

THE AUSTRALIAN SESARMINAE (CRUSTACEA: BRACHYURA):
GENERA *HELICE*, *HELOGRAPSUS* NOV., *CYCLOGRAPSUS*,
AND *PARAGRAPSUS*

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THE AUSTRALIAN SESARMINAE (CRUSTACEA : BRACHYURA) : GENERA
HELICE, *HELOGRAPSPUS* NOV., *CYCLOGRAPSPUS*, AND *PARAGRAPSUS*

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ABSTRACT

Ten species of sesarminae crab, seven occurring within Australia, are described and figured. Genera are diagnosed and a key to the Indo-West Pacific species of the genus *Cyclograpsus* H. Milne Edwards is provided. A new genus, *Helograpsus*, is set up to contain *Chasmagnathus haswellianus* Whitelegge, formerly referred to *Helice* de Haan. *Cyclograpsus punctatus* H. Milne Edwards is not considered to have a circum-subantarctic distribution, but to be confined to South Africa and Chile; *C. granulatus* H. Milne Edwards is regarded as a species distinct from *C. audouinii* H. Milne Edwards, and confined to south-eastern Australia; *C. whitei* H. Milne Edwards is shown to be conspecific with the New Zealand *C. lawaui* H. Milne Edwards; and a new species, *C. insularum* is described from Lord Howe Island, Norfolk Island, Kermadec Island and New Zealand.

Independent interest in the ecology of the Australian grapsids on the part of both authors led to the realisation of a need for prior clarification of several taxonomic points. Rather than publish separate small papers on the species of immediate interest it was decided that a comprehensive treatment of the subfamily Sesarminae was required before any experimental work could be attempted.

Members of this subfamily can be readily identified by the presence of an oblique hairy ridge running diagonally across the third maxillipeds. This feature is usually accompanied by a series of short hairs and granules regularly arranged in rows on the pterygostome, the whole mechanism presumably functioning as a reoxygenation device for water held in the gill chamber (Verwey, 1930). The genera to be considered in this first paper (*Helice* de Haan, 1833; *Helograpsus* nov.; *Cyclograpsus* H. Milne Edwards, 1837; *Paragrapsus* H. Milne Edwards, 1853) are characterised by having the reticulation of the pterygostome less fully developed than in other genera of the subfamily, reaching a maximum in *Helice*.

The following key can be used to distinguish these genera.

1. Eyestalks as long as frontal width ; two distinct teeth behind external orbital angles ; carapace broad.....*Metaplar* H. Milne Edwards (not from Australia) 2
- Eyestalks much shorter than frontal width..... 2
- 2 (1). Frontal width markedly less than half fronto-orbital width ; frontal margin curving imperceptibly into very oblique inner margins of orbits ; epistome visible beyond front in dorsal view ; third segment of male abdomen much broader than any other segment..... 3
- Frontal width half or slightly more than half fronto-orbital width ; frontal margin forming a distinct angle with inner margins of orbits ; epistome not visible in dorsal view ; third segment of male abdomen little broader than others..... 4
- 3 (2). Lateral margins of carapace very convex in their entire course.....
.....*Chasmagnathus* de Haan (not from Australia)
- Lateral margins of carapace subparallel in their posterior half.....
.....*Helice* de Haan
- 4 (2). Carapace deep (depth c. 0.65 length), vaulted, with distinct anterolateral notch ; legs slender ; terminal segment of female abdomen 1.5 times as broad as long.....*Helograpsus* nov.
- Carapace flattened (depth less than 0.6 times length) ; legs sturdy ; terminal segment of female abdomen twice as broad as long..... 5
- 5 (4). Anterolateral margins of carapace entire or obscurely notched ; post frontal lobes indistinct, front curving smoothly downwards.....
.....*Cyclograpsus* H. Milne Edwards
- Anterolateral margins of carapace distinctly toothed ; post frontal lobes distinct ; front projecting, rather shelf-like.....
.....*Paragrapsus* H. Milne Edwards

The terminology used follows that of Rathbun (1918, pp. 6-8, figs. 1, 2). Where species have been adequately dealt with in recent literature, synonymies have been abbreviated and references with more complete synonymies indicated. All line drawings have been prepared by camera lucida or by meticulous measurement of proportions.

The collections of the South Australian Museum, Australian Museum, Tasmanian Museum, National Museum of Victoria, Queensland Museum, and Western Australian Museum have been supplemented by considerable personal collecting on the Queensland and Tasmanian coasts. This additional material has been deposited at the Queensland Museum and the Tasmanian Museum respectively.

Genus **HELICE** de Haan

Helice de Haan, 1833, p. 28. (Type species: *Ocyropoda (Helice) tridens* de Haan, 1835, by monotypy). (*vide* Official List of Generic Names in Zoology, 1958, Name No. 315.)

DIAGNOSIS

CARAPACE.—Regions moderately well defined. Anterolateral margins distinctly notched. Posterolateral margins subparallel, lateral borders not smoothly convex.

FRONT.—Smoothly deflexed. Frontal width markedly less than half fronto-orbital width. Frontal border and oblique inner margins of orbits merging smoothly, with no distinct angle between them.

Epistome usually visible beyond front in dorsal view.

PTERYGOSTOME.—With granules and setae often in orderly lines, but not as conspicuously reticulate as in *Sesarma*.

ANTENNA 2.—Not excluded from orbital hiatus.

ABDOMEN.—Seven segmented. In male not occupying whole breadth of sternum between last legs. Third segment expanded laterally, much broader than first and second segments. Ultimate segment of female not deeply impacted in penultimate segment.

DISTRIBUTION

Throughout the Indo-West Pacific region from Japan to Australia, from Tahiti to Dar es Salaam.

DISCUSSION

Tesch (1918) listed ten species of this genus. Of these, *H. gaimardii* (H. Milne Edwards) must be transferred to *Paragrapsus* (from whence Tesch removed it), *H. lucasi* H. Milne Edwards has been synonymised with *H. crassa* Dana (*vide* Bennett, 1964), and *Chasmagnathus subquadratus* Dana and *Paragrapsus urvillei* H. Milne Edwards are too poorly known to be included with certainty in this genus. A possible addition to the list is *H. pilimana* A. Milne Edwards, which may prove not to be synonymous with *H. leachii* Hess.

Of the seven species remaining two have been recorded from Australia. *H. crassa* was described by Dana from Illawarra, New South Wales, but in view of the confusion existing in relation to Dana's localities and the subsequent collecting of this species from New Zealand this record is open to doubt. The only further record of *H. crassa* from the Australian coast is based on a small male from Port Jackson (Miers, 1886). No description was given and as the recorded habitat (6 fms) is unusual for *Helice* this identification may have been erroneous.

HELICE LEACHII Hess

(Text-figs. 1A, 2A ; pl. 20, fig. 1 ; pl. 23, fig. 1)

Helice leachii Hess, 1865, p. 153. Haswell, 1882b, p. 107. de Man, 1887, p. 702. Ortmann, 1894b, p. 57 (*vide* Tesch 1918). Rathbun, 1907, p. 36. Tesch, 1918, p. 120. Parisi, 1918, p. 108, pl. 8, fig. 2. McNeill, 1920, p. 109. Sakai, 1939, pp. 696-7, fig. 126. Crosnier, 1965, pp. 76-8, figs. 125-8, pl. 5, fig. 2.

(?) *Helice pilimana* A. Milne Edwards, 1873, p. 313, pl. 18, fig. 1.

Helice subquadrata (Dana). Tesch, 1918, pp. 120-4, pl. 6, fig. 1.

(non) *Chasmagnathus subquadratus* Dana, 1852a, p. 251 ; 1852b, p. 363, pl. 23, fig. 5. Hess, 1865, p. 152. Haswell, 1882b, p. 106.

MATERIAL EXAMINED

15 males (9-24 mm) ; 21 females (13-24 mm).

QUEENSLAND : Johnstone R., Townsville, Yeppoon, Boyne R., Burnett R., Mary R., Noosa, Wynnum, Redland Bay, Currumbin Ck. NEW SOUTH WALES : Trial Bay, Middle Harbour.

MATERIAL ILLUSTRATED

Male, 24 mm, Burnett R., Dec. 1961, B.C., Qd Mus. W.2272/1.

Male, 25 mm, Curtis I., Gladstone, 22.iv.62, B.C., Qd Mus. W.2275/1. (*a* in text-fig. 1A).

Male, 18.5 mm, Middle Harbour, Sydney, Jan. 1959, B.C., Qd Mus. W.2269. (*b* in text-fig. 1A).

DESCRIPTION

CARAPACE.—Quadrate, broader than long (*c.* 1.2 times), markedly vaulted longitudinally, more flattened transversely. Surface granular, punctate posteriorly, with short hairs evenly distributed among the granules except on mesogastric, cardiac, and intestinal regions which are naked.

Mesogastric region well defined, projecting anteriorly into deep frontal furrow to level of orbits ; on either side of frontal furrow adjacent to termination of mesogastric region there are 1 or 2 longer bristles. Protogastric regions usually obvious (less so in female). Epigastric lobes barely discernable. Cardiac region well defined.

Anterior posterolateral ridge oblique. Posterior posterolateral ridge strong, transverse, running parallel to margin of carapace above last two legs, from lateral margins of intestinal region to end short of carapace margin.

Lateral borders sinuous, with two forwardly directed anterolateral teeth, the second much the smaller.

Orbits wide, posterior margin sinuous, slightly oblique, continuous with very oblique inner margins, a slight discontinuity discernable between inner margins of orbit and front.

Front narrow, rounded, slightly sinuous on either side of median notch in frontal view. Frontal area smoothly deflexed so that plane of median frontal area is almost continuous with that of epistome. Epistome visible beyond front in dorsal view.

Sub-orbital crest of male variable, usually resolvable into a series of c. 8 distinct granules medially, followed by a ridge composed of c. 6 granules, the first microscopic, the remainder increasing progressively, the last two or three striate; then follows a very large, striate, asymmetrical granule (lying below the cornea), a very low rounded striate granule and two striate granules of similar shape to the largest, but decreasing in size, the last sometimes microscopic, level with the first antero-lateral notch.

In the female the crest bears a uniform series of low granules.

CHELIPEDS.—Merus with upper border very faintly granulate, lower border granulate, anterior border with a row of sparsely distributed larger granules. Distal end of anterior border in male bearing a horny stridulating ridge on its inner face.

Carpus with inner angle variable, sometimes with a smooth or serrate series of granules progressively increasing in size to a small spine; sometimes with one or two small spinules only. A variable number of small spines or granules may be present on inner face of carpus just below inner angle.

Chela in large males almost as high as long, but relatively longer in smaller specimens and females. Outer surface punctate, especially anteriorly; low granular carina on lower third running distally from near wrist articulation; granulate dorsally, and curving inwards to form an overhanging ledge above inner face. Inner face with some coarse granules, concave at base of immovable finger; ventral border with short, prominent, granular ridge at wrist articulation. A variable amount of felting may be present on outer surface of chela near wrist articulation, and between bases of fingers. (This variation is shown in Text-fig. 1A). Fingers punctate, with low dentition and wide gape in larger males, less in females and small males.

AMBULATORY LEGS.—Long and slender. Second leg c. 1.7 times carapace breadth. Merus finely granulate on anterior edge. Carpus and propodus of first leg with dense felting on upper border and upper two-thirds of anterior surfaces and on distal half of lower border. Dactyl conical, long and slender, with 6 longitudinal grooves carrying felting which is densest dorsally, reduced ventrally.

Last leg with thin row of felting, expanded distally, on upper border of carpus and propodus, tufts on distal extremity of propodus, a short row on distal third of ventral border of propodus. Dactyl as for first leg but shorter.

Tufts of hair present between bases of first and second, and second and third ambulatory legs.

STERNUM.—Very densely hirsute anterior to abdomen.

MALE ABDOMEN.—Fringed with long, dark hairs, longest proximally. Third segment much the broadest. Fourth and fifth segments evenly tapering to sixth, which curves gradually inwards to narrow ultimate segment. Ultimate segment longer than broad (c. 1.2 times), with rounded hirsute tip.

Ultimate segment of female abdomen as long as broad, not deeply impacted in penultimate segment.

COLOUR.—Carapace dark purplish with cream mottling posteriorly. The proportion of purple to cream, and the degree of mottling of the carapace is very variable. Legs purple and cream mottled. Chelae cream, carpus purple above, merus purplish where visible in dorsal view.

HABITAT

From inlets and bays, rarely penetrating for any great distance up estuaries (in the Burnett R. to a minimum high water salinity of $c. 15^0/_{00}$). High up the beach, near or above high water mark, burrowing in a firm substrate which ranges from dirty sand to firm mud or hard packed earth. It is quite usual for these crabs to burrow in very difficult areas, among loose shale, stones, or mangrove roots. The burrows are usually simple but may have long horizontal offshoots running for up to 12 feet, a few inches below the surface of the mud flat (mouth of Burnett R.).

DISTRIBUTION

From Dar es Salaam (Ortmann, 1894b) to Japan (Rathbun, 1907; Sakai, 1939), Australia, and possibly New Caledonia (A. Milne Edwards, 1873).

Within Australia from Port Jackson and Trial Bay in the south (McNeill, 1920) to Johnstone R. in the north.

DISCUSSION

Tesch (1918) referred a single male specimen from Lombok to *H. subquadrata* (Dana). His detailed description falls entirely within the variability shown to exist in the present species by a series of specimens from localities extending over 1400 miles of the east Australian coast. Although some apparent discrepancies exist between the present description and that given by Tesch, these can be reconciled as follows :

1. Epistome projecting beyond front in dorsal view. This obviously depends on the interpretation of "dorsal". If the crab is allowed to sit on a horizontal surface the epistome is readily visible from above. If the crab is held with the carapace horizontal the epistome is not visible.

2. Suborbital ridge. Of the two tubercles present behind the large one, the last is often minute, hidden among the hairs of the pterygostome.

3. The carina on the chela of *H. leachii* is not prominent, but quite as Tesch described for his specimen.

4. The patch of hairs at the base of the fingers of the chela may be quite minute in *H. leachii*, and is probably never as large as that figured by A. Milne Edwards for *H. pilimana*.

5. The rectangular ornamentation of the ambulatory meri, which Tesch denies in *H. leachii*, is actually present, and quite as he describes for "*H. subquadrata*".

The status of Dana's *Chasmagnathus subquadratus* must still remain uncertain. Attempts to locate the type have been unsuccessful. Garth (1958, p. 4) has commented on the destruction of the types of several workers' species, including those of Dana, and it seems probable that the specimen is no longer in existence. Although Dana's description has been requoted several times in the literature no further records of this

species can unequivocally be accepted (the record of Ortmann (1894a) from Tahiti was not accompanied by a description). The type locality is recorded as "New South Wales? New Zealand?", but Chilton and Bennett (1929), and Bennett (1964) have denied the presence of this species in New Zealand. This would suggest that the original specimen was collected in New South Wales, but even in the light of present knowledge of the distribution of sesarmine crabs on the east Australian coast it is not possible to assign any known species from this region to *Chasmagnathus subquadratus*. Dana stated that the front and anterolateral margins of his specimen were as in *C. laevis* (= *Paragrapsus laevis*). If this was so the specimen could not be conspecific with *H. leachii*, and it would now be placed in the genus *Paragrapsus*. Kingsley (1880, p. 220) suggested that Dana's *C. subquadratus* might be synonymous with his *C. laevis*, and Dana himself (1852b, p. 364) doubtfully placed *Cyclograpsus gaimardii* H. Milne Edwards (= *Paragrapsus gaimardii*) in the synonymy of *C. subquadratus*. The shape of the male abdomen (Dana, 1852b, pl. 23, fig. 5C) and the hirsute first sternite, however, exclude the possibility of synonymising this with any known species of *Paragrapsus*.

