

THE AUSTRALIAN PORTUNIDS (CRUSTACEA: PORTUNIDAE)

IV. REMAINING GENERA

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CONTENTS

	Page
Summary	73
I. Introduction	73
II. The family	74
III. The subfamilies	75
IV. Description of genera and species in the different subfamilies ..	80
V. Acknowledgments	116
VI. References	116
List of subfamilies, genera, and species	122

Summary

Keys to the Indo-Pacific subfamilies, genera, and species are given. Subfamily names are discussed, Portuninae being used in a new sense and Macropipinae being proposed for Alcock's Portuninae.

Catoptrus and *Aeneacancer* are synonymized with *Libystes* and *Ovalipes* respectively so that 11 genera (*Carcinus*, *Nectocarcinus*, *Libystes*, *Carupa*, *Ovalipes*, *Macropipus*, *Lissocarcinus*, *Caphyra*, *Lupocyclus*, *Scylla*, and *Podophthalmus*) containing 17 species are recorded from Australia, including two new species. Whole specimens, male abdomens, and male pleopods of these are illustrated and full descriptions are given in selected cases.

I. INTRODUCTION

Previous papers of this series have dealt with the three genera which are most abundantly represented in the Australian collections, viz. *Thalamita* Latreille (Stephenson and Hudson 1957), *Charybdis* de Haan (Stephenson, Hudson, and Campbell 1957), and *Portunus* Weber (Stephenson and Campbell 1959). Because many species of these genera are found in Australia and because the first pleopods of the males had rarely been described adequately or figured, these genera were treated fairly fully. Comparison of first male pleopods served to indicate species groups, and in most cases these confirmed groupings within the genera which had been suggested previously on the basis of general facies.

The remaining genera are spread between all the subfamilies, with relatively few Australian species in each. Because the literature is scattered it has been thought

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desirable to consolidate the essentials into one paper, and in particular to include relevant keys to and figures of the intact animals. Some genera and species have been treated adequately in recent literature, and in these cases the synonymy is greatly abbreviated. In cases where changes are proposed a fuller synonymy is given. With two exceptions all species have been described previously and hence, in general, specific diagnoses rather than descriptions are given. Detailed treatment has been reserved for (i) structures not previously described in sufficient detail, especially first pleopods of males and (ii) cases where consideration of the present specimens leads to alterations of published descriptions.

Descriptions of first pleopods of males, unless otherwise stated, refer to unflattened appendages as viewed from the ventral surface with abdomen uplifted. All figures are of the left pleopods, i.e. right as viewed from the under surface of the crab. It should be noted that the concave border lies to the outside of the animal and the convex towards the inside. In some cases permanent balsam mounts were made, after treating with caustic potash and staining in fast green; in other cases temporary mounts were made in glycerol and alcohol. All figures of pleopods are either based upon camera lucida outlines or were drawn with the assistance of a squared micrometer eyepiece.

The ultimate branches of the keys terminate in three different types of references: (i) with only an author and date: in such cases the entity which has been keyed out is treated in later pages of the present paper; (ii) with author, date, and pagination: here the keyed-out entity has been treated in a previous paper of the present series; and (iii) with author, date, pagination, and the words "not recorded from Australia".

II. THE FAMILY

H. Milne Edwards (1834, p. 432) referred to "Tribu des Portuniens", and Dana (1852*b*, pp. 267, 290) first used the term "Portunidae". He used it in a more restricted sense than at present, and its present use dates from Miers (1886, p. 169). The early synonymy of the family is given in Alcock (1899, p. 5).

Diagnostic features are given by Alcock (1899, pp. 5-7), Borradaile (1907, p. 481), Sakai (1939, pp. 365-6), and Barnard (1950, pp. 139-40). The obvious features of typical portunids are the flattened fifth pair of legs and the structure of the carapace.

The fifth legs as a whole are usually flattened, especially the last two joints, and this has been assumed to be an adaptation for swimming. While these legs are used for swimming in the genus *Portunus*, many of the so-called swimming crabs do not swim at all frequently or convincingly. Many species use them for excavation and even *Portunus pelagicus* uses them occasionally for this purpose.

It has been suggested previously (Stephenson, Hudson, and Campbell 1957; Stephenson and Campbell 1959) that the more active swimmers and burrowers may be later evolutionary developments in the family, in which case genera such as *Carcinus* Leach, *Nectocarcinus* A. Milne Edwards, and *Libystes* A. Milne Edwards, without the typical flattened appendages, could be regarded as primitive. *Caphyra*

Guérin, also without flattened appendages, is probably specialized but in a manner different from the majority of the family.

The carapace is usually wider than long, depressed or slightly convex, and is rarely areolated. The front is usually broad and cut into teeth. The flat, broad (and pointed) carapace may well be a form of streamlining related to lateral swimming (Stephenson and Campbell 1959) and again the forms with the more convex, narrower, and "squarer" carapaces could be regarded as primitive (e.g. *Carcinus*, *Nectocarcinus*, *Libystes*) or specialized for a different mode of life (e.g. *Caphyra*).

The following less conspicuous characters have diagnostic value at the family level: orbits complete, no rostrum, first antenna folding slantwise or transversely, carpus of third maxilliped articulating at or near the antero-internal angle of the merus, usually a small lobe on the inner angle of the endopodite of the first maxilliped, male opening coxal.

The portunids as a whole are close to the cancrids and xanthids, and separation of genera such as *Carcinus* from the xanthids is difficult and somewhat arbitrary. As Alcock has noted (1899, p. 4) "The Carcininae by way of *Carcinus*, approach the Xanthidae by way of *Hoploxanthus*".

III. THE SUBFAMILIES

Sakai (1939) recognized six subfamilies, viz.: Carcininae Alcock, 1899; Catoptrinae Borradaile, 1907; Portuninae Alcock, 1899; Caphyrinae Alcock, 1899; Lupinae Alcock, 1899; and Podophthalminae Borradaile, 1907 (attributed by Sakai to Rathbun 1930). Edmondson (1954) recognized the same subfamilies but used Caphrinae for the Caphyrinae. These appear the most natural groupings yet suggested and differ from Alcock's four original subfamilies by recognizing the separateness of Borradaile's Catoptrinae and Podophthalminae although not accepting his Portuninae or Carupinae. Rathbun's (1930) concept of the subfamilies was evidently similar to Sakai's, allowing for her work being restricted to the American genera and for some changing of names.

If it is accepted that there are six subfamilies, their naming is a matter of difficulty. Following upon resolutions of the International Commission on Zoological Nomenclature (1955) *Carcinides* Rathbun has been suppressed in favour of *Carcinus* Leach, so Alcock's Carcininae stands in favour of Rathbun's Carcinidinae.

As will appear later in this paper the genus *Catoptrus* Milne Edwards is a synonym of *Libystes* Milne Edwards. Since it is a junior subjective synonym the subfamily name Catoptrinae can remain unchanged (Add. Règles Internat. 1953, item 54, p. 36).

Alcock's Portuninae is based on *Portunus* Fabricius, 1798, which is a junior homonym of *Portunus* Weber, 1795 (see Internat. Comm. Zool. Nom. 1956). Of the later synonyms of *Portunus* Fabricius, *Macropipus* Prestandrea, 1833, has priority over *Liocarcinus* Stimpson & Pourtalès, 1870. Hence the Portuninae Alcock must become Macropipinae (nom. nov.).

The genus *Lupa* Leach has been rejected officially for *Portunus* Weber (Internat. Comm. Zool. Nom. 1956) and Alcock's Lupinae should therefore be

replaced. The subfamily name Portuninae, containing the genus *Portunus*, must be applied here instead of Borradaile's Thalamininae. This concept of the *Portuninae* is quite different from that of Alcock and others.

The subfamily names Caphyrinae Alcock and Podophthalminae Borradaile remain unaltered.

The features of these subfamilies are:

(i) *Carcininae*.—Legs stout and long, at least one pair as long as chelipeds, last pair with lanceolate dactylus but otherwise similar to the 3 other pairs. Carapace not broad, anterolateral borders cut into 4 or 5 teeth. Basal joint of second antenna fixed, longer than broad, lying in longitudinal axis of carapace.

(ii) *Catoptrinae*.—Last pair of legs either lanceolate or paddle-shaped. Carapace transversely elliptical and convex in both directions, anterolateral borders either toothed or entire. Basal joint of second antenna long and oblique, flagellum standing in orbital hiatus.

(iii) *Macropipinae*.—Legs stout and long, last pair typical paddles. Carapace not very broad, 5 anterolateral teeth. Second antenna arising from orbital hiatus, and lying almost in the longitudinal axis of the carapace, flagellum standing inside the orbit.

(iv) *Caphyrinae*.—Legs short, last pair either claw-shaped or lanceolate. Carapace not very broad, 4 or 5 anterolateral teeth. Basal joint of second antenna with its antero-external angle lobulate, the flagellum excluded from the orbit.

(v) *Portuninae*.—Legs shorter than chelipeds, last pair typical paddles. Carapace typically broad to very broad, 4–9 anterolateral teeth. Basal joint of second antenna usually broad, antero-external angle sometimes lobulated, flagellum sometimes included in the orbit.

(vi) *Podophthalminae*.—Eye stalks very long, orbits occupying whole anterior border of carapace except for the narrow front. Few anterolateral teeth. Last legs paddle-shaped. Basal joint of second antenna short, flagellum included in the orbit.

The subfamilies can be keyed as follows:

1. Eyestalks enormously long PODOPHTHALMINAE Borradaile (1907)
Eyestalks normal 2
- 2(1). Carapace broad (transversely elliptical) and convex in both directions. (Antennal flagellum in orbital hiatus) CATOPTRINAE Borradaile (1907)
If carapace broad, not convex in both directions 3
- 3(2). Chelipeds and legs both long, chelipeds longer than all legs, carapace typically broad PORTUNINAE, *usus nov.*
Chelipeds and legs both long, one pair of legs as long as chelipeds, carapace relatively narrow 4
Chelipeds and legs both short, carapace relatively narrow .. CAPHYRINAE Alcock (1899)
- 4(3). Last legs typically not noteworthy different from other pairs, basal joint of second antenna narrow CARCININAE Alcock (1899)
Last legs typical swimming paddles, basal joint of second antenna broad
..... MACROPIPINAE, *nom. nov.*

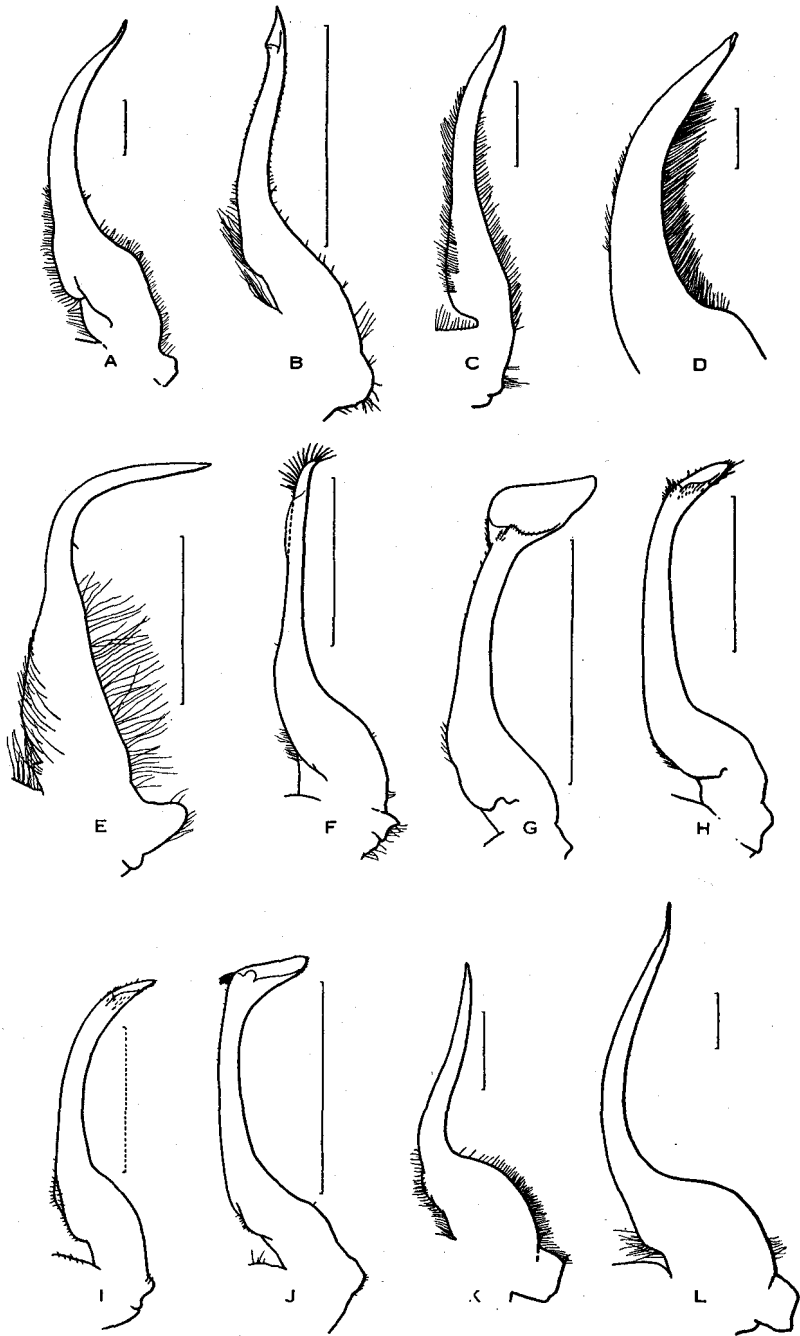


Fig. 1.—Left first male pleopods. Scale lines 2 mm unless otherwise stated. A, *Carcinus maenas*; B, *Libystes paucidentatus*; C, *Ovalipes punctatus* (right pleopod reversed); D, *O. molleri* (right pleopod reversed); E, *Macropipus corrugatus* (right pleopod reversed); F, *Lissocarcinus polybioides* (right pleopod reversed); G, *Caphyra laevis*; H, *C. rotundifrons*; I, *C. yookadai* (right pleopod reversed, scale line 1 mm); J, *C. fulva*; K, *Lupocyclus rotundatus*; L, *Podophthalmus vigil*.

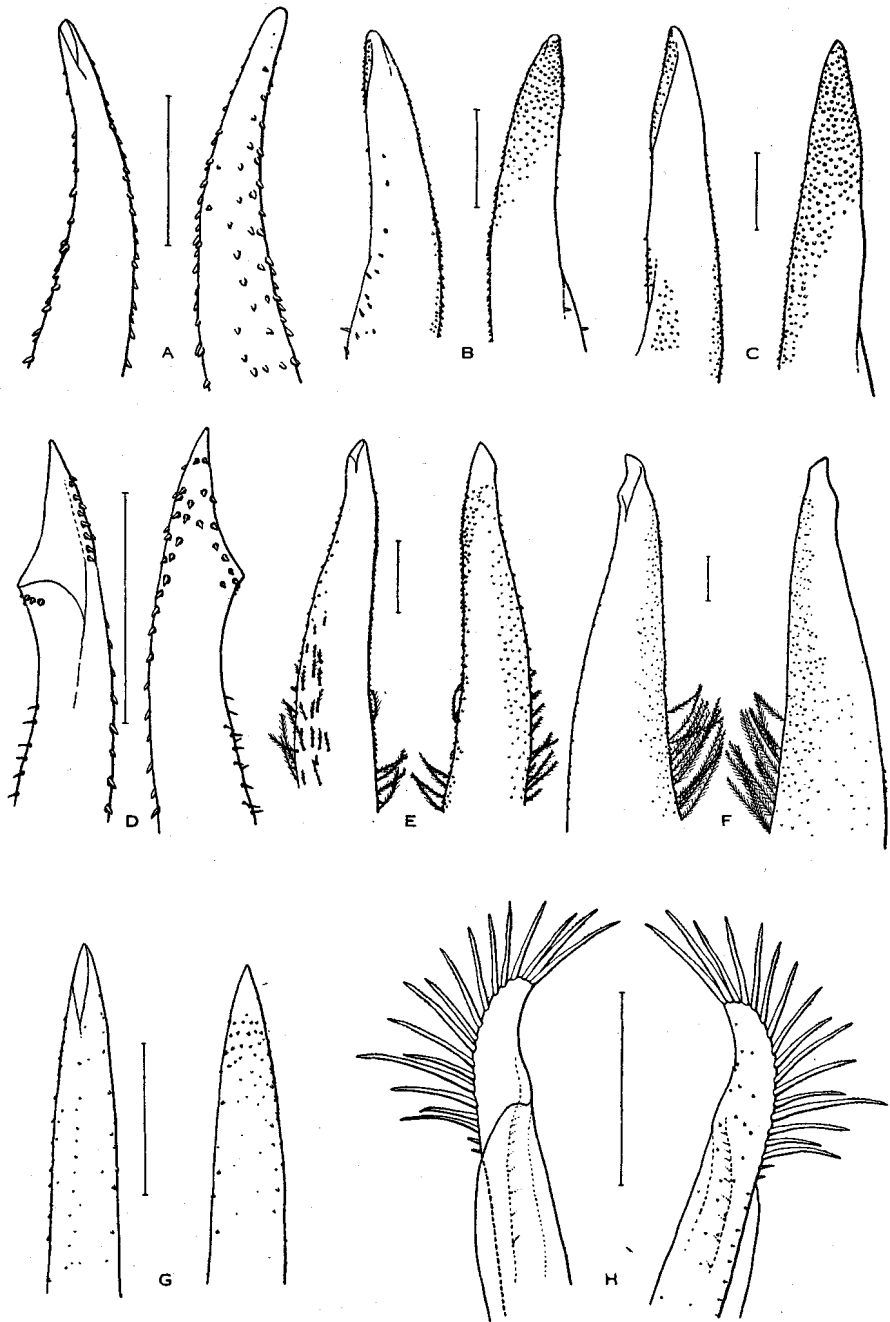


Fig. 2.—Tips of left first male pleopods. The upper surfaces are to the left of the scale lines, the under surfaces to the right. Scale lines 0.5 mm. A, *Carcinus maenas*; B, *Nectocarcinus integrifrons* (right pleopod reversed); C, *N. tuberculatus* (right pleopod reversed); D, *Libystes paucidentatus*; E, *Ovalipes punctatus* (right pleopod reversed); F, *O. molleri* (right pleopod reversed); G, *Macropipus corrugatus* (right pleopod reversed); H, *Lissocarcinus polybioides* (right pleopod reversed).

