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THE EXTINCT GENUS *PROCOPTODON* OWEN (MARSUPIALIA: MACROPODIDAE) IN QUEENSLAND

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ABSTRACT

Three species of the macropodid genus *Procoptodon* Owen are recognised in the Upper Cainozoic deposits of Queensland. Of these, *P. goliah* and *P. rapha* are less commonly encountered than the smaller *P. pusio*.

The majority of specimens were derived from the Pleistocene fluviatile deposits of the Darling Downs, southeastern Queensland; a single specimen has been recorded from cave and fissure-fill deposits. *Procoptodon* appears to be restricted to Pleistocene deposits in Queensland and elsewhere in Australia. Its morphology suggests successful adaptation to a browsing habit.

The fossil macropodids of the Pleistocene fluviatile deposits of the Darling Downs area, southeastern Queensland, comprise the bulk of the representatives of the family yet recorded from Queensland and constitute a rich and diverse assemblage of grazing and browsing animals. Particularly common among these are species which probably frequented open sclerophyll or open grassland habitats. Although many of the Pleistocene species were bigger than present-day macropodids, the larger browsing species of *Procoptodon* Owen appear to have been dominant in size. The genus is, however, also represented in the deposits by a smaller species. *Procoptodon* is generally less well represented numerically than many of the grazing macropodids. In most cases, however, the samples are sufficiently large to enable some assessment of size and morphological variation.

Several important contributions to an understanding of the taxonomy of species of *Procoptodon* have recently been presented, the most notable being those of Stirton and Marcus (1966) and Tedford (1967). Study of the Queensland representatives of the genus is considered important in indicating the variation present in the type area and in supplementing the studies based on non-topotypic samples. This investigation also provides a basis for comparison with samples known to exist in other Australian Pleistocene deposits.

Stirton and Marcus (1966) have suggested that detailed descriptions might be forthcoming from deposits at Bone Camp Gully, a tributary of Ironbark Creek, 15 miles east of Bingara, north-eastern New South Wales. These deposits contain macropodid species also reported in the fluviatile deposits of the Darling Downs (Bartholomai, 1963). Tedford (1967) has described specimens referred to the type species, *P. goliah* (Owen), from Lake Menindee, western New South Wales.

No specimens of *Procoptodon* have as yet been recovered from the possibly Pliocene Chinchilla Sand, in the western Darling Downs, nor have any been found elsewhere in Australia in deposits believed to be older than Pleistocene.

The author wishes to express his appreciation to Mr. A. J. Sutcliffe, of the British Museum (Natural History) for making available casts of the type specimens, and to Mr. T. A. Darragh, National Museum, Victoria, for the loan of specimens for comparison.

Measurements throughout are in millimetres and, unless otherwise specified, all specimens mentioned are held in the collections of the Queensland Museum, Brisbane. Where summaries of measurements are provided, original data are held in the library of the Queensland Museum, Brisbane.

Family MACROPODIDAE

Subfamily MACROPODINAE

Genus **Procoptodon** Owen, 1873

TYPE SPECIES: *Macropus goliah* Owen, 1846, by subsequent designation (Owen, 1874).

GENERIC DIAGNOSIS: Stirton and Marcus (1966) and Tedford (1966) have each presented a generic diagnosis for *Procoptodon* based largely on type specimens known or reasonably presumed to have been derived from the Darling Downs deposits, supplemented by referred specimens from the Bingara and Lake Menindee deposits. The diagnoses generally agree with what is known of the genus in the type area but include some morphological aspects not represented in the available Queensland sample.

DISCUSSION: A full historical discussion of the genus is presented in Stirton and Marcus (1966).

Procoptodon has frequently been included with the genus *Sthenurus* Owen, in a separate subfamily, the Sthenurinae. Because of its general macropodine bilophodont condition and pattern of tooth replacement, Bartholomai (1963) retained *Sthenurus* within the Macropodinae. Similar arguments may be presented for *Procoptodon*, although this genus appears to be considerably more specialised, not only in its dentition but also possibly in aspects of its postcranial skeletal morphology. Tedford (1967) has shown that in *P. goliah* the pes approaches a monodactylous condition, with even the fifth metatarsal considerably reduced. The forelimb is comparatively more elongate than in most other macropodines. The post-cranial skeleton is not known in other species of *Procoptodon*, and it is considered unlikely that specialisation to this extent would necessarily be true of *Sthenurus* as well. For this reason, the broader classification is here applied and *Procoptodon* is regarded as a highly specialised macropodine.

Procoptodon goliah (Owen, 1846)

(Pl. 16, figs. 1-3; pl. 17, fig. 3; pl. 18, figs. 3-4)

Macropus goliah Owen, 1846, p. 59; Flower, 1884, pp. 720-1.

Procoptodon goliah (Owen): Owen, 1873, pp. 386-7; 1874 (*partim*), pp. 791-7, pl. 79, figs. 1, 8, 10; pl. 80, figs. 1-4; 1877 (*partim*), pp. 460-5, pl. 94, figs. 1, 8, 10; pl. 95, figs. 1-4; Lydekker, 1887 (*partim*), pp. 234-5; 1891, pp. 571-4, pl. 21, figs. 2-2b; Simpson, 1930, p. 78; Stirton and Marcus, 1966, p. 352, figs. 3, 10; Tedford, 1967, pp. 42-84, figs. 9-23.

Procoptodon goliath Etheridge Jun., 1878, p. 190.

[non] *Procoptodon goliah* (Owen): McCoy, 1879, pp. 9-11, pls. 52-3 (= ?*P. rapha* Owen).

Sthenurus goliah (Owen): De Vis, 1895 (*partim*), pp. 89-93, pl. 15, figs. 5-9.

Sthenurus (*Procoptodon*) *goliah* (Owen): Tate, 1948, p. 338.

MATERIAL: F3862, cast of holotype, B.M.(N.H.) No. M1896, partial right maxilla with M^1-M^3, Darling Downs, southeastern Queensland (figd. Owen, 1874, pl. 79, fig. 1; 1877, pl. 94, fig. 1; Stirton and Marcus, 1966, figs. 3a-b).

F1850, partial right maxilla with P^3-M^2, King Creek, Darling Downs. F1328, partial left maxilla with M^3, King Creek, Darling Downs.

F3861, cast of B.M.(N.H.) No. M1897, partial right mandibular ramus, with M_1-M_4, Darling Downs (figd. Owen, 1874, pl. 80, figs. 1-2; 1877, pl. 95, figs. 1-2). F795, partial right mandibular ramus with M_2-M_4, Darling Downs. F797, partial right mandibular ramus with P_3-M_4, Darling Downs. F801, cast of partial left mandibular ramus with M_3-M_4, locality unknown (figd. Owen, 1874, pl. 79, figs. 8, 10, pl. 80, figs. 3-4; 1877, pl. 94, figs. 8, 10, pl. 95, figs. 3-4). F805, partial right mandibular ramus with P_3-M_4, Clifton, Darling Downs. F4457, partial left mandibular ramus with I_1 broken, P_3-M_4, Darling Downs. F4458, partial right mandibular ramus with M_4, Darling Downs.

SPECIFIC DIAGNOSIS: An adequate diagnosis for the species is presented in Stirton and Marcus (1966).

DISCUSSION: Owen's original description is contained in notes transmitted to and published in Waterhouse (1846). Owen (1846) must thus be regarded as the author of the specific name as has been noted by all subsequent workers, with the exception of Tate (1948), who attributed authorship to Waterhouse.

TABLE 1

MEASUREMENTS FOR *Procoptodon goliah* (OWEN) MAXILLA

Specimen	P^3	M^1	M^2	M^3
F3862, cast of holotype ..	—	17.3 × 17.0	21.5 × 19.6	23.6 × 19.8
F1850	15.8 × 10.9	17.8 × 17.0	20.8 × 19.2	—
F1328	—	—	—	22.6 × —

The original description is somewhat confusing, in suggesting that the holotype contained not three, but only two molar teeth in a fragment of a right maxilla. Combined length of these is stated to be 1½ inches while the breadth is indicated as 7½ lines. These measurements concur with the length of M^1M^2, and the protoloph breadth of M^2 in the British Museum (Natural History) specimen, M1896, figured by Owen (1874, pl. 79, fig. 1). This specimen was regarded as the holotype by Lydekker (1887). The specimen thought to be a right maxilla by Tate (1948) and confused with the holotype, is unquestionably a partiai left mandibular ramus. It was figured and correctly determined by Owen (1874, pl. 79, fig. 8).

The molar teeth contained in the holotype maxilla were interpreted by Owen (1874) as M^2–M^4. This determination was questioned by Stirton and Marcus (1966) and was shown by Tedford (1967) to be incorrect. The teeth represented are M^1–M^3. Evidence to support this identification has been gained from a comparison of a cast of the holotype with F1850 a maxillary fragment with P^3 exposed by fenestration and M^1–M^2. The first two molars of the holotype are nearly identical in size and proportion with those in F1850, as seen in table 1. Further, the teeth are morphologically inseparable, while the jugal processes and anterior limits of the post-palatal vacuities are similarly positioned in both specimens.

Examination of Owen's (1874, 1877) figures indicates that some of the specimens examined by that authority have been incorrectly determined as *P. goliah*. Strong accessory ornamentation, the open nature of the antero-labial metaloph "pocket" on the molars, and near vertical labial and lingual molar crown margins are conspicuous in the specimens depicted by Owen (1874, pl. 79, figs. 2-7, 9), indicating that these are, in fact, of *P. rapha* described below. In the case of the specimens illustrated by Owen (1874, pl. 80, figs. 5-8), diagnostic details cannot be evaluated in the views provided, but these may also be incorrectly associated with *P. goliah*. The P^3 shown in Owen (1874, pl. 80, fig. 7) from the lingual aspect, cannot be duplicated in its morphology in the samples available in the Queensland Museum, but in view of its apparent size, it is believed that this most likely represents extreme variation in *P. rapha* rather than in *P. goliah*. Considerably greater morphological affinity with *P. rapha* is shown in the specimen illustrated by Owen (1877, pl. 92, figs. 1-5), while the illustration presented in Owen (1874, pl. 79, fig. 11) is composite.

TABLE 2

MEASUREMENTS FOR *Procoptodon goliah* (OWEN) MANDIBLE

Specimen	P_3	M_1	M_2	M_3	M_4	Mandible depth and breadth below M_2-M_3
F3861, cast of B.M. (N.H.) No. M1897	—	18.5 × —	22.7 × —	25.1 × —	25.8 × 18.5	40.6 × 33.0
F795	—	—	22.3 × 16.4	24.6 × 18.2	25.7 × 18.3	51.7 × 35.2
F797	12.7 × 9.7	18.0 × 13.0	21.3 × 15.9	23.8 × 17.3	24.5 × 17.3	44.0 × 35.1
F801, cast of specimen figd. Owen (1874, pl. 80, figs. 3-4) ..	—	—	—	24.4 × 18.5	26.5 × 18.6	—
F805	13.5 × 9.5	18.3 × —	21.8 × 15.6	23.5 × 16.5	—	40.3 × 32.5
F4457	13.6 × 11.2	—	—	23.9 × —	25.6 × —	—
F4458	—	—	—	—	— × 21.1	—

Associated upper and lower jaw fragments of *P. goliah* have been recorded from the Lake Menindee area by Tedford (1967), but to date the Queensland deposits have yielded only dissassociated fragments. Morphological similarity of mandibular and maxillary teeth, particularly molars, suggests the correct assignment of mandibular specimens from the type area, and this is verified by comparison with Tedford's (1967) illustrations.

In addition to associated cranial remains, Tedford (1967) also records associated post-cranial material of *P. goliah*, showing marked differences from the post-cranial skeleton in other known macropodids. In particular, the species trends towards a monodactylous condition of the hind foot, with the fifth metatarsal reduced to a mere vestige. The forelimb is comparatively longer than is normal for the family.

Compared with the cast of the holotype, the molars in F1850 and F1328 possess identical convergence of the lateral surfaces of the lophs. In all the angle is 34°. F1328 presents some morphological dissimilarity in lacking an antero-labial metaloph fossette; this character has been considered specifically important by Stirton and Marcus (1966).

Morphologically, the known permanent cheek teeth appear very similar to those preserved in the partial left maxilla, Australian Museum No. MF890, from Bingara, figured by Stirton and Marcus (1966, figs. 4a–b), but the lateral slopes of the molar lophs converge ventrally at 43°. The author considers this variation in the angle of convergence to be intraspecific.

Tedford (1967) figured specimens of *P. goliah* from Lake Menindee almost identical with the Queensland material, but did not provide any assessment of the lateral loph surface convergence present. F799 from the Darling Downs referred to *P. goliah* by Tedford (1967, table 27) is of *P. rapha*.

