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THE AUSTRALIAN PORTUNIDS (CRUSTACEA: PORTUNIDAE)

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By W. STEPHENSON* and B. CAMPBELL*

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Summary

Thirteen species of the genus *Portunus* Weber are recorded from Australia, including one new species and five new records. These species are described and illustrated, and a key is given to known Indo-West-Pacific species. First pleopods of males are considered in detail and a key based on their features is included.

The problems of designating subgenera are discussed and the relevance of a knowledge of the structure of first male pleopods is indicated.

I. INTRODUCTION

The Indo-West-Pacific species of the genus *Portunus* Weber have not been revised since Alcock (1899), and the only comprehensive Australian treatments are Haswell's (1882*b*) outdated work, and Hale's (1927) study of the attenuated South Australian fauna.

The present paper details and discusses the Australian species, and is based upon the collections in Australian institutions up to January 1956, supplemented by recent collections made by or held at the University of Queensland. It (*a*) amends synonymies and brings them up to date (for reasons of brevity the less important older synonyms are rarely given); (*b*) includes keys to the Indo-West-Pacific species based upon general features; (*c*) includes descriptions of first male pleopods of Australian species and gives keys to the Indo-West-Pacific species based on their structure; and (*d*) revises and extends specific descriptions, including photographic illustrations of intact animals and male abdomens; and (*e*) includes a description of one new species.

Descriptions of first pleopods of the males 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 glycerine and alcohol. All figures of pleopods are either based upon camera lucida outlines or were drawn with the assistance of a squared micrometer eyepiece. Drawings of third maxillipeds were made similarly and again are of the left appendage, i.e. right as viewed from the under surface of the crab.

Where colour is not stated the colour of live specimens has not been recorded and that of alcohol-preserved specimens is a "washed out" shade of brown.

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II. Description of Genus and Species

Genus PORTUNUS Weber

Portunus Weber, 1795, p. 93. Fabricius, 1798, p. 325. Rathbun, 1897, p. 155. Hale, 1927, p. 149. Rathbun, 1930, p. 33 (synon.). Edmondson, 1954, p. 235. Internat. Comm. Zool. Nom., 1956, Opin. 394.

Lupa Leach, 1814, p. 390. Milne Edwards, H., 1834, p. 445. Dana, 1852*a*, p. 268. Barnard, 1950, p. 152.

Neptunus de Haan, 1833, p. 7. Milne Edwards, A., 1861, p. 314. Miers, 1876*a*, p. 23; 1886, p. 171. Alcock, 1899, p. 28 (synon.). Shen, 1937, p. 99. Sakai, 1939, p. 385.

Achelous de Haan, 1833, p. 8. Milne Edwards, A., 1861, p. 336. Barnard, 1950, p. 159.

Amphitrite de Haan, 1833, p. 8. Dana, 1852*a*, p. 277. Stimpson, 1858, p. 38 ; 1907, p. 77.

Pontus de Haan, 1833, p. 9.

Monomia Gistel, 1848, p. viii. Barnard, 1950, p. 155.

Xiphonectes Milne Edwards, A., 1873, p. 157. Doflein, 1902, p. 659.

Hellenus Milne Edwards, A., 1879, p. 221. Barnard, 1950, p. 158.

non *Portunus* Leach, 1814, p. 390.

non "*Portunus*", Palmer, 1927, p. 877. Sakai, 1939, p. 377.

The use of the name *Portunus* has been confused by its being applied to two quite different genera. This has been resolved by the International Commission on Zoological Nomenclature (1956) agreeing to suggestions from Dr. L. B. Holthuis. The genus commonly known as *Neptunus* de Haan, 1833, has thus become *Portunus* Weber, 1795. The genus commonly known as *Portunus* Fabricius, 1798, and occasionally as *Liocarcinus* Stimpson, 1870,* thus becomes *Macropipus* Prestandrea, 1833.

Further synonymy problems have arisen from the status of de Haan's genera *Achelous* and *Amphitrite*, and of A. Milne Edwards' genera *Xiphonectes* and *Hellenus*. Most recent authors relegate these to subgeneric status, with Barnard (1950) as the notable exception. Rathbun (1930) drew attention to the preoccupation of *Amphitrite*, but since then it has been used subgenerically by Shen (1937) and Sakai (1939). Here *Monomia* Gistel, 1848, should be employed.

For a fuller early synonymy at the generic level Rathbun (1930) should be consulted. The specific synonymies give the revised generic names of species previously recorded from Australia.

Generic Description (*Abbreviated*)

The nomenclature follows that of *Thalamita* cited previously (Stephenson and Hudson 1957).

Carapace.—Transverse, usually very broad, always broader than long; depressed or a little convex. Front proper relatively short ($\frac{1}{5}$–$\frac{1}{6}$ breadth of carapace excluding last anterolateral tooth). Frontal teeth usually well defined; from 3 to 6 in number, usually 4.

Anterolateral borders.—Oblique and arched, longer than posterolateral borders, typically bearing 9 regular teeth of which the last may be enlarged. (In two of the species as few as 4 teeth are present.)

* The original paper, not consulted, is cited in Zoological Record for 1871 as "Stimpson, W., and Pourtalès, L. F. de".

Carapace surface.—Sometimes with conspicuous ridges, reminiscent of *Thalamita*, and sometimes with elevated granular areas. The terminology used in the two cases is shown in Figure 1.

Basal antennal joints.—Very short, each with its antero-external angle produced to form a lobule or spine extending into the orbit; antennal flagellum not excluded from the orbit.

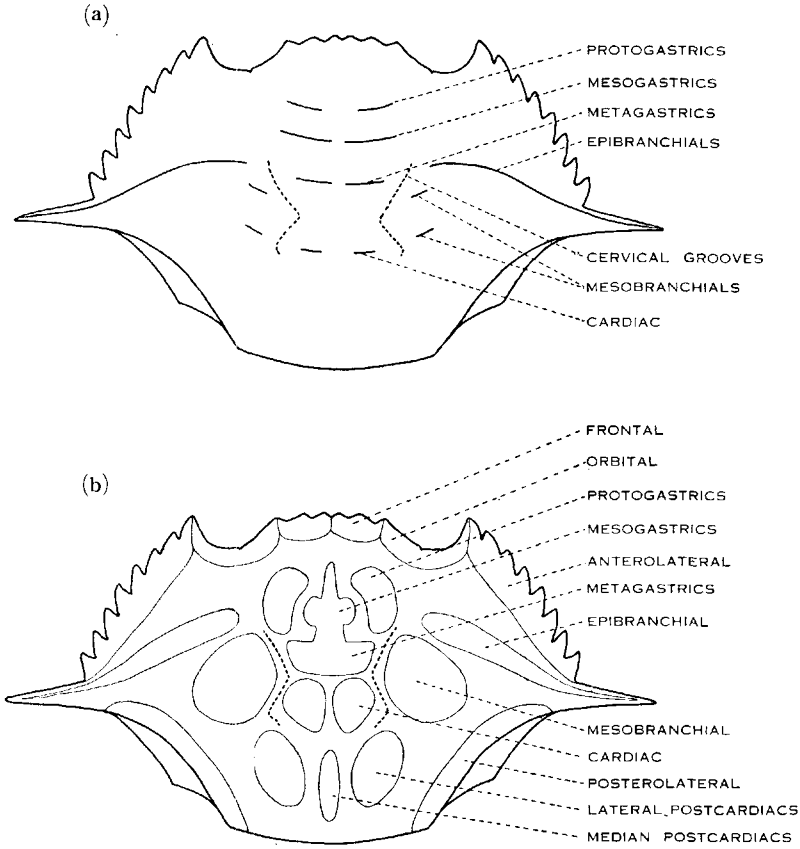

Fig. 1.—(*a*) Designation of ridges and depressions of carapace in species of *Portunus* without elevated areas (depressions dotted).
(*b*) Designation of regions of carapace in species of *Portunus* with elevated areas (main depressions dotted).

Male abdomen and pleopods.—Third to fifth abdominal segments fused. The shapes of ultimate and penultimate segments vary and are of diagnostic value. First pair of pleopods tubular and of diagnostic value.

Chelipeds.—Equal or subequal and longer, usually much longer, than any of the legs. Anterior borders of arms spinous. Wrists with both inner and outer spines. Palms prismatic, costate, and strongly toothed.

Fifth legs.—All segments conspicuously flattened, posterior border of propodus with bristles, not spines.

Comments

Species of *Portunus* have a characteristic facies, and an "average" species can be clearly recognized to belong to the genus by virtue of: (1) broad carapace, (2) nine anterolateral teeth, and (3) costate hands. The "less average" species cause more difficulty; they comprise (i) those with relatively narrow carapace and (ii) those with less than nine anterolateral teeth.

The former (*Achelous* auct. non de Haan) are distinguishable from *Carupella* Lenz & Strunck, 1914, by having a much broader carapace and also a broader basal antennal joint. The latter are distinguishable from *Thalamita* Latreille, 1829, and all of the genus *Charybdis* de Haan, 1833,* except subgenus *Gonioneptunus* Ortmann, 1893, by the fact that the basal antennal joint does not exclude the flagellum from the orbit. *Gonioneptunus* is distinguishable from *Portunus* by the possession of six tolerably regular anterolateral teeth (as in *Charybdis* as a whole), but in morphological details and presumably in evolutionary relationships this is the group closest to *Portunus*.

Lupocyclus Adams & White, 1849, with nine anterolateral teeth, also resembles the *Lupocycloporus* group of the genus *Portunus* in having elongate chelipeds, but is distinguished from *Portunus* by having alternately long and short anterolateral teeth, and by having a very narrow basal antennal joint.

III. The Subgenera

Numerous problems arise at the subgeneric level. Commonly, and following Alcock (1899), the Indo-West-Pacific species of the genus have been divided between five subgenera, viz. *Neptunus*, *Amphitrite*, *Achelous*, *Hellenus*, and *Lupocycloporus*. Rathbun (1930) on the other hand in dealing with the American species recognized only two subgenera—*Portunus* and *Achelous*. Barnard (1950) evidently distinguished the same groups as Alcock and listed four of them in the South African fauna, but gave them generic status, viz.: *Lupa*, *Monomia*, *Hellenus*, and *Achelous*.

If one wishes to distinguish several subgenera, Alcock's names would need drastic revision as follows: for *Neptunus* de Haan, 1833, read *Portunus* Weber, 1795, the former now being invalid; for *Amphitrite* de Haan, 1833, read *Monomia* Gistel, 1848, the former being preoccupied by *Amphitrite* Mueller, 1771 (Annelida : Polychaeta); for *Achelous* Alcock, 1899, non de Haan, 1833, read *Cycloachelous* Ward, 1942 (as Rathbun (1930) has shown, the type of *Achelous* de Haan has not the lateral extension of the merus of the third maxilliped which is an important feature of Alcock's diagnosis); for *Hellenus* A. Milne Edwards, 1879, read *Xiphonectes* A. Milne Edwards, 1873; *Lupocycloporus* Alcock, 1899, stands.

Achelous de Haan is without representatives in Alcock's Indian fauna, but redefinition of subgeneric characters, following the general lines of Alcock, could lead to the establishment of a much more restricted usage than that of Rathbun (1930) with possible inclusion of one Indo-West-Pacific species.

Before a detailed nomenclatural revision is attempted, the question arises as to the real distinctness of the subgenera. A sufficient number of species exist whose

* In previous papers (Stephenson and Hudson 1957; Stephenson, Hudson, and Campbell 1957) this date was erroneously given as 1850.

characters lie across subgeneric boundaries for doubt to exist as to the utility of creating such boundaries.

The species are:

(1) *Portunus pubescens* (Dana, 1852*a*). The recent Indo-West-Pacific authors have placed this species in the subgenus *Neptunus* (e.g. Sakai 1939) or the equivalent *Portunus* (e.g. Edmondson 1954 by implication). Both Sakai and Edmondson note, however, that the carapace is not as broad as in typical members of the subgenus. A. Milne Edwards (1861, p. 342) evidently regarded the carapace as sufficiently narrow to include it in the genus *Achelous*.

(2) *Portunus oahuensis* Edmondson, 1954. This is very close to *P. vocans* (A. Milne Edwards, 1878) as described by Rathbun (1930, pp. 60–2). The latter by virtue of possessing spinous junctions of the posterior and posterolateral borders of the carapace would be referred to *Xiphonectes* = *Hellenus*. *P. oahuensis* is also very close to *Neptunus* (*Hellenus*) *nipponensis* Sakai, 1938, which again possesses spinous junctions. Edmondson's species is not described or figured as possessing the spinous junctions. Unless Edmondson's figure 20*a* is inaccurate, it can be assumed that very closely allied species would be referred to different subgenera.

(3) *Portunus tenuipes* (de Haan, 1833) has generally been referred to *Hellenus* (= *Xiphonectes*) but Sakai (1939, p. 389) justifies its transference to *Amphitrite* (= *Monomia*), following Balss (1922) on the following basis: "In general character of the carapace this species approaches the subgenus *Amphitrite* rather than *Hellenus* . . . ". In *P. tenuipes* the present authors consider the junction between the posterior and posterolateral border of the carapace to be about half-way between a rounded curve and the spinous projection typical of *Xiphonectes* = *Hellenus*.

(4) *Portunus hastatoides* Fabricius, 1798, while in other respects a typical *Xiphonectes* = *Hellenus*, has a laterally produced merus of the third maxilliped which is not characteristic of the majority.

The real difficulties which arise over the four species above suggest that it is preferable at this stage to avoid the use of subgeneric categories while dealing with the Indo-West-Pacific fauna. When the first pleopods of males are described in detail from all Indo-West-Pacific species, an independent criterion of affinities will be available, and the question could be reconsidered. Inclusion of the American fauna would be an important part of such a reconsideration because the commercially important American genus *Callinectes* Stimpson, 1860, is very close to *Xiphonectes* = *Hellenus* as regards the two major points of distinction between American species of *Portunus* and *Callinectes*, viz: ⊥-shaped male abdomen and lateral production of antero-external angle of third maxilliped (Rathbun 1930, p. 98). *Callinectes* differs from *Xiphonectes* in other important respects, but not sufficiently from the general span of the genus in the Indo-West-Pacific to have more than the status of a subgenus if such are to be recognized. The uncertain position of *Callinectes* is especially emphasized by the fact that Rathbun, the authority on the genus throughout her lifetime and one who must have been thoroughly familiar with the American forms, created one Indo-Pacific species. This species *C. alexandri* Rathbun, 1907, originally from Tahiti and Fiji, was later recorded from the Indian

Ocean (Rathbun 1911). It appears to be *Portunus pelagicus*. If the commonest and best known Indo-Pacific species of *Portunus* can be designated by an acknowledged expert as a new species of *Callinectes*, some revision of the latter is obviously desirable.

IV. Key to the Indo-West-Pacific Species Based on General Characters

Paginated references are given only for species not recorded from Australia.