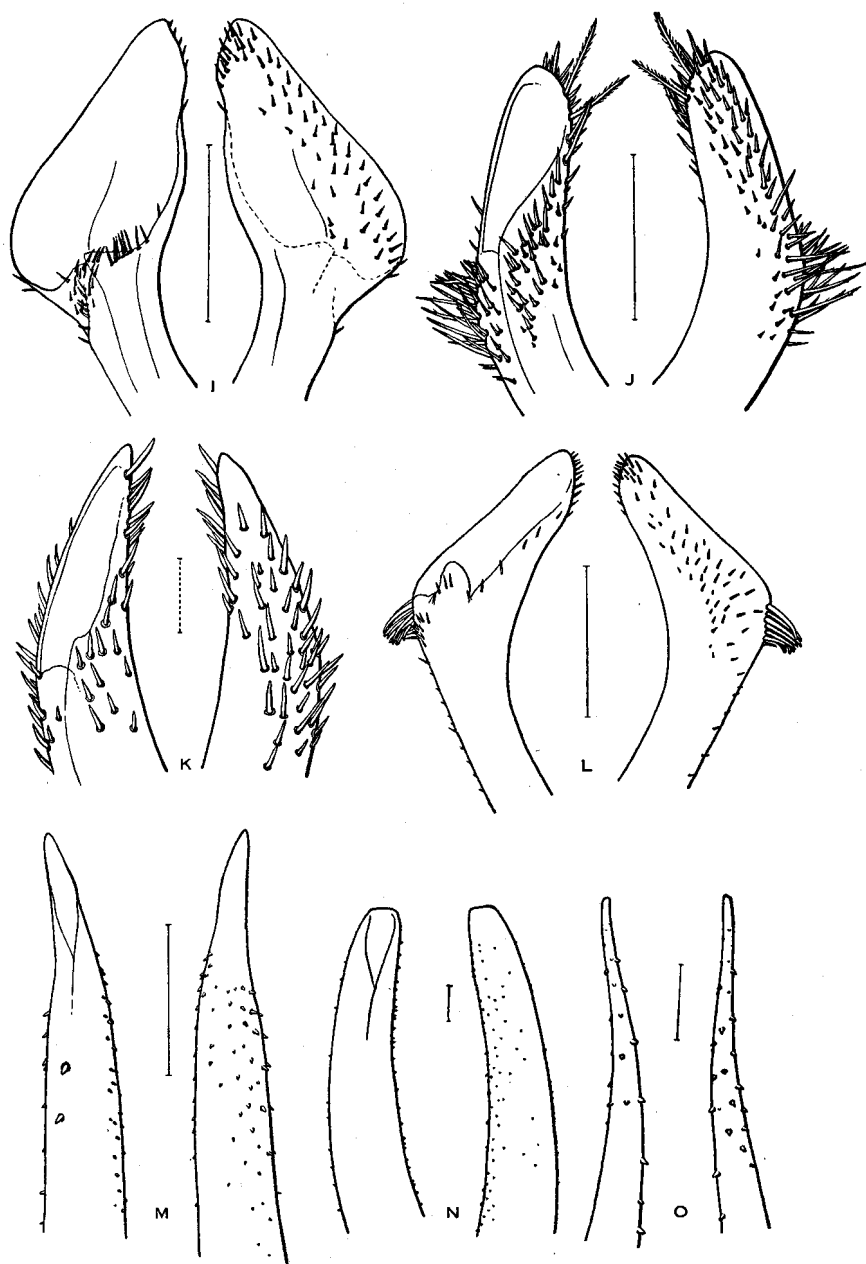


Fig. 2 (continued).—Tips of left first male pleopods. The upper surfaces are to the left of the scale lines, the under surfaces to the right. Scale lines 0.5 mm unless otherwise stated. I, *Caphyra laevis*; J, *C. rotundifrons*; K, *C. yookadai* (right pleopod reversed, scale line 0.1 mm); L, *C. fulva*; M, *Lupocyclus rotundatus*; N, *Scylla serrata*; O, *Podophthalmus vigil*.

IV. DESCRIPTION OF GENERA AND SPECIES IN THE DIFFERENT SUBFAMILIES

Subfamily CARCININAE Alcock, 1899

KEY TO INDO-WEST-PACIFIC GENERA OF SUBFAMILY CARCININAE

1. 4 anterolateral teeth *Nectocarcinus* A. Milne Edwards (1860)
 5 anterolateral teeth 2
- 2(1). Last pair of legs swimming paddles
 *Portumnus* Leach (1814, p. 430) (not recorded from Australia)
 Last pair of legs not swimming paddles *Carcinus* Leach (1814)

Genus CARCINUS Leach

- Carcinus* Leach, 1814, pp. 390, 429. Alcock, 1899, p. 12 (early synon.). Internat. Comm. Zool. Nom., 1955, pp. 321-38.
Carcinides Rathbun, 1897, p. 164; 1930, p. 14.

CARCINUS MAENAS (L.)

Figs. 1A, 2A; Plate 1, Fig. 1; Plate 5A

- Cancer maenas* L., 1758, p. 627.
Carcinus maenas (L.). Leach, 1814, p. 429. Alcock, 1899, pp. 13-14 (early synon.).
Carcinus mediterraneus Czerniavsky, 1884, p. 177. Holthuis and Gottlieb, 1958, pp. 82-5.
Carcinides maenas (L.). Rathbun 1897, p. 164; 1930, pp. 15-18, fig. 4 (synon.). McNeill, 1953, pp. 92-3.

Material Examined

NEW SOUTH WALES: At Macleay Museum: ♂ 17 mm, "Sydney" (locality suspect). VICTORIA: At Australian Museum: ♂ 58 mm, ♀ 37 mm, Queenscliffe (Reg. No. G5458). ♀ 41 mm, ♀ 65 mm Bastion Point, near Mallacoota, Misses E. Pope and I. Bennett (Reg. No. P12679-80, see McNeill 1953). At National Museum, Victoria: 3 ♂♂ 43, 47 (figured), 67 mm; 4 ♀♀ 37-52 mm, on sandbank among *Zostera*, Rosebud, 6.xii.58, Miss J. Hope McPherson (no Reg. No.).

Recorded habitats.—Rock crevices high on beach.

Description

General.—Adequately described both generically and specifically by Alcock (1899) and Rathbun (1930) *inter al.* It is readily identifiable by the keys and general facies.

Male pleopod.—Rather long, curved, with the neck tapering evenly to a fine curved tip. Beyond the basal lobes on both outer and inner surfaces long bipinnate hairs are visible for a short distance. These are followed on the outer side by a band of short stout spinules which extend to the tip. The proximal members of this band are broad and blunt becoming smaller, sharper, and backwardly directed as one moves to the tip. Stout, backwardly directed spinules are present on the distal quarter of the inner side, extending to the under surface to give a sparse covering for a short distance back from the tip.

Comments

Holthuis and Gottlieb (1958) have resurrected the species *C. mediterraneus* Czerniavsky, 1884, citing the opinions of Drs. Isabella Gordon, R. Zariquiey,

J. Forest, and L. B. Holthuis that there are constant differences between the Atlantic and Mediterranean specimens (Forest 1957). Holthuis and Gottlieb mention such differences in the shape and granulation of the carapace and also in the pleopods but do not describe them, nor are they given by Forest (1957). The only description of the features characterizing the Mediterranean form are given by Demeusey and Veillet (1953) and summarize as follows: thicker carapace, carapace regions more distinct and more rugose, last anterolateral tooth pointing obliquely, shorter antennular articles, internal flagellum generally with 3 articles excluding the terminal one as against 4 or 5, antennae longer and with more articles, basal article carrying teeth on lateral external border but the ventral face of the lateral external border smooth (vice versa in Atlantic specimens), chelae with accentuated carinae and markedly pilose carpopodite, female abdomen much broader.

The present specimens resemble the American one figured by Rathbun (1930, fig. 4) as regards distinctness of carapace regions and shape of anterolateral teeth. They resemble the Mediterranean ones in having 5 articles on the antennule and in having small teeth on the lateral external border of the basal antennal joint. The chelae are not markedly carinate nor is the carpopodite pilose.

It would appear that specimens from many areas should be examined in detail before the Mediterranean form could be given specific status. It would be especially helpful if the details of pleopod structure mentioned by Holthuis and Gottlieb could be figured and described in detail.

It should also be noted that Demeusey and Veillet were able to cross the Atlantic and Mediterranean forms and obtain viable eggs.

Distribution

North Sea almost to the Arctic, Baltic, Atlantic coast of North America, Brazil, Black Sea, Bay of Panama (Alcock 1899).

Very doubtfully from Hawaii (Edmondson 1954) and from the Red Sea (Monod 1938).

Australian records are: Australia but doubtful (Alcock 1899); Frankston to Port Arlington near Port Phillip, Victoria (Fulton and Grant 1900); Port Phillip, Beaumaris and elsewhere, Port Melbourne (Ward 1929); Mallacoota Inlet, Victoria (McNeill 1953); Port Phillip (Edmondson 1954).

When this species was recorded at Port Phillip by Fulton and Grant (1900) it was described as "plentifully distributed" and considered an introduced species. McNeill (1953) supported this view, and in recording it from a locality 400 miles distant from Port Phillip, firmly believed that the species had spread since 1900. It should be borne in mind that our general knowledge of portunid distributions in Victoria is fragmentary. A more detailed knowledge of the Australian distribution of *Carcinus* at the present time is desirable.

It should be noted that European workers (e.g. Palmer 1927) regard the widespread distribution of *Carcinus* as a natural phenomenon and in harmony with the presence of primitive portunid features. Demeusey and Veillet (1953) suggest it may be a widespread survivor of the Sea of Tethys.

The species is abundant on the cooler North Atlantic coasts of America and Europe and occupies the crevices and under-stone habitat which in lower latitudes house grapsids and xanthids.

It shows primitive features relating it to the xanthids and cancroids, and can possibly be regarded as an isolated offshoot from near the base of the portunids. The main evolution of the family has evidently occurred in warmer waters with the possibility of "relics" remaining in higher latitudes. This concept is supported by the fact that the nearest living genus, viz. *Nectocarcinus*, is restricted to the cooler waters of the Southern Hemisphere.

Genus NECTOCARCINUS A. Milne Edwards

Nectocarcinus Milne Edwards, A., 1860, pp. 219-20; 1861, p. 404. Haswell, 1882b, p. 81.

Generic Description (after A. Milne Edwards 1861, pp. 406-7).

Carapace.—Thick, neither very wide nor very convex, regions well defined. Anterolateral borders with the front forming a regular curve of short radius, whose centre lies in the anterior part of the cardiac region. Front protruding, either entire or subdivided.

Anterolateral teeth.—Four, of which the first is the broadest and the last small and sharp.

Basal antennal joint.—Broad, narrow, fused to the front.

Third maxilliped.—Elongate, third article hollowed on outer surface.

Cheliped.—Short and robust.

Walking legs.—Robust and laterally compressed.

Fifth leg.—Not adapted for swimming but wider than in *Carcinus*; propodus broadened, dactyl lanceolate except in *N. antarcticus* (Jacquinot & Lucas, 1853, fide Hodgson 1902; and Richardson 1949, pl. 1, fig. 1a).

The genus is not truly Indo-West-Pacific, as Balss (1935) has noted, but is restricted to Australia, New Zealand, and South America. Apart from the two Australian species, *N. antarcticus* occurs in New Zealand and Chatham I. while *N. bullatus* Balss, 1924, is found at Juan Fernandez.

Distinctions between Australian Species

The two Australian species (*integrifrons* and *tuberculosis*) have somewhat similar distributions and habitat and younger specimens of the two species can easily be confused. The front in *N. integrifrons* is finely granular and rounded, with the median notch minute or absent, whereas in *N. tuberculosis* the front is more coarsely granular and the median notch is always distinct. The shape of the male pleopod also provides a clear distinction between younger specimens, being evenly tapered throughout its length in *N. integrifrons* while in *N. tuberculosis* there is a more distinct separation into basal area and neck. Larger specimens of *N. tuberculosis* differ markedly from smaller specimens and also from *N. integrifrons* in having: (1) prominent spiniform granules on the front, anterior part of carapace, and upper surfaces of hands and wrists; (2) rounded, rather than crested anterolateral borders,

and (3) the highest part of the carapace apparently further forward, and the posterior half less convex from side to side.

The difficulties in distinguishing these sibling species are such that the key which follows is only workable on the largest specimens, with a carapace width greater than 70 mm.

KEY TO THE KNOWN SPECIES OF GENUS NECTOCARCINUS

1. Front (excluding inner orbital angles) 4-lobed2
 Front with 2 broad lobes separated by a small but distinct notch (older specimens with spiniform tubercles on front of carapace) ..*N. tuberculosus* (A. Milne Edwards) (1861)
 Front entire, rarely with a minute notch*N. integrifrons* (Latreille) (1825)
- 2(1). Anterolateral teeth broad and blunt, becoming smaller and sharper posteriorly
N. antarcticus (Jacquinot & Lucas) (1853, p. 51, pl. v, fig. 4) (not recorded from Australia)
 Anterolateral teeth all sharp and subequal
*N. bullatus* Balss (1924, pp. 335-6, fig. 2) (not recorded from Australia)

NECTOCARCINUS INTEGRIFRONS (Latreille)

Fig. 2B; Plate 1, Fig. 2; Plates 5B, 6A

Portunus integrifrons Latreille, 1825, p. 192. Milne Edwards, H., 1834, p. 445. Kinahan, 1858, pp. 120-1.

Nectocarcinus melanodactylus Milne Edwards, A., 1860, p. 220.

Nectocarcinus integrifrons (Latreille). Milne Edwards, A., 1860, p. 220; 1861, pp. 406-7, pl. xxxviii. Hess, 1865, p. 139. Miers, 1874, p. 2, pl. 1, fig. 3; 1876, p. 30. Haswell, 1882b, pp. 81-2 (synon.). Miers, 1884, p. 234. Fulton and Grant, 1906, p. 18. Rathbun, 1923, p. 130. Hale, 1927, pp. 152-3, fig. 153. Chilton and Bennett, 1929, p. 753. Ward, 1929, p. 79, fig. iv. Balss, 1935, p. 130.

Material Examined

42 ♂♂ (8-80 mm); 49 ♀♀ (10-70 mm). One ovigerous ♀ from month of March.

NEW SOUTH WALES: Port Stephens, Port Jackson, Jervis Bay, Port Hacking.
 VICTORIA: Port Phillip. TASMANIA: Derwent R. SOUTH AUSTRALIA: Kangaroo I.

Recorded habitats.—Intertidal, dredged 2-7 fm.

Material illustrated.—Plate 1, Figure 2: ♂ 65 mm, South Australia (S. Aust. Mus. Reg. No. C1247). Male pleopod: 36 mm, Kangaroo I., pres. June 1920, E. Troughton (Aust. Mus. Reg. No. P4823).

Description

General.—Considered unnecessary.

Male pleopod.—Moderately stout without marked lateral curvatures. The appendage is twisted in a corkscrew fashion which makes recognition of the normal bands of spinules difficult. These spinules are short and blunt and the main band begins on the upper outer surface, curves to the under surface, and reappears subterminally on the inner surface at the tip. Just beyond the basal lobes the upper surface is concave for a small area and the outer edge is relatively smoothly curved.

Distribution

Recorded only from Australia and New Zealand (Miers 1876; Chilton and Bennett 1929). Within Australia from Port Jackson (Haswell 1882b; Miers 1884),

Tasmania (Miers 1876; Haswell 1882*b*; Guiler 1952), Port Phillip (Kinahan 1858; Ward 1929) and Fremantle (Balss 1935).

Miers (1884) records this species from Port Curtis (Queensland) but because of its isolation this record is highly suspect.

NECTOCARCINUS TUBERCULOSUS A. Milne Edwards

Fig. 2*C*; Plate 1, Fig. 3; Plates 5*C*, 6*B*.

Nectocarcinus tuberculatus Milne Edwards, A., 1860, p. 220; 1861, pp. 405-6, pl. xxxvii. Miers, 1874, p. 2. Haswell, 1882*b*, p. 82. Hale, 1927, p. 153, fig. 154.

Material Examined

15 ♂♂ (13-90 mm); 9 ♀♀ (11-85 mm). Ovigerous ♀♀ from month of August; smallest ovigerous ♀ 25 mm.

NEW SOUTH WALES: Port Jackson, Eden. VICTORIA: Port Phillip, Beaumaris. TASMANIA: King I., Wedge Bay, Derwent R., Hobart, Simpson's Bay, Catamaran, Recherche Bay, Tasman I. off Cape Pillar, Bay of Fires.

Material Illustrated.—♂ 33 mm, Simpson's Bay, Derwent R., pres. Aug. 1926, M. Ward (Aust. Mus. Reg. No. P8653).

Description

General.—Considered unnecessary.

Male pleopod.—Very similar to *N. integrifrons* except that (1) the appendage is relatively thinner, particularly in the subterminal region; (2) the concavity of the upper surface just beyond the basal lobes is extensive and obvious; (3) there is a marked convexity of the lateral external border in this region.

There are minor differences in spinulation between the limited number of juvenile specimens whose pleopods have been examined but these differences are hard to see and do not always seem to apply to the larger specimens where there is a risk of spinules having been lost.

Distribution

From Victoria (Ward 1929) and Tasmania (A. Milne Edwards 1861; Haswell 1882*b*; Rathbun 1923; Guiler 1952).

Subfamily CATOPTRINAE Borradaile, 1907

The genera contained in this subfamily were originally placed by Alcock (1899, 1900) in two different families, *Carupa* Dana being placed in the Portunidae and *Catoptrus* and *Libystes* in the Gonoplacidae (=Goneplacidae). Tesch (1918) retained *Catoptrus* and *Libystes* in the latter family but most recent authors, for example Sakai (1939) and Edmondson (1954), have followed Borradaile in keeping the three genera together as a subfamily of the Portunidae. The resemblance to the subfamily of the Pseudorhombilinae Alcock, 1900, of the Goneplacidae, and especially to such genera as *Carcinoplax* H. Milne Edwards, 1852, is however extremely close. It seems probable, therefore, that the family Portunidae is a diphyletic group, with one branch stemming from a *Carcinus*-like form and the second from a *Carcinoplax*-like form. If so this would be an interesting case of parallel evolution, and would also call for the creation of a new family.