Lower dentitions figured in Stirton and Marcus (1966) and in Tedford (1967) appear to be morphologically very similar to those in the Darling Downs material. However, no measurements are provided for the angle of convergence of the lateral lophid surfaces of the molars so that no direct comparison is possible in this feature. Convergence in posterior molars in the Queensland sample ranges from 23°–41° ($\bar{X}$=33°; n=6). Some differences in size are evident between this material, measurements for which are provided in table 2, and the Lake Menindee sample, but as these are comparatively minor, no great significance is placed on them.

All specimens in the Queensland Museum, here referred to *P. goliah* have been derived either from the eastern Darling Downs deposits, or have preservation suggesting this area as their likely provenance.

Tedford (1967) has discussed the recorded geographical distribution of *P. goliah* and has indicated its relative paucity in collections. *P. goliah* is recorded definitely from Bingara, Tocumwal and Lake Menindee in New South Wales, possibly from the Pleistocene Malkuni Fauna of the Lake Eyre Basin, and from Calca Station, County Robinson, western Eyre Peninsula, South Australia (Merrilees and Ride, 1965).

Procoptodon rapha Owen, 1874

(Pl. 16, figs. 4-5; pl. 17, fig. 1; pl. 19, figs. 1-3; pl. 20, figs. 1-3)

Procoptodon rapha Owen, 1873, pp. 386-7 (*nomen nudum*).

Procoptodon rapha Owen, 1874, pp. 788-91, pl, 77, figs. 8-12; pl. 78, figs. 1-3; 1877, pp. 457-60, pl. 90, figs. 8-12; pl. 92, figs. 1-5; pl. 93, figs. 1-3; pl. 128, figs. 1-4; Lydekker, 1887 (*partim*), pp. 235-6; 1891, pp. 571-4, pl. 21, fig. 1; Simpson, 1930, p. 75; Stirton and Marcus, 1966, pp. 352-3, figs. 2, 5, 9.

Procoptodon goliah (Owen): Owen, 1874 (*partim*), pp. 791-7, pl. 79, figs. 2-7, 9; 1877 (*partim*), pp. 460-5, pl. 94, figs. 2-7, 9.

(?) *Procoptodon goliah* (Owen): McCoy, 1879, pp. 9-11, pls. 52-3.

Macropus rapha (Owen): Flower, 1884, p. 721.

Sthenurus goliah (Owen): De Vis, 1895 (*partim*), pp. 89-93.

[non] *Procoptodon rapha* Owen: Scott, 1906, 2 pp.

MATERIAL: F3864, cast of holotype, B.M.(N.H.) No. 32885, partial left mandibular ramus with I_1 broken, P_2 and DP_3 excavated from its crypt, Condamine River, Darling Downs (figd. Owen, 1874, pl. 77, figs. 8-12; 1877, pl. 90, figs. 8-12; Stirton and Marcus, 1966, figs. 5a-c).

F782, partial mandibular rami with left P_3–M_4, right P_3, M_3–M_4, Freestone Creek, Darling Downs. F794, partial mandibular rami with left P_3–M_4, right P_3–M_4, Darling Downs. F796, partial left mandibular ramus with M_2–M_4, Darling Downs. F798, partial left mandibular ramus with M_2–M_4, Darling Downs. F803, partial right mandibular ramus with M_1–M_4, Darling Downs. F804, cast of partial right mandibular ramus with M_1–M_4, locality unknown (figd. Owen, 1874, pl. 78, figs. 1–3; 1877, pl. 93, figs. 1–3). F809, partial right mandibular ramus with M_1–M_2, P_3 exposed from above, Darling Downs. F2430, partial left mandibular ramus with M_2–M_3, King Creek, near Nobby, Darling Downs. F2626, partial left mandibular ramus with M_3–M_4, near Glengallan Creek, 7 miles north of Warwick, Darling Downs. F2636, partial left mandibular ramus with P_3–M_3, Little Middle Creek, Cowabbie, Maidenwell, Darling Downs. F4463, partial right mandibular ramus with M_2, Darling Downs. F4460, partial left mandibular ramus with P_2–M_3, P_3 exposed by fenestration, King Creek, at M.R. 039454 Clifton 1 mile sheet, Darling Downs. F4462, partial left mandibular ramus with M_3, King Creek at M.R. 039454 Clifton 1 mile sheet. F4461, partial right mandibular ramus with M_3, Jimbour Creek, 2 miles south of Jimbour, Darling Downs.

F799, partial left maxilla with M^1–M^3, Darling Downs. F800, partial left maxilla with M^2–M^3, Darling Downs.

SPECIFIC DIAGNOSIS: An adequate diagnosis for this species is presented in Stirton and Marcus (1966).

DESCRIPTION: Mandible large, short, relatively deep, particularly below molar series, with longitudinal axis slightly convex laterally. Symphysis relatively elongate, ankylosed in adult individuals, set at an angle of approximately 40° to base of mandible; produced postero-ventrally resulting in decided ventral extension of basal margin of ramus below P_3–M_1; geniohyal pit very deep, rather high, well anterior to posterior symphysial limit. Diastema short; ventral margin of ramus somewhat acutely rounded between symphysis and diagastric ridge. Mental foramen moderately large, ventral and only slightly anterior to anterior root P_3, near diastemal crest; accessory foramen sometimes present, insignificant, mid-way between posterior root of M_2 and ventral margin of ramus. Ramus with labial groove between mental foramen and anterior root of M_2. Diagastric process postero-ventral of M_4, strongly developed, separated from base of angle by post-diagastric sulcus, bounded above by diagastric fossa; this fossa separated antero-dorsally from extremely shallow depression opening posteriorly into pterygoid fossa. Post-alveolar shelf short, leading to post-alveolar ridge, ascending posteriorly on mesial wall of large coronoid process, to above relatively large mandibular foramen. Masseteric crest raised to level of occlusion of cheek teeth, with production of extremely large masseteric foramen; masseteric fossa deep. Anterior margin of coronoid process inclined beyond vertical. Angle and condyle not preserved.

I_1 known only from its broken base.

P_2 small, robust, subtriangular in basal outline, broader posteriorly, shorter than DP_3. Crown with high lingual crest, slightly concave lingually, transected by two sets of vertical ridges between cuspids, with production of cuspules at crest. High, curving labial crest flanked anteriorly by deep, mesial groove. Intervening basin ornamented by ridges from crests.

DP_3 molariform, with hypolophid broader than protolophid; structurally similar to molar series.

P_3 comparatively large, robust, subtriangular in basal outline, broader posteriorly, only slightly shorter than M_1. Crown with high lingual crest very slightly concave lingually, transected between cuspids by three sets of vertical ridges, with production of cuspules at crest. High, curving, labial crest flanked anteriorly by deep, mesial groove. Deep, intervening basin coarsely ornamented by ridges from crests.

$M_1 < M_2 < M_3 = M_4$; molars subrectangular in occlusal view, somewhat constricted across talonid basin; lophids moderately high, slightly convex posteriorly, with lateral lophid surfaces converging only slightly dorsally. Hypolophid slightly broader than protolophid in M_1, approximately equal or slightly narrower in M_2, and narrower in M_3 and M_4. Trigonid basin relatively broad, its length approximately equalling distance between lophids. Forelink high, strong, descending from a point linguad to protoconid, anteriorly to antero-labial margin of relatively high anterior cingulum; high transverse ridge unites with forelink well above cingulum, extending to lingual cingulum limit; weak ridges descend anteriorly from protoconid and metaconid; accessory ridges on anterior surface of protolophid, from forelink and from transverse ridge to anterior cingulum variable, but generally strong; all ridges on molars generally sharply defined. Posterior surface of protolophid variably, but sometimes strongly ridged. Midlink descends postero-lingually from near protoconid, uniting with more extensive antero-labial ridge usually descending from point labiad to mid-point of hypolophid; junction frequently plicate. Accessory ridges from midlink usually transverse, moderately strong, the most anterior frequently limiting a fossette at the antero-lingual midlink extremity; these better developed lingually than labially. Anterior ridges from hypoconid and entoconid poorly developed; very strong ridge descends anteriorly from near midlink into lingual moiety of talonid basin; additional low folds cross talonid, labially and lingually, with development of pits in base of talonid, close to midlink. Variable, but generally strong ridges fron hypoconid, entoconid and from near mid-point of hypolophid descend posteriorly to unite near base of crown; central posterior ridge generally divided basally by groove, while posterior ridge from entoconid nearly always bifid. The strongly developed ridges throughout often secondarily and variably ornamented by very weak ridges.

Upper incisors, P^2, DP^3, P^3 and M^4 not represented.

$M^1 < M^2 < M^3$; molars subrectangular, slightly constricted across median valley, with lophs moderately high, bowed anteriorly; metaloph broader than protoloph in M^1, approximately equal or slightly narrower in M^2 and narrower in M^3. Lateral loph surfaces converging only slightly ventrally. Anterior cingulum relatively narrow, ascending lingually, short; narrow ridge frequently developed above labial extremity of cingulum, occasionally closed to produce anteriorly directed fossette; numerous, variable, coarse ridges connect cingulum and anterior surface of protoloph, these becoming stronger towards labial limit, with accessory ridges linguad to variable ridge from paracone frequently extremely well developed. Occasionally, antero-labial fossette developed in association with these ridges. Median valley sharply V-shaped, slightly ascending lingually. Strong midlink ascends from point labiad to mid-point of protoloph, to point linguad to mid-point of metaloph; midlink usually convex labially, ornamented labially and lingually by relatively coarse ridges. Strong ridge ascends posteriorly from near mid-point of protoloph, paralleling midlink and close to it, terminating in median valley. A second strong ridge ascends postero-lingually from paracone, curving lingually to unite with midlink, producing well defined fossette on postero-labial protoloph surface. Subsidiary ridge ascends from this ridge near labial margin, into median valley. Anterior ridge from metacone generally ascends directly into median valley, without production of antero-labial fossette on anterior metaloph surface. Various subsidiary ridges and tubercles are developed between this ridge and midlink. Lingually, surfaces of lophids contributing to median valley usually weakly ornamented, but low, strong, broad ridge crosses valley, delimiting well defined pocket adjacent to midlink. Similar, but weaker pocket developed in corresponding labial moiety position. Posterior metaloph surface with very strong ridge ascending postero-lingually from metacone towards median base of crown uniting with strong posterior ridge from below crest of metaloph linguad to mid-line, and with weaker ridge ascending postero-labially from hypocone. Posterior fossette formed by the two stronger ridges; accessory ridges ascend into posterior fossette. Well developed ridges throughout the molars often secondarily and variably ornamented by very weak accessory ridges.

TABLE 3

SUMMARY OF MEASUREMENTS FOR *Procoptodon rapha* OWEN MANDIBLE

Character	F3864, cast of holotype	n	O.R.	$\bar{X}$	s	V
Length P_2	—	1	—	9.4	—	—
Maximum breadth P_2 . .	—	1	—	7.2	—	—
Length DP_3	—	1	—	12.9	—	—
Breadth protolophid DP_3	—	1	—	9.2	—	—
Length P_3	14.9	8	13.8 — 15.2	14.6	0.6090	4.17
Maximum breadth P_3 . .	10.6	8	9.7 — 10.8	10.4	0.3760	3.62
Length M_1	—	6	16.0 — 18.0	16.8	0.8354	4.97
Breadth protolophid M_1	—	4	11.6 — 12.3	12.0	0.3557	2.96
Length M_2	—	12	18.2 — 20.2	19.1	0.5901	3.09
Breadth protolophid M_2	—	7	13.6 — 15.5	14.4	0.5816	4,04
Length M_3	—	13	20.1 — 23.1	21.5	0.9008	4.19
Breadth protolophid M_3	—	9	14.2 — 16.7	15.1	0.7338	4.86
Length M_4	—	10	20.2 — 23.6	21.5	1.0000	4.65
Breadth protolophid M_4	—	6	13.8 — 15.6	14.6	0.6768	4.64

DISCUSSION: The name *Procoptodon rapha* was introduced by Owen (1873) as a *nomen nudum* but was validly presented the following year (Owen, 1874), accompanied by an adequate description and figures.

The holotype, British Museum (Natural History) number 32885, represents an incomplete mandibular fragment with only P_3 allowing meaningful comparison. This tooth was originally figured within its crypt from the labial and posterior aspects. It was removed and was refigured (Stirton and Marcus 1966, figs. 5a–c). The character of its P_3 is sufficient to distinguish it from *P. goliah*. The separated nature of the labial crest differs markedly from that in *P. goliah*, in which the crest more completely encloses the basin between this and the lingual crest. The tooth is larger and more triangular in occlusal view than in *P. goliah*, the latter feature being consistent in the Queensland sample.

