrontal sulcus and longitudinal suture absent; orbital spine absent; cervical sulcus and carina restricted to short, shallow sulcus, normally hidden by pubescence; hepatic spine absent; orbito-antennal sulcus short but distinct; antennal carina as long as orbito-antennal sulcus, terminating in short antennal spine; branchiocardiac carina horizontal except for anterior

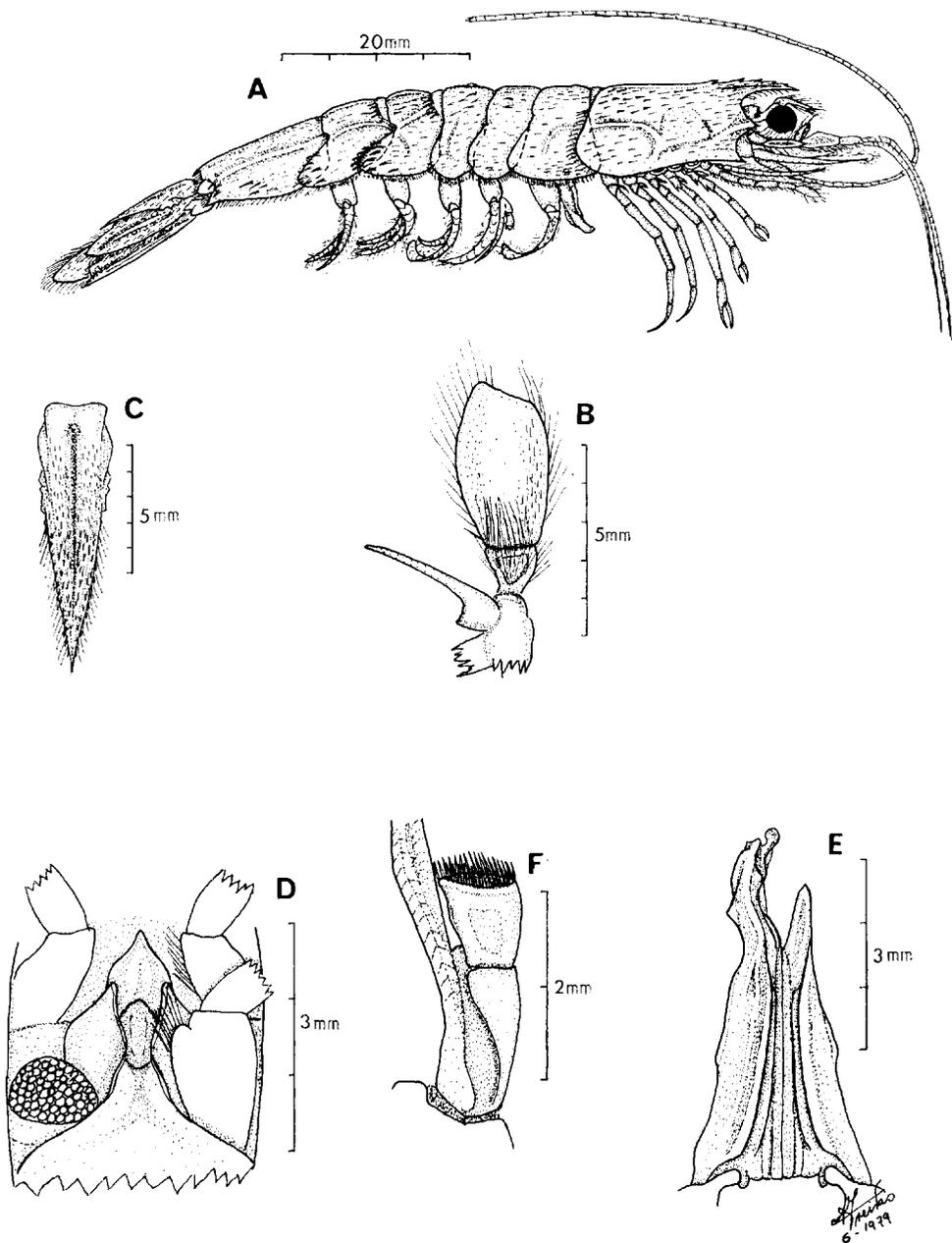


Fig. III-1 *Funchalia villosa* (Bouvier): A. Whole animal; B. Mandibular palp; C. Telson; D. Thelycum; E. Petasma; F. Appendix masculina.

quarter which bends anteroventrally, extending from posterior margin anteriorly to post-hepatic carina; post-hepatic carina short; hepatic sulcus shallow but distinct, upwardly bent anteriorly meeting antennal carina; branchiostegal spine absent; pterygostomial angle spinose with short but distinct carina.

Antennule: Flagella subequal in length, almost as long as carapace; base of lateral flagella broader than that of mesial flagella; prosarتما long and narrow, reaching to well beyond eye; stylocerite short and subquadrate, spine short, arising from upper anterior angle of stylocerite; lateral margin of first antennular article broad, concave and setose, distolateral spine short, forming apex of margin; large, triangular, hairy tubercle arises from anterodorsal surface of first antennular article; parapenaacid spine absent.

Scaphocerite: Distolateral spine reaching slightly beyond antennular peduncle; apex of lamella just longer than distolateral spine; basicerite unispinose.

Mandibular pulp: Reaching to about one-third of carapace; proximal article 0.4 times as long as wide; distal article suboval, apex rounded although some specimens have apex concave with anterior mesial angle longer than outer angle; distal article 1.5 times as long as wide and six times length of proximal article; upper mesial angle of incisor prolonged into scythe-like process about as long as distal article.

Maxilliped III: Endopodite reaching to distal end of first antennular article; sexually dimorphic; in male dactylopodite broad, very slightly longer than propodite, about four times as long as wide; in female, dactylopodite narrow, distinctly longer than propodite, about seven times as long as wide; no basal or ischial spines; exopodite long, well developed, reaching beyond distal end of endopodite; epipodites present.

Pereiopods: Exopodites present on all pereiopods; epipodites present on first three pairs; small but clear basal and ischial spines on first two pairs. Pereiopod III reaching to distal end of first antennular article; pereopod V reaching to distal end of stylocerite. Extended laterally, lengths of pereiopods in ascending order are: first, second, fifth, fourth and third.

Abdomen: Irregularly pubescent; pubescence easily rubbed off; setae fairly long and stout; dorsally carinated from fourth to sixth segments; dorsal tubercle at centre of third segment; carina of sixth segment ends in short spine; unbroken horizontal lateral cicatrices on fifth and sixth segments; lateral cicatrix on fourth segment continuous and oblique.

Telson: Telson 0.7 times length of sixth segment; about 0.9 times length of mesial ramus of uropods; median sulcus wide and deep; terminal spine long and sharp; distal third with series of small inconspicuous fixed spines; proximolateral margin with three blunt, tooth-like lobes; surface setose.

Thelycum: Simple open structure. Anterior portion consists of central arrow-head shaped plate arising from sternite between fourth pereiopods; lateral wings of plate ventrally directed; apex pointed but not long and sharp. Posterior portion consists of elevated central plate arising from sternite between fifth pereiopods; anterior margin forming deep "U"-shaped notch; mid-surface concave bordered by distinct curved carina on each side; anterolateral plate terminating in broad horn-like points. Between both portions a deep well-like pit.

Petasma: Asymmetrical; involuted and pod-like. Dorsomedian lobules membranous, subrectangular, united along midline; best seen from dorsal view; proximal margin truncate. Ventromedian lobules membranous; forms ventral fold into petasma; subequal in length to dorsomedian lobule. Dorsolateral lobules highly sclerotized; best seen from dorsal view; left lobule subtriangular; apex pointed extending beyond limit of median lobules; longitudinal carina and sulcus clearly seen dorsally; horizontal tubercle present proximally on dorsal surface; right lobule subtriangular in shape; apex produced distally in broad, slightly twisted process, reaching beyond apex of left lobule; ventrally apical process with deep sulcus; longitudinal dorsal carina and sulcus present. Ventrolateral lobule of left half subtriangular; thick and broad; ventral costa narrow, fused with rest of lobule; ventrolateral lobule of right half thick and broad; apex prolonged into twisted distal process, fitting into and fused with

ventral sulcus of apical process of dorsolateral lobule; distal process bears blunt lateral tooth.

Appendix masculina: Subquadrate; about as long as wide; distal margin truncate and about twice as wide as proximal margin; apex subelliptical in cross-section, surrounded by short, stout setae; dorsal surface glabrous and very slight concave. Basal segment of endopodite of pleopod II about twice as long as wide; about 1.4 times as long as appendix masculina; glabrous except for short longitudinal row of setae, proximally on ventral surface; dorsal surface with deep curved central sulcus.

Colour in life: As only preserved specimens were examined it is not possible to describe the colour in life of this species.

Taxonomic status and comments

There is little doubt that the specimens collected during the South African Museum's "Meiring Naudé" cruise off Natal are in fact *Funchalia villosa* as described by Kensley (1977). Kensley also clearly showed the differences in the structure of the male and female genitalia between *F. villosa* and *F. woodwardi*. Burkenroad (1936) also investigated the differences between these two species.

Distribution (Fig. III-2)

Funchalia villosa is essentially an Atlantic species although Burkenroad (1936) believes that the early postmysis stage found off New Zealand and described by Gurney (1924) may be "referable" to *F. villosa*. More specifically this species has been found from the Caribbean (Burkenroad); eastern and western North Atlantic, South Central Atlantic (Bouvier); South Africa — Agulhas Bank and Natal (Kensley).

Nothing is known with regard to the biology of *F. villosa*. This species appears to be found at depths between 50 and 500 metres. The southeast African species were found between 300 and 500 metres (Kensley 1977).

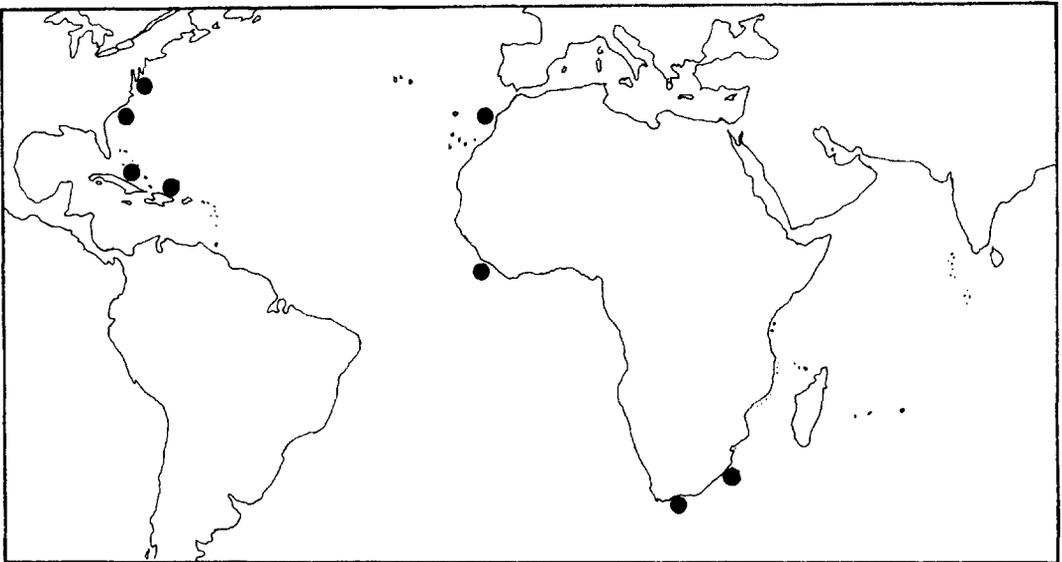


Fig. III-2 Distribution of *Funchalia villosa*

Genus *Metapenaeopsis* Bouvier (emend), 1905

- Metapenaeopsis* Bouvier, 1905: 981; Kubo, 1949: 408-411; Dall, 1957: 166-167; Hall, 1962: 32; Racek & Dall, 1965: 17-21; Perez Farfante, 1971: 7-8; Champion, 1973: 187-195.
Penaeopsis De Man, 1911 (part): 53-55; Kemp, 1915 (part): 321; Schmitt, 1926 (part): 319-323; Barnard, 1950: 592; Racek, 1955: 225.
Metapenaeus Alcock, 1905 (part): 529; Alcock, 1906 (part): 16.
Leptopenaeus Kishinouye, 1929: 282.
Ceratopenaeus Kishinouye, 1929: 282.
Erythropenaeus Kishinouye, 1929: 283.
Penaeopsis (*Metapenaeopsis*) Burkenroad, 1934a: 4-12.

This genus was originally established in 1905 by Bouvier to receive *Metapenaeopsis pubescens* which later proved to be a secondary homonym of *Penaeus pubescens* Stimpson. Kishinouye (1929) proposed the forming of a special group for those members of the genus *Penaeopsis* with asymmetric petasmata and established three genera within this group, viz.: *Leptopenaeus*, *Ceratopenaeus* and *Erythropenaeus*. Burkenroad (1934a) thought this arrangement rather artificial and revived Bouvier's genus *Metapenaeopsis* but relegated it to the status of a subgenus of *Penaeopsis* Bate, and included within it those species with asymmetric petasmata.

Kubo (1949) considered the asymmetry of the petasma, the characteristic of the appendix masculina and other structures as being of generic significance and so elevated the subgenus *Metapenaeopsis*, as defined by Burkenroad, to the rank of genus. This arrangement has been accepted by subsequent authors.

The genus is composed generally of small animals; integuments uniformly pubescent; rostrum well developed and dorsally toothed only; cervical, hepatic and orbito-antennal sulci usually absent or ill defined; orbital, antennal, hepatic and pterygostomial spines well developed; basal spines present on third maxilliped, first and second pereopods; ischial spine present only on first pereopods; parapenaeid spine present but small; telson with one pair of immovable spines and three pairs of movable spines; petasma characteristically asymmetric.

The complexity of the asymmetric petasma of the genus *Metapenaeopsis* warrants some attention if the descriptions of this organ of the four species dealt with below are to be understood. Kishinouye (1929), Burkenroad (1934a), Kubo (1949) and Perez Farfante (1971) have all studied this structure in some detail. Essentially, the general description which follows is based on the work of the last two of these authors.

Each petasmasmal endopodite (Fig. III-3), as in all penaeoid prawns, is divided into four lobules: dorsomedian, ventromedian, dorsolateral and ventrolateral. The dorsomedian lobules of both petasmasmal halves are narrow and united to one another along their entire length. The ventromedian lobules in both petasmasmal halves are also narrow but thicker than the dorsomedian lobules. Both these lobules are somewhat difficult to distinguish apart.

The dorsolateral lobules of both petasmasmal endopodites are divided into a proximal element and distal part. The proximal elements are produced into mesially curved proximedian projections. These projections may not be equal in length. The distal part of the left petasmasmal half is formed by the distodorsal element and the distodorsal projection (Perez Farfante 1971) or the intermediate strip (Kubo 1949). This distodorsal projection may be simple (as in *M. philippii*) or may be divided into two sections, i.e. the inner and outer distodorsal projections (e.g. *M. barbatus*, Kubo 1949). The distal part of the right petasmasmal endopodite is formed simply by the distodorsal element, except in the American species, in which it bears two projections.

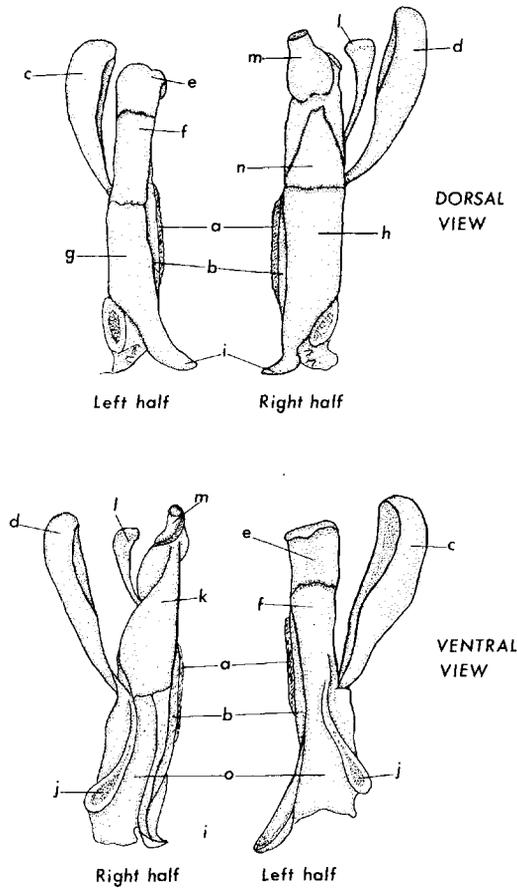


Fig. III-3 Diagrammatic sketch of left and right petasmas showing characteristics used in the description of this organ: a — dorsomedian lobule; b — ventromedian lobule; c — left distoventral projection; d — right distoventral projection; e — distodorsal projection (intermediate strip); f — distodorsal element; g — proximal part of left dorsolateral lobule; h — proximal part of right dorsolateral lobule; i — proximomedian projection; j — ventral costa; k — distoventral flap; l — distoventral element; m — distoventral coil; n — distodorsal element; o — proximal part of ventrolateral lobule.

The ventrolateral lobule of both petasmas are divided into proximal and distal parts. The proximal part is heavily sclerotized and has a short but strong ventral costa. The distal part of the left endopodite consists only of left distoventral projection which is usually hood-like and may possess, terminally or subterminally, a process bearing denticles or papillae. The distal part of the right petasmas endopodite is somewhat complex, consisting of an external hook-like right distoventral flap, the apex of which is usually twisted into a distoventral coil.

There are about 38 species to this genus but a few are still considered doubtful. Of the 38, 30 have been found in the Indo-west Pacific region and of these only *M. hilarulus*, *M. mogiensis*, *M. philippii* and *M. quinquidentatus* have been recorded from southeast African waters. Only the first two species have so far been found off Mozambique.

***Metapenaeopsis hilarulus* (De Man, 1911)**

(Fig. III-4)

Penaeopsis hilarulus De Man, 1911: 71; Barnard, 1946: 382; Barnard, 1950: 595.

Penaeopsis mogiensis Schmitt, 1926: 346-347.

Metapenaeopsis mogiensis Hall, 1962: 35; Racek & Dall, 1965: 42; Kensley, 1972: 22.

Metapenaeopsis hilarula Holthuis, 1980: 16.

Metapenaeopsis hilarulus De Bruin, 1965: 84.

Material examined

Mozambique: Maputo Bay (5-15 m), 18 ♀♀, 9.4-2.9 mm; 2 ♂♂, 10.8-12.3 mm; Moma (12 m), 2 ♀♀, 9.9-12.6 mm.

Description

Rostrum: Pubescent, straight, slightly inclined upwards, reaching or almost reaching distal end of second article of antennular peduncle, rostral formula 9-10/0; only epigastric tooth behind orbital margin of carapace; adrostral sulcus and carina present from orbital margin to second last rostral tooth; postrostral carina and median sulcus absent.

Carapace: Uniformly pubescent; postocular sulcus absent; gastrofrontal sulcus absent; orbital spine small but well developed; cervical sulcus short, obscured by tomentum; hepatic spine long; antennal carina not well defined, terminating in prominent antennal spine; orbito-antennal sulcus very short, virtually restricted to depression above antennal carina; postorbital spine absent; hepatic sulcus long and anterior half bent anteroventrally, obscured by short setae; branchiocardiac carina and branchiostegal spine absent; pterygostomial spine present; submarginal carina absent.

Antennule: Flagella roughly one-third length of antennular peduncle; subequal in length; exhibits sexual dimorphism; mesial flagellum of male laterally compressed with upper edge concave near base, followed by raised ridge bearing blunt spine; lateral flagellum crossing over mesial at basal concavity; prosartema short, wide at base, distally narrow, reaching just beyond distal margin of eye; stylocerite long, straight and ending in sharp spine, just surpassing eye; distolateral spine of basal article sharp but short; parapenaacid spine inconspicuous.

Scaphocerite: Distolateral spine reaching distal end of third antennular article; apex of lamella not extending beyond distolateral spine; basicerite unispinose.

Mandibular palp: Reaching midlength of carapace; proximal article with narrow base, about 0.5 times as long as wide; ventral surface concave; distal margin with long setae; distal article with broad proximal half tapering abruptly to narrow but rounded apex; 3.2 times length of proximal article; surface lightly setose; 1.2 times as long as wide; longitudinal sulcus running from apex to base of article.

Maxilliped III: Endopodite of both male and female reaching end of third antennular article; exopodite short, reaching about midlength of merus of endopodite; basipodite with strong spine; epipodite absent.

Pereiopods: Exopodites long and narrow, present on all five pereopods; epipodites present on first three pairs; basipodites of first two pairs of pereopods with strong spine; ischial spine present on first pair only. Pereiopod III reaching to end of third antennular article. Extended laterally length of pereopods in ascending order are: first, second, fourth, fifth and third.

Abdomen: Uniformly pubescent; third to sixth segments strongly carinate, carina of third segment widest, with upper surface flat, lacking median sulcus; carina of sixth segment terminating in strong spine; no lateral cicatrix present.

Telson: Slightly longer than sixth abdominal segment; distinctly shorter than mesial ramus of uropods; median sulcus present but obscured by pubescence; telson terminating in acute

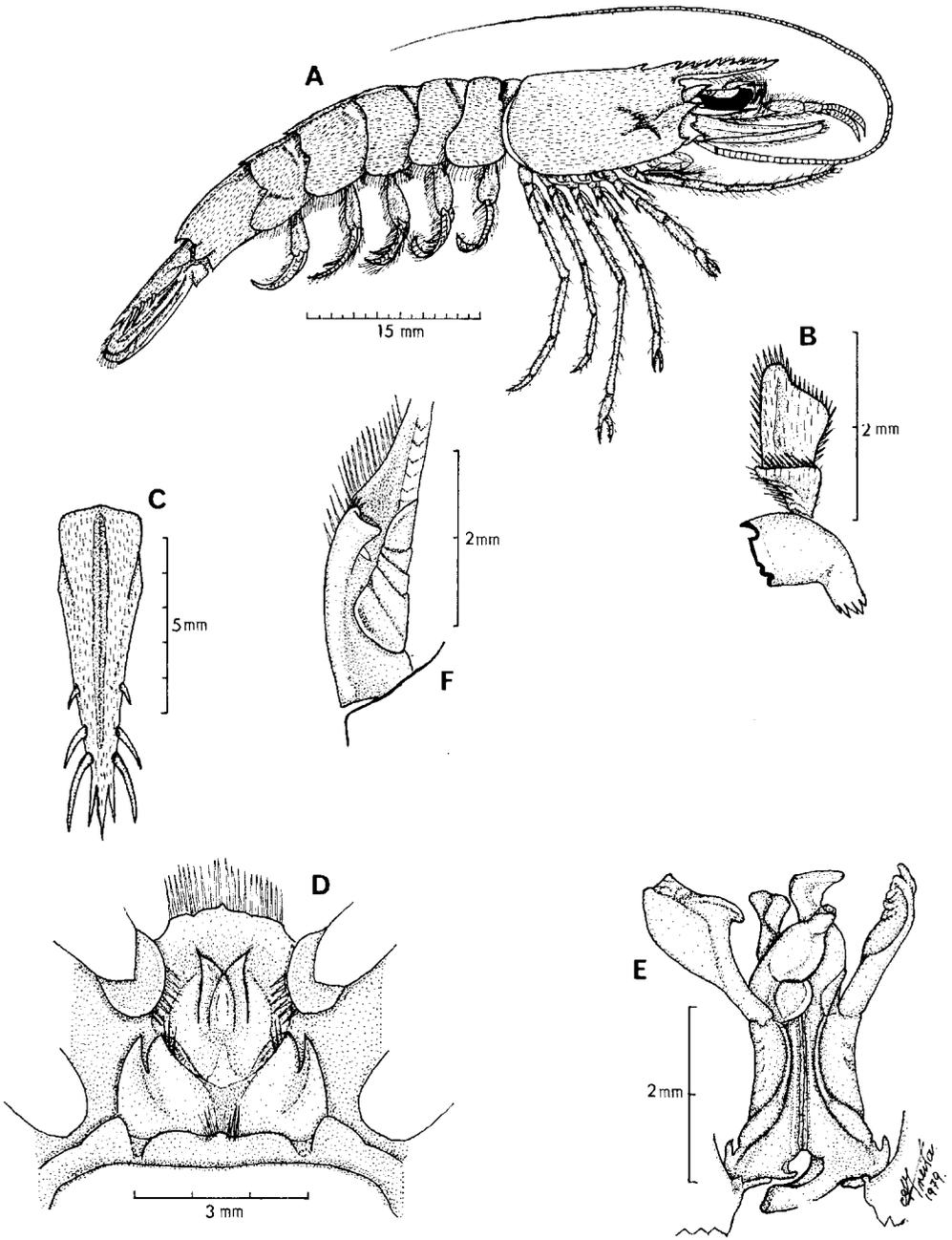


Fig. III-4 *Metapenaeopsis hilarulus* De Man: A. Whole animal; B. Mandibular palp; C. Telson; D. Thelycum; E. Petasma; F. Appendix masculina.

spine; fixed subapical spines strong; three pairs of movable marginal spines anterior to fixed pair; first pair shortest while most distal pair just surpassing fixed spines.

Thelycum: Simple open structure. Anterior portion, between fourth pair of pereopods, consisting of subquadrate plate; anterior margin horizontal with small median tooth; its concave surface bearing raised subquadrate structure in centre; sides of central structure parallel, with anterolateral angles produced anteriorly into straight sharp spines. Posterior portion, between fifth pair of pereopods, consisting of transverse plate roughly twice as wide as long; surface with median concavity; anterior margin with wide central emargination; two close-set teeth on each side, flanking central structure. Median part of posterior thoracic ridge delimited by narrow deep depression on each side.

Petasma: Characteristically asymmetrical. Dorsomedian lobules joined along entire midline; ventromedian lobules difficult to distinguish from dorsomedian lobules. Proximal part of dorsolateral lobules (best seen from dorsal view) subrectangular; proximomedian projection of left petasmal endopodite longer and stouter than right, broad and truncate; extending beyond midline of petasma. Left distodorsal element subquadrate, convex dorsally, ventrally concave with thick boss-like ridge at proximal outer angle; distodorsal projection with terminal portion broad, flattened and bearing boss-like process covered with many rounded tubercles; neck fairly broad with thin lamellate outer ridge, dorsally. Right distodorsal element subquadrate with convex surface, narrowly deltoid terminal portion preceded by deep sulcus. Proximal parts of ventrolateral lobules (best seen from ventral view) heavily sclerotized, concave, with relatively broad ventral costae; left distoventral projection narrow, concave on inner face, its apex fleshy and pointed with no well developed papillae. Right distoventral projection swollen, hood-like with external surface convex, and bearing fleshy apical flap; distoventral element contiguous with distodorsal element, short and club-like with irregular head, fitting into concave face of distoventral projection; distoventral flap longer than distoventral element, proximal margin with well developed oblique semicircular ridge; distoventral coil loose, lip smooth.

Appendix masculina: Subrectangular, its mesial margin thickened, strongly curved and trumpet-like apically; apex with concave centre; inner lips with small tubercle bearing two to three minute setae; mesial pleopod short with semicircular expansion on proximomesial margin; proximolateral margin bearing four or five scale-like ridges.

Colour in life: As only preserved material was available it was not possible to describe the colour in life of this species.

Taxonomic status and comments

There is little doubt that this species is very similar to *M. mogiensis* which has thus generated the existing confusion. De Man (1911) realized that his specimens from Indonesia were different from the Japanese specimens described by Rathbun (1902) and those from India described by Alcock (1906). Other workers such as Schmitt (1926) and Hall (1961) believe that *M. mogiensis* and *M. hilarulus* are synonymous but Racek & Dall (1965) and Grey *et al* (1983) continue to leave the question open to debate.

Barnard (1950) had doubts as to the identity of the Durban specimens and believed them to be more closely similar to De Man's specimens and so "provisionally" identified them as *M. hilarulus*. However, De Bruin (1965) claimed that several specimens of *Metapenaeopsis* were caught in Ceylon waters and, in his opinion, the collection yielded individuals of both "*hilarulus*" and "*mogiensis*", and gave clear reasons for his decision. Unfortunately his illustrations are rather schematic.

A considerable number of specimens were collected in Mozambique over the years which were originally identified as *M. mogiensis*. Although very similar in many aspects, on closer examination, it was clear that there were two different species in the collection.

Metapenaeopsis hilarulus differs from *M. mogiensis* by having the dorsal abdominal carina with no median sulcus, the third pereopod considerably longer than the fifth and the telson considerably shorter than the mesial rami of the uropods. More striking, however, are the differences in the genitalia. The structure found in the centre of the anterior portion of the thelycum of *M. hilarulus* is distinctly subquadrate with parallel sides and the spines are not strongly curved. In *M. hilarulus* the apex of the left distoventral projection of the petama bears no finger-like papillae.

There was, originally, a doubt in my mind as to whether these differences could be ascribed to age. However, small specimens of both species were available to me and these differences were always present. Also De Bruin had specimens of the same size of both species and was able to distinguish them apart.

Careful scrutiny of some of the existing literature appears to indicate that the specimens described by Schmitt (1926), Hall (1962), Racek and Dall (1965) and Kensley (1972) are most probably *M. hilarulus*. Schmitt (1926), describing some specimens from Darnley Island and Torres Straits, clearly stated that the dorsal carina of the third abdominal segment possessed no median sulcus. The illustrations and photographs presented by Hall (1962) and Racek and Dall (1965) are clearly to be ascribed to *M. hilarulus*.

Distribution (Fig. III-5)

Metapenaeopsis hilarulus was first recorded in the Indo-west Pacific from Indonesian waters. It was been recorded from Indonesia — Sulu Island, Weigo Island, Kei Island, Pulu Jedan, East Aru Island, N.E. Timor, Dangar Basar, Saleh Bay (De Man); Australia — Queensland off Prudhoe Island, Torres Strait (Schmitt, Racek & Dall); Singapore — Bedok (Hall); Sri Lanka — Manar (De Bruin); Mozambique — Moma, Maputo Bay (de Freitas); South Africa — Durban Bay (Barnard).

This species is basically a shelf penaeid with a depth range between 10 and 54 metres. Off Mozambique and South Africa *M. hilarulus* has been recorded from 5-15 metres and has been found on muddy and muddy sand substrata.

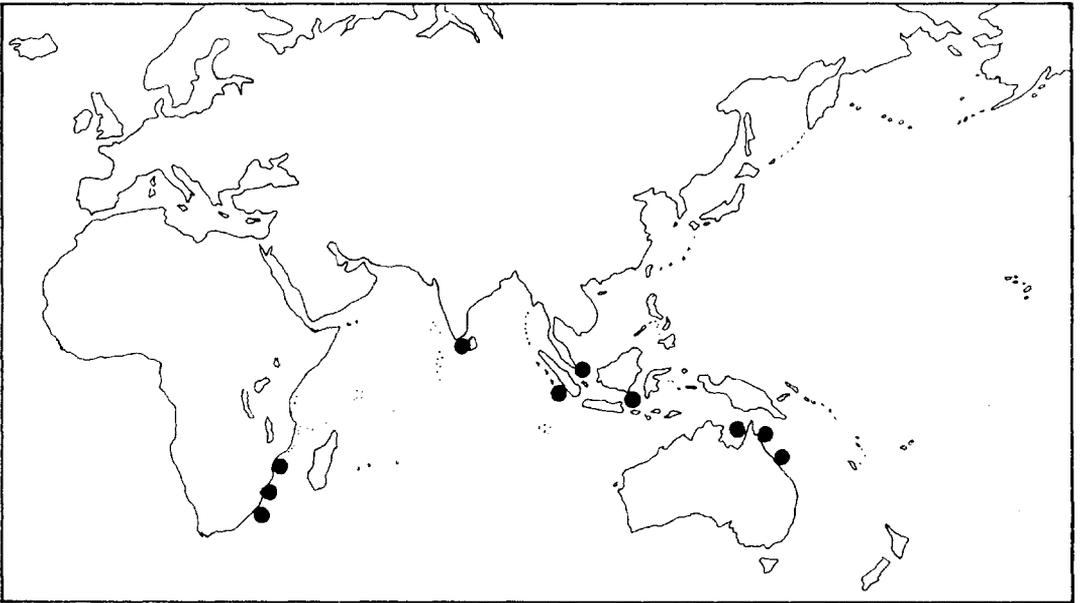


Fig. III-5 Distribution of *Metapenaeopsis hilarulus*.

***Metapenaeopsis mogiensis* (Rathbun, 1902)**

(Fig. III-6)

Parapenaeus mogiensis Rathbun, 1902: 39; Rathbun, 1906: 904.

Metapenaeus mogiensis Alcock, 1906: 29.

NOT *Penaeopsis mogiensis* Schmitt, 1926: 346-347.

Metapenaeopsis mogiensis Kubo, 1949: 412 (in key); Dall, 1957: 172; Hall, 1961: 109; De Bruin, 1965: 84; de Freitas, 1972: 5 (in key); Holthuis, 1980: 17; Grey, Dall and Barker, 1983: 81-82.

NOT *Metapenaeopsis mogiensis* Hall, 1962: 35; Racek & Dall, 1965: 42; Kensley, 1972: 22 (in key).

Material examined

Mozambique: Maputo Bay (5-15 m), 4 ♀♀, 14.1-15.8 mm, 11 ♂♂, 9.4-12.3 mm; Chiloane (15-20 m), 1 ♀, 19.0 mm; Sofala Bank (50 m), 2 ♀♀, 15.0-16.6 mm; 2 ♂♂, 14.2-16.1 mm.

South Africa: Sodwana (from gut of *Thunnus albacares*), 1 female, 22.3 mm.

Description

Rostrum: Pubescent, straight, slightly inclined upwards, reaching or almost reaching distal end of second article of antennular peduncle, rostral formula 9/0; only epigastric tooth behind orbital margin of carapace; adrostral sulcus and carina present from orbital margin of carapace to second last rostral tooth; postrostral carina and median sulcus absent.

Carapace: Uniformly pubescent; postocular and gastrofrontal sulci absent; orbital spine small but well developed; cervical sulci short and obscured by tomentum; hepatic spine long; antennal carina rather weak, terminating in relatively long antennal spine; orbito-antennal sulcus very short, virtually restricted to depression above antennal carina; postorbital spine absent; hepatic sulcus long, its anterior half bent anteroventrally, obscured by short setae; branchiocardiac carina and branchiostegal spine absent.

Antennule: Flagella about one-third length of antennular peduncle; subequal in length; exhibiting sexual dimorphism; mesial flagellum of male laterally compressed with upper edge concave near base, followed by raised bridge bearing blunt spine; lateral flagellum crossing over mesial at basal concavity; prosartema short, wide at base, narrow apically, reaching almost to distal end of eye; stylocerite long upwardly curved, ending in sharp spine; reaching beyond eye; distolateral spine of basal article sharp but short; parapenaeid spine present but inconspicuous.

Scaphocerite: Distolateral spine reaching distal end of third antennular article; apex of lamella not overreaching distolateral spine; basicerite unispionose.

Mandibular palp: Reaching midlength of carapocerate; proximal article with narrow base, about 0.6 times as long as wide; ventral surface concave; long setae along distal margin; dital article with broad proximal half tapering abruptly to narrow but rounded apex; 2.1 times length of proximal article; surface lightly setose; longitudinal sulcus running from base to apex of article.

Maxilliped III: In male endopodite reaching to distal end of antennular peduncle; in female endopodite reaching to end of second antennular article; exopodite present on first three pairs; basipodites of first two pairs bearing strong spines; ischial spine on first pair. Pereiopod III reaching to, or just beyond, distal end of second antennular article. Extended laterally length of pereiopods in ascending order are: first, fourth/second and third/fifth.

Abdomen: Uniformly pubescent; third to sixth segments strongly carinate dorsally; carina of third segment widest, with well defined median sulcus; carina of sixth segment terminating in strong spine; no lateral cicatrix present.

Telson: Just slightly longer than sixth abdominal segment; equal to or shorter than mesial ramus of uropods; median sulcus present but difficult to see due to pubescence; telson

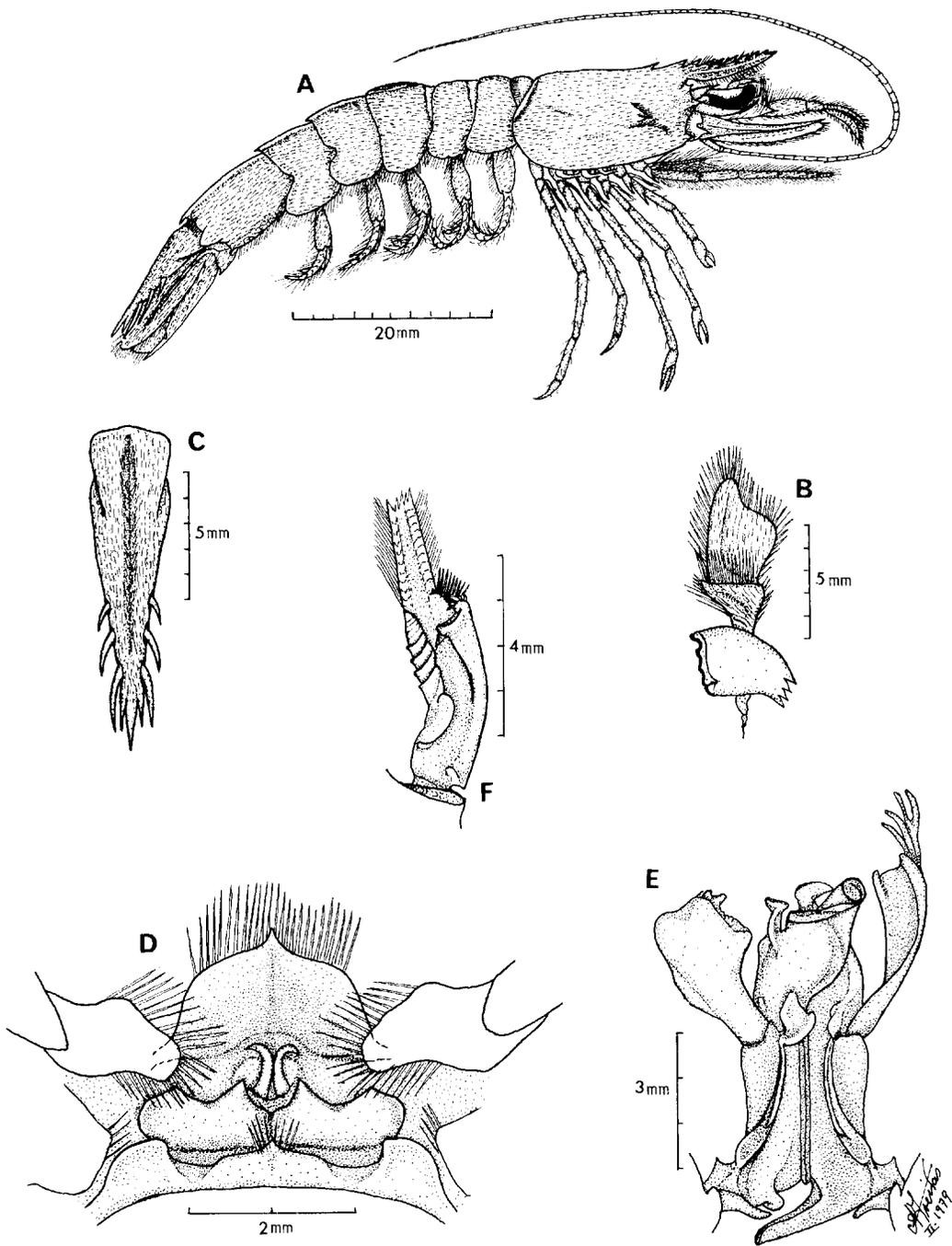


Fig. III-6 *Metapenaeopsis mogiensis* (Rathbun): A. Whole animal; B. Mandibular palp; C. Telson; D. Thelycum; E. Petasma; F. Appendix masculina.

terminating in sharp spine; immovable subapical spines strong; three pairs of movable marginal spines anterior to fixed pair; first pair short, while most distal pair broad and reaching tip of subapical spines.

Thelycum: Simple open structure. Anterior portion, between fourth pair of pereopods, consisting of concave plate with anterior margin rounded or bearing blunt tooth medially, and raised central structure forming two strongly recurved sharp spines. Posterior portion, between fifth pair of pereopods, consisting of transverse plate with slightly concave surface; anterior margin with relatively narrow central emargination separating pair of broad teeth; mesial pair of teeth encompassing base of central structure of anterior portion. Median part of posterior thoracic ridge delimited by wide depression on each side.

Petasma: Characteristically asymmetrical. Dorsomedian lobules joined along their midline; ventromedian lobules thicker than, and very difficult to distinguish from dorsomedian lobules. Proximal parts of dorsolateral lobules (best seen from dorsal view) subrectangular; proximomedian projection of left petasmas longer and stouter than that of right, narrow, truncate, extending beyond midline of petasma. Left distodorsal element subquadrate; distodorsal projection with irregular dorsal surface, its terminal portion broad and bearing dorsally boss-like process with rough surface; neck narrow and twisted; ventral face concave receiving convex face of distoventral flap of right petasmas. Right distodorsal element subquadrate with convex surface; broadly deltoid terminal portion with broad ridge and preceded by broad sulcus. Proximal parts of ventrolateral lobules (best seen from ventral view) heavily sclerotized, concave, with relatively broad ventral costae; left distoventral projection hood-like almost totally covering distoventral flap, with apical cockscomb-like process bearing four or five finger-like papillae. Right distoventral projection swollen, hook-like structure with external surface irregular, and bearing fleshy apical flap; distoventral element contiguous with distodorsal element, fitting into concave dorsal surface of distoventral element, its proximal margin with well developed oblique semicircular ridge; distoventral coil loose, lip smooth.

Appendix masculina: Subrectangular, its mesial margin thickened, strongly curved and trumpet-like apically; whole structure free of hairs; mesial pleopod short with semicircular expansion on its proximomesial margin; proximolateral margin with thickened plate bearing about seven scale-like ridges.

Colour in life: As only preserved material was available it was not possible to record the colour of this species while alive.

Taxonomic status and comments

Considerable confusion has existed in the past with regard to whether or not the De Man (1911) species, *M. hilarulus* is synonymous with *M. mogiensis* originally described by Rathbun (1902). Although Rathbun's illustrations are not very clear, her drawing of the petasma clearly shows that the left distoventral projection has a series of finger-like papillae arising from its apex. This characteristic does not exist in *M. hilarulus*.

De Bruin (1965) collected both species in Manaar, Sri Lanka, and clearly sets out the differences. These differences have made it possible to distinguish the two species in a collection from Mozambique waters. The only specimen so far recorded from South Africa is a large female taken from the gut content of a tuna, *Thunnus albacares*, caught off Sodwana Bay in February 1977. The shrimp was in perfect condition with no signs of digestion, indicating that it was ingested in the area.