It has become customary to place the New Caledonian *H. pilimana* A. Milne Edwards in the synonymy of *H. leachii*, but this practice is open to question. Although de Man (1887) compared Hess's type (of *H. leachii*) with Milne Edwards' description and figures, and pronounced them certainly identical, this certainty was apparently tempered with some doubt, for later (*loc. cit.*, p. 702) he says "Wenn die *Helice leachii* mit der *pilimana* wirklich identisch ist, muss der latstere Name ans der Wissenschaft verschwinden." When the present series of specimens is used for comparison, this doubt must be increased. Not even in the southern specimen does the tuft of hairs at the base of the immovable finger approach the size of that figured by Milne Edwards (1873, pl. 18, fig. 1a), and the carina on the outer surface of the chela is never as distinct. There is, however, almost invariably a conspicuous tuft on the outer surface of the chela near the wrist articulation which is not shown by Milne Edwards. In *H. pilimana* the ischium of the third maxilliped is shown (Milne Edwards, 1873, pl. 18, fig. 1c) to be naked except for the oblique hairy ridge and a fringe of setae on the inner edge. In *H. leachii* the ischium is almost covered with longish hairs. The articulation of the palp of the maxilliped is nearer the external angle of the merus than in Milne Edwards' figure.

Photographs of the holotype of *H. pilimana* (a dry specimen in the Muséum National d'Histoire Naturelle, Paris) suggest that the carapace is flatter than in *H. leachii*, more punctate, and with the mesogastric region less defined. The first epibranchial teeth behind the external orbital angles appear more laterally flaring than in *H. leachii*, the lateral margins of the carapace less sinuous. Because the mode of preservation permits photos of only the dorsal view, and additional specimens from New Caledonia are not available, some slight doubt remains as to the true status of *H. pilimana*.

Genus **HELOGRAPsus** nov.

Type species : *Chasmagnathus haswellianus* Whitelegge, 1889.

The generic name has been formed by a combination of "*Helice*" and "*Cyclograpsus*", to both of which the present genus bears superficial resemblance.

DIAGNOSIS

CARAPACE.—Vaulted longitudinally, and quite deep (0.65 times length). Smooth, with regions distinguishable but only cardiac and intestinal well defined.

Post-frontal lobes inconspicuous.

FRONT.—Smoothly deflexed. Frontal width slightly more than half fronto-orbital width. Lateral margins of front not passing imperceptibly into very oblique inner borders of orbits.

ANTEROLATERAL BORDERS.—With a distinct notch behind the external orbital angle, but with no distinctly projecting tooth.

PTERYGOSTOME.—With granules and setae not in orderly arrangement.

EPISTOME.—Not projecting beyond front in dorsal view.

ANTENNA 2.—Not excluded from orbital hiatus.

CHELIPEDS.—Subequal, with palm and wrist swollen in adult males.

AMBULATORY LEGS.—Slender, merus of second pair four times as long as broad.

ABDOMEN.—Seven segmented. In males, not occupying the whole breadth of sternum between the last legs; third segment not very greatly expanded laterally. Ultimate segment in mature female broader than long (c. 1.5 times), only slightly impacted in penultimate segment.

DISCUSSION

The species for which this monotypic genus has been erected was first placed by Haswell (1882a) in the genus *Chasmagnathus*. It has since been transferred to *Helice*, but cannot remain in that genus because it possesses the following characters.

1. The inner margin of the orbit is not oblique as in *Helice*, and forms a distinct angle with the front of the carapace.
2. The front is broad.
3. The male abdomen tapers regularly, the third segment is little broader than the others.
4. The epistome does not project beyond the front in dorsal view.
5. The abdomen of the female is subcircular, the ultimate segment broader in relation to its length.

All of these characters are held in common with *Cyclograpsus* and *Paragrapsus* and the species undoubtedly has close affinities with these genera. It is excluded from them on the following counts.

1. The carapace is too deep (length 1.5 to 1.6 times depth as against 1.75 to 1.9 times in *Paragrapsus*, 1.85 to 2 times in *Cyclograpsus*), and the longitudinal vaulting is much more pronounced than in *Cyclograpsus*.

2. The ultimate segment of the abdomen in mature females is not as broad in relation to its length (1.5 times) as in *Cyclograpsus* and *Paragrapsus* (more than twice).

3. The front curves down evenly and does not project forward as a "shelf" as in *Paragrapsus*.

4. The anterolateral notch is more distinct, and deeper (particularly in young specimens) than in any of the "notched" species of *Cyclograpsus*.

5. The ambulatory legs of mature specimens (particularly the meri), are more slender than in *Cyclograpsus* or *Paragrapsus*. (In small specimens the legs are broader, approaching those of *Cyclograpsus* and *Paragrapsus*).

HELOGRAPUS HASWELLIANUS (Whitelegge)

(Text-figs. 1B, 2B; pl. 20, fig. 2; pl. 23, fig. 2)

Chasmagnathus convexus Haswell, 1882a, p. 550; 1882b, pp. 106-7. (preocc.)

(non) *Chasmagnathus convexus* de Haan, 1835, pp. 56-7, pl. 7, fig. 5.

Chasmagnathus haswellianus Whitelegge, 1889, p. 229.

Helice haswellianus (Whitelegge). Hale, 1927a, pp. 177-79, figs. 177-79. Tweedie, 1942, p. 19, fig. 5.

MATERIAL EXAMINED

75 males (4-25 mm); 60 females (5-18 mm).

QUEENSLAND: ?Darnley I., Pioneer R., Burnett R., Brisbane R., Victoria Pt., Sinclair I., Tallebudgera Ck., Currumbin Ck.; NEW SOUTH WALES: Wallis Lake, Tuncurry, Broken B., Northbridge, Middle Hbr., Lane Cove, Paramatta, Port Jackson, Botany B., Shoalhaven, Jervis B., Eden. VICTORIA: Port Phillip. TASMANIA: Don R., Tamar R., Triabunna, Carlton R., Derwent R., Bridgewater, Risdon, Glenorchy, Lindisfarne, Bellerive, Brown's R., Howden, Margate. SOUTH AUSTRALIA: Port Adelaide R.

MATERIAL ILLUSTRATED

Male, 18 mm, Burnett R., Dec. 1961, B.C., Qd Mus. W.2277.

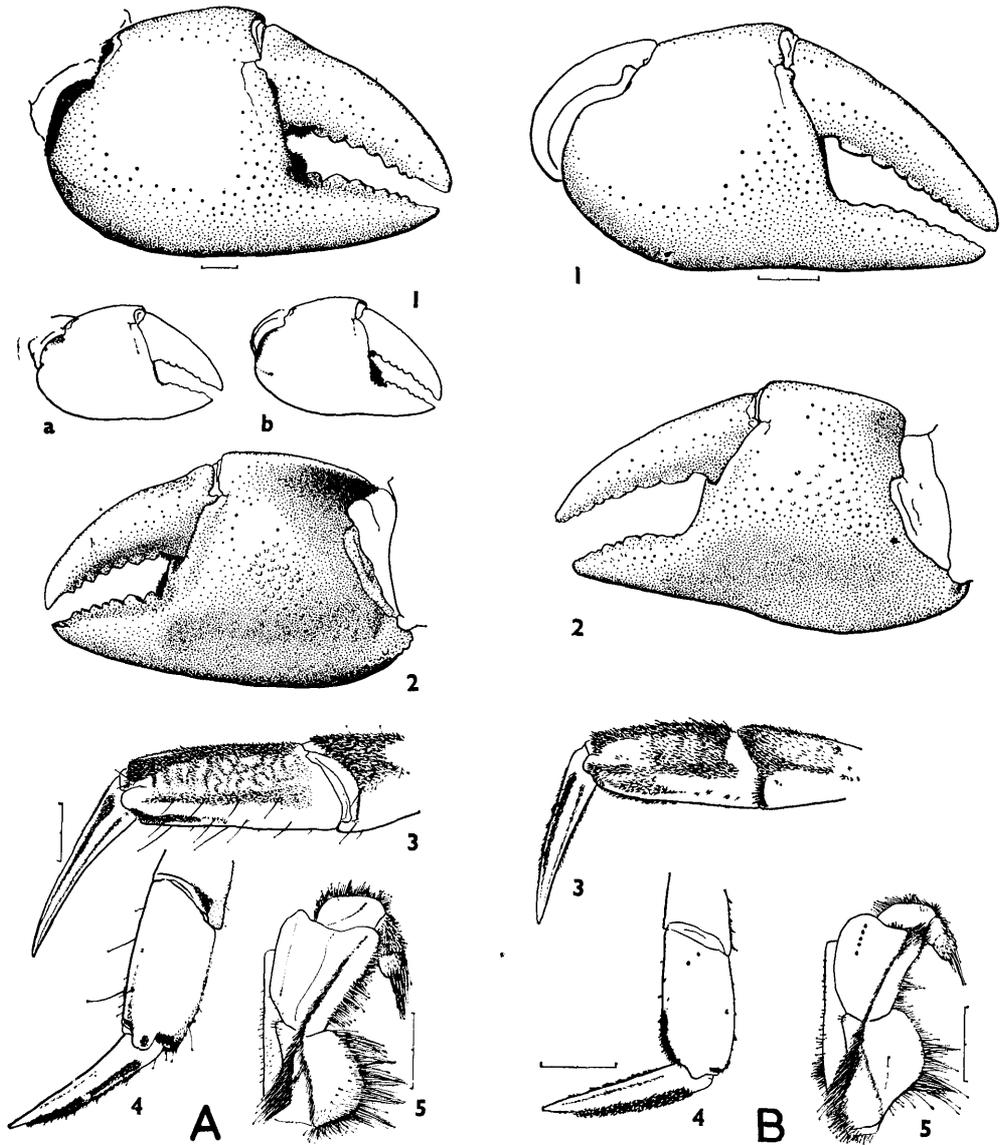
DESCRIPTION

CARAPACE.—Broader than long (usually 1.2 times, but variable in smaller specimens). Surface microscopically granular, sometimes also punctate. Carapace edge distinctly beaded on lateral margins, indistinctly beaded on frontal margin.

Cardiac and intestinal regions usually distinguishable; branchial regions swollen; other regions poorly defined or indistinguishable. Gastro-cardiac groove obvious, median frontal furrow present but shallow. Epigastric lobes indistinct.

Lateral borders convex, broadest just behind the small but distinct anterolateral notches

Orbits with posterior borders sinuous, slightly oblique.



Text-figure 1.—A, *Helice leachii* ; B, *Helograpsus haswellianus*. 1, Chela, outer face (a, minimum ; b, maximum observed pubescence of gape) ; 2, Chela, inner face ; 3, Right first walking leg, anterior face ; 4, Right last walking leg, posterior face ; 5, Third maxilliped. Scale lines 2 mm.

Front strongly deflexed, thin in ventral view except for a median extension which overlies most of the median epistomal ridge. Epistome extremely hirsute.

Sub-orbital crest in both sexes composed of some 17 to 20 granules regularly decreasing in size laterally so that the last 5 or 6 may be microscopic.

CHELIPEDS.—Carpus unornamented except for microscopic row of fine granules on upper surface and short row of hairs parallel to this on inner border.

Chela in mature males large, approximately as high as long, externally smooth. Inner surface with raised swelling covered with numerous small granules. Fingers carrying a low dentition and gaping widely proximally.

In females and smaller males, hands are smaller, gape much reduced, and dentition stronger.

AMBULATORY LEGS.—Long and slender. Second leg c. 1.5 times carapace breadth, four times as long as broad, breadth 1.5 times thickness. Merus smooth except for an indistinct low granular ridge on anterior border (more distinct in smaller specimens) and sparsely covered with short, strong bristles.

First and second legs of both sexes with irregular patches or rows of felt on anterior surfaces of carpus and propodus; dactyli with six longitudinal rows of short hairs.

Third and fourth legs with felting greatly reduced so that only a small patch on distal half of lower edge of propodus and a narrow band on upper edge of both carpus and propodus may be present. Dactyl of last leg long and slender with three upper rows of felt tending to merge and form a broad stripe.

Prominent tufts of hair present between bases of first and second and of second and third ambulatory legs.

STERNUM.—Densely hirsute anterior to abdomen, longitudinally vaulted.

MALE ABDOMEN.—Subtriangular. Penultimate segment c. 1.5 times as broad as long, twice as broad as ultimate segment. Ultimate segment nearly as broad as long, with subparallel sides and rounded tip.

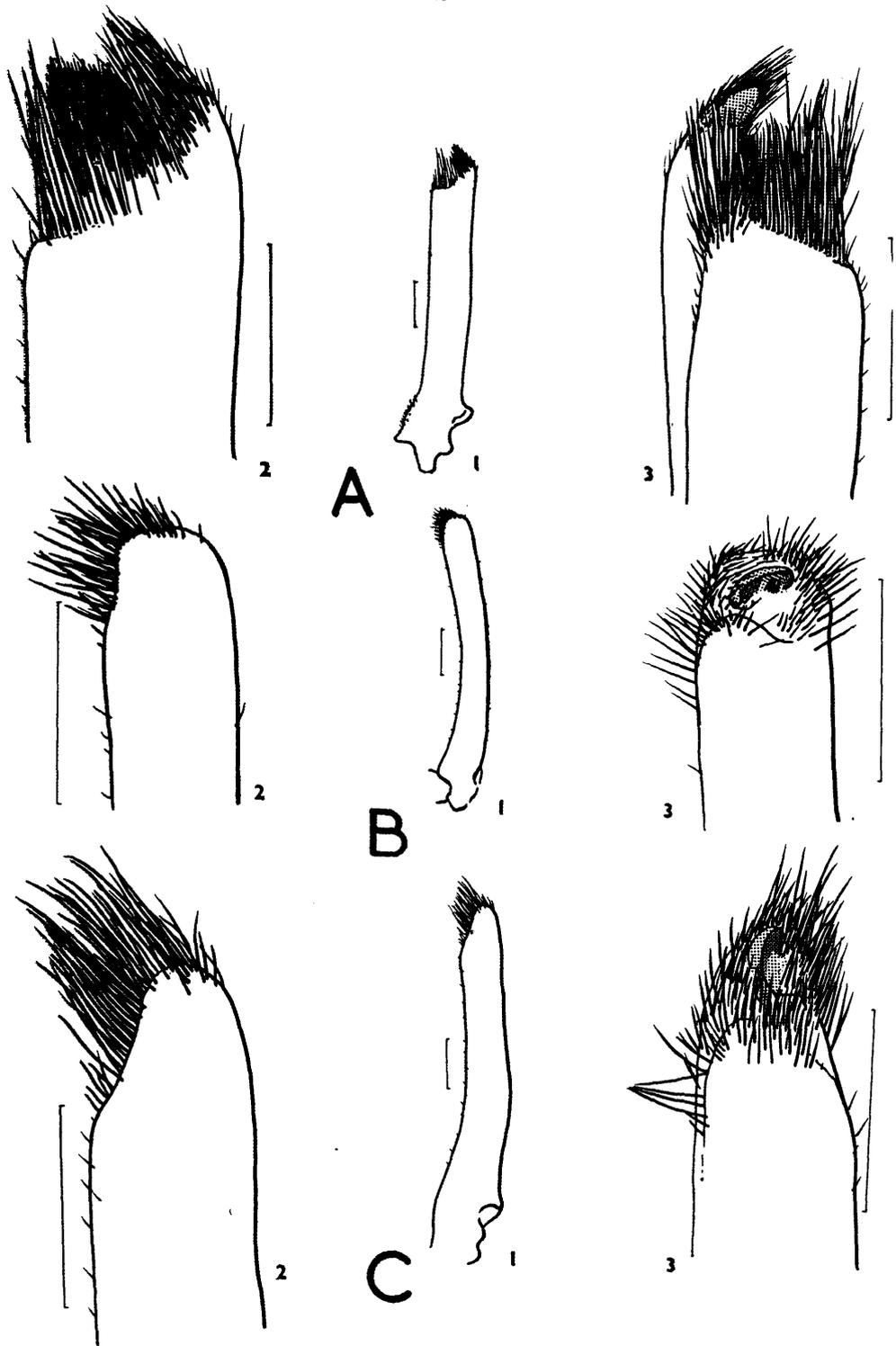
COLOUR.—Carapace slate olive to dark chocolate or reddish, with variable paler mottling. Upper surfaces of legs similar to carapace but with increased mottling. Dorsal surface of wrist and chela raw umber fading to cream ventrally.