Lydekker (1887) recognised *P. rapha* as a distinct taxon but suggested that its inferior size represented the only means for its separation from *P. goliah* and that because of the size variation evident, it was probable that it would ultimately prove to represent only a small race of the larger species. This suggestion was accepted by De Vis (1895) who placed *P. rapha* in synonymy with *P. goliah*, within the genus *Sthenurus*, a conclusion untenable in the light of current knowledge of the group.

TABLE 4

MEASUREMENTS FOR *Procoptodon rapha* OWEN MAXILLA

Specimen	M^1	M^2	M^3
F799	17.1 × —	20.8 × 18.2	22.0 × —
F800	—	19.5 × 16.2	20.7 × 16.8

Apart fron size differences already noted and the morphological differences between the permanent lower premolars, the species are readily separable by the low angle of convergence of the lateral surfaces of lophs and lophids in upper and lower molars in *P. rapha* as well as by details of the stronger, better developed accessory molar ridging in this form. Mean convergence in *P. rapha* lateral molar lophid and loph surfaces measures 14° in lowers (n=12) and 22° in uppers (n=2). Numerous minor differences are also apparent, as indicated in the revised diagnosis presented in Stirton and Marcus (1966).

The holotype of *P. pusio* was referred to *P. rapha* by Lydekker (1887). These taxa are undoubtedly separate and *P. pusio* is described below. It differs not only in its smaller size but also in its much simpler ornamentation of molar teeth.

Although the material in the collections of the Queensland Museum referred to *P. rapha* is not a statistically large sample, a summary of mandibular measurements is presented in table 3; maxillary measurements are listed in table 4. The size differences between *P. rapha* and *P. goliah* alluded to above can be seen by comparison of these tables with tables 1 and 2. Differences appear greater with respect to the mandibular parameters considered, but this results from the larger sample of mandibular specimens available for examination, and the likelihood of a greater range in observable variation being expressed in these. Lower permanent cheek teeth in *P. rapha* appear to be moderately uniform as evidenced by the relatively low values for the Coefficient of Variation throughout (2.96–4.97). These comform reasonably well with values for V currently known for other fossil species of the Darling Downs deposits (Bartholomai, 1967).

Two specimens present in the Queensland Museum collections show some morphological similarity to *P. rapha* but cannot be referred to the species with certainty. Of these, F4548, a nearly complete right mandibular ramus with M_3–M_4 from Cement Mills, Gore, shows reduced ornamentation of the teeth preserved, although in other respects it is inseparable from *P. rapha*. The Cement Mills cave earths are unstratified cave and fissure-fill deposits, and while these are generally assumed to be of Pleistocene age, they may well contain somewhat younger material. Since *P. rapha* is variable in the accessory ornamentation of its molars, F4548 may well represent only extreme variation in this feature.

The second specimen, F6143, from Jimbour Creek, eastern Darling Downs, a partial left maxilla with M^1–M^2, presents much more reduced ornamentation. Convergence of the lateral molar loph surfaces is in keeping with that in *P. rapha*, but there is almost complete absence of accessory ridging on the antero-labial metaloph surface, on the midlink, and associated with the anterior cingulum, while the strong accessory plate, paralleling the midlink across the antero-lingual portion of the median valley is completely absent. Strong pockets are not formed in the base of the median valley.

All specimens at present referred to *P. rapha* in the Queensland Museum collections have been derived from localities in the fluviatile deposits of the eastern Darling Downs, or have preservation in keeping with their derivation from these deposits.

Stirton and Marcus (1966) figured Australian Museum specimen number MF886, a mandible from the Bingara Fauna, as *P. rapha*. This specimen appears morphologically identical with specimens referred from the eastern Darling Downs and presents the more triangular P_3 typical of the present sample. Lydekker (1891) had previously referred a mandibular specimen from Bingara to the species.

P. rapha is not well recorded elsewhere in Australia. Tedford (1967) suggests that the specimens from Lake Timboon, western Victoria, figured by McCoy (1879) as *P. goliah* may be of *P. rapha*. These specimens present some features which are consistent with the topotypic sample of *P. rapha*. Measurements for a small sample from Lake Culongulac and Colac in Victoria are presented for comparison in table 5. These indicate a generally slightly larger size than in the Queensland sample, with the exception of P_3 measurements which appear to be well outside the values in the local material. Morphologically, the specimens tend to be slightly less strongly ornamented in their cheek teeth, but are considered to be generally within the range in variation exhibited in specimens of *P. rapha* from Queensland. In view of the size differences seen in the permanent lower premolars, however, it is believed that reference of the specimens to *P. rapha*, at this time, would be premature.

TABLE 5

MEASUREMENTS FOR SOME MANDIBULAR SPECIMENS OF *Procoptodon* IN THE NATIONAL MUSEUM, VICTORIA

Specimen	P_3	M_1	M_2	M_3	M_4	Angle of convergence of lateral lophid surfaces
P26901 + ...	— × 12.0	11.9 × —	20.7 × 14.8	22.0 × 15.9	23.5 × 15.8	14°
P26902 + ...	16.1 × 12.5	17.8 × —	19.5 × 14.0	21.2 × —	22.1 × 14.7	15°
P1909*	—	—	21.2 × —	22.1 × 16.8	22.9 × 16.4	17°

+ from Lake Colongulac, near "Chocolyn", Camperdown, Victoria; * from Colac, Victoria.

The specimen identified as *P. rapha* by Scott (1906) from King Island has been correctly referred to *Sthenurus occidentalis* by Anderson (1932), but the status of the limb fragment from the Mowbray Swamp in Tasmania, recorded by Scott and Lord (1924) as *Procoptodon* cannot be established until more is known of the post-cranial skeleton in smaller species of *Procoptodon*.

Procoptodon pusio Owen, 1874

(Pl. 17, fig. 2; pl. 18, figs. 1-2; pl. 21, figs. 1-3)

Pachysiagon otuel Owen, 1873 (*nomen nudum*), pp. 386-7.

Procoptodon pusio Owen, 1873 (*nomen nudum*), pp. 386-7.

Pachysiagon otuel Owen, 1874, p. 784, pl. 76, figs. 7-10.

Procoptodon pusio Owen, 1874, p. 788, pl. 77, figs. 2-6, 7; 1877, pp. 454-7, pl. 89, figs. 7-10; pl. 90, figs. 2-6, 7; pl. 91, figs. 1-6; Simpson, 1930, p. 75; Stirton and Marcus, 1966, pp. 353-4, figs. 1, 6-8.

Procoptodon rapha Owen: Lydekker, 1887 (*partim*), pp. 235-6.

Procoptodon otuel (Owen): Lydekker, 1887, pp. 236-7; Simpson, 1930, p. 75.

Sthenurus otuel (Owen): De Vis, 1895, pp. 93-4, pl. 16, figs. 1-4.

MATERIAL: F3863, cast of holotype, B.M.(N.H.) specimen 39996, associated partial right and left maxilla with M^1–M^3, P^3 exposed by fenestration on both sides, Queensland (figd. Owen, 1874, pl. 77, figs. 2-6; 1877, pl. 90, figs. 2-6; Stirton and Marcus, 1966, figs. 1a-b).

F3866, cast of holotype *Pachysiagon otuel*, B.M.(N.H.) specimen, 46310, partial right mandibular ramus with M_2–M_4, King Creek, Clifton, Darling Downs (figd. Owen, 1874, pl. 76, figs. 7-10; 1877, pl. 89, figs. 7-10; Stirton and Marcus, 1966, fig. 6).

F810, partial right maxilla with P^2–M^2, P^3 removed by fenestration, Darling Downs. F2987, partial right maxilla with P^3–M^4, Darling Downs (figd. in part, De Vis, 1895, pl. 16, figs. 3-4). F2988, partial left maxilla with M^2–M^4, Darling Downs, possibly from same individual as F2987. F2989, partial left maxilla with P^3–M^3, Condamine River, "Armour", Macalister, Darling Downs. F4471, partial right maxilla with M^1–M^2, Darling Downs.

F806, associated partial mandibular rami with right M_1–M_4, left M_1–M_4, Darling Downs. F808, partial right mandibular ramus with P_3–M_3, Darling Downs (figd. in part De Vis, 1895, pl. 16, figs. 1-2). F2979, partial right mandibular ramus with M_2–M_4, Gowrie, Darling Downs. F2981, partial right mandibular ramus with P_3 broken, M_1–M_4, ? Gowrie. F2982, associated partial mandibular rami with right P_3, M_1–M_4, left P_3, M_1–M_4, Clifton, Darling Downs. F2983, partial left mandibular ramus with M_1, M_3 in its crypt, Darling Downs. F2984, partial right mandibular ramus with P_3 and M_4 erupting, M_1–M_2, Darling Downs. F2985, partial right mandibular ramus with M_2–M_4, ? Pilton, Darling Downs. F2986, partial left mandibular ramus with M_2–M_3, Darling Downs. F4472, partial right mandibular ramus with M_2, Darling Downs. F4470, partial left mandibular ramus with M_2–M_3, Darling Downs. F4469, partial left mandibular ramus with M_2, Darling Downs. F4468, associated partial mandibular rami with right I_1, P_3–M_4, left I_1, P_3–M_1, King Creek, between Nobby and Pilton, at M.R. 039454 Clifton 1 mile sheet, Darling Downs. F4467, near complete associated mandibular rami with right I_1, P_3–M_4, left I_1, P_3–M_4, King Creek, between Nobby and Pilton, at M.R. 039454 Clifton 1 mile sheet.

SPECIFIC DIAGNOSIS: An adequate diagnosis for the species is presented in Stirton and Marcus (1966).

DESCRIPTION: Upper incisors are not preserved in any specimen. P^2 is too fractured to permit a description to be made, while DP^3, although molariform, is broken anteriorly in the only specimen containing the tooth. The posterior loph indicates that the tooth probably had similar structure to the molar series.

P^3 comparatively robust, elongate, but shorter than M^1, broader posteriorly than anteriorly. Longitudinal labial crest high, well defined, continuing to ascend posteriorly from metacone towards base of crown in most specimens, but occasionally without posterior extension; anterior extension from paracone less well defined, often absent; crest transected by two sets of vertical labial and lingual ridges between cusps. Postero-labially, strong ridge frequently descends towards metacone but only rarely is well defined postero-labial fossette developed. Strong ridge ascends lingually from paracone to protocone as does well defined ridge from metacone to hypocone; anterior and posterior ridges ascending from hypocone and protocone respectively constitute relatively low lingual cingulum; cingulum slightly concave lingually in occlusal view, not significantly marked by cuspules in lateral view. Posterior ridge from hypocone curves labially to below metacone delimiting low postero-lingual fossette. Lingual basin relatively shallow, variably ornamented by moderately strong accessory ridges between base of longitudinal crest and lingual cingulum. Anterior ridge from protocone rarely developed and then weak; antero-lingually, crown occasionally slightly excavated and plicate.

TABLE 6

MEASUREMENTS FOR *Procoptodon pusio* OWEN MAXILLAE

Specimen	P^2	DP^3	P^3	M^1	M^2	M^3	M^4
F3863 cast	—	*12.8 × 11.4	11.9 × —	*13.9 × 13.4	16.8 × 14.8	18.3 × 15.3	—
of holotype	—	*13.0 × 11.6	12.3 × 10.1	*13.6 × 13.4	16.2 × 15.3	18.0 × 16.0	—
F810 ..	8.7 × —	10.3 × —	—	12.7 × —	14.5 × 13.2	—	—
F2987 ..	—	—	12.9 × 9.4	13.1 × 13.0	15.6 × 14.3	17.9 × 15.5	18.4 × 15.0
F2988 ..	—	—	—	—	15.5 × 14.2	17.9 × 15.0	18.4 × —
F2989 ..	—	—	11.9 × 8.3	13.1 × 12.3	15.8 × 14.6	18.1 × 16.0	—

*Measured from Owen (1874, pl. 77, figs. 2-6).