1. Posterior area of carapace bearing 3 large blood-red spots, even in preserved specimens .... *P. sanguinolentus* (Herbst) (1796)
   Posterior area of carapace not bearing 3 large blood-red spots 2

2(1). Hand slender, much less massive than arm 3
   Hand robust, either more, or only a little less massive than arm 5

3(2). 7 spines on anterior border of arm .... *P. aburatsubo* (Balss) (1922, p. 109)
   4–6 spines on anterior border of arm 4

4(3). Front with low sinuous lobes, mesogastric region with 2 granulated patches .... *P. minutus* (Shen) (1937, p. 115)
   Front with 4 teeth, mesogastric region with a transverse granulated ridge .... *P. gracilimanus* (Stimpson) (1858)

5(2). Posterior-posterolateral junction of carapace either forming a right angle or a conspicuous spine 6
   Posterior–posterolateral junction of carapace rounded 16

6(5). Front distinctly 4-toothed or 4-lobed 7
   Front 3-toothed 14
   Front either indistinctly 3-lobed ("sinuous") or flat 15

7(6). Posterior border of arm with 1 spine 8
   Posterior border of arm with 2 spines 12

8(7). Stridulating apparatus on under surface of carapace parallel to and near anterolateral border .... *P. nipponensis* (Sakai) (1938, p. 301)
   No stridulating apparatus present 9

9(8). Median frontal teeth nearly as large as and more prominent than laterals .... *P. tuberculosus* (A. Milne Edwards) (1861, p. 333)
   Median frontal teeth very much smaller and less prominent than laterals 10

10(9). Penultimate segment of ♂ abdomen much longer than broad, with markedly concave lateral borders .... *P. macrophthalmus* Rathbun (1906, p. 871)
   Penultimate segment of ♂ abdomen slightly broader than long, with markedly concave lateral borders .... *P. emarginatus*, sp. nov.
   Penultimate segment of ♂ abdomen slightly longer than broad, with only very slightly concave lateral borders 11

11(10). Chelipeds very long and slender; upper surface of hand with 2 distal spines side by side .... *P. longispinosus* (Dana) (1852*a*)
   Chelipeds stouter; hand with 1 distal spine .... *P. longispinosus bidens* (Laurie) (1906, p. 415)

12(7). Posterior border of merus of natatory legs serrated but without a spine .... *P. hastatoides* Fabricius (1798)
   Posterior border of merus of natatory legs smooth.... *P. andersoni* (de Man) (1887*b*, p. 70)
   Posterior border of merus of natatory legs bearing a spine near the distal end 13

13(12). Last anterolateral spines relatively long, so that carapace breadth (including spines) is rarely less than 2·3 times carapace length ....*P. pulchricristatus* (Gordon) (1931, p. 534)

Last anterolateral spine relatively short, so that carapace breadth (including spines) is always less than twice carapace length.. ....*P. spinipes* (Miers) (1886, p. 179) non Alcock (1899, p. 39)

14(6). ♂ abdomen parallel-sided for basal two-thirds ....*P. tweediei* (Shen) (1937, p. 109)

♂ abdomen with sides converging throughout its length *P. tenuipes* (de Haan) (1833, p. 39)

♂ abdomen with sides strongly concave ..*P. mariei* Guinot (1957, pp. 476–83, figs. 5–7)

♂ abdomen with sides strongly convex ....*P. alcocki* (Nobili) (1905, p. 401)

15(6). Two teeth on posterior surface of arm of cheliped ....*P. brocki* (de Man) (1887*a*)

One tooth on posterior surface of arm of cheliped ..*P. alcocki* (Nobili) (1905, p. 401)

16(5). Antero-external angle of merus of third maxillipeds not produced in a lateral direction . 17

Antero-external angle of merus of third maxillipeds strongly produced in a lateral direction 20

17(16). Carapace very broad, breadth almost twice the length 18

Carapace not very broad, breadth distinctly less than twice the length 19

18(17). Four frontal spines ....*P. pelagicus* (L.) (1766)

Two frontal spines ....*P. trituberculatus* (Miers) (1876*a*, p. 221)

19(17). Mesogastric area of carapace bearing a pair of transverse ridges; no stridulating apparatus on the under surface of the carapace ....*P. pubescens* (Dana) (1852*a*)

Mesogastric area of carapace with 4 strong tubercles; stridulating apparatus present on under surface of carapace ....*P. oahuensis* Edmondson (1954, p. 243)*

20(16). Last anterolateral spine much larger than the preceding ones; carapace moderately broad 21

Last anterolateral spine either hardly larger or even smaller than any of the others ..25

21(20). Round, dark spot on dactyl of swimming leg ....*P. argentatus* (A. Milne Edwards) (1861, p. 332)†

No dark spot on dactyl of swimming leg 22

22(21). Arm with 1 spine on posterior border..*P. rubromarginatus* (Lanchester) (1900, p. 746)

Arm with 2 spines on posterior border 23

23(22). Spine at inner angle of wrist enormous, two-thirds as long as palm ....*P. petreus* (Alcock) (1899, p. 37)

Spine at inner angle of wrist of normal size 24

24(25). Outer frontal teeth relatively larger; posterolateral margins of carapace relatively much shorter; penultimate segment of ♂ abdomen relatively broad ....*P. samoensis* Ward (1939, p. 4) (see footnote to *P. argentatus*)

Outer frontal teeth relatively smaller; posterolateral margins of carapace relatively much longer; penultimate segment of ♂ abdomen relatively narrow ....*P. gladiator* Fabricius (1798)

25(20). Last anterolateral spine slightly smaller than the others; carapace polished ....*P. orbicularis* (Richters) (1880, p. 153)

Last anterolateral spine slightly the largest; carapace with granular patches 26

* This species ought to be close to *P. nipponensis* (Sakai) but does not appear to be close on those of the described features used in the present key.

† Ward (1939, p. 4) compares his *Monomia samoensis* with *N. gladiator* and the description does not mention the black spot on the dactylus which shows in his figures 5 and 6. Probably *P. samoensis* is a synonym of *P. argentatus*).

26(25). Granules on carapace in patches separated by broad smooth areas; penultimate segment of ♂ abdomen with bulging curved sides 27

Granules on carapace covering almost entire surface; penultimate segment of ♂ abdomen only slightly convex ....*P. granulatus* (H. Milne Edwards) (1834)

27(26). Eight anterolateral teeth, the third being equivalent to two normal ones; short stout ♂ pleopod ....*P. octodentata* (Gordon) (1938, p. 179)

Nine normal anterolateral teeth; ♂ pleopod relatively long and slender ....*P. orbitosinus* Rathbun (1911)

V. Key to Indo-West-Pacific Species Based on First Pleopods of the Males

The restricted nature of the key is due to the fact that the structure of the pleopods is undescribed for many species. When the pleopods are not figured in the present work a reference is given to the literature and because of uncertainties regarding these species it has been necessary to include several of them twice in the key and the final position of others may require alteration when further details are obtained. When length/breadth ratios are cited the breadth is the maximum as viewed under normal mounting and the length is as measured in a curved line from the sutures marking the origin of the distal segment.

1. Very elongate (ratio length/greatest breadth greater than 9) 2

Not very elongate 5

2(1). Smoothly, continuously, and conspicuously curved 3

Relatively straight ....*P. gladiator* (Figs. 2*J*, 3*J*)

3(2). Subterminal bristles on both sides of appendage 4

Subterminal bristles only on outside of appendage ....*P. pubescens* (Figs. 2*C*, 3*C*)

4(3). Subterminal bristles subequal ....*P. sanguinolentus* (Figs. 2*B*, 3*B*)

Subterminal bristles of two sizes, with longer and shorter ones tending to alternate in larger specimens ....*P. pelagicus* (Figs. 2*A*, 3*A*)

5(1). Very stout (ratio length/greatest breadth less than 3·5), widely flared tip, basal lobes with bipinnate hairs ....*P. granulatus* (Figs. 2*I*, 3*I*)

Either not very stout, or if so without widely flared tip or bipinnate hairs 6

6(5). Distal fourth of appendage very thin in relation to breadth (appendage relatively straight) ....*P. rubromarginatus* (Figs. 2*K*, 3*K*)

Distal fourth of appendage at most moderately thin (in most cases appendage relatively or conspicuously curved) 7

7(6). Upper surface of distal fifth of appendage bearing strong recurved spines (appendage very robust subterminally) ....*P. gracilimanus* (Figs. 2*M*, 3*M*)

Upper surface of distal fourth of appendage having (at most) spinules (appendage typically not very robust subterminally) 8

8(7). Inner surface of distal fourth of appendage bearing bristles 9

Inner surface of distal fourth of appendage bearing at most spinules 15

9(8). Right-angled bend in middle of the appendage, beyond which distal half is practically parallel-sided .... *P. argentatus* (see Barnard 1950, p. 157, fig. 30c; Edmondson 1954, p. 238, fig. 14c)

If a right-angled bend in the appendage, not near the middle 10

10(9). Tip relatively blunt ....*P. nipponensis* (see Sakai 1939, p. 395, text fig. 7c)

Tip relatively sharp 11

11(10). Subterminal spinules on the outer side of the appendage 12

No subterminal spinules on the outer side of the appendage ....*P. macrophthalmus* (see Edmondson 1954, p. 241, figs. 18*e*, 18*f*)

12(11). Not more than 14 subterminal spinules on the outer side 13
Not less than 16 subterminal spinules on the outer side 14

13(12). Spinules on under surface restricted to tip .... *P. longispinosus* (Figs. 2*F*, 3*F*)
Spinules on under surface beginning approximately half-way along the appendage .. .. *P. emarginatus* (Figs. 2*H*, 3*H*)

14(12). Tip of appendage straight ...... *P. spinipes* (see Gordon 1931, p. 535, text fig. 10*b*)
Tip of appendage curved ("upturned") .... *P. pulchricristatus* (see Gordon 1931, p. 535, text fig. 10*a*)

15(8). Short, broad (length *c.* 3·5 times breadth), with the broadest portion about half-way up the base, sharply curving 16
Short, broad (length *c.* 3 times breadth), with the broadest portion near the base, curving 18
Relatively elongate (length *c.* 5 times breadth) with the broadest portion near the base, hardly curved .... *P. orbicularis* (see Edmondson 1954, p. 240, fig. 16*d*)
Relatively elongate (length *c.* 5–6 times breadth), with the broadest portion a little beyond the base, markedly curving 19

16(15). Subterminal spinules on the outside of the appendage 17
No subterminal spinules on the outside of the appendage .... *P. macrophthalmus* (see Edmondson 1954, p. 241, figs. 18*e*, 18*f*)

17(16). Tip of appendage straight .... *P. spinipes* (see Gordon 1931, p. 535, text fig. 10*b*)
Tip of appendage curved .... *P. pulchricristatus* (see Gordon 1931, p. 535, text fig. 10*a*)

18(15). Inner surface just beyond the basal lobes bare .... *P. octodentata* (see Gordon 1938, p. 180, figs. 4*c*, 4*c*[1])
Inner surface just beyond the basal lobes with bipinnate hairs .... *P. alcocki* (see Guinot 1957, p. 482, figs. 10*a*, 10*b*)

19(15). Subterminal spinules on both inner and outer sides of the appendage 20
Subterminal spinules or bristles only on inner side of the appendage 21
Subterminal spinules only on outer side of the appendage .... *P. tenuipes* (figs. 2*E*, 3*E*)
No subterminal spinules on either side of the appendage .. *P. orbitosinus* (figs. 2*L*, 3*L*)

20(19). Spinules on the outer side relatively dense and more numerous than on the inner side .... *P. mariei* (see Guinot 1957, p. 482, figs. 7*a*, 7*b*)
Spinules on the inner side relatively dense, more numerous than those on the outer side .... *P. brocki* (Figs. 2*G*, 3*G*)
Spinules on the inner and outer sides both relatively sparse .... *P. tweediei* (see Shen 1937, p. 112, figs. 8*c*, 8*d*)

21(19). Subterminal armature consisting of a few small spinules .. *P. hastatoides* (Figs. 2*D*, 3*D*)
Subterminal armature consisting of hairs or bristles .... *P. argentatus* (see Edmondson 1954, p. 238, figs. 14*c*, 14*d*)

VI. Specific Descriptions

The description of the type species *Portunus pelagicus* is followed by the closely related *P. sanguinolentus* and *P. pubescens* in chronological order of description. The "*Hellenus*" group then follows in similar order, viz. *P. hastatoides*, *P. tenuipes*, *P. longispinosus*, *P. brocki*, and *P. emarginatus*. Then follows the "*Achelous*" group represented by *P. granulatus*, the "*Amphitrite*" group represented by *P. gladiator*, *P. rubromarginatus*, and *P. orbitosinus*, concluding with the "*Lupocycloporus*" group represented by *P. gracilimanus*. This allows similar species to appear adjacently.

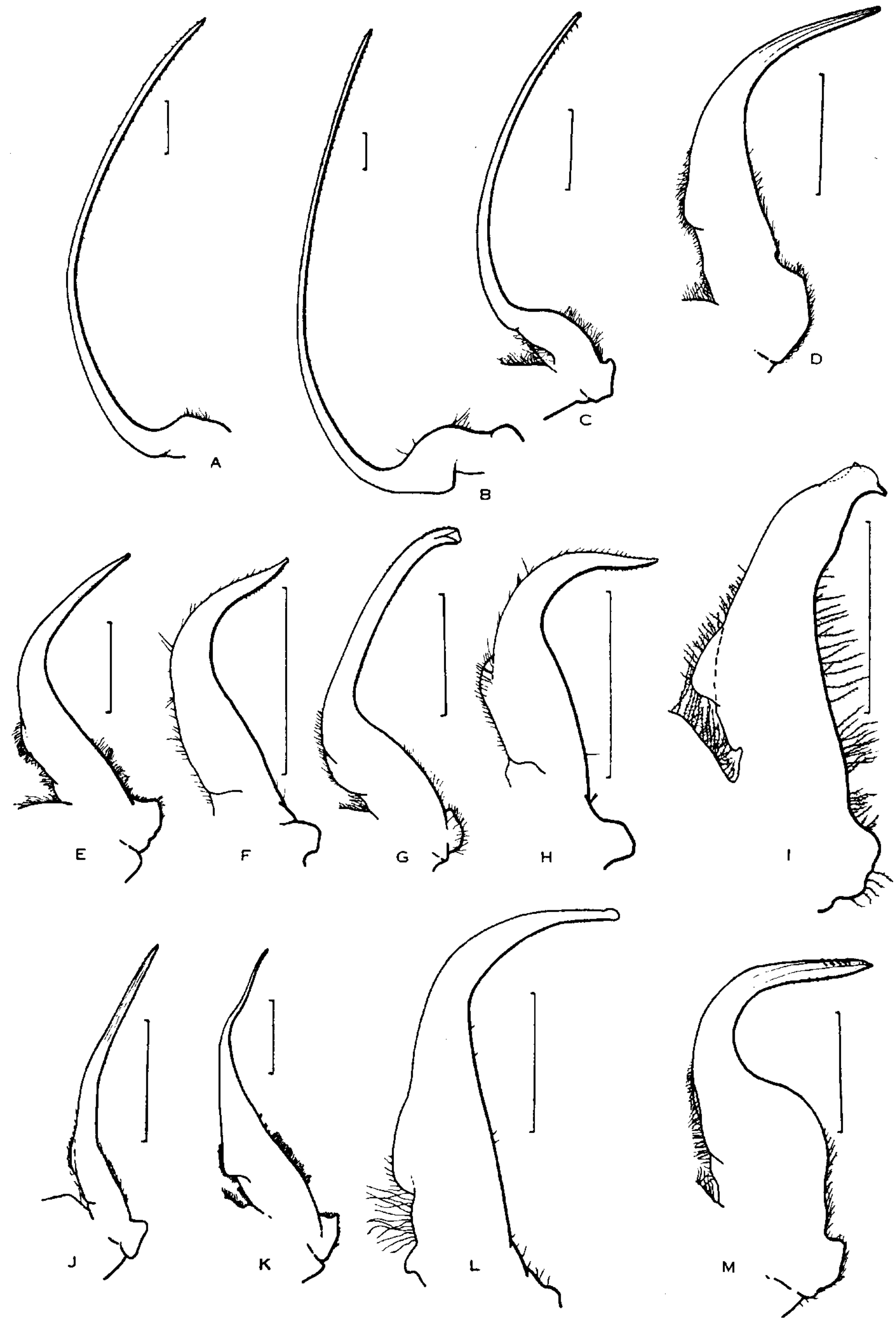

Fig. 2.—First male pleopods; outer surface on right of figure. Scale lines 2 mm. *A*, *P. pelagicus*; *B*. *P. sanguinolentus*; *C*, *P. pubescens*; *D*, *P. hastatoides*; *E*, *P. tenuipes*; *F*, *P. longispinosus*; *G*, *P. brocki*; *H*. *P. emarginatus*; *I*, *P. granulatus*; *J*, *P. gladiator*; *K*, *P. rubromarginatus*; *L*, *P. orbitosinus*; *M*, *P. gracilimanus*.