HABITAT

In sheltered bays and estuaries, penetrating well up river to a minimum salinity of c. 4‰ at high water. Under rocks or in burrows among grass well up in the Sesarmine zone, at or above high water level, in the river bank or well back on the mud flat. Burrows have been observed in a variety of substrates from moist clay to quite coarse, but dirty, sand. This crab is quite commonly found with *Sesarma erythroductyla* Hess on the Queensland coast. Hale (1927a) gives full details of burrow construction by this species.

DISTRIBUTION

From Brown's R., Tasmania (Tweedie, 1942) west to Port R., South Australia, and north to Pioneer R., Queensland. Although a specimen in the Queensland



Text-figure 2.—Right first male pleopods of A, *Helice leachii*; B, *Helograpsus haswellianus*; C, *Cyclograpsus insularum*. 1, Whole pleopod, abdominal surface; 2, Tip, abdominal surface; 3, Tip, sternal surface. Scale lines 1 mm.

Museum bears the locality label “ ? Darnley I. ”, intensive collecting on the Queensland coast south of the Endeavour R. suggests that the range of this species would not extend so far north.

Not recorded from outside Australia.

Genus **CYCLOGRAPsus** H. Milne Edwards

Cyclograpsus Milne Edwards, H., 1837, p. 77. (Type species: *Cyclograpsus punctatus* H. Milne Edwards, 1837, by subsequent designation of Rathbun, 1918).

Gnathochasmus Macleay, 1838, p. 65. (Type species by monotypy: *Gnathochasmus barbatus* Macleay, 1838 (= *Cyclograpsus punctatus* Milne Edwards, 1837)).

DIAGNOSIS

CARAPACE.—Flattened posteriorly, little vaulted. Depth of carapace less than 0.6 times length. Almost smooth, regions poorly defined. Epigastric lobes generally inconspicuous. Front and anterolateral margins forming a regular curve.

FRONT.—Smoothly deflexed. Frontal width approximately half fronto-orbital width. Fronto-orbital width more than two-thirds width of carapace, and not much more than length. Lateral margins of front not passing imperceptibly into very oblique inner borders of orbits.

ANTEROLATERAL BORDERS.—Entire or microscopically notched.

PTERYGOSTOME.—With granules and setae often in orderly lines, but not conspicuously reticulate as in *Sesarma*.

EPISTOME.—Short, not projecting beyond front in dorsal view.

ANTENNA 2.—Not excluded from orbital hiatus.

CHELIPEDS.—Subequal, with palm swollen in adult male, often globular.

AMBULATORY LEGS.—Sturdy. Meri moderately broad, compressed.

ABDOMEN.—Seven segmented. In male not occupying whole breadth of sternum between last legs; third segment not greatly expanded laterally. Ultimate segment in mature female approximately twice as broad as long, not deeply impacted in penultimate segment.

DISTRIBUTION

East and west coasts of Atlantic, Indian, and Pacific Oceans from Japan in the north to Tasmania and New Zealand in the south.

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

(Species in bold face are discussed in this paper; in the case of other species a reference is given to a recent description.)

- 1. Anterolateral margins of carapace with 1 or 2 minute, sometimes microscopic notches 2
- Anterolateral margins entire..... 5
- 2 (1). Lateral margins of carapace straight, markedly divergent posteriorly; epigastric lobes prominent; sub-orbital ridge interrupted two or three times.....
- *C. longipes* Stimpson, 1858.
- Bonin Islands; Atjeh, Tahiti, Tuamotu, and Fiji Islands. (See Sakai, 1939, p. 690; de Man, 1896, p. 355, pl. 32, fig. 43).

- Lateral margins more or less strongly convex, not markedly divergent posteriorly; epigastric lobes obscure; sub-orbital ridge crenulate with more than 10 granules 3
- 3 (2). Dactyli of first and last ambulatory legs extremely short (as long as breadth of merus), with hairs at tip only.....*C. insularum* sp. nov.
- Dactyli of ambulatory legs of comparatively uniform length; longitudinal rows of hairs along whole length of dactyli..... 4
- 4 (3). Meri of ambulatory legs smooth; sub-orbital ridge with c. 20 granules.....*C. intermedius* Ortmann, 1894. Loo Choo Islands, Japan, Indian Ocean. (See Sakai, 1939, p. 689; 1965, pp. 200-1).
- Meri with anterior and posterior edges granular; sub-orbital ridge with c. 11 granules*C. incisus* Shen, 1940. Hong Kong. (See Shen, 1940, p. 259, figs. 10-16).
- 5 (1). Nearly whole of anterior half of dorsal surface of carapace distinctly and densely granular.....*C. granulatus* Dana, 1852. Hawaii. (See Edmondson, 1959, p. 188, figs. 20a, 21a, b).
- Anterior third of carapace sparsely punctate and/or granular close to frontal and anterolateral margins..... 6
- 6 (5). Lateral borders of carapace straight, subparallel or divergent posteriorly; ambulatory propodi and dactyli with prominent scattered hairs or bristles..... 7
- Lateral borders convex, convergent posteriorly; ambulatory propodi and dactyli with very short hairs (felt) only..... 8
- 7 (6). Sub-orbital ridge composed of 3 long lobules; front of carapace with a distinct median indentation; sides of abdomen in male almost straight.....*C. integer* H. Milne Edwards, 1837. (= *C. parvulus* de Man, 1896. *vide* Forest and Guinot, 1961, 1962). Madagascar, Atjeh, Flores Sea, Marshall Is., Tuamotu, Brazil and W. Africa. (See Rathbun, 1918, p. 326, pl. 97, figs. 1, 2).
- Sub-orbital ridge regularly crenulate; front of carapace straight; sides of abdomen in male distinctly concave.....*C. henshawi* Rathbun, 1902. Hawaiian Islands. (See Edmondson, 1959, p. 188, figs. 20b, 21c, d).
- 8 (6). Meri of ambulatory legs very broad, foliaceous, keeled.....*C. lophopus* Nobili, 1905. Red Sea. (See Nobili, 1906, p. 321, pl. 11, fig. 4).
- Meri not as above..... 9
- 9 (8). Abdomen of male very broad, with lateral margins sub-parallel, sixth segment three times width of seventh.....*C. cinereus* Dana, 1852. Pacific American coast, Hawaiian Islands. (See Edmondson, 1959, p. 187, figs. 19a, b; Rathbun, 1918, p. 327, pl. 98).
- Abdomen of male with lateral margins more or less strongly convergent to seventh segment..... 10

- 10 (9). Long tufts of hair arising from between bases of ambulatory legs..... 11
 No long tufts of hair between bases of ambulatories..... 12
- 11 (10). Carpus of first ambulatory leg with felt on dorsal and anterior surfaces distally and also extending along whole length of propodus on anterior surface.....
 **C. audouinii** H. Milne Edwards, 1837.
 Carpus of first ambulatory leg naked, propodus with felt distally only.....
 **C. lavauxi** H. Milne Edwards, 1837.
- 12 (10). Inner surface of palm of chela in male distinctly and densely granular medially; frontal and anterolateral parts of carapace and legs moderately to strongly granular..... **C. granulosus** H. Milne Edwards, 1853.
 Inner surface of palm very weakly granular; carapace and legs smooth or only very weakly granular..... **C. punctatus** H. Milne Edwards, 1837.

It has been impossible to include *Cyclograpsus tasmanicus* Jacquinet and Lucas in the above key or to synonymise it with any of the known species of *Cyclograpsus*. Because of the brevity of the original description, the status and relationships of this species must remain uncertain.

Since the time of Dana (1852a), various authors have united the four established species discussed in this paper, *C. punctatus*, *C. audouinii*, *C. granulosus*, and *C. lavauxi* (= *C. whitei*), under the first named species which was accorded circum-subantarctic distribution (see Tesch, 1918; Balss, 1935; and Barnard, 1950). Since that time also each species has been misidentified from time to time, resulting in incorrect distributions being recorded in the literature. *C. granulosus* has never been positively identified since the time of Milne Edwards; *C. lavauxi* was recorded from Australia by Haswell (1882b) and from the Kermadec Islands by Chilton (1911), who at first, following Miers (1876), considered it conspecific with *C. whitei*, but later (Chilton & Bennett, 1929) as distinct. While Rathbun (1918) gave good reasons for separating *C. audouinii* from *C. punctatus*, Balss (1935) allowed the former only subspecific status, while Barnard (1950) considered the two as conspecific; Tesch (1918) inferred that both *C. punctatus* and *C. audouinii* occurred in Australia. The present study supports a partial return to the multiplicity of species originally envisaged by Milne Edwards (1837, 1853).

Of the characters which can be used to separate the species dealt with here, two, the pattern of felting of the ambulatory legs and the shape of the abdomen in the male, particularly of the third and sixth segments, stand out as universally applicable because of their distinctiveness. Other useful characters include the shape of the chela in the male, which is generally reliable but subject to variation, the shape of the carapace and the degree of granulation. The shape of the merus of the third maxillipeds differs little in the five species, while in all except *C. punctatus* the male first pleopod is so similar as to be virtually useless as a taxonomic character.

CYCLOGRAPSPUS PUNCTATUS H. Milne Edwards(Text-figs. ~~3~~⁴A, 5A; pl. 20, fig. 3; pl. 23, fig. 3)

Cyclograpsus punctatus Milne Edwards, H., 1837, p. 78; 1853, p. 197, pl. 7, figs. 9, 9a, b. Tesch, 1918, p. 126 (synon.). Rathbun, 1918, p. 328, fig. 153, pl. 99. Barnard, 1950, p. 131, fig. 24f (lit. and synon.). Garth, 1957, p. 101 (synon.)

Gnathochasmus barbatus Macleay, 1838, p. 65, pl. 3.

Sesarma barbata (Macleay). Krauss, 1843, p. 45, pl. 3, figs. 3a-c.

Cyclograpsus minutus Jacquinot, in Jacquinot and Lucas, 1852, Atlas, Crust., pl. 6, figs. 8 H; 1853, p. 75.

Cyclograpsus Reynaudi Milne Edwards, H., 1853, p. 197.

TYPES

C. punctatus.—Male holotype, carapace width c. 31 mm, Indian Ocean, M. Renaud; Muséum National d'Histoire Naturelle, Paris. The right cheliped and carpus and following segments of the left third ambulatory leg are missing, but the specimen is otherwise in perfect condition.

C. reynaudi.—Male holotype, False Bay, M. Renaud; Muséum National d'Histoire Naturelle, Paris. This specimen is intact.

Details of the types of other synonymous species and their localities are given by Rathbun (1918) and Garth (1957).

MATERIAL EXAMINED

9 males (10.5-38 mm), 4 females (10-24.5 mm). South Africa.

MATERIAL ILLUSTRATED

Male, 38 mm, South Africa. South African Museum, Cape Town.

DESCRIPTION

A full description of this species lies outside the scope of this paper. Good descriptions are given by Rathbun (1918) and by Barnard (1950).

DISTRIBUTION

South Africa, from Port Nolloth on the west coast to Natal on the east coast (Barnard). Chile, from Los Vilos to San Vicente, including Juan Fernandez Island (Garth).

DISCUSSION

The form of the male first pleopod of this species (see text-fig. 5A) immediately sets it apart from any of the other species of *Cyclograpsus* discussed here. Other less marked differences are to be found in the shape of the abdomen in the male (the sixth segment being more angular), in the chela of the male (the ventral edge being more convex basally, the gape wider and the inner surface of the palm less tuberculate), and in the pattern of felting on the first and fourth ambulatory legs. The shape of the abdomen in *C. cinereus* Dana, the other Chilean *Cyclograpsus*, readily distinguishes it from *C. punctatus* (see Rathbun, 1918, pl. 98).

The specific unity of South African and Chilean specimens is attested to by Rathbun, who examined specimens from both areas; attempts by us to obtain Chilean material have been unsuccessful. This species was recorded by Stimpson (1907) from Hong Kong; the locality is quoted by Rathbun (1918) without comment, but its existence there seems doubtful.

The restricted synonymy given of this species includes only the first descriptions of synonymous species and basic references to later treatments.

CYCLOGRAPUS LAVAUXI H. Milne Edwards

(Text-figs. ~~4~~⁵B, 5B; pl. 20, fig. 4; pl. 23, fig. 4)

Cyclograpsus audouinii H. Milne Edwards. Dana, 1852b, p. 359, pl. 23, fig. 2.

(non) *Cyclograpsus audouinii* Milne Edwards, H., 1837, p. 78.

Cyclograpsus lavauxi Milne Edwards, H., 1853, p. 197.

Cyclograpsus lavauxi H. Milne Edwards. Miers, 1876, p. 41. Filhol, 1886, p. 390, pl. 41, figs. 4-6. Thomson, 1913, p. 238. Chilton and Bennett, 1929, p. 770. Richardson, 1940, p. 34 (in key). Bennett, 1964, p. 84, figs. 98-100.

Cyclograpsus whitei Milne Edwards, H., 1853, p. 197. Filhol, 1886, p. 391.

TYPES

C. lavauxi.—Male lectotype (J. Forest), carapace width c. 23 mm, New Zealand, M. Lavaux; Muséum National d'Histoire Naturelle, Paris. This specimen lacks the right second and left first ambulatory legs but is otherwise in excellent condition.

C. whitei.—Female holotype, carapace width c. 27 mm, New Zealand; Muséum National d'Histoire Naturelle, Paris. The carapace of this specimen is slightly cracked on the dorsal surface close to the midline posteriorly, but otherwise in excellent condition.

MATERIAL EXAMINED

11 males (13-20 mm), 11 females (8.5-18 mm).

NEW ZEALAND: Sandy Beach (Bay of Islands), Waiheke Is., (Auckland), Waihou B., (eastern Bay of Plenty), Waitere Beach, (Levin), Kau Pt. and Island B., (Wellington), Palling Pt. (Otago Harbour).

MATERIAL ILLUSTRATED

Male, 20 mm, Island Bay, Wellington, 30. iii. 1947, R. K. Dell. Dom. Mus., Wellington.

DESCRIPTION

CARAPACE.—Broader than long, widest about $\frac{1}{4}$ carapace length from front, posterolateral margins subparallel. Surface smooth or very weakly granular anterolaterally and close to frontal margin. A microscopically granular elevated ridge extending around margins.