Metapenaeopsis mogiensis differs from *M. hilarulus* in having a well defined median sulcus in the dorsal carina of the third abdominal segment; the telson reaching tip of the mesial ramus of the uropod, the third and fifth pereopods almost equal in length when extended laterally; prominent finger-like papillae arising from apex of left distoventral projection of petasma, and

the central structure of the anterior portion of the thelycum composed of two divergent and strongly curved sharp spines.

The specimens described by Schmitt (1926), which lack the grooved dorsal carina of the third abdominal segment, are obviously not *M. mogiensis*. Also, those specimens described and illustrated by Hall (1982), Racek and Dall (1965) and Kensley (1972) cannot be ascribed to this species.

Distribution (Fig. III-7)

Metapenaeopsis mogiensis is an Indo-west Pacific species, first recorded off Mogi, Japan. It has been recorded from Japan — Mogi, Minato, Satsumi (Rathbun, Schmitt); Hawaii — Molokai Island (Rathbun); Australia — Queensland off Darnley Island, Torres Strait, Murray Island (Dall); India — Andaman Islands, Malabar Coast (Alcock); Sri Lanka — Mullaitivu, Mannar (Alcock, De Bruin); Tanzania — Mafia Archipelago (Racek & Dall); Mozambique — Chinde, Sofala Bank, Chiloane, Maputo Bay (de Freitas); South Africa — off Sodwana Bay (de Freitas).

This species is basically a shelf penaeid with depth range between 10 and 65 m. Off Mozambique *M. mogiensis* has been recorded from 10 to 50 m, and has been found on muddy to muddy sand substrata.

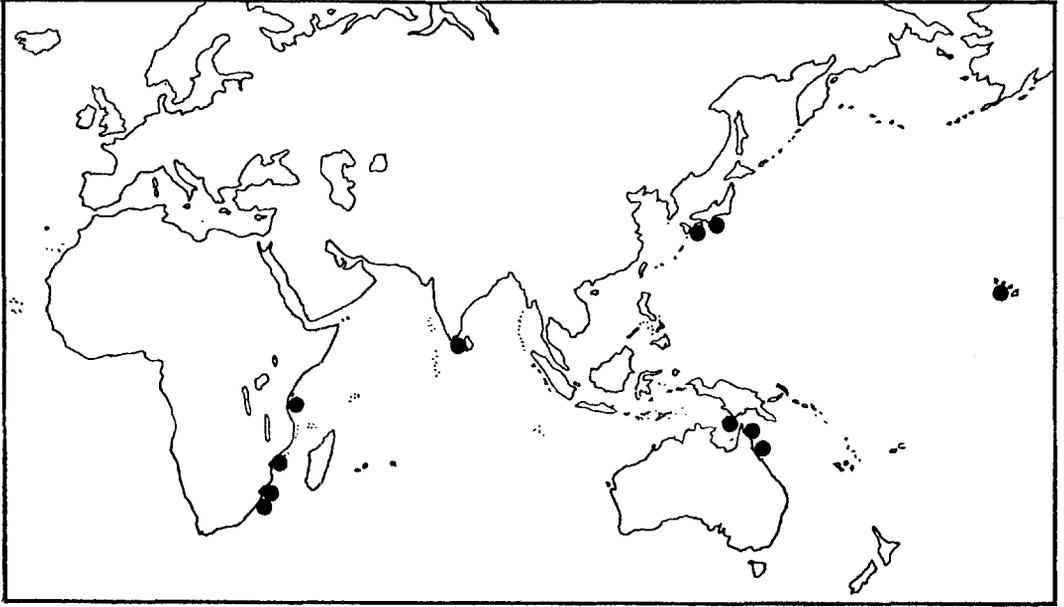


Fig. III-7 Distribution of *Metapenaeopsis mogiensis*.

***Metapenaeopsis philippii* (Bate, 1881)**
(Fig. III-8)

Penaeus philippii Bate, 1881: 181.

Penaeus philippinensis Bate, 1888: 261.

Penaeopsis philippii Calman, 1923: 536.

Penaeopsis (Metapenaeus) philippii Ramadan, 1938: 70.

Penaeopsis (Matapenaeopsis) philippii Barnard, 1950: 592.

Metapenaeopsis philippi Kensley, 1972: 22 (in key).

Metapenaeopsis scotti Champion, 1973: 195 (female paratype).

Material examined

South Africa: Durban, 1♂, 16.0 mm (*M. scotti* paratype); 30♀♀, 12.9-18.9 mm; 15♂♂, 12.4-17.8 mm.

Description

Rostrum: Pubescent; straight but slightly ascending distally; almost reaching to or extending beyond distal end of third antennular article in female; in male extending to within second antennular article; rostral formula 6-7/0; only epigastric tooth behind orbital margin of carapace; adrostral sulcus absent; adrostral carina somewhat indistinct reaching orbital margin; postrostral carina obscure; median sulcus absent.

Carapace: Uniformly pubescent (pubescence easily rubbed off to leave bare punctate patches; gastrofrontal and postocular sulci absent; orbital spine small but distinct; cervical sulcus somewhat indistinct and short; cervical carina restricted to slight swelling terminating anteriorly in short but well defined hepatic spine; gastro-orbital carina, orbito-antennal sulcus, as well as postorbital spines absent; antennal carina restricted to swollen buttress of short but sharp antennal spine; hepatic sulcus restricted to distinct depression below swollen buttress of hepatic spines; branchiocardiac carina very faint, extending from posterior end of hepatic groove to almost posterior margin of carapace; branchiostegal spine absent; pterygostomial angle spinose.

Antennule: In female mesial flagella longer than lateral; tapering gradually; mesial flagella equal to last two and a half of first antennular article in length; lateral flagella thicker than mesial; abruptly tapering at anterior quarter; in male mesial flagella as long as last two and a half first article of antennular peduncle; mesial flagella tapering gradually; blunt tooth-like tubercle at one quarter distance from base of mesial flagellum; prosartema subtriangular; apex pointed, reaching to about end of eye; stylocerite with long upwardly curved anterior style terminating in short spine; style reaching distal end of eye; distolateral spine of basal article sharp; parapenaeid spine very well developed, located just before anterior ventromedian angle of basal article.

Scaphocerite: Distolateral spine reaching distal end of third antennular article in female and almost reaching it in male; apex of lamella extending slightly beyond distolateral spine; basicerite with minute spine ventrally.

Mandibular palp: Reaching base of carapace; proximal article with narrow base, about 0.3 times breadth of distal margin; proximal article 0.8 times as long as wide; ventral surface concave and lightly setose; distal article 2.1 times length of proximal article; roughly subquadrate with mesiodistal angle extending to broadly rounded apex; lateral margin broadly rounded; ventral surface setose; longitudinal sulcus runs from apex to base of article.

Maxilliped III: Endopodite of male reaching at least to end of second antennular article and at most to about midlength of third antennular article; endopodite of female reaching to or slightly beyond distal end of third antennular article; exopodite extending to midlength of merus of endopodite; basipodite with conspicuous spine; epipodites absent.

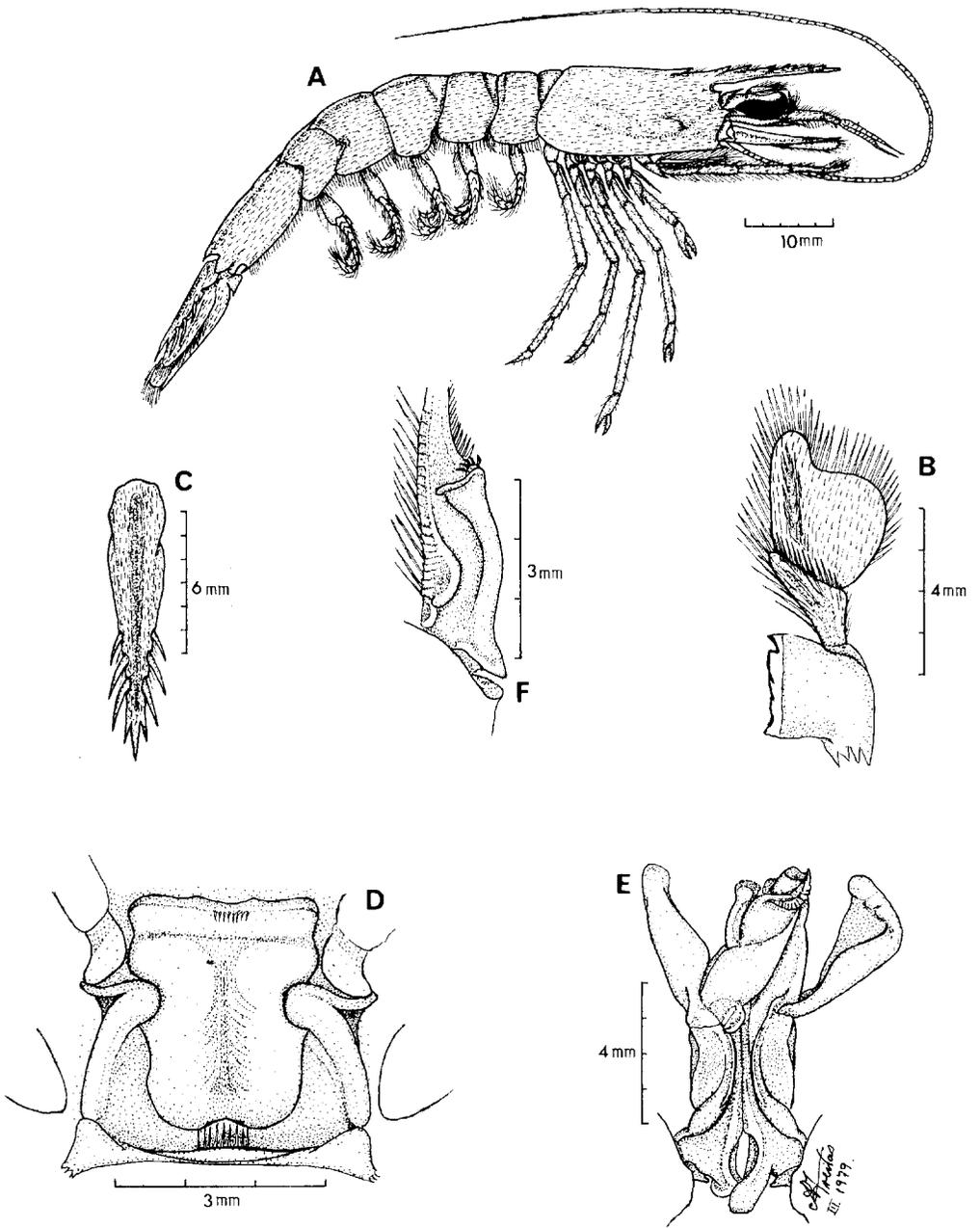


Fig. III-8 *Metapenaeopsis philippii* (Bate): A. Whole animal B. Mandibular palp; C. Telson; D. Thelycum; E. Petasma; F. Appendix masculina.

Pereiopods: Exopodite narrow and fairly long; present on all five pereiopods; epipodites present on first three only; basipodites of first and second pereiopods with short but strong spines; movable ischial spine on first pair only. Extended laterally lengths of pereiopods in ascending order are: first, second/fourth, and third/fifth. Some variation has been recorded (see Taxonomic status and comments).

Abdomen: Lightly pubescent (pubescence easily rubbed off leaving bare punctate patches); very short somewhat indistinct dorsal carina in middle of second segment; third to sixth segments with strong dorsal carina; posterior end of dorsal carina of each segment cleft accommodating anterior end of following segments; dorsal carina of sixth segment terminating in distinct spine; lateral cicatrices absent.

Telson: Just shorter than sixth abdominal segment; slightly shorter than mesial ramus of uropods; median sulcus shallow, almost indistinct and obscured by pubescence; telson terminating in sharp spine; three pairs of long movable marginal spines anterior to fixed pair; first pair shortest of three.

Thelycum: Simple open structure. Anterior portion, between fourth pair of pereiopods, consisting of broad median plate; anterior half with shallow transverse sulcus; posterior half somewhat narrower, projecting about two-thirds into posterior portion of thelycum; median longitudinal sulcus distinct in some specimens, indistinct in others; posterior edge indented. Posterior portion, between fifth pereiopods consisting of deeply concave central transverse plate; anterolateral arms accommodated in lateral notches of anterior thelycal plate; posterior ridge possessing setae medially.

Petasma: Characteristically asymmetrical. Dorsomedian lobules joined along entire midline. Ventromedian lobules thicker and difficult to distinguish from dorsomedian lobules. Proximal parts of dorsolateral lobules (best seen from dorsal view) subrectangular; proximomedian projection of left petasmas longer than that of right, extending beyond midline of petasma. Left distodorsal element subrectangular with distinctly concave inner or ventral face; distodorsal projection quadrate, its distal lip curled inwardly; area below distal angle rough due to too many minute tubercles; ventral face strongly concave, receiving convex face of right distoventral flap; distal part of right dorsolateral lobule consisting of subrectangular distodorsal element; slightly shorter than that of left endopodite. Proximal parts of ventrolateral lobules (best seen from ventral view) suboval, concave with strongly outwardly curved ventral costae; left distoventral projection hood-like almost totally covering distoventral flap. Right distoventral projection hood-like and shorter than left distoventral projection, completely covering distoventral element; distoventral element club-like with inwardly curved "shaft"; margins covered with minute tubercles; element half length of distoventral flap; distoventral flap as long as distoventral projection; base broad with strongly convex ventral face; distally tightly coiled; ventral lip of coil with transversally grooved ridge.

Appendix masculina: Appendix masculina trapezoid, its mesial margin greatly thickened and curved, trumpet-like apically; few short bristles on inner lips of apex; mesial pleopod short with semicircular expansion on its proximomesial margin.

Colour in life: Body generally cream to light pink, with delicate orange mottlings especially on abdomen; antennules and particularly antennular flagella darker orange to red; pereiopods and pleopods with reddish blotches at articulations; uropods cream becoming reddish orange on distal half; antennal flagella pink to orange; marginal setae of pleura, scaphocerite and pleopods cream to white; setae on uropods cream to orange.

Taxonomic status and comments

Champion (1973) in trying to identify three specimens caught off Durban in 160 fathoms (290 m) found it necessary to review the group of related species, namely *M. coniger*, *M. provocatoria*, *M. andamanensis* and *M. philippii*. By comparing preserved material obtained

from the Australian Museum, Sydney, and the National Museum of Natural History, Washington D.C., he concluded that the first three of those cited above were distinct species. However, the type material, for *M. philippii* was not available so he could not compare, at first hand, *M. philippii* with *M. andamanensis* and thus accepted these to be different species by stating "... there seems sufficient evidence to accept Hall's (1961, 1962) promotion of the variety to species *M. andamanensis*."

With regard to the three specimens caught off Durban, Champion (1973) indicated that they differed from *M. philippii* (as described by Bate, 1888) in having a rostrum *not* reaching beyond the antennular peduncle; the longer antennular flagellum being *shorter* than the last two articles of the peduncle; prosartema *just reaching* end of the eye; third pair of pereopods reaching *beyond* rostrum and finally, they did not "... have a furrow longitudinally traversing the propodus of the posterior of two pairs of pereopods." Champion (1973), therefore, went on to state that "The specimens are therefore described as a new species (*M. scotti*) pending clarification of the position of *M. philippii*" and concludes his discussion on the new species by saying that "... the 'Challenger' types of *M. philippii* should be re-examined, not only to verify the validity of the erection of *M. scotti* but also to define more clearly the taxonomic relationships of *M. philippii*. In addition, further *M. scotti* material is obviously necessary to consolidate the position of this species."

In November 1976 thirty females and fifteen males were trawled from a depth of 270 metres off Durban. These were at first identified as *M. scotti* as the thelyca are identical to that of the female paratype examined. However, following a closer examination, doubt arose in my mind as to the correctness of this identification. Further, Champion himself is quite clearly not completely convinced that his three specimens were indeed a new species.

First, with regard to those characteristics of the general morphology where Champion states there are differences between *M. scotti* and Bate's *M. philippii* I found that of my 45 specimens, 21 had clear entire rostrums and of these one showed its rostrum extending to *well beyond* the antennular peduncle. With regard to the antennular flagella, although the vast majority were broken, it was clear that in the three specimens where they seemed entire, the long flagella were considerably *longer* than the last two antennular articles.

Again a similar situation arose with regard to the stylocerites, some of which just reached the end of the eye while others extended just beyond the eye. The prosartema of all specimens reached to about the end of the eye and never to well beyond the eye as illustrated by Bate (1888). However, I believe that Bate has illustrated the long setae extended forward rather than just the prosartema. This being the case it seems probable that no difference exists between this characteristic in *M. scotti* and *M. philippii*.

Of the 28 specimens where the third pereopods were unbroken, there was a variation with regard to the distance that this pereopod could reach. Seventeen had the third pereopods reaching beyond the antennular peduncle; in six these just reached the end of the peduncle; in four they fell short of the distal end of the peduncle and in one case the right pereopod just reached the end of the second antennular article while the left was shorter than the right by the length of the chela.

No longitudinal furrow was found on the propodus of the last two pereopods although, generally speaking, the mesial surface of the propodus of many species examined were somewhat concave which may have resulted in Bate's description.

It seems to me that the above characteristics as exhibited by the 45 specimens caught in 1976, cannot be used as distinguishing features.

The thelyca of the 30 females in question clearly resemble closely the illustrations presented by Calman (1923) and Bate (1888) in spite of the fact that the drawings are rather bad. Further they agree completely with the thelecum of the female paratype of *M. scotti* deposited in the collection of the Oceanographic Research Institute (ORI).

Where the petasma is concerned, my specimens agree more closely with the illustration of *M. andamanensis* by Champion (1973) than with his descriptions and illustrations of *M. scotti*. For example, he states that the distomedian lobule is absent whereas it is quite obviously present in my specimens. This difference can only be clarified by comparing my specimens with the holotype of *M. scotti*.

I conclude, therefore, that my specimens, as well as the female ascribed as the paratype of *M. scotti* and found in the collection at the ORI Durban, be identified as *Metapenaeopsis philippii* (Bate) until the taxonomic validity and position of this species is clarified.

Distribution (Fig. III-9)

Metapenaeopsis philippii is an Indo-west Pacific species found from Japan in the east to South Africa in the west. More specifically it has been recorded from Japan (Barnard); Philippines (Bate); Indonesia — Kei Islands, Celebes (Bate); Admiralty Islands (Bate); India — Andaman Islands (Barnard); Zanzibar (Ramadan); South Africa — Durban (Calman, Barnard, de Freitas).

Metapenaeopsis philippii is a deep water species having been found between 145 m to 894 m. The deepest record is given by Ramadan (1938) for specimens caught off Zanzibar. Off Durban this species was caught at 270 m (de Freitas) and 290 m (Champion). Although most of the specimens have been found on muddy substrata, Bate (1888) records specimens from coral, stony and gravel substrata.

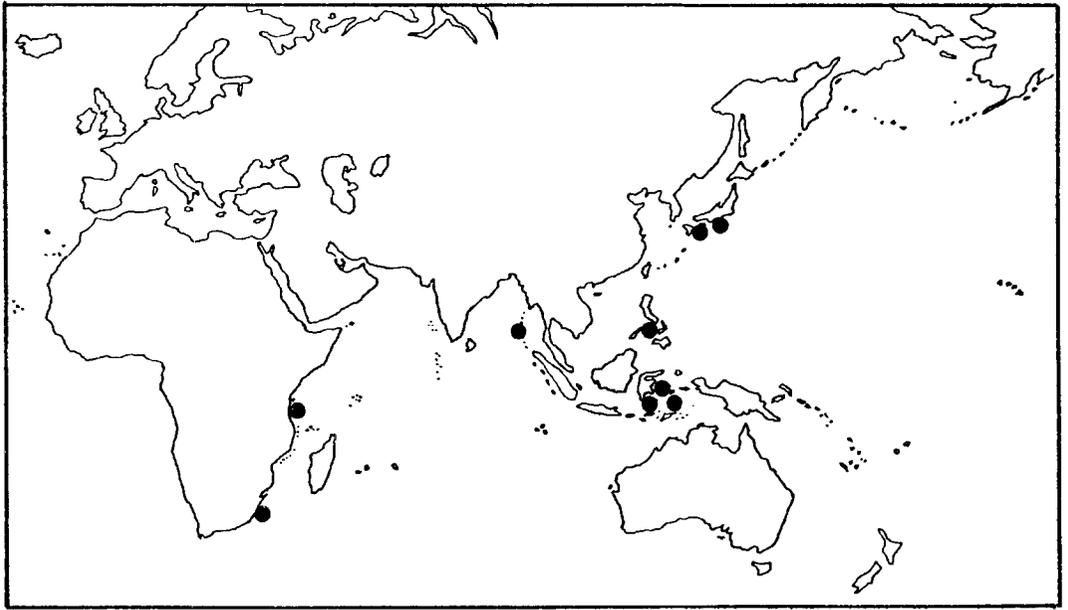


Fig. III-9 Distribution of *Metapenaeopsis philippii*.

Genus *Macropetasma* Stebbing, 1914

Macropetasma Stebbing, 1914a: 22; Burkenroad, 1934b: 74. 117-120; Barnard, 1950: 605-606; Holthuis, 1962: 108.

The genus *Macropetasma* was created by Stebbing in 1914 to accommodate Balss'

Parapenaeus africanus which did not have the characteristic parapenaeid longitudinal sutures on the carapace nor the small transverse suture on the carapace just above the second pereopod. As the name implies the male genitalia of the type species have two long stiletto-like terminal processes. Members of this genus are generally small animals; parapenaeid spine absent; longitudinal and vertical sutures absent; exopodites on maxilliped I and first pereopod only; epipodites absent from maxilliped III and pereopods IV and V; telson with 4 pairs of movable marginal spinules; sexual dimorphism exhibited on inner antennular flagella, on coxopodites of second and third pereopods and on ischiopodite of third pereopod.

There is only one known species, *M. africanus*, which is restricted to southern African waters.

***Macropetasma africanus* (Balss, 1913)**

(Fig. III-10)

Parapenaeus africanus Balss, 1913: 105.

Macropetasma africanum Barnard, 1946: 382-383; Barnard, 1950: 606-608.

Macropetasma africana Kensley, 1972: 20 (in key).

Macropetasma africanus Stebbing, 1914a: 22-23; Holthuis, 1962: 110.

Material examined

South Africa — Durban (10 m), 12♂♂, 4.4-8.6 mm; 11♀♀, 4.6-9.3 mm.

Description

Rostrum: Straight with arched dorsal crest; exhibits sexual dimorphism; in male reaching or almost reaching distal end of basal antennular article; distally terminating immediately after last tooth; in female reaching to midway along third antennular article; distally projecting somewhat beyond last tooth; rostral formula 8-10/0; epigastric only situated behind orbital margin of carapace; adrostral sulcus distinct; reaching base of first rostral tooth but not reaching epigastric; postrostral carina absent; median sulcus absent.

Carapace: Very sparsely pubescent; gastrofrontal sulcus absent; postocular sulcus present and situated on carapace between epigastric and first rostral tooth; orbital spine absent; cervical sulcus distinct but short; cervical carina terminating anteriorly in well developed hepatic spine; gastro-orbital and antennal carina absent; antennal spine small but distinct; orbito-antennal sulcus, postorbital and postantennal spines absent; hepatic sulcus distinct, short and horizontal; branchiocardiac sulcus present but somewhat indistinct; longitudinal and transverse sutures absent; branchiostegal spine absent; pterygostomian angle rounded.

Antennule: Flagella longer than peduncle; subequal in length; mesial flagella of male have flattened section near base with distinct tooth-like keel on mesial margin; prosartema small and laterally flattened, copiously provided with long setae, apex pointed, reaching to distal end of optic-peduncle; stylocerite relatively broad, pointed distally but not forming sharp spine; about half length of basal antennular article; distolateral spine short; parapenaeid spine absent.

Scaphocerite: In male distolateral spine reaching to midpoint of third antennular article; in females distolateral spine reaching distal end of third antennular article; apex of lamella does not extend beyond distolateral spine; basicerite with prominent ventral spine.

Mandibular palp: Reaching to base of carpocerite; proximal article subrectangular; 0.6 times as long as wide; mesial half occupied by swollen tubercle; distal article subtriangular; four times as long as proximal article and 1.6 times as long as wide; ventral surface slightly convex; glabrous except for one or two long setae near mesial border; apex narrow and rounded; mesial margin of both articles with long setae; outer margin of distal article setose.

Maxilliped III: Endopodites not exhibiting sexual dimorphism; reaching to midpoint of basal antennular article; both exopodites and epipodites absent.

Pereopods: Exopodites present only on first pair, well developed; epipodites only on pereopods I-III; no coxal, basal or ischial spines in female; in male, coxopodite of second

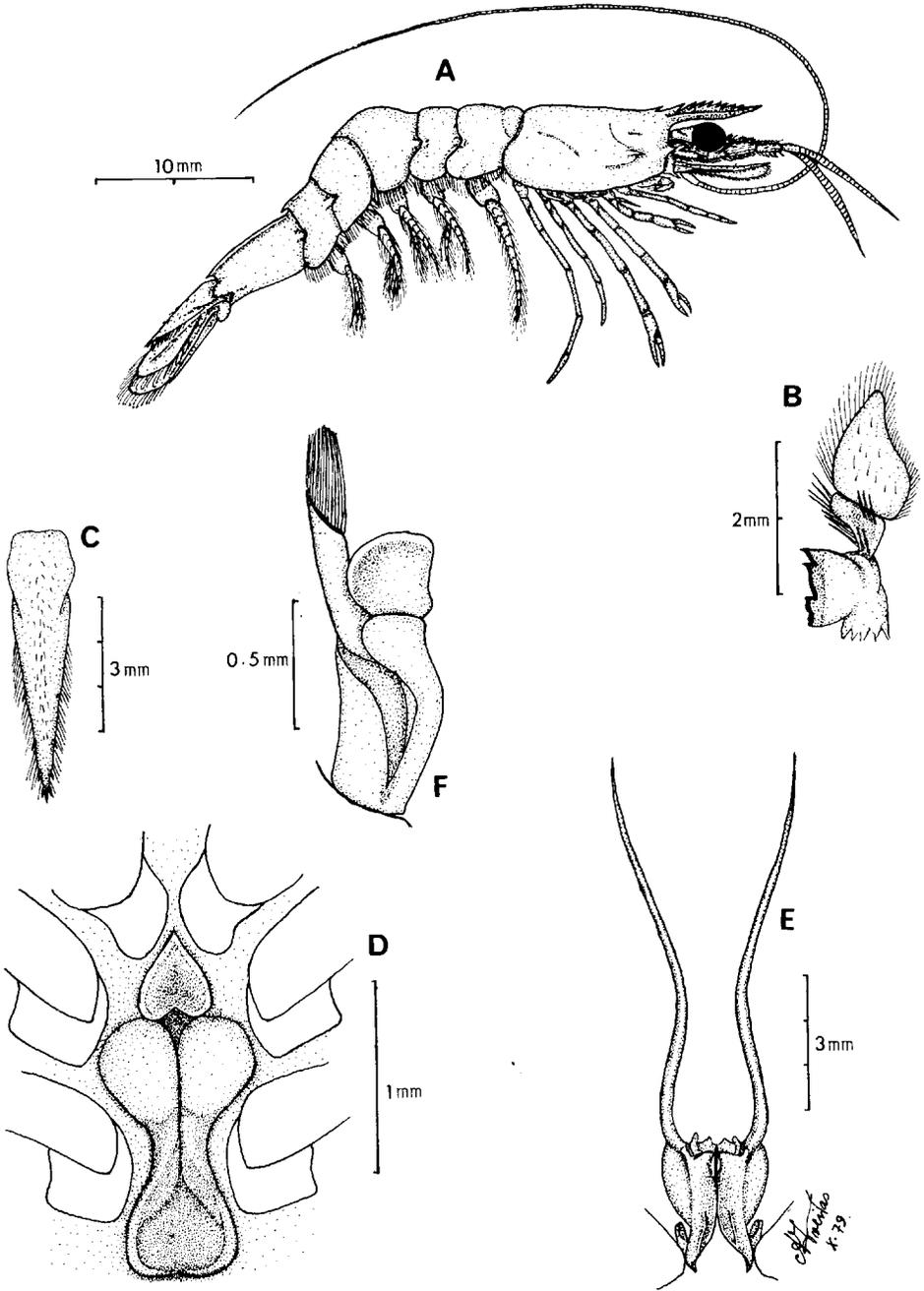


Fig. III-10 *Macropetasma africanus* (Balss): A. Whole animal; B. Mandibular palp; C. Telson; D. Thelycum; E. Petasma; F. Appendix masculine.

pereiopods have distinct ridge on mesial margin; coxopodite of third pair broadly flattened with blunt backwardly directed spine on inner margin; ischiopodite of second leg with very small tubercle-like tooth on mesial edge proximally; ischiopodite of third pereiopod with prominent keeled tooth directed backwards on inner edge proximally. Pereiopod V reaching to 0.75 of first antennular article. Extended laterally lengths of pereiopods in ascending order are: first, second, third/fourth and fifth.

Abdomen: Very sparsely pubescent; dorsal carina distinct only on sixth segment and feeble on posterior half of fifth; third segment exhibits sharp “hunchback”-like bend similar to that found among the Caridea; sixth segment twice as long as fifth; lateral cicatrices absent; peduncle of first pleopod of female greatly expanded and flattened.

Telson: Slender, slightly shorter than sixth abdominal segment; shorter than mesial ramus of uropods; finely pubescent; median sulcus absent; telson terminating in acute spine; four pairs of movable marginal spinules; distal two pairs close together; other two pairs more widely separated and inconspicuous, being hidden by marginal setae.

Thelycum: Simple semi-open structure. Anterior portion consisting of single central plate; inverted heart-shaped; apex pointed with fine marginal setae; plate arises from sternite between fourth pereiopods; surface very slightly concave. Posterior portion consisting of elongated narrow receptacle with two wavy longitudinal walls; anterior third of each wall developed into fleshy, bulb-like swellings between fourth and fifth pereiopods; posterior third forming an oval concave bowl-like section.

Petasma: Subrectangular, involuted pod-like structure; attached near base of pleopodal peduncle. Dorsomedian lobules united along midline; distal ends slightly curved ventrally. Ventromedian lobule narrow and subrectangular; as long as dorsomedian lobules. Dorsolateral lobule expanded into lateral keel-like swellings; anteriorly projecting into long gracefully curved stiletto-like processes which lie between pereiopods and reach as far forward as buccal cavity. Ventrolateral lobule extends proximally slightly beyond proximal limit of median lobe; ventral costae broad, meeting along midline; anteriorly margin has small oval fleshy tubercle; face of ventral costa slightly concave.

Appendix masculina: Roughly bell-shaped; apex broadly rounded; glabrous. Basal article of endopodite of pleopod II broad at base; central deep furrow; mesial margin twisted outwardly; article about twice length of appendix masculina.

Colour in life: Exhibits efficient protective colouration. Colour variation goes from transparent with numerous reddish-brown chromatophores, to dark brown, almost black. Colour changes depend on background. Other colour variations include light cream with brown blotches; light olive green to bright green. Constant with all colour changes are the antennae which are white or transparent with brown or red bands. Marginal setae are all transparent. Photophores present on basal pleopodal articles and, according to Barnard (1950), also on the abdominal segment, telson and uropods.

Taxonomic status and comments

This species is not difficult to identify due to the characteristically long petasomal processes. Barnard (1950) states that there is a weak chitinized coxal spine on the first pereiopods of the males. I closely examined several males and could not find these spines. In all other characteristics the specimens agree completely with the existing descriptions. The modification in the rostrum illustrated by Barnard (1950) has now been related to the sex of the animal. This species seems to exhibit sexual dimorphism in several limbs not normally associated with sexual differences.

The specific name of this penaeid has varied from *M. africanus* (Stebbing), *M. africanum* (Barnard) and *M. africana* (Kensley). However, the ending in the genus name is of neuter gender and the specific name should agree with it. Holthuis (1962) has proposed that the name

Macropetasma africanus be officially adopted and placed on the Official List of Generic and Specific Names in Zoology.

Distribution (Fig. III-11)

Macropetasma africanus has a very restricted distribution being found only in southern African waters. More specifically it has been recorded from South West Africa — Swakopmund (Balss); South Africa — False Bay, Muisenberg, Mossel Bay, Knysna, Plettenberg Bay, Durban (Stebbing, Barnard, Kensley).

No information exists on the biology of this species. The adults have been caught in depths from 10-27 m. Off Durban this species was found forming large aggregates apparently feeding on detritus (Berry, pers. comm.; Cockcroft, 1982).

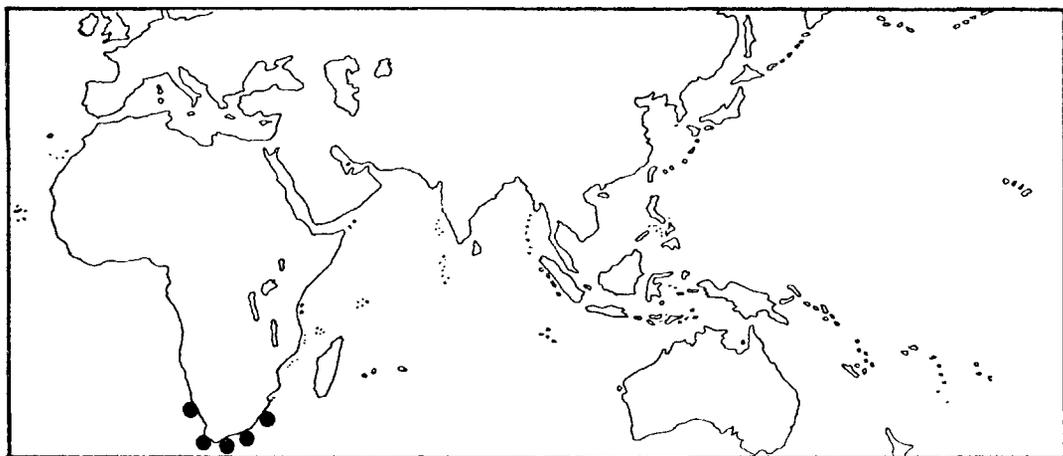


Fig. III-11 Distribution of *Macropetasma africanus*.

***Parapenaeus* Smith, 1885**

Parapenaeus Smith, 1885: 170; De Man, 1911: 77-79; Stebbing, 1914: 18-19; Schmitt, 1926: 323-324; Burkenroad, 1934b: 10-108; Ramadan, 1938: 73; Kubo, 1949: 398-399; Barnard, 1950: 600-601; Dall, 1957: 178; Racek & Dall, 1965: 51.

Parapenaeus Alcock, 1901: 14; Alcock, 1906: 30-31.

The genus *Parapenaeus* is very closely related to the genera *Metapenaeus* and *Penaeopsis*. Burkenroad (1934b) dealt with the problem in some detail and has re-defined these genera quite satisfactorily. However, there are still two points which seem to be causing some confusion, viz.: the presence in *Parapenaeus*, according to Burkenroad (1934b), of a minute pair of mobile spinules anterior to the fixed pair of telsonic spines, and his statement that all pereiopods of this species possess a minute exopod.

Notwithstanding the above difficulties, it seems widely accepted that *Parapenaeus* is a distinct genus and differs from both *Metapenaeus* and *Penaeopsis* by having a distinct longitudinal suture and a transverse suture just above the second pereiopods.

The genus consists of relatively deep water animals; rostrum with dorsal teeth only; pterygostomian spine present in all species except *P. longipes*; carapace with longitudinal and transverse sutures; exopods absent from all legs or extremely minute; parapenaeid spine

present but very small; epipodite absent from maxilliped III and pereopods IV and V; basal and ischial spines on first pereopods only; telson with a pair of fixed subterminal spines; minute movable lateral spinules may be present; petasma symmetrical.

As defined by Burkenroad the genus contains at present eight species, two from the Atlantic and the remaining six from the Indo-west Pacific. Although two, *P. fissurus* and *P. investigatoris* have been recorded from southeast African waters, only the former is known off the Mozambique coast. The recording of *P. investigatoris* was originally based on a single female trawled by the S.S. Pieter Faure off Durban in 185 fathoms (336 m) (Barnard 1950). However, in June and July 1964 the Oceanographic Research Institute in Durban collected a further nine females and one male off Durban.

***Parapenaeus fissurus* (Bate, 1881)**

(Fig. III-12)

Penaeus fissurus Bate, 1881: 180; Bate, 1888: 263-266.

Parapenaeus fissurus Alcock & Anderson, 1894: 144; De Man, 1911: 79-80; Stebbing, 1914a: 19-20; De Man, 1922: 9; Ramadan, 1938: 73; Kubo, 1949: 400-403; Barnard, 1950: 601-602; Hall, 1962: 30; Racek & Dall, 1965: 53-54; Hall, 1966: 99; Kensley, 1972: 22 (in key); Holthuis, 1980: 35.

Parapeneus fissurus Alcock, 1905: 520; Alcock, 1906: 31-32.

Material examined

Mozambique: Monte Belo (310 m), 29♂♂, 27.1-36.0 mm; 7♀♀, 23.05-27.30 mm; ilha do Fogo (280 m), 7♀♀, 17.4-28.5 mm; 1♂, 23.1 mm.

South Africa: Off Durban (29°40'S, 31°34'E) (270 m), 13♀♀, 21.6-31.4 mm; 6♂♂, 22.2-25.3 mm.

Description

Rostrum: Distinctly double-curved; reaching slightly beyond terminal article of antennular peduncle in female; in male reaching to middle of second article of antennular peduncle; rostral formula 6-8/0; there are two teeth behind orbital margin of carapace; adrostral sulcus distinct, extending posteriorly to just behind second rostral tooth; postrostral carina well developed, extending to just before posterodorsal margin of carapace; no median sulcus.

Carapace: Uniformly glabrous; postocular and gastrofrontal sulci absent; longitudinal suture present; extending from orbital margin to almost posterior margin of carapace, suture narrow and not easily detectable unless on dried surface; distinct orbital spine; no gastro-orbital carina; orbito-antennal sulcus shallow; antennal carina simply a broad hump posteriorly, forming narrow, clear cut ridge anteriorly, terminating in prominent antennal spine, occupying about anterior two-thirds of distance between hepatic and antennal spines; cervical sulcus ill-defined; hepatic spine prominent; no branchiocardiac carina; hepatic sulcus broad and ill-defined in region below hepatic spine; hepatic carina clear anteriorly where it runs anteroventrally, terminating in distinct pterygostomial spine; no branchiostegal spine; transverse suture short, situated just above base of second pereopod.

Antennule: Flagella of female almost as long as first two articles of antennular peduncle; taken together; those of male longer than antennular peduncle; flagella themselves subequal in length; mesial flagellum thicker than lateral, more so in male; prosartema has pointed apex, straight mesial margin fringed with long setae; lateral margin broadly curved out and not fringed with hair, although long setae are found on lateral surface below outer margin; prosartema reaching distal edge of optic calathus which almost completely covers eye dorsally; stylocerite terminating in long sharp spine, reaching distal third of basal antennular article; prominent sharp spine at distolateral angle of basal article; parapenaeid spine present but

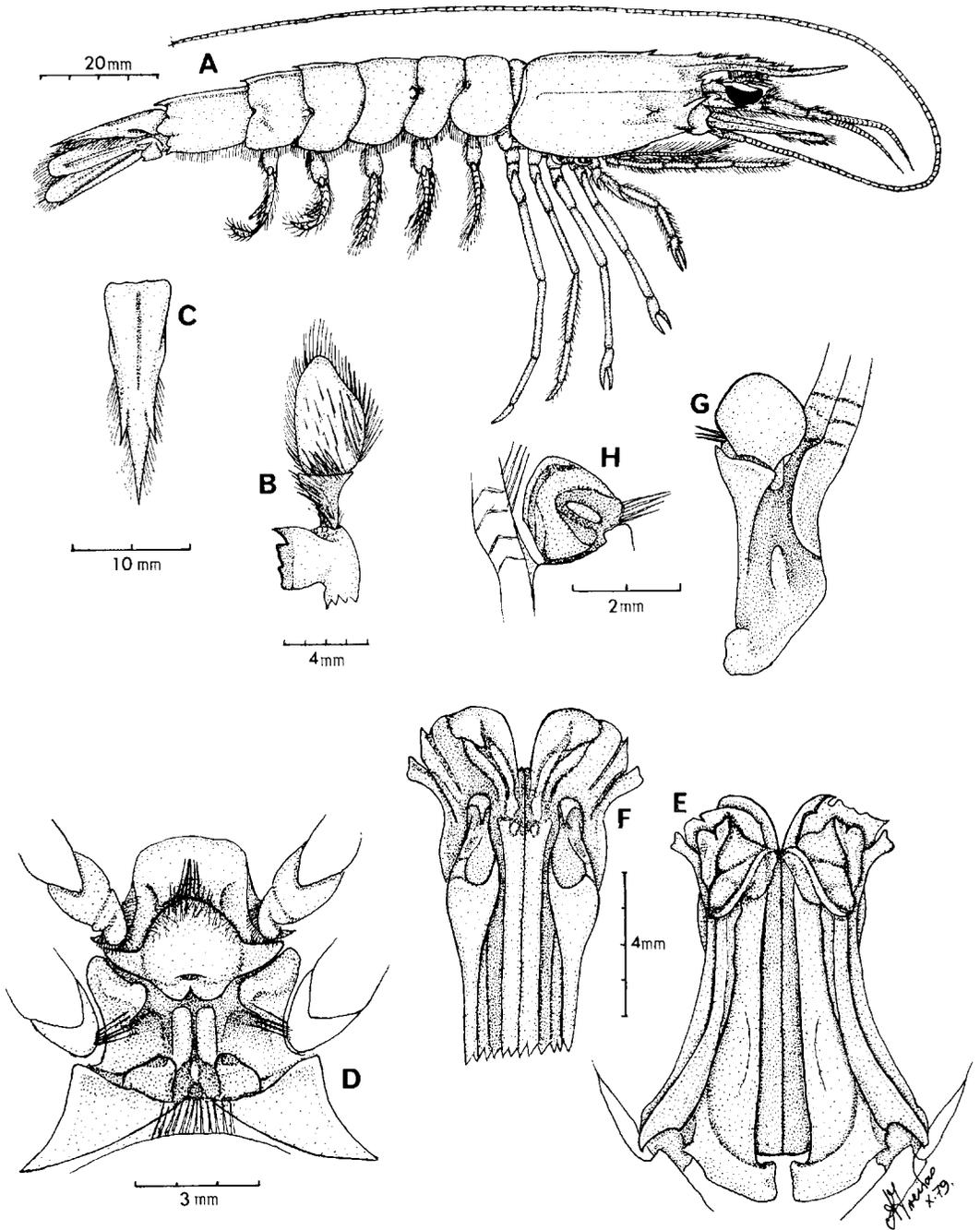


Fig. III-12 *Parapenaeus fissurus* (Bate): A. Whole animal; B. Mandibular palp; C. Telson; D. Thelycum; E. Petasma (ventral view); F. Petasma (dorsal view of distal end); G. Appendix masculine (anterior view); H. Appendix masculina (posterior view).

reduced to minute tooth which is subterminal on lower mesial margin of basal article in female; very minute or missing in males.