$M^1 < M^2 < M^3 < M^4$; molars subrectangular, slightly constricted across median valley, with lophs moderately high, somewhat bowed anteriorly; metaloph broader than protoloph in M^1, approximately equal in M^2, and narrower in M^3 and M^4. Lateral loph surfaces converging only slightly ventrally. Anterior cingulum relatively narrow, only very slightly ascending lingually, short; labial margin of cingulum connected to paracone by well defined ridge; moderately few ridges ornament anterior surface of protoloph and of these only one or occasionally two low ridges cross to the cingulum; no well-defined forelink present; occasionally, low tubercular ridge passes above cingulum from labial margin to about mid-line of crown. Median valley sharply U-shaped, but sometimes V-shaped particularly in anterior molars, slightly ascending lingually. Strong midlink ascends from point labiad to mid-point of protoloph, to unite with ridge from below mid-point of metaloph, above median valley; midlink usually sinuous in occlusal view, but generally convex labially, ornamented labially and lingually by variable weak, vertical ridges. Relatively strong ridge ascends posteriorly from point linguad to mid-point of protoloph, subparallel to midlink, uniting with posterior loph surface towards base, or with side of midlink. A second, moderately strong ridge ascends postero-lingually from paracone, uniting with short ridge from midlink to delimit well defined fossette on postero-labial protoloph surface; rare, very weak ridge descends posteriorly from this towards median valley. Slight ridge from protocone ascends postero-labially on posterior protoloph surface. Anterior ridge from metacone weak, ascending antero-lingually towards median valley without production of antero-labial fossette on anterior metaloph surface; anterior hypocone ridge very weak. Anterior metaloph surface rarely ornamented by additional accessory ridging. Base of median valley near planar, without development of marked pockets. Posterior metaloph surface with strong ridge ascending almost directly lingually from metacone while broader, posterior ridge ascends labiad to this; second strong ridge ascends from point about one quarter distance along metaloph crest from hypocone, curving abruptly labially near crown base to unite with lingual metacone ridge; weaker ridge from hypocone subparallel to this. Posterior fossette present above mid-line of crown. Moderately strong ridge ascends from near mid-point of metaloph crest into posterior fossette. Coarsest ridges throughout crown, occasionally ornamented by extremely weak subsidiary ridging.

Mandible strong, comparatively large, deep, with longitudinal axis slightly convex laterally. Symphysis relatively elongate, ankylosed in adult specimens, set at an angle of approximately 40° to base of mandible; produced postero-ventrally resulting in marked ventral extension of basal margin of ramus below P_3–M_1; geniohyal pit very deep, set high and well anterior to posterior symphyseal limit. Diastema short; ventral margin of ramus acutely rounded between symphysis and diagastric ridge. Mental foramen large, ovate, ventral and only slightly anterior to anterior root of P_3, below diastemal crest; accessory foramen absent. Ramus with labial groove moderately well defined, developed from between mental foramen and P_3 to below anterior roots of M_3, close to alveolar margin. Diagastric process strongly developed separated from base of angle by post-diagastric sulcus, bounded above by diagastric fossa; this fossa separated antero-dorsally from shallow depression opening posteriorly into pterygoid fossa. Post-alveolar shelf moderately short, leading to post-alveolar ridge, ascending posteriorly on mesial wall of large coronoid process, to above relatively large mandibular foramen. Masseteric crest raised to about level of occlusion of cheek teeth, with production of very deep, masseteric foramen and deep masseteric fossa. Anterior margin of coronoid process inclined almost 20° beyond vertical. Angle of mandible markedly inflected. Condyle not preserved in any specimen.

I_1, relatively small, weak, with crown curved dorsally and mesially to approximate with incisor from other ramus; antero-ventral surface markedly curved. Crown and root laterally compressed, with crown subovate in section, tapering somewhat distally. Young individuals with tips passing posterior to I^1, but older individuals showing anterior wear facet with I^1. Dorsal enamel flange with wear facet near planar.

P_2 and DP_3 are not retained in any specimen.

P_3 relatively large, but smaller than M_1, subovate to subtriangular in occlusal view, broader posteriorly. Crown with high lingual crest very slightly concave lingually, transected between cuspids by two and occasionally three sets of vertical labial and lingual ridges, with production of cuspules at crest. High, curving, labial crest separated from posterior continuation of lingual crest by vertical groove; anteriorly, labial crest unites with first cuspule along lingual crest from anterior cuspid. Labial ridge from anterior cuspid curves posteriorly to unite with labial crest below dorsal limit of crown. Slight cuspule frequently present at anterior base of crown. Basin between crests variably presents accessory ridging.

TABLE 7

SUMMARY OF MEASUREMENTS FOR *Procoptodon pusio* OWEN MANDIBLE

Character	F3866, cast of holotype *P. otuel*	n	O.R.	$\overline{X}$	s	V
Length P_3	—	6	9.7 — 10.2	9.9	0.1897	1.92
Maximum breadth P_3	—	6	6.0 — 6.4	6.3	0.1673	2.66
Length M_1	—	7	12.5 — 13.4	12.9	0.3391	2.63
Breadth protolophid M_1	—	6	9.4 — 10.2	9.9	0.3134	3.17
Length M_2	16.0	16	12.7 — 16.5	14.9	0.9699	6.51
Breadth protolophid M_2	—	8	10.9 — 12.1	11.6	0.4017	3.46
Length M_3	17.1	13	15.9 — 18.0	16.6	0.6799	4.10
Breadth protolophid M_3	12.0	12	12.0 — 13.6	12.7	0.5300	4.17
Length M_4	18.4	12	16.8 — 20.0	18.1	0.7316	4.04
Breadth protolophid M_4	11.5	11	11.5 — 13.7	12.6	0.6253	4.96

$M_1 < M_2 < M_3 < M_4$; molars subrectangular in occlusal view, slightly to moderately constricted across talonid basin; lophids moderately high, slightly convex posteriorly, with lateral lophid surfaces converging only slightly dorsally. Hypolophid broader than protolophid in M_1, approximately equal in M_2, equal or slightly narrower in M_3, and narrower in M_4. Trigonid basin relatively broad, its length approximately equalling distance between lophids. Forelink high, strong, sharply curving anteriorly to appear markedly concave labially in occlusal view; forelink descends to point well labiad to mid-line of crown; high transverse ridge unites with forelink well above anterior cingulum, extending from above antero-labial margin to lingual cingular limit; strong ridge descends anteriorly from protoconid into talonid, but anterior metaconid ridge very weak. Trigonid basin with well defined antero-labial fossette. Accessory ridges on anterior surface of protolophid, forelink and transverse ridge variable but usually weak and numerically few in number. Posterior surface of protolophid usually unornamented, and where present, accessory ridging very weak. Midlink descends antero-lingually from hypoconid, then strongly curves anteriorly to unite with short ridge from point labiad to mid-point of protolophid; junction rarely marked by more than vertical grooves, accessory ridges from midlink usually transverse but moderately weak, and most are developed lingually. Anterior ridges from hypoconid and entoconid weak; accessory ridges on anterior surface of hypolophid variable but usually weak and numerically poorly represented; lingually, that closest to midlink usually somewhat better developed. Talonid basin sharply U-shaped, near planar transversely. Posterior surface of hypolophid rounded, usually with broad basal ridge extending dorsally; ridges from hypoconid and entoconid generally weak, but that from entoconid usually the stronger of the two; posterior surface of crown variably ornamented by weak vertical ridges. All ridges and accessory ridges throughout generally less well defined than in other species.

DISCUSSION: As with *Procoptodon rapha*, redescribed above, the name *P. pusio* was introduced in abstract by Owen (1873) as a *nomen nudum*, but was published, accompanied by an adequate description and figure in a subsequent study (Owen, 1874). The holotype is well preserved, and being juvenile, shows little evidence of occlusal wear in permanent erupted cheek teeth. P^3 has been exposed by fenestration to indicate the morphological characters of that tooth.

The type locality is not mentioned in Owen (1874) but is listed by Lydekker (1887) as Queensland. It is highly likely that it was derived from the Pleistocene fluviatile deposits of the Darling Downs. The specimen was donated by Sir D. Cooper, and where specified, most material emanating from this source came from the eastern Darling Downs, particularly from Gowrie.

In early publications, the lower dentition of this species was referred by Owen (1873, 1874) to a separate genus and species, *Pachysiagon otuel*. Although this name had page precedence over *P. pusio*, Owen (1877) as first revisor, recognised *P. pusio* as the valid name for the taxon, and placed *P. otuel* in synonymy. Owen's action is supported by the present study, in contrast to the conclusion reached by Lydekker (1887) who retained *Procoptodon otuel* as a valid taxon, but placed *P. pusio* in synonymy with *P. rapha*. This is not upheld when a size comparison is made, nor can it be justified by consideration of morphology, as both mandibular and maxillary cheek teeth present reduced ornamentation compared with *P. goliah* and *P. rapha*. De Vis (1895) reverted to the use of the specific name "*otuel*" for the taxon, but Stirton and Marcus (1966) have correctly reapplied the name *P. pusio*. These authors have indicated the type locality for *P. pusio* as King Creek, Darling Downs. This locality, in fact, belongs to the holotype of *Pachysiagon otuel* and not to the holotype for *P. pusio*.

De Vis (1895) considered *P. goliah* and *P. rapha* synonymous, and that "mean size" was no reason for the separation of *P. pusio* from this group. He considered, however, that the difference between the largest widths in *P. goliah* and the smallest in *P. pusio* precluded this possibility and rendered their identity impossible.

Upper dentition in the present sample is too poorly represented to allow meaningful statistical treatment. Morphologically, the sample indicates similar structural simplicity to the holotype, compared with the larger species, *P. goliah* and *P. rapha*. This is particularly evident in the reduced accessory ridging. The structure of P^3 is, however, somewhat different in those specimens possessing it. In F2987, a well defined postero-labial fossette is present near the metacone, while in F2989, the lingual basin is marked by a strong ridge, subparallel to the longitudinal crest in the posterior portion. In no cases are the differences as great as between the holotype P^3 and those of the larger species.

The mandibular specimens are very similar morphologically to the holotype of *Pachysiagon otuel* and form a sample sufficiently large to permit statistical analysis. A summary of mandibular measurements is provided in table 7. The unity of the material is indicated by the relatively low values for the Coefficient of Variation throughout. In most instances V has a value well within that expected for a sample from a single population from slightly differing stratigraphic levels (Simpson et. al., 1960). In the case of length of P_3 this value is low, presumably because of small sample size. The value for length of M_2 is slightly higher than is normally expected, and as the sample is adequate, this may represent greater than normal variability in this feature.

As with the upper cheek teeth, structural simplicity is generally the rule, although occasional specimens, as with F808, show somewhat more complex accessory structure. Structural similarity and size indicate the correct association of upper and lower remains, although these have not, as yet been referred to the species.

REMARKS

At present, three species of *Procoptodon* Owen are known from Upper Cainozoic deposits in Australia, these comprising the large *P. goliah*, the slightly smaller *P. rapha* and the much smaller *P. pusio*. The species are moderately widely spread, particularly the larger forms, but are known from relatively few localities, and are at present known only from the eastern portion of the continent and possibly Tasmania. All are restricted to sediments believed to be of Pleistocene age.

Figure 1 presents information on some of the data derived from the Darling Downs populations of the three species in the form of a log difference diagram (Simpson, 1941), showing comparatively, the proportional relationships of some mandibular dental parameters. It is apparent that although *P. rapha* is relatively and actually smaller than *P. goliah* in most characters, its P_3 is relatively longer. Both *P. pusio* and *P. rapha* have posterior lower molars which become progressively smaller than those in *P. goliah*. Some indication of the position relating to upper cheek teeth is also presented in figure 2, but in this the comparison is rendered less valuable by the small samples involved. To a limited extent, conclusions drawn from lower molars are true of molars in *P. rapha*, but in *P. pusio*, a larger sample, the comparison between upper and lower molars is not paralleled to the same extent.