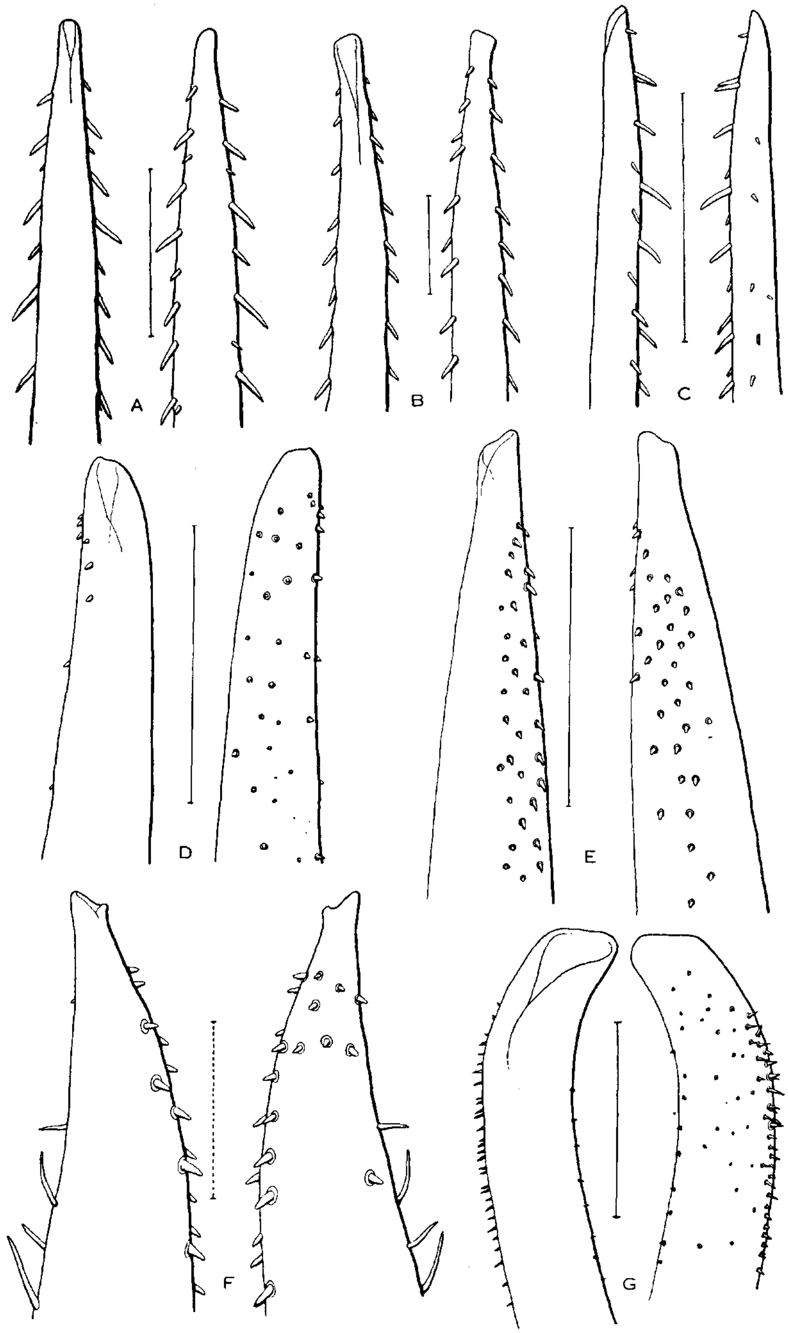

Fig. 3.—Tips of left first male pleopods. The upper surfaces are to the left of the scale lines, the lower to the right. Scale lines 0·5 mm unless otherwise stated. *A, P. pelagicus*; *B, P. sanguinolentus*; *C, P. pubescens*; *D, P. hastatoides*; *E, P. tenuipes* (right pleopod reversed); *F, P. longispinosus* (scale line 0·1 mm); *G, P. brocki.*

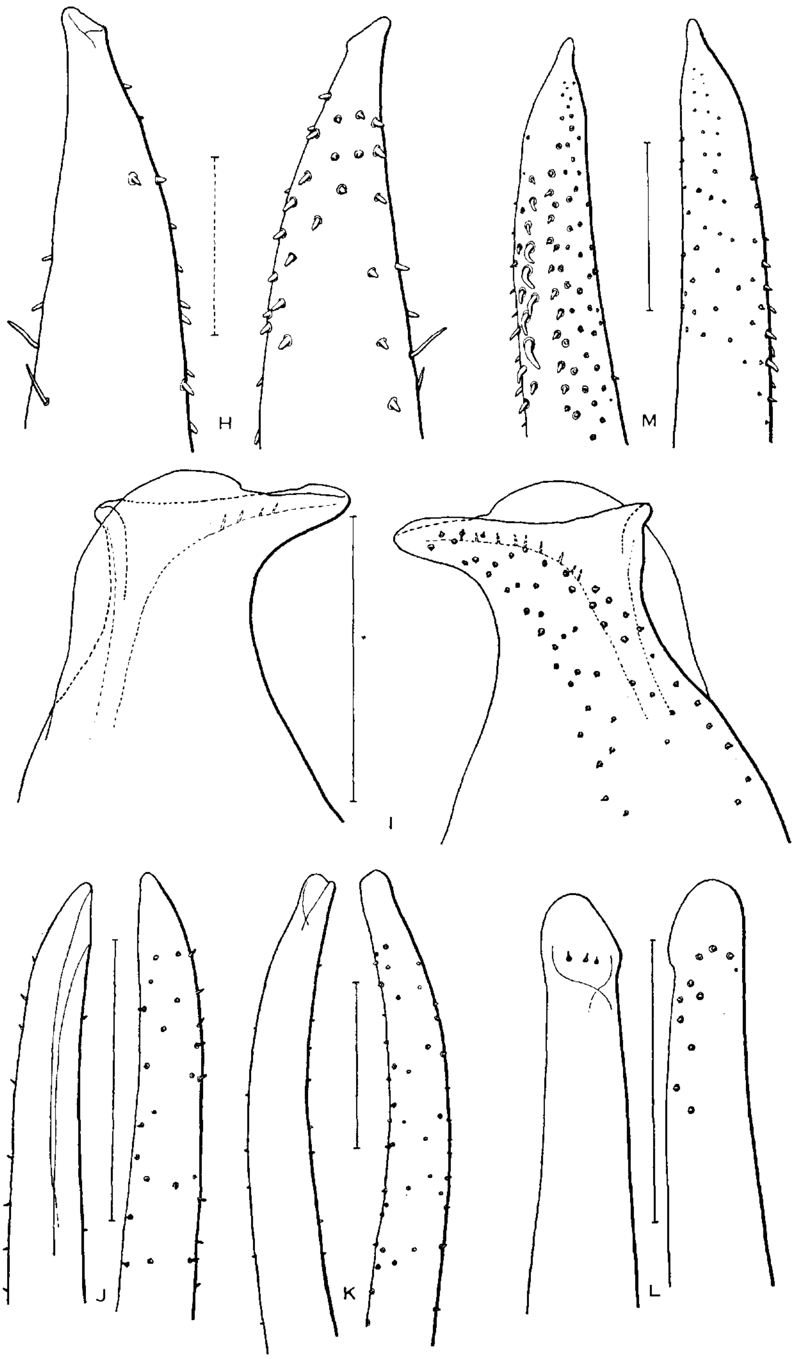

Fig. 3 (*continued*)—Tips of left first male pleopods. The upper surfaces are to the left of the scale lines, the lower to the right. Scale lines 0·5 mm unless otherwise stated. *H*, *P. emarginatus* (scale line 0·1 mm); *I*, *P. granulatus*; *J*, *P. gladiator*; *K*, *P. rubromarginatus*; *L*, *P. orbitosinus*; *M*, *P. gracilimanus*.

PORTUNUS PELAGICUS (Linnaeus)

Figs. 2*A*, 3*A*; Plate 1, Fig. 1; Plates 4*A*, 5*A*

Cancer pelagicus Linnaeus, 1766, p. 1042.

Portunus pelagicus (L.). Fabricius, 1798, p. 367. Hale, 1927, pp. 149–50, fig. 150.

Neptunus pelagicus (L.). De Haan, 1833, pp. 37–8, pls. ix, x. Milne Edwards, A., 1861, pp. 320–1. Miers, 1876*a*, pp. 25–6. Alcock, 1899, p. 34 (lit. and synon.). Calman, 1900, p. 21. Whitelegge, 1900, pp. 154–5. Boone, 1934, pp. 63–7, pls. 21–4. Sakai, 1934, p. 303. Chopra, 1935, pp. 476–7. Sakai, 1936, p. 128, pl. 38. Shen, 1937, p. 101. Sakai, 1939, pp. 387–8, pl. xlix. Chhapgar, 1957, pp. 418–9, pl. *A*, fig. 6, pl. 6, figs. *a*, *b*, *c*.

Lupa pelagica (L.). Milne Edwards, H., 1834, p. 450. Barnard, 1950, pp. 152, 153–4, fig. 27.

Portunus mauritianus Ward, 1942, p. 79, pl. 5, fig. 4.

(?) *Callinectes alexandri* Rathbun, 1907, p. 61, pl. 2, fig. 1, pl. 9, figs. 3, 3*a*, 3*b*; 1911, p. 206, pl. 17, fig. 4.

Material Examined

103 ♂♂ (9–185 mm); 54 ♀♀ (18–170 mm). Smallest ovigerous ♀ 136 mm; ovigerous ♀♀ from October; *Sacculina* infection, 1.

QUEENSLAND: 29 localities from Thursday I. to Southport. NEW SOUTH WALES: 8 localities from Coff's Harbour to Bateman's Bay. LORD HOWE I. SOUTH AUSTRALIA: Spencer Gulf. WESTERN AUSTRALIA: C. Bossut, Roebuck Bay, Exmouth Gulf, Fremantle. NORTHERN TERRITORY: Port Essington, Darwin, Groote I., Sir Edward Pellew Group.

Recorded habitats.—Intertidal, in mud and *Zostera*, shallow pools and under stones, also 3–34 fm.

Material illustrated.—♂ 70 mm, Exmouth Gulf, Dec. 1955–Feb. 1956, W. Dall and O. K. Godfrey (Zool. Dept. Univ. Qld.).

Description

Front.—Four acute tooth-like lobes of which the outer are the larger and more prominent, all lower and more rounded in juveniles.

Anterolateral teeth.—First larger than those immediately after, these becoming progressively more acute. Ninth very large and projecting straight out laterally.

Carapace.—Very broad (breadth from just over 2 to $2\frac{1}{3}$ times length). The anterolateral borders form a broad arc whose centre lies behind the posterior border of the carapace.

Surface granulated and varying from coarse, more widely spaced granules to finer, closer ones, frequently with a short but dense pubescence between the granules. The following carapace ridges are generally recognizable: mesogastrics set at a slight angle to the antero-posterior line; epibranchials; and indistinct metagastrics. The cardiac and each of the mesobranchial areas bear a pair of low granular eminences, indistinct in the mesobranchial areas.

Chelipeds.—Elongate, massive, spinous, and ridged; under surface smooth. Posterodistal border of arm spinous, anterior border with 3 or 4, typically 4, sharp spines. Wrist with inner and outer spines. Upper surface of hand with 3 carinae, typically granular, the middle and inner ones terminating in spines, and with well-marked carinae along the middle of the inner and outer surfaces of the hand. Upper surface of movable finger typically with 3 strong carinae.

Fifth leg.—Posterior surface with fine fringing hairs, no spines or spinules.

Third maxilliped.—Antero-external angle of merus not produced laterally.

Male abdomen.—Gradually tapering, ultimate segment noticeably longer than broad.

First male pleopod.—Long, thin, curved, gradually tapering to a fine and regular tip. Beyond the basal lobes, outer surface bearing short stout spinules which are sparsest on the middle of the appendage and which continue into the terminal armature. Inner surface bare for half-way up, then showing the ends of sparsely distributed bristles which arise a little way in on the under surface. These bristles run as an irregular row to near the tip, where they fuse into the terminal armature. *Terminal bristles on both the outer and inner surfaces* are similar, being regularly arranged, stout, inclined backwards, and becoming smaller towards the tip. In larger specimens there is a roughly alternate arrangement of longer and stouter bristles.

Colour.—When alive, legs blue to lilac with white mottling, carapace purplish brown with pale mottling. After preservation in alcohol the mottling generally remains, but in various shades of brown.

Comments

There is considerable uncertainty as to the distinctness of *P. trituberculatus* (Miers 1876*b*) from the present species. Of the more recent authors Sakai (1939) kept *P. trituberculatus* separate, whereas Barnard (1950) synonymized it with the present species. To judge from Sakai's coloured plate (pl. L) the appearance in life of *P. trituberculatus* is very different from that of *P. pelagicus*, but of the diagnostic features that could be used with preserved material only the frontal teeth appear to be of much value. The other character, viz. finer granulation of the carapace, is present upon some specimens of *P. pelagicus* which have the typical colour and frontal teeth of this species.

P. pelagicus is quite the commonest of the species of this genus in shallow waters in Australia, where it forms the basis of a moderate fishery. The Queensland fishery has been commented upon by Thomson (1951) and it should be noted that the females and *Sacculina*-parasitized males are protected by law. The species is common in shallow, sandy-muddy, inshore waters, but much less common in clearer offshore waters.

According to Mr. E. M. Grant (personal communication) this species commonly rises to the surface after nightfall, swimming powerfully and purposefully, usually with the current.

Distribution

Abundantly recorded in published and present records from within Australia (Haswell 1882*b*; Ortmann 1894; Stead 1898; Calman 1900; Whitelegge 1900; Etheridge and McCulloch 1916; Rathbun 1923, 1924; Hale 1927; Yonge 1930;

Boone 1934; Chopra 1935; Ward 1937; Thomson 1951; Dakin, Bennett, and Pope 1952). The only published record located from Victoria is Ward's (1929, p. 79) statement: "The edible blue crab is recorded from the Bay" (Port Phillip). It is apparently common in Victoria (Miss J. Hope Macpherson, personal communication).

From East Africa (Barnard 1950) to Tahiti and Japan (Sakai 1939) and the Philippines (Miers 1876*a*). At the fringe of the West Pacific area at Hawaii the species seems to be absent (Edmondson 1954). It has migrated through the Suez Canal to the Mediterranean (Holthuis 1956).

Portunus sanguinolentus (Herbst)

Figs. 2*B*, 3*B*; Plate 1, Fig. 2; Plates 4*B*, 5*B*

Cancer sanguinolentus Herbst, 1796, p. 161, pl. viii, figs. 56, 57.