Scaphocerite: Distolateral spine reaching end of antennular peduncle in female; in male reaching into first third of last antennular article; apex of lamella just reaching beyond distolateral spine; basicerite unispinose.

Mandibular palp: Reaching to distal end of basal article of carpoperite; proximal article about as long as wide; ventral surface slightly concave; covered in long setae; distal article 1.8 times length of proximal article; roughly 1.4 times as long as wide; suboval in shape; apex broadly rounded; ventral surface slightly convex and setose.

Maxilliped III: In male endopodite reaching beyond distal end of basal antennular article by dactylus; in female endopodite almost reaching distal end of second antennular article; no further sexual dimorphism; exopodite reaching about middle of carpopodite; no epipodites present.

Pereiopods: Exopodites absent from all pereopods; epipodites found only on first two pairs; basipodites and ischiopodites of first pair of pereopods only bear strong spines. Pereiopod III reaching distal end of second antennular article. Pereiopod V reaching to 0.75 of second antennular article. Extended laterally lengths of pereopods in ascending order are: first, second, fourth, third and fifth.

Abdomen: Uniformly glabrous; dorsally carinated from fourth to sixth segment; carina of each segment terminating in spine; no lateral cicatrices on any segment.

Telson: Telson just a little longer than sixth abdominal segment and just shorter than mesial ramus of uropods; median sulcus well defined, occupying only anterior half of telson; telson terminating in acute spine; pair of strong, sharp fixed lateral spines present, situated about one quarter of distance from end of telson; no movable lateral spines.

Thelycum: Simple open structure. Anterior portion consisting of swollen subcircular plate with broad tooth-like process on each side; anterior to this plate is depressed part with broad, truncate margin. Posterior portion consisting of subquadrate cavity with central elevated rectangular ridge with median sulcus; subtriangular tubercle at each anterolateral corner, with less pronounced tubercle at each posterolateral corner; between posterior pair is small tubercle.

Petasma: An involuted pod-like structure. Dorsomedian lobules united along midline, narrow distally but somewhat wider in proximal three-quarters of its length; distally dorsomedian lobules much shorter than lateral lobules. Ventromedian lobules forming lateral walls of incomplete tube but are not as long as dorsomedian lobules distally; mediolateral ridge well developed and may actually touch distally but does not touch along most of length. Dorsolateral lobules proximally projecting medially into truncate processes which overlap one another; distally much longer than other lobules, forming broad laterally curved horns from which arise fleshy process ventrally directed. Ventrolateral lobules with broad ventral costae curving gently inwards and terminating in short bifurcate twisted projection, passing over fleshy process of dorsolateral lobule; narrow bifurcate process directed almost at right-angles to long axis of petasma found distolaterally.

Appendix masculina: Subcircular in shape; surface convex; glabrous except for very small row of short setae. Basal article of endopodite of pleopod II broad at base, twisted, narrowing distally; short, narrow, embossed ridge found on inner surface about half way along article.

Colour in life: Body generally light orange/pink; abdominal segments with deeper orange mottlings; rostrum with darker pink blotches almost forming bands; pleopodal exopods red; antennules dark pink; antennal flagella pink at base becoming somewhat yellow distally; marginal setae of pleura, pleopods and scaphocerite, transparent; setae of uropods light orange to pink.

Taxonomic status and comments

Although I have no doubts that the Mozambique and Natal specimens belong to this species, there are several points where they differ from the general characteristics of the genus and species given by other authors. Firstly, although great care was taken no exopods, no matter how minute, could be found on any of the pereopods. This is contrary to the general statement of the genus by Burkenroad, Kubo and others. However, only Ramadan (1938) specifically states of *P. fissurus* that "... exopodites present on all legs but those of the last three pairs are very minute." Alcock (1906) states that exopodites are absent from all legs while all other workers make no mention of exopodites in their description.

The next characteristic in which my specimens differ from the general genus is in the absence of small, movable lateral spines anterior to the fixed pair. Nevertheless none of the workers consulted makes mention of these spinules.

With regard to the parapenaeid spine, most workers make no mention of this important characteristic. Ramadan (1938) says they are "very small" and Kubo (1949) states that they are "hardly recognisable". In my specimens what is striking is the minuteness in size of the parapenaeid spines of the male specimens; many being actually absent leaving only the scar, suggesting that the spine has dropped off.

A final comment now on the problem brought up by Hall (1962) and Racek and Dall (1965), regarding the thelycum. My larger specimens also do not agree with the description given by Alcock (1906) nor do they agree with his illustrations, or with the illustrations by Bate (1888) and Kubo (1949), and unfortunately the photograph given by Racek and Dall (1965) is not clear. Hall's illustration (1962) is closer to what I have described and the sketch by Barnard (1950) closer still.

The smallest female in my collection has a carapace length of 17.4 mm. The thelycum of this specimen is identical to the description and illustration given by Alcock. Hall (1962) is therefore probably correct in suggesting that the differences encountered are due to age.

Distribution (Fig. III-13)

Parapenaeus fissurus is an Indo-west Pacific species found from Japan and New Britain in the east to Port St Johns on the south coast of Africa. According to Barnard (1950) the Port St Johns specimens were washed ashore during a cold water upwelling which occurred in September 1943 and March 1944.

In more detail *P. fissurus* has been recorded from New Britain — Talili Bay (Borradaile); New Guinea (Bate); Indonesia — Timor Sea, Rotti Island, Lobetobi Straits, North Sumbawa (Bate, De Man); Japan — Shizouka Prefecture, Mie Prefecture, off Owasw, Kumana-nada, Yokohama (Kubo, Balss); Philippines — Zebu, Tablas Islands (Bate, Alcock); South China Sea off Sarawak (Hall, Racek & Dall); Straits of Malacca (Hall); Burma — Gulf of Martaban (Alcock), India — Andaman Islands, Bay of Bengal, Ganjam Coast (Alcock & Anderson, Alcock); Red Sea (Balss), Zanzibar (Ramadan); Mozambique — Ilha do Fogo, Monte Belo (de Freitas); South Africa — Natal off Tugela Bank, Port St Johns (Stebbing, Barnard, de Freitas).

No information can be found regarding the distribution of the juvenile forms or nursery areas. The adults have been caught at depths ranging from 65 to 310 metres. The substrates of the Mozambique and Natal localities are sandy mud. Bate (1888) records that the bottom in the Philippine localities was of "green mud" and "blue mud" and the bottom temperature off Zabu was 71° F (21.7° C).

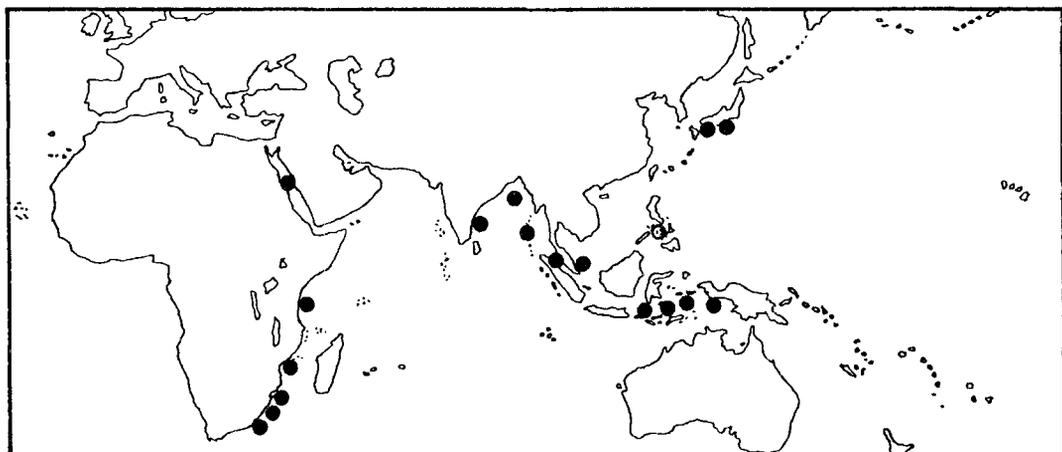


Fig. III-13 Distribution of *Parapeneus fissurus*.

***Parapeneus investigatoris* Alcock & Anderson, 1899**
(Fig. III-14)

Parapeneus investigatoris Alcock & Anderson, 1899: 289; De Man, 1911: 80; Ramadan, 1938: 73; Barnard, 1946: 382; Kubo, 1949: 406; Barnard, 1950: 602; Dall, 1957: 179 (in key); Kensley, 1972: 22 (in key); Holthuis, 1980: 35.

Peneus (Parapeneus) investigatoris Alcock, 1901: 18.

Parapeneus investigatoris Alcock, 1906: 32.

Material examined

South Africa: Durban (360-415 m), 9 ♀♀, 14.8-19.7 mm, 1 ♂, 15.3 mm.

Description

Rostrum: Straight; reaching end of first antennular article in both male and female; rostral formula 6-7/0; only epigastric tooth located behind orbital margin of carapace; adrostral sulcus well developed and bordered, above and below, by distinct carina; adrostral sulcus extends to just above orbital margin of carapace; postrostral carina distinct, extending into posterior one-third of carapace; median sulcus absent.

Carapace: Uniformly glabrous; postocular and gastrofrontal sulci absent; longitudinal suture fairly distinct; extending from orbital margin to almost posterior margin of carapace; orbital spine distinct; gastro-orbital carina absent; orbito-antennal sulcus shallow; antennal carina restricted to broad hump, terminating anteriorly in prominent antennal spine; cervical sulcus ill-defined but hepatic spine prominent; branchiocardiac carina absent; hepatic sulcus ill-defined restricted to depression under hepatic spine; hepatic carina absent; pterygostomial angle rounded; branchiostegal spine prominent and submarginal; transverse suture short and found just above base of second pereopod.

Antennule: Flagella of both male and female as long as antennular peduncle; subequal in length and thickness; prosartema with pointed apex; straight mesial margin fringed with long setae; lateral margin broadly curved with no marginal setae; prosartema not reaching distal end

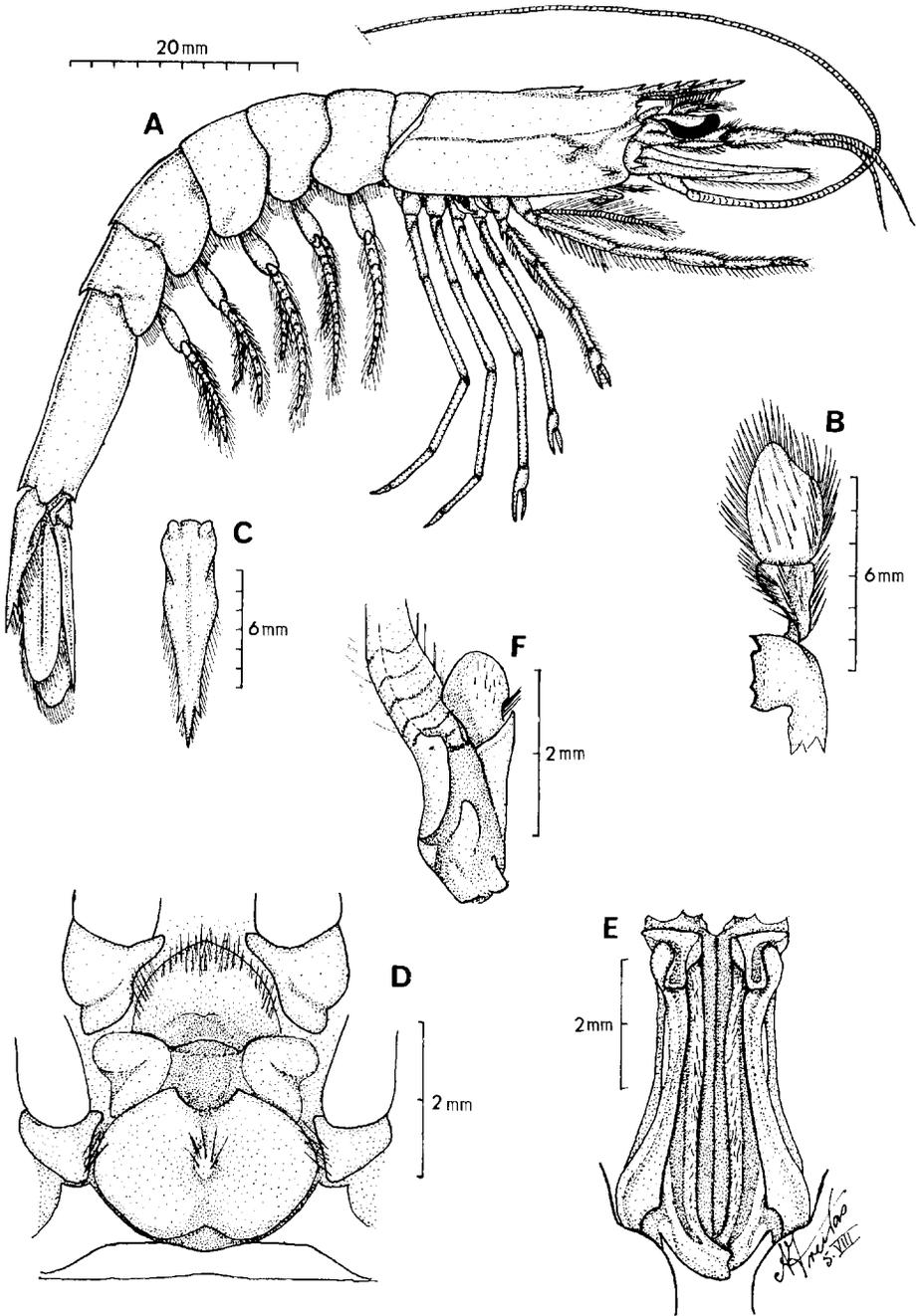


Fig. III-14 *Parapenaeus investigatoris* Alcock & Anderson: A. Whole animal; B. Mandibular palp; C. Telson; D. Thelycum; E. Petasma; F. Appendix masculina.

of optic calathus which almost completely covers eye dorsally; stylocerite terminating in short spine reaching midway along basal antennular article; distolateral spine of basal antennular article short and sharp; parapenaeid spine absent.

Scaphocerite: Distolateral spine almost reaching distal end of antennular peduncle in male and extending beyond in female; apex of lamella not extending beyond distolateral spine; basicerite unispinose.

Mandibular palp: Reaching to distal end of basal article of carpocerite; proximal article about as long as wide; mesial half of ventral surface convex with long setae; outer half of ventral surface concave with but a few long setae near outer margin; distal article 1.5 times length of proximal article; about 1.4 times as long as wide; suboval in shape; apex broadly rounded; ventral surface somewhat flat, lightly covered with long setae.

Maxilliped III: Endopodite of male reaching distal end of second antennular article while in female endopodite reaching beyond third article by length of dactylus; no further sexual dimorphism; exopodite reaching distal end of merus; epipodites absent.

Pereiopods: Exopodites absent from all pereiopods; epipodites present on pereiopods I and II; basipodites and ischiopodites of first pair only bear prominent spines, those of ischiopodites long and very strong. Pereiopod III reaching to 0.5 of second antennular article. Pereiopod V reaching to 0.75 of second antennular article. Extended laterally lengths of pereiopods in ascending order are: first, second, third, fourth and fifth.

Abdomen: Uniformly glabrous; dorsally carinated on segments four to six; carina terminating posteriorly in short spine; lateral cicatrices absent.

Telson: Telson shorter than sixth abdominal segment; shorter than mesial ramus of uropods; median sulcus virtually nonexistent; terminal spine acute; fixed lateral subterminal spines strong and situated about one quarter distance from end of telson; no movable lateral spines.

Thelycum: Anterior portion situated between coxae of fourth pereiopods; consisting of central swollen semicircular plate with lightly setose convex surface; (in one specimen the anterior margin of this semicircular plate bears small spine-like tubercle); just posterior to central plate is median depression bordered laterally by subdeltoid plates with convex surface. Posterior portion consisting of broad elliptical central plate situated between fifth pereiopods; surface flat with distinctly rounded edges; in centre there is small setose tubercle; anteromedian margin of plate shows notch continuous with median depression.

Petasma: Petasma an involuted pod-like structure. Dorsomedian lobule united along midline; narrow, subrectangular in shape; distally dorsomedian apex bending ventrally forming two lobes; from dorsal view each lobule has prominent laterally directed spikes situated about a sixth distance from proximal end. Ventromedian lobules consisting of flexible membrane forming lateral walls of incomplete tube; not as long as dorsomedian lobule, ending where dorsomedian lobule bends ventrally; mediolateral ridge sharp but does not touch along midline. Dorsolateral lobules proximally forming medially directed membranous process, centrally furrowed and twisted; in dorsal view has two strongly sclerotized sections; anterior one small and subtriangular in shape; posterior section stretching length of lobule; prolonged beyond proximal end of petasma into inwardly curved proximal projections; projections of both petasmas overlap medially. Ventrolateral lobules strongly sclerotized with moderate ventral costae; gently curved, terminating distally in single claw-like apex situated under distal membranous process of dorsolateral lobule.

Appendix masculina: Deltoid in shape; surface convex; lightly setose. Basal article of endopodite of pleopod II, broad; subrectangular; surface with two deep furrows joining distally.

Colour in life: As no fresh specimens were examined no details of colour can be given.

Taxonomic status and comments

The specimens to hand agree well with the descriptions and illustrations of this species given

by other workers with the exception of Ramadan's (1938) drawing of the carapace. As pointed out by Barnard (1950) the longitudinal suture arises from the orbital margin and not from the antennal carina.

Parapenaeus investigatoris differs from *P. fissurus* essentially by being a smaller species, having a proportionately shorter rostrum, telson is shorter than the sixth abdominal segment and the branchiostegal spine submarginal.

Distribution (Fig. III-15)

Parapenaeus investigatoris is an Indo-west Pacific species found from Japan to South Africa. More specifically this species has been recorded from Japan — Maisaku, Shirouka Prefecture (Kubo); Indonesia — Kei Island (De Man); India — Andaman Islands, Pulicat, Gulf of Manaar, Bay of Bengal (Alcock); Gulf of Aden (Ramadan); South Africa — off Durban (Barnard).

Nothing is known about the postlarval distribution of this species. Adults are usually found in fairly deep water ranging from 220 metres to 1220 metres. The deepest record is given by Alcock from the Bay of Bengal. Off Durban *P. investigatoris* was found in 360-415 metres of water.

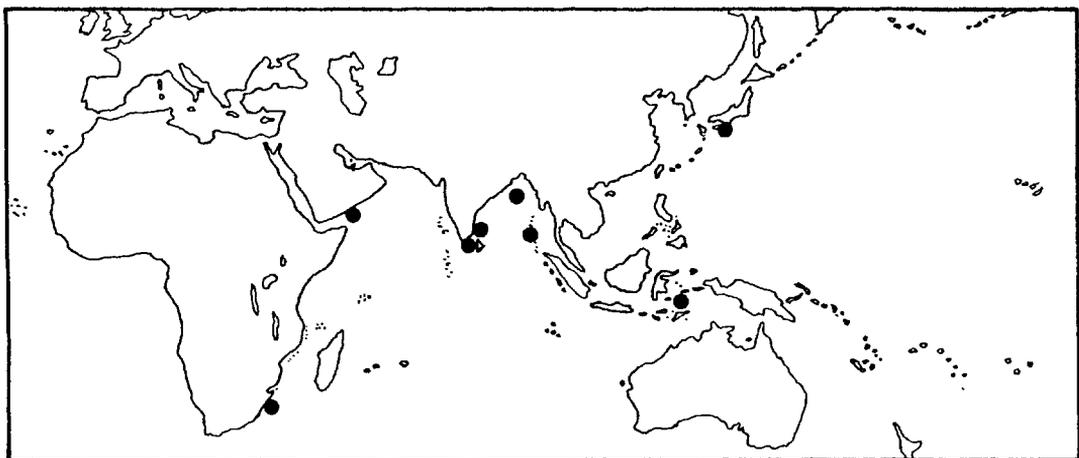


Fig. III-15 Distribution of *Parapenaeus investigatoris*.

Genus *Trachypenaeus* (Alcock, 1901)

Trachypenaeus Alcock, 1901: 15; Alcock, 1906: 43; Burkenroad, 1934a: 49; Burkenroad, 1934b: 94-96.

Trachypenaeus De Man, 1911: 87-88; Kubo, 1949: 391-392; Dall, 1957: 202; Racek & Dall, 1965: 87-89; Perez Farfante, 1971: 365-366.

The genotype was firstly designated *Penaeus anchoralis* by Bate in 1881. Alcock (1901) created the genus *Trachypenaeus* (sic) originally as a subgenus of the genus *Penaeus*. I have adopted the spelling of the generic name as *Trachypenaeus* instead of *Trachypeneus* in accordance with the decision of the International Commission on Zoological Nomenclature, Opinion 864; *Bull. Zool. Nomencl.*, 25(4-5): 138-147.

The genus is composed of relatively small animals with integuments uniformly pubescent; rostrum toothed dorsally only; hepatic, antennal and orbital spines present but small; invariably a short, tubercle-like carina on dorsum of second abdominal segment; usually a minute ischial spine on first pereopods only; petasma has, normally, distal horn-like processes; exopodites present on all pereopods; epipodites found on first three pairs although some members of this genus have pereopodal epipodites on third pair only. For this reason Burkenroad (1934a and 1934b) suggested that the genus *Trachypenaeus* be divided into two subgenera, namely *Trachypenaeus* and *Trachysalambria*. The former with no epipodites on the first two pereopods while the latter possessing them on the first three pairs. Coupled with these characteristics, differences in the thelycal structure were suggested. However, subsequent investigation has shown doubts as to the validity of Burkenroad's assumptions and therefore more detailed analyses of the members of the genus *Trachypenaeus* are required before a final decision can be taken on this point.

There are about 15 species to this genus of which nine are found in the Indo-west Pacific region. Of these only *T. curvirostris* and *T. sedili* have been recorded in southeast African waters and only the former has been found south of Maputo Bay.

***Trachypenaeus curvirostris* (Stimpson, 1860)**

(Fig. III-16)

Penaeus curvirostris Stimpson, 1860: 44; Kishinouye, 1900: 23.

Penaeus anchoralis Bate, 1881: 181; Bate, 1888: 258.

Parapenaeus curvirostris Rathbun, 1902: 38.

Trachypenaeus asper Alcock, 1905: 531; Alcock, 1906: 43.

Trachypenaeus curvirostris Alcock, 1905: 523; Schmitt, 1926: 353; Burkenroad, 1934b: 94; Racek, 1955: 235; Hall, 1961: 98-100; Hall, 1962: 29; Hall, 1966: 99.

Trachypenaeus curvirostris De Man, 1911: 87; Balss, 1914: 11; Balss, 1959: 1519; Ramadan, 1938: 83; Kubo, 1949: 393; Dall, 1957: 203; De Bruin, 1965: 92; Racek & Dall, 1965: 89; de Freitas, 1972: 5 (in key); Kensley, 1972: 20 (in key); Champion, 1973: 181-182.

Material examined

Mozambique: Maputo Bay (5-15 m), 43 ♀♀, 8.5-22.5 mm; 16 ♂♂, 8.6-14.6 mm; Sofala Bank (50 m), 13 ♀♀, 17.4-23.9 mm; 4 ♂♂, 12.2-14.6 mm; Chilokane (15-20 m), 3 ♀♀, 16.7-19.5 mm; Chinde (22 m), 10 ♀♀, 17.2-20.9 mm; Macuse (20 m), 2 ♀♀, 17.0-19.9 mm; Mafamede Island (20 m), 1 ♀, 21.1 mm.

Description

Rostrum: Distinctly curved upward in female but almost straight in male; in female reaching or slightly surpassing third article of antennular peduncle; in males does not reach distal end of third antennular article; rostral formula 9-11/0; adrostral sulcus clear but short and reaching only as far as second rostral tooth; occasionally to between second and third rostral teeth; postrostral carina faint and ill-defined reaching halfway between epigastric tooth and posterior margin of carapace; median sulcus absent.

Carapace: Surface uniformly pubescent; postocular and gastrofrontal sulci as well as gastro-orbital carina absent; orbital spine small but well defined; although cervical sulcus as such not present there is clearly marked depression under hepatic spine; hepatic spine; although small, well developed and found at end of very faint cervical carina; antennal carina well developed and terminating in prominent antennal spine; orbito-antennal sulcus very short, virtually restricted to depression above antennal carina; postorbital spine absent; hepatic carina and sulcus restricted to depression below hepatic spine; pterygostomial angle straight;

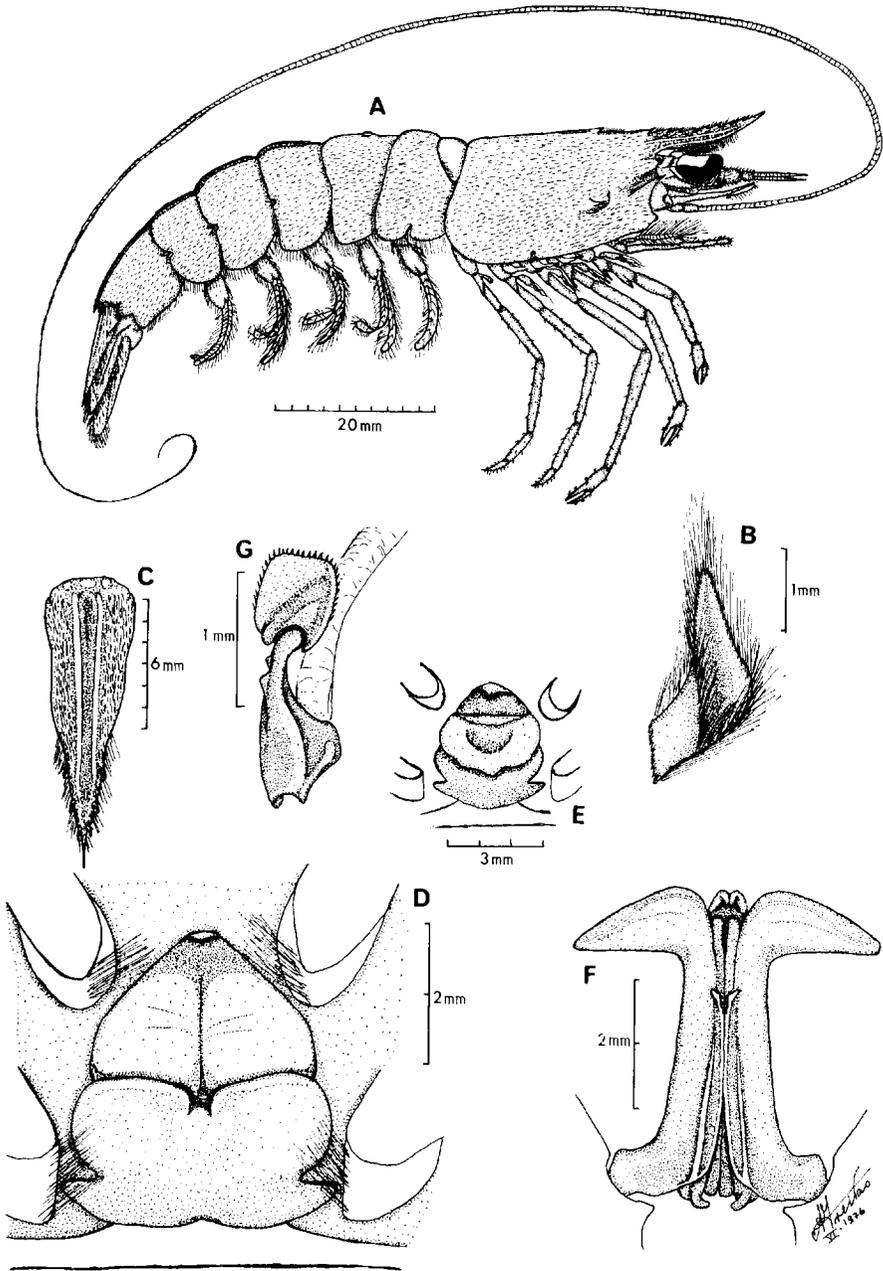


Fig. III-16 *Trachypenaeus curvirostris* (Stimpson): A. Whole animal; B. Prosartema; C. Telson; D. Thelycum; E. Thelycum with spermatophore; F. Petasma; G. Appendix masculina.

branchiocardiac carina and branchiostegal spine absent; submarginal carina well defined reaching pterygostomial angle; short and very indistinct transverse suture present above submarginal carina in line with third pereopods.

Antennule: Flagella about as long as basal article of antennular peduncle; flagella themselves subequal in length; prosartema with pointed apex and fairly wide base, reaching beyond distal end of optic calathus which covers about two-thirds of dorsal surface of eye; stylocerite pointed distally but does not form long antennular peduncle; prominent spine at distolateral angle of basal article present; scale-like projection, profusely covered with fine setae arising from distomedian angle; no parapenaeid spine.

Scaphocerite: Distolateral spine reaching distal end of antennular peduncle; apex of lamella not extending beyond distolateral spine; basicerite with deep notch laterally, lower angle of which forms short blunt spine.

Mandibular palp: Reaching base of carpocerite; proximal article 0.5 times as long as wide; ventral surface concave; margins bear long setae; distal article approximately 4 times as long as proximal article; about 1.6 times as long as wide; mesial margin straight; lateral margin broadly curved; article distally tapering to narrow rounded apex; ventral surface and margins setose.

Maxilliped III: Endopodites almost reaching end of basal article of antennular peduncle; exhibit no sexual dimorphism; exopodites reaching distal margin of merus of endopodite; no epipodites.

Pereopods: Exopodites present on all five pereopods and are paddle-like; one on fifth pereopod being smaller; epipodites present on first three pairs of pereopods; basipodites of first two pairs have strong spines; minute ischial spine present on first pair only. Pereopod V reaching distal end of basal antennular article. Extended laterally lengths of pereopods in ascending order are: first, second/fourth, third and fifth.

Abdomen: More or less uniformly pubescent; median tubercle on dorsum of second abdominal segment present; third to sixth segments strongly carinate; on sixth segment carina terminates in spine; posterior end of carina of fourth and fifth segments cleft; lateral abdominal cicatrices absent.

Telson: Slightly longer than sixth abdominal segment; roughly 0.75 times length of mesial ramus of uropod; median sulcus well defined with dorsolateral carina on either side; posterior half armed with three pairs of small movable spinules, terminating in somewhat sharp apical spine; in few specimens some spinules have broken off making it difficult to distinguish presence of three pairs.

Thelycum: Anterior portion consisting of median plate which is more or less semicircular in shape with median sulcus; anteriorly plate projecting slightly between fourth pair of pereopods. Posterior portion consisting of single transverse plate arising from sternite and situated between fifth pair of pereopods; anterior margin has notch medially and whole of posterior portion is on different plane to that of anterior portion; in some specimens presence of spermatophore may partially obscure thelycum (see Comments).

Petasma: An involuted pod-like structure with lateral horns distally. Dorsomedian lobules united along their midline and curved ventrally at distal end forming narrow hood-like structure which almost closes distal opening of petasma. Ventromedian lobules forming lateral and ventral walls of an incomplete tube; mediolateral ridges of each side meeting along midline. Dorsolateral lobules are about three quarters length of petasma; distally are narrow but curve widely outwards almost reaching lateral margins of ventrolateral lobules, proximally narrow again and terminating in rounded processes which are bent dorsally. Ventrolateral lobules very thick and sclerotized; lateral margins almost parallel although slightly narrower distally than proximally; distolateral horns projecting at right angles to long axis of petasma; distal margin of each horn broadly curved and convex in outline; from dorsal view, just above point of attachment with endopodite there is a prominent hook-like process.

Spermatophore: Spermatophore hard; central raised part with two wing-like portions which slightly overlap anterior margin of posterior portion of thelycum.

Appendix masculina: Subquadrate in shape; distal margin rounded; mesial and distal margins setose; ventral surface convex and glabrous. Basal article of endopodite of pleopod II glabrous; wide at base; greatly narrowed distally; anteromedian margins somewhat swollen with two slightly raised processes.

Colour in life: Generally a cream to pink in colour due to numerous red chromatophores, more concentrated on the dorsum. The antennules are cream to pink with deeper pink colouration at the base and at the anterior tips. The antennae are pink at the base but becoming white. The uropods and the tip of the telson are blood red. The extremities of the uropods also have a bluish tinge which may vary within the individuals. The lateral edge of the pleopods have a longitudinal bluish white stripe. The fringing setae are transparent except those of the uropods which are reddish-brown in colour.

Taxonomic status and comments

The specimens taken from Mozambique agree in every detail with the description given by other authors. It is of interest to note that very often females which were examined were found to be impregnated. This condition was found not only in those specimens collected offshore but also in the larger females caught within Maputo Bay. The spermatophore is often closely fitting and unless it is recognized as a spermatophore, the structure of the thelycum may appear to be different from that of this species. It is quite obvious, for example, that Kensley (1972) has illustrated a thelycum with spermatophore. Also, many of the female specimens of *T. curvirostris* held in the British Museum have their identity queried precisely because the thelycum does not, at first hand, concur with the illustrations. The specimens have been impregnated.

Distribution (Fig. III-17)

The distribution of *T. curvirostris* is widespread within the Indo-west Pacific region. It was

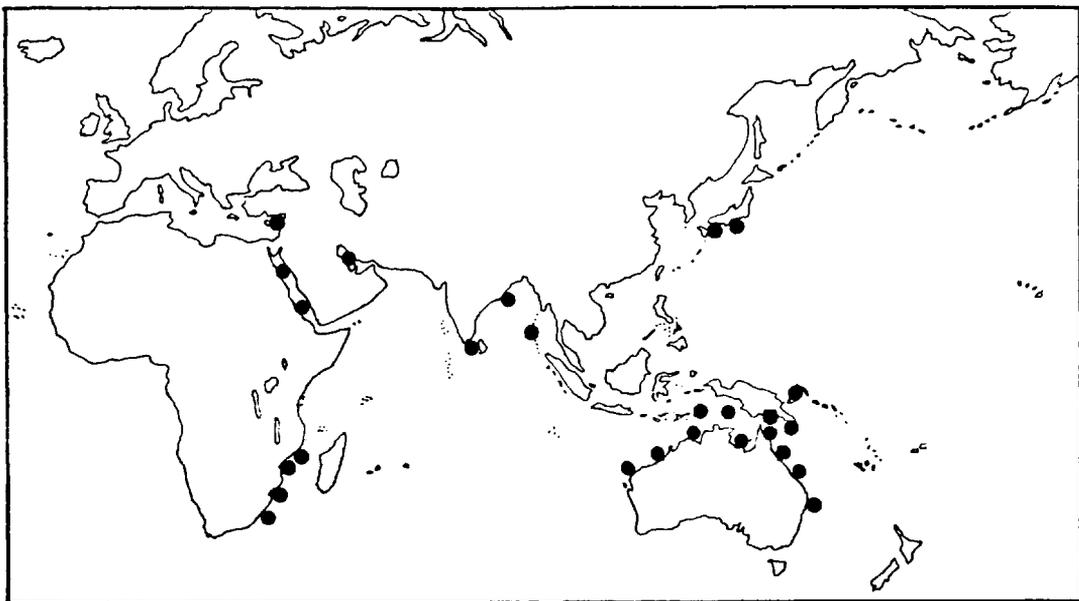


Fig. III-17 Distribution of *Trachypenaeus curvirostris*.

first recorded by Stimpson from Simouda Harbour in Japan. Subsequently it has been found in Japan — off Yokohama, Nagasaki, Hiroshima, Japanese Inland Sea (de Man, Bate, Balss, Kubo); Korea — Fusan (Balss); Hong Kong (Balss); Australia — Queensland, Fraser Island, New South Wales, Northern Territories, Western Australia (Racek & Dall, Schmitt); New Guineas, New Britain (Racek & Dall); Indonesia — Ararufa Sea (Bate); India — Andaman Islands, Garjam Gulf (Alcock); Red Sea (Ramadan); Suez Canal, Eastern Mediterranean Sea (Holthuis); Tanzania — Mafia Archipelago (Racek & Dall); Mozambique — Mafamede Island, Macuse, Chinde, Chiloane, Sofala Bank, Maputo Bay (de Freitas); South Africa — Natal coast (Champion).

The finding of *T. curvirostris* in Mozambique is a new record linking the presence of this species in Tanzania and Natal.

Little is known on the biology of *T. curvirostris*. The depth range distribution is from 7-250 metres although most of the records seem to be from 36-90 metres.

In Mozambique the specimens caught in Maputo were from 5-15 metres but all records along the coast were from 15-50 metres. Champion (1972) claims that in spite of regular sampling from St Lucia Estuary only one specimen of *T. curvirostris* was ever found. He suggests that this species possibly has a low tolerance to low salinities restricting its distribution to areas where the salinity approaches that of the open sea.

***Trachypenaeus sedili* Hall, 1961**

(Fig. III-18)

Trachypenaeus sedili Hall, 1961: 100-102; Hall, 1962: 30; De Bruin, 1965: 92-93.

Trachypenaeus sedili Racek & Dall, 1965: 92; Mohamed, 1969: 30; George, 1969: 33; Thomas, 1969: 192-195; Miquel, 1984: (PEN. Trachyp. 12).

Material examined

Mozambique: Mafamede (15 m), 1♀, 23.2 mm; 1♂, 14.8 mm; Chinde (22 m), 12♂♂, 13.0-25.1 mm, 2♂♂, 13.0-14.5 mm; Sofala Bank (50 m), 8♀♀, 14.3-22.1 mm, 1♂, 12.9 mm; Maputo Bay (5-15 m), 9♀♀, 8.6-17.4 mm, 4♂♂, 10.3-13.1 mm.

Description

Rostrum: Distinctly curved upward in female but almost straight in male; in female reaching or slightly surpassing third article of antennular peduncle; in male not reaching distal end of same article; rostral formula 9-10/0; adrostral sulcus clear but short; reaching to between second and third rostral teeth; postrostral carina well defined reaching to about half way between epigastric tooth and posterior margin of carapace; no median sulcus.

Carapace: Surface uniformly pubescent; postocular and gastrofrontal sulci as well as gastro-orbital carina absent; orbital spine small but well defined; although cervical sulcus as such is not present there is clearly a marked depression under hepatic spine; although small, hepatic spine is well developed and found at end of short broad but faint cervical carina; antennal carina well developed terminating in prominent antennal spine; orbito-antennal sulci very short, virtually restricted to depression above antennal carina; postorbital spine absent; hepatic carina and sulcus restricted to depression below hepatic spine; no branchiocardiac carina; branchiostegal spine absent; pterygostomial angle straight; submarginal carina well defined reaching pterygostomial angle; short and very distinct transverse suture present above submarginal carina in line with third pereopods.

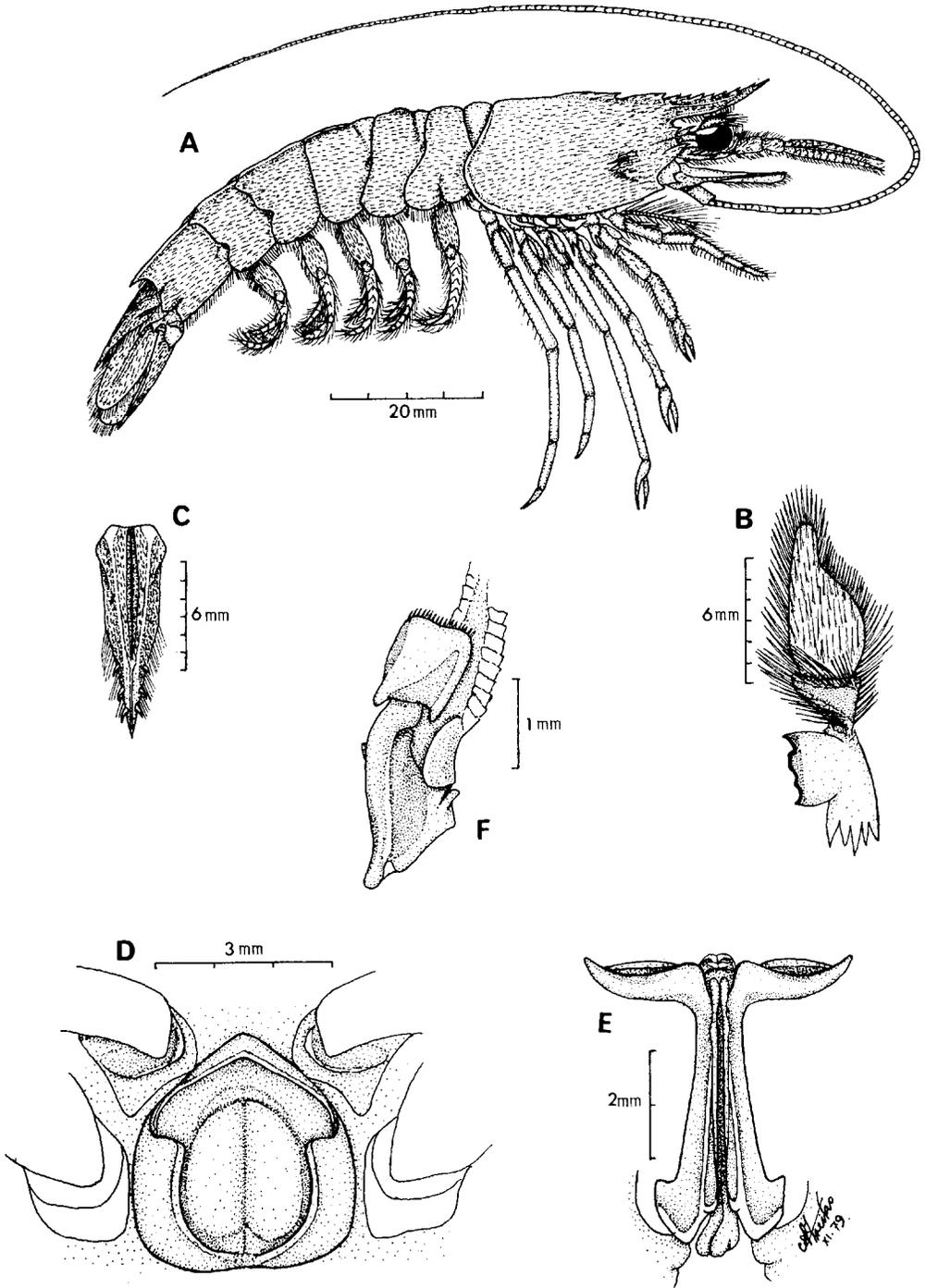


Fig. III-18 *Trachypenaeus sedili* Hall: A. Whole animal; B. Mandibular palp; C. Telson; D. Thelycum; E. Petasma; F. Appendix masculina.