Regions poorly defined, gastrocervical groove prominent. Punctulations absent except for a shallow one anterolaterally, midway between external orbital angle and gastrocervical groove.

Lateral margins entire.

Orbits uniformly concave to subquadrate, junction with front sharp, posterior border transverse to sloping obliquely posterolaterally; outer angle a sharp point, not advanced as far as level of front.

Front well deflexed, barely visible in dorsal view, convex to weakly bilobate, median frontal furrow prominent, extending to opposite widest part of carapace.

Sub-orbital ridge strongly granular, granules 10-17 in number, most commonly 13-15, irregular in size.

CHELIPEDS.—Carpus smooth except for a minutely granular area at dorsomedial angle.

Chela of male longer than deep, compressed, dorsal and ventral edges of palm subparallel, surface smooth except for a strongly granular longitudinal ridge medially on inner face of palm. Ventral edge of chela straight or very weakly concave at base of fixed finger. Fingers gaping as an almost right angled triangle for about basal third, narrow and linear beyond this, dentition weak, uniform; fixed finger weakly convex midway along inner edge, weakly concave distally.

AMBULATORY LEGS.—Long, moderately robust, compressed, second leg about 1.5 times carapace width, surfaces generally smooth; dactyli long and slender.

First leg with carpus naked. Propodus moderately felted on dorsal surface for distal half, anterior surface with slender medial line of felt for about the distal half of the segment, shorter and even more slender indistinct rows anteroventrally and posteroventrally. Dactyli with 6 distinct, slender longitudinal rows of felt for entire length, three dorsal ones wider than others.

Second and third legs with propodi bearing a distal transverse row of felt dorsally, dactyli with 6 rows of felt as in first leg.

Last leg with carpus naked. Propodus with a short row of felt on dorsal surface extending for distal two-thirds, widening distally. Dactyl with 6 rows of felt, 3 dorsal very wide, hardly distinct, others very sparse.

Moderately long tufts of hair arising from between bases of first and second, and second and third ambulatories, absent from between third and fourth.

STERNUM.—Anterior 2 segments very sparsely pubescent, second segment almost naked.

MALE ABDOMEN.—Third segment convex laterally or with edges almost straight and widening slightly distally to just short of distal edge; following segments tapering to base of sixth segment, sides of which are strongly convex, subparallel for basal half, distally tapering, junction of basal and distal portions smoothly rounded. Seventh segment much narrower than sixth, wide basally, distally rounded.

COLOUR.—Carapace pale yellow dorsally, mottled red anteriorly; legs similar with irregular red mottling dorsally; undersides of carapace and legs, both outer and inner surfaces of chelae, pale.

HABITAT

On stony or sandy beaches, under logs or stones, throughout the littoral. According to Richardson (1949), this species is found in the lower part of the intertidal zone.

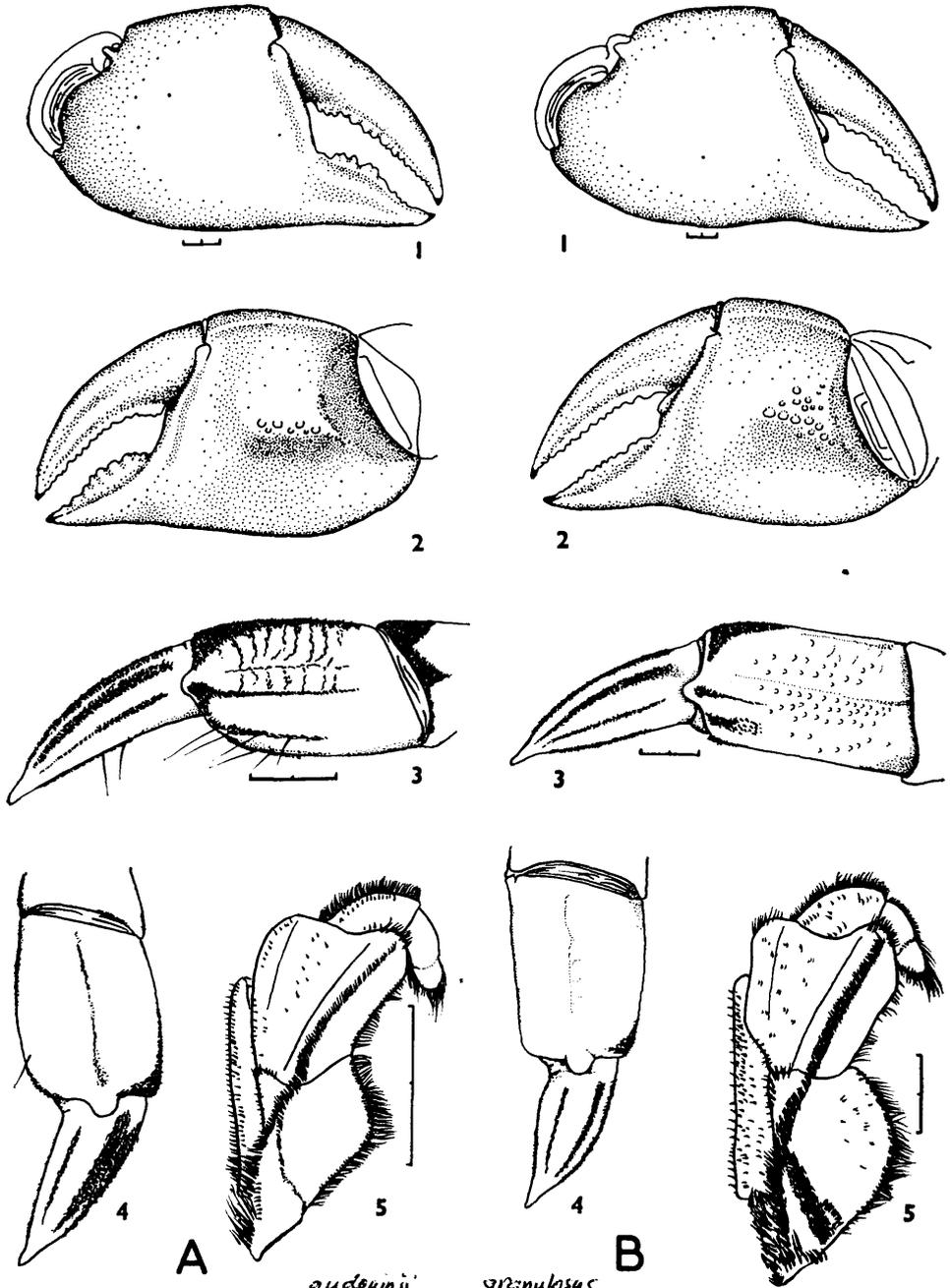
DISTRIBUTION

Throughout New Zealand, from Bay of Islands in the north to Otago Harbour in the south; not extending outside New Zealand.

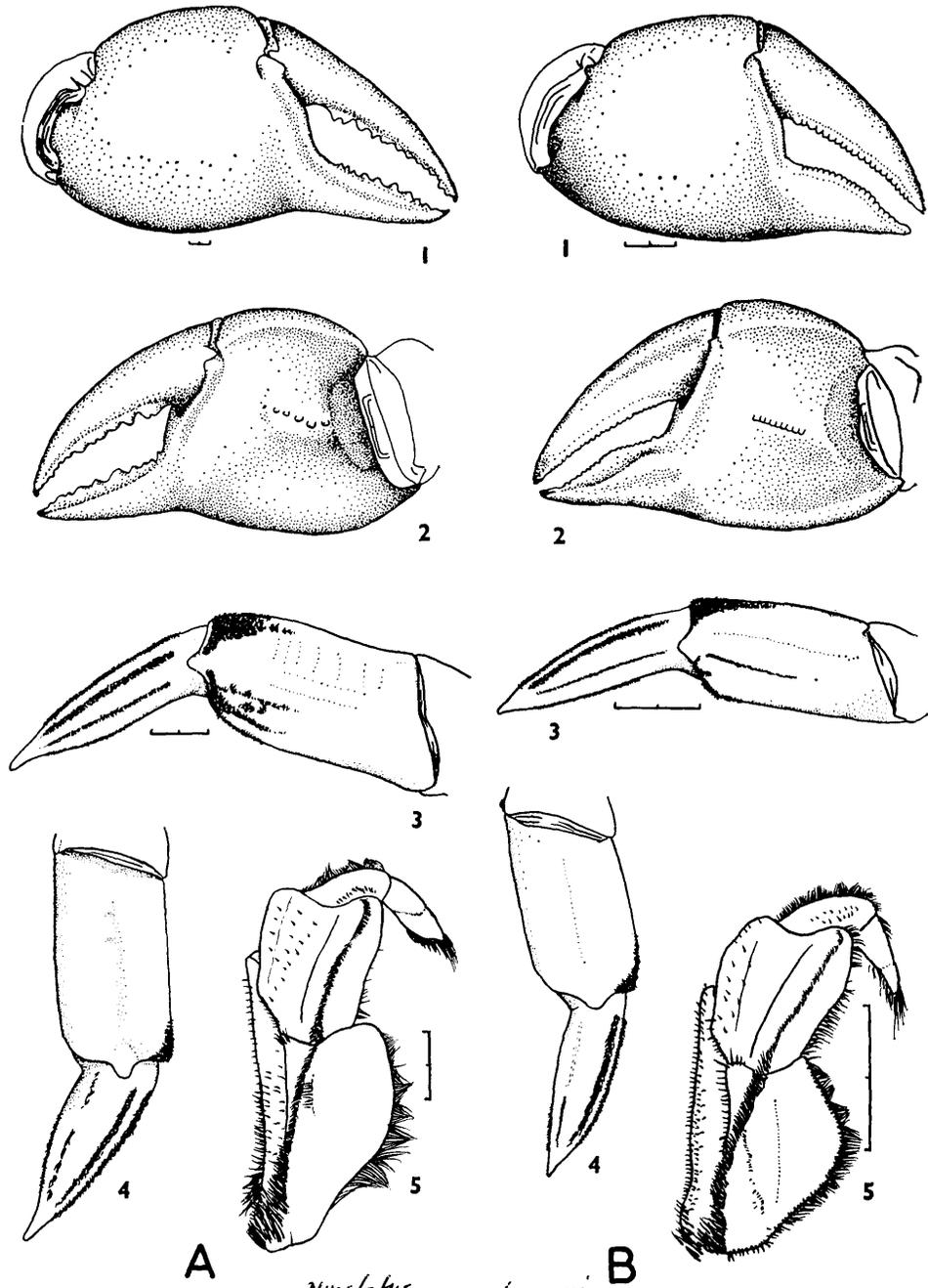
DISCUSSION

Examination of photos of the male lectotype of *C. lavauxi* and of the female holotype of *C. whitei* strongly suggests that the two are in fact conspecific, as Chilton (1911) and students of the New Zealand Crustacea before him considered. Certainly, the descriptions given of the two species by Milne Edwards (1853) were not adequate enough to distinguish the two. However, when confronted by a large series of specimens, Chilton & Bennett (1929) recognised two species and must naturally have assumed that one was *C. whitei*. The characters attributed to the latter species by Chilton & Bennett do not exist in the holotype of *C. whitei*, but typify the new species described here, *C. insularum*. The specific name *lavauxi* has line preference over *whitei*.

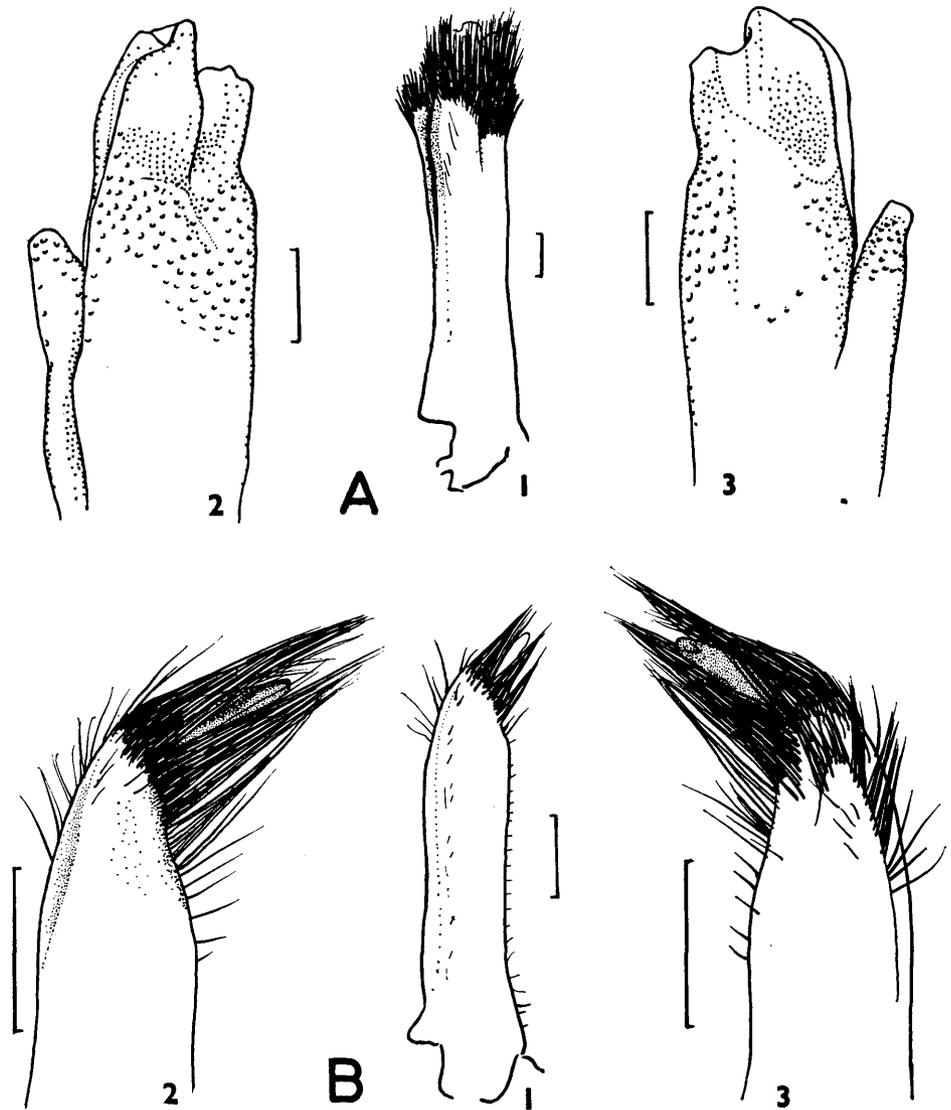
Several New South Wales specimens referable to *C. audouinii* are very similar to some specimens of *C. lavauxi* in a few characters. For instance, the basal portion of the lateral margin of the sixth segment of the abdomen in the male widens slightly from the base instead of tapering, the third segment in some *C. lavauxi* also widens from the base as is typical in *C. audouinii*; the shape of the chela in the male is also similar. However, the pattern of felting of the ambulatory legs is strikingly different in all specimens of the two species.