KEY TO INDO-WEST-PACIFIC GENERA OF SUBFAMILY CATOPTRINAE

- Anterolateral border of carapace entire or bearing at most 6 teeth; arm and wrist of cheliped usually unarmed *Libystes* A. Milne Edwards (1867)
 7 anterolateral teeth (sixth the largest); arm and wrist of chelipeds bearing teeth
 *Carupa* Dana (1851)

Genus LIBYSTES A. Milne Edwards

- Libystes* Milne Edwards, A., 1867, p. 285; 1868, p. 83. Alcock, 1900, pp. 304-5. Tesch, 1918, pp. 177-8. Balss, 1922, p. 113. Sakai, 1939, pp. 371, 372. Edmondson, 1954, p. 222 (in key).
Catoptrus Milne Edwards, A., 1870, p. 82. Ortman, 1894, p. 685. Alcock, 1900, p. 307. Tesch, 1918, pp. 178-9. Sakai, 1939, p. 371. Edmondson, 1954, p. 222.
Goniocaphyra de Man, 1887b, p. 339.

As Tesch (1918, p. 178, under *Libystes*) has shown, there are no reasons to justify the continued maintenance of the genus *Catoptrus*. The characters which have been used for diagnostic purposes are the entirety or toothed nature of the anterolateral borders; the production or otherwise of the antero-external angle of the third maxillipeds; and the relative flattening of the fifth leg. Only the last seems to have any quality of generic exclusiveness. There are great differences in this feature within the species of the genus *Libystes* and since *Catoptrus* only slightly exceeds the range of form within *Libystes* it seems necessary to suppress the genus *Catoptrus*. Since *Libystes* and *Catoptrus* have each contained a species bearing the name *nitidus* some alteration of trivial names is necessary and *Catoptrus nitidus* A. Milne Edwards, 1870, becomes *Libystes truncatifrons* (de Man, 1887b).

Generic Description

Carapace.—Deepish, subquadrilateral or subelliptical, vastly broader than long, with little or no distinction of regions. Convex fore and aft, slightly so from side to side.

Fronto-orbital borders much narrower than the greatest breadth of the carapace, so that the anterolateral borders, which may be toothed or entire, have a caneroid-like curve. Front square-cut and quite straight, not well separated from the supra-orbital angles, slightly notched in the middle line, a third or less the greatest breadth of the carapace.

Orbits.—Shallow, their upper border entire.

Basal antennal joint.—Short, the antennal flagellum standing loosely in the orbital hiatus.

Antennules.—Folding transversely.

Buccal cavern.—Square-cut, much broader than long; the efferent branchial canals of the palate very well defined.

Third maxilliped.—Merus short and broad. In some species the external angle much produced, as in many species of *Portunus*.

Chelipeds.—Subequal, longer, and much more massive than the legs. Hands somewhat tumid and unequal in the adult.

Walking legs.—Slender, unarmed.

Fifth leg.—Forming a typical swimming paddle in some of the species, but not paddle-like in others.

Male abdomen.—Covering the whole width of the sternum between the last pair of legs. Third to fifth abdominal terga fused.

KEY TO THE INDO-WEST-PACIFIC SPECIES OF GENUS LIBYSTES

- | | | |
|-------|---|---|
| 1. | Anterolateral border bearing teeth | 2 |
| | Anterolateral border entire, without teeth | 5 |
| 2(1). | Fifth legs markedly flattened and paddle-like | 3 |
| | Fifth legs not paddle-like | 4 |
| 3(2). | 6 or 7 anterolateral teeth (including the extra-orbital angle); front straight | |
| | <i>L. edwardsi</i> Alcock | |
| | (1900, p. 306), Alcock and McArdle (1902, pl. lxi, fig. 1) (not recorded from Australia) | |
| | 5 anterolateral teeth (including the rounded extra-orbital angle); front curved | |
| | <i>L. paucidentatus</i> , sp. nov. | |
| 4(2). | Carapace relatively narrow (length : breadth ratio c. 1 : 1.4, excluding the last anterolateral teeth); first anterolateral tooth much broader than fifth; merus of third maxilliped longer than broad and slightly produced at antero-external angle | |
| | <i>truncatifrons</i> (de Man) (1887b, p. 339, pl. 14, fig. 1) (not recorded from Australia) | |
| | Carapace relatively broad (length : breadth ratio c. 1 : 1.7, excluding the last anterolateral teeth); first and fifth anterolateral teeth subequal; merus of third maxilliped broader than long with antero-external angle greatly produced | |
| | <i>L. inequalis</i> | |
| | (Rathbun) (1906, p. 870, text fig. 29, pl. 12, fig. 9) (not recorded from Australia) | |
| 5(1). | Borders of carapace and legs densely haired | |
| | <i>L. villosus</i> Rathbun (1924, p. 127) (not recorded from Australia) | |
| | Borders of carapace and legs hairless | 6 |
| 6(5). | Carapace elliptical | |
| | <i>nitidus</i> A. Milne Edwards (1868, p. 83, pl. 20, figs. 5-7) (not recorded from Australia) | |
| | Carapace subquadrilateral | |
| | <i>L. alphonsi</i> Alcock | |
| | (1900, p. 306), Alcock and McArdle (1902, pl. lxi, fig. 2) (not recorded from Australia)* | |

LIBYSTES PAUCIDENTATUS, sp. nov.

Fig. 1B, 2D; Plate 1, Fig. 4; Plate 5D

Material Examined

♂ 18 mm, Redland Bay, in gritty mud M.L.W., 11.viii.58, W.S. and B.C. (paratype). ♂ 14.5 mm (holotype), ♀ 15 mm (paratype), and ♀ 16 mm (allotype), Redland Bay, in gritty mud M.L.W., 7.i.59, B.C. The holotype and allotype are to be deposited in the Australian Museum and the paratypes in the Queensland Museum.

Material illustrated.—Holotype.

Description

Front.—Narrow (c. $\frac{1}{4}$ carapace width) and consisting of two slightly rounded lobes; inner orbital lobes indistinguishable.

* Tesch (1918) and Edmondson (1954) both consider that *L. alphonsi* is probably a synonym of *L. nitidus*.

Anterolateral teeth.—Five, all blunt, of which the first is a flat protuberance, the fourth normally the smallest, and the fifth a projecting procurved spine.

Carapace.—Almost twice as broad as long (from 1·8 to 1·9 times), microscopically punctate over most of its surface, granular near the anterolateral borders. With a blunt eminence near each posterior angle and a slight concavity of the lateral epibranchial region to give the carapace a quadrilateral appearance.

Chelipeds.—With the right larger than the left in the males but equal in the females. The chelipeds are more than three times the length of the carapace and without carinae or spines except on the fingers. The arm bears lines of granules, especially on the upper surface, tending to a squamiform appearance. Fingers slender and hooked at the tip, equal to the length of the palm except in the smaller chelipeds of the males where they are longer. The opposed surfaces of the fingers are lined with small denticles amongst which there are occasional teeth, some 4 or 5 short ones on the movable finger and typically 3 elongate sharp ones on the immovable finger. Walking legs long and slender, fifth leg paddle-like, with the greatest length of the carpus less than half the greatest length of the propodus.

Male pleopods.—Little curved, evenly tapering to a pointed, obliquely cut tip. On the outer side there is a patch of bipinnate hairs just beyond the basal lobes, which thin out and almost fuse with a second band of long hair-like bristles commencing about half-way up the appendage. These bristles become shorter, stouter, and backwardly directed, and continue to the tip as a single row which tends to pass to the under surface, there fusing with the terminal armature. On the inner side just beyond the basal lobes there is a conspicuous tuft of long bipinnate hairs. Leading forward from this there are isolated hairs, which become more frequent and stouter, forming a row which ends just behind the tip. Apart from the row of recurved bristles on the outer side, the terminal armature consists only of short scattered spines on the under surface. A sparse row is distinguishable near the inner side of the under surface, and this becomes more concentrated and passes around just behind the proximal border to end on the upper surface.

Colour.—Dull brown.

Discussion

This species is close to *L. edwardsi* Alcock, 1900 (see also Alcock and McArdle 1902, pl. lxi, fig. 1).

It differs in the following particulars: (1) fewer anterolateral teeth; (2) rounded instead of straight front; (3) broader carapace; (4) lines of granules tending to form squamiform markings on the upper surface of the arm of the cheliped; (5) relatively smaller carpus of the fifth leg; (6) presence of teeth on both movable and immovable fingers of both chelipeds as against only on the immovable finger of the smaller cheliped.

The marked gap in the distribution between *L. edwardsi* and the present specimens also supports the idea that they are different species, the former having been recorded only from the Persian Gulf and the Andamans.

Genus *CARUPA* Dana

Carupa Dana, 1851, p. 129; 1852*a*, p. 85; 1852*b*, p. 279. Alcock, 1899, pp. 25-6 (synon.).
Leene, 1938, p. 9 (synon.); 1940, p. 164.

CARUPA TENUIPES Dana

Plate 2, Fig. 1

Carupa tenuipes Dana, 1851, p. 129; 1852*a*, p. 85; 1852*b*, pp. 279-80. Leene, 1940, pp. 165-8, figs. 1, 2 (male pleopod).

Carupa laeviscula Heller, 1862, p. 520; 1865, p. 27, pl. 3, fig. 2. Alcock, 1899, p. 26 (synon.). Leene, 1938, pp. 9-10. Sakai, 1939, p. 373, pl. xlv, fig. 3 (coloured). Edmondson, 1954, pp. 266-7, figs. 3*b*, 4*e*, 4*f*, 4*g*.

Material Examined and Illustrated

♀ 26 mm, Hope I., Aug. 1913, A. R. McCulloch (Aust. Mus. Reg. No. P3800).

Description

General.—See key, plate, and description by Leene (1940).

Male pleopod.—Not available.

Distribution

From Madagascar (fide Leene 1940) to Hawaii (Edmondson 1954), but apparently not previously recorded from Australia.

Subfamily **MACROPIPINAE**, nom. nov.

KEY TO INDO-WEST-PACIFIC GENERA OF SUBFAMILY MACROPIPINAE

1. Front bearing spines *Ovalipes* Rathbun (1898)
Front bearing lobules or teeth 2
- 2(1). Dactyl of fifth leg lanceolate; carapace with transverse ridges
..... *Macropipus* Prestandrea (1833)
Dactyl of fifth leg broadly oval; carapace without transverse ridges 3
- 3(2). Carapace smooth; arm short and without spines, legs stout
..... *Benthochascon* Alcock & Anderson (1899, p. 10) (not recorded from Australia)
Carapace with definitely disposed tubercles; arm longish and with a spine or spines;
legs slender *Parathranites* Miers
(1886, p. 186 under *Lupocyclus* (*Parathranites*) *orientalis*) (not recorded from Australia)

Genus *OVALIPES* Rathbun

Platyonichus Latreille, 1825, p. 151.

non *Platyonichus* Latreille, 1818, p. 4 (emend. pro *Portumnus* Leach, 1814).

Anisopus de Haan, 1833, pp. 3, 12.

non *Anisopus* Meigen, 1803, p. 264. (Diptera.)

Platyonichus Voigt, 1836, p. 104. Dana, 1851, p. 130. Miers, 1886, pp. 201-2.

Ovalipes Rathbun, 1898, p. 597; 1930, pp. 18-19. Sakai, 1939, p. 374. Barnard, 1950, p. 150.

Aeneacancer Ward, 1933, p. 381. McNeill, 1953, p. 93.

Platyonichus and its misspelling *Platyonychus* are in the Official Index of Rejected and Invalid Generic Names in Zoology (Internat. Comm. Zool. Nom. 1958, Direction 84, pp. 109-10, names 1091, 1092). *Anisopus* de Haan is preoccupied and *Ovalipes* is thus the first acceptable name.

The genus *Aeneacancer* was created by Ward for his species *A. mollerii*. After comparison with *O. ocellatus* (Herbst, 1799) from America, Ward detailed six features

distinguishing his genus. As McNeill (1953) has pointed out *A. molleri* is much closer to *O. iridescens* (Miers 1886) than to *O. ocellatus*. Ward's six features, with comments thereon, are as follows:

- (1) Presence of two transparent areas near the posterior margin of the dorsal surface of the carapace. There are suggestions of similarity in Miers's (1886, pl. xvii, fig. 2) and Sakai's (1939, pl. xlii, fig. 4) plates of *O. iridescens*.
- (2) Presence of a stridulatory mechanism. According to Rathbun (1930, p. 19) a similar mechanism is present in the species of *Ovalipes* Ward used for comparison—*O. ocellatus*.
- (3) More robust third maxillipeds, with merus only slightly produced at the antero-external angle. This is comparable with Miers's original description of *O. iridescens* (see Miers 1886, p. 203).
- (4) Larger orbits. This does not apply if *O. iridescens* is used for comparison.
- (5) Regions of the carapace more deeply marked. This feature is possibly valid.
- (6) Fronto-orbital region equal to half the carapace width, and produced beyond the outline of the anterolateral margin. This again does not apply if *O. iridescens* is used for comparison.

One is left with a single relative feature, viz. more deeply marked regions of the carapace, as justification for the separateness of the genus. Against this, additional features are shared between *A. molleri* and *O. iridescens*. McNeill (1953) has commented on the iridescent sheen of the carapace, and in addition the armature of the immovable fingers of the chelipeds is similar in the two species. Either *Aeneacancer* should disappear into the synonymy or *O. iridescens* should be transferred to Ward's genus. Having no specimens of *O. iridescens* for comparison, the present authors prefer to take the former alternative.

KEY TO INDO-WEST-PACIFIC SPECIES OF GENUS OVALIPES

1. Anterolateral teeth broad and narrowly separated; a strong tooth on upper margin of orbit *O. punctatus* (de Haan) (1833)
- Anterolateral teeth consisting of narrow, well-separated spines, no tooth on upper margin of orbit 2
- 2(1). Front bearing 3 spines; no transparent areas in mesobranchial portion of carapace ..
 *O. iridescens* (Miers) (1886, p. 202, pl. xvii, fig. 2) (not recorded from Australia)
- Front bearing 4 spines; conspicuous transparent areas in mesobranchial portion of carapace *O. molleri* (Ward) (1933)

OVALIPES PUNCTATUS (de Haan)

Figs. 1C, 2E; Plate 2, Fig. 2; Plate 5E

- Corystes (Anisopus) punctatus* de Haan, 1833, p. 44, pl. 2, fig. i.
Platyonichus bipustulatus Milne Edwards, H., 1834, p. 437, pl. 17, figs. 7-10.
Platyonichus bipustulatus Milne Edwards, H. Haswell 1882b, pp. 84-5.
Ovalipes bipustulatus (Milne Edwards, H.) Rathbun, 1898, p. 597. Hale, 1927, pp. 147-8, fig. 148. Ward, 1929, p. 79 (record only).
Ovalipes punctatus (de Haan). Rathbun, 1930, pp. 24-7, pls. 5-8 (synon.). Sakai, 1939, pp. 374-5, pl. xlii, fig. 3 (coloured). Barnard, 1950, pp. 150-2, figs. 27a, 29a-d.

Material Examined

42 ♂♂ (12-97 mm); 23 ♀♀ (27-85 mm); 2 sex indetermined (30, 90 mm).
 Additional specimens were more cursorily examined.

QUEENSLAND: Wide Bay, Point Lookout (Stradbroke I.), Miami Beach. NEW SOUTH WALES: Yamba, Port Stephens, Newcastle, Cudgee Beach, Broken Bay, Pitt Water, Manly, Port Jackson, Sydney Heads, Maroubra Bay, Botany Bay, Gunnamatta Bay, Lake Illawarra, Shoalhaven R., Jervis Bay. LORD HOWE ISLAND. VICTORIA: Port Phillip Heads, Frankston, Mentone, Beaumaris, Brighton, Queenscliffe, Lonsdale. TASMANIA: King I., Cole's Bay, Dunally, Seven Mile Beach (Frederick Henry Bay), Cowrie Point, Stewart Bay. SOUTH AUSTRALIA: Gulf St. Vincent, Sellicks Beach, Vivonne Bay. WESTERN AUSTRALIA: King George Sound, Carnac I., Leighton, Cottesloe.

Recorded habitats.—Surf beaches (attacking angler's bait), swimming and burrowing in surf sand at L.W.M., dredged 16–19 fm, trawled 8 fm, washed up on beach, on reef (Lord Howe I.), sand flats in shallow water.

Material illustrated.—Carapace: ♀ 51 mm, Miami Beach, S. Qld., 22.viii.53, B. Winks (At Zool. Dept. Univ. Qld.). Male abdomen: ♂ 70 mm, Stewart Bay, Tasman Peninsula, 13.iv.52 (at Tasmanian Museum, Hobart). Male pleopod: ♂ 39 mm, Seven Mile Beach, Tas., V. V. Hickman, Jan. 1956 (at Zool. Dept. Univ. Qld.).

Description

General.—Considered unnecessary.

Male pleopod.—Only slightly curved and tapering gently. Beyond the basal lobes a row of bipinnate hairs on both outer and inner sides extends up the appendage to end a quarter of the way back from the tip. A separate upper row is present on the inner side in the proximal quarter. Terminal armature on the outer side consists of a narrow band of backwardly directed spinules which commences before the bipinnate hairs end, becomes denser, and spreads to the under surface, terminating just behind the tip.

On the inner side a scattered band on the under surface originates about half-way along the appendage and extends to the upper surface, ending just short of the tip.

Distribution

Indo-West-Pacific from South Africa to Japan and New Zealand; East Pacific from Juan Fernandez, Peru, and Chile; South Atlantic from Argentine and Uruguay (Rathbun 1930).

Common throughout the southern half of Australia with present records extending the range to Queensland and West Australia. Past Australian records are given by Haswell (1882*b*), Miers (1886), Stead (1898), Whitelegge (1900), Hale (1927), Ward (1929), Rathbun (1930), and Anderson (1938).

OVALIPES MOLLERI (Ward), comb. nov.

Figs. 1*D*, 2*F*; Plate 2, Fig. 3; Plate 5*F*

Aeneacancer molleri Ward, 1933, pp. 381–3, pl. xxiii, fig. 11. McNeill, 1953, p. 93, pl. 7, figs. 1, 2.

Material Examined

28 ♂♂ (53–93 mm); ♀ 67 mm.

NEW SOUTH WALES: S. of Montague I., off Broken Bay. VICTORIA: 20 miles W. of Babel I., Bass Strait.

Recorded habitats.—20–120 fm.

Material illustrated.—♂ 93 mm, off Broken Bay, N.S.W., 120 fm, Capt. K. Moller (Aust. Mus. Reg. No. P10730, part).

Description

General.—See discussion following generic synonymy and also key. The following combination of characters is diagnostic: (1) The iridescence; (2) the semi-transparent areas on the carapace; (3) the spines (four or five) on the immovable finger of the chela; (4) the four frontal spines; and (5) the stridulating ridge of elongated granules “parallel to and just below the line of demarcation between the subhepatic and pterygostomial regions” (Ward 1933, p. 382).