Antennule: Flagella about as long as basal article and half second article of antennular peduncle taken together; flagella themselves subequal in length; prosartema with pointed apex and fairly wide base, reaching beyond distal end of optic calathus which covers about two-thirds of dorsal surface of eye; stylocerite pointed distally but not forming long sharp spine, reaching little beyond midpoint of basal article of antennular peduncle; prominent spine at distolateral angle of basal article present; scale-like projection profusely covered with fine setae, arising from distomedian angle; parapenaeid spine absent.

Scaphocerite: Distolateral spine reaching distal end of antennular peduncle; apex of lamella not extending beyond distolateral spine; basicerite with deep notch laterally, lower angle of which forms short blunt spine.

Mandibular palp: Reaching half way along carpocerite; proximal articles subtriangular; roughly 0.8 times as long as wide; ventral surface concave; margins bearing long setae; distal article 3 times as long as proximal article, about 1.8 times as long as wide; mesial margin straight; lateral margin curved; article distally tapering to narrow rounded apex; ventral surface and margins setose.

Maxilliped III: Endopodite just reaching distal end of basal article of antennular peduncle; exhibiting no sexual dimorphism; exopodites reaching distal end of merus of endopodite; epipodites absent.

Pereiopods: Paddle-like exopodites present on all five pereiopods; one on fifth pereiopod being smaller; epipodites present on first three pairs of pereiopods; basipodites of first two pairs have strong spines; minute ischial spine present on first pair only. Pereiopod III reaching distal end of antennular peduncle. Pereiopod V reaching just beyond distal end of first antennular article. Extended laterally lengths of pereiopods in ascending order are: first, second/fourth, third and fifth.

Abdomen: More or less uniformly pubescent; median tubercle on dorsum of second abdominal segment present; third to sixth segments strongly carinate; carina of sixth segment terminating in spine; posterior end of carina of fourth and fifth segments cleft; no lateral cicatrices.

Telson: Slightly longer than sixth abdominal segment; roughly 0.75 times length of mesial ramus of uropods; median sulcus very deep; bordered by prominent dorsal carina and well defined dorsolateral carina on either side; posterior half armed with three pairs of movable spinules which are often not clearly distinguishable; telson terminates in somewhat sharp apical spine.

Thelycum: Anterior portion hood-like in structure with dorsal apex projecting down between coxae of fourth pair of pereiopods; ventrally, upper front margin of 'hood' has median peak. Posterior portion arising from sternite between fifth pereiopods, is U-shaped in structure with lateral arms of 'U' wide and thick and anteriorly touch posterolateral ends of anterior portion; transverse arm of 'U' narrow; in centre of this open thelycum is soft cushion-like structure fused with inner surface of hood-like anterior portion and at midpoint of transverse arm of U-like posterior portion; between central 'cushion' and lateral arms of posterior portion on each side is deep furrow.

Petasma: An involuted pod-like structure with lateral horns distally. Dorsomedian lobules united along their midline and curving ventrally at their distal end forming narrow hood-like structure which almost closes distal opening of petasma. Ventromedian lobules forming lateral and ventral walls of incomplete tube; mediolateral ridges of each side meeting along midline. Dorsolateral lobules thin in distal half but thicker and fairly well sclerotized in proximal half; proximal ends curving slightly dorsally and forming rounded processes overlapping proximal end of median lobe; dorsolateral lobules are just seen from dorsal view. Ventrolateral lobules very thick and sclerotized; wide proximally narrowing down distally; from narrowest section they are projecting laterally forming pair of cow-like horns which are distally curved; from concave distal margin of horns there arises thin plate-like flap projected dorsally; from dorsal

view, just above point of attachment with endopodite there is a prominent hook-like process.

Spermatophore: Externally, spermatophore is hard brown mass with very irregular cusped surface firmly anchored within open thelycum at lateral furrows.

Appendix masculina: Subquadrate; mesial and distal margins bear short, stout setae; ventral surface glabrous and convex with sedge-shaped thickening. Basal article of endopodite of pleopod II glabrous, wide at base; greatly narrowed distally; anteromedian border longitudinally swollen.

Colour in life: Generally a greyish-brown but the dorsum is tinged with bluish-black colour, which is more intense on the rostrum and postrostral and abdominal carinae. The tip of the telson, the upper half of the mesial uropodal ramus and the central portion of the lateral ramus are a deep bluish-black in colour. The antennules are white with the tip bluish-black. The antennae are light pink but deeper pink at base. The fringing setae are transparent except those of the uropods which are reddish-brown. The pereopods and pleopods are pink.

Taxonomic status and comments

The Mozambique specimens agree in every detail with the descriptions and illustrations given by Hall (1961), De Bruin (1965) and Thomas (1969). Although in general *T. sedili* is very similar to *T. curvirostris*, they cannot be confused when the genitalia are compared. The finding of the male by De Bruin (1965) and Thomas (1969) completed the description. In the fresh male material the two species can easily be distinguished by the colouration.

Distribution (Fig. III-19)

Trachypenaeus sedili was first described by Hall from the Singapore Straits. It has so far been recorded from Singapore — Malacca Straits (Hall); Sri Lanka — Mullaitivu (De Bruin); India — Palk Bay, Gulf of Manaar west coast (Thomas); Mozambique — Mafamede Island, Chinde, Sofala Bank, Maputo (de Freitas).

The finding of *T. sedili* in Mozambique waters is a new record and extends westwards and southwards the known distribution of this species.

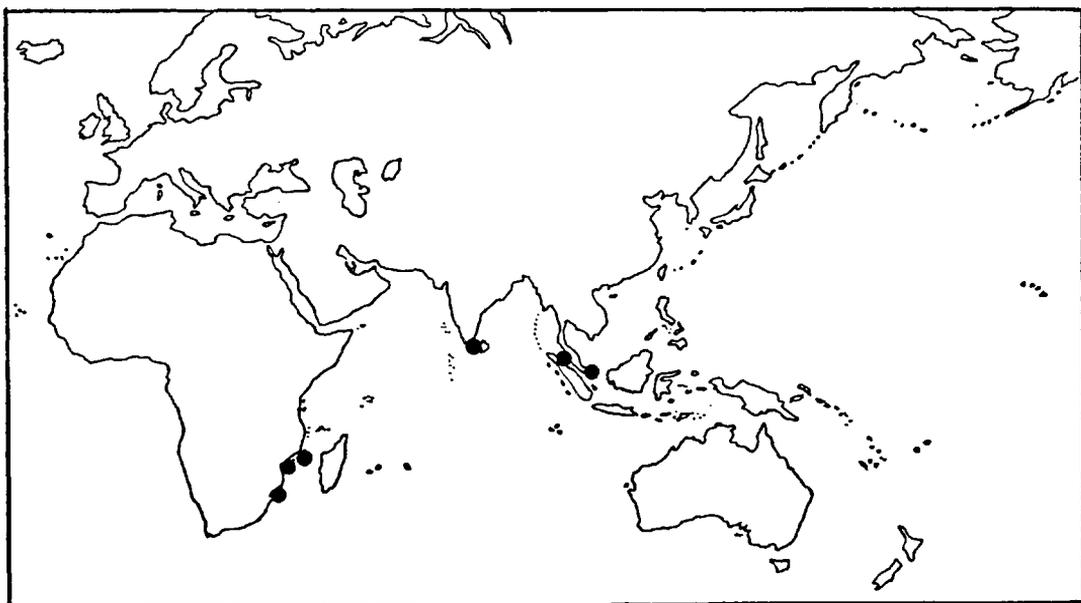


Fig. III-19 Distribution of *Trachypenaeus sedili*.

Nothing is known on the biology of this species. Their nursery areas have not been located as yet. The adults are found together with *T. curvirostris* and have been caught in depths ranging from 5-50 metres. The Singapore specimen was recorded from 43 metres while in India and Ceylon *T. sedili* was found in 18-15 m of water. In Mozambique this species was commonly found within Maputo Bay in rather shallow water between 5 and 15 metres, the deepest record being in 50 metres of water on the Sofala Bank.

Genus *Parapeneopsis* (Alcock, 1901)

Parapeneopsis Alcock, 1901: 14; Alcock, 1905: 520; Alcock, 1906: 34-35; Burkenroad, 1934a: 58-59; Burkenroad, 1934b: 95.

Peneopsis De Man, 1911: 92; Balss, 1925: 229; Kubo, 1949: 368-371; Barnard, 1950: 604; Balss, 1959: 1519; Dall, 1957: 213-214; Racek & Dall, 1965: 96.

In 1891 Wood-Mason, in a review of the genus *Peneaus*, noticed that Milne-Edward's species *Peneaus styliferus* seemed to be distinctly different from the other members of the genus. He therefore suggested a new name *Parapeneopsis*. However, Wood-Mason did not publish this and it was Alcock in 1901 who first defined the genus to accommodate *P. styliferus*.

The genus is composed of medium to small animals; rostrum dorsally toothed only; carapace with longitudinal sutures which do not reach to posterior margin of carapace; cervical, orbito-antennal, and hepatic sulci present; pterygostomian angle subacute but with no spine; exopods on all pereopods; epipods absent from maxilliped III and from at least pereopods III, IV and V; telson without fixed subapical spines (except in *P. styliferus*) but may have movable spinules; petasma symmetrical and tubular.

There are 18 known species in this genus. *P. balli* is the only known American species found on the west coast of that continent. Sixteen species are Indo-west Pacific forms and one, *P. atlantica* is found in the Atlantic Ocean off the west coast of Africa. This species has now been recorded off Mozambique extending its distribution around the Cape to the east coast of Africa.

P. acclivirostris is, however, the most common species of this genus found in Mozambique and off the southeast coast of South Africa.

Parapeneopsis acclivirostris (Alcock, 1905)

(Fig. III-20)

Parapeneopsis acclivirostris Alcock, 1905: 530; Alcock, 1906: 42.

Parapeneopsis acclivirostris De Man, 1911: 92; Barnard, 1946: 382; Barnard, 1950: 604; Dall, 1957: 215 (in key); Kunju, 1960: 127; Racek & Dall, 1965: 108; Hall, 1966: 99; de Freitas, 1972: 5 (in key); Kensley, 1972: 20 (in key); Holthuis, 1980: 29; Miquel, 1984: (PEN. Para.1)

Material examined

Mozambique: Maputo Bay, 47♀♀, 7.15-20.15 mm, 9♂♂, 7.00-13.90 mm; Chinde, 4♀♀, 16.2-18.65 mm.

South Africa: Tugela Bank, 11♀♀, 15.85-20.55 mm.

Description

Rostrum: Straight to distally curved upward in larger individuals; reaching end of second antennular article in small individuals but extending beyond distal tip of antennular peduncle in large specimens; no epigastric tooth; rostral formula 7-9/0; adrostral sulcus well developed

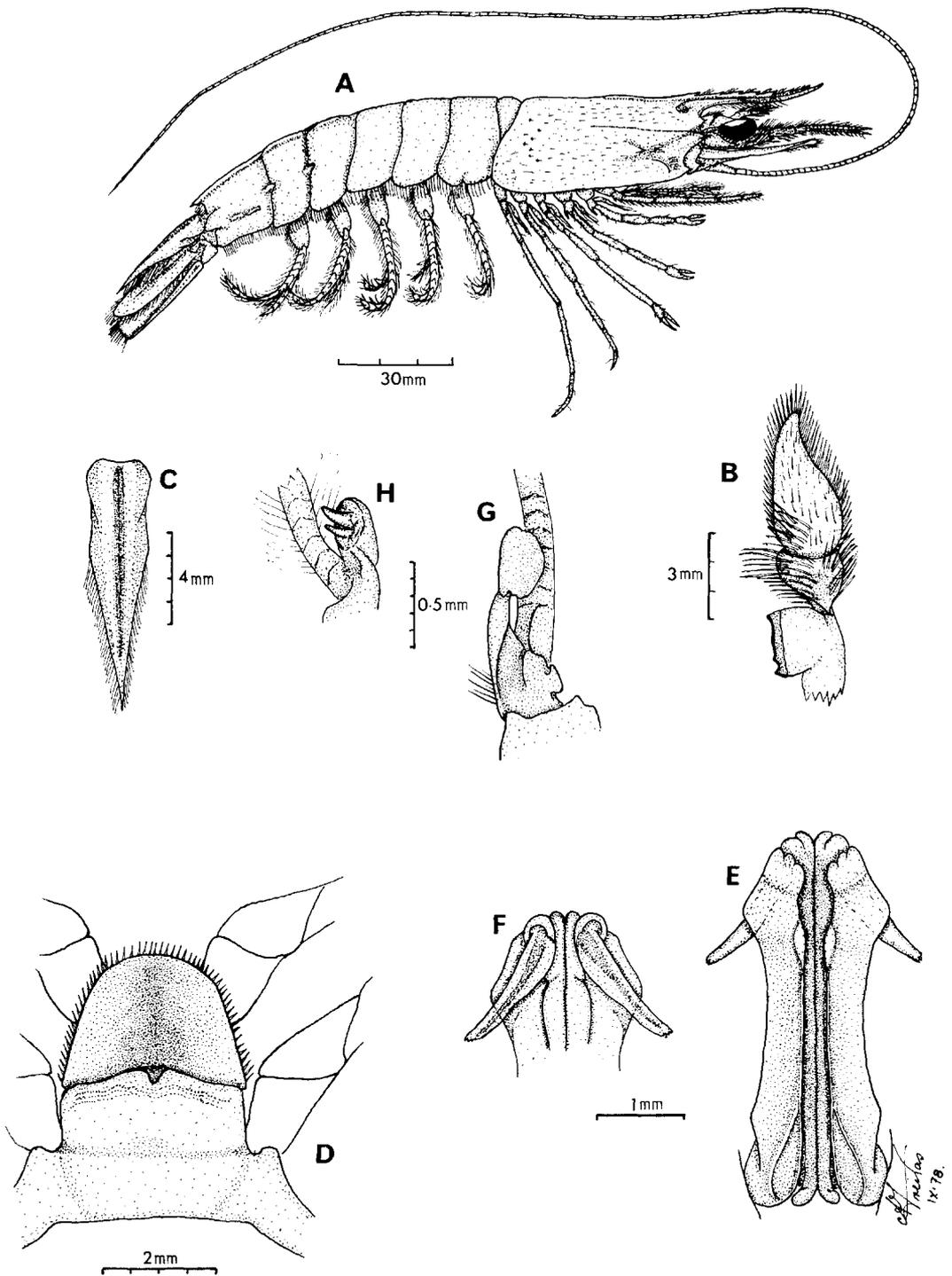


Fig. III-20 *Parapenaopsis acclivirostris* (Alcock): A. Whole animal; B. Mandibular palp; C. Telson; D. Thelycum; E. Petasma (ventral view); F. Petasma (dorsal view of distal end); G. Appendix masculina (anterior view); H. Appendix masculina (posterior view).

and reaching to behind first rostral tooth; very faint postrostral carina extending half way along dorsum of carapace; no median sulcus.

Carapace: Surface irregularly punctate and hispid; postocular sulcus present as wide depression just below posterior end of adrostral sulcus; gastrofrontal sulcus absent but there is well developed orbital spine; cervical sulcus absent but there is well developed orbital spines; cervical sulcus restricted to short depression while cervical carina terminating in well defined hepatic spine; antennal carina broad, terminating in prominent antennal spine; carina occupies about three-quarters of distance between hepatic and antennal spines; orbito-antennal sulcus short but clearly defined; no postorbital spine; from orbital margin arises clear but narrow longitudinal suture which extends posteriorly for about two-thirds length of carapace; no gastro-orbital carina; well defined hepatic sulcus passing horizontally under hepatic spine then curving anteroventrally, where hepatic carina is more distinct and possesses row of setae; no distinct branchiocardiac carina; pterygostomial angle subacute; no branchiostegal spine.

Antennule: Flagella about half length of antennular peduncle; subequal in length; prosartema very narrow and extending to little beyond optic calathus; stylocerite forming short sharp spine distally and just about half length of basal antennular article; distolateral spine short and sharp; no parapenaeid spine.

Scaphocerite: Distolateral spine reaching distal end of antennular peduncle; apex of lamella extending just beyond distolateral spine in small individuals but not so in larger forms; basicerite unispinose.

Mandibular palp: Reaching distal end of basal article of carapocerite; proximal article as long as wide; ventral surface concave; margins bearing long setae; distal article 2.25 times as long as proximal article; approximately 1.9 times as long as wide; mesial margin gently curved; lateral margin broadly curved; article distally tapering to pointed apex; ventral surface lightly setose.

Maxilliped III: Endopodite extending into anterior third of basal article of antennular peduncle; exhibiting no sexual dimorphism; exopodite reaching distal end of carpus of endopodite; no epipodites present.

Pereiopods: Exopodites present on all pereiopods; epipodites absent from all; first two basipodites have well developed spines; none are present on ischiopodites; coxopodites of third pereiopods of females have plate-like dilations extending over sternite almost meeting on ventral midline. Pereiopod V reaching to just short of distal end of basal antennular article. Extended laterally, lengths of pereiopods, in ascending order are: first, second, third, fourth and fifth.

Abdomen: Uniformly glabrous; ventral margin of pleuron of first abdominal segment has notch which is not visible in young individuals; dorsally carinate from posterior half of fourth to sixth segment where carina terminates in spine; in young individuals carina of each segment terminating in spine; two small lateral cicatrices on sixth segment.

Telson: A little longer than sixth segment; somewhat shorter than mesial ramus; well developed median sulcus; terminating in sharp spine; no marginal or subapical spines present.

Thelycum: Anterior portion roughly semicircular in shape; surface concave; anterior margin has row of short setae. Posterior portion subquadrate; slightly convex surface; anterior margin rounded with medial notch.

Petasma: An incomplete tube-like structure. Dorsomedian lobules joined along midline; proximally extending beyond margins of lateral lobes in two outwardly curved fleshy processes; distally they extend as far as lateral lobes. Ventromedian lobules membranous; distally projecting proximolaterally into two well developed, movable, horn-like structure; from dorsal view, proximally there are two horizontal papillae almost meeting medially. Dorsolateral lobules thickly sclerotized, forming broad lateral borders of petasma; distally forming fleshy "mouth" of petasma; small lateral bulge on margin just above horn-like projections of ventromedian lobules; proximally margin deeply notched. Ventrolateral lobules narrow; meeting medially; ventral costae occupies proximal half of lobule.

Appendix masculina: Subquadrate; attached to basal article by lower, inner corner; dorsal surface convex and glabrous; distal margin rounded and slightly bilobed; from ventral surface arise two pointed tongue-like processes, distal one longer of two. Basal article of endopodite of pleopod II, broad at base narrowing considerably distally; few isolated setae on inner margin.

Colour in life: Pink or light buff in colour with numerous large red chromatophores which are more concentrated on the dorsum and on the abdomen give the appearance of red transverse bands; uropods are a deep blood-red; antennules are a dark pink while the antennae are light pink; all fringing setae including those of uropods are transparent.

Taxonomic status and comments

The Mozambique specimens agree completely with the existing descriptions of this species. Only one other species of this genus has been recorded from this side of the Indian Ocean. *P. acclivirostris* is not a species of economic importance because, although always found in shrimp trawls, they are never caught in large enough numbers to warrant their exploitation.

The closest relative of this species seems to be *P. tinella* Bate but the distinction is clearly seen in the secondary sexual characteristics.

Distribution (Fig. III-21)

Parapenaeopsis acclivirostris is essentially an Indian Ocean species found from the east coast of India down to the Natal coast of South Africa. It has been recorded from India — Ganjam coast, Madras, Palk Straits, Bombay (Alcock, De Man, Kunju); Persian Gulf (Alcock, De Man); Gulf of Aden (Hall); Red Sea (Miquel); Mozambique — off Chinde, Maputo Bay (Barnard, de Freitas).

Little or no information exists with regard to the larval stages of this species. The exact nursery areas have not been established although juvenile *P. acclivirostris* is the most abundant species in the backwater areas of Maputo Bay such as the Matola River (de Freitas & Diniz 1972). This may indicate that the nursery areas of this species are, in fact, estuarine or estuarine-like zones. That is to say the nursery areas are probably well sheltered habitats affording good protection from predators, with a muddy substratum, rich in organic matter and salinities somewhat below that of the open sea.

Adults of this species, in breeding condition, have been found within Maputo Bay at depths between 15 and 22 metres. The recorded depth range for the adults is from 15-48 metres.

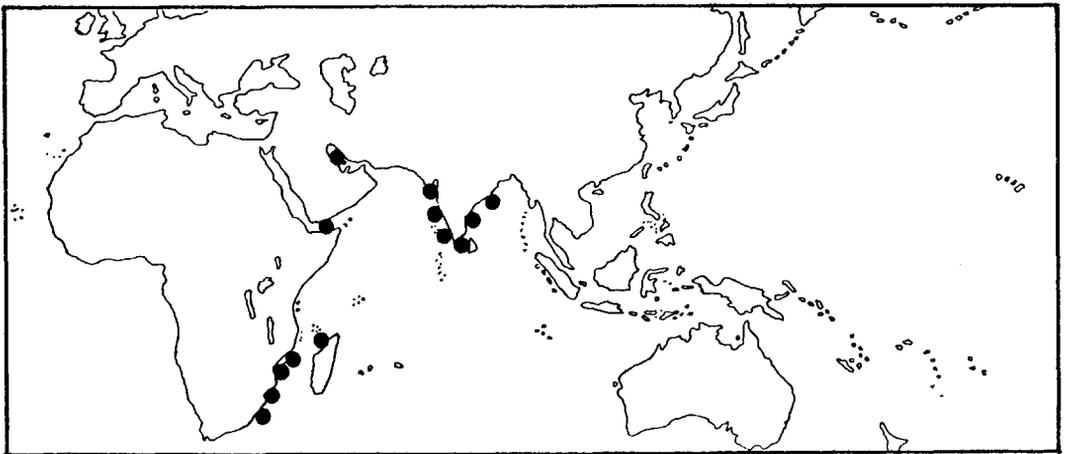


Fig. III-21 Distribution of *Parapenaeopsis acclivirostris*.

***Parapenaopsis atlantica* Balss, 1914**

(Fig. III-22)

Parapenaopsis atlantica Balss, 1914: 539; Balss, 1916: 16; Balss, 1925: 229-231; Vilela 1949: 47-70; Holthuis, 1952: 83-84; Holthuis & Rosa, 1965: 3; Crosnier & Bondy, 1967: 12-15; Crosnier & Wise, 1968: 552-569; Mota, 1972: 36-42; Holthuis, 1980: 30.

Material examined

Mozambique: Sofala Bank (50 m), 8♀♀, 23.8-29.7 mm.

Description

Rostrum: Distinctly double curved reaching beyond antennular peduncle, almost to end of antennular flagella; rostral formula 10-11/0; epigastric only or epigastric and one other tooth found behind orbital margin of carapace; adrostral sulcus reaching between epigastric and first rostral tooth; postrostral carina not very distinct, reaching about two-thirds length of carapace; median sulcus absent.

Carpace: Glabrous except for frontal and gastric regions; gastrofrontal sulcus absent; postocular sulcus present; orbital spine well developed; cervical sulcus short and oblique situated just posterodorsal to prominent hepatic spine; gastro-orbital carina absent; antennal carina broad with oval pubescent patch in lower half; antennal spine prominent; orbito-antennal sulcus shallow, indistinct and free of spines; hepatic carina well developed extending from well behind hepatic spine to somewhat behind pterygostomial angle; hepatic carina bent anteroventrally from below hepatic spine; longitudinal suture distinct extending from orbital margin for about two-thirds lengths of carapace; distinct vertical carina (better seen in dry conditions) situated at level of third pereopod; branchiostegal spine absent; pterygostomial angle pointed but not forming spine.

Antennule: Flagella about as long as basal antennular article; subequal in length; prosartema with pointed apex reaching to end of eye; stylocerite just about half length of basal article; pointed distally forming short, blunt spine; distolateral spine of basal article prominent and sharp; parapenaoid spine absent.

Scaphocerite: Distolateral spine just reaching distal end of antennular peduncle; apex of lamella rounded and just extending beyond distolateral spine; basicerite unispinose.

Mandibular palp: Reaching distal end of basal article of scaphocerite; proximal article as long as wide; ventral surface concave, lightly setose; margins bearing long setae; distal article 2.5 times as long as proximal article; approximately twice as long as wide; mesial margin straight to slightly curved distally; lateral margin broadly curved; article distally tapering to narrowly rounded apex; ventral surface lightly setose.

Maxilliped III: Endopodites reaching end of basal antennular article; exhibit no sexual dimorphism; exopodite reaching end of merus; epipodites absent.

Pereopods: Well developed exopodites present on all pereopods; epipodites present on first two legs only; basipodites of first two pereopods with prominent spine; ischial spines absent; fifth pereopod considerably longer than preceding legs. Pereopods III and V reaching to just before distal end of second antennular article. Extended laterally, length of pereopods in ascending order are: first, second, third, fourth and fifth.

Abdomen: Glabrous except for sixth segment and small patches in depressions situated on each pleuron; dorsal carina present on posterior half of fourth segment and on fifth and sixth segments; carina on sixth segment terminating in distinct spine; two short, horizontal, lateral cicatrices on sixth segment.

Telson: Slightly longer than sixth abdominal segment; a little shorter than mesial ramus of uropod; pubescent; median sulcus well defined; telson terminating in acute spine; possessing

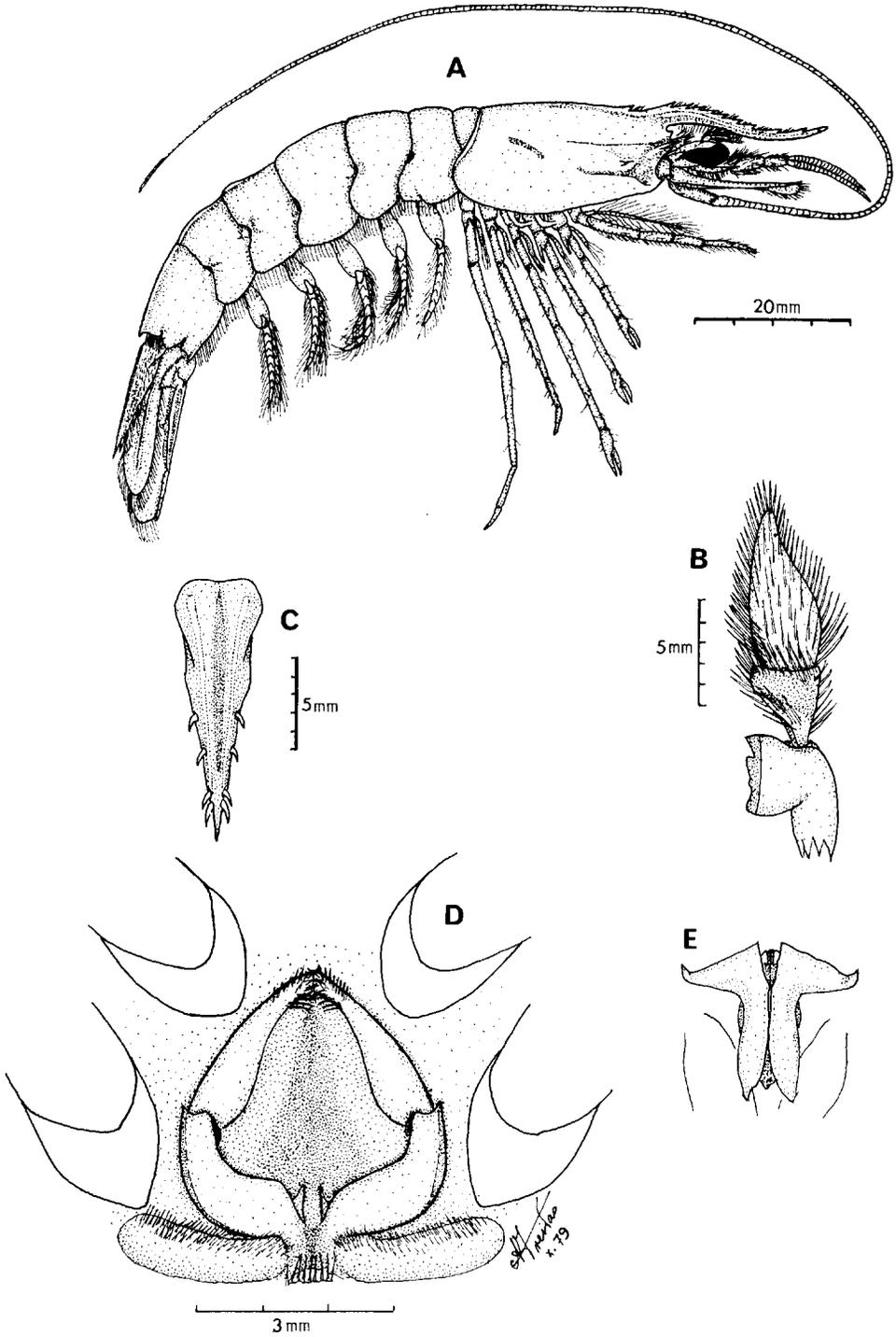


Fig. III-22 *Parapenaeopsis atlantica* Balss: A. Whole animal B. Mandibular palp; C. Telson; D. Thelycum; E. Petasma (after Balss 1916 or Monod 1966).

four pairs of movable marginal spines; subapical pair longest; distal two pairs close together.

Thelycum: Anterior portion consisting of subtriangular plate with deep concave centre and steeply upright lateral edges; apex rounded and slightly setose. Posterior portion consisting of two horn-like projections; apex of each "horn" slightly indented to receive posterior corners of lateral sides of anterior portion; at midpoint junction of two "horns" is a notched depression; posterior thoracic ridge composed of two oval setose plates.

Petasma: No male specimens were found to permit a first hand description of the petasma and no description exists in the known literature. Balss (1925) gives a reasonable illustration of the male genitalia which appears to be an involuted pod-like structure, united along inner margin of dorsomedian lobule; distomedian projection curved slightly ventrally; ventrolateral lobule broad; distally projected laterally into broad "horns"; lateral apex of "horns" pointed and turned anteriorly.

Appendix masculina: No descriptions or illustrations have been found to permit inclusion in this paper.

Spermatophore: Ventrally, an irregularly shaped hard, brown mass firmly attached to thelycum. When dislodged, dorsal view shows two lateral ridges broadened at one extremity; lateral edges of ridges jagged; sperms contained in membrane covered deep central furrow.

Colour in life: No live specimens were examined to permit description of living colour patterns of this species.

Taxonomic status and comments

The only species of the genus *Parapenaepsis* previously known from southeast African waters was *P. acclivirostris*. The eight female specimens found on the Sofala Bank of Beira in Mozambique were easily identified with this genus but they did not agree with the descriptions and illustrations given for the other Indo-west Pacific species. The Mozambique specimens were closest in resemblance to the Indian species *P. stylifera* but differed from it by having no distinct pterygostomial spine, by having the hepatic carina stopping before the pterygostomial angle, by having the antennular flagella much shorter than the carapace and the telson did not have "very distinct fixed marginal spinlets" as indicated by Alcock (1906). Also the thelycum of the eight females in question differed considerably from that illustrated by Alcock (1906) for *P. stylifera*.

However, the Mozambique specimens agreed very well with the existing descriptions and illustrations of Balss' species *P. atlantica*. The fact that this species has been found only along the West African coast is a little disturbing. Also no males have been found to permit one to compare the genitalia. Nevertheless in the female genitalia and in most of the other characteristics the Mozambique specimens agreed so well that I could not but conclude that they do indeed belong to the same species as the west African forms.

The only differences that could be found between the eight female specimens from Mozambique and the species described by Balss (1914 and 1925) are that whereas Balss declared that a postrostral carina was absent, the Mozambique specimens are described here as having a postrostral carina which is not very distinct. This indistinct carina could easily have been missed by Balss. Secondly, Balss claimed that the longitudinal suture reached the posterior end of the carapace. This does not occur in the Mozambique specimens nor in the illustrations of *P. atlantica* given by Holthuis (1952), Crosnier and Bondy (1967) and Mota (1972), all of which agree with the Sofala Bank specimens. Finally, although the fifth pereopod in the eight female specimens in question is considerably longer than the preceding ones and reaches the distal end of the second antennular article, it does not go as far as reaching substantially beyond the scaphocerite as claimed by Balss (1925). This, of course, could be a characteristic exhibited by the male and therefore not available to me.

In spite of this I have no alternative but to identify the Mozambique specimens as *P. atlantica*.

Distribution (Fig. III-23)

Parapenaeopsis atlantica has in the past been restricted to west African waters between Senegal and Angola. The finding of this species off the Mozambique coast is a new record extending its distribution around the Cape and into the Indian Ocean. In more detail this species has been recorded from Guinea-Bissau (Vilella); Sierra Leone (Holthuis); Ghana (Balss, Holthuis); Ivory Coast (Crosnier & Bondy); Cameroons (Balss, Holthuis), Gabon (Holthuis); Congo-Brazzaville — Point Noire (Holthuis, Crosnier & Wide); Zaire — Banana (Holthuis); Angola — Cabinda, Cuanza (Holthuis; Crosnier & Bondy, Mota); Mozambique — Sofala Bank (de Freitas).

Not much is known about the life cycle of this species although, as suggested by Mota (1972), *P. atlantica* probably completes its life cycle at sea, not being dependent on coastal nursery areas.

The adults are found at depths ranging from 3-60 metres although probably most abundant in water from 15-40 metres, inhabiting muddy to sand-mud bottoms (Crosnier & Wise, 1968).

The Mozambique specimens were trawled from muddy-sand bottom in 50 metres of water on the Sofala Bank just north of Beira.



Fig. III-23 Distribution of *Parapenaeopsis atlantica*.

Genus *Penaeopsis* Bate, 1881

Penaeopsis Bate, 1881: 182; Bate, 1888: 273; Burkenroad, 1934a: 7-12; Kubo, 1949: 320-322; Balss, 1957: 1519.

NOT *Penaeopsis* Barnard, 1950: 592.

The genus *Penaeopsis* was established in 1881 by Bate based on a manuscript of A. Milne-Edwards and was founded on a species *Penaeopsis serratus* caught in Caribbean waters. In 1891 Wood-Mason established the genus *Metapenaeus* and within it described three new species from the Indian Ocean.

The characteristics used in describing these two genera were similar and for many years they were considered synonymous. It was, however, clear to some workers (e.g. Schmitt, 1926; Kubo, 1949; Barnard, 1950) that the genus *Penaeopsis* in the unrestricted sense could be divided

into two distinct groups. In 1934 Burkenroad analysed the situation in some details and concluded that it was possible to establish two distinct genera, *Penaeopsis* and *Metapenaeus*, within the original genus.

This genus is composed of medium to small animals; parapenaeid spine present; branchiostegal spine present; telson armed with a pair of fixed subapical spines; mobile marginal spinules present; exopodites on all pereopods; no spine on basipodite of third pereopods; petasma symmetrical and open pod-like.

Peréz Farfante (1977, 1979) believes that there are six known species. One, *P. serrata*, is a western Atlantic species; three, *P. rectacuta*, *P. edwardsi* and *P. challengerii* are found east of Sumatra while two species, *P. balssi* and *P. jerryi* are found in the Indian Ocean from Africa to Sumatra. Only *P. balssi* has been recorded from southeast African waters.

***Penaeopsis balssi* Ivanov, 1976**

(Fig. III-24)

Penaeopsis serratus Ramadan, 1938: 68-69.

Penaeopsis balssi Ivanov & Hassan, 1976: 1-5.

Material examined

Mozambique: Ilha do Fogo (17°13'S, 39°00'E in 280 m), 1♀, 20.0 mm, 1♂, 20.6 mm; Bazaruto (20°17'S, 35°38'E in 320 m), 1♀, 32.4 mm, 1♂, 22.2 mm; Cabo S. Sebastiao (22°00'S, 35°41'E in 360 m), 7♀♀, 20.1-28.55 mm; Monte Belo (15°20'S, 34°50'E in 220-405 m), 1♂, 30.3 mm, 6♀♀, 21.6-34.5 mm.

Description

Rostrum: Distinctly arched; almost reaching second article of antennular peduncle; reaching it in females; rostral formula 11-13/0 usually 11/0; last tooth is minute; epigastric tooth lies on carapace in line with hepatic tooth; epigastric and one or two teeth found behind orbital margin of carapace; adrostral sulcus limited to rostrum, extending anteriorly to last rostral tooth; postrostral carina terminating just behind epigastric tooth.

Carapace: Surface glabrous; postocular and gastrofrontal sulci and longitudinal suture as well as gastro-orbital carina absent; no orbital spine; cervical carina distinct, terminating in prominent hepatic spine, situated at level lower than that of antennal spine; cervical sulcus well defined starting about midway between hepatic spine and end of postrostral carina; distinct although faint branchiocardiac carina present; antennal carina very short but well defined, terminating in prominent antennal spine; orbito-antennal sulcus restricted to slight depression above antennal carina; hepatic carina distinct starting just below hepatic spine; hepatic sulcus occurs posterior to start of hepatic carina and is faint in this region; anterior of hepatic spine, hepatic sulcus follows obtuse angled hepatic carina; hepatic carina terminating in well defined branchiostegal spine a little above pterygostomial angle; pterygostomial angle rounded.

Antennule: Flagella about as long as antennular peduncle; mesial flagella of male forming stiff semicircular loop at its base; looped section has blunt tooth at proximal end and crest at its distal end; prosartema has pointed apex but widens posteriorly, reaching just beyond optic calathus which is very large almost completely covering eye dorsally; stylocerite pointed but does not form sharp spine, reaching from one-third to half way along basal article; sharp spine at distolateral angle of basal article; prominent parapenaeid spine present situated subterminally on lower mesial margin of basal article.

Scaphocerite: Scaphocerite reaching half way along third antennular article; basicerite deeply notched with small spine anteroventrally.

Mandibular palp: Reaching to half way along carapace; proximal article subtriangular in shape; roughly 0.6 times as long as wide; ventral surface concave and lightly setose; margins

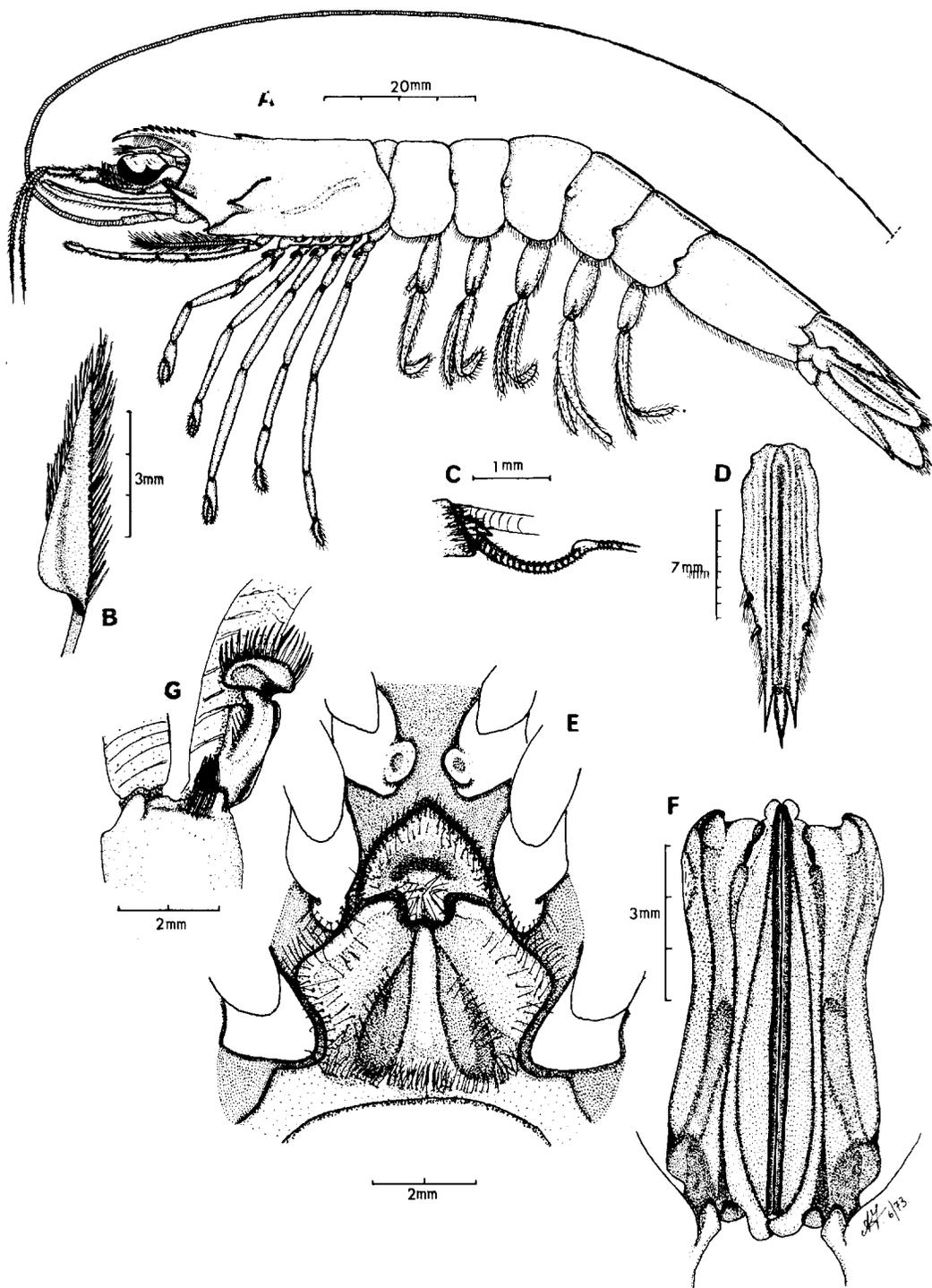


Fig. III-24 *Penaeopsis balssi* Ivanov: A. Whole animal; B. Prosartema; C. Base of median antennular flagellum; D. Telson; E. Thelycum; F. Petasma; G. Appendix masculina.

bearing long setae; distal article suboval in shape; 3.5 times length of proximal article; 1.3 times as long as wide; outer half of ventral surface convex, mesial half concave; surface lightly setose; apex broadly round.

Maxilliped III: Endopodite of males reaching to within first half of second antennular article while in females it is longer, reaching as much as half way along third antennular article; no sexual dimorphism; exopodite reaching to half way up carpus of endopodite; epipodites absent.