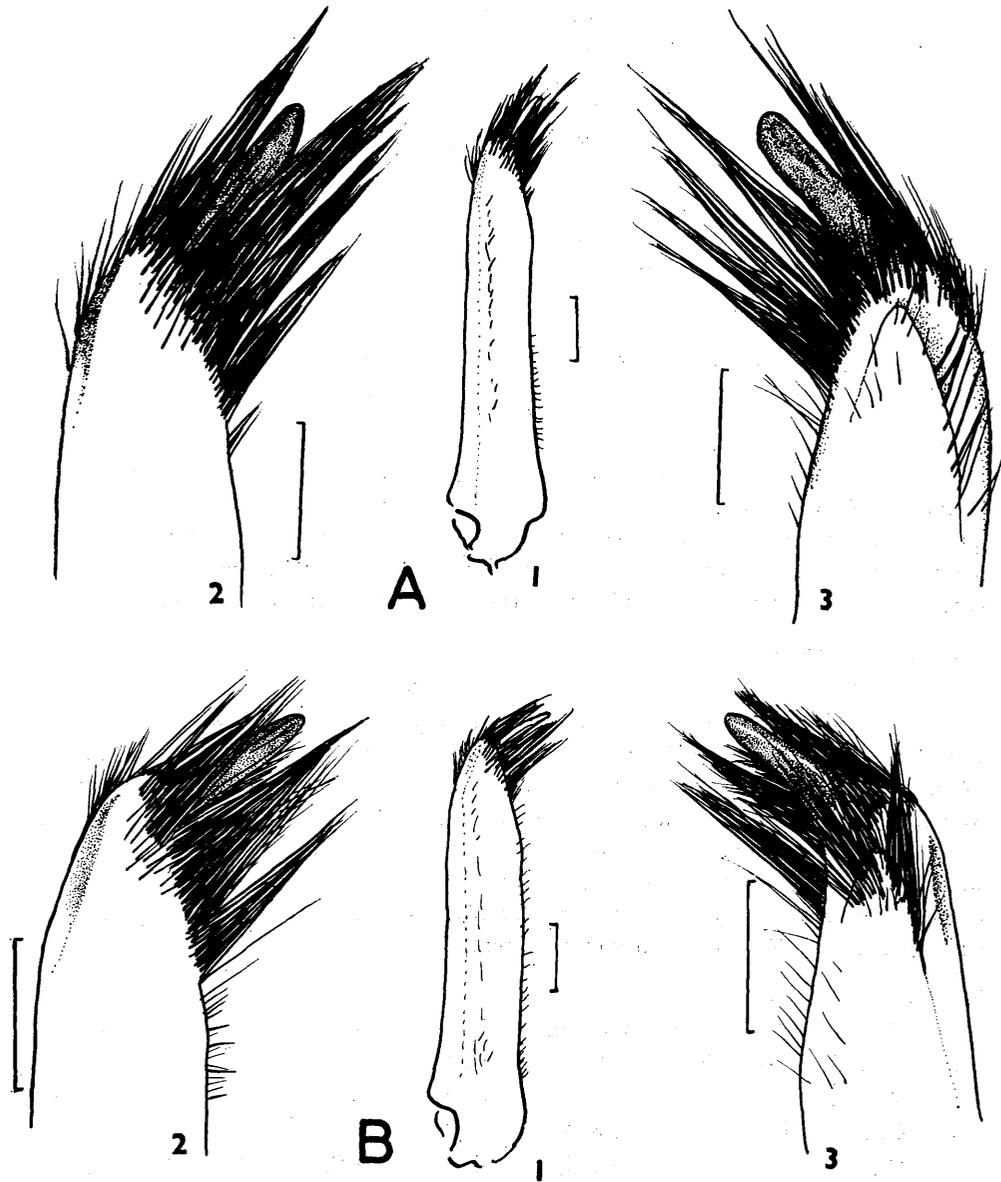
Text-figure 3.—A, *Cyclograpsus audouinii*; B, *C. granulatus*. 1, Chela, outer face; 2, Chela, inner face; 3, Right first walking leg, anterior face; 4, Right last walking leg, posterior face; 5, Third maxilliped. Scale lines 2 mm.



Text-figure 4.—A, *Cyclograpsus punctatus*; B, *C. granulatus*. 1, Chela, outer face; 2, Chela, inner face; 3, Right first walking leg, anterior face; 4, Right last walking leg, posterior face; 5, Third maxilliped. Scale lines 2 mm.



Text-figure 5.—Left first male pleopods of A, *Cyclograpsus punctatus*; B, *C. lavauxi*. 1, Whole pleopod, abdominal surface; 2, Tip, abdominal surface; 3, Tip, sternal surface. For figs. A. 2, 3, the tip has been denuded to show sculpturing. Scale lines 1 mm.



Text-figure 6.—Left first male pleopods of A, *Cyclograpsus audouinii*; B, *C. granulatus*. 1, Whole pleopod, abdominal surface; 2, Tip, abdominal surface; 3, Tip, sternal surface. Scale lines 1 mm.

CYCLOGRAPSPUS AUDOUINII H. Milne Edwards(Text-figs. ³/₄A, 6A ; pl. 21, figs. 1, 2 ; pl. 23, figs. 5, 6)*Cyclograpsus Audouinii* Milne Edwards, H., 1837, p. 78 ; 1853, p. 197.*Cyclograpsus audouinii* H. Milne Edwards. Stimpson, 1907, p. 132. Tesch, 1918, p. 126. Hale 1924, p. 70 ; 1927a, p. 176, fig. 176 ; 1927b, p. 312. Montgomery, 1931, p. 456.(non) *Cyclograpsus audouinii* H. Milne Edwards. Edmondson, 1925, p. 56 (= *C. integer* H. Milne Edwards).*Cyclograpsus laevis* Hess, 1865, p. 152 (type-locality : Sydney). De Man, 1887, p. 700.*Cyclograpsus lavauzi* H. Milne Edwards. Haswell, 1882b, p. 103.(non) *Cyclograpsus lavauzi* Milne Edwards, H., 1853, p. 197.*Cyclograpsus punctatus* H. Milne Edwards. Ortmann, 1894a, p. 729 (part : Sydney specimens only).(non) *Cyclograpsus punctatus* Milne Edwards, H., 1837, p. 78.*Cyclograpsus punctatus audouinii* H. Milne Edwards. Balss, 1935, p. 142.**TYPE***C. audouinii*.—Male lectotype (J. Forest), carapace width *c.* 27 mm, New Guinea, MM. Quoy and Gaimard ; Muséum National d'Histoire Naturelle, Paris. The dorsal surface of the carapace is badly damaged and the right fourth ambulatory leg has the propodus and dactyl missing while the left third ambulatory has the carpus and following segments missing ; the specimen is otherwise intact.**MATERIAL EXAMINED**

142 males (6.5–40.5 mm), 92 females (5–28 mm).

QUEENSLAND : Mouth of Elliott R., Hervey B., Noosa. NEW SOUTH WALES : Port Macquarie, 2m. S. of Tuggerah Lakes, Pittwater (Broken B.), North Harbour (Manly), Little Sirius Cove and Mosman B. (Port Jackson), Coogee, Botany B., Winday I. (Lake Illawara), Wollongong, Shell Harbour. SOUTH AUSTRALIA : Flinders I., St. Vincent's Gulf. WEST AUSTRALIA : Salmon B. (Rottnest I.), Freshwater B., Pt. Peron, Cottesloe B., Cowaramp B., Koombana B. (Bunbury), Duke of New Orleans B., Oyster Harbour (Albany), Woodmans Pt., Pallinup Estuary, Christmas I. and Middle I. (Recherche Archipelago).

MATERIAL ILLUSTRATEDMales, 25, 26.5 mm, Woodmans Pt., Groyne, W.A., 13. xii. 1959, W.A. Nats. Excursion., W.A. Mus. 203.62 (text-figs. ³/₄A, 1, 2 ; 6A).Male, 22 mm, Mosman B., Port Jackson, N.S.W., Dec. 1908, T. Whitelegge. Aust. Mus. P.1840 (text-figs. ³/₄A, 3, 4).Males, 17, 18.5 mm, Noosa, Qld., Jan., 1963, B.C. (text-figs. ³/₄A, 5 ; pl. 21, fig. 1 ; pl. 23, fig. 5).

Male, 26 mm, Woodmans Pt., Groyne, W.A., 13. xii. 1959, W.A. Nats. Excursion. W.A. Mus. 203.62 (pl. 23, fig. 6).

Male, 40.5 mm, St. Vincents Gulf, S.A., South Australian Mus. (pl. 21, fig. 2).

DESCRIPTION

CARAPACE.—Broader than long, lateral margins almost uniformly convex, widest close to half carapace length from front. Surface smooth or very finely granular around anterolateral margins and front only. A microscopically granulate ridge extending around frontal and lateral margins.

Regions poorly demarcated, gastro-cardiac groove prominent. Several punctulations anterolaterally and posteromedially.

Lateral margins entire.

Front moderately deflexed, clearly visible from above, transverse to uniformly convex or bilobate, median frontal furrow extending to just behind orbits.

Orbits almost uniformly concave in dorsal view, junction with front a definite angle (c. 90°), laterally raised and sharply pointed, posterior border transverse.

Sub-orbital ridge strongly and distinctly granular, composed of 13–21 granules, most commonly 17.

CHELIPEDS.—Carpus smooth except for minutely granular narrow portion dorsomedially.

Chela of male longer than deep, compressed, palm enlarged distally, surface smooth except for ridge of strong granules on raised swelling extending longitudinally along inner surface of palm medially. Ventral edge straight or very weakly concave at junction of fixed finger. Fingers widely gaping basally, dentition strong in both fingers, toothed inner edge of fixed finger strongly convex midway along, weakly concave distally.

AMBULATORY LEGS.—Long (second leg almost 1.5 times carapace width), moderately robust, compressed, surfaces generally smooth.

First leg with carpus and following segments densely felted, especially on anterior surfaces; carpus with broad band of felt along distal edge usually extending proximally as two very short rows, 1 dorsal and 1 medial; propodus with two dense longitudinal rows, 1 dorsal and 1 medial, extending for almost entire length and joined by fine lines, in addition 2 short rows of felt, 1 anteroventral and 1 posteroventral; dactyl with 6 longitudinal rows, 3 dorsal wider than others.

Second and third legs naked except for a single fine mid-dorsal row of felt on propodus and 6 rows on dactyl as in first leg.

Last leg with carpus often bearing a slender mid-dorsal row of felt, propodus with a strong row of felt mid-dorsally, widening distally, dactyl with 6 rows of felt, dorsal 3 extremely wide, hardly separated.

Long tufts of hair between bases of ambulatory legs arising from antero-ventral and posteroventral surfaces of bases, tufts equally long between first and second and second and third legs.

STERNUM.—Anterior 2 segments generally strongly hirsute, hairs clumped anteromedially anterior to, and around anterior margin of, abdominal fossa.

MALE ABDOMEN.—Third segment convex laterally or widening slightly from base to just short of distal edge, the widest part of the abdomen. Following segments tapering to base of sixth, the sides of which are basally subparallel or narrowing slightly, distally straight, junction of basal and distal portions sharp or smoothly rounded. Seventh segment with sides concave basally, rounded distally.

COLOUR.—Carapace dorsally brownish purple, very often darker anteriorly than posteriorly; legs similar in colour with paler markings, chelae pale on outer and inner surfaces; undersides of carapace and legs pale. Specimens from mud-flats and reefs often mottled with purple, dark grey or brownish-grey (Hale, 1927a, modified).

HABITAT

Among heaped boulders and stones at or above highest tide limit, extending into shallow water, often in association with seaweed or logs, on rocky platforms, beaches and on reefs and estuarine flats (Hale, 1927a; McNeill, 1962; R. W. George, pers. comm.). Both Hale and McNeill state that this species can survive long periods out of water.

DISTRIBUTION

Australia, excluding Victoria and Tasmania, from Shark Bay in the north-west to Hervey Bay in the north-east; New Guinea.

DISCUSSION

The distinctions between this and other species are discussed under *C. granulatus* and *C. lavauxi*.

Through the kindness of Edwin H. Bryan Jr. of the Bernice P. Bishop Museum, Honolulu, it has been possible to examine four specimens (two males and two females) from the material recorded from Wake Island, N.W. Pacific Ocean by Edmondson (1925, p. 56) as *C. audouinii*. These specimens prove to belong to *C. integer* H. Milne Edwards.

Two specimens (a small male and female, P.1702) in the Australian Museum collections, referable to this species, bear the locality label "Tasmania, Dec. 1908, Old Collection". No other collections from Tasmania contain this species so it appears highly likely that the label is erroneous.

CYCLOGRAPSPUS GRANULOSUS H. Milne Edwards

(Text-figs. ³A, 6B; pl. 21, fig. 3; pl. 23, fig. 7)

Cyclograpsus granulatus Milne Edwards, H., 1853, p. 197. Haswell, 1882b, p. 104. Guiler, 1952, p. 40.

Cyclograpsus punctatus H. Milne Edwards. Haswell, 1882b, p. 104, Guiler, 1952, p. 40; 1956, p. 7.

(non) *Cyclograpsus punctatus* Milne Edwards, H., 1837, p. 78.

Cyclograpsus audouinii H. Milne Edwards. Tweedie, 1942, p. 18, fig. 4.

(non) *Cyclograpsus audouinii* Milne Edwards, H., 1837, p. 78.

TYPE

Female lectotype (J. Forest), carapace width *c.* 22 mm, Tasmania, MM. Quoy and Gaimard; Muséum National d'Histoire Naturelle, Paris. Specimen complete and in good condition.

MATERIAL EXAMINED

86 males (7–35 mm), 59 females (8.5–28.5 mm).

SOUTH AUSTRALIA: Kingsgote and Shoal Bay (Kangaroo Island). VICTORIA: Beaumaris, Appollo B., Lady B., BASS STRAIT: Frazer B. and S. of Currie Harb. (King Island), Goose Island. TASMANIA: Stanley, Ulverstone, Hawley Beach (Devonport), Low Head, Bicheno, Coles B., Meredith R., Orford, Rheban, Eaglehawk Neck (inner bay), Pirates B., Derwent R. (Bellerive, Sandy B., Tarroona), Kingston, Blackman's B., Howden, Oyster Cove, Gordon, Falmouth.

MATERIAL ILLUSTRATED

Male, 29 mm, Rheban, Tas., 17. vi. 1962, D.J.G.G., Tas. Mus. G.1076. (text-figs. ³4B, 1, 2, 5).

Male, 35 mm, Goose I., Bass Strait, 19. vi. 1954, pres. Miss I. Bennett, Aust. Mus. P.12450 (part). (text-figs. ³4B, 3, 4).

Male, 27 mm, Sandy Bay Rivulet, Tas., 13. vii. 1962, D.J.G.G., Tas. Mus. G.1077. (text-fig. 6B; pl. 23, fig. 3).

Male, 31.5 mm, Victoria, National Museum of Victoria. (pl. 21, fig. 3).

DESCRIPTION

CARAPACE.—Broader than long, lateral margins strongly divergent anteriorly, widest about one-third carapace length from front, posteriorly weakly convergent. Surface very strongly granular anteriorly, around anterolateral margins and front. A finely beaded, elevated ridge extending around frontal and lateral margins.

Regions generally poorly defined. Gastrocardiac groove prominent, cervical groove weak, cardiac and intestinal regions weakly demarcated. Several punctulations or shallow depressions anteriorly at posterior part of hepatic region, centrally at each end of gastrocardiac groove, and posteriorly lateral to intestinal regions.

Lateral margins entire.

Front moderately deflexed, clearly visible from above, strongly bilobate or sometimes quadrilobate, median frontal furrow extending posteriorly almost to opposite widest part of carapace. Orbits almost uniformly concave in dorsal view, junction with front sharp, almost a right angle; lateral angle raised as a sharp triangular tooth; posterior border transverse to oblique, sloping posterolaterally.