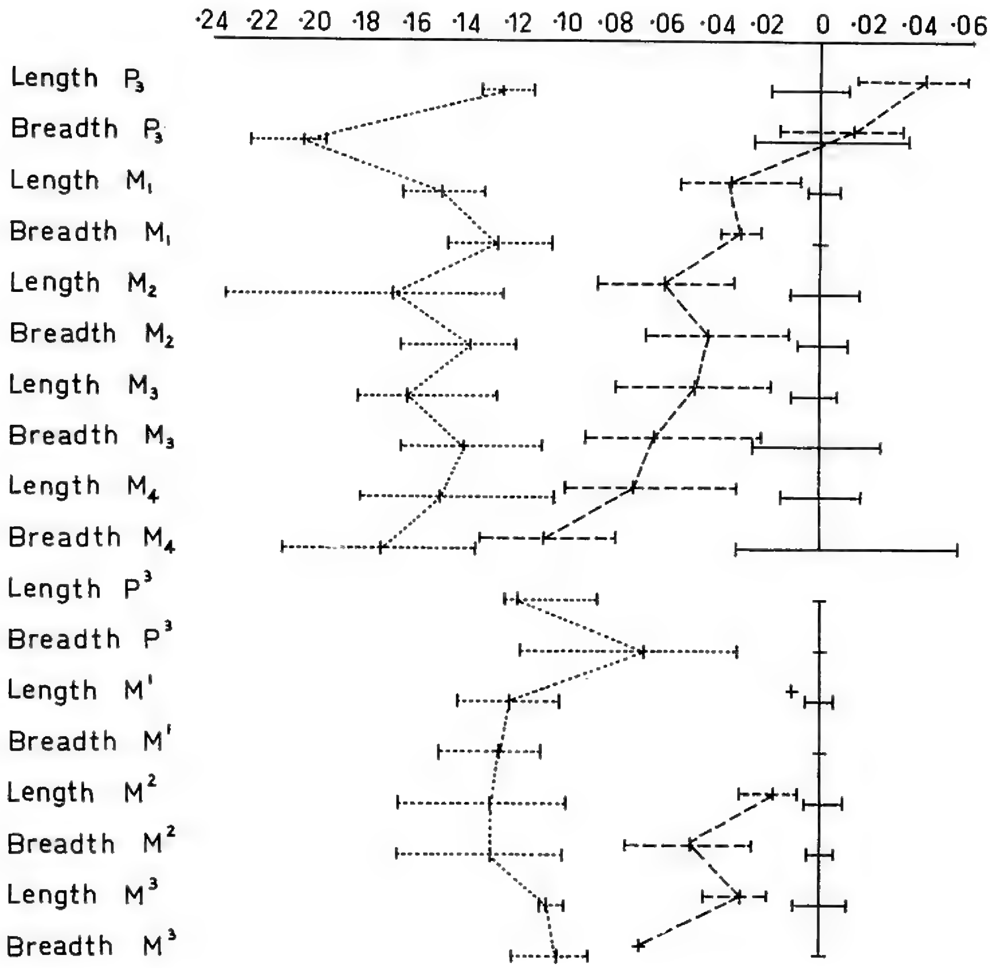

FIG. 1: Log Difference Diagram indicating the proportional relationships of samples of lower and upper permanent cheek teeth in *Procoptodon rapha* and *P. pusio*, utilising data for the mean of the *P. goliah* sample as standard. Coarse dashes represent *P. rapha*; fine dashes represent *P. pusio*. Horizontal limits are based on observed ranges while mean values have been included and have been joined to facilitate comparison.

Ride (1959) has presented observations of masticatory adaptations as they relate to *Procoptodon*. While his comments are valid for the mandibular remains considered, the inclusion of possible phylogenetic implications relating to the premaxillary dentition have been shown by Tedford (1966) to be inappropriate, the specimen in question actually being of a species of *Sthenurus*, most probably *S.* (*Simosthenurus*) *orientalis*.

On the basis of cranial and dental morphology alone it is apparent that the genera *Sthenurus* and *Procoptodon* are closely related. The geological record indicates the group had its origin in the late Tertiary. *Sthenurus* is well established and diverse in the Chinchilla Sand (Bartholomai, 1963), while Woodburne (1967) has shown the presence of a possibly related form, *Hadronomas puckridgi* in the Alcoota Fauna of the late Miocene or early Pliocene Waite Formation of central Australia. *H. puckridgi*, however, also presents features observable in grazing macropodids, and the permanent premolars are very similar to those in the protemnodonts. As indicated by Tedford (1966) there is little reason to doubt the derivation of the larger browsing forms from more generalised macropodines. However, as shown above there is no evidence to support a considerable antiquity for the *Sthenurus–Procoptodon* group, based on their browsing adaptations, as suggested by Tedford (1966). The earliest record of the group from the Lake Eyre Basin is of an isolated incisor of Pliocene age (Stirton et al., 1961).

Tedford's (1966) suggestion of parallel evolutionary trends of *Procoptodon* and the brachycephalic *Simosthenurus* during the Pleistocene appears reasonable, although there is no supporting evidence to suggest that his contention of a dichotomy before the Pliocene is correct. It is felt that on the basis of current evidence this took place no earlier than the late Pliocene or even early Pleistocene and that adaptive radiation in the group as a whole has been rapid.

The current study is based solely on cranial specimens and no attempt has been made to associate post-cranial specimens. All specimens, with the exception of one partial mandible from fissure-fill deposits, have the appearance of derivation from fluviatile sedimentary deposits. Prospects for locating articulated skeletons in such deposits are limited because of the scattering of elements which generally takes place prior to burial.

Procoptodon, in its aberrant structural characters and extreme specialisation, constitutes one of the most interesting of the macropodine genera. It evolved to the stage where its browsing habits must have dominated its way of life. This trend was much more complete than in short-jawed species of *Sthenurus* which were also adapted for a similar habitat.

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PLATE 16

Procoptodon goliah (Owen), F1850, King Creek, Darling Downs, × 1.

FIGS. 1, 2. Stereopair of occlusal view.

FIG. 3. Lateral view.

Procoptodon rapha Owen, F799, Darling Downs, × 1.

FIGS. 4, 5. Stereopair of occlusal view.

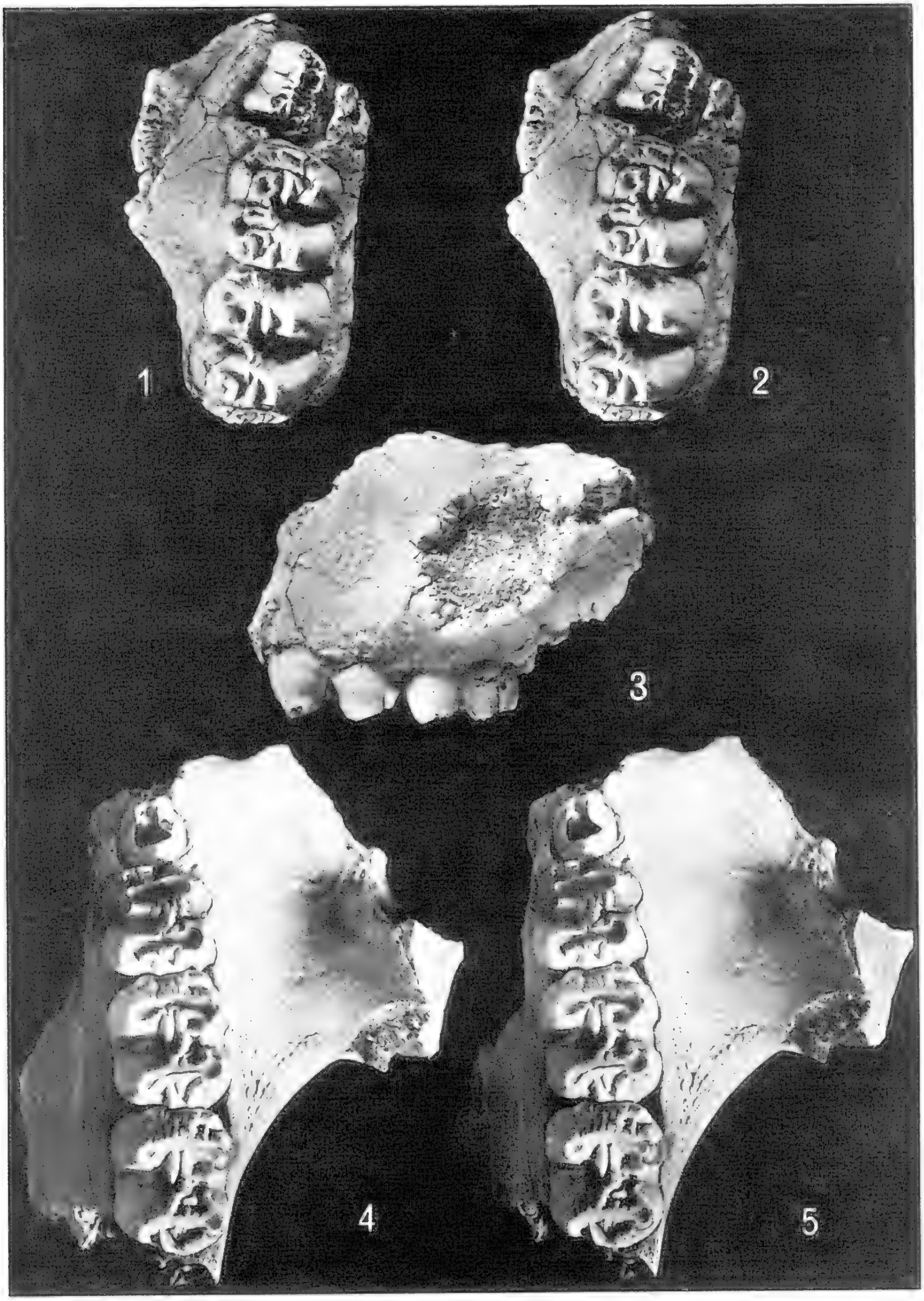
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PLATE 17

Procoptodon rapha Owen, F799, Darling Downs, × 1.

FIG. 1. Lateral view.

Procoptodon pusio Owen, F2989, Condamine River, "Armour", Macalister, Darling Downs, × 1.

FIG. 2. Lateral view.

Procoptodon goliah (Owen), F805, Clifton, Darling Downs, × 0.66.

FIG. 3. Lateral view.

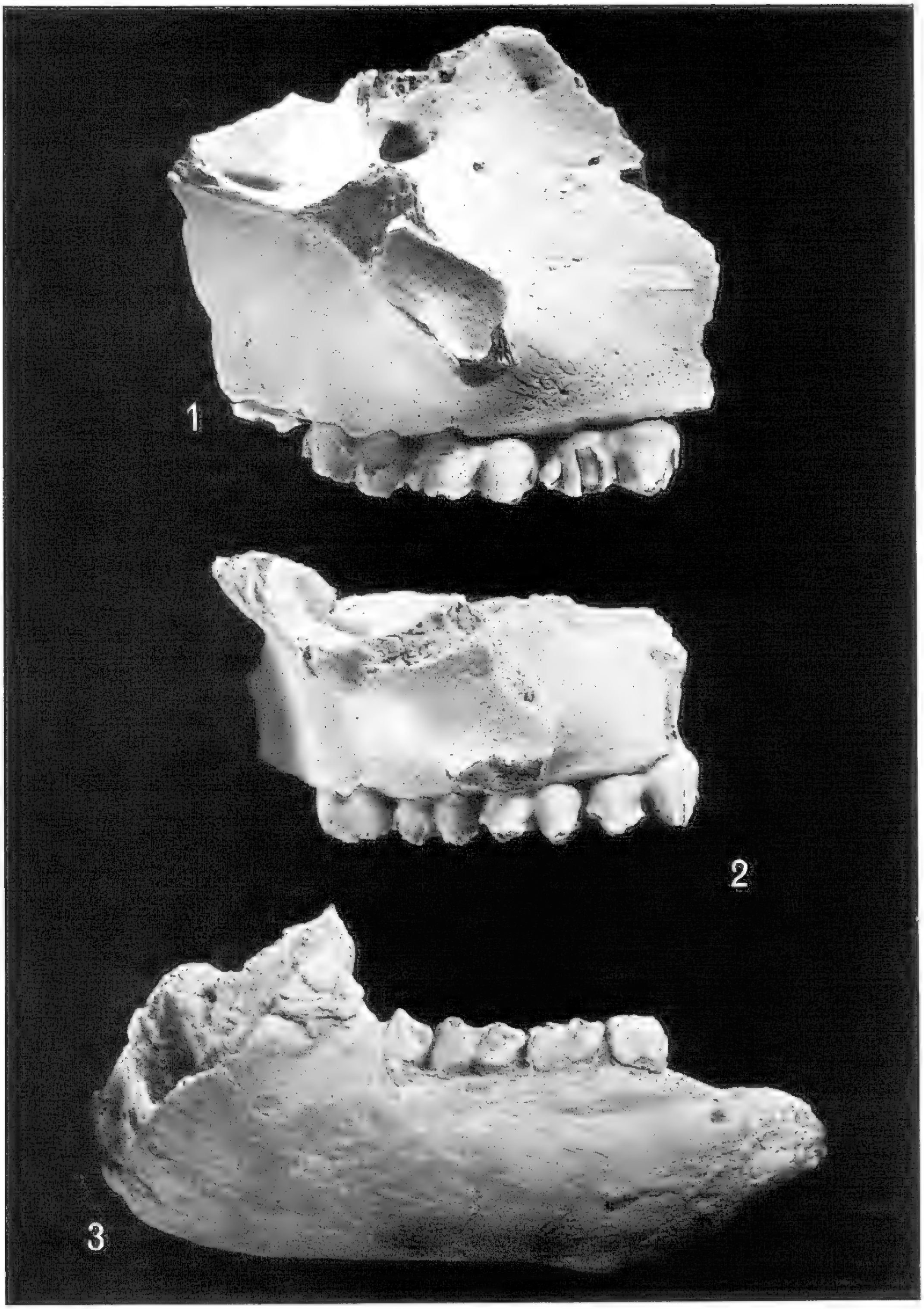
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PLATE 18

Procoptodon pusio Owen, F2989, Condamine River, "Armour", Macalister, Darling Downs, × 1.