Pereiopods: Exopodites present on all pereiopods; exopodites small and scale-like; epipodites found on first three pairs of pereiopods; basipodite and ischiopodite of first pair of pereiopods only bear strong spines. Pereiopod III reaching to midpoint of third antennular article. Pereiopod V reaching to distal end of basal antennular article. Extended laterally, lengths of pereiopods in ascending order are: first, second/fourth and third/fifth.

Abdomen: Uniformly glabrous; dorsally carinated from fourth to sixth segment where carina terminates in spine; no lateral cicatrices on any segment.

Telson: Telson slightly longer than sixth abdominal segment; stops just short of end of mesial ramus of uropods; wide and well developed median sulcus present; crest on each side of sulcus projected backwards ending in two prominent and fixed spines; telson terminating in acute spine; two pairs of small but well developed movable spines anterior to fixed pair.

Thelycum: Posterior portion forming seminal receptacle; roughly hexagonal; narrowest anterior side notched to receive poteromedian process of anterior portion; lateral plates arise obliquely from anteromedian projection of sternite; between these plates there is median ridge formed from anteromedian projection of sternite; whole portion forming concave structure copiously provided with long setae situated on surface of lateral plates and at base of median projection. Anterior portion, situated on sternite between fourth pereiopods, consisting of more or less "arrow-head" shaped central plate with pointed apex; plate translucent and somewhat flexible to very flexible in young specimens; ventral surface slightly concave and richly supplied with long setae; from middle of posterior margin of plate arises relatively wide bi-lobed projected which fits into anterior notches of lateral plates of posterior portion; edge of this projection has brown pigmentation.

Petasma: An involuted pod-like structure. Dorsomedian lobules narrow, unted along their midline. Ventromedian lobules membranous; subrectangular; distally extending beyond dorsomedian lobules, tip rounded; proximally subequal to dorsomedian lobule. Dorsolateral lobule subrectangular; proximally projecting beyond limits of petasma into two, flattened, club-like processes directed medially and usually overlapping; distally lobule tapers down to end below mesial distal branch of ventrolateral lobule; from dorsal view lobule bears prominent ridge. Ventrolateral lobule with curved lateral margin; heavily sclerotized; distal end broadly bifurcate; inner branch curving slightly medially; dorsal surface with subtriangular plate almost at base of lobule.

Appendix masculina: More or less kidney shaped; long axis horizontally placed; dorsal surface convex and glabrous; apex rounded bearing short, stout setae. Basal article of endopodite of pleopod II subrectangular; mesial half of dorsal surface convex, lateral half concave; distal mesial angle projecting forward into outwardly twisted process bearing appendix masculina.

Colour in life: Generally a light pink in colour with delicate irregular small markings on abdominal segments; scaphocerite white with very slight red markings along edges of inner margin; telson uniformly pink but darker at apex; pereiopods and pleopods pink with red patches at articulations; marginal setae of scaphocerite, pleura, pleopods and uropods white.

Taxonomic status and comments

I have no doubt that the specimens found off southeast Africa are in fact *P. balssi*. Kensley (1969) has identified one female collected off southern Mozambique by the "Anton Brun" as *P. rectacuta* but has illustrated the thelycum (Kensley 1972) as having the median plate with a

pointed apex. This illustration is reminiscent of *P. balssi* rather than *P. rectacuta*. However, only an examination of the specimens held in the South African Museum, Cape Town, will clarify the identity of Kensley's specimen.

Distribution (Fig. III-25)

The present records of *P. balssi* limit its distribution to the east coast of Africa. It has been found in Tanzania — Dar-es-Salaam, Zanzibar (Balss, Ramadan); Mozambique — Ilha do Fogo, Bazaruto, Monte Belo, central Mozambique (de Freitas, Ivanov & Hassan).

It is not possible to determine exactly where Ivanov and Hassan (1976) found their holotype and paratypes, as the positions given by these authors place the location of their stations 264 and 348 a good distance inland.

Nothing is known about the distribution of the juvenile forms, nor of the nursery areas. The adults, however, are found in relatively deep water. The Tanzanian records are from depths of 400-600 metres while the specimens found off Mozambique have been caught in depths of 200-420 metres.

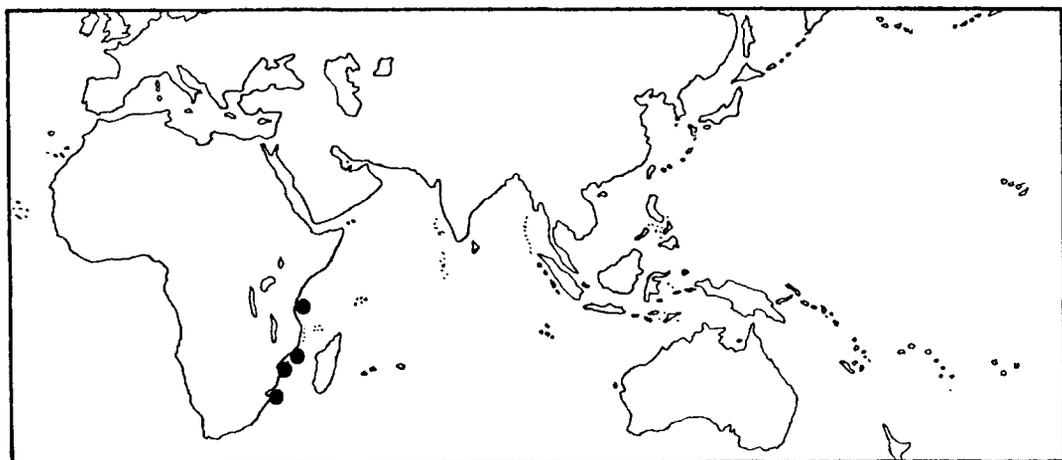


Fig. III-25 Distribution of *Penaeopsis balssi*.

Genus *Metapenaeus* Wood-Mason, 1891

Metapenaeus Wood-Mason, 1891: 271; Burkenroad, 1934a: 4,19; Kubo, 1949: 327-328; Barnard, 1950: 596-597; Dall, 1957: 182-183; Hall, 1962: 18-22; Joubert, 1965: 26; Racek & Dall, 1965: 54-56.

Metapeneus Alcock, 1906: 16.

Penaeopsis De Man, 1911: 53-55, 61; Stebbing, 1914a: 15; Kemp, 1915: 320; Schmitt, 1926: 319-323.

Much controversy has arisen around the generic name of *Metapenaeus*. Agreeing with the view of Holthuis (1962) in his desire to uphold well-established generic names, I have accepted the name *Metapenaeus*.

The members of this genus have the rostrum toothed dorsally only; hepatic and antennal spines well developed; orbital spine small; pterygostomial angle blunt and bears no spine; no

parapenaeid spine on mesial margin of basal article of antennular peduncle; basipodites of first three pairs of pereopods have spines; fifth pereopods bear no exopodites; epipodites present on first three pereopods; telson has deep dorsomedian sulcus; no fixed subterminal spines; a number of small movable marginal spines always present but sometimes very difficult to distinguish (e.g. *M. monoceros*).

There is still much confusion and many as yet unclarified and doubtful species exist due to the fact that detailed and complete descriptions for the members of this genus have seldom been given. However, there seems to be a total of about 22 species (Racek & Dall 1965), all of which are from the Indo-Pacific region. Of these only two, *M. monoceros* and *M. stebbingi* have been recorded in southeast African waters.

***Metapenaeus monoceros* (Fabricius, 1789)**

(Fig. III-26)

Penaeus monoceros Fabricius, 1789: 409; Miers, 1878: 310.

NOT *Penaeus monoceros* Bate, 1881: 177.

NOT *Penaeus monoceros* Stimpson, 1860: 44.

Penaeopsis monoceros Stebbing, 1914b: 70-71; Calman, 1925: 12; Balss, 1927: 221.

Penaeopsis spinulicauda Stebbing, 1914a: 17-18.

NOT *Penaeopsis monoceros* De Man, 1911: 55-57.

Metapenaeus monoceros Alcock, 1905: 517; Alcock, 1906: 18-20.

Metapenaeus monoceros Burkenroad, 1934a: 7; Barnard, 1950: 597-599; Hall, 1958: 537-544;

Crosnier, 1965: 32; Joubert, 1965: 27-29; De Bruin, 1965: 79-80; Racek & Dall, 1965: 57 (in key);

Hall, 1966: 98; George, 1970: 1544-1555; de Freitas, 1972: 5 (in key); Kensley, 1972: 22 (in key);

Holthuis, 1980: 27; Miquel, 1982: 110-114; Miquel, 1984: (PEN Metap. 19).

NOT *Metapenaeus monoceros* Kubo, 1949: 329-333; Dall, 1957: 184-187.

Material examined

Mozambique: Maputo Bay, 21♀♀, 17.0-46.1 mm, 10♂♂, 17.1-30.9 mm; Moma (18 m), 5♀♀, 32.6-37.6 mm, 3♂♂, 19.2-33.0 mm; Moebase (15 m), 4♀♀, 12.7-37.4 mm, 3♂♂, 20.2-21.3 mm; Mafamede Island (10 m), 2♀, 18.4-19.0 mm, 2♂♂, 15.8-21.6 mm; Micaune, 5♀♀, 14.9-21.9 mm, 1♂, 16.1 mm; Ligonha River, 1♀, 29.3 mm.

South Africa: Natal on Tugela Bank (10-40 m), 10♀♀, 14.6-26.1 mm, 17♂♂, 14.8-26.2 mm; Durban Bay, 2♀♀, 24.3-28.8 mm, 1♂, 21.8 mm.

Description

Rostrum: Straight and reaching distal end of third article of antennular peduncle; rostral formula 8-9/0 but usually 9/0; two teeth behind orbital margin of carapace; adrostral sulcus well developed, extending to little behind epigastric tooth; postrostral carina distinct; almost reaching posterior margin of carapace; median sulcus absent.

Carapace: Irregularly pubescent; gastrofrontal sulcus absent; small but clearly defined postocular sulcus present which arises below adrostral carina under second rostral tooth; cervical sulcus well defined and cervical carina terminating anteroventrally in prominent hepatic spine; gastro-orbital carina absent; small but well developed orbital spine; antennal carina fairly well developed terminating anteriorly in antennal spine; postorbital spine absent; orbito-antennal sulcus distinct; hepatic carina distinct; hepatic sulcus anterior to it, deep; hepatic carina and sulcus more or less 'L-shaped' descending vertically from hepatic spine then curving anteriorly ending slightly before pterygostomial angle; pterygostomial angle rounded; distinct branchiocardiac carina present, originating in line with posterior end of postrostral carina and extending anteroventrally terminating almost in line with posterior end of cervical carina; no branchiostegal spine; submarginal carina absent.

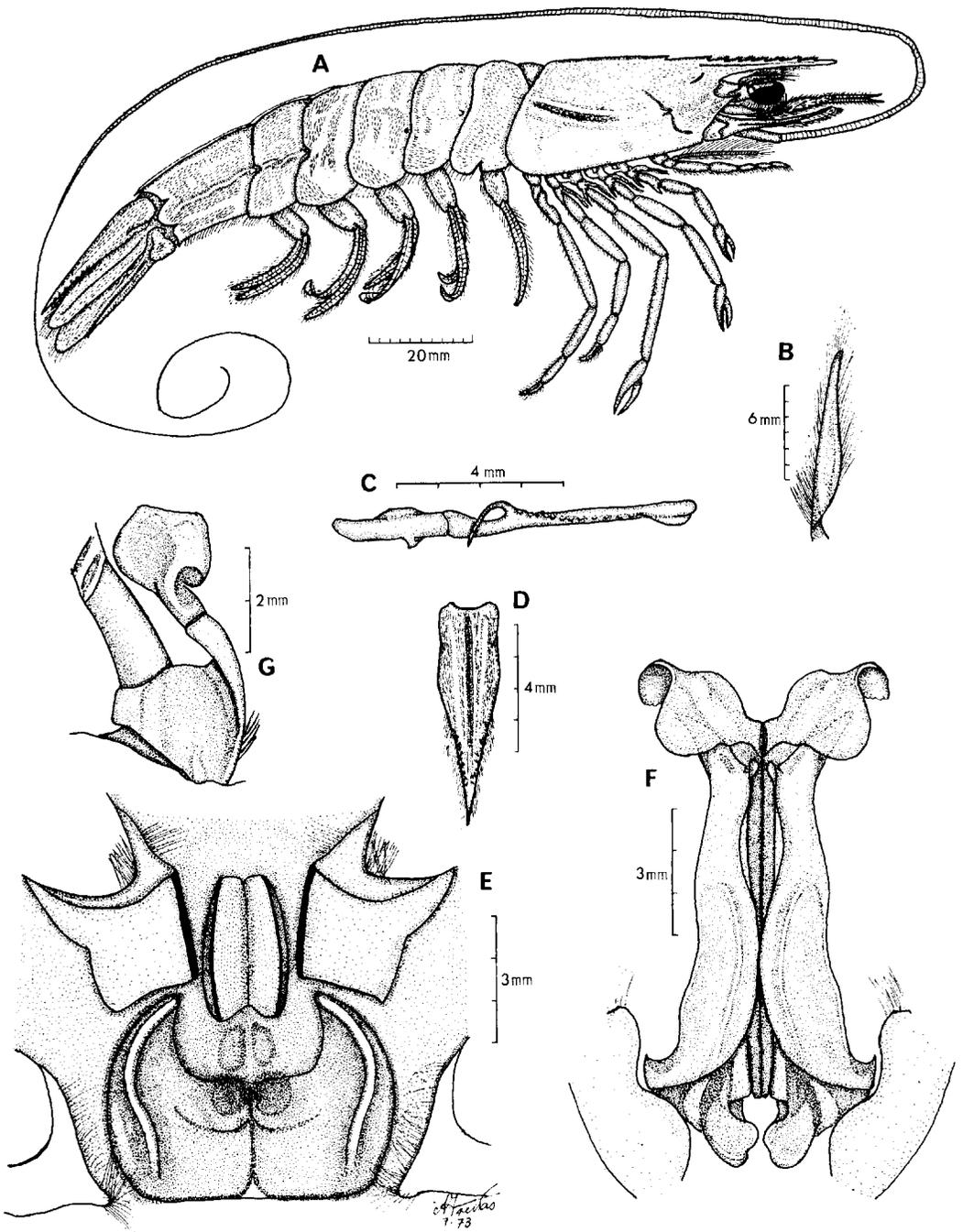


Fig. III-26 *Metapenaeus monoceros* (Fabricius): A. Whole animal; B. Prosartema; C. Fifth ischiopodite and meropodite; D. Telson; E. Thelycum; F. Petasma; G. Appendix masculina.

Antennule: Flagella about half length of antennular peduncle; prosartema narrow, a little wider at base; reaching to distal end of basal article of antennular peduncle; stylocerite about half length of basal antennular article and terminates in point; small but sharp spine at distolateral angle of basal article present; parapenaoid spine absent.

Scaphocerite: Distolateral spine reaching distal end of antennular peduncle; basicerite free of spines.

Mandibular palp: Reaching to base of carpocerite; proximal article 1.1 times as long as wide; ventral surface lightly setose; margins bearing long setae; distal article 2.6 times as long as proximal article; twice as long as wide; ventral surface lightly setose; distally tapering to rounded apex, slightly curving outwardly.

Maxilliped III: Endopodite reaching about half way along basal article of antennular peduncle; no sexual dimorphism; exopodite reaching little beyond carpus of endopodite; no epipodites.

Pereiopods: Exopodites present on pereiopods I-IV; epipodites present only on first three; spine present on basipodite of first three pairs; only first pair bearing ischial spine; in female, ischiodite of fifth pereiopod fairly flattened, bearing notch on proximal upper margin; in male, posterior distal margin of ischiodite of fifth pereiopod has keel; outwardly and downwardly curved spine present on posterior proximal margin of merus; pereiopod III and V reaching half way along second antennular article. Extended laterally lengths of pereiopods in ascending order are: first, second/fourth, third and fifth.

Abdomen: Irregularly pubescent; dorsally carinated from posterior half of fourth segment to tip of sixth where carina terminates in blunt spine; a wavy, broken lateral cicatrix present on fifth and sixth segments.

Telson: Longer than sixth abdominal segment; just shorter than mesial ramus of uropods; dorsally has deep and wide median sulcus; telson ends in sharp spine; there are numerous minute movable spinules along lateral margins often difficult to see.

Thelycum: Simple open structure. Anterior portion consisting of median, longitudinal, elevated process arising from sternite between fourth pereiopods; this median process has central sulcus and fits closely between medially directed dilation of fourth coxopodite. Posterior portion consisting mainly of deeply concave median plate with prominent raised margins.

Petasma: Involuted pod-like structure. Dorsomedian lobules very narrow, rather thin and joined along midline. Ventromedian lobules even narrower; as long as dorsomedian lobules; together forming narrow furrow deep within petasmat structure; median lobes better seen from dorsal view. Dorsolateral lobules very thickly sclerotized and again better seen from dorsal view; proximally slightly narrower and twisted; some-what extending beyond proximal limits of median lobes; form club-like projections which may touch each other medially; distally dorsolateral lobules form pair of large rounded hood-like projections. Ventrolateral lobules extremely thickened and medially directed, almost touching in midline; distally these lobules form two horn-like structures which twist under and are obscured by hood-like projections of dorsolateral lobules; generally petasma greatly thickened and very long, reaching to between third pair of pereiopods.

Appendix masculina: Club-shaped; shaft of 'club' short and twisted; apical surface rounded; glabrous. Basal article of endopodite subtriangular; wide at base with mesial margin projected distally into twisted arm bearing appendix masculina; article glabrous except for row of short setae along mesial edge.

Colour in life: Generally a pink to brown with brown and bluish chromatophores. The antennules are brownish while the antennae are red. The fringing hairs are transparent except those fringing the uropods which are red. The uropods themselves are reddish-brown in colour. The dorsal abdominal carinae are brown.

Taxonomic status and comments

For many years this species was confused with others from the Indo-west Pacific region. Quite probably this was due to the fact that no complete and detailed descriptions existed. It was really only when Hall (1958) showed the distinction between *M. monoceros* and *M. ensis* that the picture became clear.

Accepting Hall's distribution of the two above mentioned species, I feel it is very unlikely that Stimpson's (1860) specimens from Hong Kong can be classified as *M. monoceros*. Also, I agree with Burkenroad (1934a) and Barnard (1950) and consider Stebbing's species *M. spinulicauda* as a synonym for *M. monoceros*.

Distribution (Fig. III-27)

After Hall (1958) clarified the confusion which existed between *M. ensis* and *M. monoceros* it became clear that the latter species was to be found west of the Malayan Peninsula. *M. monoceros* has therefore been recorded from Malaya — Penang (Miers); Burma — Gulf of Martaban, Akyab (Alcock); India — Calcutta, Ganjam, Orissa, Coromandel coast, Palk Straits, off Bombay (Miers, Alcock); Pakistan — Indus Delta (Alcock); Sri Lanka (Miers, Miquel, De Bruin); Egypt — Port Said, Red Sea, Suez Canal (Balss, Miquel); Madagascar — N.W. coast (Crosnier, Miquel, Le Reste); Reunion, Mauritius (Miquel); Mozambique — Quirimba Archipelago, Mafameded Island, Moma, Moebase, Micaune, Ligonha River, Maputo Bay (de Freitas, Stebbing, Barnard); South Africa — Natal coast, Tugela Bank, St Lucia Bay, Durban Bay (Calman, Barnard, Stebbing, Joubert & Davis, de Freitas).

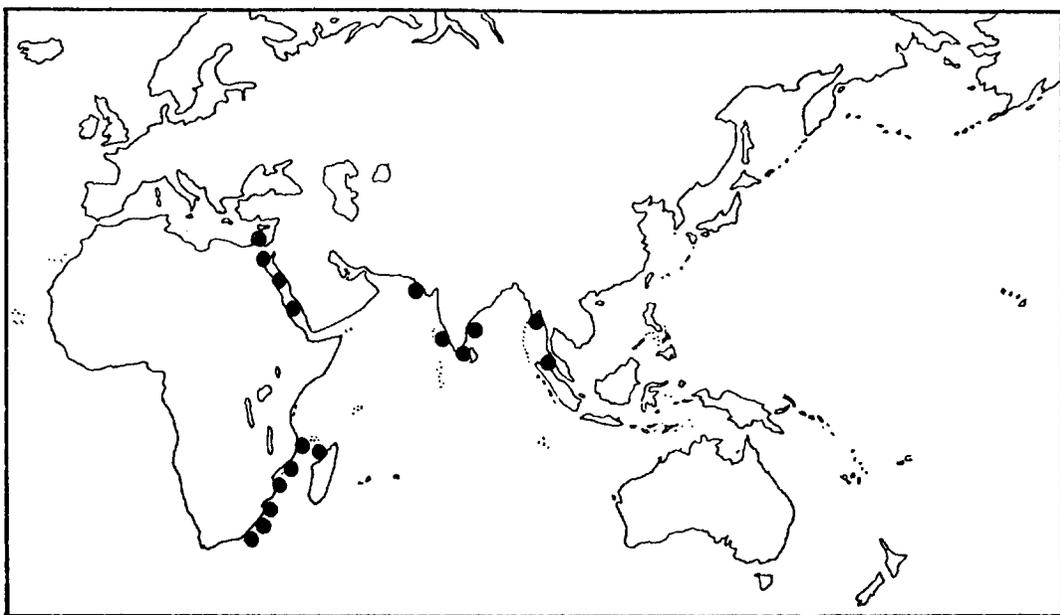


Fig. III-27 Distribution of *Metapenaeus monoceros*.

There is no information with regard to any particular locality occupied by eggs and early larval stages. Late mysis and postlarval stages are taken into backwater areas and estuaries which serve as nurseries. Juveniles also occupy these nursery areas until, as young immature adults they migrate to deeper water. The characteristics of *M. monoceros* nursery areas will be dealt with later.

Adults are found in deeper water of depths from 3 to 20 metres. They may occupy large embayments where water depths are favourable but are also found offshore on the continental shelf. George and George (1964) recorded what they believed to be a spawning population in 50-60 metres of water off Cochin in India.

Biology

Metapenaeus monoceros is a species virtually restricted to the Indian Ocean. It has considerable economic value constituting an important part of the catches in India, Pakistan, Sri Lanka, Madagascar and Mozambique. Although this species has often been mentioned in general papers on economically important penaeoids of the Indian Ocean, surprisingly few papers deal specifically with it (George, 1959, 1970; George and George 1964; Nalini 1975; Le Reste & Marcille 1976).

In Mozambique this species is of considerable importance to the prawn fishery forming, at times, as much as 70% of the catches. It is an excellent species for commercial purposes being an exceptionally hardy creature. If kept moist and chilled, it will arrive live at the markets several hours after being caught. For this reason too, this species may prove a valuable type for culture.

Most of the data used in this study was obtained from 1968 to 1973 from sampling 22 stations within Maputo Bay (Fig. III-28) and from frequent and detailed analyses of the commercial catches within the Bay. During the fieldwork for this study a total of 301 063 individuals were

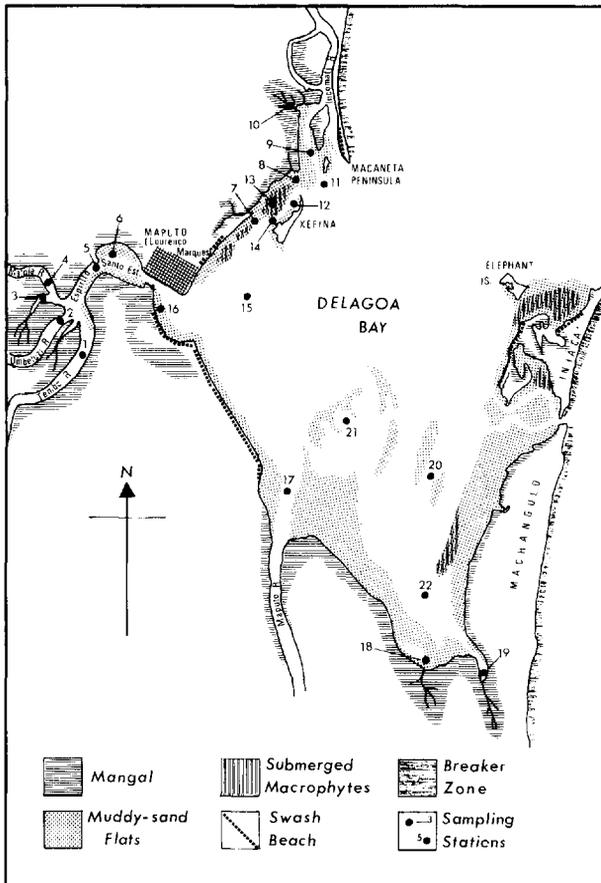


Fig. III-28 Maputo Bay (Delagoa Bay) showing location of sampling stations.

caught and 29 171 measured. Data for the Tugela Bank fishery was mainly obtained from the catch records of two Durban-based vessels during the period May 1976 to April 1977.

Reproduction

Maturity: No work has been done on the anatomy of the male and female reproductive systems of *M. monoceros*, although it must follow the general penaeid pattern. As in most penaeoids, the maturation of the ovary is accompanied by distinctive changes in colour and size. No maturity studies have previously been carried out (George 1970) and the changes in colour undergone by the developing ovary have never been described. The following five stages can be distinguished and are based on the examination of developing ovaries of 10 907 females:

- | | | | |
|------------|--------------------|---|---|
| Stage I: | <i>Undeveloped</i> | — | Translucent, smooth and threadlike. |
| Stage II: | <i>Developing</i> | — | Opaque, cream to light yellow; slightly distended and finely granular. |
| Stage III: | <i>Mature</i> | — | Fully distended; yellow to orange; granular. |
| Stage IV: | <i>Ripe</i> | — | Fully distended; green to very dark olive green bordering brown; individual ova distinct. |
| Stage V: | <i>Spent</i> | — | Flaccid; lime to green. |

The data collected in Maputo Bay from 1968-1973 shows that probably all females smaller than 19-20 mm carapace length (Lc) have undeveloped ovaries and that the largest females with undeveloped ovaries measured Lc = 49-50 mm. The smallest females with mature (III), ripe (IV) or spent (V) ovaries measured Lc = 21-22 mm and the majority (50% or more) of females first showed mature or ripe ovaries at Lc = 35-36 mm (Fig. III-29).

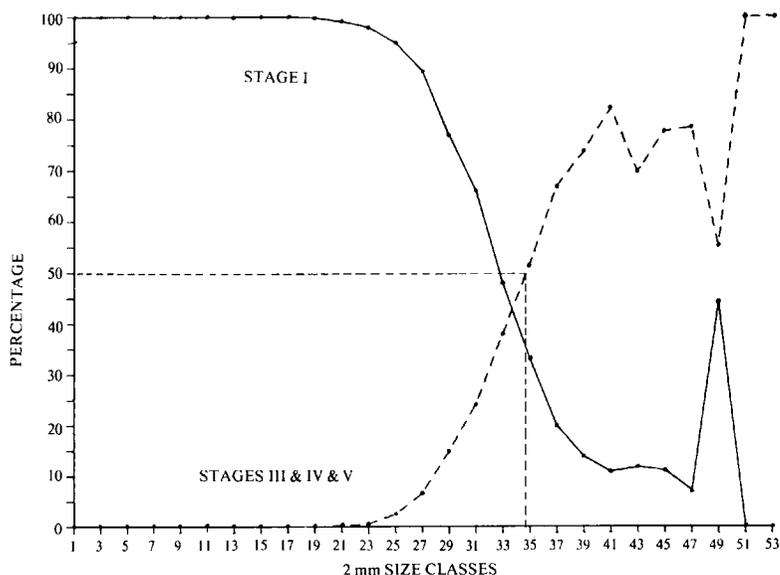


Fig. III-29 Size frequency distribution of *M. monoceros* females with stages I and III + IV + V from Maputo Bay (1965-1973).

Sampling of *M. monoceros* from the Tugela Bank from April 1976 to February 1977 showed that the majority of females attain sexual maturity at $L_c = 37-38$ mm which is similar to what occurred in Maputo Bay.

With regard to the male of the species, it is not possible to determine, with the naked eye, when an individual has attained sexual maturity. As yet, no work has been done on the histology of the developing testes of *M. monoceros* and it is not possible to determine exactly at what size and age the spermatophores are fully developed.

An indirect method of obtaining some indication of male adulthood and maturity is the determination of the size at fusion of petasmas halves (Tuma 1967). Of the 18 264 males examined, no individual of $L_c = 5-6$ mm and less had fused petasmas endopodites. The size at which the majority (50% or more) of males had fused petasmas halves was found to be $L_c = 15-16$ mm and individuals of $L_c = 29-30$ mm always had fused petasmas (Fig. III-30). Whereas 35.8% of the males in backwater areas had unfused petasmas only 1.2% of males in the open bay were found to be in this state.

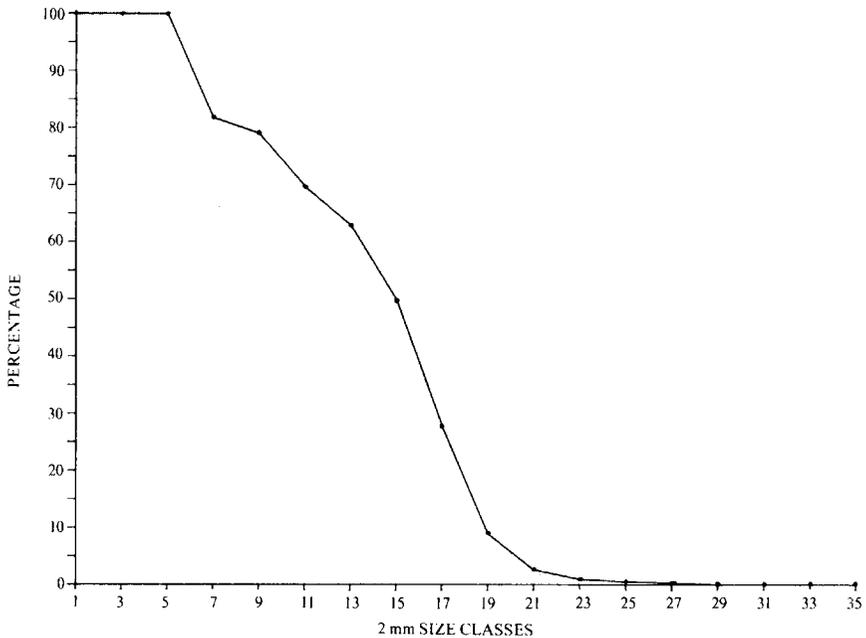


Fig. III-30 Percentage of *M. monoceros* males, within each class, with unfused petasmas endopodites — Maputo Bay (1968-1973).

Mating: Fertilization is external and the sperms are dispensed from the spermatophore as the eggs are liberated. As in other members of this family, copulation takes place between a soft-shelled female and a hard-shelled male (Hudinga 1942; Eldred 1958).

Of the 10 464 females sampled from the backwater stations none were ever found to be impregnated and of the 10 907 females sampled from the open bay area only 37 were found to be impregnated. However, of these 37 impregnated females, 8.1% had undeveloped ovaries, 13.5% had developing gonads, 32.4% were mature and 45.9% were ripe females.

The smallest females found impregnated measured $L_c = 23-24$ mm and accepting that the majority of females are mature at $L_c = 35-36$ mm, one finds that of the impregnated individuals examined 62.1% measured $L_c = 35-36$ mm and larger.

Of the 576 soft-shelled females examined none were found to be impregnated which may indicate that the spermatophores are far more easily dislodged before the shell hardens.

On analysis of the monthly incidence of impregnation it was found that 100% of impregnated females in Maputo Bay were found in spring and summer, September to March, none being found from April to August (Fig. III-31).

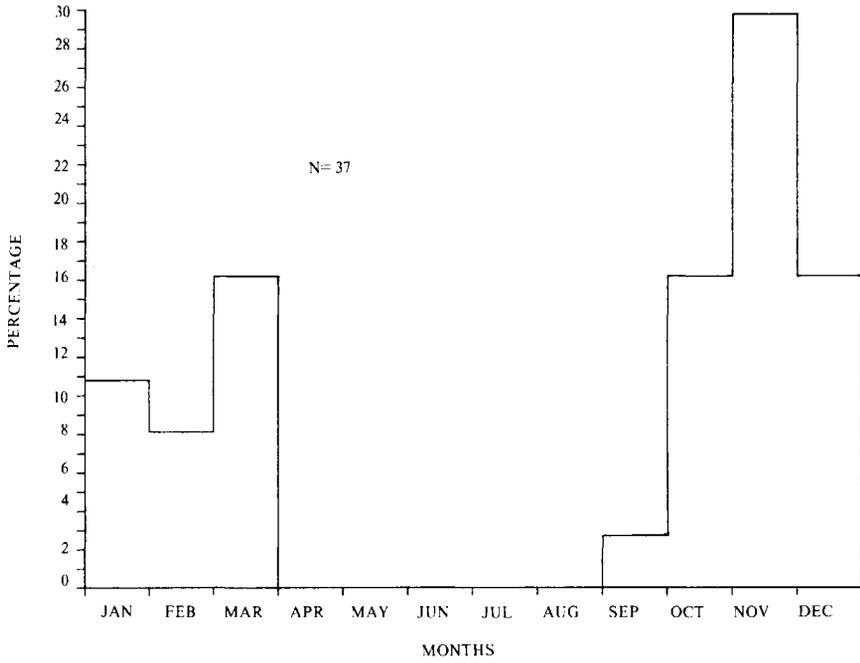


Fig. III-31 Monthly frequency of impregnated *M. monoceros* females from Maputo Bay (1968-1973).

Spawning: Spawning is indicated by the presence of gonads in advanced stages of maturation. There seems to be very little variation in the mean monthly size distribution of ripe and spent females (Fig. III-32). Table III-1 summarizes the situation recorded in Maputo Bay from 1968 to 1973, and sets out the monthly percentage of ripe and spent females, both in relation to the number of females of $L_c = 21-22$ mm and larger. This size group represents the smallest size where ripe or spent females were recorded.

The female population shows the highest incidence of spawning during summer, from October to February when 14.3% to 23.0% of the females larger than $L_c = 21-22$ mm or 10.2% to 15.2% of the total female population are found to be ripe or spent. From February the numbers decreased and ripe or spent females were completely absent from the population during June and July. The odd few appeared in August and increased again to October.

Nursery areas

No work was carried out in Mozambique on the planktonic stages of *M. monoceros* and no information is available with regard to the eggs and early larval stages of this species. In a survey carried out along the northeast margin of Maputo Bay (de Freitas 1986), early stage *M. monoceros* juveniles ($L_c < 20$ mm) were found in all but the four stations located either in the swash zone or in shallow pools on tidal mudflats where recorded salinities were 33‰ and over. The largest number of juveniles were found in a tertiary mangrove channel where during low tide freshwater seepage was such that salinities as low as 10.3‰ — 13‰ were recorded (de Freitas 1986).

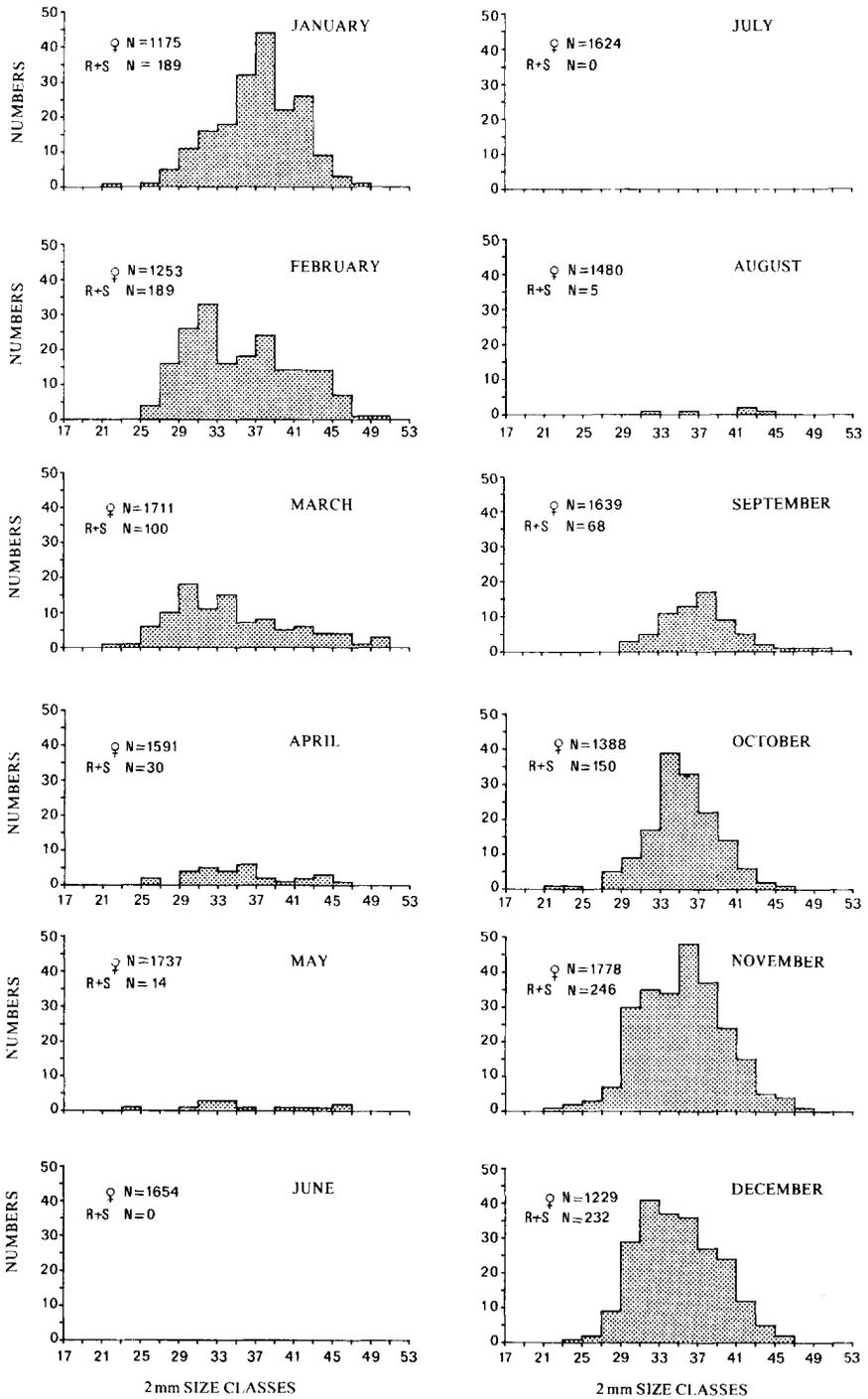


Fig. III-32 Monthly size frequency distribution of ripe + spent females of *M. monoceros* in Maputo Bay from 1968-1973.

Table III-1 *M. monoceros*. Monthly percentage of ripe and spent females in relation to total numbers of females and numbers of females larger than Lc = 21mm.

Month	Total No	Individuals > 21 mm		Stages IV + V		% IV + V of Tot.
		No.	%	No.	%	
JAN.	1 527	1 127	73.8	189	16.8	12.4
FEB.	1 654	818	49.5	188	23.0	11.4
MAR.	2 069	928	44.9	100	10.8	4.8
APR.	2 248	1 015	45.1	30	3.0	1.3
MAY	2 158	1 008	46.7	14	1.4	0.6
JUN.	2 048	1 007	49.2	0	0	0
JUL.	1 759	999	56.8	0	0	0
AUG.	1 515	1 012	66.8	5	0.5	0.3
SEP.	1 522	1 051	69.1	68	6.5	4.5
OCT.	1 475	1 052	71.3	150	14.3	10.2
NOV.	1 803	1 219	67.6	246	20.2	13.6
DEC.	1 522	1 049	68.9	232	22.1	15.2
	21 300	12 285	57.7	1 222	9.9	5.7

Associated species, predators and parasites

The sampling programme carried out during 1971-1973 showed that the main penaeoid species associated with the postlarvae and juvenile *M. monoceros* within the nursery areas were *Parapenaeopsis acclivirostris* and juvenile *Penaeus indicus*. To a lesser degree, *P. semisulcatus*, *P. monodon*, *P. japonicus* and *M. stebbingi* are also found together with *M. monoceros* both in the nursery areas and in the adult habitat.

The goby, *Gobius nebulosus*, and the mudskipper, *Periophthalmus sobrinus*, are common predators of postlarval *M. monoceros* found on the fringes of the shallow mangrove channels. Very few stomach contents were analyzed and positive identification of *M. monoceros* remains were found only in *Pomadasyd hasta*, *Johnius belengeri* and *Platycephalus crocodilus*.

The most obvious parasite found on *M. monoceros* is an, as yet unidentified bopyrid isopod, possibly *Epipenaeon* sp.. Of the total of 21 381 females examined 846 or 3.96% were infected. Of the 18 264 males examined, 549 or 3.00% were infected, giving an average of 3.25% for both sexes together. Of the 1 395 infected shrimp 47% were found in backwater areas and 53% in the open bay.

The mean monthly frequency distribution of all the parasitised *M. monoceros*, based on data collected from 1968 to 1973, showed that infestation is more frequent during summer, with a maximum peak in January (Fig. III-33). The smallest individuals infected measured Lc = 11-12 mm, the largest Lc = 39-40 mm while the mode was situated at Lc = 21-22 mm. A small percentage, 2.9% of the parasitized individuals were found to be infected on both sides of the carapace.

Of the infected females, 97.2% had undeveloped ovaries (Stage I), 0.7% had developing ovaries (Stage II), 0.7% had ripening ovaries (Stage III) and 1.4% had ripe ovaries (Stage IV).

Relating the ovarian development of the parasitized females with size it is found that the majority of the infected females have ripening or ripe ovaries at $L_c = 35-36$ mm. This is identical to the situation found among healthy females. Among the infected males the situation is similar to that found with uninfected individuals and the majority of males have fused petasma at $L_c = 19$ mm.

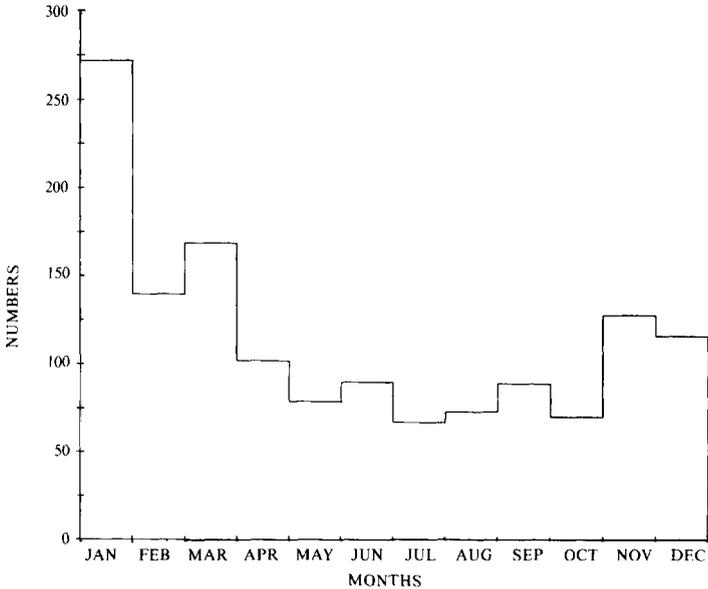


Fig III-33 Monthly frequency of parasite infected *M. monoceros* in Maputo Bay from 1968-1973.