Sub-orbital ridge strongly and distinctly granular, composed of 12–19 granules, most commonly 16.

CHELIPEDS.—Carpus smooth, except for narrow minutely granular area dorso-medially.

Chela of male longer than high, enlarged distally, compressed, surface smooth except for a ridge of strong granules on raised swelling extending longitudinally along inner surface of palm medially, the swelling itself less strongly granular. Ventral edge generally strongly concave at junction of fixed finger. Fingers weakly gaping basally except in very large males where the fingers gape for their entire length; gape linear. Dentition strong in both fingers, toothed inner edge of fixed finger straight.

AMBULATORY LEGS.—Moderately robust, long, compressed, second leg almost 1.5 times carapace width, surfaces weakly pitted and finely granular dorsally.

First leg with carpus naked; propodus distally felted on anterior surface, dorsally a triangle of felt widening distally extending half length of segment, a narrow row of felt medially and two smaller rows ventrally, 1 anteroventral and 1 posteroventral; dactyl with 6 longitudinal rows of felt, 3 dorsal ones wider than ventral.

Second and third legs naked except for fine rows of felt on dactyl.

Last leg with carpus naked; propodus naked except for short distal triangular area of felt dorsally as on first leg; dactyl with 6 rows of felt, dorsal 3 very broad, others slender.

Bases of ambulatories bearing very short hairs which do not protrude between legs as tufts.

STERNUM.—Anterior segments generally weakly hirsute or naked.

MALE ABDOMEN.—Third segment laterally convex or narrowing from base, widest part of abdomen. Following segments tapering to base of sixth. Sixth segment hexagonal, lateral borders subparallel for basal half or weakly convergent, distally strongly convergent to just short of distal margin; junction of basal and distal portions sharp to smoothly rounded. Seventh segment slightly longer than wide with subparallel to weakly convergent margins, distally rounded.

COLOUR.—Carapace deep red or purple to brownish red, sometimes with paler yellowish mottling, especially posteriorly; legs with similar colouring, chelae pale yellow to white on both outer and inner faces, undersides of carapace and legs pale.

HABITAT

On boulder or shingle beaches on sheltered to fully exposed coasts under stones, often near masses of seaweed in the upper part of the midlittoral or above high tide mark.

DISTRIBUTION

Tasmania and Victoria, extending westward to Kangaroo Island, South Australia.

DISCUSSION

Apart from the differences in the pattern of felting of the ambulatory legs, this species may be distinguished from *C. audouinii* in the following characters:

1. Carapace shape.—In *C. granulosus* generally widest closer to the front than in *C. audouinii*, the anterolateral margins more widely flaring from the outer orbital angle.

2. Granulation.—The dorsal surface of the carapace, especially anteriorly, and the legs, are generally distinctly granular in *C. granulosus* but smooth or only minutely granular in *C. audouinii*.

3. Front.—Often quadrilobate in *C. granulosus* and longer than the anterolateral margin; usually bilobate or uniformly convex in *C. audouinii* and shorter than the anterolateral margin.

4. Sternum and third maxillipeds.—Much less hairy in *C. granulosus*.

5. Male chela.—In *C. granulosus* the ventral edge is generally strongly concave at the base of the fixed finger rather than straight as in *C. audouinii*, the gape is linear and moderate rather than wide, with the inner edge of the fixed finger almost straight instead of strongly convex midway along and the ridge of the inner surface of the palm is more densely granular in *C. granulosus*.

6. Bases of ambulatory legs.—The absence in *C. granulosus* and the presence in *C. audouinii*, of strong tufts of hair between the bases of the ambulatories completely distinguishes these two species.

7. Male abdomen.—While generally distinctive in the two species, the third segment is sometimes laterally convex in both, and the sixth segment almost hexagonal with the sides subparallel basally or slightly tapering. However, in *C. granulosus* the distal portion of the sixth segment is weakly concave whereas in *C. audouinii* it is straight.

8. Male first pleopod.—In *C. granulosus* the horny tip is straight and pointed with a slender aperture on the abdominal surface, while in *C. audouinii* the tip is weakly curved and rounded with a prominent aperture on the sternal surface.

In samples from near the boundaries of their distributions there is much less variation between specimens and the distinguishing characters are much better developed than in samples from widely separated areas. For instance, specimens of *C. audouinii* from South Australia and of *C. granulosus* from Victoria are more easily distinguishable from each other than are Western Australian specimens of *C. audouinii* and Tasmanian specimens of *C. granulosus*.

It is probable that the range of this species coincides with the Maugean cool-temperate province as defined by Bennett & Pope (1953).

CYCLOGRAPUS INSULARUM sp. nov.

(Text-figs. 2C, 7 ; pl. 21, fig. 4 ; pl. 23, fig. 8)

Cyclograpsus lavauxi H. Milne Edwards. Chilton, 1911, pp. 560-1.(non) *Cyclograpsus Lavauxi* Milne Edwards, H., 1853, p. 197.*Cyclograpsus whitei* H. Milne Edwards. Chilton and Bennett, 1929, pp. 769-70. Bennett, 1964, p. 85, figs. 101-2, 139.(non) *Cyclograpsus Whitei* Milne Edwards, H., 1853, p. 197.*Epigrapsus politus* Heller. Lenz, 1901, p. 471.(non) *Epigrapsus politus* Heller, 1862, p. 522.**MATERIAL EXAMINED****HOLOTYPE** : Male, 22 mm, under basalt boulders on surf beach, Little Slope, Lord Howe I., A. R. McCulloch, 2. iii. 1921. Australian Museum, P.5263.**PARATYPES** : Australian Museum, Sydney.—seven males (7-14 mm), two females (9, 15 mm), same data as holotype, P.5264. Male (12 mm), female (14 mm)—Norfolk I., Mrs. F. E. Grant, Feb. 1907, dry pres., G.5880. Three females (11-15 mm)—Lord Howe I., "Thetis" Expedition, Dec. 1908, P.1644. Two males (12, 15 mm), male (12 mm)—Lord Howe I., "Thetis" Expedition, Dec. 1908, P.1645. Two males (14, 15 mm)—on reef, Lord Howe I., A. R. McCulloch, Oct. 1908, P.1134.

Dominion Museum, Wellington. Four males (8-15 mm), female 13 mm, Denham Bay, Raoul I., Kermadec I., Miss P. Bergquist, June 1956.

Canterbury Museum, Christchurch. Three males (14-19 mm), four females (11-18 mm) "New Zealand, C. Chilton." (Identified by Chilton and Bennett, 1929, as *C. whitei* Milne Edwards.)**MATERIAL ILLUSTRATED**

Holotype.

DESCRIPTION**CARAPACE**.—Broader than long (c. 1.2 times), quite flat dorsally. Surface very smooth, microscopically punctate, sometimes granulate laterally. A very faintly granulate rim extending around lateral and frontal margins.

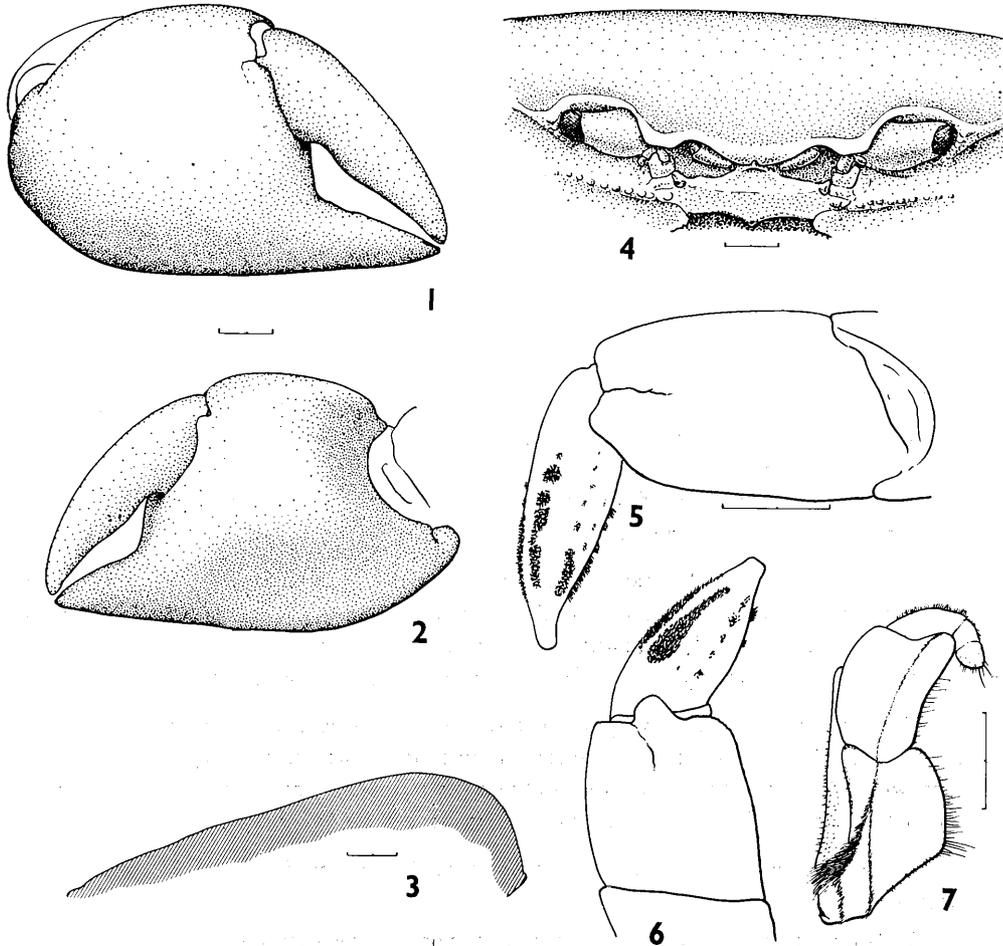
Gastric regions not defined. Frontal furrow absent. Gastrocardiac groove shallow. Cardiac regions not defined, or indicated only by aggregation and elongation of punctae.

Anterolateral borders usually twice microscopically interrupted, with shallow grooves leading inwards from the interruptions, of which the more posterior is less distinct, sometimes absent.

Orbits very small, less than half frontal width, with outer angle not projecting. Frontal area (and anterolateral region anterior to first pair of anterolateral notches) curving abruptly downwards, frontal region at right angles to rest of carapace. In anterior view frontal border is characterised by deep indentations for first antennae on either side of notched median ventral extension.

Sub-orbital crest consisting of some 15 tubercles, largest beneath orbit, decreasing in size laterally.

CHELIPEDS.—Carpus smooth and rounded. In smaller specimens inner angle projecting sharply, appearing spinous in ventral view. Inner angle rounded in large specimens.



Text-figure 7.—*Cyclograpsus insularum*. 1, Chela, outer face; 2, Chela, inner face; 3, Median longitudinal section of carapace; 4, Front; 5, Right first walking leg, anterior face; 6, Right last walking leg, posterior face; 7, Third maxilliped. Scale lines 2 mm.

Chela of male with all surfaces smooth, devoid of granules or ridges. Dentition low, sometimes obsolete. Dentition in female distinct, regularly serrate.

AMBULATORY LEGS.—Robust, with segments swollen. Second leg a little more than 1.5 times carapace breadth. Merus finely granulate, especially on anterior and posterior borders. All legs naked except for rows of sparse tufting on dactyli, and scattered long bristles on posterior margins of propodi.

Last leg with propodus little longer than broad, dactyl as long as propodus, twice as long as broad.

No tufts of hair between bases of ambulatory legs.

STERNUM.—Hirsute between tip of abdomen and base of maxillipeds, hairs tending to form transverse parallel rows.

MALE ABDOMEN.—Evenly tapering (only slightly concave laterally) from proximal border of third segment to distal quarter of sixth segment, then sharply incurving to the terminal segment which is paraboloid, almost as long as broad.

COLOUR.—All available specimens alcohol bleached.

DISTRIBUTION

Kermadec I. (Chilton, 1911), New Zealand (Chilton and Bennett, 1929), and now Lord Howe I. and Norfolk I.

DISCUSSION

As was mentioned under *C. lavauxi*, Chilton and Bennett (1929) recorded this species as *C. whitei* which is here considered a synonym of *C. lavauxi*. *C. lavauxi* (and the type of *C. whitei*) differs from the present species in that the carapace is transversely vaulted, there is an obvious median frontal furrow, the lateral margins of the orbits project anteriorly, the front does not show the characteristic indentations for the first antennae, and the dactyl of the last leg is more slender.

Balss (1935, p. 143) states that the specimens from French Pass in New Zealand referred by Lenz (1901) to *Epigrapsus politus* Heller in fact belong to *Cyclograpsus whitei* H. Milne Edwards. *E. politus* Lenz (not of Heller) presumably therefore becomes a synonym of *C. insularum* (see also Bennett, 1964, p. 85).

The present species is very close both to *C. intermedius* Ortmann and to *C. incisus* Shen. These three, plus *C. longipes* Stimpson (in which, however, the carapace is narrowed anteriorly, the areas well defined, and the sub-orbital ridge composed of but 3 to 4 tubercles) form a well defined subgroup within the genus.

C. insularum can be distinguished from *C. intermedius* and *C. incisus* in having—

1. No median furrow on the frontal region of the carapace. (Faint furrows are present in *C. intermedius* and *C. incisus*).

2. Anterolateral notches less distinct than those figured for *C. intermedius* (Sakai, 1939, pl. 75, fig. 3; 1965, pl. 94, fig. 4) or for *C. incisus* (Shen, 1940, fig. 10).

3. Chela not granular on dorsal border, dentition of male greatly reduced or absent.

4. Walking legs naked except for very interrupted rows of felting on the dactyli. Merus not granular on its anterior border.

5. Dactyli sub-cylindrical rather than compressed. That of the last leg is very short (length twice breadth).

6. Terminal segment of male abdomen paraboloid, not square cut as shown in Shen's figure (1940, fig. 11) of *C. incisus*.

Genus **PARAGRAPSUS** H. Milne Edwards

Paragrapsus Milne Edwards, H., 1853, p. 195. (Type species: *Cyclograpsus quadridentatus* H. Milne Edwards, 1837, by subsequent designation of Tesch, 1918).

DIAGNOSIS

CARAPACE.—Little vaulted, and not deep (depth up to 0.6 times length). Not smooth as in *Cyclograpsus* but regions not always well defined. Epigastric lobes distinct.

FRONT.—Not convexly deflexed as in *Cyclograpsus*, but concave, with forwardly projecting frontal margin overhanging first antennae. Frontal width slightly more than half fronto-orbital width. Lateral margins of front not passing imperceptibly into very oblique inner borders of orbits.

ANTEROLATERAL BORDERS.—With one or two distinct teeth behind external orbital angle.

PTERYGOSTOME.—With distinct granules and short hairs, but not in orderly arrangement.

EPISTOME.—Not projecting beyond front in dorsal view.

ANTENNA 2.—Not excluded from orbital hiatus.

CHELIPEDS.—Subequal, moderate to large and swollen in adult males. Smaller in females.

AMBULATORY LEGS.—Sturdy. Meri moderately broad, flattened.

ABDOMEN.—Seven segmented. In males not occupying whole breadth of sternum between last legs; third segment not greatly expanded laterally. Ultimate segment in mature females approximately twice as broad as long, not deeply impacted in penultimate segment.