FIGS. 1, 2. Stereopair of occlusal view.

Procoptodon goliah (Owen), F805, Clifton, Darling Downs, × 0.66.

FIGS. 3, 4. Stereopair of occlusal view.

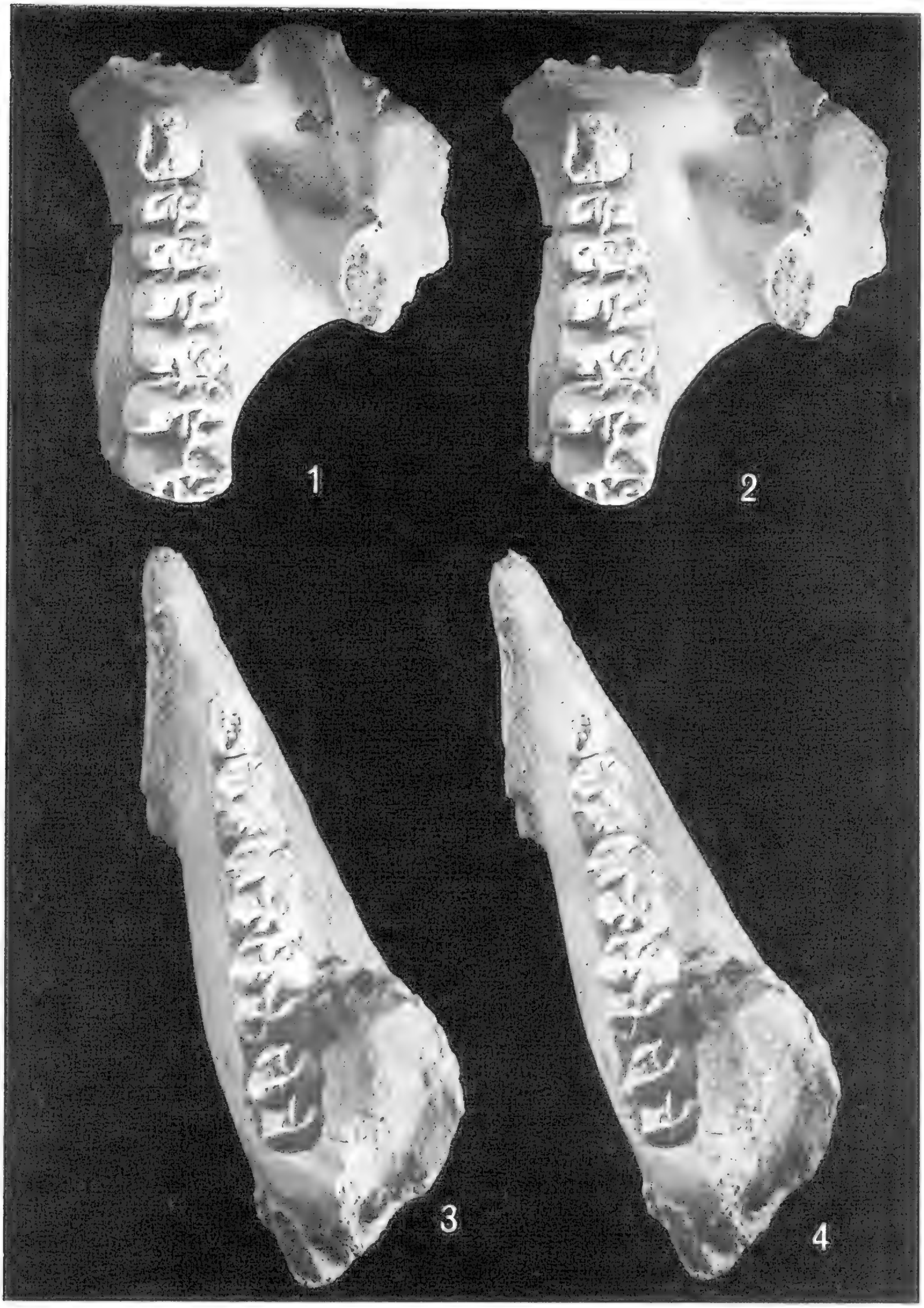
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PLATE 19

Procoptodon rapha Owen, F794, Darling Downs, × 0.75.

FIGS. 1, 2. Stereopair of occlusal view.

FIG. 3. Lateral view.

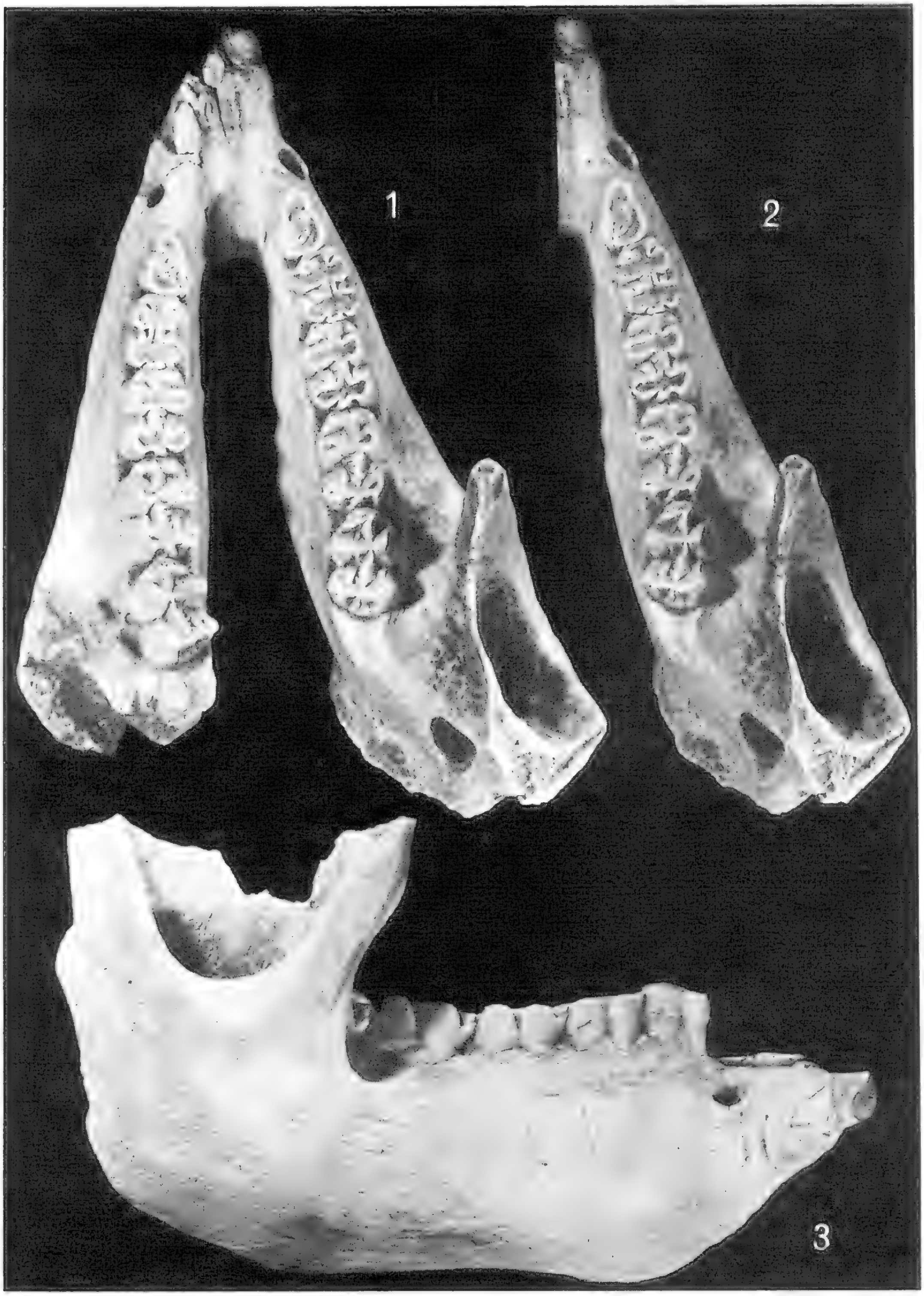
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PLATE 20

Procoptodon rapha Owen, F4460, King Creek, at M.R. 039454 Clifton 1 mile sheet, Darling Downs, × 1.

FIGS. 1, 2. Stereopair of occlusal view.

FIG. 3. Lateral view.

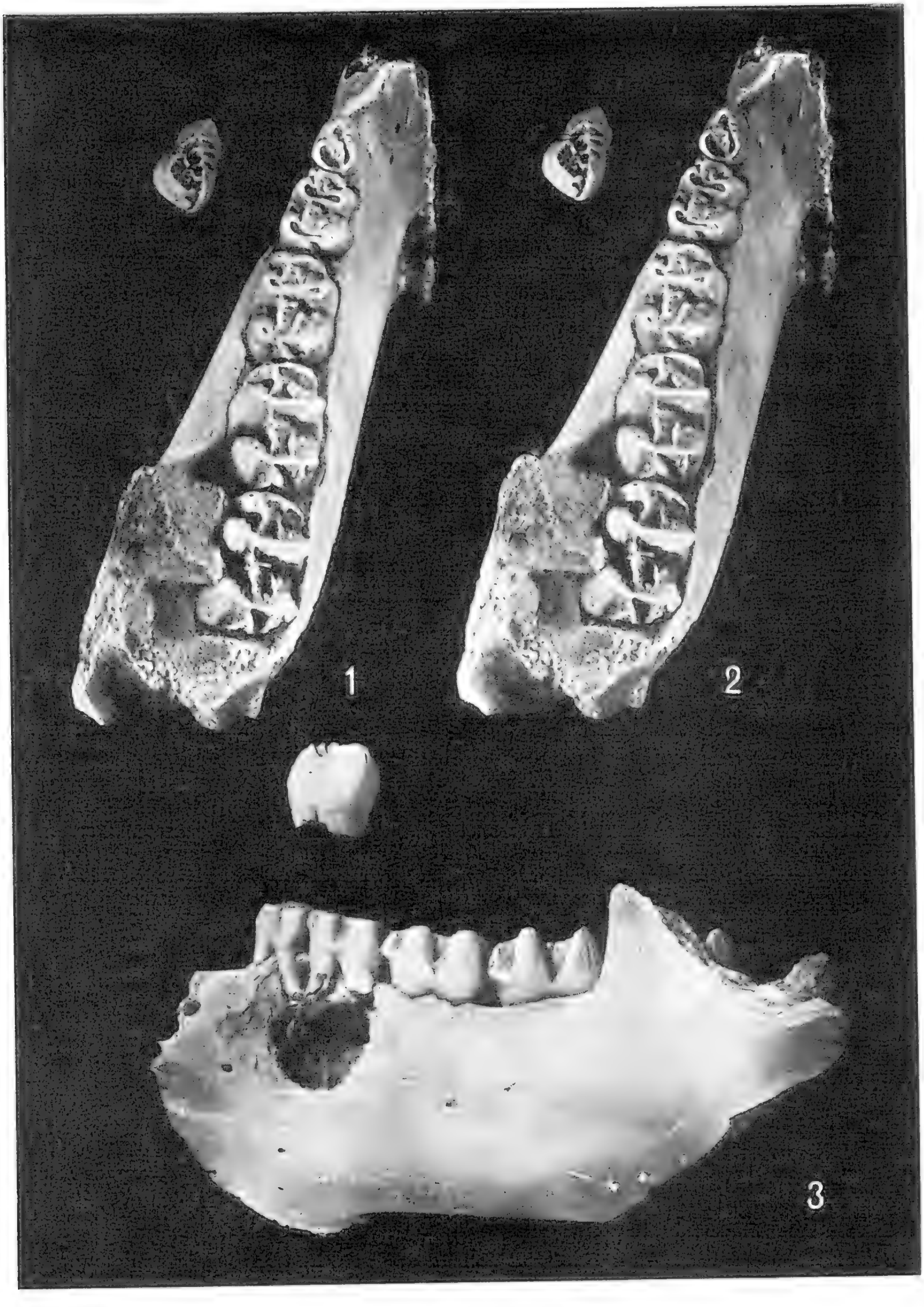
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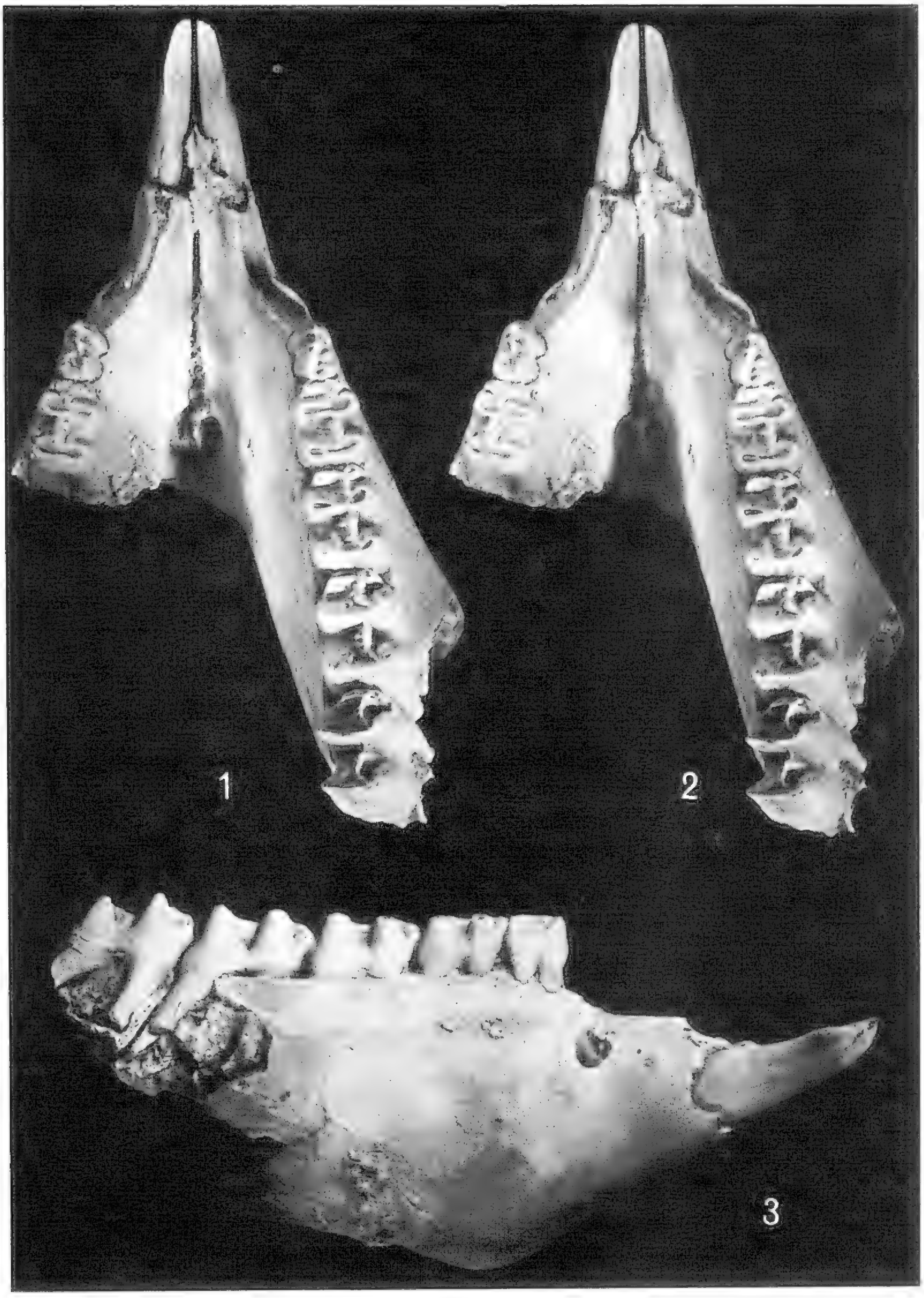
PLATE 21