Schooling

Although there is evidence to support the belief that certain penaeid species form extensive schools (Kirkgaard, Tuma & Walker 1970), this does not seem to be the case with *M. monoceros*. Large catches exclusively of this species are not known.

Migration

Individuals of both sexes smaller than $L_c = 12-13$ mm were seldom found in the open bay (Fig. III-34). From $L_c = 14-15$ mm the percentage found in the open bay increased and individuals of $L_c = 33-34$ mm and above were seldom found in backwater areas. The size group which was found 50% in each area was $L_c = 18-21$ mm.

Burying

Of the many juvenile and adult *M. monoceros* kept in the laboratory none were ever seen to bury themselves in the substratum at any time of day or night. However, some individuals have been seen to sit quietly on the substratum with pereopods buried, as if 'holding-on' to the sediment.

Population

Sex ratio: In the backwater areas of Maputo Bay, from a total of 17 625 individuals examined over a period of three years, 10 475 were females and 7 154 were males, giving a percentage of

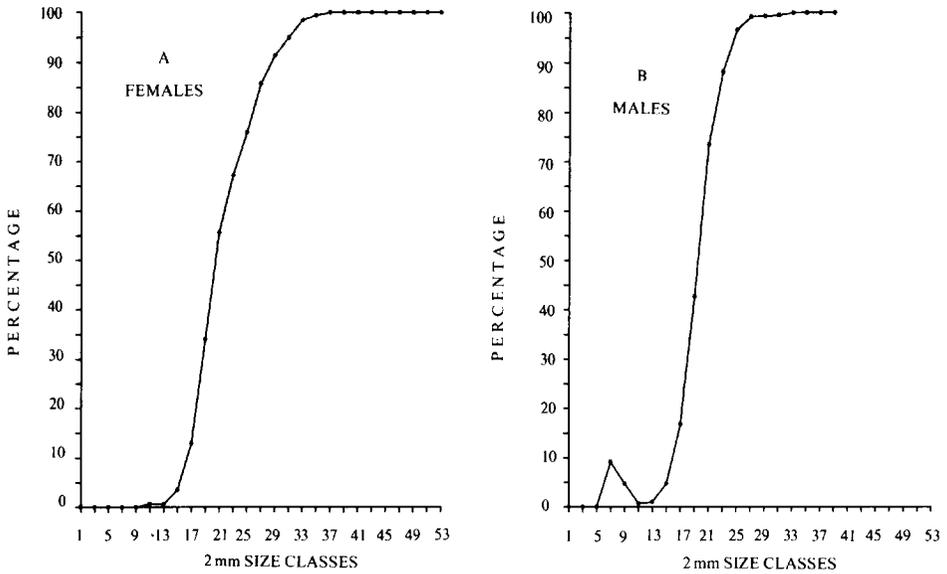


Fig. III-34 Percentage of each size class of *M. monoceros* found in the open bay areas from 1968-1973.

59.42% females, or a ratio of females to males of 3:2. In the open bay, however, of the 22 067 individuals sampled, 10 943 (49.59%) were females and 11 124 (50.41%) males, or a ratio of 1:1.

The female component, as a percentage of the total population in the backwater areas of Maputo Bay and in the open bay, varied slightly from month to month (Fig. III-35).

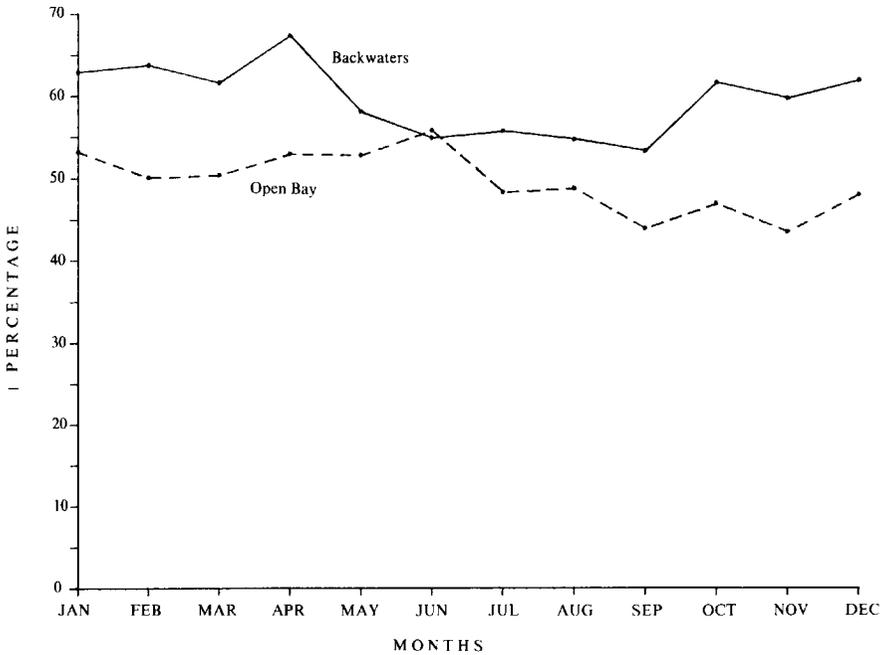


Fig. III-35 Monthly sex ratio of *M. monoceros* in backwater and open bay areas of Maputo Bay in percentage of females.

On the Tugela Bank, the *M. monoceros* stock sampled from July to October 1976, yielded 115 (53%) females and 102 (47%) males or a ratio of 1:1.

Morphometrics: The carapace length/total length, carapace length/weight and total length/weight relationships were calculated from 300 males and 300 females taken from the samples measured from 1970-1973. All specimens were measured while fresh and no formalinized individuals were used. The range of carapace lengths was from 8.1 mm — 37.0 mm in the males and 6.7 mm — 38.2 mm in the females.

For the carapace length/total length relationship both the power curve and the straight line relationships were determined. Weight was related to the carapace length as well as to the total length. The carapace lengths and total lengths were measured in mm and weight in grams.

The power curve carapace length (C)/total length (T) relationships are expressed by the equations:

Males:	$T = 5.920C^{0.924}$ with $r = 0.995$
Females:	$T = 5.675C^{0.932}$ with $r = 0.993$
Sexes combined:	$T = 5.755C^{0.930}$ with $r = 0.993$

The straight line carapace length (C)/total length (T) relationships are expressed by the equations:

Males:	$T = 4.257C + 8.593$ with $r = 0.993$
Females:	$T = 4.223C + 7.652$ with $r = 0.993$
Sexes combined:	$T = 4.246C + 8.190$ with $r = 0.992$

The carapace length (C)/weight (W) relationships are expressed by the equations:

Males:	$W = 1.515 \times 10^{-3}C^{2.75}$ with $r = 0.991$
Females:	$W = 1.216 \times 10^{-3}C^{2.81}$ with $r = 0.995$
Sexes combined:	$W = 1.328 \times 10^{-3}C^{2.79}$ with $r = 0.993$

The total length (T)/weight (W) relationships are expressed by the equations:

Males:	$W = 8.3 \times 10^{-6}T^{2.95}$ with $r = 0.991$
Females:	$W = 7.0 \times 10^{-6}T^{3.00}$ with $r = 0.995$
Sexes combined:	$W = 7.7 \times 10^{-6}T^{2.98}$ with $r = 0.993$

Size composition: The size composition of the *M. monoceros* population found in the backwater and open bay regions of Maputo Bay are summarized in Table III-2. In the backwater the annual average size range for male *M. monoceros* was $L_c = 5-29$ mm in carapace length with an annual mean of $L_c = 16.8$ mm (Fig. III-36). The range for females was $L_c = 3-35$ mm and an annual mean of $L_c = 17.4$ mm (Fig. III-37). In the open bay the average annual size range was 11-37 mm carapace length for males (Fig. III-36) and 11-49 for females (Fig. III-37), with the annual mean carapace lengths being 23.9 mm and 27.00 mm for males and females respectively.

The annual average size group migrating from all backwaters to the bay was composed of males of $L_c = 15-25$ mm and females of $L_c = 15-21$ mm. The size group, found 50% in the open bay and 50% in the backwaters, was $L_c = 19-20$ mm (males) and $L_c = 21-22$ mm (females) (Fig. III-34).

The monthly variation in size composition of the male and female populations of the backwaters (Fig. III-38) are composed of individuals of very similar size range. Generally monthly modes differ very slightly. In the open bay (Fig. III-39) however, the female population tends to be composed of larger individuals with the possible exception of March, April and May when both sexes appear to occupy the same size range.

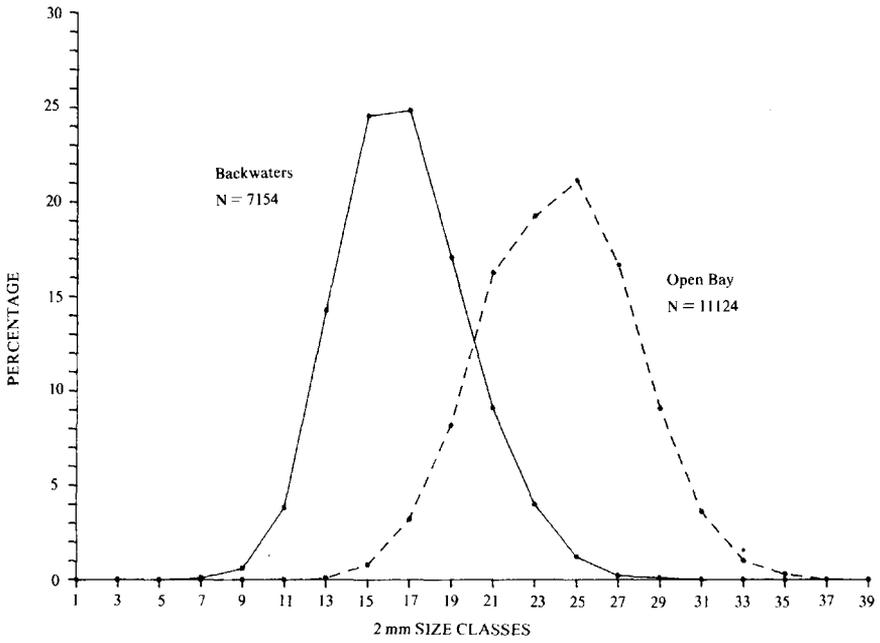


Fig. III-36 Mean annual size distribution of *M. monoceros* males in backwater and open bay areas of Maputo Bay (1968-1973).

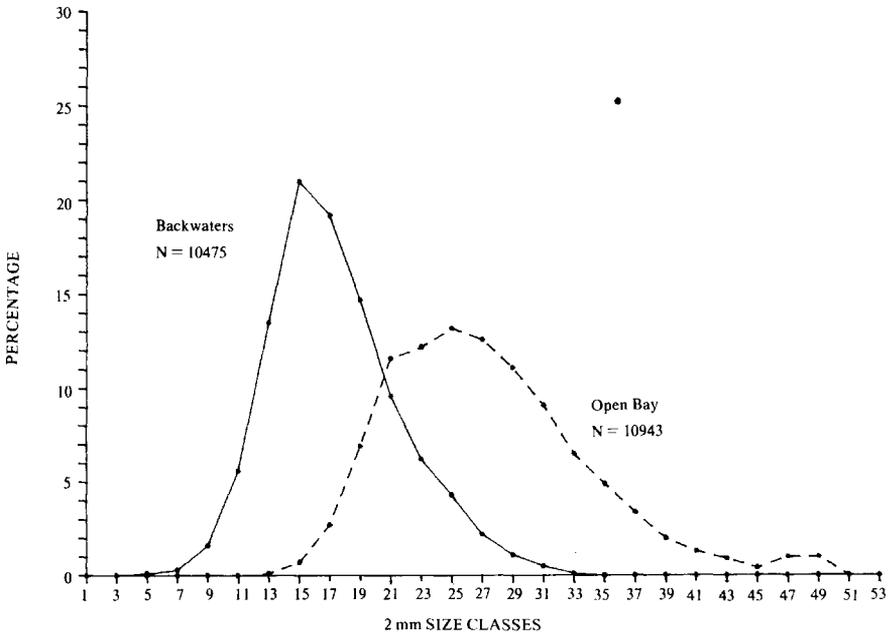


Fig. III-37 Mean annual size distribution of *M. monoceros* females in backwater and open bay areas of Maputo Bay (1968-1973).

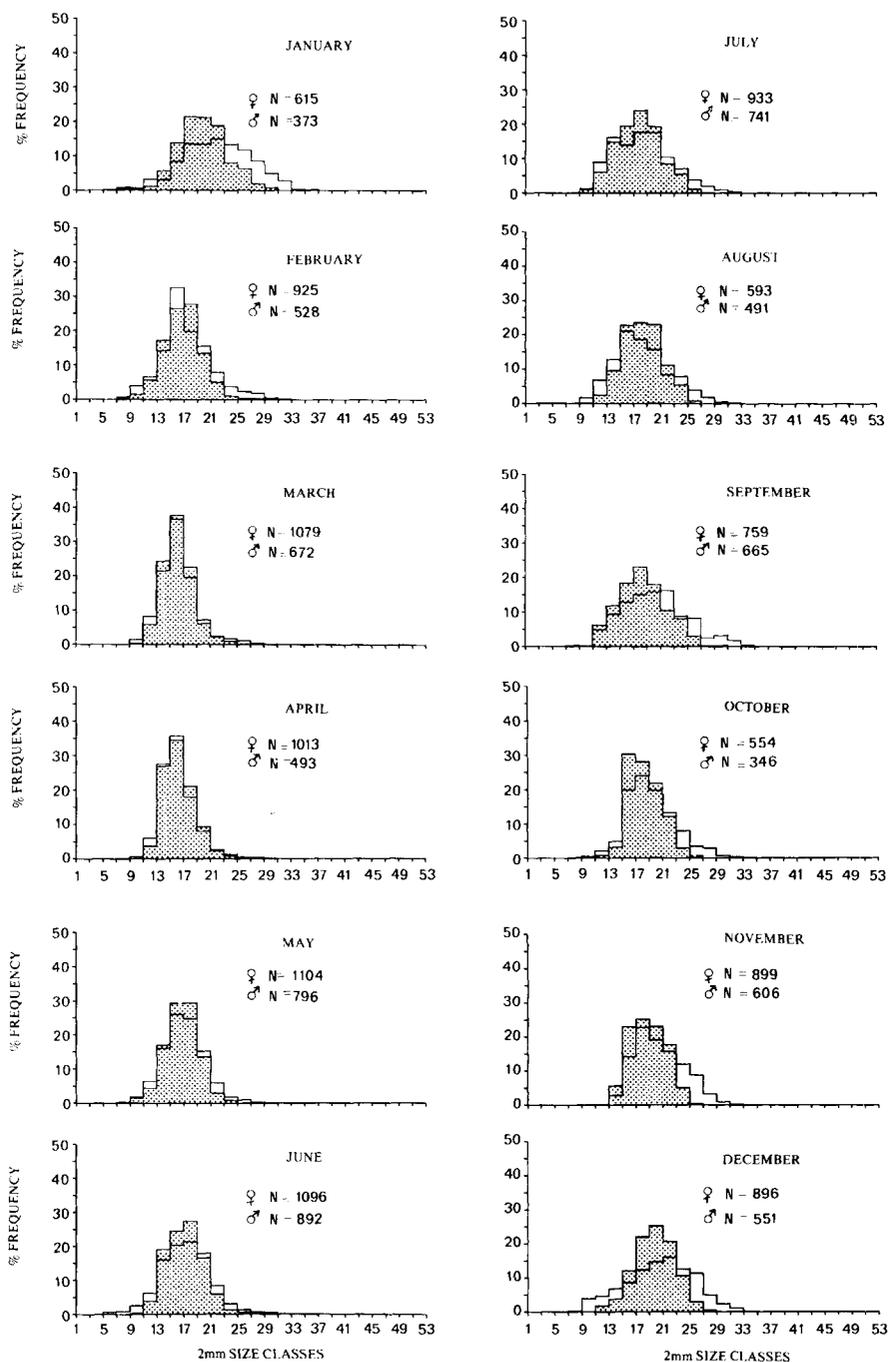


Fig. III-38 Monthly size frequency distribution of *M. monoceros* males (shaded) and females (unshaded) in backwater stations of Maputo Bay (1968-1973).

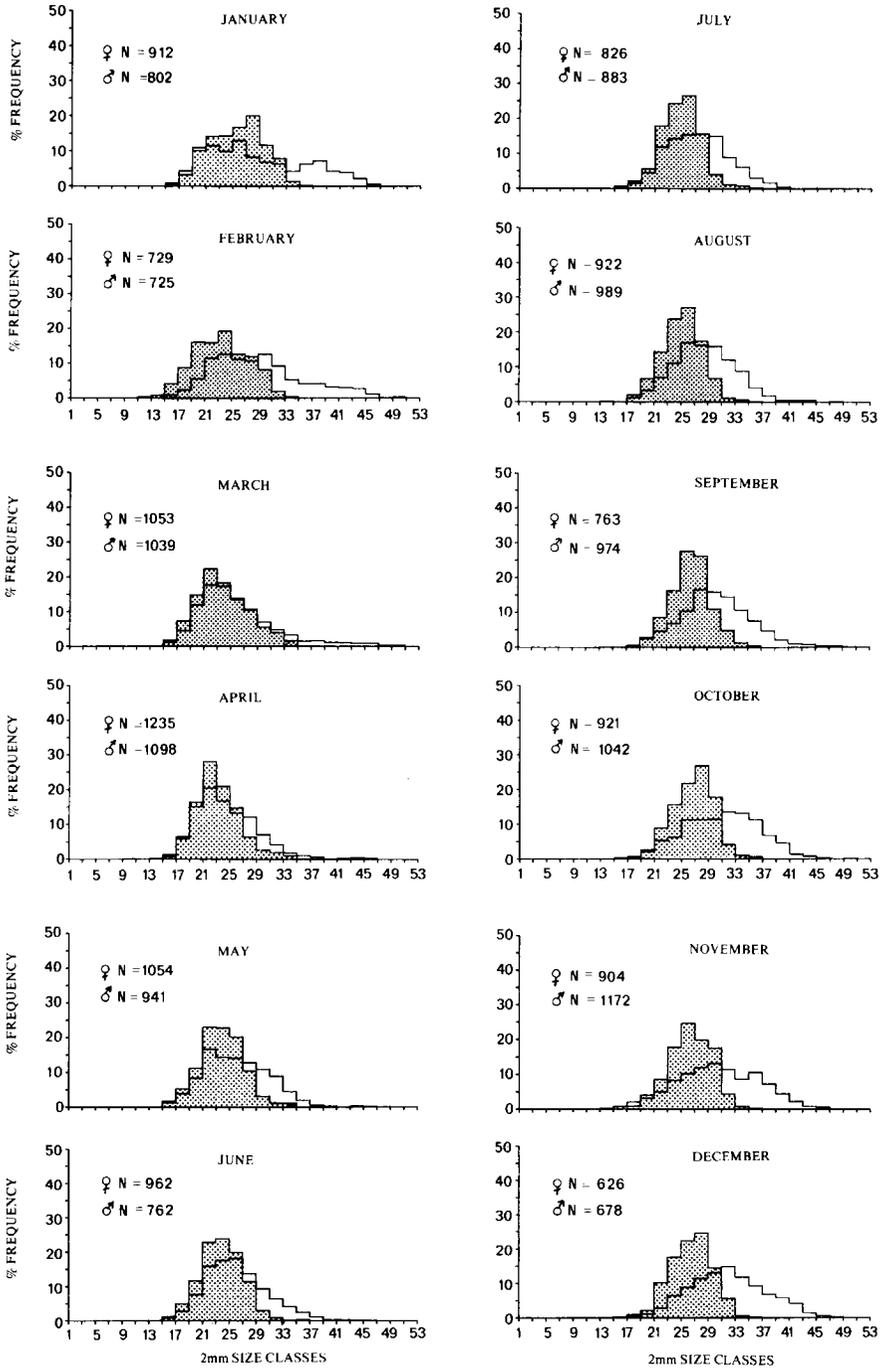


Fig. III-39 Monthly size frequency distribution of *M. monoceros* males (shaded) and females (unshaded) in open bay areas of Maputo Bay (1968-1973).

Table III-2 *M. monoceros*. Average monthly carapace size range and mean carapace length from backwater and open bay stations.

Month	BACKWATERS				OPEN BAY			
	Male		Female		Male		Female	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
JAN.	7-29	18.8	5-35	22.2	15-37	24.7	15-47	27.6
FEB.	7-29	15.9	7-31	16.5	11-35	24.5	11-49	28.0
MAR.	9-25	15.2	9-33	15.3	13-35	22.9	11-49	25.0
APR.	7-29	15.6	5-29	15.2	13-37	22.3	13-45	23.7
MAY	7-23	15.7	7-31	16.1	13-35	22.9	13-47	25.0
JUN.	9-27	16.2	3-35	16.4	11-35	22.8	15-45	25.1
JUL.	7-27	16.7	9-31	17.3	15-37	23.9	11-47	26.4
AUG.	5-25	17.3	3-29	17.1	15-35	24.1	13-47	27.4
SEP.	9-29	17.3	5-33	19.1	15-35	25.5	13-49	29.3
OCT.	9-25	17.3	7-33	18.3	15-35	25.7	15-49	30.0
NOV.	11-25	18.4	11-35	19.5	13-37	25.3	15-47	29.5
DEC.	11-27	18.7	7-33	19.5	13-35	25.4	15-47	30.9
YEAR	5-29	16.8	3-35	17.4	11-37	23.9	11-49	27.0

Abundance

The mean monthly abundance of *M. monoceros* given in numbers of individuals caught by the sampling net in 15 minute drags for four backwater areas of Maputo Bay (Table III-3) showed that the most productive area was the Incomati River Estuary where an annual mean of 317.0 individuals per 15 minutes were caught. The least productive was the Xefina Sea-grass area which yielded 4.4 individuals per 15 minute drag.

In the breakdown of the sampling data (Fig. III-40A) one sees that of the stations within the Incomati River Estuary by far the highest abundance (520 individuals per 15 minutes) was recorded from the Montanhana or Chadana River (Station 10). This 'river' is in fact nothing more than a creek draining the surrounding mangroves. It was a relatively shallow channel only workable during high tides. During the period of the study the mean salinities varied from 0‰ to as much as 37‰.

Relating the mean monthly catches within the Montanhana River (Fig. III-40B) with the average monthly salinities (Fig. III-40C) it appears that the highest yields corresponded to periods of lowest salinities. This seems to confirm the belief that *M. monoceros* can tolerate low salinities. In fact it would appear that it favours, as nursery areas, localities within the lower salinity ranges (De Freitas, 1986).

The Xefina Sea-grass localities yielded low numbers of *M. monoceros* with an annual mean of 4.4 individuals per 15 minute drag (Table III-3). Here salinities were below 10‰ only in February and March. The substratum was of a coarse muddy sand densely covered with submerged macrophytes. These results confirm the findings of the nursery area survey already described.

Table III-3 Monthly abundance of juvenile *M. monoceros* in backwater areas of Maputo Bay (1971-1973).

MONTH (1971 - 1973)	Yield in numbers caught per 15 mins.			
	Espirito Santo Estuary	Machangulo	Xefina Sea-Grass	Incomati Estuary
STATIONS	1, 2, 3, 4, 5, 6	18, 19	7, 8, 13	9, 10, 11, 12, 14
JAN.	11.0	49.5	0.4	71.1
FEB.	45.9	30.0	1.4	65.0
MAR.	81.4	32.2	3.0	939.8
APR.	56.5	63.8	1.8	334.9
MAY	44.1	115.6	29.6	562.2
JUN.	25.3	62.7	6.2	213.9
JUL.	21.4	42.5	0.3	76.6
AUG.	16.2	33.8	1.2	164.5
SEP.	24.8	34.8	0.4	227.3
OCT.	23.4	26.6	0.5	267.2
NOV.	20.1	87.8	1.3	70.0
DEC.	18.2	26.2	0.8	62.1
MEAN	33.1	43.0	4.4	317.0

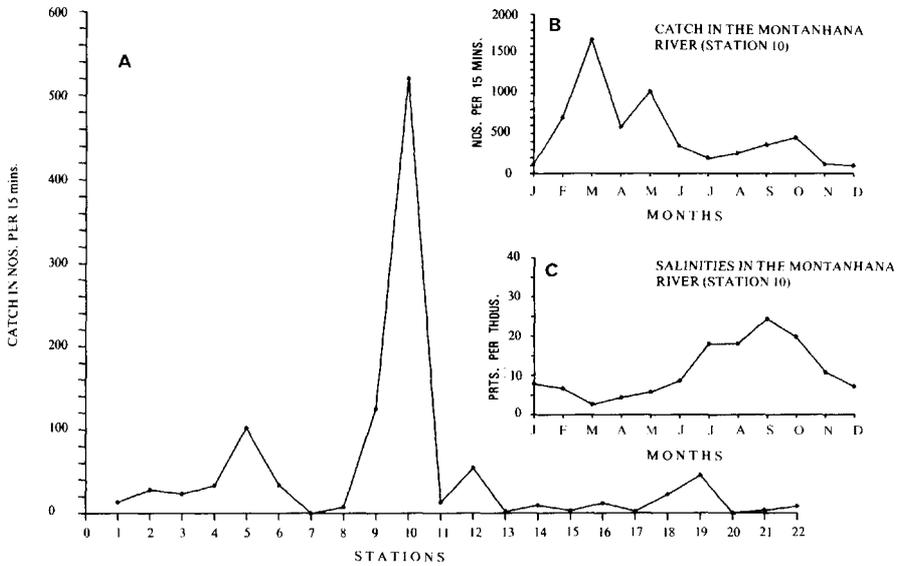


Fig. III-40 *M. monoceros* A-Catch in 22 sampling stations of Maputo Bay. B-Catch in station 10. C-Salinities in station 10.

Exploitation

Fishing grounds

Metapenaeus monoceros or the brown prawn as it is known commercially in Southern Africa is a species of considerable economic importance throughout the Indian Ocean, in particular India, Madagascar and Mozambique.

Along the coast of southeast Africa, the best *M. monoceros* grounds are situated off Mozambique between the Zambesi River and Mafamede Island, in depths of 3-20 metres of water. In the southern part of the Sofala Bank this species is found in commercial quantities in the vicinity of Chiloane Island although the grounds are very shallow (3-10m) making it impossible to use anything but the smallest boats. Primitive weirs and stake nets are very efficient in this region.

South of Bazaruto the continental shelf narrows considerably and *M. monoceros* is only again found in exploitable amounts within Maputo Bay. In the bay, commercial fishing is carried out in two main areas, the Polana and Machangulo grounds, separated by the Maputo Bank. The mean monthly catch for these two areas in kg/hr, taken from the yields of commercial trawlers, shows that the Polana area yields (2.54 kg/hr) are slightly better than the yields from the Machangulo grounds (1.73 kg/hr) (Fig. III-41).

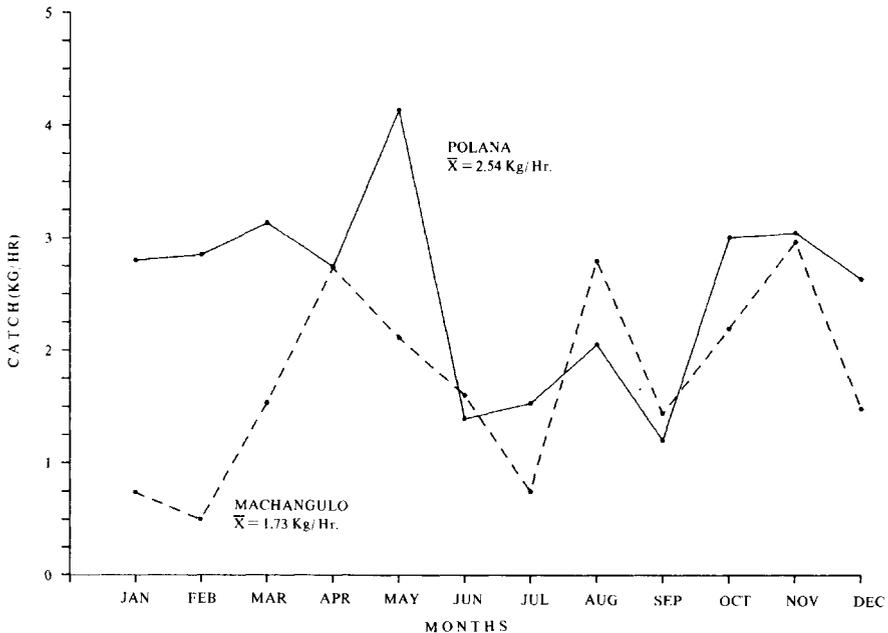


Fig. III-41 Catch in kg/hr of *M. monoceros* on the Polana and Machangulo fishing grounds made by commercial vessels in Maputo Bay (1968-1973).

South of Mozambique commercial quantities of *M. monoceros* are only found on the Tugela Bank where the trawlable grounds appear to have an area of some 200 square miles. In the bait fishery of the St Lucia Lake system *M. monoceros* forms roughly 20% of the catch, while in Richards Bay it constitutes a mere 2% (Forbes & Benfield, 1985, 1986).

Fishing activity

Season: In general this species is fished throughout the year and in India, Madagascar, Mozambique and South Africa (Holthuis, 1980). There are, however, periods of peak abundance and, in India, there is some variation with regard to the best season. Winter seems to

be the most favourable period in East and West Pakistan (Qureshi 1956), while in Bombay waters the peak fishery is during the rainy season from July to August (Shaikhmahmud & Tembe 1960). George *et al* (1968) and George (1970) have recorded considerable variation in the peak season for *M. monoceros* off Cochin. "November and December are usually the months of peak occurrence . . . but in certain years the species fails to appear in the catches in these months."

In central Mozambique *M. monoceros* is caught throughout the year although the best catches are made in autumn and spring, although as recorded by George *et al* (1968) in India, there is also a considerable variation with regard to the actual peak period.

Within Maputo Bay, *M. monoceros* is caught throughout the year. Based on the commercial catches from 1968 to 1973, there seem to be two peak periods, namely May and October-November, with secondary peaks in August and December. For the above period the lowest catches were recorded in June/July and September (Fig. III-42). The monthly catches for the years 1968 to 1973 (Fig. III-43), illustrates that there is considerable variation of the peak months from year to year.

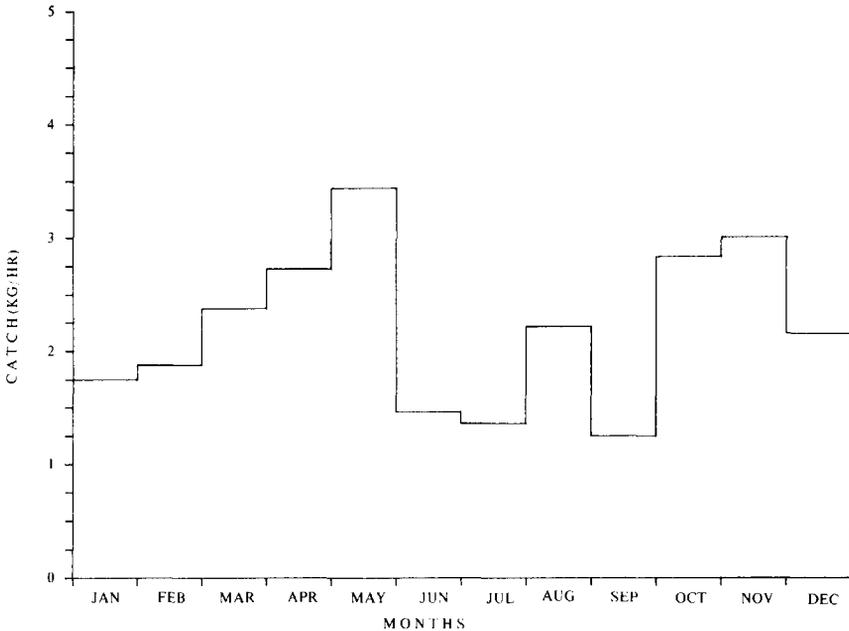


Fig. III-42 Mean monthly catch of *M. monoceros* made by commercial vessels in Maputo Bay from 1968-1973.

On the Tugela Bank, analysis of the catches of two commercial vessels seem to indicate that the best season for *M. monoceros* is during summer. However, accepting that there is generally a variation from year to year, the best season based on the catches of several years may prove to be different (Fig. III-44).

Catch: From February 1968 to December 1973, *M. monoceros* constituted an average of 31.9% of the total penaeid prawn catch from the exploited Maputo Bay stock. On the average, *M. monoceros* constituted more than 50% of the combined catch only in October and November, forming about 43% of the total catches in August and December (Fig. III-45).

In the central Mozambique fishing grounds *M. monoceros* constitutes an average of 42% of the total annual catch and more than 50% of the catch from July to November inclusive (Table III-4).

The analysis of the daily catch returns of two Durban-based vessels that operated on the

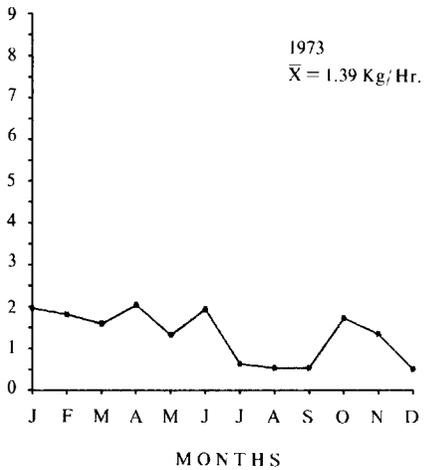
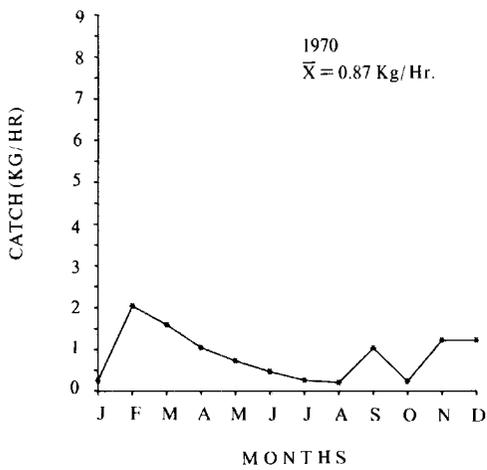
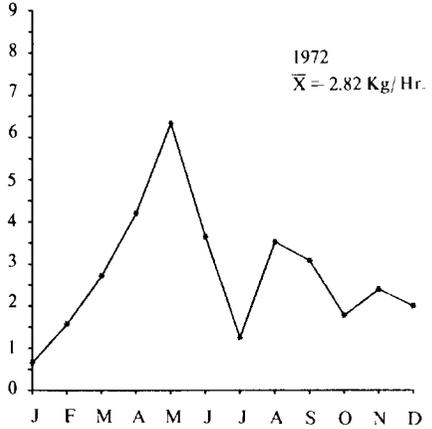
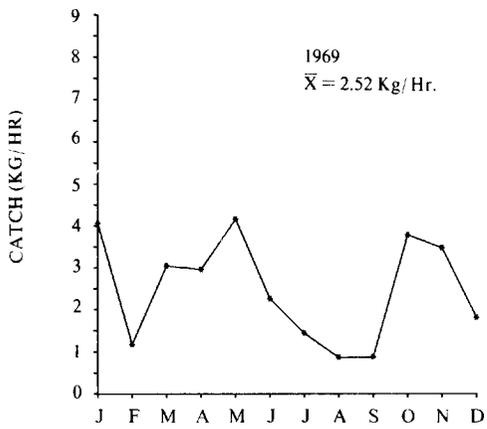
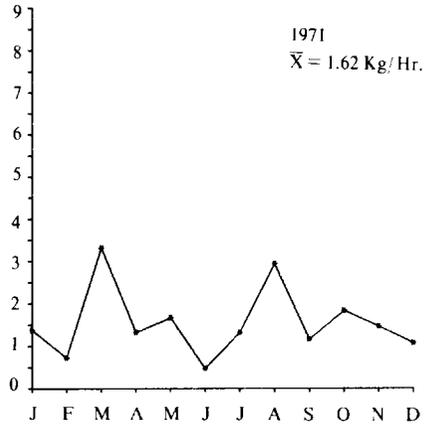
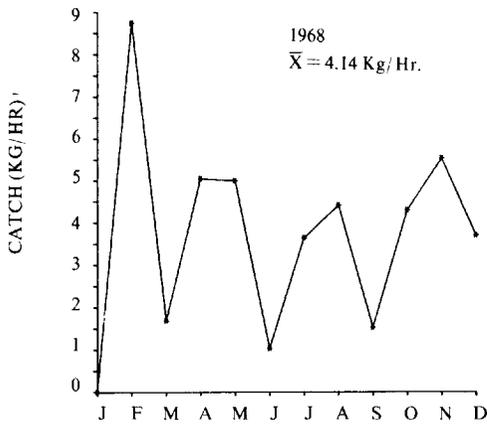


Fig. III-43 Monthly catch of *M. monoceros* in Maputo Bay from 1968-1973.

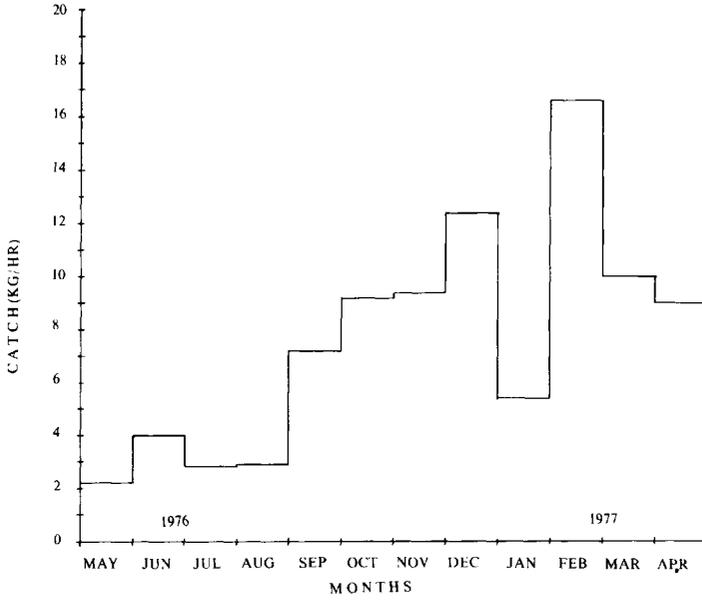


Fig. III-44 Mean monthly catch of *M. monoceros* made by two commercial vessels on the Tugela Bank (1976/1977).

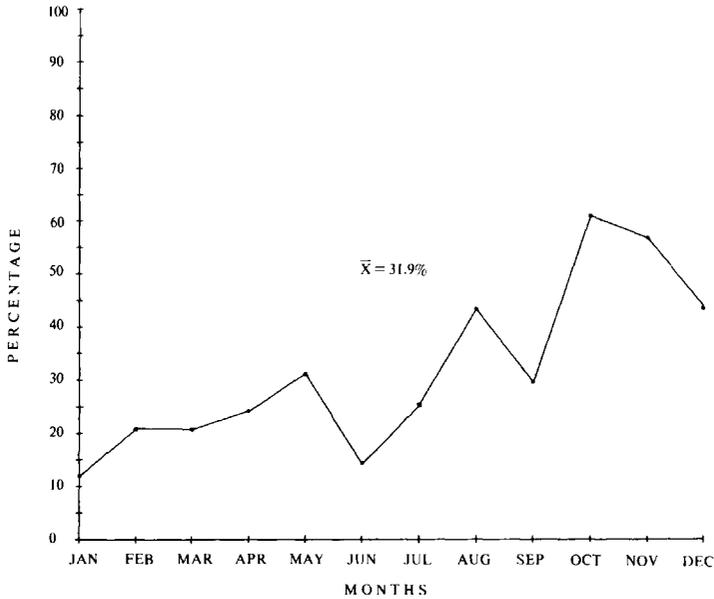


Fig. III-45 Monthly relative abundance of *M. monoceros* as a percentage of the total monthly catches in Maputo Bay (1968-1973).

Tugela Bank from May 1976 to April 1977 showed that *M. monoceros* formed, on the average, 44.3% of the total catch. The months during which they had the lowest relative abundance (<25%) were May to August inclusive (Table III-4).

Table III-4 Monthly relative abundance of *M. monoceros* from central Mozambique and Tugela Bank.

MONTH	Central Mozambique 1975	Tugela Bank 1976/1977
JAN.	37.2%	—
FEB.	21.3%	—
MAR.	14.4%	—
APR.	11.3%	—
MAY	18.8%	20.4%
JUN.	47.9%	24.3%
JUL.	70.2%	20.8%
AUG.	59.7%	21.8%
SEP.	64.4%	37.4%
OCT.	67.2%	61.1%
NOV.	52.9%	69.5%
DEC.	43.7%	63.9%
JAN.	—	59.5%
FEB.	—	70.0%
MAR.	—	36.4%
APR.	—	30.9%
MEAN	42.4%	44.3%

Although *M. monoceros* can be fished both during the day and night, by far the best fishing is during the daylight hours. In Maputo Bay 90.4% of the catches were made between sunrise and sunset (Fig. III-46).

The analysis of the size composition of the commercial catches of the Maputo Bay fishery in the three main commercial size classes, namely large (under 30 tails per pound), medium (31-60 tails per pound) and small (over 60 tails per pound) (Fig. III-47) shows that from January to August the small sizes predominate in the catches forming between 54% and 79%. During the last four months of the year the small sizes decrease in quantity to between 38% and 42% of the total catches. The large sizes which include individuals of total weight over 22.5 grams never attain 10% of the catches. This is, however, understandable as *M. monoceros* is a species where on the average only 4.1% of the population exceed weights of 22.5 grams, or a carapace length of above 36 mm.

Unfortunately very little information is available with regard to the commercial grade breakdown for catches in central Mozambique. The average annual size distribution based on the exported product of one company, from January to November 1974 is shown in Table III-5.