Male pleopod.—Extremely stout, evenly curved with a short base, a gradually tapering neck, and a slightly flared tip. Beyond the basal lobes on the outer side is a dense row of very long bipinnate hairs extending for seven-eighths the length of the appendage. On the inner side a similar row of shorter hairs terminates about a quarter of the way back from the tip. The terminal armature on the outer side consists of a band of small backwardly directed spinules commencing just before the termination of the bipinnate hairs, and continuing almost to the tip. On the inner side a thinner band extends from the end of the bipinnate hairs, terminating a short distance back from the tip. On the under surface of the base on the inner side there is a wide sparse band of small spinules, which widens out about half-way up the appendage to give a sparse covering to the whole under surface. It then narrows again a short distance past the end of the series of bipinnate hairs on the outer side. This band merges with the terminal armature on the outer side.

Distribution

Only from moderately deep water off the south-east of Australia. The next closest species *O. iridescens* has been infrequently recorded by Miers (1886), Yokoya (1933), Leene (1938), and Sakai (1939), in an area extending from Japan to the west of New Guinea. Again moderately deep water is mentioned.

Genus *MACROPIPUS* Prestandrea

- Macropipus* Prestandrea, 1833, p. 5. Internat. Comm. Zool. Nom., 1956, pp. 317–36.
Portunus Milne Edwards, A., 1861, p. 392. Balss, 1922, p. 101. Sakai, 1939, p. 377.
 “*Portunus*” Palmer, 1927, pp. 879–81.
 non *Portunus* Weber, 1795, p. 93. Fabricius, 1798, pp. 325, 363. Rathbun, 1897, p. 155.
 Hale, 1927, p. 149. Rathbun, 1930, p. 33. Edmondson, 1954, p. 235. Stephenson and Campbell, 1959, p. 85.
Liocarcinus Stimpson & Pourtalès, 1870, p. 146. Rathbun, 1897, p. 155; 1902, p. 25.
 Stimpson, 1907, p. 74. Parisi, 1916, p. 170. Urita, 1926, p. 3. Hale, 1927, p. 148. McNeill and Ward, 1930, p. 379. Guiler, 1952, p. 39.

The use of the present unfamiliar generic name, to replace the familiar "*Portunus*" of European workers and *Liocarcinus* of Australian workers is due to a decision of the International Commission on Zoological Nomenclature (1956).

Only one species occurs in the Indo-West-Pacific.

MACROPIPUS CORRUGATUS (Pennant)

Figs. 1E, 2G; Plate 2, Fig. 4; Plate 5G

- Cancer corrugatus* Pennant, 1777, p. 5, pl. v, fig. 9.
Portunus corrugatus (Pennant). De Haan, 1833, p. 40. Miers, 1879, p. 34; 1886, p. 200.
 Ortmann, 1893, p. 70. Fulton and Grant, 1906, p. 18.
Portunus strigilis Stimpson, 1858, p. 38 (fide Sakai 1939).
Portunus subcorrugatus Milne Edwards, A., 1861, p. 402, pl. xxxvi, fig. 2. Nobili, 1906, pp. 186-7.
Liocarcinus strigilis (Stimpson). Rathbun, 1902, p. 25. Stimpson, 1907, p. 74, pl. ix, fig. 6. Parisi, 1916, p. 170. Urita, 1926, p. 3.
Portunus corrugatus strigilis Stimpson. Balss, 1922, p. 101. Yokoya, 1933, p. 173. Sakai, 1934, p. 301; 1936, p. 128, pl. 32, fig. 1 (coloured); 1939, p. 377, pl. xliii, fig. 1 (coloured).
Liocarcinus corrugatus (Pennant). Hale, 1927, p. 148, fig. 149. McNeill and Ward, 1930, pp. 379-80. Guiler, 1952, p. 39.
 "*Portunus*" *corrugatus* (Pennant). Palmer, 1927, pp. 881-2, fig. 2A-H, pp. 899-900 (discussion *P. subcorrugatus* and *P. strigilis*).
 (?) *Portunus corrugatus* (Pennant). Borradaile, 1916, p. 98, fig. 9 = *P. borradalei* Bennett, 1930, pp. 256-7, figs. 1-4.

The complex synonymy arises from two causes, first from alterations in generic names and secondly from real doubts concerning the degree of separation of the different closely allied forms from various parts of the world. Five such have been considered in the past.

(1) The European forms, probably more exactly the Plymouth ones, described by Palmer (1927). These are undoubtedly the same as Pennant's originals. Here there is tolerably continuous distribution from Scotland to Cape Verde, the Azores, the Canary Islands, the Mediterranean, and the Adriatic. Apparently no studies have been made of possible structural variations within this extensive range, along the lines of the comparison of Channel and Mediterranean populations of *Carcinus* by Demeusey and Veillet (1953).

(2) The Japanese forms, described as *P. strigilis* by Stimpson. The Japanese workers, leading up to Sakai (1939), have recognized the distinctness of their forms, by virtue of their possessing a relatively narrower carapace and more strongly marked regional boundaries (Borradaile 1916, p. 97 and Rathbun in Palmer 1927, footnote p. 900). The most recent tendency has been to give this form subspecific status.

(3) The Red Sea forms, described as *P. subcorrugatus* by A. Milne Edwards (1861). Rathbun (in Palmer 1927) considers they fall within the variability of the typical *P. corrugatus*.

(4) The Australian forms. These were mentioned by Borradaile (1916, p. 97) and have been dealt with by Hale (1927) and by McNeill and Ward (1930). Although the carapace regions are more strongly marked, and probably the carapace is relatively narrower than in the British specimens, none of the above workers separated

them either specifically or subspecifically from Pennant's species. It would require a much greater range of Australian material than the present authors have had access to, and also a detailed study of the Northern Hemisphere populations, before the question of separateness finally could be decided. The present authors have considered it advisable to "lump" European, Japanese, Red Sea, and Australian specimens.

(5) The New Zealand forms. Bennett (1930) thinks that these deserve specific status by virtue of the straight-sided male abdomen. In the distinctness of the carapace regions and the relative narrowness of the carapace they appear to resemble the Australian forms. It is unfortunate that this species is based upon a single badly preserved juvenile, especially so when the basis for comparison is with specimens "which approached the maximum size found in the species" (Palmer 1927, p. 878).

Material Examined

6 ♂♂ (6-21 mm); 6 ♀♀ (6-26 mm).

NEW SOUTH WALES: Jervis Bay, Botany Bay, Green Cape, Gunnamatta Bay.
VICTORIA: Port Phillip, Cape Everard. TASMANIA: Wineglass Bay.

Recorded habitats.—Trawled, 40-75 fm; hand-netted in weed on tidal flat.

Material illustrated.—♂ 21 mm, Gunnamatta Bay, pres. March 1947, Miss E. Pope (Aust. Mus. Reg. No. P11729).

Description

General.—The species is clearly recognizable from the keys, figures, and Palmer's description (Palmer 1927, pp. 881-2, figs. 2A-H). In the Australian specimens the carapace regions are strongly marked and the carapace is relatively narrow.

Male pleopod.—Regularly tapering to an unflared tip bent practically at right angles to form a sickle shape. Proximal two-thirds on the outer border bears very long bipinnate hairs, and on the inner side a proximal area of shorter hairs on the upper surface which extends around the inner border to the under surface. Microscopic spinules on the upper surface begin a quarter of the way back from the tip and extend to both borders, more being visible in profile view on the inner border than on the outer. On the under surface microscopic spinules begin about a quarter of the way back and increase in size and density to form a fairly dense patch of backwardly directed spinules ending just behind the tip.

Palmer's (1927) figure (2E) is inadequate for purposes of comparison.

Comments

Palmer (1927, p. 904) states that *P. corrugatus* approaches the primitive form of the genus, with little modification of the merus of the fifth legs for swimming. He notes affinities with *Nectocarcinus integrifrons* and the genus *Bathynectes*, and suggests that almost world-wide distribution is indicative of primitiveness in this species as in *Carcinus maenas*.

Distribution

Published and present records within Australia are from Tasmania (Miers 1886, repeated Guiler 1952), Victoria (Miers 1886; Fulton and Grant 1906), South Australia (Hale 1927), New South Wales (McNeill and Ward 1930).

Palmer (1927) gives its distribution as "British Isles, France, Belgium, Mediterranean, Adriatic, Canary Is. (Heller 1863); Scotland to Cape Verde, Azores, and Canaries (Bouvier 1922); Oran (Lucas 1849); Red Sea (A. Milne Edwards 1861); Senegambia (Miers 1881); Senegambia to Sierra Leone (Balss 1922); Japan (Miers 1879); Victoria, Australia (Miers 1886); New Zealand (Borradaile 1916)". The doubtful status of the last record has been discussed.

Subfamily **CAPHYRINAE** Alcock, 1899

KEY TO INDO-WEST-PACIFIC GENERA OF SUBFAMILY CAPHYRINAE

1. Front produced into a blunt projecting lobe; propodus of fifth leg subcircular
..... *Coelocarcinus* Edmondson (1930, p. 13) (not recorded from Australia)
Front not produced into a projecting lobe; propodus of fifth leg not subcircular .. 2
- 2(1). Fifth legs turned back dorsally over carapace 3
Fifth legs not turned back dorsally over carapace 4
- 3(2). Front, upper border of orbit, and anterolateral borders lamellate; carpus of fifth legs
much broader than propodus. (Wrist and hand of chelipeds markedly carinate,
carapace very convex)
..... *Sphaerocarcinus* Zehntner (1894, pp. 163-4) (not recorded from Australia)
Front, upper border or orbit, and anterolateral borders not lamellate; carpus of fifth
legs not broader than propodus *Caphyra* Guérin (1832) (most spp.)
- 4(2). Dactylus of fifth pair of legs paddle-shaped ... *Lissocarcinus* Adams & White (1849)
Dactylus of fifth pair of legs claw-shaped
..... *Caphyra* Guérin (1832) (some spp., but none recorded in Australia)

Genus **LISSOCARCINUS** Adams & White

Lissocarcinus Adams & White, 1849, p. 45. Alcock, 1899, p. 18. Leene, 1938, pp. 3-5
(synon.). Sakai, 1939, p. 378. Barnard, 1950, p. 145.

The genus is adequately described by Leene (1938) who gives keys to the eight Indo-West-Pacific species.

KEY TO AUSTRALIAN SPECIES OF GENUS LISSOCARCINUS

(adapted from Sakai (1939))

- Dorsal surface of carapace rather flat; front medially notched; supra-orbital angles well defined;
anterolateral teeth acuminate; without bold colour patterning
..... *L. polybioides* Adams & White (1849)
- Dorsal surface convex in central area; front entire; supra-orbital angles obscurely defined;
anterolateral teeth blunt and confluent; with bold light and dark colour patterning
..... *L. orbicularis* Dana (1852a)

LISSOCARCINUS POLYBIOIDES Adams & White

Figs. 1*F*, 2*H*; Plate 3, Fig. 1; Plate 5*H*

Lissocarcinus polybioides Adams & White, 1849, p. 46, pl. 11, fig. 5. Haswell, 1882*b*, p. 83.
Miers, 1886, p. 205. Alcock, 1899, pp. 19-20 (synon.). Rathbun, 1911, p. 284. Hale,
1927, p. 146. McNeill and Ward, 1930, pp. 378-9, pl. lix, fig. 4. Leene, 1938, pp. 6-7.
Monod, 1938, p. 113, fig. 9. Sakai, 1939, p. 379, pl. xliii, fig. 3 (coloured).

Material Examined

5 ♂♂ (6–19 mm), 4 ♀♀ (13–20 mm). Smallest ovigerous ♀ 14 mm. Ovigerous ♀♀ from months of February and October.

QUEENSLAND: Holbourne I., Bowen Harbour, Middle I. (Port Denison), Port Molle. NEW SOUTH WALES: Port Jackson, Newcastle. WESTERN AUSTRALIA: Roebuck Bay.

Recorded habitats.—In branches of live coral; dredged 5–9 fm; trawled.

Material illustrated.—Dorsal view. ♀ (ovigerous) 14 mm, off Middle I., Port Denison, pres. February 1924, E. H. Rainford (in branches of live coral) (Aust. Mus. Reg. No. P6999). Male pleopod: ♂ 16 mm, Holbourne I., Port Denison, pres. July 1918, E. H. Rainford (Aust. Mus. Reg. No. P4189).

Description

General.—Considered unnecessary.

Male pleopod.—Base robust; shaft straight and untapered, curving outwards at the extreme tip. A membrane is attached to the outer edge of the distal half of the shaft and projects over the inner edge. Beyond the basal lobes bare except for an occasional hair until near the tip. Subterminally on the under surface there are minute scattered spinules.

The terminal armature, which is reminiscent of a cockatoo's crest, consists of a row of very long, straight, evenly tapered bipinnate bristles on the inner margin, extending from the upper edge of the membrane right around the tip.

The present structure shows resemblances to Edmondson's (1954) figures 7*b* and 7*e* of *Lissocarcinus laevis* Miers (1886). In these figures, however, the bristles towards the tip of the appendage are decreasing progressively in size.

Distribution

From the Seychelles (Rathbun 1911) to Japan (Sakai 1939) and Australia. Previous Australian records are from Port Denison, Port Molle (McNeill and Ward 1930), Port Jackson (Haswell 1882*b*); and South Australia (Miers 1884; Hale 1927).

LISSOCARCINUS ORBICULARIS Dana

Plate 3, Fig. 2

Lissocarcinus orbicularis Dana, 1852*a*, p. 86; 1852*b*, p. 288, pl. xviii, figs. *a–e*. Alcock, 1899, pp. 20–1 (synon.). Leene, 1938, p. 7. Sakai, 1939, pp. 379–80, pl. xlv, fig. 1 (coloured). Barnard, 1950, pp. 145–6, fig. 28*g*. Edmondson, 1954, p. 230, fig. 6*b*.

Material Examined and Illustrated

♀ 8 mm, from surface *Holothuria atra*, Jaeger, outer banks at Dunwich, Moreton Bay, Queensland, coll. D. McColm, 5.x.58.

Description

General.—Considered unnecessary.

Distribution

The only previous Australian record is from Murray I., Queensland (Calman 1900). The species is known from South Africa (Barnard 1950) and the Red Sea (Monod 1938) to Hawaii (Edmondson 1954).

Genus CAPHYRA Guérin

Caphyra Guérin, 1832, pp. 285, 286-7. Milne Edwards, A., 1873, p. 172. Haswell, 1882b, p. 82. Nobili, 1901, p. 11; 1906, p. 188. Balss, 1934, p. 506. Leene, 1938, pp. 8-9.

Some 16 species of this typically commensal genus have been described from the Indo-West-Pacific. Prior to the present work only three were known from Australian waters, and one of these must disappear into the synonymy. Two additional species (one new) are recorded below.

The genus is a difficult one because many of the features generally used to distinguish species of portunids here vary within a given species. This applies particularly to the nature of the front and the anterolateral borders. A complete revision of the genus is desirable, and in this emphasis would no doubt be placed upon the first male pleopods and the shape of the propodus and dactylus of the last walking legs. Gordon (1941) was the first to employ these features, which show marked differences from species to species.

The experience of the authors suggests that coloration of the live specimens is diagnostic, and also that the species have marked host preferences. These essential details are rarely given in the older descriptions, and in revising the group, collection and examination of living topotypical material would be desirable.

In describing the fifth legs, difficulties arise over orientation. Because in most species these legs are directed forward above the carapace, what is normally the posterior surface becomes the anterior. There are further complications due to flexion of the legs, sometimes with the ultimate segment reversed in orientation compared with the rest of the leg. In the present work the terms "inner" and "outer" are employed, the former being the inside of the curve made by the appendage *in situ*, and being morphologically equivalent to "posterior" in other genera.

In measurements of the fifth legs, the breadths of segment are the maximum breadths, and lengths are from the distal extremity to the centre of the articulation in a straight line.

KEY TO THE INDO-WEST-PACIFIC SPECIES OF GENUS CAPHYRA

- | | | |
|-------|--|---|
| 1. | Fifth pair of legs not turned back dorsally over the carapace | 2 |
| | Fifth pair of legs turned back dorsally over the carapace | 3 |
| 2(1). | Anterolateral margins toothed | |
| | ... <i>C. natatrix</i> Zehntner (1894, p. 162, pl. vii, fig. 10) (not recorded from Australia) | |
| | Anterolateral margins entire | |
| | ... <i>C. archeri</i> Walker (1887, p. 116) (not recorded from Australia)* | |
| 3(1). | Front composed of rounded lobes or sinuous (effectively bilobed) | 4 |
| | Front composed of teeth | 9 |
| 4(3). | Carapace circular in outline and markedly convex | |
| | ... <i>C. hemisphaerica</i> Rathbun (1911, p. 204, pl. 15, fig. 9) (not recorded from Australia) | |
| | Carapace not as above | 5 |

* Balss (1934, p. 506) suggests this species should belong to the oxyrhynchids, not the portunids.

- 5(4). 2 anterolateral teeth (the second very conspicuous)
 *C. unidentata* Lenz (1910, pp. 555-6, figs. 2, 3, 4) (not recorded from Australia)
 More than 2 anterolateral teeth (usually four) 6
- 6(5). Front extended and smoothly rounded except for a small median notch
 *C. rotundifrons* (A. Milne Edwards) (1869)
 Front not as above 7
- 7(6). Propodus of fourth walking leg elongate, length more than thrice breadth 8
 Propodus of fourth walking leg broad, length less than thrice breadth
 *C. alcyoniophila* Monod (1928, pp. 4-10, figs. 1-4) (not recorded from Australia)
- 8(7). Hand of cheliped with 2 parallel carinae *C. yookadai* Sakai (1933)
 Hand of cheliped with 1 dorsal carina, interrupted by a spine *C. fulva*, sp. nov.
- 9(3). Front, excluding inner orbital lobes, four-toothed 10
 Front, excluding inner orbital lobes, six-toothed 11
- 10(9). Hand costate but spineless; 4 anterolateral teeth
 *C. alata* Richters (1880, p. 154, pl. xvi) (not recorded from Australia)
 Hand with costae and spines; 3 anterolateral teeth
 *C. rouxi* Guérin (1832, pp. 287-9, pl. viiiA) (not recorded from Australia)
- 11(9). Carapace smooth over most of its surface 12
 Carapace closely granulated (4 anterolateral teeth)
 *C. monticelli* Nobili (1901, pp. 10-11) (not recorded from Australia)
- 12(11). 5 or 6 anterolateral teeth 13
 4 anterolateral teeth 14
- 13(12). Front relatively straight *C. laevis* (A. Milne Edwards) (1869)
 Front advanced *C. suwaensis* Edmondson (1935, p. 24, fig. 6) (not recorded from Australia)
- 14(12). Three ridges on carapace
 *tricostata* Richters (1880, p. 154, pl. xvi) (not recorded from Australia)
 Single ridge on carapace 15
- 15(14). A spine on the external face of the hand near the wrist articulation 16
 No spine on the external face of the hand near the wrist articulation
 *C. polita* (Heller) (1861, p. 359, pls. iii, iv) (not recorded from Australia)
- 16(15). Host *Xenia* *C. laevis* (A. Milne Edwards) (1869) (unusual specimen, see p. 98)
 Host *Pinna*
C. octodentata Balss (1934, p. 506) non Haswell (1882a) (not recorded from Australia)

CAPHYRA LAEVIS (A. Milne Edwards)

Figs. 1*G*, 2*I*, 3*D-G*, 3*J*; Plate 3, Fig. 3; Plate 5*I*

Goniosoma laeve Milne Edwards, A., 1869, p. 152.