Portunus sanguinolentus (Herbst). Fabricius, 1798, p. 367. Rathbun, 1906, p. 870. Hale, 1927, p. 150, fig. 151. Shen, 1932, pp. 34–6, figs. 2, 3, pl. 7, fig. *a*. Edmondson, 1954, pp. 236–7, figs. 12, 13.

Neptunus sanguinolentus (Herbst). De Haan, 1833, p. 38. Milne Edwards, A., 1861, pp. 319–20. Miers, 1876*a*, p. 26. Alcock, 1899, pp. 32–3 (synon.). Calman, 1900, p. 21. Chopra, 1935, p. 475. Boone, 1938, pp. 223–5, pls. 81–3. Sakai, 1939, p. 387, pl. xlviii, fig. 1. Chhapgar, 1957, pp. 417–8, pl. *A*, fig. 3, pl. 4, figs. *m–o*.

Lupa sanguinolenta (Herbst). Milne Edwards, H., 1834, p. 451. Dana 1852*a*, pp. 271–2. Barnard, 1950, pp. 152, 154–5.

Material Examined

20 ♂♂ (15–145 mm); 16 ♀♀ (24–134 mm). Ovigerous female 122 mm.

QUEENSLAND: Kennedy Sd., Darnley I., Endeavour R., Port Curtis, Double I. Pt., Moreton Bay (Deception Bay, Sandgate). NEW SOUTH WALES: Port Jackson, Broken Bay, Parramatta R. WEST AUSTRALIA: Exmouth Gulf, Geraldton.

Recorded habitats.—None recorded with specimens.

Material illustrated.—Carapace, male abdomen, third maxilliped: ♂ 117 mm, Deception Bay, 24.iii.1951, Patricia Roberts (Zool. Dept. Univ. Qld.). Male pleopod: ♂, 115 mm, Woody Pt., 18.ix.1954, E.M.G. (Zool. Dept. Univ. Qld.).

Description

Front.—Four lobes just less than right angles in small specimens and more acute in larger specimens. Outer lobes broader but barely more projecting than the inner ones.

Anterolateral teeth.—First longer and much more pointed than those immediately after (at least in unworn specimens). Next 7 more or less the same size and shape, while the last is very large and projects straight out laterally.

Carapace.—Very broad, in females breadth about $2\frac{1}{4}$ times and in males $2\frac{1}{4}$–$2\frac{1}{2}$ times length. The anterolateral borders form a broad arc whose centre lies well behind the posterior border of the carapace. Surface finely granular anteriorly, becoming smooth posteriorly. The following carapace ridges are present: mesogastrics, almost joined, forming an arc concave anteriorly; epibranchials; and metagastrics.

Chelipeds.—Elongate, spiny, and ridged; under surface smooth. Postero-distal border of arm smooth, anterior border with 3 or 4 sharp spines. Wrist with inner and outer spines. Upper surface of hand with 3 smooth carinae, the inner ones terminating in spines, and with well-marked carinae along the middle of the inner and outer surfaces of the hand. Fingers very long.

Fifth leg.—Posterior surface with fine fringing hairs, no spines or spinules.

Third maxilliped.—Antero-external angle of merus not produced laterally.

Male abdomen.—Gradually tapering, ultimate segment rounded, as broad as long.

First male pleopod.—Long, thin, curved, gradually tapering to a fine and regular tip. Outer surface bare for the proximal half, then with backwardly directed spines sparsely arranged, which gradually become larger and merge with the terminal armature. Inner surface bare for the proximal three-quarters, then a row of backwardly directed spines which merge with the terminal armature. *Terminal bristles on outer side* stout, regularly arranged, backwardly directed, and of reasonably uniform size. *Terminal bristles on inner side* stout backwardly directed bristles in 2 rows. The row on the extreme lateral surface consists of only some 5 or 6 bristles, but a more abundant row coming from the under surface projects laterally. Both rows appear lateral in a flattened mount.

Colour.—After prolonged preservation in alcohol, brown with three dark blood-red spots on the hinder end of the carapace. There are similar markings on certain of the cheliped joints, as shown in Plate 1, Figure 2. Variable amounts of red are present on the fingers.

Comments

After *P. pelagicus* this is the commonest conspicuous member of the genus in Australia. Typically it occurs in deeper water and cleaner habitats, from which it is brought to surface on rod and line.

According to Mr. E. M. Grant (personal communication) it ascends to the surface at night and swims as does *P. pelagicus.* It is highly prized as food.

Distribution

Published and present records within Australia are from Queensland (Haswell 1882*b*; Calman 1900; Grant and McCulloch 1907; Rathbun 1923), New South Wales (Haswell 1882*a*, 1882*b*), South Australia (Hale 1927), and West Australia (Rathbun 1924).

From East Africa (Barnard 1950) through the Indo-Pacific to Hawaii (Edmondson 1954). Babić (1911) records this species from the Adriatic, where presumably it had been accidentally introduced.

Portunus pubescens (Dana)

Figs. 2*C*, 3*C*, Plate 1, Fig. 3; Plates 4*C*, 5*C*

Lupa pubescens Dana, 1852*a*, pp. 274–5, pl. 16, fig. 9; 1852*b*, p. 84.

Achelous pubescens (Dana). Milne Edwards, A., 1861, p. 342.

Neptunus tomentosus Haswell, 1882*a*, p. 547; 1882*b*, p. 78.

Portunus pubescens (Dana). Rathbun, 1906, p. 870, pl. 14, fig. 1. Edmondson, 1954, pp. 237–8, figs. 12, 13.

Neptunus pubescens (Dana). Sakai, 1934, p. 303; 1939, pp. 388–9, pl. lxxx, fig. 1.

Material Examined

QUEENSLAND: ♂ 33 mm Murray I., Aug.–Oct. 1907, C. Hedley and A. R. McCulloch (Aust. Mus. Reg. No. P2830). NEW SOUTH WALES: ♂ 31 mm, Port Jackson, old coll. (Aust. Mus. cabinet G, drawer 14).

Material illustrated.—Murray I. specimen mentioned above.

Description

Front.—Four bluntly rounded lobes of which the outer are slightly the larger; all protruding well forward of the rounded inner orbital lobes.

Anterolateral teeth.—First broad and large, next 7 equal and sharp, the last distinctly the longest and stoutest, and projecting slightly forward.

Carapace.—Moderately broad (breadth *c.* 1·63 times length). The anterolateral borders form an arc whose centre lies approximately on the posterior border of the carapace. Carapace covered by a short dense pubescence which on removal reveals microscopic granulation and the following ridges: continuous bow-shaped mesogastric, epibranchials, and metagastrics.

Chelipeds.—Pubescent, reasonably short and stout, very spiny, under surface microscopically granulated. Posterodistal border of arm smooth, anterior border with 3 spines. Wrist with 2 spines on the outer side, a carina on the upper surface terminating in a spiniform process, and the 2 usual spines at the hand articulation, the inner of these 2 being very long. Upper surface of hand with 3 carinae, of which the middle and inner are very conspicuous and end in long spines. Well-marked carinae on inner and outer surfaces of hand.

Fifth leg.—Posterior surface with fine fringing hairs, no spines or spinules.

Third maxilliped.—Antero-external angle of merus not produced laterally.

Male abdomen.—Gradually tapering, ultimate segment 1½ times as long as broad.

First male pleopod (based on a single specimen).—Long, thin, curved, gradually tapering to an obliquely ending tip. Beyond the basal lobes the outer surface is bare for the proximal fourth, then bears a row of backwardly directed spines which increase regularly in size. Behind the tip this row passes to the under surface. Inner surface bare for proximal two-thirds, then begins a row of spinules which increase to short outwardly directed spines, these terminating well back from the tip. *Terminal bristles on the outer surface* stout, backwardly directed, and in general becoming larger and more widely spaced towards the tip. *Terminal bristles on the inner surface*: none present, and no signs of accidental loss.

Comments

Haswell's (1882*a*) separation of *Neptunus tomentosus* from *P. pubescens* is based upon the former having more rounded frontal teeth and shorter anterolateral teeth.

In Sakai's (1934) figured specimen and in the present specimens the frontal teeth are reasonably rounded. This and the slightly shorter anterolateral teeth are well within the range of variation to be expected within a single species. The dried specimen in the older collections of the Australian Museum labelled "*Neptunus tomentosus*" is most probably Haswell's type, and can be referred to *P. pubescens* without hesitation.

Haswell's specific description gives eight instead of the usual nine anterolateral teeth; nine are present in the above specimen. As Gordon (1938) has pointed out, Haswell probably excluded the outer orbital lobes in his count. If so, this would be an error of haste or oversight, because Haswell (1882*b*, p. 76) lists as a feature of *Neptunus* "latero-anterior margins with nine or more teeth (including the external orbital angle) . . . "

Distribution

Previously recorded in Australia from Port Jackson (Haswell 1882*a*, 1882*b*). Hawaii; "not uncommon on the reef . . . where it conceals itself in the sand" (Edmondson 1954). The Sandwich Is., Japan; "mud or sandy mud, 20 to 30 metres deep" (Sakai 1939).

PORTUNUS HASTATOIDES Fabricius

Figs. 2*D*, 3*D*; Plate 1, Fig. 4; Plates 4*D*, 5*D*

Portunus hastatoides Fabricius, 1798, p. 368.

Neptunus (*Amphitrite*) *hastatoides* (Fabricius). De Haan, 1833, pp. 39–40, pl. 1, fig. 3. De Man, 1895, pp. 557–8.

Neptunus (*Hellenus*) *hastatoides* (Fabricius). Alcock, 1899, pp. 38–9 (synon.). Laurie, 1906, pp. 414, fig. 8. Sakai, 1934, p. 303. Chopra, 1935, pp. 477–8. Sakai, 1936, p. 130. Shen, 1937, pp. 106–7. Sakai, 1939, pp. 391–2, pl. xlvii, fig. 1.

Neptunus (*Hellenus*) *hastatoides* var. *unidens* Laurie, 1906, pp. 414–5.

Hellenus hastatoides (Fabricius). Barnard, 1950, pp. 158–9.

Material Examined

16 ♂♂ (17–47 mm); 5 ♀♀ (21–39 mm). Ovigerous ♀ 30 mm Dec.-Feb.

QUEENSLAND: Magnetic I., near Townsville, Moreton Bay (Woody Pt., Pearl Banks). WEST AUSTRALIA: Roebuck Bay, Ninety-Mile Beach between Cape Jaubert and Wallal, Exmouth Gulf. NORTHERN TERRITORY: Darwin.

Recorded habitats.—Trawled and dredged in soft mud, sandy mud, and shelly mud, 3–9 fm.

Material illustrated.—♂ 43 mm, 3½ miles S. Woody Pt. pier, 2.xi.1952, E.M.G. (Zool. Dept. Univ. Qld.).

Description

Front.—Four acute but somewhat rounded lobes, of which the outer are very much larger than the inner.

Anterolateral teeth.—Increasing in acuteness from front to rear, with the last a very long sharp spine directed straight outwards.

Carapace.—Very broad (breadth from 2 to 2·4 times length). The anterolateral borders merge into the ninth anterolateral tooth to form a *concave* arc. Posterior–posterolateral junction an acute spine. Surface with conspicuous elevated granular areas, almost hidden by a dense pubescence in some specimens. Granules on elevated areas smooth, rounded and regular. All the areas indicated in Figure 1*B* are recognizable, with the protogastrics and mesogastrics practically confluent. Mesobranchials resolvable into 3 areas. Posterolaterals confluent with epibranchials.

Chelipeds.—Elongate, slender, with rounded granules sometimes obscured by a dense felting, but always visible on the under surface. Posterodistal end of arm with 2 long sharp spines, anterior border with 4 spines. Upper surface of wrist with granulated carinae, 2 usual spines present. Hand long and slender, upper surface with 3 low granulated carinae, of which only the inner terminates in a spine. Carina on outer surface of hand well developed, but that on inner surface relatively ill developed. Fingers very long and slender.

Fifth leg.—Posterodistal border of merus serrated. Remaining segments bearing only hairs.

Third maxilliped.—Antero-external angle of merus strongly produced in a lateral direction.

Male abdomen.—⊥-shaped, penultimate segment twice as long as broad.

First male pleopod.—Short, stout, strongly curved. Beyond the basal lobes apparently bare on both sides up to the terminal armature. Inner surface actually bears minute, almost invisible, sparsely distributed, short fine hairs. On the under surface spinules begin as a single row about half-way up the appendage, this widening into a scattered field covering the entire under surface and merging with the terminal armature. *Terminal bristles* short, stout spinules directed slightly backwards. These are sparsely and irregularly distributed on the under surface and come to the lateral surfaces near the tip, where approximately 2 are visible on the inner surface and one on the outer.

Comments

In spite of the paucity of previous Australian records, this species has appeared fairly commonly in recent collections from the warmer inshore waters around the continent. Sakai gives its habitat as " . . . muddy bottoms 30 to 100 metres deep".

The ornamentation of the posterodistal border of the merus of the fifth leg is diagnostic.

Distribution

Previous Australian records are: Friday I., Torres Strait, Arafura Sea (Miers 1884); North Australia (Henderson 1893).

From the coast of Zululand (Barnard 1950) to Japan (Sakai 1939) and the Philippines (Balss 1922), but not from the Red Sea (Stephensen 1945) nor Hawaii (Edmondson 1954).

PORTUNUS TENUIPES (de Haan)

Figs. 2*E*, 3*E*; Plate 2, Fig. 1; Plates 4*E*, 5*E*

Amphitrite tenuipes de Haan, 1833, p. 39, pl. 1, fig. 4. Haswell, 1882*b*, p. 83.

Neptunus tenuipes (de Haan). Milne Edwards, A., 1861, pp. 335, 339. Ortmann, 1893, p. 74.

Neptunus (*Amphitrite*) *tenuipes* (de Haan). Thallwitz, 1891, p. 48. Sakai, 1939, pp. 389–90, pl. lxxx, fig. 2.

Neptunus (*Hellenus*) *tenuipes* (de Haan). Alcock, 1899, p. 42. Shen, 1937, p. 104, figs. 4, 8.

Material Examined

QUEENSLAND: ♀ 16 mm, Albany Passage, Cape York, Aug.–Oct. 1907, C. Hedley and A. R. McCulloch (Aust. Mus. Reg. No. P3118); ♀ 13 mm, fragmented, near Booby I., dip net and submarine light on surface, "Stanley" trawler, 21.x.1949, collection G. P. Whitley (Aust. Mus.); ♂ 40, ♂ 42 mm near Batt Reef, 1.iv.1958, otter trawl in 20 fm on coral sand bottom, collection N. Haysom, *Challenge* survey (Zool. Dept. Univ. Qld.). WEST AUSTRALIA: ♂ 42 mm, Exmouth Gulf, June–Sept. 1954, per Fisheries Division, C.S.I.R.O., otter trawl, 5–10 fm (Zool. Dept. Univ. Qld.); ♂ incomplete, Lugger Cove, Cygnet Bay, NW. Australia, surface dip net and lamp, 15.x.1949, pres. C.S.I.R.O. Fisheries Division (Aust. Mus. Reg. No. P12499).

Material illustrated.—Exmouth Gulf specimen, see above.

Description

Front.—Three-toothed, with all teeth somewhat projecting, the laterals much broader than the median.

Anterolateral teeth.—First broad and blunt, the next 7 increasing in sharpness, the last much the longest and directed slightly backwards.