The fishery on the Tugela Bank requires a more detailed study with regard to the commercial grade breakdowns. Unfortunately the catch is almost exclusively destined for the local market in Durban and no selection, by species, is made and all species together are grouped into six grades, namely TG (tiger giants), T (tigers), K (kings), Q (queens), S (small) and SS (extra small). The first two categories are usually composed of *Penaeus monodon*, 'K' is almost

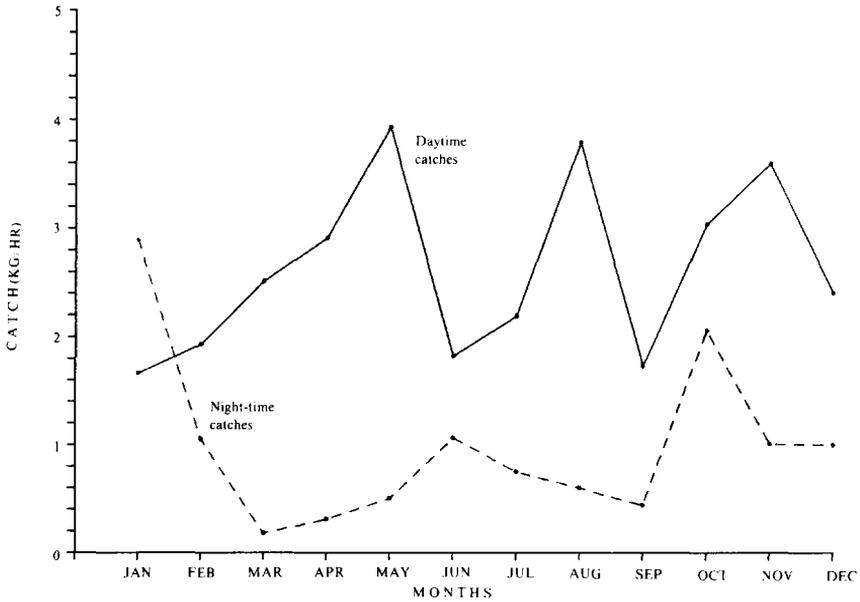


Fig. III-46 Daytime and night-time catches of *M. monoceros* in Maputo Bay made by commercial vessels from 1968-1973.

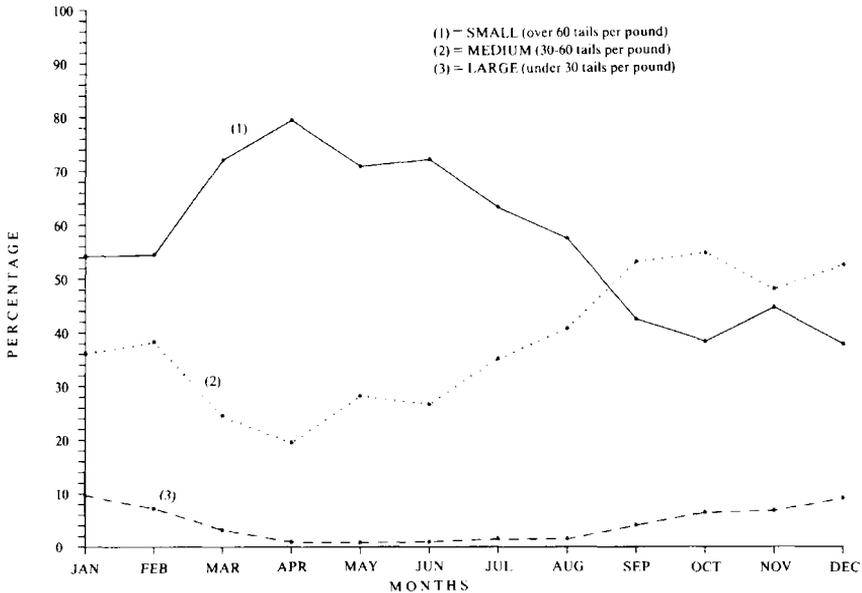


Fig. III-47 Percentage of the monthly catch of *M. monoceros* in Maputo Bay according to the three commercial size grades.

certainly only large *P. indicus*, while 'Q' will be essentially medium *P. indicus* with the larger *M. monoceros*. The category 'S' contains basically medium sized *M. monoceros* with small *P. indicus* and 'SS' is almost certainly composed of *M. monoceros* only.

For a short period, July to October 1976, one factory in Durban was grading *M. monoceros* from the Tugela Bank. The average size grade breakdown for the period is given in Table III-5.

Table III-5 *M. monoceros*. Mean commercial size grades in percentage in central Mozambique and Tugela Bank.

Commercial size grades in numbers of tails per pound	Central Mozambique	Tugela Bank
< 10	0.0	0.0
11 — 20	0.3%	0.1%
21 — 30	26.7%	4.2%
31 — 40	21.6%	5.6%
41 — 60	32.1%	21.6%
> 60	19.3%	68.5%

Discussion

Metapenaeus monoceros is a species of economic importance particularly in Mozambique, Madagascar and, to a lesser extent, in India (Holthuis 1980; Miquel 1982, 1984).

George (1959) gave indirect evidence that *M. monoceros* in Cochin, India, does not seem to mature before attaining a total length of 120 mm ($L_c = 26.3$ mm). However, he does not say exactly what he means by maturity. It is unclear whether he means the smallest size at which maturity occurs or whether he is referring to the size at which most of the female population are mature. The present study showed that females are mature at $L_c = 35-36$ mm in Mozambique and $L_c = 37-38$ mm on the Tugela Bank.

The maturity of males is difficult to determine macroscopically but an indication of male adulthood is given by the fusion of petasmas halves (Tuma 1967). Based on this technique, one can accept that *M. monoceros* males are juveniles and incapable of copulation at sizes smaller than $L_c = 15-16$ mm. The size group from $L_c = 15-16$ mm to $L_c = 19-20$ mm can be considered as the group of males migrating from the backwater areas to the open bay. At this size only 1% of males had unfused petasmas halves. Therefore, one can consider this group (i.e. $L_c = 15-16$ mm to $L_c = 19-20$ mm) as being immature adults, while males larger than $L_c = 19-20$ mm (that is the group making up 45% of the total male population in the open bay) can be considered as mature males.

Only 0.3% of the females sampled from Maputo Bay had attached spermatophores. However, it must be remembered that the thelycum of *M. monoceros* is of the open type and the spermatophore is very easily dislodged, many being lost by the mere mechanical action of the trawl. The fact that the few females found impregnated ranged from having undeveloped to ripe ovaries, indicates that mating occurs independently of sexual maturity. Nevertheless, only 21.6% of the mating involved females which were not in a position to spawn.

It has generally been accepted that the incidence of ripe and absent females in a population is indicative of spawning activity. George (1959, 1962) believed that in Cochin waters, *M. monoceros* breeds throughout the year, with peaks in July/August and November/December. This idea was, to a certain extent, confirmed when, in August 1963, an experimental trawl of a half-an-hour yielded 25 kg of exclusively *M. monoceros* in an advanced stage of maturity. This catch was made in 50-60 m of water on some 'sand shelves' and George and George (1964) were of the opinion that this occurrence indicated a possible spawning ground. In the Gulf of Kutch, the spawning season is believed to be from February to April (Srivasta 1953).

The Maputo Bay populations appears to spawn during summer (October to February) when 14.3% to 23.0% of the females are found to be ripe or spent. The decrease from February to May followed by the total disappearance of spawning females in June and July (Table III-2) could be

indicative of an offshore migration of females for the purpose of spawning during autumn and winter. However, although this is possible, the facts, including the predominance of impregnated females during summer, within Maputo Bay, seems to favour the idea that a considerable degree of spawning occurs during most of the year, within the Bay. The scarcity of impregnated females on the other hand may favour migration.

The fact that the period of spawning activity is so long may indicate that a mature female spawns repeatedly during her lifetime. This could explain the presence, in the population, of large females ($L_c = 39-40$ mm and larger) with undeveloped ovaries (Stage I) (Fig. III-29). These are very probably females with ovaries in the process of regeneration after spawning.

No work on the planktonic larval forms was carried out in Mozambique. It is therefore impossible to claim with any certainty that *M. monoceros* spawns within Maputo Bay, in spite of the evidence given above. Panikkar and Aiyar (1939) did suggest that *M. monoceros* bred in the backwater areas and Menon (1951) states that "Penaeid prawns with the exception of *M. stebbingi* and *M. monoceros* breed, as far as is known, only in the sea." This implies that *M. monoceros* may breed in backwater areas. However, George and George (1964) claim that "... the presence of mature adults in a sand area at a depth of 50 to 60 metres off Cochin points to this as a possible spawning ground."

In September 1972 off Moma in central Mozambique, in catches predominantly of mating *Penaeus indicus*, a considerable number of large *M. monoceros* females measuring $L_c = 46-53$ mm with ripe ovaries were caught. This is further indication that spawning is not restricted to backwater areas.

As in most penaeids, the larvae of *M. monoceros* are carried into the nursery areas by the ocean currents, winds and tides. Although it is known that late mysis and postlarval stages are found in the plankton of backwaters and estuaries in India (Pannikar & Aiyar 1939; George 1970) and South Africa (Forbes 1986), the full larval development of this species has never been described (George 1968).

Although it is difficult to generalise from the data presented by de Freitas (1986), it seems that *M. monoceros* favours a nursery area: a) which is well sheltered, offering good protection from predators, b) which has a very muddy substratum, rich in organic content, and c) with a wide range of salinity, being able to tolerate fairly fresh water. In a survey of the rivers of Maputo Bay, *M. monoceros* was the only penaeid species regularly found in completely fresh water, as far as 25.1 km from the river mouths.

In Mozambique and in Maputo Bay itself, there is no lack of optimal conditions for nursery areas for *M. monoceros* particularly within the vast mangrove swamps (de Freitas 1984). Along the coast of Natal favourable nursery areas probably do exist but to a far lesser extent than those found further north. In a detailed survey of 62 Natal estuaries south of the Tugela River (Begg 1983), it was shown that *M. monoceros* was found in 58% of the systems, 2.25 times more systems than the second most frequent species, *Penaeus monodon*. Further, in 66.7% of the occasions on which *M. monoceros* occurred with other penaeids, it was the most abundant.

M. monoceros is frequently infected by an, as yet, unidentified bopyrid parasite, probably *Epipenaeon* sp. This crustacean attaches itself to the gills and is more prevalent in summer. Although Tuma (1967) claimed that bopyrid parasitism resulted in arrested gonadal development, this does not seem to be necessarily so with *M. monoceros* because the majority of the parasitised females of $L_c = 35-36$ mm were found to have ripening or ripe ovaries. Parasitism does not affect the fusion of petasmas halves of the male, but whether or not the testes are influenced is not known.

De Freitas (1966) showed that in Maputo Bay *M. monoceros* started their migration out of the backwater areas when they were about $L_c = 12-13$ mm. By the time they have reached $L_c = 24-25$ mm they were found in the deeper channels of the Bay. This agrees with the data collected during 1968-1973 (Fig. III-34) and the findings of Menon (1955) and Crosnier (1965).

Le Reste and Marcille (1976) working in Madagascar with tagged individuals of *M. monoceros* failed to show definite migration patterns as observed with *Penaeus indicus*. However, they state that the reason for this is due to the fact that the tagging was done "... during the dry season when the salinity is homogeneous".

The migration of young adults of *M. monoceros* from the nursery areas to the deeper waters probably occurs during the ebb tides and, in particular, the ebbs of spring tides. Diniz (unpublished data) during a marking experiment showed that young *M. monoceros* released within the Espirito Santo Estuary were found to be recaptured in the open Bay in waves which corresponded with spring tide ebbs. This agrees with the findings of Copeland (1965) who gave evidence that the brown shrimp *Penaeus aztecus* migrated from inshore waters to the sea during ebb tides, usually during the full moon.

If one accepts that there is a certain degree of spawning in offshore areas, particularly in central Mozambique, a north-south 'migration' is made possible by the Mozambique and Agulhas Currents. Inshore counter currents and eddies may result in some of the larvae produced by adults from a particular nursery area being returned to the parental nursery areas for development.

Laboratory observations that *M. monoceros* do not bury themselves completely contrasts with the findings of Hughes (1966). However, it is quite possible that Hughes was confusing *M. monoceros* with *P. japonicus*. To the naked eye these two species are very similar in appearance and in colouring. Also, the description of the nursery area attributed by Hughes (1966) to *M. monoceros*, namely "intertidal pools on sandflats" is typically that found for *P. japonicus* (de Freitas 1986).

George (1959) studied the backwater juvenile population of Cochin during 1952 to 1955 and found a slightly higher percentage of females than males, namely 51.38% of females. Shaikhmahmud and Tembe (1960) for inshore waters in Bombay and Crosnier (1965) off Madagascar also recorded a slight predominance of females in the *M. monoceros* populations (George 1970). This concurs with the data from the backwater areas of Maputo Bay where the female to male ratio is 3:2, slightly favouring the females.

On the other hand, the adult population in the open bay and offshore on the Tugela Bank have a 1:1 ratio.

During the period of the study (1968-1973) *M. monoceros* constituted, on average, 32% of the total commercially caught penaeids in Maputo Bay, 42% of the catch of the Tugela Bank fishery. Miquel (1982) states that, in 1977, this species formed 31% of the commercial catches in Mozambique.

***Metapenaeus stebbingi* Nobili, 1904**

(Fig. III-48)

Metapenaeus stebbingi Nobili, 1904: 229; Nobili, 1906: 15; Burkenroad, 1934a: 33; Barnard, 1950: 599; Dall, 1957: 184; Tirmizi, 1962: 103; Lewinsohn & Holthuis, 1964: 46; Ramamurthy, 1964: 170; Racek & Dall, 1965: 57 (in key); de Freitas, 1972: 5 (in key); Kensley, 1972: 22 (in key); Holthuis, 1980: 29; Miquel, 1982: 120-122; Miquel, 1984: (PEN Metap 22)

Metapeneus stebbingi Alcock, 1906: 50.

Penaeopsis stebbingi De Man, 1911: 9; Tattersall, 1921: 365; Balss, 1927: 221; Gurney, 1927: 228, 233.

Material examined

Mozambique: Maputo Bay, 12♂♂, 10.4-14.8 mm, 10♀♀, 11.4-23.1 mm; Mafamede Island (10 m), 5♀♀, 16.5-23.0 mm; Moma (20 m), 8♀♀, 19.4-27.1 mm, 1♂, 15.8 mm; Ligonha River, 7♀♀, 23.9-29.4 mm; Chinde (22 m), 8♀♀, 21.5-29.2 mm; Macuse (20 m), 3♀♀, 23.8-26.6 mm.

Description

Rostrum: Straight but very slightly curved upwards at tip; reaching a little beyond last article of antennular peduncle; rostral formula 9-10/0; two teeth behind orbital margin of carapace; adrostral sulcus fairly well developed, reaching epigastric tooth; postrostral carina short, terminating just posterior to epigastric tooth; median sulcus absent.

Carapace: Glabrous except along edges of sulci and a small patch below posterior portion of adrostral sulcus; no gastrofrontal sulcus; postocular sulcus small but clearly defined, arising below adrostral sulcus under second rostral tooth; cervical sulcus well defined, starting below end of adrostral sulcus and runs anteroventrally; cervical carina terminating in fairly prominent hepatic spine; a short and somewhat ill-defined gastro-orbital sulcus; branchiocardiac carina absent; orbital spine small but well developed; antennal carina short but well developed, terminating in very prominent antennal spine; orbito-antennal sulcus restricted to slight depression above antennal carina; no postorbital spine; hepatic carina distinct; hepatic sulcus adjacent to it deep and more or less 'L-shaped' descending vertically from hepatic spine and curving anteriorly to slightly before pterygostomial angle; pterygostomial angle more or less rounded and bears no spine; branchiostegal spine absent; a clear submarginal carina parallel to posterolateral margin of carapace.

Antennule: Flagella about half length of antennular peduncle; prosartema narrow, wider at its base, reaching distal end of first antennular article; stylocerite about half length of basal article of antennular peduncle, terminating in a point; small but sharp spine at distolateral angle of basal article; parapenaoid spine absent.

Scaphocerite: Distolateral spine stops just short of distal end of antennular peduncle; basicerite free of spines.

Mandibular palp: Reaching to base of carpocerite; proximal article 1:1 times as long as wide; ventral surface slightly concave and lightly setose; margins bear long setae; distal article twice as long as proximal article and 1.7 times as long as wide; surface slightly convex and lightly setose; distally tapering to rounded apex.

Maxilliped III: Endopodite reaching about half way along basal article of antennular peduncle; exhibits no sexual dimorphism; exopodite almost reaching distal end of carpus of endopodite; no epipodites present.

Pereiopods: Exopodites present on pereiopods I to IV; epipodites found on first three only; first three basipodites bearing strong spines; none present on ischiodites; ischiodites of fifth pereiopod of females rather flattened; meropodites of males have well developed notch on lower proximal edge; at distal edge of notch there is rounded crest-like projection; coxopodites of fourth pereiopod of females have plate-like dilations which extend over sternite almost reaching ventral midline; third coxopodites have small and less developed dilations; none present in male. Pereiopod III reaching to beyond basal antennular article by half of chela; pereiopod V reaching half way in basal antennular article. Extended laterally lengths of pereiopods in ascending order are: first, fourth, second/third and fifth.

Abdomen: Uniformly glabrous; dorsally carinated from posterior third of fourth segment to tip of sixth where carina terminates in spine; a wavy broken lateral cicatrix on posterior part of fifth and sixth segments.

Telson: Telson is just longer than sixth abdominal segment; about as long as mesial ramus of uropods; dorsal median sulcus wide and deep; telson terminating in long acute point; 6-15 small movable lateral spines present but are often missing leaving distinct notch.

Thelycum: Posterior portion composed of two subquadrate and convex plates rising up from sternite; between these two plates is median process formed from anteromedian projection of sternite between and behind fifth pereiopods. Anterior portion located between fourth pereiopods and between anterolateral extensions of lateral plates of posterior portion; consisting of three small plates normally hidden by dilations of fourth coxopodites; plates

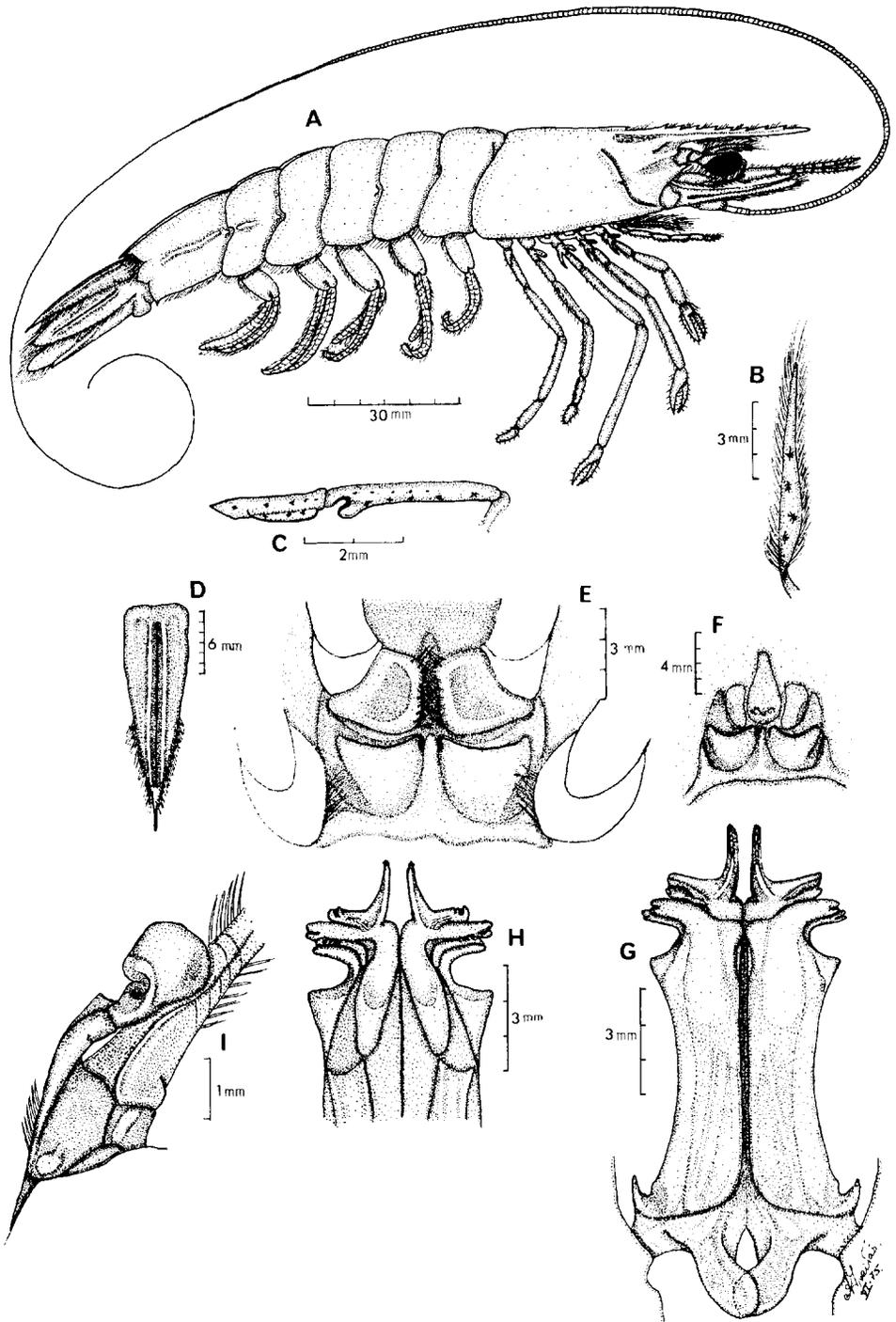


Fig. III-48 *Metapenaeus stebbingi* Nobili: A. Whole animal; B. Prosartema; C. Fifth ischiopodite meropodite; D. Telson; E. Thelycum; F. Thelycum with coxal process of fourth pereopods removed; G. Petasma (ventral view); H. Petasma (dorsal view of distal end); I. Appendix masculina.

consist of two flattened elongated lateral plates and wider, swollen median plate possessing two slight but distinct tubercles.

Petasma: Involved pod-like structure with complicated series of distal processes. Dorsomedian lobules very narrow, thin and united along midline. Ventromedian lobules narrower and as long as dorsomedian lobules; together forming furrow deep within petasmas structure; these lobules are best seen from dorsal view. Dorsolateral lobules also best seen from dorsal view; a thickly sclerotized lobule and apparently divided into anterior and posterior section; posterior section about twice length of anterior section; is narrow distally, broadening out, forming pointed lateral process; it runs proximally, mesial edge broadening out into half rectangular bulge which touches its pair in midline about level of proximal end of median lobes; beyond this point dorsolateral lobule twists forming club-like process; anterior section formed by dorsal subrectangular plate; distally divides into three finger-like processes; first is directed anteriorly while other two project laterally and are difficult to distinguish apart; tips of anteriorly projected process and lower lateral processes bear several tiny tubercles. Ventrolateral lobules very thickly sclerotized subrectangular plates; distally forming deep lateral notch above which lobules divide into two lateral horn-like processes; proximally lobules have lateral tooth-like process just above point of attachment to exopodite.

Appendix masculina: Club-shaped; shaft of 'club' slender and twisted inwardly; apical surface convex with small tuft of short setae on mesial edge. Basal article of endopodite wide at base with mesial margin projected distally into twisted arm, bearing appendix masculina; article glabrous except for few setae on mesial edge.

Colour in life: Generally a white to cream with numerous brown and blue chromatophores. The antennules are banded while the antennae are a deep reddish-brown. The extremity of the telson and the mesial ramus of the uropods as well as the extremity and outer margin of the lateral uropodal ramus are bright green. All fringing setae are white except those fringing the uropods which are light brown in colour.

Taxonomic status and comments

This species belongs to the *M. monoceros* group because of the structure of the fifth pereopods of the male. However, it differs from it by being essentially glabrous, by the shortness of the postrostral carina, by the structures of the petasma and thelycum and by the presence of movable marginal spines on the telson (Nobili 1906).

The specimens described here clearly belong to this species although there are some slight differences from the descriptions given by other authors. Both Nobili (1904, 1906) and Tattersall (1921) refer to the presence of six to eight pairs of movable marginal spines on the telson whereas Alcock (1906) mentions only three to four pairs. The specimens examined here have eight to fifteen pairs of marginal spines in agreement with Barnard (1950).

Nobili (1906) describes the notch on the merus of the male as preceded by a tooth and Barnard (1950) also mentioned a "triangular tooth". Tattersall (1921) does not describe the notch and tooth but in his illustration (Plate 26, Fig. 8) the notch is preceded by a keeled dilation rather than a tooth as is seen in *M. monoceros*. All the male specimens examined by myself agree with Tattersall's figure.

Burkenroad (1934a) seems to be correct in pointing out that Tattersall's figures 9 and 12 of Plate 27 have been transposed, as the thelycum of the specimen examined from Mozambique agrees with figure 12 rather than with Tattersall's figure 9.

Distribution (Fig. III-49)

Metapenaeus stebbingi has a limited distribution. It was first recorded from Suez and the Red Sea (Nobili, Tattersall). Subsequently it has been recorded from Egypt — Port Said (Balss); Pakistan — off Karachi (Tirmizi); India — Gulf of Cutch (Ramamurthy);

Mozambique — Mafamede Island, Moma, Ligonha River, Chinde, Macuse, Maputo Bay (Barnard, de Freitas); South Africa — Tugela Bank (de Freitas).

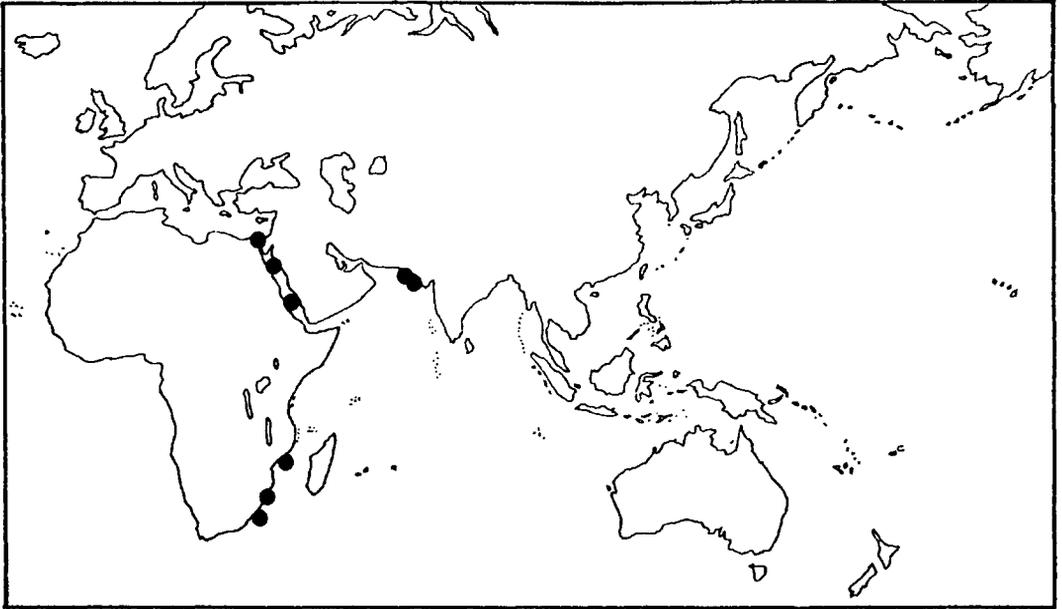


Fig. III-49 Distribution of *Metapenaeus stebbingi*.

Gurney (1927) found penaeid eggs and all larval stages of a penaeid species within the Bitter Lakes of the Suez Canal. By a process of elimination he arrived at the conclusion that they probably belonged to *M. stebbingi*. The presence of eggs indicated that this species actually bred in the Lakes where the adults were also found.

In Maputo Bay juveniles were also found in backwater areas and adults were found in deeper areas although in almost landlocked large bodies of water. Adults have also been found offshore in 3-20 metres of water in central Mozambique and India.

Biology

Metapenaeus stebbingi is a species with limited economic importance as it is seldom found in large quantities. Very little is known on the biology of this species as it has attracted negligible attention from workers. It is very similar in appearance to *M. monoceros* and commercially these two species are probably lumped together. Although it has been found in the offshore fishing grounds, the quantities are small and do not significantly affect the catch statistics of *M. monoceros*.

All the data referring to *M. stebbingi* was collected from sampling stations within Maputo Bay (Fig. III-28) and by frequent and detailed analyses of commercial catches. During the fieldwork for this study a total of 84 091 individuals of this species were caught and 29 938 were analysed in more detail.

No data is available from central Mozambique and *M. stebbingi* is very scarce on the Tugela Bank and, as yet, has not been recorded from the estuaries of Natal.

Reproduction

Maturity: As yet, no study has been made of the anatomy of the male and female

reproductive system of *M. stebbingi*. As in other penaeids, the maturation of the ovary is accompanied by distinctive changes in colour and size. No previous studies on ovarian maturation in this species are known and, up to now, the colour changes of the ovary have not been described. From the examination of 12 017 females ranging from carapace length 5 mm to 33 mm the following stages were distinguished:

- Stage I: *Undeveloped* — Translucent, smooth and threadlike.
- Stage II: *Developing* — Opaque; cream to light yellow; somewhat distended but surface still smooth.
- Stage III: *Mature* — Fully distended; lime to light green; finely granular.
- Stage IV: *Ripe* — Fully distended; green to olive green; individual ova visible.
- Stage V: *Spent* — Flaccid; lime to light green.

The data collected in Maputo Bay from February 1968 to December 1973, indicates that all females smaller than $L_c = 9-10$ mm have undeveloped ovaries and that the largest females with undeveloped ovaries measured $L_c = 33-34$ mm. Most probably those females larger than $L_c = 27-28$ mm with undeveloped ovaries are individuals with gonads in the process of regeneration after spawning. The smallest females with mature (III), ripe (IV) or spent ovaries were found to measure $L_c = 11-12$ mm and the majority (50% or more) of females first showed mature or ripe ovaries at $L_c = 23-24$ mm (Fig. III-50).

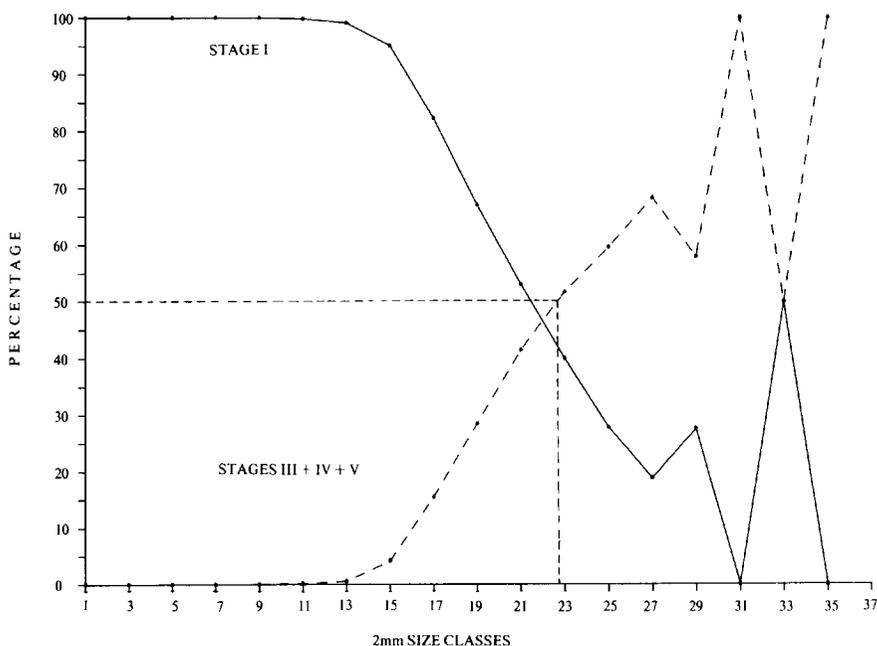


Fig. III-50 Size frequency distribution of *M. stebbingi* females with gonadal stages I and III + IV + V (Maputo Bay 1968-1973).

Unfortunately it is not possible to determine, macroscopically, sexual maturation in the males of this species. Histological studies of the testes of *M. stebbingi* are not known. However, one can indirectly get some idea of the maturation of the male by knowing the size at fusion of the petasmas halves (Tuma 1967).

Of the 7010 males examined, no individual smaller than $L_c = 3-4$ mm was ever found to have fused petasmas. The size at which the majority (50% or more) of the individuals have fused petasmas proved to be at $L_c = 7-8$ mm. All males larger than $L_c = 21-22$ mm have fused petasmas (Fig. III-51). Of the males found in the backwater areas, 15.4% had unfused petasmas while in the open bay this condition was found on 2.6% of the males.

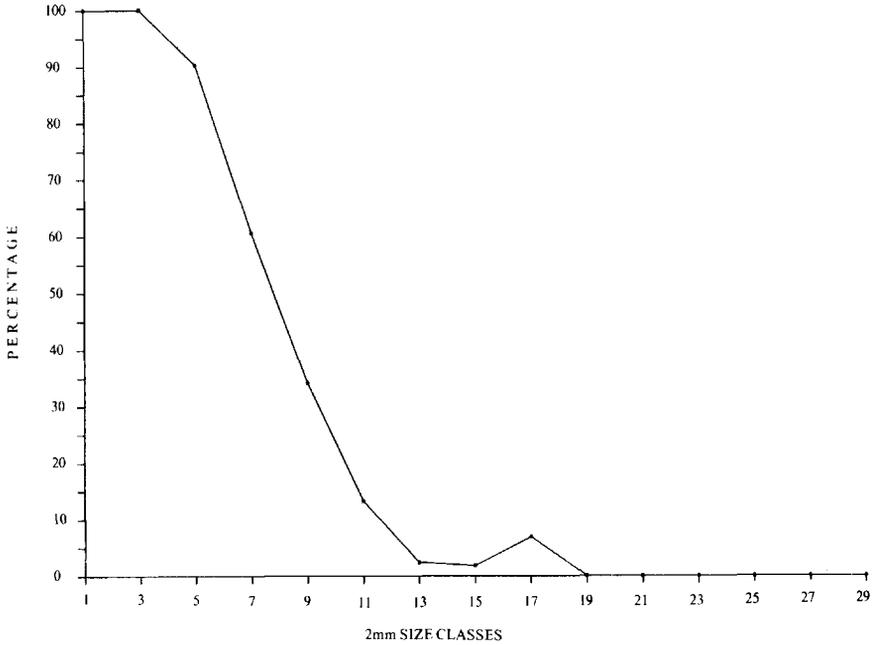


Fig. III-51 Percentage of *M. stebbingi* males within each class with unfused petasmas endopodites (Maputo Bay 1968-1973).

Mating: As in other penaeoids fertilization is external, the sperms being dispensed from the spermatophores as the eggs are shed. The presence of impregnated females and, in particular, the presence of impregnated ripe females could be considered as an index of mating. However, of the 17 934 females sampled only one female of $L_c = 21-22$ mm was found impregnated, in September 1971.

Spawning: The presence of ovaries in advanced stages of maturation is taken as indication of spawning activity. There seems to be very little variation in the mean monthly size distribution of ripe and spent females. The smallest females found in these advanced maturation stages measured $L_c = 11-12$ mm and were caught in November, December and January (Fig. III-52). Table III-6 summarises the situation found in Maputo Bay from 1968 to 1973 and sets out the monthly percentage of ripe and spent females in relation to the total number of females as well as in relation to the number of females of $L_c = 11$ mm and larger, the smallest class of ripe and spent females.

The female population has the highest incidence of spawning during spring and summer, from September to March, when 24.2% to 40.6% of the females of $L_c = 11$ mm and larger and 22.7% to 33.1% of the total female population were found to be ripe or spent. Of all the females examined only 32 (0.2%) were classified as spent. These measured $L_c = 19-29$ mm and were found from August to January, with the largest number (11) being caught in October. The highest incidence of spawning females was found in October (Fig. III-53), the number decreasing thereafter to June when only 1.6% of the female population were spawning.

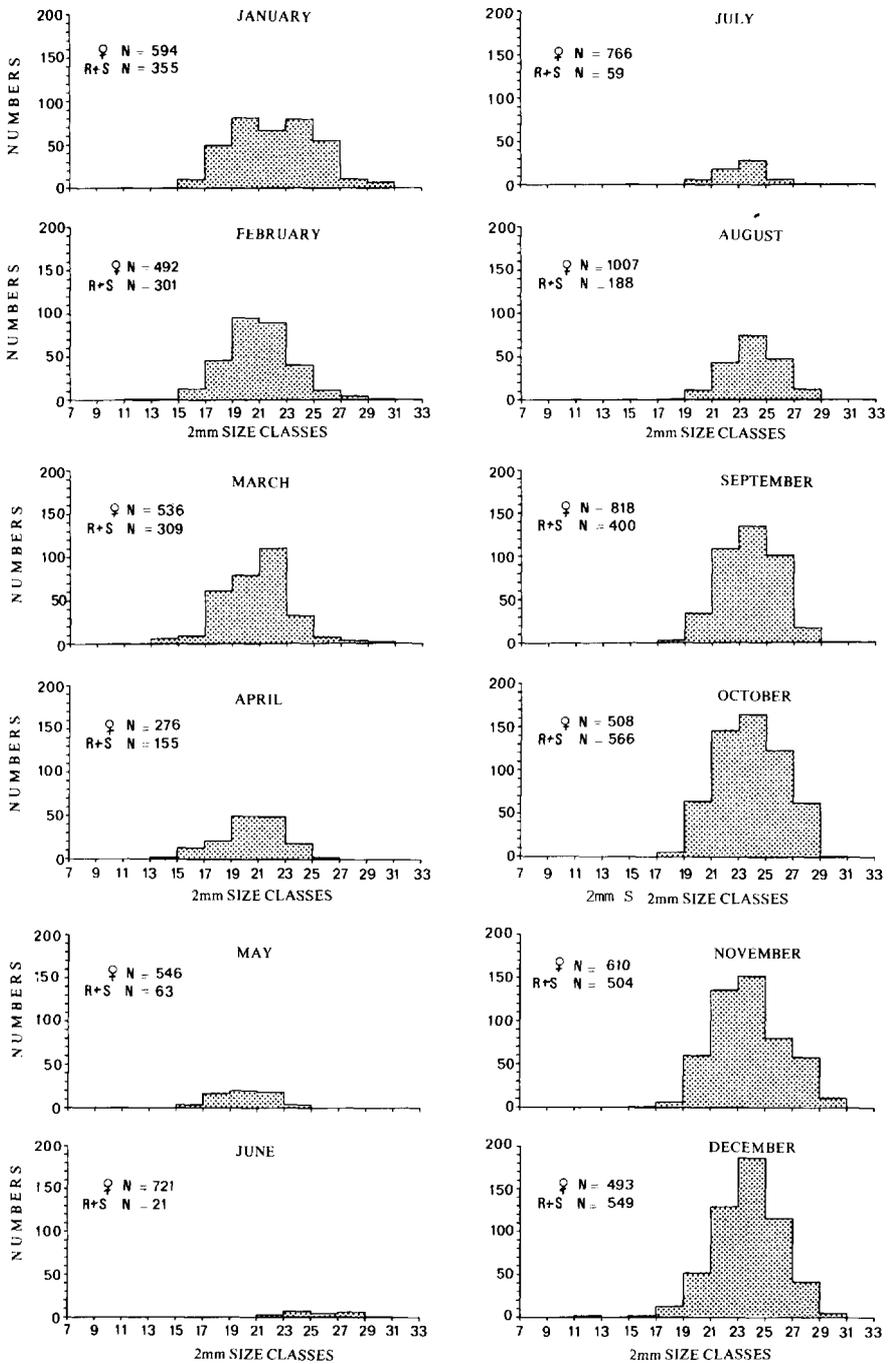


Fig. III-52 Monthly size frequency distribution of ripe + spent females of *M. stebbingi* in Maputo Bay from 1968-1973.

Table III-6 *M. stebbingi*. Monthly percentage of ripe + spent females in relation to total numbers of females and numbers of females larger than Lc = 11mm.

Month	Total No	Individuals > 21 mm		Stages IV + V		% IV + V of Tot.
		No.	%	No.	%	
JAN.	1 562	1 441	92.2	355	24.6	22.7
FEB.	1 255	1 036	82.5	301	29.1	24.0
MAR.	1 366	1 192	87.3	309	25.9	22.6
APR.	909	788	86.7	155	19.7	17.1
MAY	1 150	1 053	81.6	63	6.0	5.5
JUN.	1 338	1 253	93.6	21	1.7	1.6
JUL.	1 617	1 587	98.1	59	3.7	3.6
AUG.	1 922	1 790	93.1	188	10.5	9.8
SEP.	1 718	1 654	96.3	400	24.2	23.3
OCT.	1 632	1 611	98.7	566	35.1	34.7
NOV.	1 808	1 690	93.5	504	29.8	27.9
DEC.	1 657	1 352	81.6	549	40.6	44.1
	17934	16447	91.7	3470	21.1	19.3

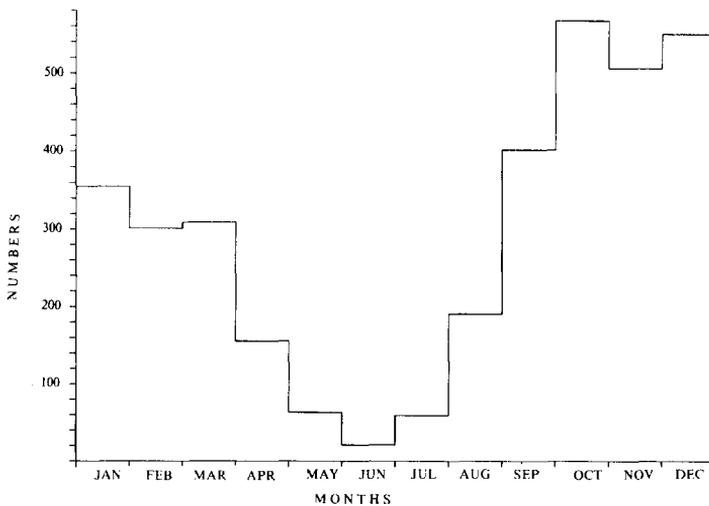


Fig. III-53 Monthly frequency of ripe + spent females of *M. stebbingi* from Maputo Bay (1968-1973).

Nursery areas

No work was carried out in Mozambique on the planktonic stages of *M. stebbingi*. However, Gurney's (1927) study is very complete on this aspect. The Bitter Lakes of the Suez Canal where

Gurney found the eggs, larvae and postlarvae of this species in a fairly protected area with little or no wave action.

In a survey carried out along the northwest margin of Maputo Bay (de Freitas 1986), early juvenile stages of *M. stebbingi* ($L_c < 9$ mm) were found in only three stations; namely the primary mangal channel with a muddy sand substratum, and on two stations in the swash zone of sandy beaches. In fact this was the only penaeid species found in the two swash zone stations. Of the 49 individuals caught, 61% were caught in the swash zone, where salinities ranged between (16.3‰ — 22.0‰) (de Freitas 1986).