DISTRIBUTION

Wholly restricted to Australia, including Tasmania. Miers' (1876) record of *P. laevis* from New Zealand is certainly erroneous (Hutton, 1882; Chilton and Bennett, 1929), and the poorly known *Paragrapsus urvillei* H. Milne Edwards from Vanikoro Is., Santa Cruz, has been referred by Tesch (1918) to *Helice*.

DISCUSSION

In the past this genus has sometimes been confused with *Chasmagnathus*. Tesch (1918) pointed out its true affinities with *Cyclograpsus*, yet still wrongly transferred *P. gaimardii* to *Helice*. The list of characters in the key to genera (couplet 2 (1)) indicates the distinct division between *Paragrapsus* and *Cyclograpsus* on the one hand, and *Helice* and *Chasmagnathus* on the other.

Within the genus the resemblance between *P. gaimardii* and *P. laevis* is very much closer, both morphologically and ecologically, than that between either of those two species and *P. quadridentatus*.

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

1. Anterolateral margins with 2 teeth behind the external orbital angle. 2
 Anterolateral margins with 1 tooth behind the external orbital angle.
 *P. quadridentatus* (H. Milne Edwards, 1837).
- 2 (1). First walking legs with felt on anterior surface of carpus and propodus, and on dactyl;
 suture between first and second sternites not marked by prominent ridge.
 *P. laevis* (Dana, 1852).
- First leg of male with felt only on edge of propodus and on dactyl (possibly naked in
 female); first and second sternites of male separated by a distinct ridge.
 *P. gaimardii* (H. Milne Edwards, 1837).

PARAGRAPSUS QUADRIDENTATUS (H. Milne Edwards)

(Text-figs. 8A, 10A; pl. 22, fig. 1; pl. 23, fig. 9)

Cyclograpsus quadridentatus Milne Edwards, H., 1837, p. 79. Hess, 1865, p. 152.

Paragrapsus quadridentatus (H. Milne Edwards). Milne Edwards, H., 1853, p. 195. Haswell, 1882b, p. 105, pl. 3, fig. 1. de Man, 1889, p. 441. Tesch, 1918, p. 125 (key and footnote). Tweedie, 1942, pp. 21-2, fig. 7.

Chasmagnathus quadridentatus (H. Milne Edwards). Ortmann, 1894a, p. 728.

MATERIAL EXAMINED

47 males (6-32 mm), 40 females (6-20 mm).

VICTORIA: Lady B., Port Phillip. BASS STRAIT: King I. TASMANIA: Wynyard, Ulverstone, North Cape, Cape Portland, Pirates B., Fort Direction, Pittwater, Derwent R. (Bellerive, Sandy B.), Kingston, Howden, Gordon, Adventure B. (Bruny I.), Broadbent.

MATERIAL ILLUSTRATED

Male, 32 mm, Port Phillip, M. Ward, Jan. 1926. Aust. Mus. P.8598.

DESCRIPTION

CARAPACE.—Broader than long (c. 1.2 times).

Surface microscopically granular on anterolateral areas. Margins of carapace indistinctly beaded. Posterolateral corners deflexed, cardiac and branchial regions not transversely convex.

Cardiac and intestinal regions vaguely defined. Gastrocardiac groove obvious. Epigastric lobes distinct, but not prominent. Gastric regions not defined.

Lateral borders with one large, rounded, projecting tooth behind each external orbital angle. Posterior to this the margins are straight, convergent.

Front projecting, divided by a broad shallow emargination into two broad lobes with anterior margins straight but inclined posteriorly.

Sub-orbital ridge bears some 25 low serrate granules largest beneath base of eye and gradually decreasing in size laterally.

CHELIPEDS.—Carpus bears no spine on its inner, upper angle.

Chela in larger males longer than high (c. 1.2 times), externally punctate (not granular). Inner surface with a longitudinal row of some five large granules and c. 8 scattered smaller granules. Fingers with low dentition; tips with horny U-shaped ridge; gape moderately large; large fleshy cushion between fingers proximally.

Female with longitudinal row of granules on outer surface of chela.

AMBULATORY LEGS.—Reasonably strong, second legs c. 1.5 times carapace breadth. Upper border of merus sharp, with blunt spine near distal end.

Dactyl with 6 grooves. Legs naked except for felt in the two upper grooves on dactyl of first leg and some sparse felting on anterior surface of propodus of first leg, in the three upper grooves on dactyl of last leg, and a small patch on upper extremity of propodus of last leg.

MALE STERNUM.—Suture between first and second segments smooth, not as described for *P. gaimardii*.

MALE ABDOMEN.—Subtriangular. Penultimate segment almost twice as broad as long, twice as broad as ultimate segment. Ultimate segment as broad as long, paraboloid.

COLOUR.—Dorsal surface of carapace greenish grey or pale brown, legs similar but tinged with pink or purple. Carapace spotted dorsally with irregular, very dark red spots sparsely distributed, at least posteriorly, with more numerous microscopic spots scattered among them. Legs and dorsal surfaces of chelae possessing only the scattered microscopic spots. Under surfaces pale cream.

HABITAT

On sandy or shingle beaches or rocky coasts under stones in the lower mid-littoral. In many localities, at least in Tasmania, this species occupies a zone immediately below *Cyclograpus granulatus*, both species preferring semi-exposed to fully-exposed coasts although present in some sheltered localities. On slightly muddy beaches *P. quadridentatus* is sometimes found together with *P. gaimardii*.

DISTRIBUTION

Tasmania and Victoria.

PARAGRAPSUS LAEVIS (Dana)

(Text-figs. 8B, 10C; pl. 22, fig. 2; pl. 23, fig. 10)

Chasmagnathus laevis Dana, 1852a, p. 252; 1852b, p. 365, pl. 23, fig. 7. Kingsley, 1880, p. 222. Haswell, 1882b, p. 106. Miers, 1884, p. 246. Ortmann, 1894a, p. 728. Fulton and Grant, 1906, p. 19.

Paragrapsus Verreauxi Milne Edwards, H., 1853, p. 195. Haswell, 1882b, p. 105.

Paragrapsus laevis (Dana). Heller, 1865, p. 55. Tesch, 1918, p. 125 (key and footnote).

MATERIAL EXAMINED

31 males (10–42 mm), 13 females (7.5–32 mm).

QUEENSLAND: Brisbane R., Nerang R., Burleigh, Currumbin Ck. NEW SOUTH WALES: Trial B., Port Macquarie, Wallis Lake, Port Stephens, Tuggerah Lakes, Brisbane Water, Broken B., Lane Cove, Port Jackson, Botany B., Jervis B. VICTORIA: S.E. Victoria, Port Phillip. TASMANIA: Tasmania.

MATERIAL ILLUSTRATED

Male, 26 mm, Port Stephens, Qd Mus. W.1949.

DESCRIPTION

CARAPACE.—Broader than long (1.15 to 1.25 times). Breadth between external orbital angles slightly less than carapace length (0.95 to 1.0 times).

Surface microscopically granular or punctate. Margins of carapace distinctly beaded. Posterolateral corners rather abruptly deflexed, cardiac and branchial regions not transversely convex.

Cardiac and intestinal regions well defined by wrinkled grooves in most older specimens, but poorly defined in specimens of less than 25 mm. Gastro-cardiac groove distinct. Epigastric lobes prominent, anterior and lateral edges of protogastric region slightly raised above sunken hepatic area. Mesogastric region not well defined.

Lateral borders convex, subparallel, with two deep notches forming two distinct anterolateral teeth behind each external orbital angle.

Front divided into two broad projecting lobes well separated by the median groove.

Sub-orbital ridge bearing some 25 (23 to 26) large, distinct tubercles which are largest beneath base of eye and gradually decrease in size laterally.

CHELIPEDS.—Carpus bears a more or less blunt spine on its inner upper angle.

Chela in larger males (over c. 20 mm) longer than high (c. 1.2 times), externally microscopically granular. Granulation on inner surface varying greatly with age. In males of more than 25 mm carapace width raised swelling covered with numerous distinct granules increasing in size towards peak of swelling and tending to form a longitudinal ridge. In smaller males granules much less numerous and less distinct. Fingers with low dentition, tips with horny U-shaped ridge. Gape varying with size, greatest ($\frac{1}{4}$ height of chela) in males over 40 mm.

Females with no distinct granules on inner surface of hand, dentition of fingers lower, almost obsolete, and horny ridges on tips extending much further back (c. one-third length of fingers). A row of low granules running along lower part of outer surface and on to immovable finger.

AMBULATORY LEGS.—Reasonably strong, second legs c. 1.5 times carapace breadth. Merus granulate on upper border, with acute spine, lowest and least acute in the last legs, near distal end.

First leg bearing patches of dark felt on distal half of anterior surface of carpus, and on whole of anterior surface of propodus (except for a longitudinal bare strip in the distal quarter). Dactyl with six rows of felt, upper three densest, posterior one thinnest.

Second and third legs with carpus naked, propodus naked or with small patch or stripe of felt on distal half of upper border, dactyl with six rows of felt less dense than on first dactyl.

Last leg usually with carpus naked (rarely with small patch of felt on upper border), upper border of propodus with stripe of felt along distal two-thirds, lower border with stripe on distal half. Dactyl with three upper rows more or less coalesced to form a broad stripe, lower rows faint.

MALE STERNUM.—Suture between first and second sternites smooth, not as described for *P. gaimardii*.

MALE ABDOMEN.—Subtriangular. Penultimate segment c. 1.5 times as broad as long, twice as broad as ultimate segment. Ultimate segment as broad as long, paraboloid.

COLOUR.—Carapace and legs covered dorsally with small dark red spots which run together but leave irregular bare spots. These bare spots are most common posteriorly on the carapace, and on the legs. Anteriorly the red spots are much denser, usually running together completely to form a solid red area with few pale spots. Wrist and chelae red dorsally, fading to cream ventrally.

HABITAT

Under stones or in burrows about mean sea level. Not penetrating far up estuaries.

DISTRIBUTION

Eastern Australia, as far south as Tasmania and north to Moreton Bay. The Tasmanian record depends on a single specimen (Aust. Mus., old coll., P.7418). Haswell's record from Port Molle is much further north than personal collecting would suggest was the range of this species.

Miers' (1876) record of this species from New Zealand was queried by Hutton (1882), and has not since been confirmed.

DISCUSSION

One specimen (P.7273, male 42 mm) (see figs. 9B, 10D ; pl. 22, fig. 4 ; pl. 23, fig. 12) at the Australian Museum is unusual in that it seems half-way between *P. gaimardii* and *P. laevis* in the following characters.

1. The ratio of fronto-orbital width to length of carapace (0.85).
2. The depth of the division between the two frontal lobes.
3. The distinctness of the post-frontal lobes.
4. The granulation of the inner surface of the chela.
5. The shape of the teeth on the suborbital ridge.
6. The felting of the posterior leg.
7. The presence of a low ridge between first and second sternal segments.
8. The vaulting of the cardiac region.
9. The colour is almost completely washed out, but the spots that remain are much larger than those of *P. gaimardii*.

In the felting of the first walking leg the specimen closely resembles *P. laevis*.

The specimen is one of a series of six collected by M. Ward under stones on sandy mud flat at Port Phillip, Victoria. The other specimens in the series are definitely *P. laevis*. That such a large number of characters should be intermediate between those of two distinct species (placed in different genera by Tesch, 1918) is remarkable. The crab shows no features peculiar to itself that are not intermediate between *P. laevis* and *P. gaimardii* and the possibility that this specimen is a hybrid can not be ignored. It was collected from a locality where the ranges of both species overlap.

PARAGRAPSUS GAIMARDII (H. Milne Edwards)

(Text-figs. 9A, 10B; pl. 22, fig. 3; pl. 23, fig. 11)

Cyclograpsus Gaimardii Milne Edwards, H., 1837, p. 79.

Paragrapsus Gaimardii (H. Milne Edwards). Milne Edwards, H., 1853, p. 196. Haswell, 1882b, p. 105, pl. 2, fig. 4.

Paragrapsus gaimardii (H. Milne Edwards). Hale, 1927a, pp. 179-80, fig. 180. Tweedie, 1942, p. 20, fig. 6.

Helice gaimardii (H. Milne Edwards). Tesch, 1918, p. 119 (key and footnote).

MATERIAL EXAMINED

85 males (5-48 mm), 60 females (15-47 mm).

VICTORIA: Port Phillip, Queenscliffe. SOUTH AUSTRALIA: Coorong. TASMANIA: Wynyard, Emu B., Swan B. (Tamar R.), Triabunna, Carlton R., Dunally, Eaglehawk B., Pipe Clay Lagoon, Ralph's B., Pittwater, Derwent R. (Sandy B.), Brown's R., Howden, Oyster Cove, Isthmus B. (Bruny I.), Southport, Strahan.

MATERIAL ILLUSTRATED

Male, 41 mm, Port Phillip, M. Ward, Aug. 1924. Aust. Mus. P.7259.

DESCRIPTION

CARAPACE.—Subquadrate slightly broader than long (1.05 to 1.15 times). Breadth between external orbital angles markedly less than carapace length (0.75 to 0.85 times).

Surface microscopically granular, margins of carapace distinctly beaded. Posterolateral corners deflexed but curvature merges smoothly with transversely convex cardiac and branchial regions. Regions not well defined although mesogastric, cardiac and intestinal areas usually distinguishable. Epigastric lobes less prominent than in *P. laevis*, but distinct.

Lateral borders slightly divergent posteriorly, with 2 distinct teeth behind each external orbital angle.

Entire front markedly projecting and shelf-like, incompletely divided into 2 lobes by a shallow median emargination.

Sub-orbital ridge bearing some 25 (23–26) serrate teeth largest beneath base of eye and gradually decreasing in size laterally.

CHELIPEDS.—Carpus bearing a more or less blunt granular spine on its inner upper angle.

Chela in larger males longer than high (c. 1.2 times), externally microscopically granular, with longitudinal row of granules extending to base of immovable finger. Most of inner surface bearing small scattered granules tending to form a longitudinal row of some 10 granules. Fingers with low dentition, tips with horny U-shaped ridge, gape slight, even in large males.

Female, with row of granules on outer surface of hand more distinct and extending to tip of immovable finger; only a very faint row of granules on inner surface; horny ridge on tips of fingers extending much further back (c. one-third length of fingers).

AMBULATORY LEGS.—Strong, second legs c. 1.5 times carapace width. Merus granulate on upper border, with spine, lowest and least acute on the last legs, near distal end.

First leg of male bearing strip of dark felt along distal half of ventral border of propodus; dactyl naked. First leg of female usually naked.