Carapace.—Moderately broad (breadth twice or just less than twice length) with very large orbits. Anterolateral borders form a curve whose centre lies just behind the cardiac region. Posterior–posterolateral junction elevated to form a short ridge bearing an almost right-angled border. Surface with well-defined granular elevations, between which is a fine pile of hairs. All the areas shown in Figure 1*B* are present and in addition a pair of postfrontals. The protogastric is almost split into 2 areas, the mesogastric is split into 3, the metagastric into 2, and the meso-branchial into 3 or 4. There are 2 distinct anterolateral clumps and a small postero-lateral. The posterior border of the carapace is beaded.

Chelipeds.—Elongate, with granules showing through a tomentum on the upper surface and with granules or squamiform markings on the under surface. Postero-distal border of the arm bearing 1 spine, sometimes almost obsolescent, anterior border bearing 3 or 4 spines. Wrist with the 2 usual spines and granular carinae. Upper surface of hand bearing 3 granular carinae, of which only the innermost ends in a spine. Dactyl with granular carinae on upper surface.

Fifth leg.—Posterodistal border of merus finely serrated.

Third maxilliped.—Antero-external angle of merus with a flattened expansion directed more forwards than laterally.

Male abdomen.—Penultimate segment tapering abruptly and with slightly concave borders in distal third. Ultimate segment much longer than broad, and broadly rounded. (In Shen's (1937) figure 4*b* the ultimate segment is only slightly longer than broad, and much shorter than in the present specimens.)

First male pleopod.—Short, stout, moderately strongly curved, with a slightly transverse tip. Beyond the basal lobes short, stout, backwardly directed spinules begin as a single row on the under surface of the appendage, about one-third of the way up from the base, and spread to form a wide band covering the under surface almost to the tip and spreading to give the terminal armature. *Terminal bristles on the outer side:* in one specimen, evidently relatively undamaged, the short backwardly directed spinules of the under surface appear in lateral view about two-thirds of the way up, a total of *c.* 27 being visible. In another specimen (the largest) only *c.* 6 are visible. Shen (1937, fig. 8*a*) shows 13 such bristles. *Terminal bristles on the inner side:* in both specimens 4–5 spines from the under surface are visible in lateral view behind the tip. Shen (1937, fig. 8*b*) shows 2 such bristles.

Comments

This species is particularly difficult to fit into any of the accepted subgenera, in that the antero-external angle of the third maxillipeds is not produced laterally to anything like the extent of either *Monomia* = *Amphitrite* or *Xiphonectes* = *Hellenus*. It is probably closer to *Xiphonectes*, but is atypical in a second important character, viz. the junction between posterior and posterolateral borders of the carapace is not an acute spine but much closer to a right-angled or even slightly obtuse-angled ledge.

Distribution

The only previous Australian records are from Bowen and Darnley I. (Haswell 1882*b*). From the central part of the Indo-West-Pacific area ranging from the Andamans (Alcock 1899) to Japan and the Philippines (Sakai 1939).

PORTUNUS LONGISPINOSUS (Dana)

Figs. 2*F*, 3*F*; Plate 2, Fig. 2; Plates 4*F*, 5*F*

Amphitrite longispinosa Dana, 1852*a*, pp. 277–8, pl. 17, fig. 2; 1852*b*, p. 84.

Amphitrite vigilans Dana, 1852*a*, p. 278; 1852*b*, p. 84.

Neptunus longispinosus (Dana). Milne Edwards, A., 1861, pp. 337, 339.

Xiphonectes leptocheles Milne Edwards, A., 1873, p. 159, pl. iv, fig. 1.

Neptunus (Hellenus) longispinosus (Dana). Alcock, 1899, pp. 40–2 (lit.; synon. doubtful). Sakai 1939, pp. 392–3, pl. lxxxi, fig. 4.

Portunus (Xiphonectes) longispinosus (Dana). Rathbun, 1906, p. 871, pl. xii, fig. 6. Edmondson, 1954, pp. 241–2, figs. 18, 19.

Material Examined and Illustrated

LORD HOWE I.: ♂ 14 mm, ♀ *c.* 17 mm (fragmented), 4 fm, coll. A. A. Livingstone, April 1933 (Aust. Mus. Reg. No. P10335).

Description

The description is a composite one taken from the two specimens, both of which are incomplete.

Front.—Four-lobed, all lobes low-set and rounded, the laterals very much broader than the medians.

Anterolateral teeth.—In both specimens 8 on the right, the fourth of those normally present being missing; 9 on the left, of which the fourth is very small and the sixth also small. The first tooth is blunt, the last is very clongate, and the remainder vary in length and sharpness.

Carapace.—Very broad (breadth *c.* $2\frac{1}{2}$ times length). The anterolateral borders (excluding the ninth tooth) form a fairly narrow arc whose centre lies just behind the cardiac region. Posterior–posterolateral junction an elevated region with an angle of approximately 90°. Carapace with elevated granular areas, the main ones being: gastric, 2 epibranchials, cardiac, 3 postcardiacs, and 2 posterolaterals. Within these the protogastrics are each 2 ill-defined areas, the lateral portions of the mesogastrics are distinctly separated from the central portion, the metagastrics are a pair of granular crests, and the cardiacs are conspicuously elevated and separated in the mid line. The anterolaterals are diffuse, the epibranchials a granulated crest, the mesobranchials each have 2 ill-defined granular areas, while the posterolaterals are larger and more conspicuously elevated than usual.

Chelipeds.—Elongate and slender. Posterodistal border of arm with a single spine, anterior border with 4 spines. Wrist with 2 usual spines, of which the inner is much the larger. Upper surface of hand with 3 carinae, of which the 2 inner ones end in spines.

Fifth leg.—Posterodistal border of merus very finely serrated.

Third maxilliped.—Antero-external angle of merus produced forwards.

Male abdomen.—Penultimate segment tapering gently, with slightly concave borders and slightly longer than broad. Ultimate segment rounded and slightly longer than broad. (There are minor differences between the shape of the male abdomen of the present specimens and Rathbun's (1906, fig. 30), e.g. curvature of boundary between ultimate and penultimate segments.)

First male pleopod.—Short and robust, curving smoothly but sharply to an oblique and slightly flared tip. Beyond the basal lobes on the outer surface bare to just behind the tip. Inner surface bare for the first third, from there to the end there is a regular series of 13 hairs of which the first 2 point outwards and the remainder towards the tip. *Terminal bristles on the outer side:* 14 spinules in 2 rows extending almost to the tip. *Terminal bristles on inner side:* an apparently bare area showing the tip of a spinule from the under surface, followed by 2 more or less outwardly directed bristles and numerous recumbent bristles.

The under surface is without bristles except at the tip, the spinules beginning on the outer lateral surface and spreading to the inner surface as 2 indistinct rows just behind the tip. From the under view 3 spinules are visible near the inner surface.

Comments

P. macrophthalmus, *P. longispinosus*, and *P. emarginatus* all have somewhat similar pleopods, viz. short, robust, markedly curvate, and bearing a series of moderately elongate hairs on the inner surface. The spinulation on the under surface affords a clear distinction between *P. longispinosus* and *P. emarginatus* (see below). Existing figures of *P. macrophthalmus* (Edmondson 1954, figs. 18*e*, 18*f*) are not detailed enough for exact comparison, but no spinulation or terminal armature of any kind is shown.

Distribution

Not previously recorded from Australia, but known in the Indo-West-Pacific from the Persian Gulf and Mauritius (Alcock 1899) to Japan (Sakai 1939), New Caledonia (Milne Edwards 1873), and Hawaii (Edmondson 1954).

PORTUNUS BROCKI (de Man)

Figs. 2*G*, 3*G*; Plate 2, Fig. 3; Plates 4*G*, 5*G*

Neptunus brockii de Man, 1887*a*, pp. 328–31, pl. xiii, fig. 4.

Neptunus (*Hellenus*) *brockii* de Man. Alcock, 1899, pp. 43–4. Shen 1937, p. 111, figs. 7, 8*e*, 8*f*.

Material Examined and Illustrated

QUEENSLAND: ♂ 28 mm, fragmented, Dunk I., Family Group, pres. Nov. 1912, E. J. Banfield (Aust. Mus. Reg. No. P3211).

Description

Front.—In the present specimen with 4 very flat and indistinct lobes, the laterals the broader. (Alcock describes the front as "a simple lamina" and Shen as "undulating".)

Anterolateral teeth.—Increasing in sharpness from front to rear, the last large and directed laterally.

Carapace.—Reasonably broad (breadth slightly less than twice length). Anterolateral borders forming an arc whose centre is just behind the cardiac region. Posterior–posterolateral junction approximately right-angled. Surface with conspicuously elevated patches, whose granulation is not always distinct and which are separated by areas of fine pubescence. All those shown in Figure 1*B* are recognizable. Frontal elevations indistinct. Protogastrics a single diffuse mass. Mesogastrics in the form of an arrow pointing backwards and merging with the single metagastric. Cardiacs and postcardiacs well developed. Mesobranchials obscurely divided into three. Posterolateral area restricted, anterolateral area with broad band of granulations.

Chelipeds.—Moderately stout, granulated, and tomentose. Posterior border of arm in present specimen with 2 lobulated teeth. (According to Shen the distal one would normally be spiniform.) Anterior border of arm with 2 spines (2 or 3 according to Shen). Wrist with inner spine present, outer one reduced to a lobule. Hand with the 3 upper carinae, less conspicuous than usual, with the innermost ending in a spiniform lobule. Carina on outer surface distinct and granulated, that on the inner surface barely recognizable. Fingers short and stout.

Fifth leg.—With the normal fringing bristles.

Third maxilliped.—Extremely hirsute, with an anterolateral production of the merus.

Male abdomen.—Penultimate segment with slightly convex border, maximum breadth a little over twice that of ultimate segment. Shape very similar to that of *P. granulatus*.

First male pleopod.—Curved, stout, and bluntly ending. Just beyond the basal lobes on the inner side there is an area of closely packed short spinules. These extend right along the appendage, becoming smaller and more distantly spaced towards the tip. Inner surface bare for the proximal half, then bearing short spinules which become longer, more hair-like, and more closely packed towards the tip. The under surface of the appendage bears numerous small spinules which are in continuity with the area on the proximal portion of the outer surface. *Terminal bristles on the outer side:* minute, backwardly directed spinules commencing some distance behind the tip. *Terminal bristles on the inner side:* numerous short hairs beginning a short distance behind the tip. (Shen's figures 8*e*, 8*f* show a generally similar form of the appendage, but not the proximal area of fine spinules nor the distinction between the outer spinules and inner hairs near the tip.)

Distribution

Not previously recorded from Australia and known only from Amboina (de Man 1887*a*), the Andamans (Alcock 1899), and Singapore (Shen 1937).

Portunus emarginatus, sp. nov.

Figs. 2*H*, 3*H*; Plate 2, Fig. 4; Plates 4*H*, 5*H*

Material Examined and Illustrated (Holotype)

QUEENSLAND: ♂ 15 mm, Darnley I. (Previously identified by M. Ward as "*Xiphonectes leptocheles*? A.M.E.") (Macleay Museum.)

Description

Front.—Four flat rounded lobes, the medians very much smaller than the laterals.

Anterolateral teeth.—First large and blunt, the fourth and sixth noticeably smaller than the remainder, the ninth extremely long.

Carapace.—Extremely broad (breadth 2·4 times length), bearing very large orbits. Anterolateral borders concave anteriorly and the posterior–posterolateral junction approximately a right angle. Finely pubescent and with elevated granular areas. These consist of frontals, a large gastric mass with subregions ill defined, a single median cardiac, 3 postcardiacs, mesobranchials divided into 2, broad anterolaterals, conspicuous epibranchials, and broad posterolaterals. The posterior border is finely beaded.

Chelipeds.—Elongate, slender, and granular. Posterodistal border of the arm bearing a lobule followed by a blunt spine. Anterior border of the arm with 4 spines. Two usual wrist spines are elongate. Upper surface of hand with only 2 carinae, each ending in a conspicuous spine. The usual carinae are present on inner and outer surfaces of hand. Movable finger less grooved than normal.

Fifth leg.—Posterodistal border of merus finely serrated.

Third maxilliped.—Antero-external angle produced forwards but not laterally.

Male abdomen.—Penultimate segment with borders extremely concave and broader than long; ultimate segment rounded and about as broad as long.

First male pleopod.—Short and robust, curving smoothly but sharply to an oblique and slightly flared tip. Beyond the basal lobes on the outer surface bare to just behind the tip. Inner surface bare for the first third, from there to the end is an irregular series of hairs of which the second is extremely large and conspicuous. *Terminal bristles on the outer side:* 12 microscopic spinules in 2 rows extending almost to the tip. *Terminal bristles on the inner side:* a bare area followed by 2 backwardly directed spinules one above the other, then by a sparse row of forwardly directed hairs.

The spinules visible at the tip are part of a series beginning on the under surface approximately half-way back and becoming denser and more widespread immediately behind the tip, here passing conspicuously to the outer side but only just to the inner side.

Colour.—Dried specimen with dark patches on fingers and middle of hand of the cheliped, also dark bands on the legs and across the propodus of the fifth leg. Dark margins to the gastric regions of the carapace just above the epibranchial and round the median postcardiac area.

Comments

This species is close to *P. macrophthalmus* Rathbun and to *P. longispinosus* (Dana) in the structure of the male pleopods and in having an irregular series of anterolateral teeth. It further resembles *P. longispinosus* in having two spines on the upper surface of the hand of the cheliped, and *P. macrophthalmus* in the concavity of the lateral borders of the penultimate segment of the male abdomen. The species is distinguished by the shape of this structure (hence the specific name) and by the details of male pleopod structure.

PORTUNUS GRANULATUS (Milne Edwards, H.)

Figs. 2*I*, 3*I*; Plate 3, Fig. 1; Plates 4*I*, 5*I*

Lupea granulata Milne Edwards, H., 1834, p. 454.

Achelous granulatus (Milne Edwards, H.). Milne Edwards, A., 1861, p. 344.

Neptunus (Achelous) granulatus (Milne Edwards, H.). Ortmann, 1893, p. 72. Alcock, 1899, pp. 45–6 (lit. and synon.). Boone, 1934, pp. 61–2, pl. xx. Sakai, 1939, p. 397, pl. lxxxi, fig. 3.

Portunus (Achelous) granulatus (Milne Edwards, H.). Rathbun, 1906, p. 871, pl. xli, fig. 6; 1911, p. 205, pl. xv, fig. 10. Balss, 1938, p. 31. Edmondson, 1954, p. 239.

Material Examined

19 ♂♂ (21–26 mm); 4 ♀♀ (11–23 mm).

QUEENSLAND: Darnley I., Morris I. (Claremont Group), Murray I., Low Isles, Cairns, Port Denison, Heron I., North West I. NEW SOUTH WALES: Port Jackson.

Recorded habitats: Dredged, 5–7 fm.

Material illustrated: ♂ 26 mm, Heron I., Aug. 1948, coll. I. M. and M. J. Mackerras (Zool. Dept. Univ. Qld.).

Description

Front.—Two broad, reasonably sharp lateral lobes and a central mass consisting of 2 lobes which fuse medianly and on a lower plane. Depending upon the aspect, this central area could be described as a single lobe, 2 lobes, or even 3.

Anterolateral teeth.—Approximately of equal size, the first the broadest, the fourth usually the smallest, the last slightly the most protruding.