Caphyra laevis (Milne Edwards). Milne Edwards, A., 1873, pp. 173-4, pl. iv, figs. 2*a-c*.

De Man, 1887*b*, pp. 377-8. Nobili, 1901, p. 12 (key only, corrected 1906, p. 188). Grant and McCulloch, 1906, p. 18. McNeill, 1926, p. 307. Balss, 1938, p. 30. Leene, 1938, p. 9. Gordon, 1941, pp. 126-7, figs. 1, 2, 3*b*.

Caphyra octodentata Haswell, 1882*a*, pp. 753-4; 1882*b*, pp. 82-3. Nobili, 1901, p. 12 (key only, corrected 1906, p. 188).

Caphyra semigranosa de Man, 1887*b*, pp. 337-8. Nobili, 1901, p. 12 (corrected 1906, p. 188). (See Leene, 1938, p. 9. Gordon, 1941, pp. 126-7.)

Material Examined

21 ♂♂ (5-17 mm); 25 ♀♀ (6-21 mm). Smallest ovigerous ♀ 13 mm; ovigerous ♀♀ from Jan., Apr., Sept., and Dec.

QUEENSLAND: Murray I., Howick I., Whitsunday I., Dunk I., Capricorn Group (Masthead I., North West I., Heron I.), Dunwich.

Recorded habitats.—In *Xenia* on reef flats or from low water mark.

Material illustrated.—Whole carapace: ♀ 16 mm, N. side Heron I., middle of reef flat, 15.viii.50, W.S. (at Zool. Dept. Univ. Qld.). Male abdomen and fifth legs: ♂ 13 mm, Dunwich, commensal among *Xenia*, 18.viii.55 (at Zool. Dept. Univ. Qld.). Male pleopods: ♂ 11 mm, North West I., F. A. McNeill, April 1933 (Aust. Mus. Reg. No. P10376). Front: Fig. 3*D*, ♀ 12 mm, Heron I., in *Xenia*, 7.i.59, W.S. Fig. 3*E*, ♀ 12 mm, other data as last specimen. Fig. 3*F*, ♀ 14 mm, other data as last specimen. Anterolateral teeth: ♂ 5 mm, other data as last specimen.

Description

Front.—With 6 teeth normally clearly demarkated, rounded, and protruding (see Fig. 3*D*), but occasionally the 3 teeth on each side tend to fuse, thus giving 2 sinuous lobes, one on either side (see Fig. 3*E*). Alternatively the median and submedian teeth on each side coalesce, giving a quadrilobed front (see Fig. 3*F*).

Inner orbital lobes large, clearly separated from the frontal lobes.

Anterolateral teeth.—Typically 5; stout and sharply pointed; the first 3 larger than the last 2. In some specimens the fourth tooth is extremely small and in some the first 4 teeth are blunt (see Fig. 3*G*). (Gordon (1941) notes that one specimen from Masthead I. has the fourth anterolateral tooth absent on the left and vestigial on the right.)

Carapace.—Convex, broader than long, shiny. A pair of mesogastric ridges is clearly visible on some specimens but indistinguishable on others. In all cases, epibranchial ridges are well developed. The anterior half of the carapace is microscopically punctate, and this is clearest in the smallest specimens.

Chelipeds.—Right slightly larger than left and microscopically granular. Anterior border of arm with 3–5 blunt flattened spines; under surface of arm entire. Hand with only one carina on the inner margin of the upper surface, this carina being interrupted just beyond a single large spine which occurs not quite half-way along.

Legs.—Elongate and slender. The fifth, which is turned back over the dorsal surface, has the propodus roughly twice as long as broad (2.1 times), and has long fringing hairs on its inner and shorter ones on its outer surface. Dactyl slightly shorter than the propodus (0.8 times), reasonably broad (3.1 times as long as broad), flattened, lanceolate, and of a moderately typical portunid shape. Fringing hairs are present on both sides, those on the inner side being longer, and the distal eighth of the segment is bare.

Male pleopod.—Short, straight, and untapered, ending in a widely flared spoon-shaped tip set at an angle to the shaft of the appendage. Beyond the basal lobes, bare on the outer side. On the inner side c. 10–12 bristles are visible a short way up from the base, and a sparse series, which begins about half-way back from the tip, merges with a clump on the proximal edge of the flared tip. On the outer side just behind the tip 6–12 bristles are visible in profile view, these being part of a band on the distal half of the under surface of the flared area. On the upper surface the proximal end of the flared tip bears a row of bristles. A second upper series arises from the inner surface and curves to meet the previous row.



Fig. 3.—A-G.—Variation in the front of *Caphyra rotundifrons* (A-C), in the front of *C. laevis* (D-F), and in the anterolateral teeth of *C. laevis* (G). H-K.—Terminal segments of the right fifth legs of H, *C. yookadai*; I, *C. fulva*; J, *C. laevis*; K, *C. rotundifrons*. All drawings were made to the same scale.

Colour.—Background colour cream or light grey. Typically with six longitudinal marks in grey or greenish grey, each with a lighter central area. The lateral marks expand opposite the first three anterolateral teeth, the median marks are the shortest, and all are more conspicuous in the region anterior to the epibranchial ridge. Sometimes specimens are without markings, and have a uniform cream colour shortly after collection.

Comments

Of the 31 specimens examined while making the final description, eight contained branchial parasites causing distortion on the left of the animal, and four causing distortion on the right.

One of the Australian species of *Caphyra*, *C. octodentata* Haswell (1882a) remains obscure in spite of the present work. The type was placed in the Macleay Museum, University of Sydney, but is no longer there, nor is it in any other museum in Australia. There is no record of whether the species was based upon a single specimen or several, and no further specimens referable to this species have appeared in later collections from Australia. No record of the habitat was given. The species is distinguished from *C. laevis* solely by having four anterolateral teeth on each side instead of five.

There are three possibilities:

(1) Haswell made a simple error in misstating the number of teeth; possibly he excluded the first tooth or outer orbital lobe. Although this seems unlikely on the face of it, he almost certainly made a similar misstatement in describing his only other "new" species in this family (*Neptunus tomentosus* Haswell, 1882a, p. 547; see Stephenson and Campbell, 1959, p. 101).

(2) He was dealing with an unusual specimen of *C. laevis*. As already stated, Gordon (1941) obtained a specimen of *C. laevis* with only four anterolateral teeth on one side. However no truly and symmetrically four-toothed individual has appeared in Australian collections since Haswell's time.

(3) He examined an undescribed habitat which has been passed over by subsequent Australian workers. Balss (1934) has recorded *C. octodentata* from *Pinna* in Madagascar, and while the authors have not examined *Pinna* from the type locality of *C. octodentata* (Palm I., Queensland), numerous specimens from Moreton Bay have failed to reveal any *Caphyra*.

Of these three possibilities, the authors incline to the first, being influenced by the fact that Haswell did not list *C. laevis* in the Australian crustacean fauna. This is a common species, often obtained in student collections. It would be extraordinary for Haswell to find a new species which nobody else in Australia has since collected, and simultaneously pass over the most obvious species in the genus. It would be even more extraordinary for him to find a four-toothed *C. laevis* as his first and only specimen of that species. If *C. octodentata* Haswell is a synonym of *C. laevis*, problems arise regarding *C. octodentata* Balss. Although no extended description was given by Balss, he states that his specimen agrees with Haswell's description excepting that the spine at the articulation of the carpus and propodus occurs on the carpus instead of on the propodus as Haswell described. The spectacular feature of Balss' specimen was that it came from within *Pinna nigra*.

The habitat of *C. laevis* in Australia is restricted to amongst the polyps of the dove-grey soft coral, *Xenia*. If *C. octodentata* Haswell is the same as *C. laevis*, it would appear, from a consideration of habitat alone, that *C. octodentata* Balss is a different species. Obviously Balss's specimen merits careful re-examination, pending which it has been included in the key as "*C. octodentata* Balss non Haswell".

Distribution

From Amboina (Gordon 1941), Damar I. (Leene 1938), and Pulo Edam (de Man 1887b) to New Caledonia (A. Milne Edwards 1869) and Fiji (Balss 1938).

Previously recorded in Australia from Masthead I. (Grant and McCulloch 1906), North West I. (McNeill 1926), and Batt Reef, North I., Low Isles, and Masthead I. (Gordon 1941).

CAPHYRA ROTUNDIFRONS (A. Milne Edwards)

Figs. 1H, 2J, 3A-C, 3K; Plate 3, Fig. 4; Plate 5J

Camptonyx rotundifrons Milne Edwards, A., 1869, p. 156, pl. 7, figs. 11, 12.

Caphyra rotundifrons (A. Milne Edwards). Milne Edwards, A., 1873, p. 174. Borradaile, 1900, p. 579. Calman, 1900, p. 20. Nobili, 1901, p. 11 (key only, corrected Nobili 1906, p. 188). Doflein, 1904, pp. 95-6. Rathbun, 1907, p. 60, pl. 1, fig. 4; 1911, p. 204. McNeill, 1926, pp. 307-8. Gordon, 1941, p. 124, figs. 2b, 3a.

non *Caphyra rotundifrons* (A. Milne Edwards). Barnard, 1957, pp. 2-3, fig. 1 (= *Caphyra yookadai* Sakai, 1933).

Material Examined

11 ♂♂ (4-14 mm); 19 ♀♀ (8-24 mm). Ovigerous ♀♀ 9-15 mm from December and January.

QUEENSLAND: Murray I., North West I., Heron I. LORD HOWE I.: Elizabeth Reef.

Recorded habitats.—From green algae (*Chlorodesmis comosa* Bailey & Harvey) on reef flat.

Material illustrated.—Whole carapace, male abdomen, male pleopod, fifth leg: ♂ 14 mm, North West I., M. Ward (Aust. Mus. Reg. No. P12761). Front: Fig. 3A, ♀ 15 mm, Heron I., Dec. 1956, W. K. Patton; Fig. 3B, ♀ 12 mm, Heron I., 7.i.59, W.S.; Fig. 3C, ♀ 9 mm, Heron I., 7.i.59, W.S.

Description

Front.—Typically bilobed, the two smooth lobes being interrupted by a distinct median notch (see Figs. 3A, 3B). In a minority of specimens this notch is indistinguishable, the whole front forming a single smooth curve (see Fig. 3C).

Inner orbital lobes very ill developed, barely distinguishable from the front.

Anterolateral teeth.—Four, all very sharp and pointing forwards, decreasing in size from front to rear. In some specimens the fourth tooth is sufficiently small to be distinguished only with difficulty.

Carapace.—Relatively long, microscopically granular, especially on the anterior surface. Mesogastric ridges obscurely developed, epibranchials distinct, cervical grooves conspicuous.

Chelipeds.—With long hairs on the upper and outer surfaces. Anterior border of arm bearing two tubercles, and two large sharp teeth followed by a flat tooth near the articulation of the wrist. Under surface of arm smooth. The hand bears dorsally two carinae with a hollow between them. Neither carina bears spines, but in some specimens each ends anteriorly in a blunt tubercle.

The legs are relatively short for this genus and in undamaged specimens bear moderately long hairs.

Fifth leg.—Curved back dorsally over the carapace. The propodus less than twice as long as broad (1.7 times) and with bipinnate fringing hairs on both sides, those on the outer side being the longer, and those on the inner side increasing in stoutness distally and finally becoming bristles. Dactyl slightly shorter than propodus (0.93 times), very narrow (3.8 times as long as broad), proximally swollen, then gradually tapering overall, forming a conspicuous hook-like structure with short hairs on the inner side and elongate bipinnate hairs on the outer side. Distal two-fifths bare.

Male pleopod.—Short, practically untapered, and distinctly curved outwards at the tip. Beyond the basal lobes bare to the tip except for a group of bipinnate hairs a short way up on the inner side. This group continues distally for a little way as a row of short bristles. The terminal armature consists of a dense clump of long bristles on the inner side at the point where the tip is bent, and an irregular clump of 2–3 very long bipinnate bristles and numerous shorter ones. At the tip of the outer border these two clumps are connected on the lower surfaces by bands of bristles, and both clumps also extend to the upper surface.

Colour.—Translucent pea green, legs and chelae with darker green spots in indistinct longitudinal rows. The anterior fifth of the carapace bears transverse rows of darker green, the posterior four-fifths bears olive green longitudinal patches, often with white areas between them. Digestive glands and gonads show through the cuticle as brown and yellow respectively. Often one whitish mark in the posterior part of each mesobranchial area.

Comments

The authors have only obtained this species from a green alga, *Chlorodesmis comosa*, where it was discovered by Mr. W. K. Patton. In this weed it is abundant and shows marked protective coloration. In that the genus as a whole is believed to be commensal, this habitat may be unusual.

Distribution

New Caledonia, Samoa, Mauritius (Doflein 1904); Fiji (Balss 1938); Mariana Is. (Holthuis 1953); Torres Strait (Calman 1900).

CAPHYRA YOOKADAI Sakai

Figs. 1I, 2K, 3H; Plate 4, Fig. 1; Plate 5K

Caphyra yookadai Sakai, 1933, pp. 141–3, pl. xiii, fig. 3; 1936, p. 120, pl. xxxii, fig. 4; 1939, p. 378, pl. xliii, fig. 4.

Caphyra rotundifrons Barnard, 1957, pp. 2–3, fig. 1.
non *Caphyra rotundifrons* (Milne Edwards, A., 1869).

Material Examined

QUEENSLAND: ♂ 6 mm; ♀ 11 mm, "commensal with brown *Alcyonium* sp.", Myora, Moreton Bay, 28.vii.46, pres. J. S. Hynd (Aust. Mus. Reg. No. P12205).

Material illustrated.—Carapace, male abdomen, male pleopod: ♂ above. Fifth leg: ♀ above.

Description

This description is based on the present specimens, but with reference to Sakai's and Barnard's specimens.

Front.—Four-lobed, the median notch being distinct, but the lobes on each side almost confluent. (Barnard's specimens identified as *C. rotundifrons* are described as having "front straight or fully bilobed on either side of the median notch".)

Inner orbital lobes distinct and clearly separated (apparently obscurely so in two out of three of Barnard's specimens).

Anterolateral teeth.—The anterolateral margin forms a ledge which is obscurely divided into flattened lobes scarcely meriting the name of teeth. Four lobes are present except on the right side of the female specimen where a long first lobe apparently represents the fusion of two. (Sakai notes that only three teeth may be present. In Barnard's specimens the number of anterolateral teeth ranges from two to four.)

Carapace.—Very convex, broader than long, with the elevated central areas smooth and shining, and the margins, especially in the frontal area, bearing minute, regular granules. Mesogastric ridges faint in the female, distinct in the male; epi-branchial ridges very clearly marked.

Chelipeds.—Short and granular, anterior border of arm without spines, under surface smooth; the wrist with 2 carinae running from the upper to the outer surface. Hand bears on the upper surface 2 elevated unarmed carinae separated by a broad depressed area. Movable finger flattened.

The legs are elongate and without hairs in the present specimens. (Barnard describes the legs as bearing plumose setae on their anterior surfaces, but these are not shown or described by Sakai.)

Fifth leg.—Only one fifth leg was present on the two specimens and this appeared to have lost some of its setae. Propodus 3.1 times as long as broad and with short fringing hairs along the length of the outer side, followed by a terminal clump. The inner side is bare except for a distal clump. Dactyl much shorter than the propodus (0.57 times), of moderate breadth (3.1 times), approximately lanceolate with a marked change in curvature on the inner side near the end. On the inner side there are a small number of subterminal hairs and suggestions of an almost continuous row (specimen damaged). On the outer side there is a short proximal row which probably extends further on an intact specimen. Barnard mentions plumose setae on the legs, but the present specimens have been subjected to too much handling for these to show.

Male pleopod.—Slightly curved, swollen just beyond the base and then almost untapered except at the tip. Beyond the basal lobes the inner surface of the swollen

area bears sparsely arranged hairs followed by a very sparse row of fine bristles merging with the terminal armature. The outer side is bare except near the tip. The terminal armature consists of numerous bristles covering both upper and under surfaces and appearing in profile view on both inner and outer sides. They extend further back on the inner side than the outer, and c. 20 bristles are visible on this side and c. 12 on the outer side. The bristles on the inner side do not continue to the tip but leave a short terminal area.

Colour.—Present specimens colourless after prolonged preservation. Sakai describes the colour alive as follows: “. . . whitish pink, brown or white dots being visible under magnifying glass. Brown mottled speckles are on the upper and lower surface of the carapace in pairs: two are on protogastric regions and also a pair behind them on the median part; two are on each anterolateral margin, sometimes joined with each other, and a small one inside of them; two pair of light-coloured ones on the posterolateral margins and a small one inside of them; and a pair on the cardiac region, sometimes fused together. On the ventral side, a pair is on the suborbital region and one or two on the subhepatic region.”

Comments

These specimens are identical with Sakai's description and differ from Barnard's only in that he described plumose setae on the legs. All specimens including the present ones have come from alcyonarians. Frequent examinations of the common brown "*Alcyonium*" in Moreton Bay have failed to add to Hynd's pair of specimens.

Distribution

Previously recorded from Izu and Kii Peninsulas, Japan (Sakai 1933, 1939) and South Africa (Barnard 1957).

CAPHYRA FULVA, sp. nov.

Figs. 1J, 2L, 3I; Plate 4, Fig. 2; Plate 5L

Material Examined

3 ♂♂; 2 ♀♀, Heron I., in fawn *Xenia*-like alcyonarian, 7.i.59, W.S. and N. Heather, designated as follows: holotype ♂ 9 mm, allotype ♀ 7 mm, paratypes ♀ 8 mm (ovigerous) and 2 ♂♂ 6 mm.

Material illustrated.—Holotype.

Description

Front.—Four-lobed, the median notch being distinct, but the lobes on each side almost confluent.

Inner orbital lobes small, clearly separated from the frontal lobes.