Associated species, predators and parasites

Based on the work done from 1971 to 1973 it appears that the most common penaeid species associated with *M. stebbingi* within Maputo Bay was *Parapenaeopsis acclivirostris*, *Penaeus indicus* and *M. monoceros*. To a lesser degree, where the adult is concerned, *P. semisulcatus*, *P. monodon* and *P. japonicus* may compete with *M. stebbingi*.

The goby, *Gobius nebulosus* is probably a common predator of postlarval *M. stebbingi* especially in those nursery areas in the vicinity of mangals and with a muddy sand substratum. Very few fish stomachs were analysed and although remains of penaeids were common, no positive identification of *M. stebbingi* was made.

Although some penaeoids, e.g. *M. monoceros* and *H. triarthrus* are often infected by an unknown pyrid, none were ever found on *M. stebbingi*.

Schooling

Although some penaeids are believed to form large schools while migrating (Kirkgaard, Tuma & Walker 1970) there is no evidence that *M. stebbingi* behaves in this way at any stage.

Migration

Both male and female *M. stebbingi* smaller than $L_c = 8.9$ mm were seldom found in the open bay (Fig. III-54). From $L_c = 10-11$ mm the percentage found in the open bay increased and

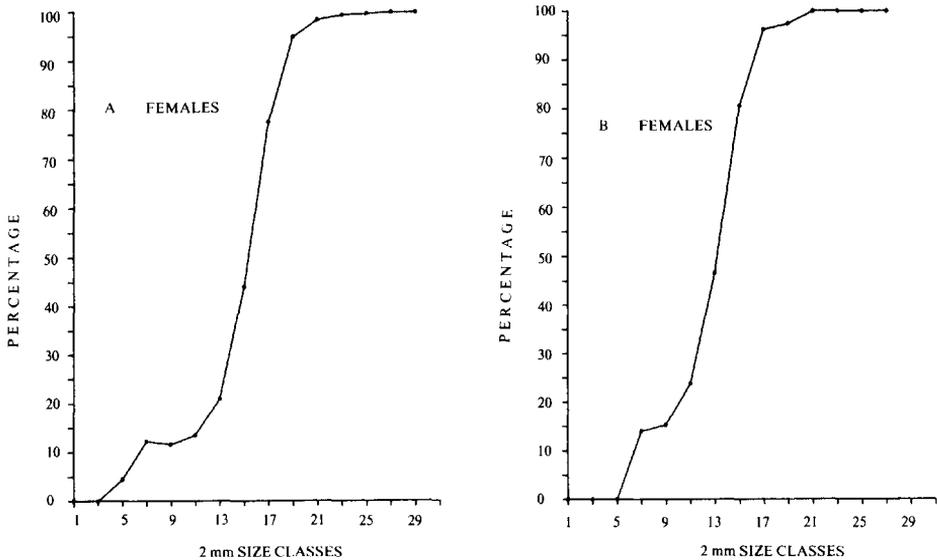


Fig. III-54 Percentage of each size class of *M. stebbingi* found in the open bay areas of Maputo Bay from 1968-1973.

individuals of $L_c = 20-21$ mm and above were seldom found in backwater areas. The size group which was found 50% in each area was $L_c = 16-17$ mm for the females and $L_c = 12-13$ mm for the males.

Burying

Not many individuals were observed in aquaria, but the few juveniles and adults were never seen to bury themselves in the substratum.

Population

Sex ratio: There are no published data on the sex ratio of *M. stebbingi*. The analysis of the Maputo Bay population shows that, of 9 569 individuals examined from the backwater areas, 5 916 (61.8%) were females and 3 652 (38.2%) were males, giving a ratio of 16:10. In the open bay the position changed little, because of 20 369 individuals examined, 12 018 (59.0%) were females while 8 351 (41%) were males; that is a ratio of 14:10.

The monthly variation in the female components as a percentage of the total population in backwater and open bay areas of Maputo Bay is shown in Figure III-55. No information is available for central Mozambique and the scarcity of this species (only two females found) on the Tugela Bank make it impossible to give the sex ratio in this regions.

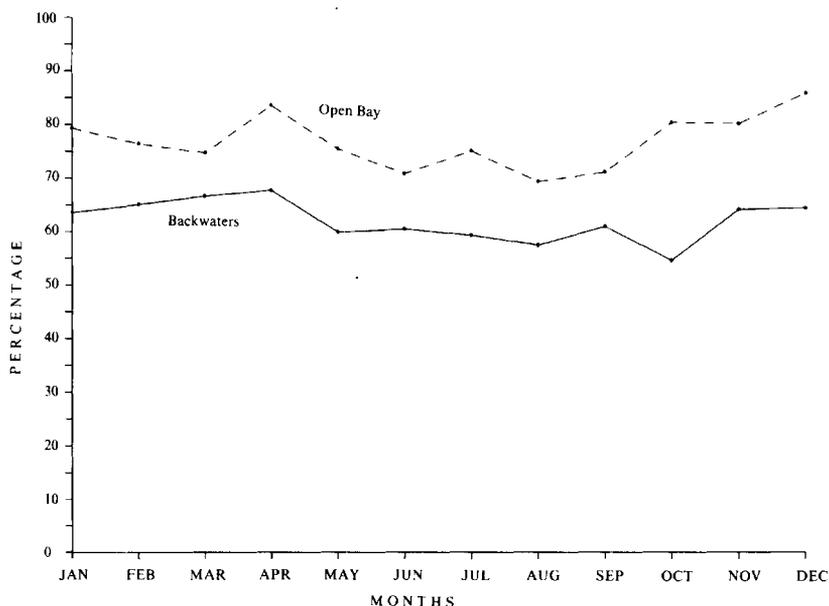


Fig. III-55 Monthly sex ratio of *M. stebbingi* in backwater and open bay areas of Maputo Bay given in percentage of females.

Morphometrics: The carapace length/total length, carapace length/weight and total length/weight relationships were calculated from 1970-1973. All specimens were measured while fresh and no formalinised individuals were used. The range of carapace lengths was from 8.0-28.0 mm in the males and 8.1-31.0 mm in the females.

For the carapace length/total length relationship both the power curve and the straight line relationships were determined. Weight was related to the carapace length as well as to the total length. The carapace lengths and total lengths were measured in mm and weight in grams.

The power curve carapace length (C)/total length (T) relationships were expressed by the equations:

Males: $T = 6.697C^{0.895}$ with $r = 0.982$
 Females: $T = 5.666C^{0.947}$ with $r = 0.987$
 Sexes combined: $T = 6.115C^{0.924}$ with $r = 0.985$

The straight line carapace length (C)/total length (T) relationships are expressed by the equations:

Males: $T = 4.272C + 11.530$ with $r = 0.977$
 Females: $T = 4.515C + 6.122$ with $r = 0.988$
 Sexes combined: $T = 4.415C + 8.506$ with $r = 0.985$
 with an F value of 19.1, 20.9 and 20.1 respectively.

The carapace length (C)/weight (W) relationships are expressed by the equations:

Males: $W = 1.966 \times 10^{-3} C^{2.658}$ with $r = 0.985$
 Females: $W = 1.600 \times 10^{-3} C^{2.774}$ with $r = 0.994$
 Sexes combined: $W = 1.600 \times 10^{-3} C^{2.726}$ with $r = 0.991$

The total length (T)/weight (W) relationships are expressed by the equations:

Males: $W = 8.0 \times 10^{-6} T^{2.935}$ with $r = 0.991$
 Females: $W = 10.3 \times 10^{-6} T^{2.887}$ with $r = 0.992$
 Sexes combined: $W = 9.1 \times 10^{-6} T^{2.910}$ with $r = 0.992$

Size composition: The size composition of the *M. stebbingi* population found in the backwater and open bay areas of Maputo Bay are summarized in Table III-7.

Table III-7 *M. stebbingi*. Average monthly carapace size range and mean carapace length from backwater and open bay stations (1968-1973).

Month	BACKWATERS				OPEN BAY			
	Male		Female		Male		Female	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
JAN.	7-15	10.7	5-25	12.3	7-25	14.3	5-29	19.4
FEB.	5-15	9.8	5-21	10.5	7-23	12.4	9-29	18.0
MAR.	5-23	9.6	5-19	10.9	9-19	13.1	7-29	18.5
APR.	7-19	10.3	5-15	10.5	9-21	12.8	9-27	18.3
MAY	5-15	10.9	5-19	11.7	11-21	13.5	5-25	17.5
JUN.	7-19	12.3	5-21	13.3	9-27	14.7	7-29	19.1
JUL.	9-17	12.8	7-23	14.4	7-25	15.3	7-29	20.1
AUG.	5-17	11.6	3-25	12.7	7-27	15.2	7-29	20.3
SEP.	7-17	11.8	5-25	13.1	7-25	14.7	7-29	20.7
OCT.	7-19	12.3	5-21	13.6	9-25	15.8	7-29	21.7
NOV.	7-19	11.9	7-25	12.7	9-23	15.8	7-29	21.8
DEC.	7-15	10.7	7-21	11.0	7-23	14.3	5-29	21.4
YEAR	5-23	11.4	3-25	12.3	7-27	14.6	5-29	20.1

In the backwaters the annual average size range for male *M. stebbingi* was Lc = 5-23 mm (Fig. III-56) with an annual mean of Lc = 11.4 mm. The range for females was Lc = 3-25 mm (Fig. III-57) with an annual mean of Lc = 12.3 mm. In the open bay the average annual size range was Lc = 7-27 mm for males (Fig. III-56) and Lc = 5-29 mm for females (Fig. III-57) with the annual mean carapace lengths being Lc = 14.6 mm and Lc = 20.1 mm for males and females respectively.

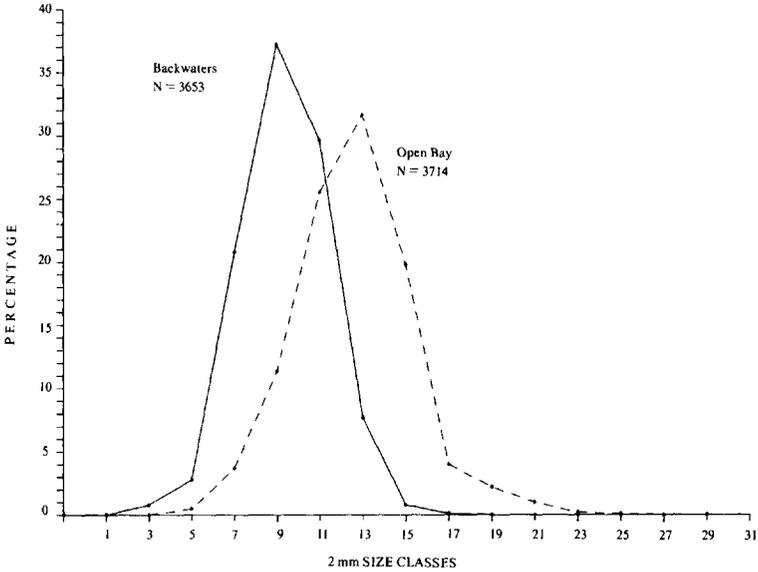


Fig. III-56 Mean annual size distribution of *M. stebbingi* males in backwater and open bay areas of Maputo Bay (1968-1973).

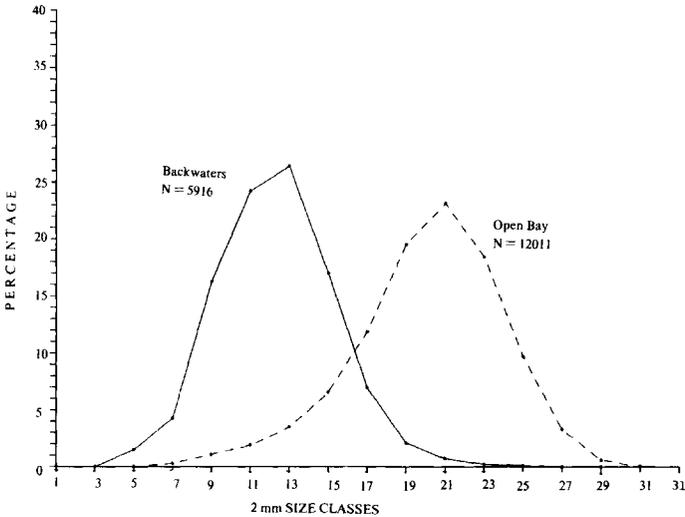


Fig. III-57 Mean annual size distribution of *M. stebbingi* females in backwater and open bay areas of Maputo Bay (1968-1973).

The annual average size group migrating from the backwaters to the bay was constituted of males of $L_c = 7-18$ mm and females of $L_c = 7-23$ mm. The size group found 50% in the backwaters and 50% in the open bay, was $L_c = 13-14$ mm for males and $L_c = 15-16$ mm for females (Fig. III-54).

The monthly variation in size composition of the male and female populations of the backwaters (Fig. III-58) are composed of individuals of very similar size range, the monthly modes being, almost always, identical. In the open bay (Fig. III-59), however, the males are found in the company of considerably larger females. The male modes vary from $L_c = 11-12$ mm (February) to $L_c = 17-18$ mm (October), while the modes of the females vary from $L_c = 19-20$ mm (January-June) to $L_c = 23-24$ mm (December).

Abundance

The mean monthly abundance of *M. stebbingi* given in numbers of individuals caught by the sampling net in a 15 minute drag for four backwater areas of Maputo Bay (Table III-8) showed that the most productive area for this species proved to be the Machangulo channels where an annual mean of 49.5 individuals per 15 minutes were caught. The least productive of the four zones was, as with *M. monoceros*, the Xefina Seagrass which yielded on the average 6.3 individuals per 15 minutes.

Table III-8 Monthly abundance of juvenile *M. stebbingi* in four backwater areas of Maputo Bay (1971-1973).

MONTH (1971 - 1973)	Yield in numbers caught per 15 mins.			
	Espirito Santo Estuary	Machangulo	Xefina Sea-Grass	Incomati Estuary
STATION	1, 2, 3, 4, 5, 6	18, 19	7, 8, 13	9, 10, 11, 12, 14
JAN.	31.4	63.6	4.4	17.9
FEB.	56.4	55.7	12.9	66.7
MAR.	57.4	9.0	4.7	44.4
APR.	34.0	22.0	2.8	11.0
MAY	24.2	33.0	7.1	8.1
JUN.	25.6	37.7	7.3	3.9
JUL.	20.1	84.6	1.7	1.8
AUG.	14.0	117.8	3.5	6.6
SEP.	10.1	18.2	5.7	10.1
OCT.	7.3	35.0	4.8	4.1
NOV.	13.3	35.8	4.0	2.7
DEC.	52.8	19.6	19.1	9.5
MEAN	28.8	49.5	6.3	15.9

In a breakdown by sampling stations (Fig. III-60) one sees that station 18, in the Machangulo sack, yielded the best results (89.9 individuals per 15 minutes), followed by station 5, within the Espirito Santo Estuary (58.9 ind./ 15 min). The poorest results were registered from station 7 which was in an area of muddy sand substratum, partially covered with macrophytes. It is of interest to note that whereas station 10 in the Montanhana River, yielded an average of 520 individuals per 15 minutes of *M. monoceros*, it produced only 5.6 individuals/ 15 minutes of *M. stebbingi*.

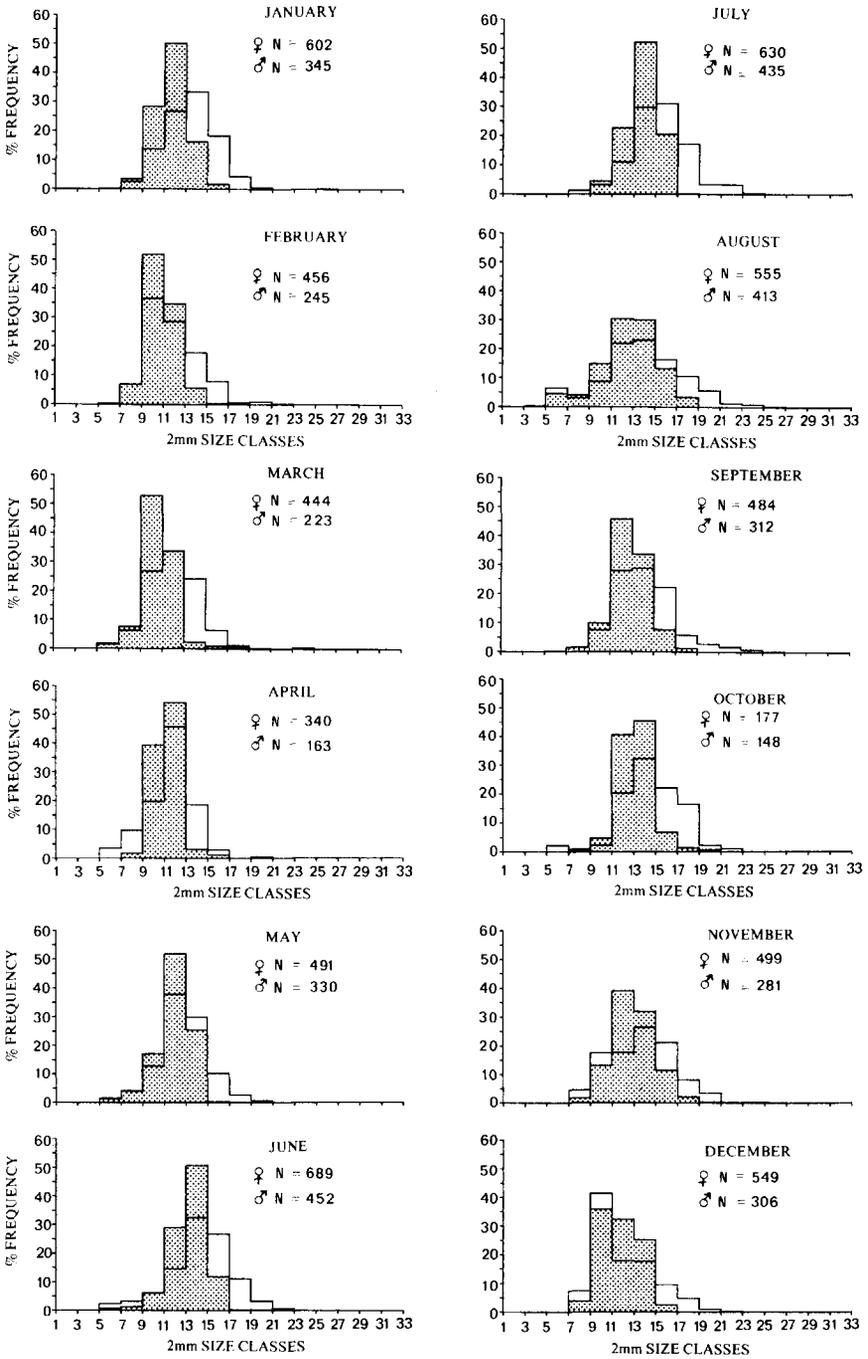


Fig. III-58 Monthly size frequency distribution of *M. stebbingi* males (shaded) and females (unshaded) in backwater stations of Maputo Bay (1968-1973).

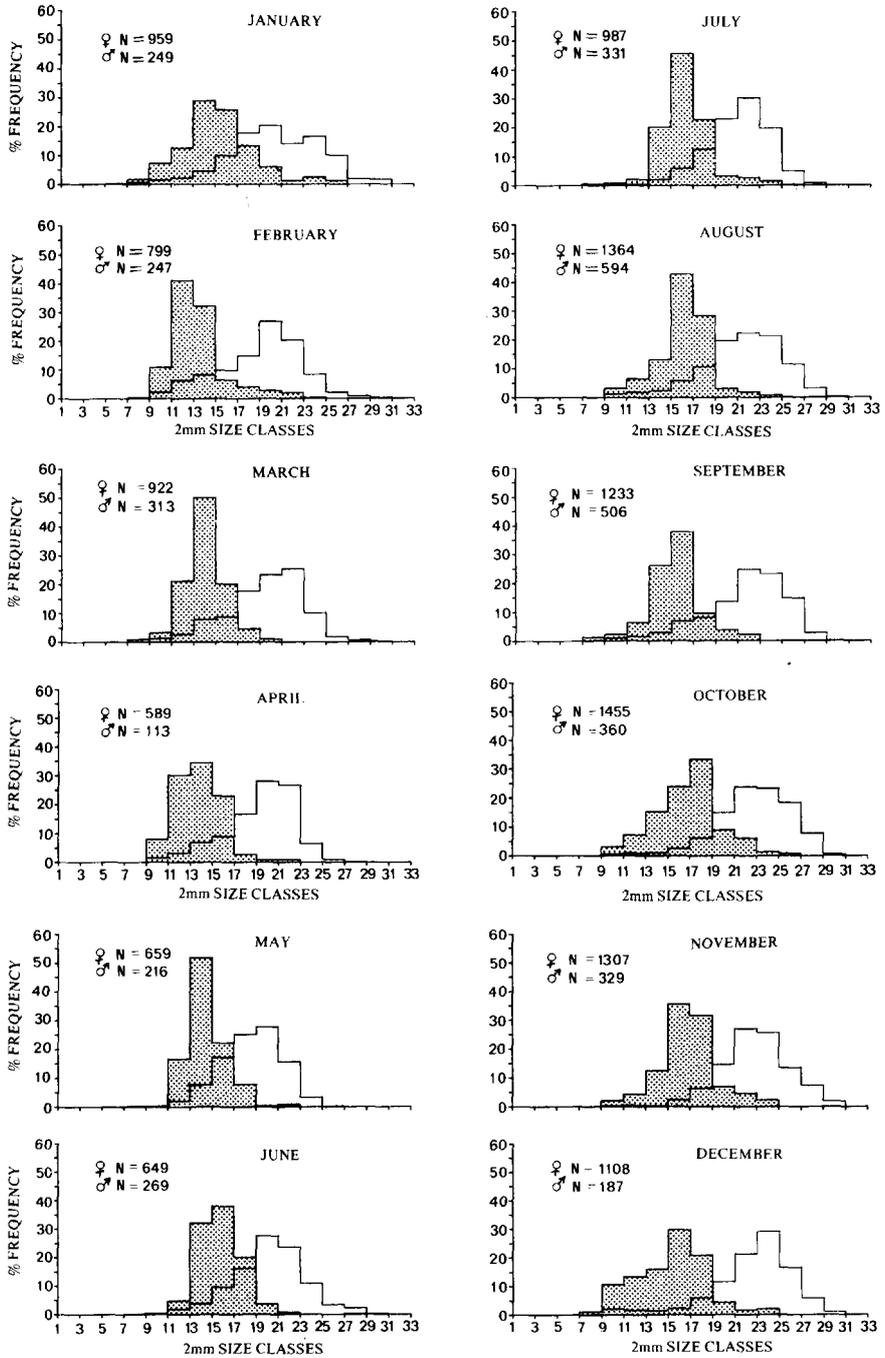


Fig. III-59 Monthly size frequency distribution of *M. stebbingi* males (shaded) and females (unshaded) in open bay stations of Maputo Bay (1968-1973).

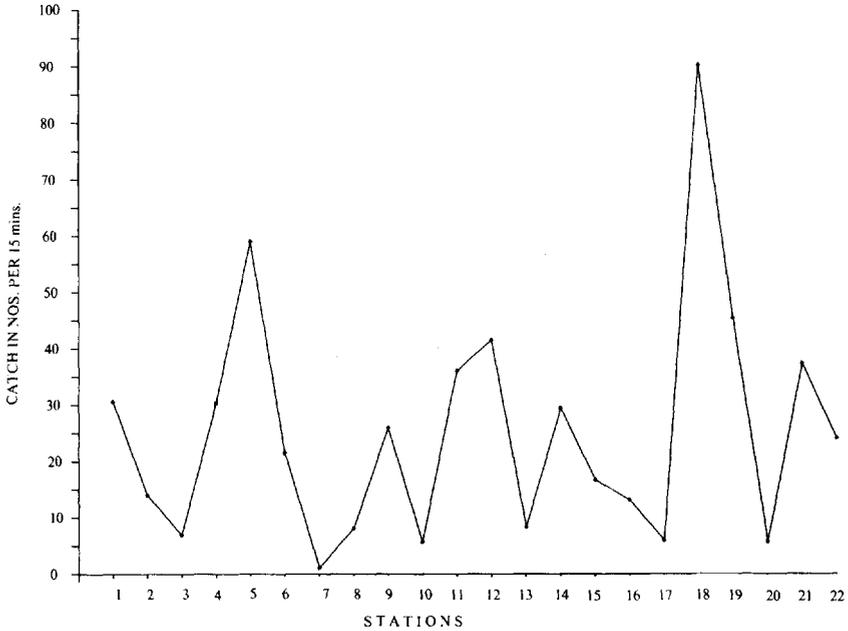


Fig. III-60 Catch of *M. stebbingi* in 22 sampling stations of Maputo Bay.

Exploitation

Fishing grounds

Metapenaeus stebbingi is not a commercial target species in any country, as far as is known. In Mozambique the only locality where some data exists with regard to catches is Maputo Bay. During the first six months of the year catches in kg/hr, in the Polana area were equal to or just better than those of the Machangulo grounds (Fig. III-61). During July to December Machangulo proved somewhat more favourable. Although *M. stebbingi* is caught in central Mozambique, not enough information exists to determine whether any particular area is more favourable.

Fishing activity

Season: Although *M. stebbingi* appears in the penaeid catches of Maputo Bay throughout the year, the best yields are during spring (Fig. III-62). An analysis of the monthly catches from 1968 to 1973 (Fig. III-63) shows that from 1968 to 1971 there was generally a regular pattern, with the weak months from about April to August, while the best months proved to be from September to January. During 1972 and 1973 this pattern changed considerably and no reason is apparent.

Catch: From February 1968 to December 1973 *M. stebbingi* constituted an average of 3.5% of the total penaeid shrimp catch from the exploited stock of Maputo Bay. During the study period *M. stebbingi* generally formed a very small component of the monthly catch (Fig. III-64) and only in September and November did it form over 10% of the catch.

M. stebbingi was caught both during the day and night and daytime fishing was only marginally better (Fig. III-65).

As this species was never specially selected, packed and marketed separately, it is not possible to give a breakdown of the catch in commercial size categories. Generally due to its small size, only a very small percentage of the catch of this species could be classified as anything but medium sized.

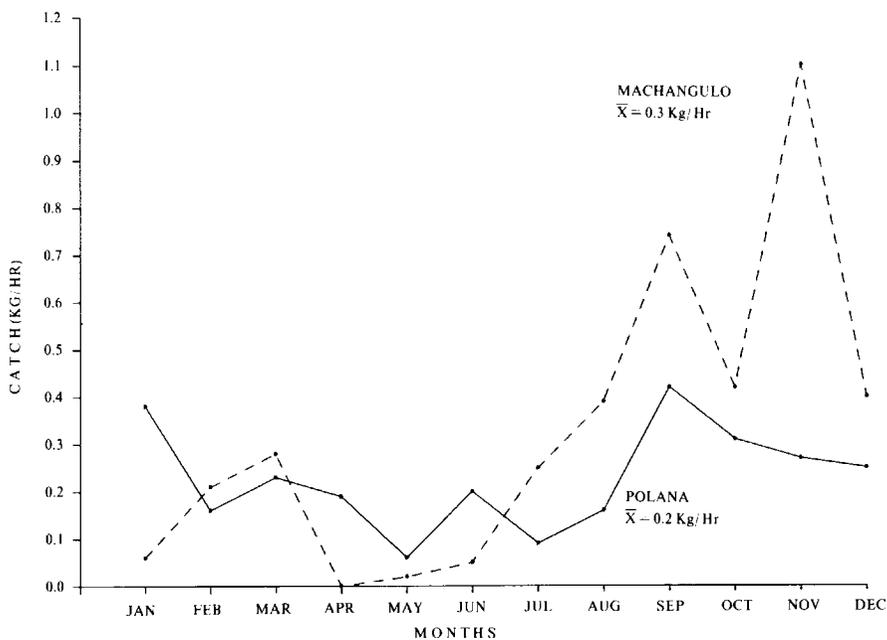


Fig. III-61 Catch in kg/hr of *M. stebbingi* in the Polana and Machangulo fishing grounds made by commercial vessels in Maputo Bay (1968-1973).

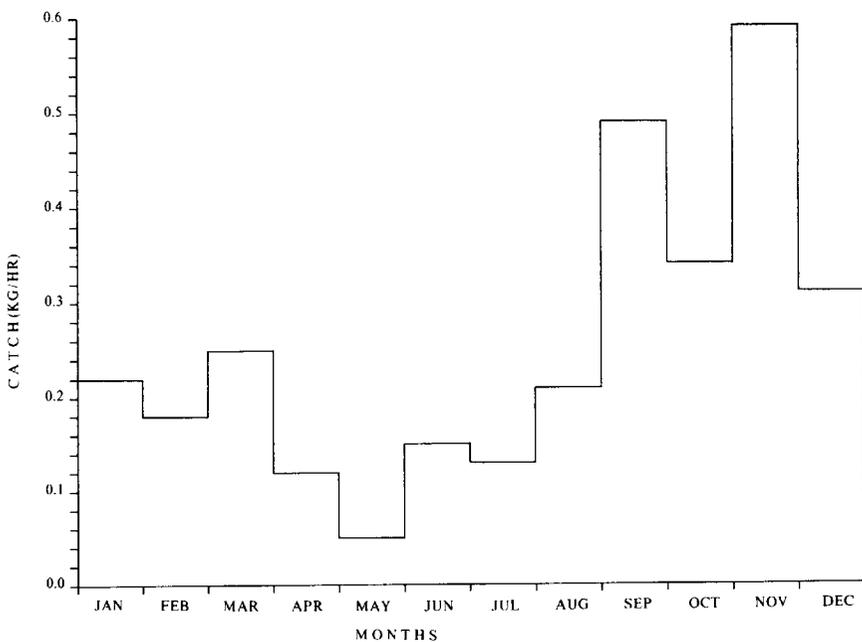


Fig. III-62 Mean monthly catch of *M. stebbingi* made by commercial vessels in Maputo Bay from 1968-1973.

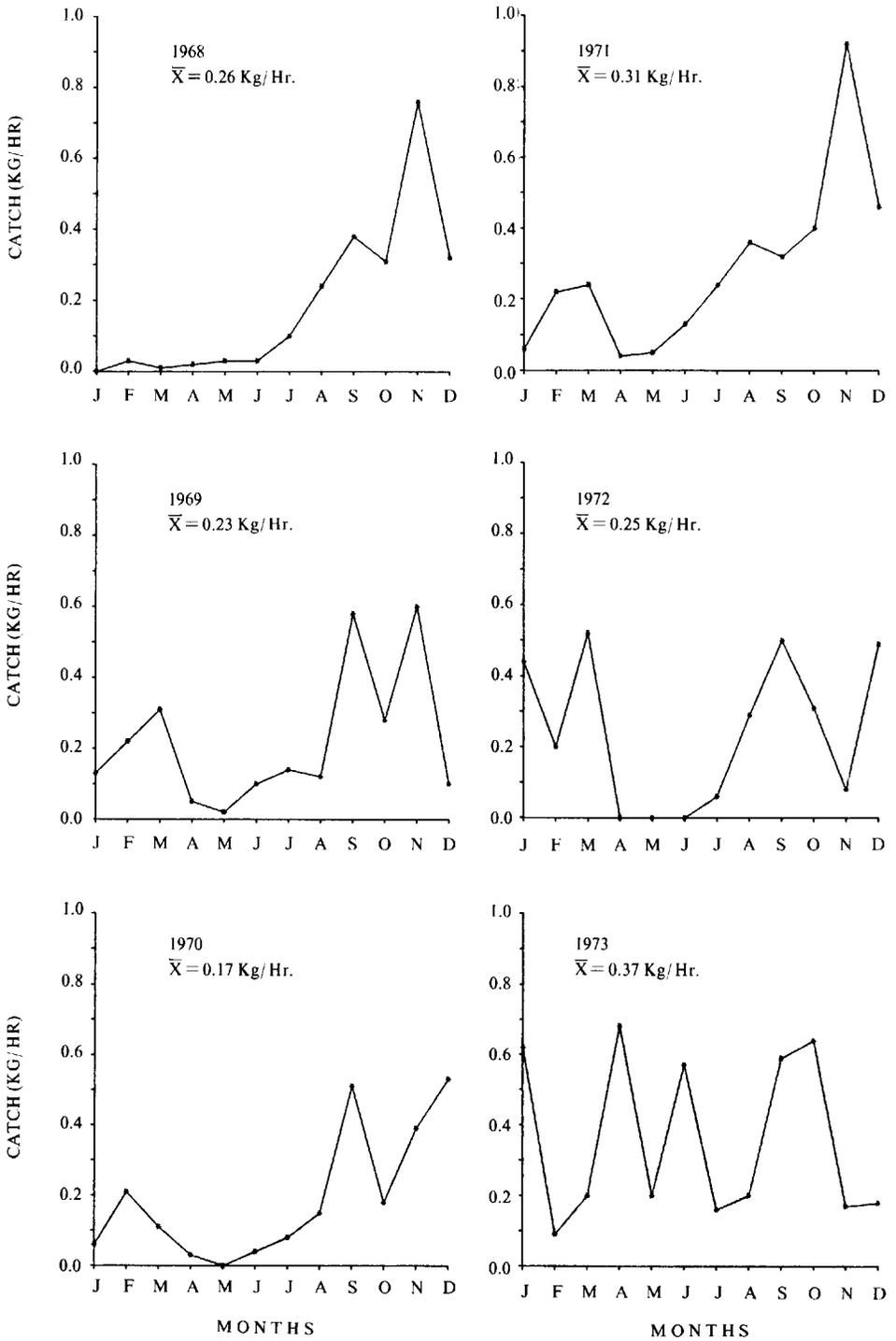


Fig. III-63 Monthly catch of *M. strebbingi* in Maputo Bay from 1968-1973.

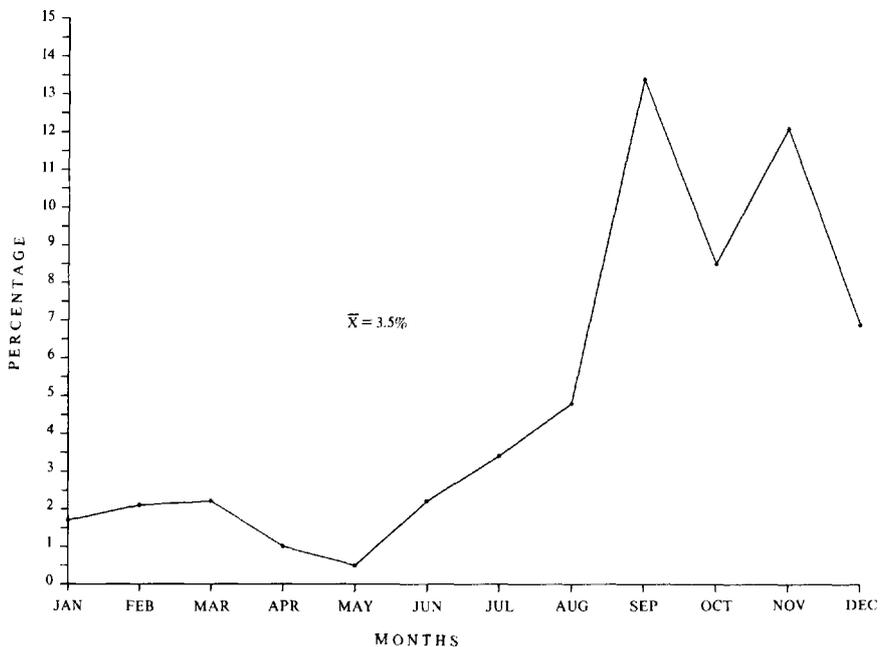


Fig. III-64 Monthly relative abundance of *M. stebbingi* as a percentage of the total catches in Maputo Bay (1968-1973).

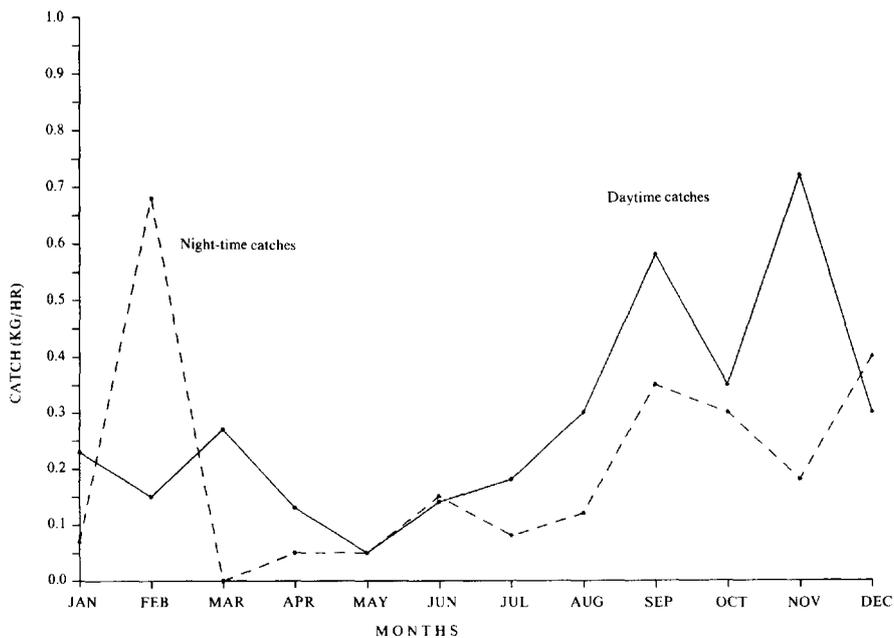


Fig. III-65 Daytime and night-time catches of *M. stebbingi* in Maputo Bay made by commercial vessels from 1968-1973.

Discussion

Metapenaeus stebbingi is a species of very limited commercial value along the east coast of Africa, Madagascar, the Red Sea and the Persian Gulf. In Pakistan, however, it is considered as commercially important (Miquel 1982).

From the gonadal studies carried out during 1968-1973, it was found that the majority of the females may be considered mature when they reach a size of $L_c = 23-24$ mm and probably all are mature by the time they reach $L_c = 29-30$ mm. The presence in the population of Stage I females of $L_c = 29-30$ mm and larger is probably indicative of the fact that females spawn several times after maturity.

The maturity of the males is difficult to determine macroscopically. However, an indication of male adulthood is given by the fusion of petasmas halves (Tuma 1967). Generally, therefore, one can accept that the males of *M. stebbingi* can be considered juveniles and incapable of copulation at sizes smaller than $L_c = 7-8$ mm. From this size to about $L_c = 13-14$ mm (which is the size group migrating out of the backwaters) one can consider the individuals as immature males. At this size, although 2.4% of those still in the backwaters have unfused petasmas, only 0.6% of those out in the open bay are in this condition. Almost all males larger than $L_c = 13$ mm have fused petasmas and may then be considered as adults. That is to say that 34% of the total population and 60% of the population of the open bay may be considered as mature males.

Tirmizi and Javed (1970), studying the development of the genitalia of male *M. stebbingi* stated that at their fourth stage (with $L_c = 12.5$ mm) "... the two halves of the petasma are joined together." This agrees well with the findings of this present study.

As in most penaeid prawns, mating occurs at night between soft-shelled females and hard-shelled males (Hudinaga 1942; Eldred 1958). Only one of the 17 934 females analysed was found to be impregnated. This, however, is ascribed to the fact that the simple open thelycum of this species is inefficient in retaining the spermatophore during the mechanical action of the trawl, rather than being indicative of an offshore migration for mating and spawning.

The incidence of ripe and spent females in a population has generally been accepted as indicative of spawning activity. With the exception of a study of the larval development of *M. stebbingi* carried out by Gurney (1927), no further work has been done on the reproduction of this species. It appears from the analysis of ripe and spent females, that the peak spawning seasons are spring and summer, particularly during October.

In spite of the lack of impregnated females already mentioned, the relatively high number of ripe and spent females found within Maputo Bay seems to indicate that this species may very well breed within the bay. *M. stebbingi* was observed by Gurney (1927) to breed in the Bitter Lakes of the Suez Canal.

The fact that the period of spawning activity is fairly long, and as the size range of spawning individuals is quite wide, it seems probable that once mature, a female spawns several times during her life. This would explain the presence of large individuals ($L_c = 33-34$ mm) with undeveloped (Stage I) ovaries (Fig. III-50). These are probably gonads in the process of regeneration.

In his study of the larval stages of this species, Gurney (1927) described the egg, three stages of the nauplius, three of the protozoa and three mysid stages. Only one specimen of a postlarva was found. *M. stebbingi*, as is the case with most shelf penaeids, spend the postlarval and juvenile periods of their life history in nursery areas situated in backwaters along the coast. In Maputo Bay the most favoured areas serving as nurseries for this species seem to be in calm, protected beaches and mangal channels, with a muddy sand substratum. The juveniles seem to occupy particularly the swash zone.

As in all typical shelf penaeids, the larvae of *M. stebbingi* move from deeper waters into backwater nursery areas, assisted by the winds, currents and tides. Here, protected from

predators, they grow rapidly. Movement out of these areas probably occurs, as with *M. monoceros*, during spring ebb tides.

Young adults of *M. stebbingi* start migrating out at a size of $L_c = 7-8$ mm and by the time they reach $L_c = 13-16$ mm the majority are out of the nursery area environment (Fig. III-54). Migration out of the nursery areas seem to occur throughout the year although there is some evidence that during summer both sexes are smaller during peak outward movement.

There is no information with regard to the movements of adult members of this species. Menon (1951) obviously basing himself on the findings of Gurney (1927) believes that *M. stebbingi* breeds in the backwaters such as the Bitter Lakes. However, adults have been found on the offshore fishing grounds of central Mozambique. Although not in large quantities this evidence may indicate that when large landlocked bodies of water such as the Bitter Lakes and Maputo Bay do not exist, *M. stebbingi* does migrate to offshore waters to be found together with adult *M. monoceros* and *P. indicus*.

The sex ratios slightly favour females both among the juveniles (1:1.6) and among the adults (1:1.4). The structure of the juvenile populations is similar for males and females with the mean sizes being $L_c = 11.4$ mm for males and $L_c = 12.3$ mm for females. In the deeper water occupied by adults the mean sizes are $L_c = 14.6$ mm for males and $L_c = 20.1$ mm for females.

In Maputo Bay, this species occurs only incidentally in the prawn fishery and forms only 3.5% of the total penaeid catch. In the Persian Gulf, *M. stebbingi* forms a small part of the artesanal fishery and in Kuwait it constitutes about 3% of the catches (Miquel 1982). It is also a species of some economical importance in Pakistan.

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