Carapace.—Narrow (breadth *c.* $1\frac{1}{2}$ times length). Anterolateral borders form a narrow arc whose centre lies a little forward of the cardiac region. Posterior–posterolateral junction rounded. Surface covered with close-packed granulated areas with a fine pubescence among the granules. All the areas indicated in Figure 1*B* are present excepting the frontals and orbitals, but are not very clearly recognizable in the more hirsute specimens. Protogastrics each as 2 confluent patches; meso- and metagastrics fused, but the latter with a prominent anterior margin almost forming a ridge; cardiac almost divided in the mid line; postcardiacs very prominent; anterolaterals well developed and sharply marked off from an unnamed area just behind, which in turn merges with an indistinctly subdivided epibranchial and mesobranchial area; posterolateral area extensive.

Chelipeds.—Elongate, granular, and hirsute, except on under surface which is polished and pitted. Two spines on the posterior border of the arm, one two-thirds of the way along and one distal. Anterior border of arm with spines set among spiniform granules. The spines become smaller proximally and merge into tubercles, approximately 5 spines and up to 2 tubercles being present. Wrist with the 2 usual spines. Hand with 3 usual upper carinae, the innermost being much the best developed and the only one terminating in a spine. Outer carinae very well developed, inner one not recognizable amongst the lines of tubercles.

Fifth leg.—With the usual fringing hairs.

Third maxilliped.—Antero-external angle of merus acutely produced in a lateral direction.

Male abdomen.—Penultimate segment with slightly convex borders, maximum breadth a little over twice that of ultimate segment. Shape very similar to that of *P. brocki*. (The ultimate segment in the present specimens is longer than figured by Sakai (1939, text fig. 86). The penultimate segment as figured by Gordon (1938, fig. 6*b*) has much less convergent sides.)

First male pleopod.—Short, stout, with an undulating outer side and widely flared tip. Continuing from the basal lobes on both outer and inner sides there is a row of bipinnate hairs which extend about two-thirds of the way up the appendage. No terminal armature is visible in profile view, but on the under surface there are small backwardly directed spinules which begin about one-fourth of the way down the appendage and extend to form numerous irregular rows. These terminate on the level of the larger of the flared lips and extend across the entire under surface. Within the lips the forwardly directed surface of the larger lip bears a series of fine, small, hair-like bristles, of which approximately 9 are visible in profile view.

Comments

The first male pleopod has been figured by Gordon (1938, fig. 5*e*) with the flared lip imperfectly shown, and by Edmondson (1954, fig. 16*b*), whose figure is barely recognizable. The pleopod is quite unlike that of any other species of *Portunus* so far figured, and in the form of the tip shows resemblances to the genus *Charybdis* (see Stephenson, Hudson, and Campbell 1957, fig. 3). However, it possesses a much wider flare, and is somewhat reminiscent of *Thalamita sexlobata* and *T. sima* (see Stephenson and Hudson 1957, figs. 3*b*, 3*c*).

Distribution

Published and present records within Australia are from Queensland (Calman 1900; Boone 1934), New South Wales (present records), West Australia (Rathbun 1924), and North Australia (Henderson 1893).

Outside Australia extending from Mauritius, Madagascar, and the Red Sea to Hawaii, Samoa, and Fiji (fide Sakai 1939).

PORTUNUS GLADIATOR Fabricius

Figs. 2*J*, 3*J*; Plate 3, Fig. 2; Plates 4*J*, 5*J*

Portunus gladiator Fabricius, 1798, p. 368.

Cancer menestho Herbst, 1803, p. 34, pl. lv, fig. 3.

Portunus (Amphitrite) gladiator Fabricius. De Haan, 1833, p. 39, pl. i, fig. 5.

Lupea gladiator (Fabricius). Milne Edwards, H., 1834, p. 456.

Neptunus gladiator (Fabricius). Milne Edwards, A., 1861, pp. 330, 339. De Man, 1897*b*, pp. 69–70.

Neptunus (Amphitrite) gladiator (Fabricius). Alcock, 1899, pp. 35 6 (lit. and synon.). Balss, 1922, p. 107. Shen, 1937, pp. 101–3, fig. 2. Sakai, 1939, pp. 390–1, pl. xlvii, fig. 3.

non *Portunus (Amphitrite) gladiator* de Haan, 1833, p. 65, pl. xviii, fig. 1 (= *P. orbitosinus* Rathbun).

Material Examined

WESTERN AUSTRALIA: ♂ 28 mm, Ninety-Mile Beach between Cape Jaubert and Wallal, dredged 5 fm, Sept. 1929 (Aust. Mus. Reg. No. P12602). ♀ 44 mm, dredged between C. Bossut and Broome, 5 fm, 11.ix.1929 (Aust. Mus. Reg. No. P12596).

Material illustrated.—Ninety-Mile Beach specimen.

Description

Front.—Four-lobed, the medians acute, the laterals right-angled and much broader.

Anterolateral teeth.—First stout and blunt, then increasing in size and sharpness to the eighth, the ninth a long spine directed outwards.

Carapace.—Moderately broad (breadth *c.* 1·8 times length). Anterolateral borders form an arc whose centre lies behind the cardiac region. Posterior–postero-lateral junction rounded and with a right-angled projection on a lower plane. Surface covered with widely spaced, very conspicuously granular areas, these being separated by regions with a dense pubescence. All the areas shown in Figure 1*B* are present except that the frontals and orbitals are sometimes absent. Protogastrics almost subdivided into 2, the posterior portion merging with the transverse mesogastric, giving a semblance to a granulated ridge; the anterior portion of the metagastrics gives a similar appearance; ill-defined separation between the two halves of the cardiac region; 3 distinct postcardiacs; anterolaterals with a more or less discrete patch opposite each tooth; epibranchials distinct; each mesobranchial consisting of 3 or 4 distinct patches; posterolaterals small; posterior border of carapace finely beaded.

Chelipeds.—Stout, pubescent, and granular, with squamiform markings on under surface. Posterodistal border of arm with 2 large spines, anterior border with 4. Wrist with the 2 usual spines; the outer being more than usually developed. Three usual carinae on the upper surface of the hand, of which only the innermost ends in a spine. Carina on outer surface of hand very distinct, that on inner surface barely recognizable.

Fifth leg.—Posterodistal border of merus serrated, the last 1 or 2 serrations being spiniform.

Third maxilliped.—Antero-external angle of merus produced laterally.

Male abdomen.—⊥-shaped, penultimate segment less than twice as long as broad, ultimate segment twice as long as broad. (The male abdomen in the present specimen is longer and narrower than figured by Sakai (1939, text fig. 5*a*) or by Shen (1937, fig. 2*b*).)

First male pleopod.—Short, only slightly curved, and regularly tapering to a rounded end. Beyond the basal lobes on the outer surface backwardly directed spinules begin about half-way up the appendage as a fairly dense row which becomes sparser and continues to just behind the tip. Inner surface bare until the distal third, where backwardly directed, sparsely arranged, small spines (some 6 in number) continue to just behind the tip. Tip itself bare in profile view apart from the above bristles. On the upper surface backwardly directed spinules begin about one-third of the way up the appendage and continue mostly nearer the inner edge but eventually give a sparse cover to the whole under surface in the region behind the tip.

Comments

The ♀ 44 mm, P12596, is abnormal in having only 8 teeth on the right anterolateral border, the fourth of those normally present being represented only by a small spine distinctly median to the carapace margin.

Distribution

Although Sakai (1939) lists Queensland in his distributional data, the nearest acceptable published record the present authors have obtained lies nearer New Guinea (Miers 1886).

Known from Mauritius to Japan (Sakai 1939).

PORTUNUS RUBROMARGINATUS (Lanchester)

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

Achelous rubromarginatus Lanchester, 1900, pp. 746–7, pl. 46, fig. 8.

Neptunus (Amphitrite) rubromarginatus (Lanchester). Shen, 1937, p. 104.

Material Examined

30 ♂♂ (15–54 mm); 22 ♀♀ (13–50 mm). Ovigerous ♀ 38 mm from Aug.–Sept.

QUEENSLAND: Albany Passage, Albany I., Palm I., Port Denison, Mackay, Prudhoe I., Scawfell I., Port Curtis, Moreton Bay (Dunwich, Woody Point). NEW SOUTH WALES: Port Jackson. WESTERN AUSTRALIA: Cygnet Bay, C. Jaubert, Wallal, Marat I., Exmouth Gulf.

Recorded habitats.—Trawled, sandy mud, 3–12 fm.

Material illustrated.—♂ 51 mm, 3½ miles S. Woody Point pier, 19.x.1952, E.M.G. (Zool. Dept. Univ. Qld.).

Description

Front.—Four-lobed, the 2 medians distinct and acute, the laterals right-angled and much broader.

Anterolateral teeth.—Approximately of equal size, the first broad and blunt, the next 7 subequal, the last distinctly the broadest and most protruding, and directed slightly forwards.

Carapace.—In most specimens narrow (breadth *c.* 1½ times length). In some smaller specimens moderately broad (just less than twice length). Anterolateral borders form a reasonably narrow arc whose centre lies just behind the cardiac region. Posterior–posterolateral junction rounded and with a rounded projection on a lower plane. Surface covered with widely spaced very conspicuously granulated areas, these being separated by regions with a dense pubescence. All the areas shown in Figure 1*B* are present. Frontals lie a little behind the elevated border; the orbitals lie on this border; protogastrics subdivided; mesogastrics subdivided into central area and a pair of laterals; a pair of metagastrics; a pair of cardiacs; 3 distinct postcardiacs; anterolaterals with a more or less discrete patch opposite each tooth; epibranchial distinct; mesobranchial consisting of 4 discrete patches; posterolaterals small; posterior border of carapace finely beaded.

Chelipeds.—Pubescent and with squamiform granulation. Posterodistal border of arm with a single spine, just proximal to which a beaded carina reaches the lower margin. Anterior border of the arm with 3–5 spines. Wrist with the 2 usual spines, each marking the end of a beaded carina. Upper surface of hand with the 3 usual carinae, each granular, but only the innermost ending in a spine. Carina on outer surface distinct and granular, that on the inner surface barely recognizable.

Fifth leg.—Posterodistal border of merus very finely serrated.

Third maxilliped.—Antero-external angle of merus produced laterally.

Male abdomen.—Proximal end of ultimate segment much narrower than distal end of penultimate, giving a step-like junction; both segments with straight sides.

First male pleopod.—Elongate, slightly curved, most of the taper in the proximal half and then with a gentle taper to a slightly indented membranous tip. Beyond the basal lobes about half-way up the appendage on the outer surface there is a dense cluster of backwardly directed spinules, these thinning out but continuing almost to the tip and in the course of doing so becoming slightly forwardly directed. The inner surface is bare for the proximal three-fourths and thereafter there is a row of microscopic bristles. These are sparsely arranged, at right angles to the appendage, and increase in density towards the tip, terminating just behind it. *Terminal bristles on the outer side* are absent; *on the inner side*, slightly back from the tip, there may be either none or very few spinules before the row of microscopic bristles begins. These spinules are part of a series which leads from the dense cluster on the outer surface to give a sparse covering to the ventral surface, this extending almost to the tip, and near the tip crossing to, or almost to, the inner surface.

Colour.—After moderately prolonged alcohol preservation usually the spines on the anterior border of the arm and on the anterolateral border are a fleshy pink.

Distribution

The only previous records are from the South China Sea, Hong Kong, and the Malay Archipelago (fide Shen 1937) but evidently the species is moderately common in the northern half of Australia.

PORTUNUS ORBITOSINUS Rathbun

Figs. 2*L*, 3*L*; Plate 3, Fig. 4; Plates 4*L*, 5*L*

Portunus (*Amphitrite*) *gladiator* de Haan 1833, only p. 65, pl. xviii, fig. 1.* (Non *Portunus gladiator* Fabricius 1798.)

Portunus (*Achelous*) *orbitosinus* Rathbun, 1911, p. 205, pl. 15, fig. 11.

Neptunus (*Achelous*) *orbitosinus* (Rathbun). Gordon, 1938, pp. 182–5, figs. 5*a*–5*g*, 6*c*, 6*d*.

Neptunus (*Achelous*) *orbitospinis* (Rathbun). Sakai, 1939, p. 396, pl. lxxxi, fig. 2.

* De Haan (1833), p. 39, pl. i, fig. 5 is true *Portunus gladiator* Fabricius.

Material Examined and Illustrated

QUEENSLAND: ♂ 33 mm, Mapoon, pres. Aug. 1903, C. Hedley (Aust. Mus. Reg. No. G4230).

Description (based on a single specimen)

Front.—Two protruding lateral lobes and a central mass consisting of 2 lobes which fuse medianly and on a lower plane. These lobes are larger than in *P. granulatus*. Depending on the aspect, this central area could be described as a single lobe, 2 lobes, or even 3.

Anterolateral teeth.—Nine in number, of approximately equal size and all sharp, the first the broadest, the second the smallest, the last slightly the most protruding.

Carapace.—Narrow (breadth *c.* 1½ times length). Anterolateral borders form a narrow arc whose centre lies in the cardiac region. Posterior-posterolateral junction rounded. Surface covered with widely spaced, very conspicuous, granulated areas, these being separated by regions with a dense pubescence. All the areas shown in Figure 1*B* are present. Frontals and orbitals lie a little behind the elevated fronto-orbital ledge; protogastrics almost subdivided; meso- and metagastrics confluent; one pair of cardiacs; postcardiacs very distinct; anterolaterals as a series of patches; epibranchials a diffuse band curving far forwards; mesobranchial 4 distinct patches; posterolaterals well developed; posterior border of carapace beaded.

Chelipeds.—Granular and with a dense pubescence, except on the under surface, which bears squamiform markings. Arm with posterior border bearing 2 spines, the proximal (the sharper) lying about two-thirds of the way along and marking the end of a granular carina. The spines on the anterior border become smaller proximally, 4 are present on the right chela and 4 plus 2 stout spiniform tubercles on the left. Wrist with 2 usual spines. Upper surface of hand with 3 usual carinae, all granular, and only the inner ending in a spine. Carina on outer surface distinct, on inner surface just recognizable as a row of slightly more prominent tubercles.

Fifth leg.—Posterodistal border of merus with small serrations.

Third maxilliped.—Antero-external angle of merus produced acutely in a lateral direction.

Male abdomen.—Penultimate segment swollen, i.e. with extremely convex borders, maximum breadth nearly 3 times breadth of ultimate segment. (In Sakai's (1939) text figure 8*a*, the ultimate segment is less pointed than in the present specimen. In Gordon's (1938) figure 6*d*, the sides of the penultimate segment are less smoothly curved.)

First male pleopod.—Reasonably long, curving smoothly to a narrow tip, which is thinned out into a spoon-shaped membrane. No ornamentation on either side from the basal lobes until near the tip. The outer side of the tip with no armature and the inner side with 3 or 4 microscopic spinules. Three microscopic hairs are present on the upper surface of the membrane and a scattered series of *c.* 10 spinules on the under surface of the appendage, the most distal reaching just to the membrane.

Comments

Gordon noted some differences between a specimen from Singapore and cotypes of the present species, and suspected the existence of an undescribed species for which she suggested the name *Neptunus octodentata*. The present work, which is the most extensive to date on pleopods in this genus, confirms her suspicion. It is inconceivable that the variation in pleopod structure within *P. orbitosinus* could encompass the structures she figured (figs. 4*c*, 4*c*[1]). Evidently some variation occurs within this species, and Gordon's figure 5*f* shows hairs or bristles on the outside of one appendage which are not present upon two others or upon the specimen here examined.

Distribution

Seychelles (Rathbun 1911) to Japan (Sakai 1939). Not previously recorded from Australia.