Anterolateral teeth.—Typically 4, sharp, with points directed anteriorly, decreasing in size from front to rear. On the allotype there are 5 teeth on the right side, the last 2 being very small; there are also 5 teeth on the left, of which the fourth is minute.

Carapace.—Microscopically punctate, sometimes bearing microscopic hairs, slightly broader than long and with the broadest point somewhat behind the last anterolateral teeth. Mesogastric and epibranchial ridges are present.

Chelipeds.—Microscopically granular. Anterior border of arm bears 3–5 spines increasing in size distally; the under surface in most specimens bears 5–6 sharp spines. The hand is rounded and without carinae except for a single one on the inner side of the upper surface. This bears a spine a third of the distance along, followed by a blunt distal tubercle.

The legs are elongate and slender with hairy dactyls.

Fifth legs.—Curved back over the dorsal surface. Propodus roughly twice as long as broad (1·8 times) and with long fringing hairs on both surfaces. Dactyl slightly shorter than propodus (0·85 times), 3·5 times as long as broad, with a sharp change in curvature just beyond the middle. Proximally with fringing hairs on both sides and distally bare.

Male pleopods.—Practically straight, tapering slightly to a narrow neck and terminating in a widely flared tip bearing a papilla on its upper surface. Beyond the basal lobes bare on the outer side up to the terminal armature; bare on the inner side for about three-fifths of its length, from whence there are sparsely scattered spinules which continue to the tip, becoming gradually larger. Terminal armature consists of sparsely arranged bristles on the upper side mostly as a single row near the edge of the flared area. There is a distal outer patch with *c.* 15 visible in profile view which continues to the under surface where a broad scattered band almost merges with the inner spinules. Just below the flare on the inner side there is a dense patch of stout recurved bristles, *c.* 12 in number, and just above them a second patch of normal bristles, *c.* 6 in number.

Colour.—Background colour pale cream with longitudinal reticulated areas of brown typically well developed. These areas comprise a small median mesogastric area, two broad submedian longitudinal bands, each extending to the hind end of the carapace and each with a discrete anterior branch leading to the orbit. In addition there is a short lateral area opposite each fourth anterolateral tooth.

Comments

The species is not at all common and is apparently restricted to a fawn-coloured *Xenia*-like soft coral. Its colour when alive merges against the background of its host, hence the specific name. It more readily quits the tentacle of this than in the case of *Caphyra laevis* living in blue-grey *Xenia*.

This species is clearly distinguished from *C. yookadai* by the carination of the dorsal surface of the cheliped. The row of spines on the under surface of the arm of the cheliped and the form of the first male pleopods are also diagnostic.

Possible Diphyletic Origin of Caphyra

Balss (1934, p. 506), after dismissing *C. archeri* Walker as being probably an oxyrhynchid rather than a portunid, considers that the remainder either derive from *Thalamonyx* ("ceux dont le bord frontal est bilobe") or from *Charybdis* ("ceux dont le bord frontal est simple").

The following comments seem appropriate:

(1) The distinction between a bilobed and non-bilobed front is an insecure one upon which to recommend a drastic division of the genus. Thus there is variation between a bilobed and an entire front within a single species, *C. rotundifrons* (see Figs. 3A-C).

(2) The majority of the species which have not bilobed fronts have either four-lobed, six-lobed, or six-toothed fronts as distinct from "simple".

(3) In a previous paper (Stephenson and Hudson 1957) the closeness of *Thalmonyx* to *Thalamita* was commented upon; and indeed they are probably best regarded as synonyms. Similarly *Thalamita* and *Charybdis* are most difficult to separate with five species of the former extremely close to one species of the latter.

(4) The structure of the male pleopods in the five species of *Caphyra* for which they have been described do give a hint of two subgeneric groups. Thus the three species *C. laevis*, *C. fulva*, and *C. polita* (see Gordon 1941, fig. 1b) have flared tips reminiscent of some species of *Thalamita* (e.g. *T. sexlobata* and *T. sima*, see Stephenson and Hudson, 1957, figs. 3B, 3C). The other two species, viz. *C. rotundifrons* and *C. yookadai* have non-flared pleopods somewhat reminiscent of those in *Charybdis* (see Stephenson, Hudson, and Campbell 1957, fig. 3). Until the pleopods of more species of *Caphyra* are known, any subdivision of the genus based upon their structure would be unwise. This is especially so since in general facies, including the nature of the front, each of the above groups is heterogeneous.

Subfamily PORTUNINAE, usus nov.

KEY TO THE INDO-PACIFIC GENERA OF SUBFAMILY PORTUNINAE

This differs from those in the literature and is based upon the most obvious of the features, i.e. the numbers of anterolateral teeth. "Small", "minute", and "rudimentary" teeth are included below, these being plainly visible if looked for. In three genera the numbers of teeth vary from species to species; thus *Lupocyclus* and *Portunus* which are typically nine-toothed may have fewer, and *Charybdis* which is typically six-toothed may have more. To allow for this these genera are duplicated or triplicated in the key. Specimens of *Portunus* with nine, eight, and six teeth are accommodated in the key. The very unusual specimens with other than these numbers of teeth are best identified by reference to the general facies of the species (see Stephenson and Campbell 1959).

- | | | | |
|-------|---|-------|--|
| 1. | 9 anterolateral teeth | | 2 |
| | 8 anterolateral teeth | | 5 |
| | 7 anterolateral teeth | | 7 |
| | 6 anterolateral teeth | | 8 |
| | 5 or fewer anterolateral teeth | | 11 |
| 2(1). | Anterolateral teeth alternately large and small (carapace only a little broader than long) | | <i>Lupocyclus</i> Adams & White (1849) |
| | Anterolateral teeth subequal, or if smaller teeth present, these not alternating with larger ones | | 3 |
| 3(2). | Carapace almost exactly as broad as long; basal antennal joint narrow, and with no distal lobule | | <i>Carupella</i> Lenz & Strunck (1914, p. 278) (not recorded from Australia) |
| | Carapace broader than long; basal antennal joint relatively broad, and with distal lobule | | 4 |

- 4(3). Hand of cheliped inflated and smooth; surface of carapace smooth, and regions ill defined *Scylla* de Haan (1833)
 Hand of cheliped prismatic and costate; surface of carapace divided into regions
 *Portunus* Weber (1795, p. 93)
- 5(1). Last anterolateral tooth markedly larger than the remaining, which are subequal ..
 *Portunus* Weber
 (1795, p. 93) (certain spp. only, e.g. *P. longispinosus* (Dana) 1852b, p. 277, pl. 17)
 Last anterolateral tooth not larger than most of the remainder 6
- 6(5). Carapace much broader than long (3 of the 8 teeth much smaller than the remainder)
 *Charybdis*
 subgenus *Goniosupradens* Leene (1938, pp. 18-19) (not recorded from Australia)
 Carapace only slightly broader than long (large and small teeth alternating)
 *Lupocyclus* Adams & White (1849)
- 7(1). 6 large and 1 small anterolateral teeth
 *Charybdis* subgenus *Charybdis* de Haan (see Leene 1938, p. 18)
 5 large and 2 very small anterolateral teeth *Charybdis*
 subgenus *Goniosupradens* Leene (1938, pp. 18-19) (not recorded from Australia)
 4 large and 3 very small anterolateral teeth
 *Charybdis* subgenus *Gonioinfradens* Leene (1938, p. 18) (not recorded from Australia)
- 8(1). 6 anterolateral teeth subequal 9
 Second anterolateral tooth much smaller than the remainder, which are subequal ..10
 Last anterolateral tooth much larger than the remainder, which are subequal but
 irregularly spaced *Portunus*
 Weber (1795, p. 93) (Some spp. only, e.g. *P. macrophthalmus* Rathbun 1906, p. 871)
- 9(8). Chelae extremely long, arm distinctly longer than breadth of carapace
 *Lupocyclus* Adams & White (1849)
 (single sp. *L. philippinensis* Semper (1880, p. 68), not recorded from Australia)
 Chelae of normal length, arm shorter than breadth of carapace
 *Charybdis* de Haan (1833, p. 10) (most spp., see Leene 1938)
- 10(9). Second anterolateral tooth small *Charybdis* de Haan (1833, p. 10)
 (one sp. only, *C. rathbuni* Leene (1938, p. 97-9, fig. 52), not recorded from Australia)
 Second anterolateral tooth tiny *Thalamita* Latreille
 (1829, p. 33) (the "exetastica" group; see Stephenson and Hudson 1957, pp. 361-2)
- 11(1). Tips of chelipeds pointed, spines on hands of chelipeds normally developed12
 Tips of chelipeds spoon-shaped, spines on hands of chelipeds exceptionally well developed
 *Thalamitoides* A. Milne Edwards (1869, pp. 146-7) (not recorded from Australia)
- 12(11). Chelae extremely long, arm distinctly longer than breadth of carapace
 *Lupocyclus* Adams & White
 (1849) (single sp. *L. sexspinosus* Leene (1940, p. 176), not recorded from Australia)
 Chelae of normal length, arm shorter than breadth of carapace
 *Thalamita* Latreille (1829, p. 33) (including
Thalamonyx A. Milne Edwards' 1873, p. 168; see Stephenson and Hudson 1957, p. 361)

Of the genera in the above key two (*Carupella* and *Thalamitoides*) have not been recorded from Australia, and three (*Thalamita*, *Charybdis*, and *Portunus*) have been dealt with in previous papers of this series (Stephenson and Hudson 1957; Stephenson, Hudson, and Campbell 1957; Stephenson and Campbell 1959). The remaining genera, *Lupocyclus* and *Scylla*, are treated below.

Genus LUPOCYCLUS Adams & White

Lupocyclus Adams & White, 1849, pp. 46-7. Milne Edwards, A., 1861, p. 387. Alcock, 1899, pp. 22-3 (synon.). Leene, 1938, p. 10. Sakai, 1939, p. 382. Leene, 1940, pp. 168-9.

Generic Description

This description follows Alcock (1899) and Leene (1940) with slight modification.

Carapace.—Slightly broader than long, convex; regions faintly indicated. Covered with a fine pile of hairs through which protrude granular transverse ridges or groups of granules of definite positions. Front prominent, cut into 4 or 6 teeth. Anterolateral borders moderately oblique and curved, and approximately equalling the posterolateral borders; 5 or 6 anterolateral teeth, sometimes with small or minute denticles in some or all of the interdental spaces, bringing the total number to 8 or 9.

Orbits.—Large, with distinct dorsal inclination; upper border with 2 incisions; inner angle of lower border dentiform.

Antennules.—Folding transversely.

Basal antennal joint.—About as long as broad, filling orbital hiatus; not quite firmly fixed; flagellum standing in the orbital hiatus.

Epistome.—Short, somewhat sunken.

Buccal cavern.—Somewhat broader than long; efferent branchial channels well defined.

Chelipeds.—Either long or very long, with squamiform markings; if very long, much longer than any of the legs. Slender, and with the hand more slender than the arm. Arm with spines; wrist with spines on inner and outer angles; hand with spines and costae; fingers long and slender.

Walking legs.—Slender.

Fifth leg.—Flattened; merus bearing a spine posteriorly.

Male abdomen.—Third to fifth segments fused.

Partial Revision of the Species of the Genus

In view of the fact that there is a recent monographic treatment of this genus (Leene 1940) some justification for the present reasonably extensive treatment is necessary.

Specimens in the collections of the Department of Zoology, University of Queensland, while close to Leene's description of *L. rotundatus* Adams & White, 1849, (Leene 1940, pp. 169–71, fig. 3, pl. i), disagree with it in the following particulars:

(1) Present specimens are rounder. They have a length/breadth ratio of 85/100 as against 75/100 in Leene's plate.

(2) They have no conspicuous groove separating the lateral frontal teeth from the inner supra-orbital lobes.

(3) They have a different ornamentation of the central carapace area. Thus, using the terminology of the last paper of the present series (Stephenson and Campbell 1959), in the present specimens there is a broad gap between the epibranchial and metagastric ridges, against a very narrow one in Leene's (1940) plate i. Also the anterior mesobranchial ridge is a granulated area lying almost on the line of prolongation of the epibranchial as against distinctly posterior to it. Further, the metagastrics lie quite transversely instead of forming a broad posteriorly directed V-shape.

(4) They have a differently shaped male abdomen, with a more rounded ultimate segment.

(5) They have different first pleopods in the males. Leene figured and described some 6 or 7 very large spines on the anterior (under) surface as against two such spines on the upper surface in the present specimens.

It is evident that the present specimens are different from Leene's. After a survey of the literature they were shown to belong to *L. rotundatus* Adams & White, 1849, non Leene. They agree with the original descriptions and plate excepting that Adams and White describe the front as being divided into five equal dentiform lobes. A. Milne Edwards (1861) has pointed out that this is almost certainly a simple numerical error.

By reference to the shape of the front, the carapace markings, and the length/breadth ratio of the carapace, Leene's figured specimen can be referred to *Goniosoma inaequale* Walker, 1887.

Prior to Walker, Miers (1884) had doubts about whether an Australian specimen differed specifically from *L. rotundatus*, and had noted most of the essential features of *L. inaequalis* although not giving it specific status. Subsequent to Walker, only Henderson (1893) has recognized *L. inaequalis* as a distinct species. Since 1893 the two species have been confused, and an attempt is made below to clarify the synonymy, mostly through consideration of length/breadth ratios. Only two records (Laurie 1906, pp. 411-2; Balss 1922, p. 113) cannot be referred to one or other of the species with reasonable certainty and these are omitted. The true *L. rotundatus* which is not included in Leene's (1940) work is redescribed from the present material.

KEY TO INDO-PACIFIC SPECIES OF GENUS LUPOCYCLUS

- 1. 6 subequal and equally prominent frontal teeth *L. quinquedentatus*
Rathbun (1906, p. 869, pl. 12, fig. 7, text fig. 28) (not recorded from Australia)
- 2 pairs of frontal teeth protruding well forward, if a third pair present, these much further back 2
- 2(1). 6-8 spines on anterior border of arm of cheliped, 6 main anterolateral teeth
..... *L. philippinensis* Semper (1880, p. 68) (not recorded from Australia)
- 5-6 spines on anterior border of arm, 5 main anterolateral teeth (or if 6, the second smaller than the third) 3
- 3(2). Epibranchial ridges on carapace indistinct
L. sexspinosus Leene (1940, pp. 176-9, fig. 6, pl. iv) (not recorded from Australia)
- Epibranchial ridges on carapace distinct 4
- 4(3). Broad gap between epibranchial and metagastric ridges
..... *L. rotundatus* Adams & White (1849)
- Epibranchial almost joining metagastric ridges *L. inaequalis* (Walker) (1887)

LUPOCYCLUS ROTUNDATUS Adams & White

Figs. 1*K*, 2*M*; Plate 4, Fig. 3; Plate 5*M*

Lupocyclus rotundatus Adams & White, 1849, p. 47, pl. xii, fig. 4. Milne Edwards, A., 1861, p. 387. De Man, 1883, p. 153. Miers, 1884, pp. 184, 234-5 (part only, ♀ Port Molle). Miers, 1886, p. 186 (part only). De Man 1887*a*, p. 718. Alcock, 1899, pp. 23-4 (part only—four smallest specimens). Gordon, 1938, pp. 175-6. Sakai, 1939, pp. 382-3, pl. lxxx, fig. 5.

Material Examined and Illustrated

QUEENSLAND: ♂ 39 mm, off Lookout Point, North Queensland, 17.iii.58, otter-trawled in 7 fm on mud bottom, N. Haysom, "Challenge" Prawn Survey (carapace, male abdomen illustrated). ♂ 33 mm, Princess Charlotte Bay, 7.iii.58, otter-trawled, 10 fm, mud and rubble, N. Haysom, "Challenge" prawn survey (male pleopod illustrated). The first specimen has been deposited in the Australian Museum and the second in the Queensland Museum.

Description

Front.—Protruding with 4 teeth, the laterals almost merging with the inner supra-orbital lobes. Median teeth rounded, laterals triangular with convex outer sides.

Anterolateral teeth.—Six (including outer supra-orbital lobe), all stout, with beaded granular edges and inclined forwards. The first the broadest, the third the next broadest, the second the smallest, and the remainder subequal. Between the third and the fourth and again between the fourth and fifth there are "small teeth", or "spinules" less than a quarter the length of the teeth proper, and also with beaded edges.

Carapace.—Slightly broader than long, length 85 per cent. of breadth. Bearing the following main granular areas (nomenclature after Stephenson and Campbell 1959): frontal region—a pair of patches extending to the frontal teeth; proto-gastrics—one group of granules on each side; a pair of mesogastric ridges interrupted in the midline and concave anteriorly; a pair of metagastrics; a pair of cardiacs each in the form of a rounded patch; a minute median postcardiac. There are three pairs of mesobranchials; a conspicuous epibranchial ridge; and scattered granules running medially from the anterolateral teeth, especially from the third, fourth, and fifth.

Chelipeds.—Elongate, $2\frac{1}{2}$ times length of carapace. Anterior border of arm bearing 5 spines which become larger distally; posterior border with 2 spines, one near and one at the distal end. Wrist with 2 spines. Hand with 3 spines and 6 granular carinae. Fingers grooved, and approximately the length of the palm.

First male pleopod.—Smoothly and regularly curving to a non-flared acute tip. Beyond the basal lobes on the outer side minute backwardly directed spinules begin about half-way up the appendage and continue to just behind the tip where they become denser and sufficiently large to be termed "spines". The inner side bare for two-thirds of the way up, then bearing sparsely distributed microscopic spines which continue until replaced by the subterminal armature. Subterminal armature on the outer side merging with the general spinulation; on the inner side some 4 or 5 backwardly directed spines are visible in profile view. Subterminally on the upper surface there are 2 stout blunt conical spines, these being nearer the inner than the outer surface. The patch of bristles which was visible in profile view on the inner surface passes round to the under surface, where some 20 backwardly directed spines are present.

Distribution

Balanbangan, Borneo (Adams and White 1849); seas of Amboina (de Man 1883); off Ceylon and Andamans (Alcock 1899), off E. coast of Malay Peninsula (Gordon 1938); Japan (Sakai 1939).

Previously known within Australia from a single specimen, Port Moller, Queensland (Miers 1884).

LUPOCYCLUS INAEQUALIS (Walker)

Goniosoma inaequale Walker, 1887, pp. 110, 116, pl. 8, fig. 4.

Lupocyclus inaequalis (Walker). Henderson, 1893, p. 378.

Lupocyclus rotundatus Miers, 1884, pp. 184, 234-5 (part only—♀ Friday I.); 1886, p. 186 (part only). Alcock, 1899, pp. 23-4 (part only—two largest specimens). Rathbun, 1911, p. 210. Shen, 1937, pp. 98-9, fig. 1. Leene, 1938, p. 11; 1940, pp. 169-71, fig. 3, pl. i.