Procoptodon pusio Owen, F4468, King Creek, near M.R. 039454 Clifton 1 mile sheet, Darling Downs, × 1.

FIGS. 1, 2. Stereopair of occlusal view.

FIG. 3. Lateral view.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THE SUBLITTORAL BRACHYURA (CRUSTACEA: DECAPODA) OF MORETON BAY

B. M. Campbell
Queensland Museum
and
W. Stephenson
Department of Zoology, University of Queensland

ABSTRACT

Eighty-four species are recorded as the result of an intensive dredging and trawling programme in Moreton Bay. New species are described in the genera *Cryptodromia* and *Hexapus* and a possibly undescribed species of *Hyastenus* is discussed. Numbers of species per family agree closely with numbers found at a similar depth in Sagami Bay. Moreton Bay sublittoral brachyuran fauna shows much greater affinity with the northern Indian Ocean than with the western Pacific Ocean.

The material reported on has been obtained from dredging and trawling operations carried out in Moreton Bay by the Zoology Department of the University of Queensland (Z.D.U.Q.) mostly by the research trawler 'Wanderer II' and mostly under the direction of one of us (W.S.). Most of this material has been deposited at the Queensland Museum (Q.M.), but some duplicate material has been sent to the Australian Museum, Sydney, (A.M.). Because of the large numbers involved many specimens of common species were not retained by the collecting party, but these were identified and recorded before being discarded.

Moreton Bay is a shallow indentation in the southern Queensland coastline some 40 miles long by 15 miles wide, bounded on the seaward side by the almost unbroken line of Moreton I., North Stradbroke I. and South Stradbroke I. While it is moderately open to the north, through a series of gutters and shallow banks, in the south it breaks up into narrow, shallow channels which are ultimately a continuation of the Nerang River mouth. The present survey extends south to Redland Bay and Macleay I. In this area the maximum depth is approximately 20 fm and the bottom is predominantly fine sand with patches of mud, coarse sand, and grit (see pl. 22). Because of the risk to vessel and gear, collections were seldom attempted in depths of less than 2 fm.

Trawling and dredging for this survey has been carried out over a period of six years (1962–1968) and recordings were made from over 400 stations (see fig. 1). Localities are indicated with reference to the charts of Moreton Bay published by the Department of Harbours and Marine, Queensland, 1964 edition. To facilitate location of these localities Moreton Bay is here arbitrarily divided into sections based on a 0° 5′0″ grid (see fig. 1), and a grid reference to these localities is given in bold face with each locality listed. Localities are listed in ascending order of grid reference numbers.

Measurements of carapace width (cw.) are taken across the widest part of the carapace and length (cl.) is measured in the mid-line. Illustrations have been prepared using a camera lucida and are provided not only to facilitate future identification of material from this area but to provide a basis for future workers to criticise the present identifications. Male pleopods are drawn from the abdominal aspect, without dissection. Synonymies are restricted to significant or recent works.

LIST OF SPECIES RECORDED

The order of listing and classification follows Serene, 1965, except that *Libystes* is retained in the family Portunidae (see Stephenson and Campbell, 1960, p. 84), and *Calmania* in the Xanthidae. The bracketed notation after a species refers to its known overall distribution. The key to this notation is given in the 'Discussion' (see p. 295) where distribution patterns are briefly analysed.

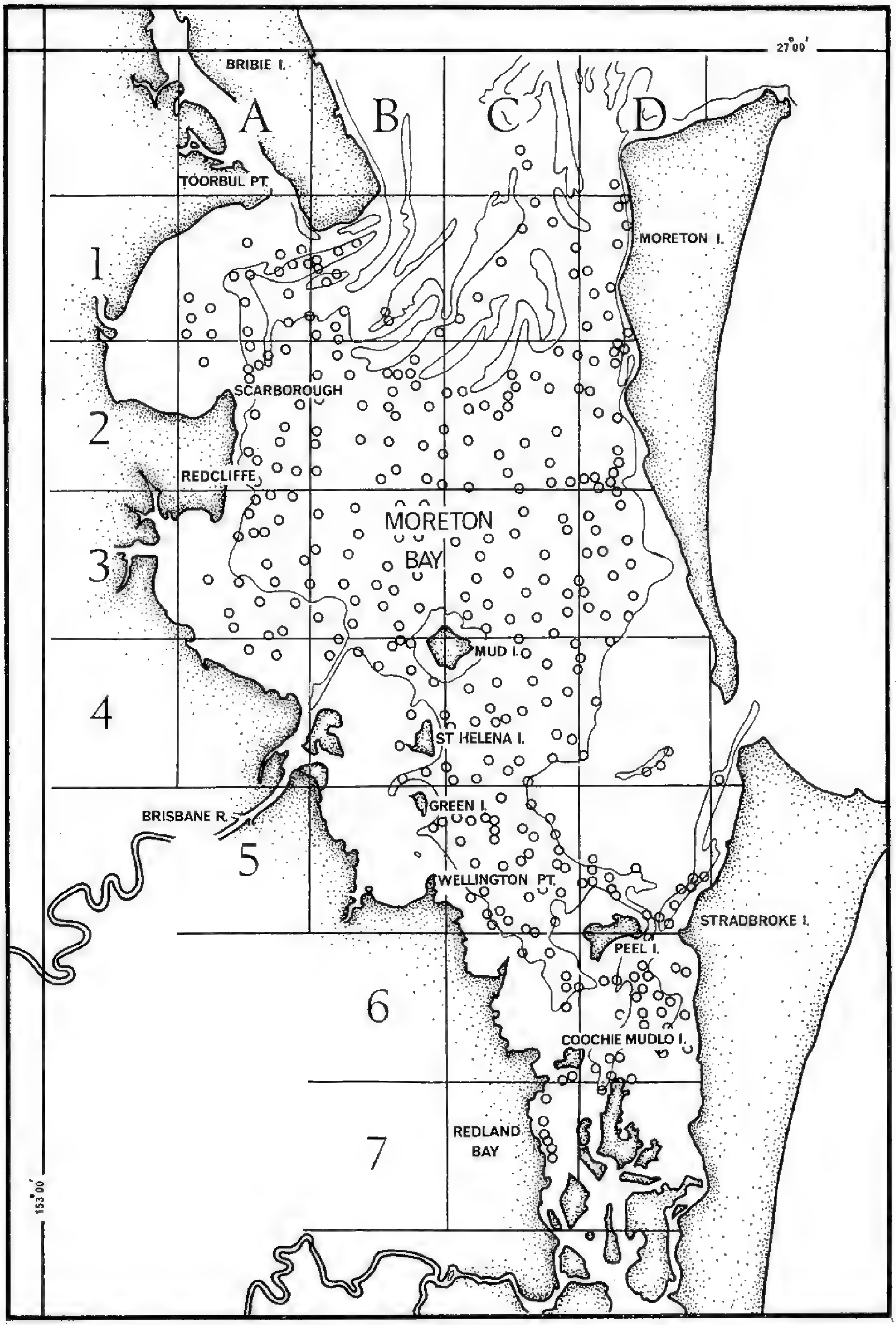


FIG. 1: Map of Moreton Bay showing collection stations, arbitrary grid reference, and 3 fm contour.

Tribe DROMIACEA

Family DROMIIDAE

Cryptodromia unilobata sp. nov.

(Fig. 2)

HOLOTYPE: female, 16.5 mm cw., dredged ½ mile W. of Naval Reserve Bank beacon, **5C**, 4½ fm, sandy mud, 24.ix.1962, A.M., P15708.