Portunus gracilimanus (Stimpson)

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

Amphitrite gracilimanus Stimpson, 1858, p. 38; 1907, p. 77, pl. x, fig. 3.

Achelous whitei Milne Edwards, A., 1861, pp. 336, 343, pl. xxxi, fig. 6. Lanchester, 1900, p. 746.

Neptunus (*Lupocycloporus*) *whitei* (Milne Edwards, A.). Alcock, 1899, pp. 44–5. Laurie, 1906, p. 416.

Portunus (*Lupocycloporus*) *innominatus* Rathbun, 1909, p. 114.

Neptunus (*Lupocycloporus*) *gracilimanus* (Stimpson). Alcock, 1899, p. 45. Balss, 1922, p. 108. Chopra, 1935, pp. 481–2. Shen, 1937, pp. 113–4, fig. 9.

Material Examined

4 ♂♂ (19–40 mm); 2 ♀♀ (16 and 17 mm).

QUEENSLAND: Albany Passage (Cape York), Townsville, Port Curtis.

Recorded habitats.—Dredged 9 fm.

Material illustrated.—♂ 40 mm, Magnetic I., Feb.–March 1953, R. K. Bryson (Zool. Dept. Univ. Qld.).

Description

Front.—Four teeth, of which the lateral pair are slightly broader and the median pair slightly the more projecting.

Anterolateral teeth.—After the first, increasing in length and sharpness, the last approximately twice the length of the others.

Carapace.—Only moderately broad (breadth *c*. 1¾ times length). Anterolateral borders forming an arc whose centre lies behind the cardiac region. Posterior–posterolateral junction rounded. Surface covered with conspicuous ridges, between which there is a fine dense pubescence. All the ridges shown in Fig. 1*A* are present. Protogastrics are interrupted in the mid line while the meso- and metagastrics are continuous. Epibranchial forks obscurely near its inner termination. The anterior mesobranchial and the cardiacs are actually the discrete anterior borders of granular patches. Similar but less well-defined patches occur in the frontal, orbital, anterolateral, and median postcardiac regions (see Fig. 1*B*). Posterior border of carapace beaded.

Chelipeds.—Very elongate, the wrist and hand much more slender than the arm; with numerous squamiform granules and a fine pubescence. Posterior border of the arm with 2 sharp spines, one about two-thirds of the way along, marking the end of a conspicuous granular carina, the other terminal. Wrist with the 2 usual spines, both elongate. Hand with the 3 usual upper carinae, the 2 innermost terminating in long spines. The spine at the wrist articulation is also elongate and sharp. Granular, but somewhat rounded carinae on both inner and outer surfaces of the hand. Fingers slender, compressed, ending very acutely, with tips bent slightly outwards.

Fifth leg.—Posterodistal border of the merus ending in a sharp spine.

Third maxilliped.—Hirsute, antero-external angle of merus slightly produced laterally.

Male abdomen.—Ultimate and penultimate segments with straight sides, except for the slightly rounded tip of the former.

First male pleopod.—Short, very stout, sharply curved, narrowly tapering at the extreme tip. Beyond the basal lobes on the outer side bare to the tip, except that the point only of an occasional spinule from the upper surface may be seen. Inner surface beyond the basal lobes in the proximal third bears a sparsely arranged row of forwardly directed elongate hairs. Near the tip 9 backwardly directed short stout spines.

The tip itself tapers abruptly at the extreme end and behind this the conspicuous ornamentation is on the *upper* surface. This consists of (1) a moderately dense area of backwardly directed spinules on the outer half of the upper surface, these extending almost to the tip, where they become very small; and (2) a shorter patch of much larger backwardly directed spines on the inner half of the upper surface. Some two dozen spines are present, the uppermost being the largest, the lowermost showing in lateral view, the most distal being very small and not extending into the sharply tapered area.

Comments

Rathbun (1907) has shown that *P. whitei* (Milne Edwards 1861) is synonymous with *Amphitrite gracilimanus* Stimpson, 1858, and the present specimens belong to this species. It is less certain whether *Neptunus gracilimanus* Alcock non Stimpson (= *P. innominatus* Rathbun) is distinct from the above or synonymous with it. The position is complicated by Chopra's (1935, p. 481, footnote) statement: "I have also examined the specimens that Alcock called *gracilimanus*, and am of the opinion that they cannot be referred to any of the known species of *Neptunus* (*Lupocycloporus*)". Shen (1937) considers that *N. gracilimanus* Alcock is a synonym of *N. whitei* Alcock and in erecting his new species *N. minutus* makes no detailed comparison with the former, i.e. *Portunus innominatus* Rathbun. A detailed re-examination of the specimens of this group from extra-Australian sources is necessary before the validity and affinities of *P. innominatus* in particular can be determined. Therefore the above synonymy, with some hesitation, follows Shen (1937).

Distribution

Previously recorded from Gladstone, Queensland, by Grant and McCulloch (1907).

Distribution outside Australia from the Andamans, east coast of India, Hong Kong, and Malaya, to New Guinea (Alcock 1899; Chopra 1935; Shen 1937).

VII. Discussion

(a) *Subgenera*

The outstanding problem in this genus, as indicated in Section II, concerns the distinctness of the subgenera, and here knowledge of the structure of the first pleopods of males is helpful. Of the few studies which have been made in the past, several are insufficiently detailed, and even with the present detailed work, in a majority of species these structures have not yet been investigated. A consideration of the minority does, however, give helpful indications.

The first male pleopods of *P. pelagicus*. *P. sanguinolentus*, and *P. pubescens* are all elongate, smoothly curving, and practically parallel-sided structures whose terminal armature consists of laterally placed, robust, backwardly directed spines. The resemblances between the three species are close, and there are no other species approaching them at all closely in pleopod structure. On this basis, *P. pubescens* would clearly belong to the subgenus *Portunus* in spite of its carapace not having quite the characteristic breadth. The subgenus itself would appear to be worth maintaining in existence.

Two other Australian species stand apart on the basis of pleopod structure, but as individual species. They are *P. gracilimanus* and *P. granulatus*. The former is unique in possessing an appendage which is sharply curved, extremely robust, and bears robust backwardly directed spines on the upper surface. Allied with the general facies and especially the pronounced slenderness of the arm, this species is sufficiently distinctive to validate the continued application of the subgenus *Lupocycloporus*.

The other species (*P. granulatus*) is equally distinctive, the pleopod being very broad, with bipinnate hairs proximally on its lateral borders and a flared tip. It is also distinctive amongst the Australian species by the narrowness of its carapace. Together with *P. orbicularis*, it was placed in Alcock's subgenus *Achelous*, now Ward's *Cycloachelous*. Unfortunately, in *P. orbicularis*, according to Edmondson's figures (1954, figs. 16*d*, 16*e*), the structure of the male pleopod is very different from *P. granulatus*. It should be noted that Edmondson's figure of *P. granulatus* (fig. 16*b*) bears little resemblance to actuality. However, his figures of *P. orbicularis* (16*d*, 16*e*), while needing refiguring, could not possibly be from an animal bearing a pleopod resembling that of *P. granulatus*. It seems probable (1) that the subgenus *Cycloachelous* is not a homogeneous group and (2) that *P. granulatus* is sufficiently distinctive from all other species in the genus to be placed in a separate subgenus.

P. gladiator and *P. rubromarginatus* have elongate, moderately straight pleopods, whose upper surfaces near the tip are practically bare and whose lower surfaces bear minute spinules. *P. orbitosinus* has comparable terminal armature, but the curved form of the appendage gives it a very different general appearance. These three species all belong to Alcock's subgenus *Amphitrite*, correctly *Monomia*, and give qualified support to the reality of this grouping. Against this, the terminal armature of *P. argentatus* (in the same "subgenus"), as figured by Edmondson (1954, figs. 14*c*, 14*d*), is apparently quite different.

The remaining Australian species all belong to Alcock's subgenus *Hellenus*, correctly *Xiphonectes*, and in all cases the pleopods are curved in a somewhat similar fashion, usually to an acute tip. This resemblance, which would be difficult to define precisely, would not apply to *N. octodentata* as figured by Gordon (1938, figs. 4*c*, 4*c*^{1}).

Within the species of *Xiphonectes*, affinities in pleopod structure can be distinguished between *P. emarginatus* and *P. longispinosus*. In both cases the pleopods are stout distally and bear stout subterminal bristles on the inner side. Apparently the following species, as judged by published figures, also show these features: *P. macrophthalmus*, *P. pulchricristatus*, and *P. spinipes*. This is a tolerably natural grouping, judged on the basis of general facies, with *P. emarginatus*, *P. longispinosus*, and *P. macrophthalmus* being especially close. The pleopod of *P. nipponensis*, as figured by Sakai (1939, text fig. 7), also shows affinities to this group.

The remaining Australian species (*P. hastatoides*, *P. tenuipes*, and *P. brocki*) lie outside this grouping and show no special affinities one with another.

In conclusion it appears:

(i) that *P. pelagicus*, *P. sanguinolentus*, and *P. pubescens* have a close affinity with one another;

(ii) that *P. gracilimanus* is distinctly apart from the remainder;

(iii) that the remaining Australian species, whose segregation into different subgenera on the basis of general facies is difficult, are an equally confused assemblage on the basis of structure of the male pleopods.

(*b*) *Possible Origin of the Genus*

There seems to be general agreement on the probable origin of most of the Portunids from a genus such as *Carcinus* Leach, 1814, and this will be commented upon in a later paper of this series. Three main structural developments are required to convert a walking, crevice-dwelling crab like *Carcinus* into a swimming and shallowly burrowing crab like *Portunus pelagicus*. These are first a flattening of the fifth legs, secondly a broadening of the carapace, and thirdly an increase in size.

Flattening of the fifth legs occurs to some extent in genera close to *Carcinus*, and can probably be regarded as the initial development. The highly successful genus *Thalamita* Latreille, 1829, which has already been treated in this series (Stephenson and Hudson 1957), can probably be regarded as the culmination of an evolutionary development on the general line towards *Portunus*, but which has involved little more—of an obvious nature—than the legs. From a broadly functional viewpoint *Thalamita* spp. are not swimming crabs; they usually walk upon their second to fourth legs and assist their walking by flipping actions of the fifth legs.

The most obvious significance of a broadening of the carapace would appear to be in effecting some degree of streamlining with respect to lateral motion (see Schäfer 1954). On this basis the groups which obtain maximum "flipping" propulsion from their fifth legs can be expected to be the broadest. Broadening of the carapace involves elongation of both the anterolateral and posterolateral borders. Since the former bears teeth, one of two things would result—either the same number of larger teeth, or a greater number of teeth. The latter appears to have happened, and from five anterolateral teeth in *Carcinus* and *Thalamita* (most species), the evolutionary trend would appear to be six teeth in *Charybdis* de Haan, 1833 (see Stephenson, Hudson, and Campbell 1957), and nine in *Portunus* (most species) and *Scylla* de Haan, 1833.

The critical place of *Charybdis* in this progression should be noted, especially since within the genus the teeth vary in number. Some species possess five well-developed teeth and one smaller tooth (these approach *Thalamita*), others have six well-developed teeth, and yet others have five well-developed teeth with three small teeth. These last approach *Portunus*, especially such species as *P. longispinosus*, *P. macrophthalmus*, and *P. emarginatus*, which normally possess irregular anterolateral teeth, and also *P. gladiator*, which occasionally shows this phenomenon. The fact that in *Charybdis* the carapace is broader in juveniles than in adults (at least in some species, e.g. *C. helleri* (A. Milne Edwards 1867), see Stephenson, Hudson, and Campbell 1957, text fig. 1*C*, 1*D*) shows that possibly swimming is more characteristically a juvenile activity. On this basis *Charybdis* as a whole may have come from swimming ancestors and thus be secondarily demersal.

In adults of *Charybdis* swimming seems to be an infrequent phenomenon and regular swimming habits, upon which the popular name for the family depends, are only seen conspicuously (amongst the Australian adult representatives at least) in the genus *Portunus*. Once free swimming has been attained many ecological restrictions will be removed. Distribution can be extended by the adults under their own efforts, and possibly this explains the successful establishment of *P. pelagicus* in the Mediterranean and the reported establishment of *P. sanguinolentus*. Dependence upon crevices and the under-stone habitat can be expected to lessen, and with this the necessity for fitting into such habitats. In other words, different factors are likely to control the overall size. Possibly large size is an advantage in reducing the number of predators which could make successful attacks; possibly it increases swimming efficiency. All that can be stated is that certain species of *Portunus* are almost the largest and most abundant of the Australian crabs. To this they owe their economic importance.

(*c*) *Possible Evolution within the Genus*

If the above arguments are sound, the most primitive members of the genus will be those with least broadening of the carapace. Three distinct units have roughly equal claim to primitiveness on this basis. These are:

(1) *P. pubescens*; the carapace ridges and the "set" of the anterolateral teeth are typically *Charybdis*-like, while the general carapace shape shows considerable resemblances to certain species of *Charybdis*, e.g. *C. helleri* (A. Milne Edwards 1867). Of the Australian species, *P. pubescens* also appears closest to *Scylla*. Against this, the male pleopods do not greatly resemble the *Charybdis* form as previously described in this series (Stephenson, Hudson, and Campbell 1957).

From something not too different from *P. pubescens*, *P. pelagicus* and *P. sanguinolentus* could have evolved.

(2) The "*Achelous*" group, comprising *P. granulatus*, *P. rubromarginatus*, and *P. orbitosinus*. Here the carapace is at its longest and has the same general shape as certain species of *Charybdis*, e.g. adult *C. callianassa* (Herbst 1789). However, the carapace bears granular patches, as against the transverse ridges of *Charybdis*. While the male pleopods vary from one species to another, in the case of *P. granulatus*, at least, there is an approximation to the *Charybdis* form of male pleopod.

The "*Achelous*" group merges with the "*Hellenus*" group, and the important "advance" of the latter is a broadening of the carapace. This affects the ninth anterolateral tooth in a much more exclusive fashion than in the cases of *P. pelagicus* and

P. sanguinolentus, with a resultant tendency for concavity in the anterolateral borders.

On this basis it would appear that carapace broadening has happened in two different ways in two different subgroups of the genus, in other words that this is a case of parallel evolution.

(3) *P. gracilimanus* possesses a carapace broader than the majority of adult *Charybdis* species, but resembles that of juveniles (e.g. *C. callianassa*, Stephenson, Hudson, and Campbell 1957, text fig. 1*C*). It also bears *Charybdis*-like ridges on the carapace.

This species is almost as different from a generalized *Portunus* as is the genus *Scylla*, both in male pleopod structure and in the form of the chelipeds. The cheliped development, which is towards attenuation, is the reverse of that in *Scylla*, and possibly this species has an equal right to be placed in a separate genus.