Description

See Leene (1940). The distinctions between *L. rotundatus* and *L. inaequalis* have already been given.

Distribution

Singapore (Walker 1887; Shen 1937), Gulf of Martaban (Henderson 1893), off Ceylon and Andamans (Alcock 1899). Seychelles (Rathbun 1911), and East Indies (Leene 1938).

Recorded in Australia only from Friday I. (Miers 1884).

Genus SCYLLA de Haan

Scylla de Haan, 1833, p. 11. Milne Edwards, A., 1861, p. 347. Haswell, 1882b, pp. 78-9. Alcock, 1899, p. 27.

SCYLLA SERRATA (Forskål)

Fig. 2*N*; Plate 4, Fig. 4; Plates 5*N*, 6*C*

Cancer serratus Forskål, 1755, p. 90.

Cancer olivaceus Herbst, 1796, p. 157, pl. xxxviii, fig. 3.

Portunus tranquebaricus Fabricius, 1798, p. 366.

Scylla serrata (Forskål). De Haan, 1833, p. 44. Milne Edwards, A., 1861, p. 349. Miers, 1876, pp. 27-8. Haswell, 1882b, p. 79. Alcock, 1899, p. 27. Shen, 1932, pp. 36-8, figs. 4, 5 (male pleopod). Boone, 1934, pp. 70-2, pls. 25-30. Leene, 1938, pp. 14-15. Sakai, 1939, pp. 384-5, fig. 4. Estampador, 1949a, pp. 99-101, pl. 1, fig. 1. Barnard, 1950, pp. 160-1, figs. 31b, 31c. Serene, 1952, pp. 134-7, pl. i, fig. 3, pl. ii, figs. 3, C. Edmondson, 1954, pp. 234-5, figs. 10b, 11a-c (male pleopod). Chhappgar, 1957, pp. 416-7, pl. 5, figs. a-c (male pleopod).

Lupa tranquebarica (Fabricius). Milne Edwards, H., 1834, p. 448.

Lupa lobifrons Milne Edwards, H., 1834, p. 453.

Scylla tranquebarica var. *oceanica* Dana, 1852b, p. 270. Stimpson, 1907, p. 75.

Scylla oceanica Dana. Estampador, 1949a, pp. 101-2, pl. 1, fig. 2. Serene, 1952, pp. 134-7, pl. i, fig. 1, pl. ii, figs. 1, A.

Scylla tranquebarica (Fabricius). Estampador, 1949a, p. 103, pl. 3, fig. 1. Serene, 1952, pp. 134-7, pl. i, fig. 2, pl. ii, figs. 2, B.

Scylla serrata var. *paramamosain* Estampador, 1949a, p. 104, pl. 3, fig. 2. Serene, 1952, pp. 134-7, pl. i, fig. 4, pl. ii, figs. 4, D.

Discussion of Synonymy

Serene (1952) has noted that a complete synonymy would exceed 80 references, hence only selected ones are included above, stressing the more recent and more controversial.

Until the work of Estampador (1949a, 1949b) it had become generally accepted that there was only one species of *Scylla*, *S. serrata* (Forskål). In particular *S. tranquebarica* (Fabricius) with its variety *oceanica* Dana were regarded as synonyms.

Estampador considered that, in the Philippines, there are four sorts of *Scylla*:

(1) General colour deep ferruginous brown ranging to light purplish brown with irregular small whitish spots on carapace and last legs. Setae on carapace restricted to hepatic region. H mark on carapace relatively faint. Usually living in holes. This was regarded as *S. serrata*.

(2) General colour predominantly green to greyish green. Carapace legs and abdomen with large pigmented areas of whitish grey bordered by purplish dark brown lines. Brush-like setae abundantly on carapace. H mark on carapace deeply impressed. "Prefers a nomadic life." This was regarded as *S. oceanica* (Dana).

(3) General colour deep purplish drab-green. Large pigmented areas only distinct on last legs and abdomen of female. Chelipeds enormously big. H mark on carapace deeply impressed. This was regarded as *S. tranquebarica* (Fabricius).

(4) As *S. serrata* but with the median frontal lobes slightly more anteriorly produced than the laterals. Outer of two spines at base of fingers smaller than inner but not obsolescent or dentiform. Colour lighter. Estampador described this form as a new variety of *S. serrata*, var. *paramamosain*.

He supported these separations by reference to variations in spermiogenesis and oogenesis; also to the form and physical constitution of the chromosomes. The cytological evidence of differences between the groups is not impressive.

Estampador noted that the Philippine fishermen recognize either two or three different groups; if the former, they designate a *mamosain* group without colour markings (*S. serrata* and the variety *paramamosain*) and a *banhawin* group with colour markings (*S. oceanica* and *S. tranquebarica*).

Serene (1952) notes that the Vietnam fishermen also recognize four groups which translate to: banana or white crabs, green crabs, rust red crabs, and moving ("roulant") crabs. Serene himself claims that two categories are tolerably easily separated on a basis of coloration, i.e. the rust and moving crabs (corresponding to Estampador's *mamosain* group) and the banana and green crabs (corresponding to Estampador's *banhawin* group). These Serene regards as species with the subdivisions of each as varieties. However, to avoid complications and recognizing the tentative nature of the work, he adopts Estampador's nomenclature.

After redescribing the fresh colours, and noting that they are useless features for use upon preserved material, he lists morphological features which separate the forms. He shows that the relative length of the chelipeds is not a good character, nor is the conspicuousness of the H groove on the carapace, nor is the relative protrusion of the median frontal lobes in *S. serrata* var. *paramamosain*.

The characters he found useful were:

(1) In males of similar size, length of external spine on upper surface of hand of cheliped, near the finger. This is very feebly developed in *S. serrata*, slightly developed in the var. *paramamosain*, and well developed in the other two forms.

(2) In males of similar size length of spine on antero-inferior border of the carpus. This is absent in *S. serrata*, feebly developed in *S. oceanica*, moderately developed in *S. tranquebarica*, and well developed in *S. serrata* var. *paramamosain*.

(3) Frontal lobes more acute in *S. oceanica* and more rounded in *S. serrata*, with the others intermediate.

(4) Relatively broader posterior border of carapace in *S. oceanica*.

(5) Relatively narrower orbital space in *S. oceanica*.

(6) Relatively acuter but shorter anterolateral teeth in *S. oceanica*.

Comparing the work of Estampador and Serene, it will be noted that they agree in separating two groups, marked from unmarked crabs, and further agree that each group can be divided into two on the basis of colour. Broadly speaking they disagree upon the features other than colour which can be used to effect a separation.

All the live specimens seen by the authors from central and southern Queensland and from New South Wales, are unmarked and thus belong to *S. serrata* or its var. *paramamosain*. The more important differences between these two (viz. spines on hand and wrist of chelipeds) could well be due to different degrees of wear, which would be related to different intervals since the last moult. Until this possibility has been eliminated, it seems preferable not to recognize the var. *paramamosain*.

Conspicuously mottled crabs have been reported by the general public from islands within the Great Barrier Reef, from Cairns and northwards, but the authors have not seen these alive. One specimen (σ 27 mm, Aust. Mus. Reg. No. P4285) from Finches Bay, Cooktown, might have been one of the mottled forms. On morphological features it may possibly be Serene's *S. tranquebarica*, although the distinctions from *S. serrata* var. *paramamosain* are extremely slight.

It is felt that a great deal more work is required before the separation of the old *S. serrata* into four forms can be regarded as justified. In particular evidence is required upon:

(1) The effect of wear and tear upon the spinulation of the chelae and shape of the anterolateral teeth.

(2) The effect of the general environmental background upon the basal colour and the markings of individuals.

(3) Whether given individuals live permanently in one type of habitat (e.g. holes amongst mangrove roots) or whether they migrate.

(4) The structure of the male pleopods. These structures, which are of great diagnostic value, were not considered by either Estampador or Serene.

Therefore, and tentatively, the four forms of Estampador and of Serene are fused into the synonymy.

Material Examined

14 ♂♂ (23–190 mm); 10 ♀♀ (19–165 mm).

QUEENSLAND: Cape York, Flinders I., Cooktown, Townsville, Bloomfield R., Mackay, Gladstone, Burnett R., Caboolture R., Caloundra, Brisbane R., Clontarf, Southport. NEW SOUTH WALES: Port Jackson, Sailor's Bay, Middle Harbour, Sydney. WESTERN AUSTRALIA: Broome. NORTHERN TERRITORY: Darwin.

Recorded habitats.—Mangrove mud flats, burrows on bank, M.T.L.

In addition a considerable number of specimens from central and southern Queensland and from northern New South Wales have been examined cursorily.

Material illustrated.—Carapace, male abdomen: ♂ 190 mm, Caboolture, March 1952, pres. Dept. Harb. and Mar. (Zool. Dept. Univ. Qld.). Male pleopod: whole mount ♂ 140 mm, Cooktown, D. Chapman (Zool. Dept. Univ. Qld.), tip ♂ 67 mm (Qld. Mus.).

Description

General.—Considered unnecessary.

Male pleopod.—Rather long, sinuous, and evenly tapered to a blunt tip. Beyond the basal lobes on the outer side a band of hairs commences on the upper surface. These extend distally to form a broad band of spinules which extend on the upper outer surface towards the tip and also spread to the under surface covering it almost entirely from about half-way up the appendage and becoming sparser towards the tip. On the inner side a dense patch of hairs on the basal area extends up the appendage as a band of short fine hairs. These become much sparser and shorter towards the tip and continue as a row of small spinules on the inner border. In larger specimens the finer hairs on the upper surface may be absent so that only a row on the inner border remains.

Comments

The smallest specimen seen (Aust. Mus. Reg. No. P3827, ♂(?) 13 mm, doubtfully Australian) looks superficially quite atypical because of the fine pile of hairs over most of the carapace.

This species, known locally as the "mud crab", is the largest of the Australian portunids in terms of bulk and is greatly sought after as food. Catching methods include: (1) probing in burrows, typically amongst mangroves, with a long iron hook, (2) in shallow baited nets ("dilly nets") hung down vertically from boats or piers, (3) in baited pots, and (4) in tangle nets. From the fact that sometimes burrow-probing, and on other occasions trapping methods, give the best results, it seems probable that the population has an alternation between sedentary and mobile phases in the life cycle. Mr. E. M. Grant (personal communication) reports that individuals may rise to the surface at night and swim purposefully.

The general habitat of the species in the region from central Queensland to northern New South Wales is in muddy estuaries which are typically lined with mangroves. It occurs in Moreton Bay down to 4 fm, and penetrates upstream into water of very low salinity. After freshwater floods, unusual concentrations of mud crabs have been reported off the mouths of rivers, and it is generally believed that they have been swept downstream.

Distribution

Throughout the Indo-West-Pacific from E. Africa and the Red Sea to Japan, Tahiti and New Zealand (Chhappgar 1957).

Previous Australian records are: "Neu Holland" (Hess 1865), Queensland (Yonge 1930; Stephenson *et al.* 1931; Roughley 1936; Dakin, Bennett, and Pope 1952), New South Wales (Stead 1898) and Western Australia (subfossil) (Etheridge and McCulloch 1916).

Subfamily **PODOPHTHALMINAE** Borradaile, 1907

Only one genus has been recorded from the Indo-West-Pacific.

Genus **PODOPHTHALMUS** Lamarck

Podophthalmus Lamarck, 1801, p. 152. Alcock, 1899, p. 92 (early lit.). Sakai, 1939, pp. 426-7.

KEY TO THE INDO-WEST-PACIFIC SPECIES OF GENUS *PODOPHTHALMUS*

Carapace broad (breadth c. 2.5 times length); front entire, deflexed; supra-orbital borders inclined; distal portion of inner surface of palm bearing a spinule . . . *P. vigil* (Fabricius) (1798)
 Carapace breadth c. 2 times length; front bilobed, horizontal; supra-orbital borders transverse; distal portion of inner surface of palm without a spinule
 *P. nacreus* Alcock (1899, pp. 93-4) (not recorded from Australia)

PODOPHTHALMUS VIGIL (Fabricius)

Figs. 1L, 2O; Plate 5, Fig. 1; Plate 5O

Portunus vigil Fabricius, 1798, p. 368.
Podophthalmus spinosus Lamarck, 1801, p. 152; 1838, p. 471.
Podophthalmus vigil (Fabricius). Leach, 1815, p. 149, pl. 108; Milne Edwards, A., 1861, p. 420. Boone, 1934, pp. 81-5, pls. 37, 38. Shen, 1937, p. 137, fig. 20. Leene, 1938, pp. 12-13 (lit. and synonym.). Sakai, 1939, p. 427, pl. xlviii. Stephensen, 1945, p. 137, figs. 32a,b (male pleopods). Edmondson, 1954, pp. 271-2, figs. 43d,e, 44.

Material Examined

19 ♂♂ (55-142 mm); 8 ♀♀ (76-117 mm).

QUEENSLAND: Moreton Bay (Bribie I., Pearl Banks, Woody Pt., Peel I., Victoria Pt., Stradbroke I.), Southport, Morris I. (Claremont Group). WESTERN AUSTRALIA: Exmouth Gulf.

Recorded habitats.—Trawled, 5-10 fm, sandy mud and weed.

Material illustrated.—♂ 92 mm, east channel Pearl Banks, Moreton Bay, trawled on soft mud 12 m, coll. E. Grant, 23.v.52 (Zool. Dept. Univ. Qld.).

Description

General.—Considered unnecessary.

Male pleopod.—The broad base curves slightly to a long neck which tapers to a fine extended tip. A row of stout, short, tubercle-like spines commences about half-way up the appendage on the outer side. This row extends to the tip, the spines becoming progressively smaller and sharper and merging with the terminal

armature. This consists of sparsely arranged recurved spines which form irregular upper, under, and inner rows extending a short distance back from the tip and with from 5-7 spines per row.

Distribution

Previously recorded in Australia from Brisbane R. (subfossil) (Etheridge and McCulloch 1916) and Southport (Boone 1934). Now also from Western Australia.

Outside Australia from the Indian Ocean, Red Sea (Shen 1937) and Iranian Gulf (Stephenson 1945) through Formosa and the Philippines (Balss 1922) to Hawaii (Shen 1937; Edmondson 1954).

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LIST OF SUBFAMILIES, GENERA, AND SPECIES

	Page		Page
Subfamily Caphyrinae Alcock		Genus <i>Libystes</i> A. Milne Edwards ..	85
Genus <i>Caphyra</i> Guérin	96	<i>paucidentatus</i> , sp. nov.	86
<i>fulva</i> , sp. nov.	104	Subfamily Macropipinae, nom. nov.	
<i>laevis</i> (A. Milne Edwards)	97	Genus <i>Macropipus</i> Prestandrea	91
<i>rotundifrons</i> (A. Milne Edwards)	101	<i>corrugatus</i> (Pennant)	92
<i>yookadai</i> Sakai	102	Genus <i>Ovalipes</i> Rathbun	88
Genus <i>Lissocarcinus</i> Adams & White	94	<i>molleri</i> (Ward), comb. nov.	90
<i>orbicularis</i> Dana	95	<i>punctatus</i> (de Haan)	89
<i>polybioides</i> Adams & White	94	Subfamily Podophthalminae Borradaile	
Subfamily Carcininae Alcock		Genus <i>Podophthalmus</i> Lamarck	115
Genus <i>Carcinus</i> Leach	80	<i>vigil</i> (Fabricius)	115
<i>maenas</i> L.	80	Subfamily Portuninae, usus nov.	
Genus <i>Nectocarcinus</i> A. Milne Edwards	82	Genus <i>Lupocyclus</i> Adams & White	107
<i>integrifrons</i> (Latreille)	83	<i>inaequalis</i> (Walker)	111
<i>tuberculatus</i> (A. Milne Edwards)	84	<i>rotundatus</i> Adams & White	109
Subfamily Catoptrinae Borradaile		Genus <i>Scylla</i> de Haan	111
Genus <i>Carupa</i> Dana	88	<i>serrata</i> (Forskål)	111
<i>tenuipes</i> Dana	88		

AUSTRALIAN PORTUNIDS. IV

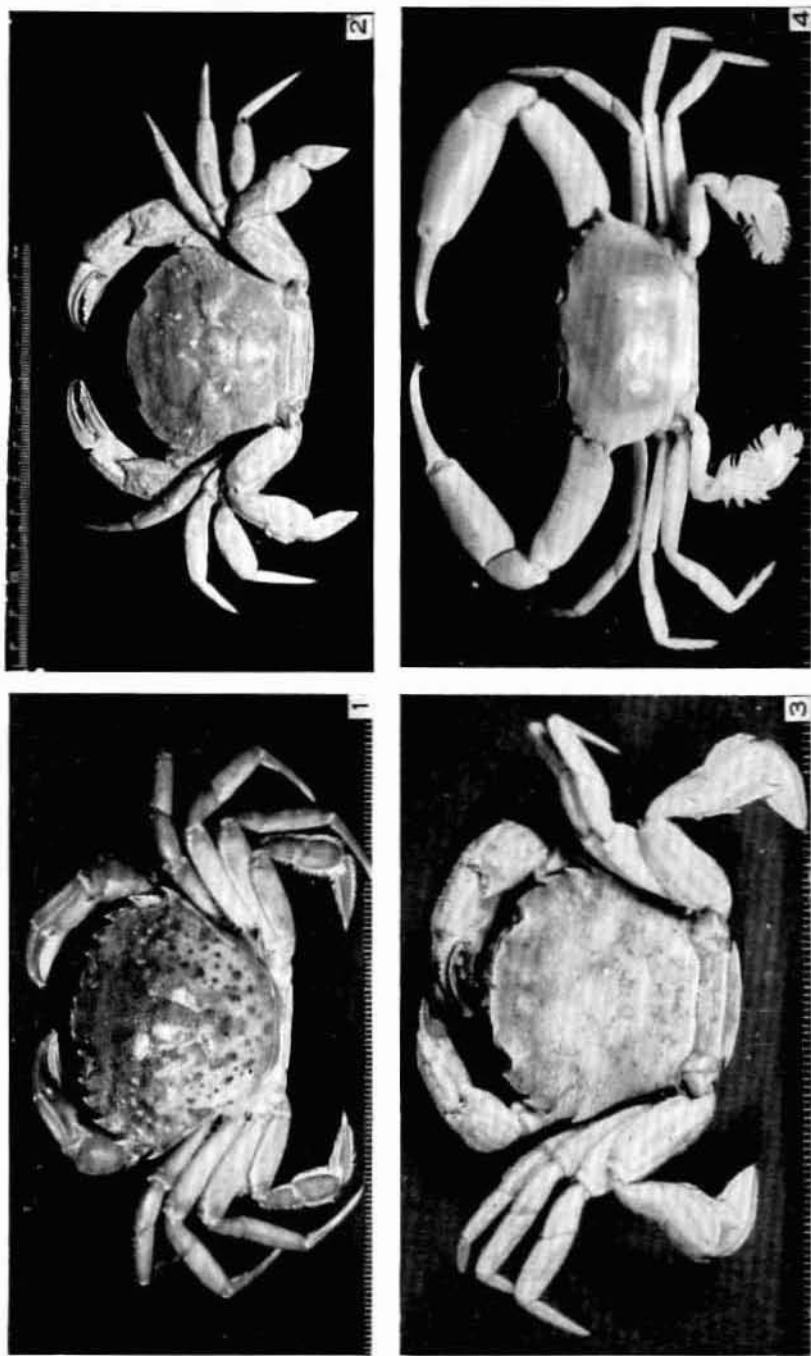


Fig. 1.—*Carcinus maenas*. Fig. 2.—*Nectocarcinus integrifrons*. Fig. 3.—*N. tuberculatus*. Fig. 4.—*Libinia pouilleulatus*. Scale divisions 1 mm.