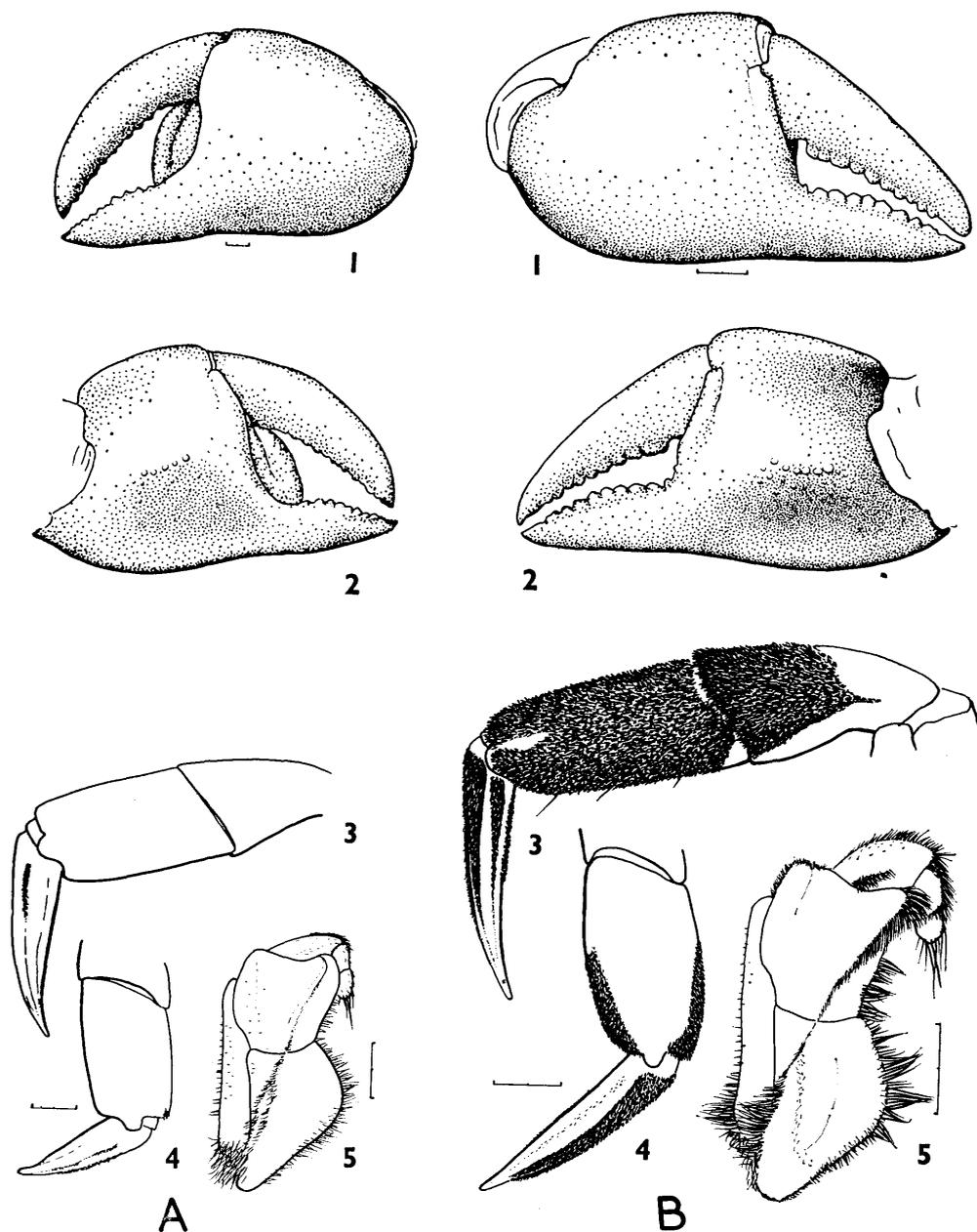
Second and third legs of both sexes naked.

Last leg of both sexes with 2 rows of felt on anterior (upper) edge of dactyl. Ventral border of propodus usually with a small patch at its distal end; this patch is often larger and more commonly found in Victorian specimens than in Tasmanian ones.

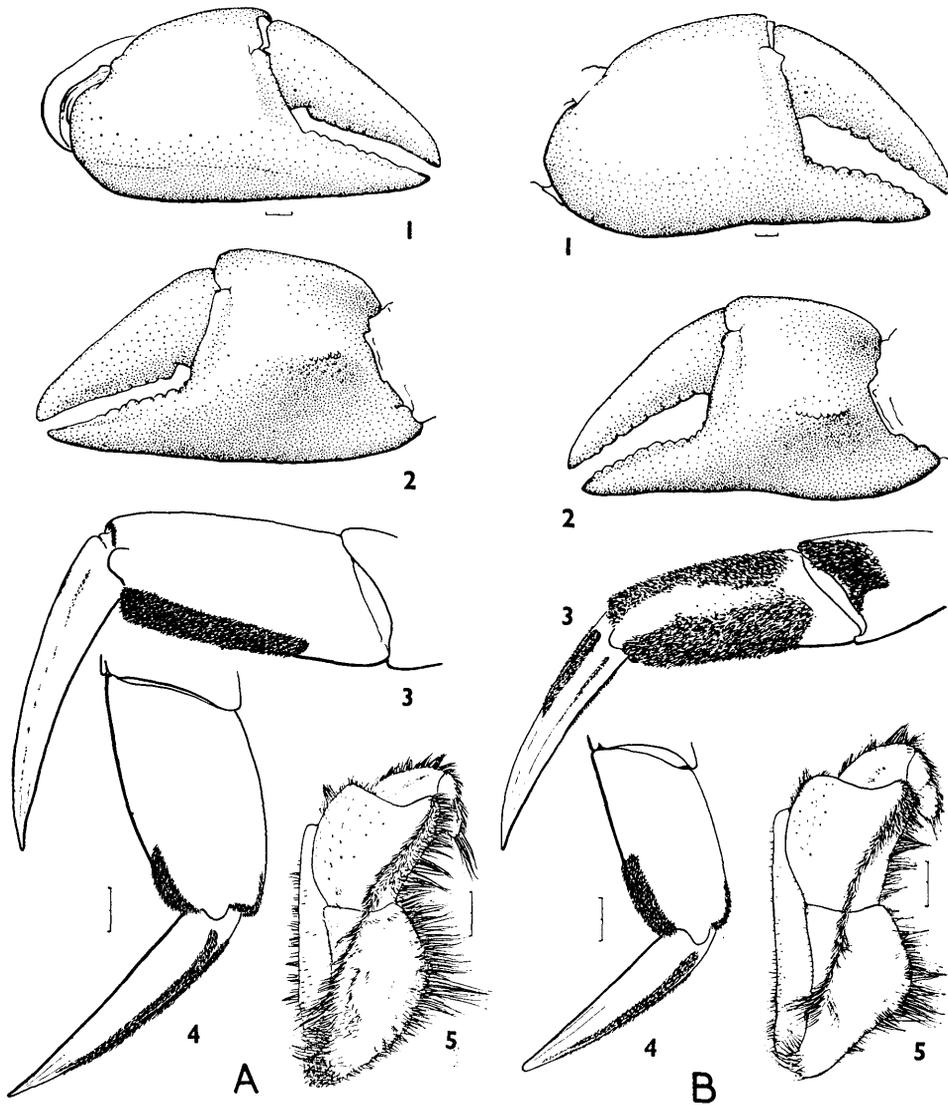
MALE STERNUM.—Suture between first and second sternites usually with edge of first sternite more or less distinctly raised above second.

MALE ABDOMEN.—Broad. Penultimate segment more than twice as broad as long, twice as broad as ultimate segment. Ultimate segment broader than long, sub-triangular, with rounded tip.

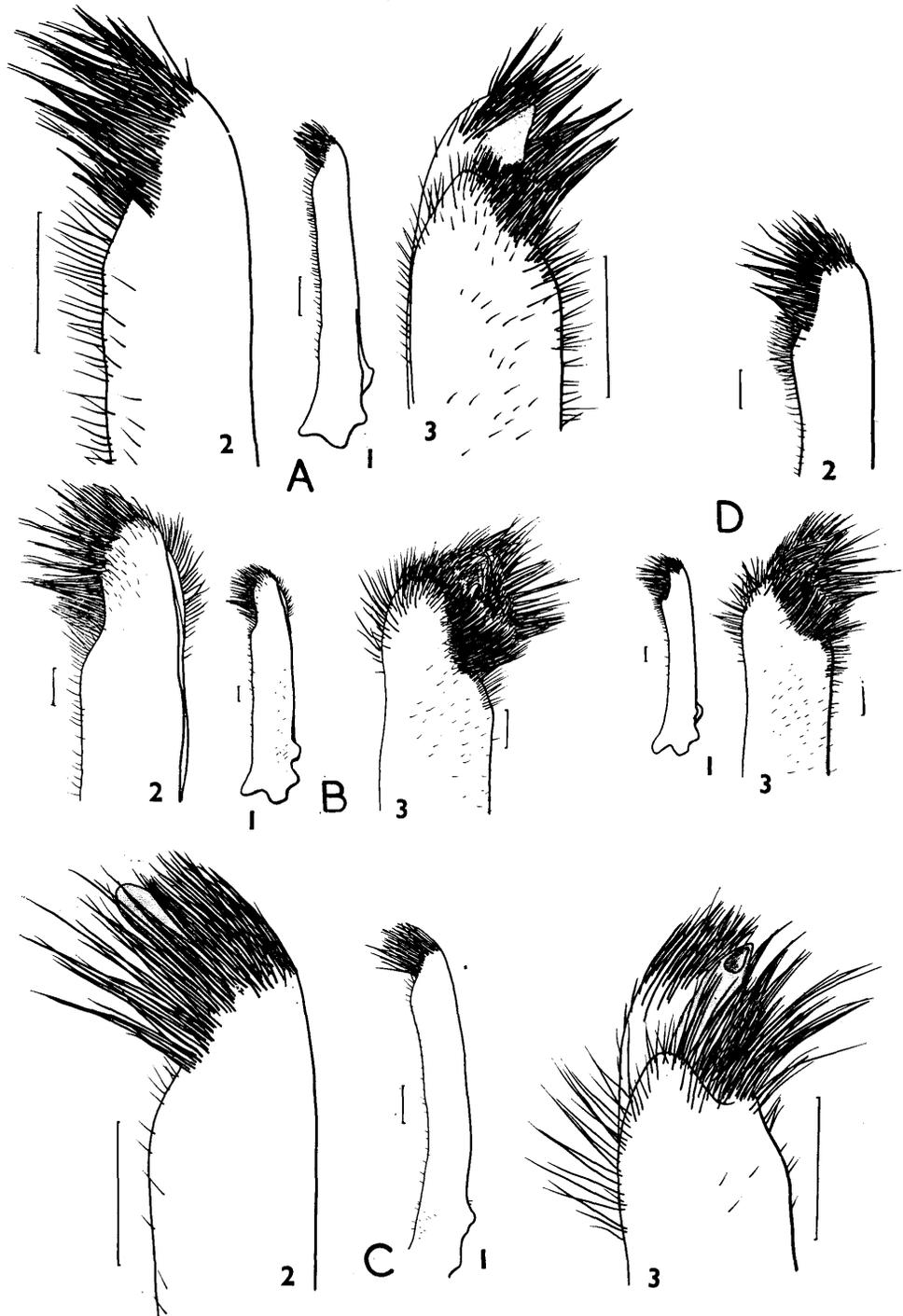
COLOUR.—Dorsal surface of carapace yellowish brown with dark red spots on all surfaces visible in dorsal view. On anterior half of carapace spots are smaller but more tightly packed, sometimes running together to form large blotches. Spots anteriorly on ventral surface of carapace (rarely extending to tip of abdomen), and on anterior faces of ambulatory legs covering all surfaces of the distal three segments. Ventral surfaces otherwise grey. Outer surface of chelae orange, especially dorsally.



Text-figure 8.—A, *Paragrapsus quadridentatus*; B, *P. laevis*. 1, Chela, outer face; 2, Chela, inner face; 3, Right first walking leg, anterior face; 4, Right last walking leg, posterior face; 5, Third maxilliped. Scale lines 2 mm.



Text-figure 9.—A, *Paragrapsus gaimardii*; B, *P. gaimardii/P. laevis* intermediate. 1, Chela, outer face; 2, Chela, inner face; 3, Right first leg, anterior face; 4, Right last leg, posterior face; 5, Third maxilliped. Scale lines 2 mm.



Text-figure 10.—Right first male pleopods of A, *P. quadridentatus*; B, *P. gaimardii*; C, *P. laevis*; D, *P. gaimardii*/*P. laevis* intermediate. 1, Whole pleopod, abdominal surface; 2, Tip, abdominal surface; 3, Tip, sternal surface. Scale lines 1 mm.

HABITAT

Under stones or in burrows on sheltered sandy or slightly muddy shores, most commonly in lower intertidal areas extending well into the sublittoral, but sometimes found above high tide in burrows. Tweedie (1942) states that this species is never found with "*C. audouinii*" (= *C. granulosis* of present paper). This is only partly true. In Tasmania, both species are sometimes found on the same strip of coast, especially on sheltered shingly or pebbly beaches. However, *C. granulosis* generally occupies a higher zone on the shore than does *P. gaimardii*, and moreover *P. gaimardii* is a more estuarine species than either *P. quadridentatus* or *C. granulosis*, even extending short distances up streams and rivers.

DISTRIBUTION

Victoria, South Australia, all sheltered coasts of Tasmania (Tweedie, 1942; Guiler, 1956).

Snelling's (1959) record of this species from the Brisbane R. was due to a misidentification of specimens of *P. laevis*.

DISCUSSION

Tesch (1918, p. 125) considered this species to belong to the genus *Helice*. By virtue of its possession of all the characters of *Paragrapsus* in couplet 2 (1) of the key to genera there is no doubt that it should remain in the present genus. If further confirmation is needed it is provided by the existence of a specimen intermediate between *P. gaimardii* and *P. laevis* (see above).

DISCUSSION

Although it is convenient to postpone a more detailed zoogeographical discussion until the taxonomy of the Australian species of the genus *Sesarma* has been completed, the high proportion of endemism is worthy of some comment. Of the four genera here treated, two (*Helograpsus* and *Paragrapsus*) are wholly confined to Australia. Of the seven species which occur on the Australian continent (including Tasmania), only two are to be found elsewhere (*Cyclograpsus audouinii* in New Guinea, *Helice leachii* throughout the Indo-West Pacific).

Also, of these seven species all but *H. leachii* occur in the south, and three (*Cyclograpsus granulosis*, *Paragrapsus quadridentatus*, *P. gaimardii*) do not range further north than the Victorian and South Australian coasts. In contrast to this, the genus *Sesarma* in Australia shows an essentially northern distribution, with only two species extending south for any distance down the New South Wales coast.

It seems no coincidence that of the species so far discussed, *H. leachii*, in addition to having a *Sesarma*-like distribution, should also have the best developed, almost *Sesarma*-like reticulation of hairs on the pterygostome (see p. 127). It would appear that this reticulation has considerable adaptive value for estuarine, tropical, semi-terrestrial crabs, and is a major factor determining the geographical distribution of this subfamily on the Australian continent.

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EXPLANATION OF PLATES

- Plate XX. 1, *Helice leachii*; 2, *Helograpsus haswellianus*; 3, *Cyclograpsus punctatus*; 4, *C. lavauxi*. Scale in mm.
- Plate XXI. 1, *Cyclograpsus audouinii* (Queensland); 2, *C. audouinii* (South Australia); 3, *C. granulatus*; 4, *C. insularum*. Scale in mm.
- Plate XXII. 1, *Paragrapsus quadridentatus*; 2, *P. laevis*; 3, *P. gaimardii*; 4, *P. gaimardii*/*P. laevis* intermediate. Scale in mm.
- Plate XXIII. Male abdomen of 1, *Helice leachii*; 2, *Helograpsus haswellianus*; 3, *Cyclograpsus punctatus*; 4, *C. lavauxi*; 5, *C. audouinii* (Queensland); 6, *C. audouinii* (Western Australia); 7, *C. granulatus*; 8, *C. insularum*; 9, *Paragrapsus quadridentatus*; 10, *P. laevis*; 11, *P. gaimardii*; 12, *P. gaimardii*/*P. laevis* intermediate.