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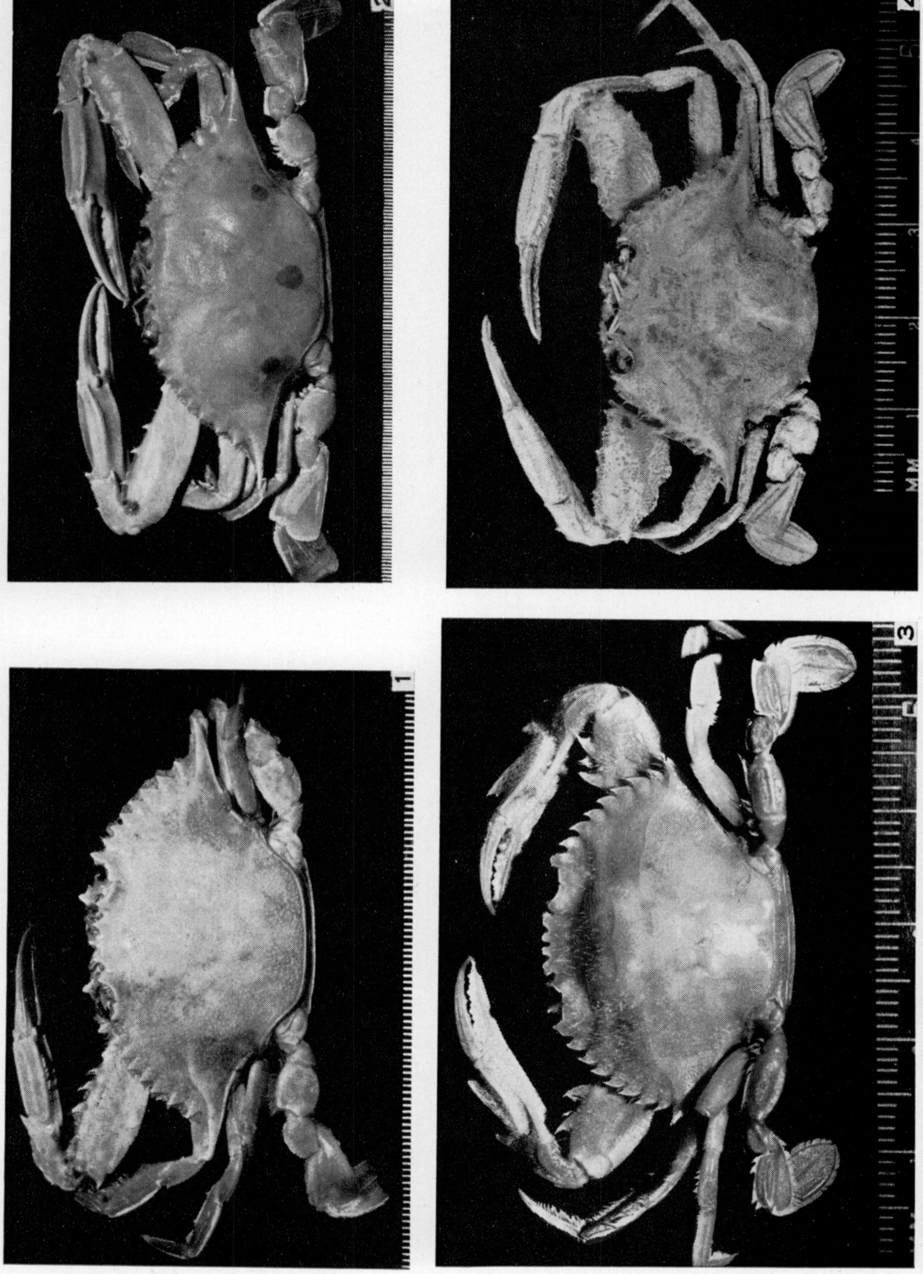
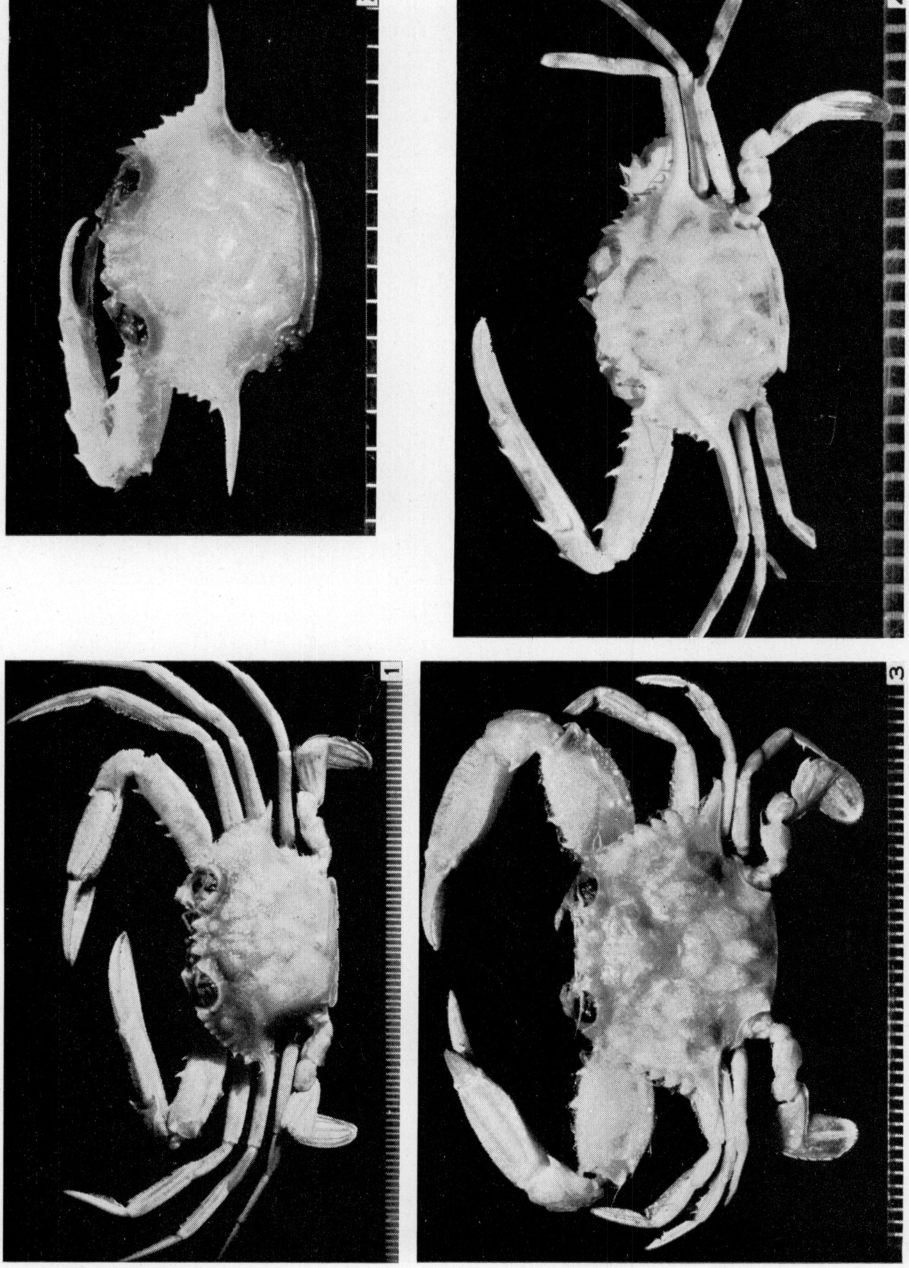
LIST OF SPECIES

AUSTRALIAN PORTUNIDS. III



Dorsal views of *Portunus* spp. Scale divisions, 1 mm. Fig. 1.—*P. pelagicus.* Fig. 2.—*P. sanguinolentus.* Fig. 3.—*P. pubescens.* Fig. 4.—*P. hastatoides.*

AUSTRALIAN PORTUNIDS. III



Dorsal views of *Portunus* spp. Scale divisions, 1 mm. Fig. 1.—*P. tenuipes*. Fig. 2.—*P. longispinosus*. Fig. 3.—*P. brocki*. Fig. 4.—*P. emarginatus*.

AUSTRALIAN PORTUNIDS. III

Dorsal views of *Portunus* spp. Scale divisions, 1 mm. Fig. 1.—*P. granulatus*. Fig. 2.—*P. gladiator*. Fig. 3.—*P. rubromarginatus*. Fig. 4.—*P. orbitosinus*.

AUSTRALIAN PORTUNIDS. III

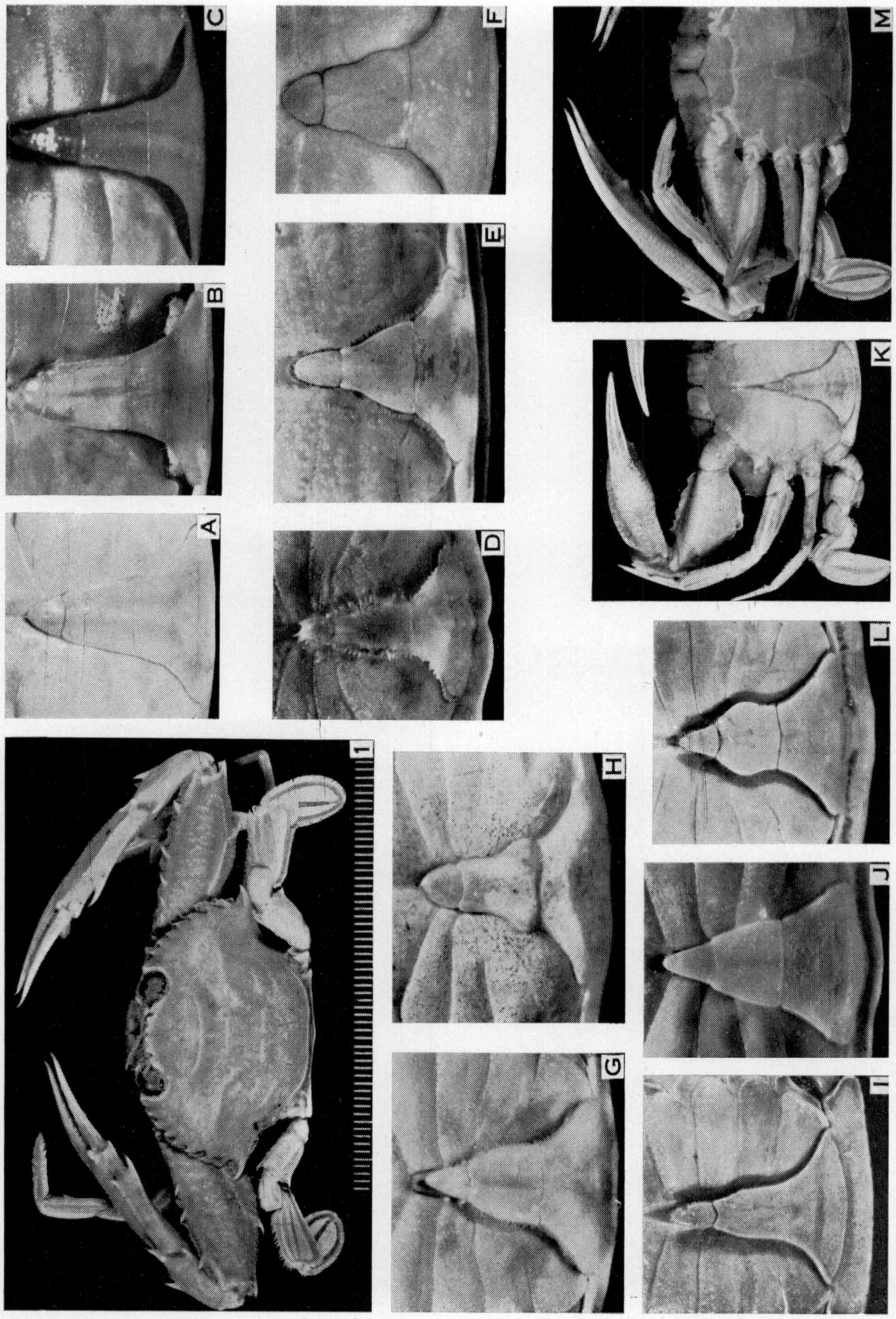
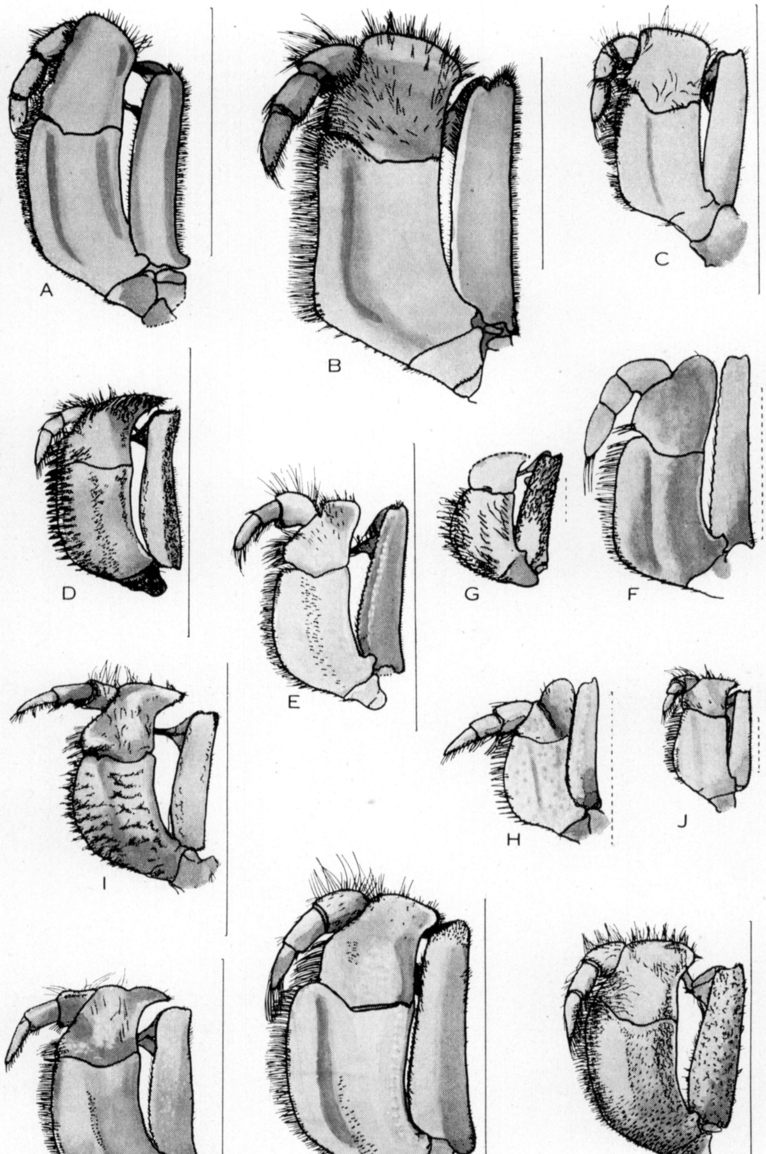


Fig. 1.—Dorsal view of *P. gracilimanus*. Scale divisions, 1 mm. Figs. *A–M*.—Male abdomens of *Portunus* spp. *A*, *P. pelagicus*; *B*, *P. sanguinolentus*; *C*, *P. pubescens*; *D*, *P. hastatoides*; *E*, *P. tenuipes*; *F*, *P. longispinosus*; *G*, *P. brocki*; *H*, *P. emarginatus*; *I*, *P. granulatus*; *J*, *P. gladiator*; *K*, *P. rubromarginatus*; *L*, *P. orbitosinus*; *M*, *P. gracilimanus*.

AUSTRALIAN PORTUNIDS. III



Wash drawings of third maxillipeds. *A*, *P. pelagicus*; *B*, *P. sanguinolentus*; *C*, *P. pubescens*; *D*, *P. hastatoides*; *E*, *P. tenuipes*; *F*, *P. longispinosus*; *G*, *P. brocki*; *H*, *P. emarginatus*; *I*, *P. granulatus*; *J*, *P. gladiator*; *K*, *P. rubromarginatus*; *L*, *P. orbitosinus*; *M*, *P. gracilimanus*. Scale lines: full lines, 1 cm; broken lines, 2 cm.