AUSTRALIAN PORTUNIDS. IV

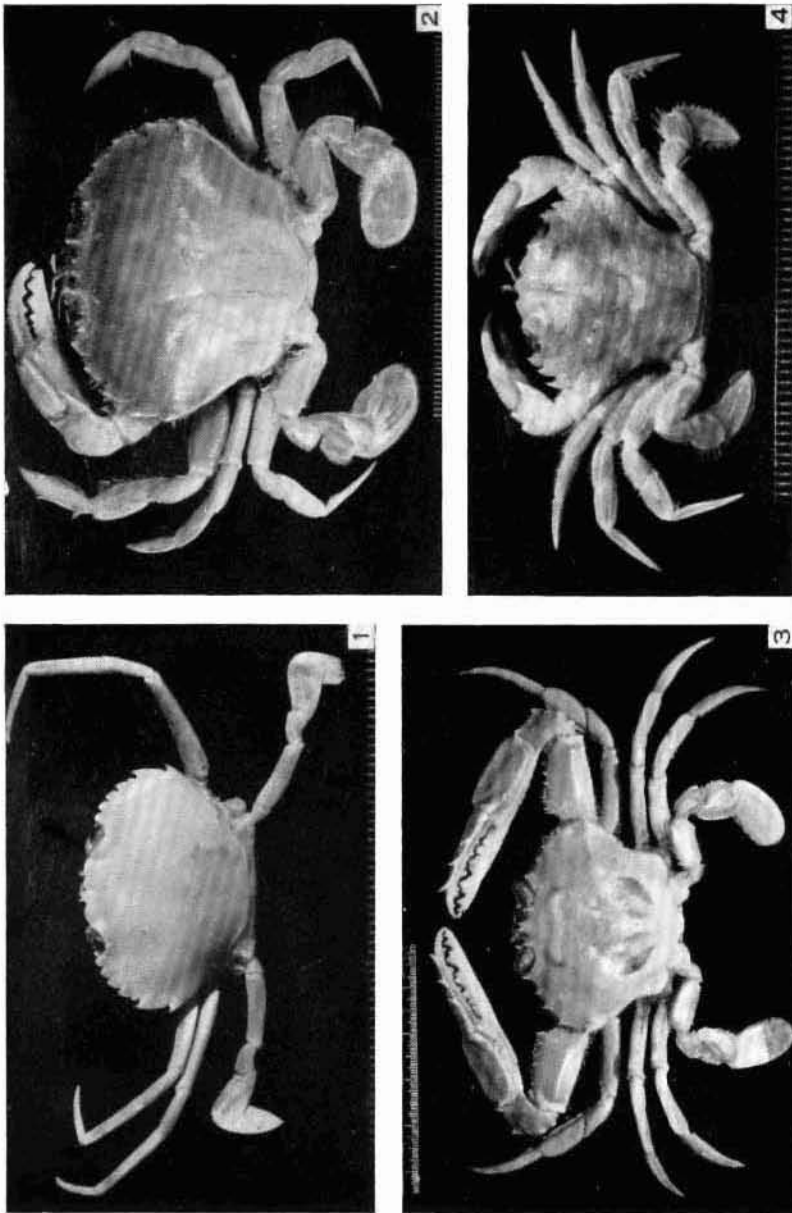


Fig. 1.—*Carapca tenuipes*. Fig. 2.—*Ondulipes punctatus*. Fig. 3.—*O. malleri*. Fig. 4.—*Macropipus corrugatus*.
Scale divisions 1 mm.

AUSTRALIAN PORTUNIDS. IV

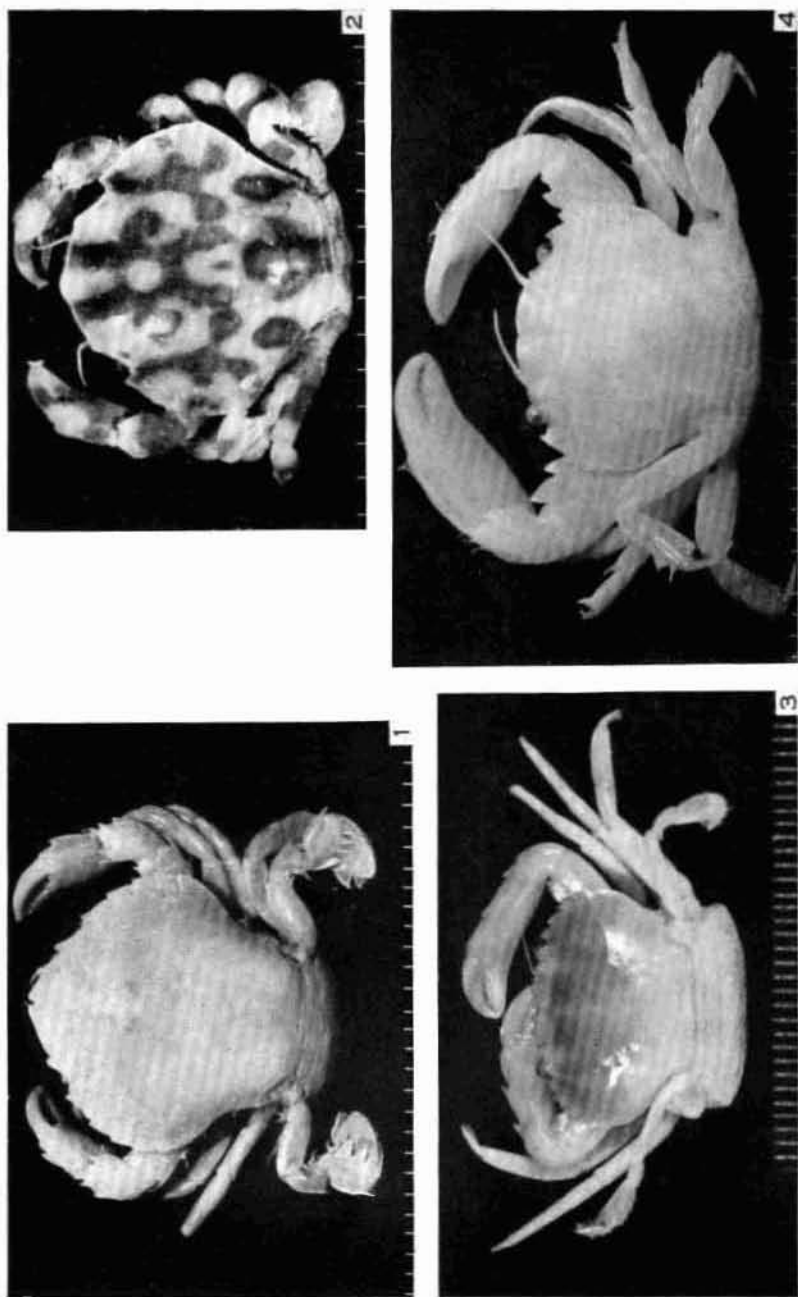


Fig. 1.—*Lissocarcinus polybioides*, Fig. 2.—*L. orbicularis*, Fig. 3.—*Caphyra laevis*, Fig. 4.—*C. rotundifrons*. Scale divisions 1 mm.

AUSTRALIAN PORTUNIDS, IV

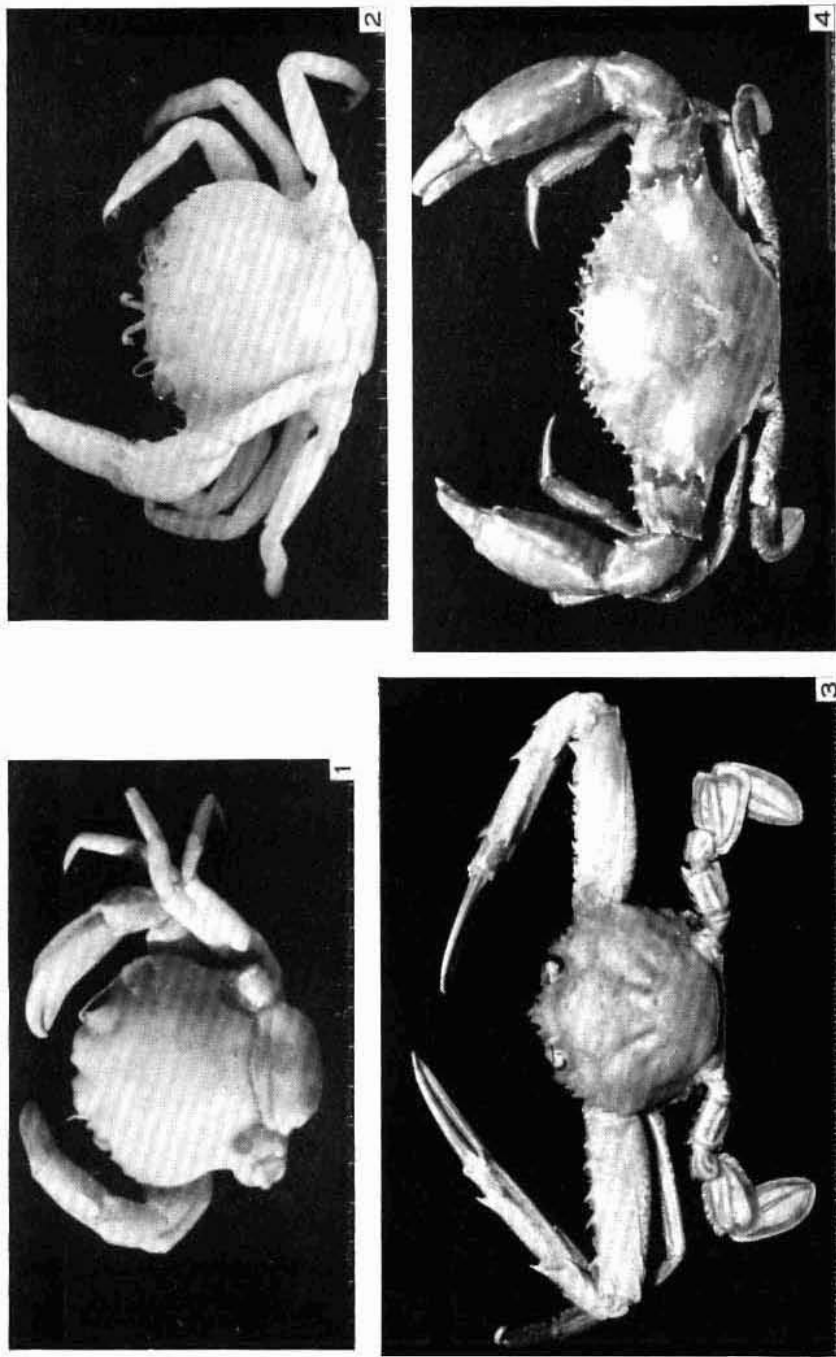


Fig. 1.—*Caphyra pookadai*. Fig. 2.—*C. fulva*. Fig. 3.—*Lupocyclus rotundatus*. Fig. 4.—*Scylla serrata*. Scale divisions 1 mm.

AUSTRALIAN PORTUNIDS. IV

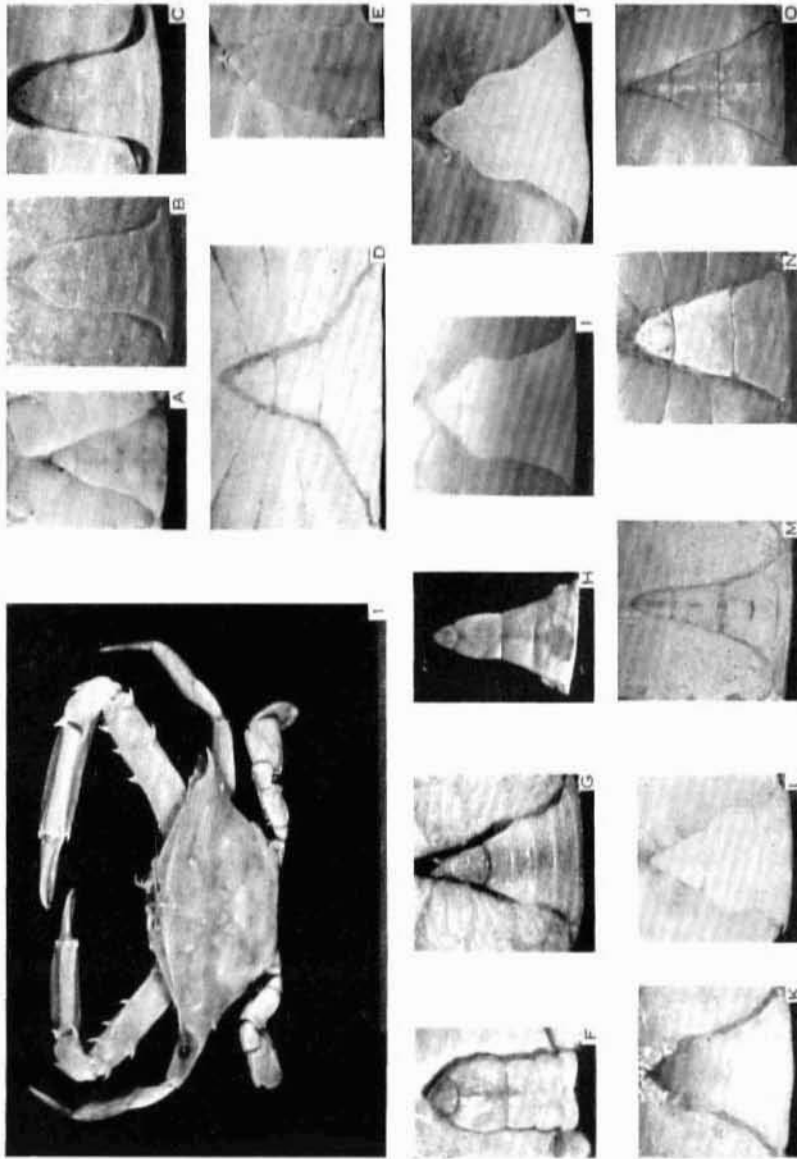
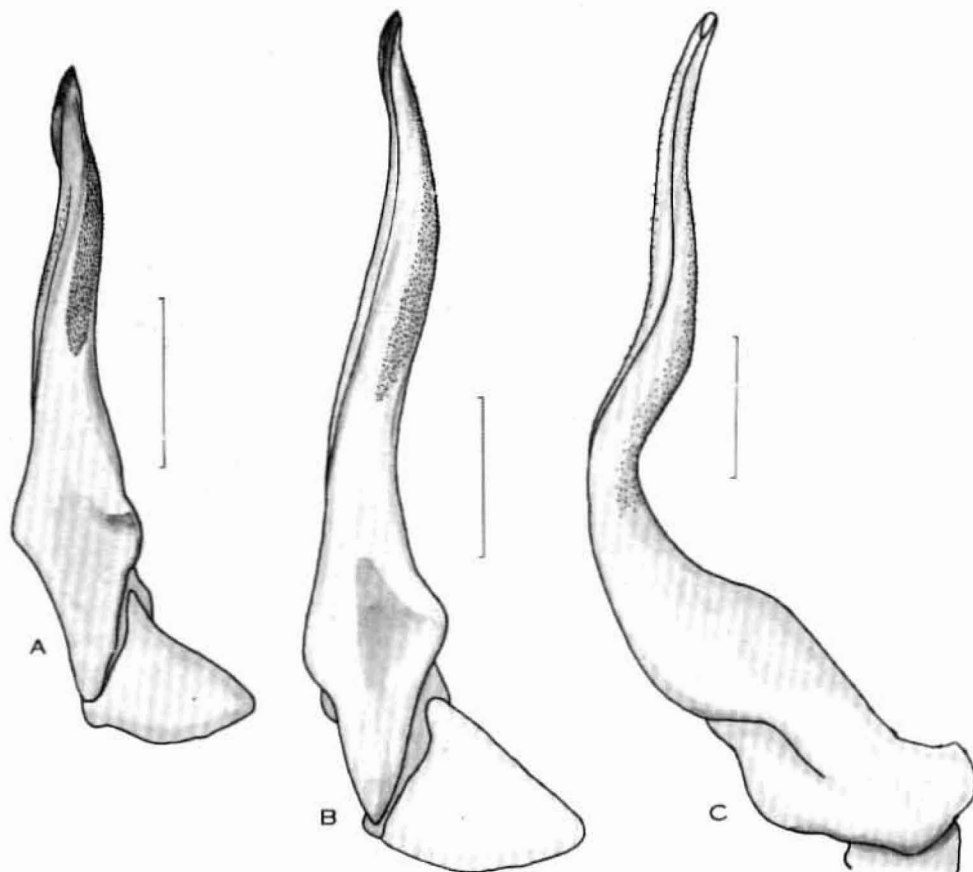


Fig. 1.—*Podophthalmus vigil*. Scale divisions 1 mm. Figs. A–O.—Male abdomens. A, *Carcinus maenas*; B, *Nectocarcinus integrifrons*; C, *N. tuberculatus*; D, *Libystes paucidentatus*; E, *Ovalipes punctatus*; F, *O. malleri*; G, *Macropipus corrugatus*; H, *Lissocarcinus polybioides*; I, *Caphyra laevis*; J, *C. rotundifrons*; K, *C. yookadai*; L, *C. fulva*; M, *Lupocyclus rotundatus*; N, *Scylla serrata*; O, *Podophthalmus vigil*.

AUSTRALIAN PORTUNIDS. IV



Wash drawings of male pleopods. *A*, *Nectocarcinus integrifrons*; *B*, *N. tuberculatus*; *C*, *Scylla serrata*. Scale lines 5 mm.