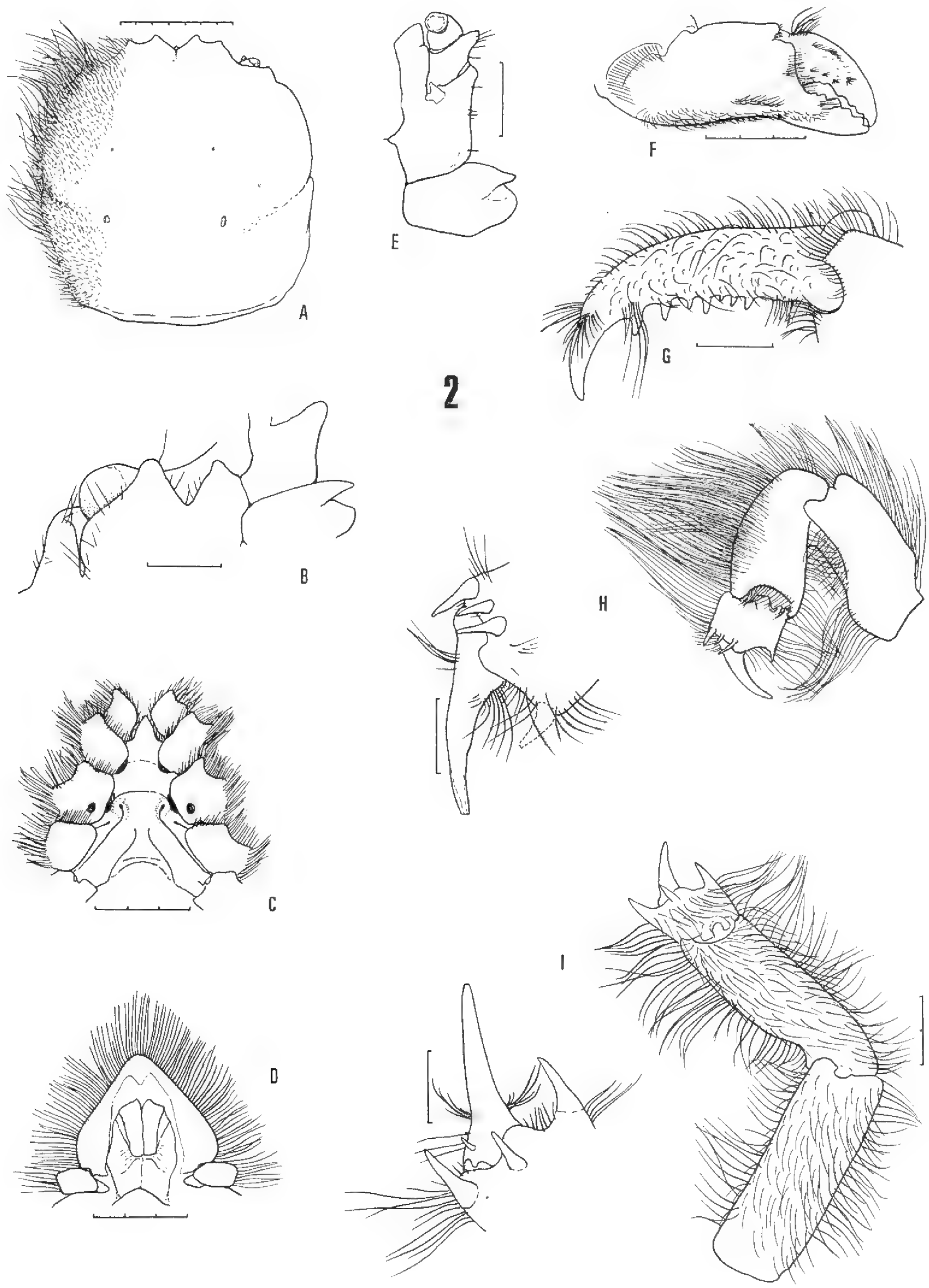
DESCRIPTION

CARAPACE: little longer than broad (cw. 16.5 mm, cl. 16.7 mm in mid-line, 17.5 mm including frontal teeth), very convex, covered with long and short hairs on dorsal surface, with very serrate long hairs laterally and on legs and chelae. Regions unmarked except by median frontal groove and deep cervical grooves. Lateral margins with deep indentation at termination of cervical groove, anterior to this a single long anterolateral lobe, curving sharply in to base of outer orbital angle; outer orbital angle *c.* one fifth as long as anterolateral lobe.

Front with single median deflexed tooth, scarcely visible in dorsal view but equal in size to two lateral frontal teeth; lateral frontal teeth acute, separated by right-angled notch; inner orbital teeth prominent but smaller than frontal teeth.

Sternal grooves of female ending on low, widely separated tubercles between the coxae of the second walking legs, just anterior to the genital openings.

FIG. 2: *Cryptodromia unilobata* sp. nov.; holotype, A.M., P15708. A, carapace; B, suborbital lobes; C, sternum; D, sternal face of last segment of abdomen; E, basal antennal joint; F, cheliped; G, dactyl of first left ambulatory leg; H, left third ambulatory leg; I, last leg.
Scale divisions 1 mm, or 0.5 mm (broken line).


A
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G
H
I
2

Basal antennal joint with outer angle markedly produced to meet front and with subsidiary lobe on inner border of this projection.

CHELIPED: without epipodite; without prominent tubercles. Merus triangular in section, with dense long serrate hairs proximally and shorter pubescence dorsally. Carpus long, with sparse pubescence. Propodus with long hairs ventrally and distally on outer face; fixed finger with 6 strong teeth. Movable finger with long curved hairs proximally on upper face shorter hairs on flattened basal half of outer face; cutting edge with two small teeth, proximally followed by series of four larger teeth decreasing in size distally.

AMBULATORY LEGS: first and second subequal, with numerous long pinnate hairs dorsally, forming a thick mat. Dactyli with series of 7–8 horny spines on inner border decreasing in size proximally. Third ambulatory leg shortest; propodus with two (right leg) or three (left leg) spines on distal margin of outer (dorsal) face behind dactylus, one on distal margin in front of opposing dactylus. Fourth ambulatory leg almost as long as first and second legs (0.9 times); propodus with two long subequal spines on distal border one at each angle, third shorter spine near base of dactylus on outer (dorsal) face; dactylus with basal spine on outer (dorsal) face.

DISCUSSION

This species bears a strong resemblance in many features to *Dromidia unidentata* (Rüppell) (see Sakai, 1936, pp. 13–15, pl. 6, fig. 2; Barnard, 1950, pp. 323–4, fig. 61h, i.) It differs most markedly from that species in the configuration of the sternal sulci which in *D. unidentata*, according to Barnard, end together between the bases of the second legs (=first walking legs). This feature appears significant at the generic level.

Although the generic situation in Dromiidae does not appear to be firmly resolved, only two genera (*Dromides* Borradaile and *Cryptodromia* Stimpson) have been described in which there is no epipod on the cheliped and in which the sternal sulci of the female end apart. Ihle (1913) has fused both under *Cryptodromia*, which is now regarded in a much broader sense than was accepted by early authors. If the present species is to be included in this genus—and the only alternative would be to erect a new monotypic genus—the generic diagnosis as given by Ihle must be altered to include not only those species in which the female sternal sulci end "mehr nach hinten oder mehr nach vorn zwischen den 2. Pereiopoden" but also those in which the sulci end between the bases of the third pereiopods.

Only one other species of *Cryptodromia*, *C. incisa* Henderson, has been described as having no teeth on the anterolateral border of the carapace. The present species can be readily distinguished from *C. incisa* by the following features;

(1) Sternal sulci terminate on low tubercles between the bases of the second walking legs instead of between the first walking legs and there is no distinct median tubercle between the endings.

(2) The hairs on the sides of the carapace and on the legs are not clubbed, but serrate, and very long.

(3) The anterolateral margins of the carapace are not evenly curving throughout their length but are more abruptly curved anteriorly.

(4) The propodus of the third walking leg bears three terminal spines in addition to the one opposing the dactyl.

The specific name refers to the presence of a single anterolateral lobe between the end of the cervical groove and the outer orbital angle.

Cryptodromia hilgendorfi de Man

(Fig. 3)

Cryptodromia Hilgendorfi de Man, 1887, pp. 404–6, pl. 18, fig. 3.

Cryptodromia hilgendorfi de Man: Ihle, 1913, pp. 45–6 (lit. and synon.).

DREDGED: One, Brisbane R. mouth, **4A**, 1964–5, T.S. Hailstone, A.M., P15707.

This specimen keys without hesitation to this species in Ihle's (1913, pp. 33–5) key to the species of *Cryptodromia*. It agrees well with de Man's figure, but differs in that the median frontal tooth is a little larger, and the notch between the lateral frontal teeth is more acute (as in Ihle's material). The distal border of the propodus of the last leg carries spines on its inner and outer angles which were not illustrated by de Man.

DISTRIBUTION: Red Sea to Ellice Islands.

Conchoecetes artificiosus (Fabricius)

Dromia artificiosa Fabricius, 1798, p. 360.

Dromia conchifera Haswell, 1882a, p. 757; 1882b, pp. 141–2, pl. 3, fig. 4.

Conchoecetes artificiosus (Fabricius): Barnard, 1950, pp. 308–9, figs. 58a, b. Sakai, 1965, pp. 11–12, pl. 5, fig. 3 (lit. and synon.).

DREDGED: One, 1 mile S. of Bribie I. beacon, **1A**, 3 fm, clean fine sand, 14.viii.1967, Q.M., W2924. One, $\frac{1}{2}$–$\frac{3}{4}$ mile W. of M3 Buoy, **2C**, 10 fm, 29.x.1962. Two, $\frac{1}{2}$ mile NW. of M1 Buoy, **2C**, $7\frac{1}{2}$ fm, sand with broken shell, 29.viii.1967. Three, $\frac{1}{4}$ mile NW. of M1 Buoy, **2C**, $7\frac{1}{2}$ fm, hard sand with shell, 29.viii.1967. One, $2\frac{1}{2}$ miles E. of Scott Pt, **3A**, 3 fm, culch, 6.ii.1968, Q.M., W2968. One, 3 miles E. of S. end of St Helena I., **4C**, 6 fm, 13.viii.1967, Q.M., W2923. One, $1\frac{1}{2}$ miles SW. of Blue Hole beacon, **4D**, 3 fm, 29.viii.1967. One, from Hanlon Light east, **5C**, gritty sand with mud, 12.x.1961. One, 1 mile SE. of Hope Banks, **5C**, 5 fm, muddy grit, 1.vi.1962. One, $\frac{1}{2}$ mile SE. of Hope Banks, **5C**, 2–3 fm, 1.vi.1962. Three, $1\frac{1}{4}$ miles SE. of Hope Banks, **5C**, 5 fm, clean sand with shell, 30.viii.1967. Two, $2\frac{1}{4}$ miles NW. of Hanlon Light, **5C**, $4\frac{1}{2}$ fm, muddy sand, 30.viii.1967. One, $1\frac{1}{2}$ mile NNW. of Cleveland Light, **5C**, $3\frac{1}{2}$ fm, gritty muddy sand, 6.x.1967, Q.M., W2927. One, halfway between Cleveland and Peel I. jetties, **6C**, $4\frac{1}{2}$ fm, muddy grit, 24.ix.1962.

TRAWLED: One, Moreton B., late 1962, coll. L. Wale. One, 1 mile E. of Goat I., **6D**, 4 fm, 24.ix.1962.

DISTRIBUTION: South Africa to Japan and Australia (Sakai, 1965).

Tribe CORYSTOIDEA

Family ATELECYCLIDAE

Kraussia sp.

(Fig. 4)

DREDGED: Female, ¾ mile NW. of M1 Red Buoy, **2C**, 7½ fm, sand and broken shell, 29.viii.1967, Q.M., W3123.

This specimen has the carapace crushed, and the entire fronto-orbital region and epistome is missing. It is clearly referrable to the genus *Kraussia* and closely resembles *K. nitida* Stimpson (see Sakai, 1965, pl. 49, fig. 2) and *K. hendersoni* Rathbun (see Rathbun,) 1906, pl. 14, fig. 2) but the damage is too extensive to permit further identification.

Tribe OXYSTOMATA

Family DORIPPIDAE

Dorippe australiensis Miers

(Fig. 5)

Dorippe australiensis Miers, 1884, pp. 258–9, pl. 26, fig. D. Grant and McCulloch, 1906, p. 26. Tyndale-Biscoe and George, 1962, pp. 66–7, figs. 2.2, 2.3.

Dorippe astuta Fabricius: Haswell, 1882b, pp. 136–7.

[non] *Dorippe astuta* Fabricius, 1798, p. 361.

DREDGED: Two, 1 mile NNE. of Toorbul Pt red beacon, **1A**, 3 fm, sandy mud, 13.vi.1967. One, ½ mile SE. of Toorbul Pt red beacon, **1B**, sand, 29.x.1962, Q.M., W2599. One, 2 miles ESE. of Caboolture, **2A**, 2 fm, mud with shell, 6.vi.1967. One, 5½–6 miles ENE. of Scarborough, **2B**, 2½ fm, 6.xii.1962, Q.M., W2727. One, ½ mile offshore N. end of Tangalooma Gutter, **2D**, 1.vi.1962, Q.M., W2714. One, 1 mile E. of Otter Rock beacon, **3A**, 3½ fm, mud, 17–18.v.1967, Q.M., W2799. One, ½ mile off middle of St. Helena I., S. beacon on N. tip of Green I., **4C**, 4 fm, Q.M., W2728. Three, water airport between Redland Bay and Garden I., **7C**, 2–6 fm, muddy grit, 26.iv.1962, Q.M., W2711 (two spems.).

TRAWLED: One, 1 mile E. of Otter Rock beacon, **3A**, 3½ fm, mud, 1.iii.1967, Q.M., W2577. Four, between Peel I. and Green I., **5C**, L. Wale, 1.xi.1961, Q.M., W2597, W2719. One, 1 mile E. of Goat I., **6D**, 4 fm, 24.ix.1962, Q.M., W2722. One, off Snipe I., **7C**, 2½–8 fm, 30.vii.1962, Q.M., W2718.

DISTRIBUTION: Australian coast (Miers, 1884) from Port Denison, Bowen (Haswell 1882) to Moreton B.

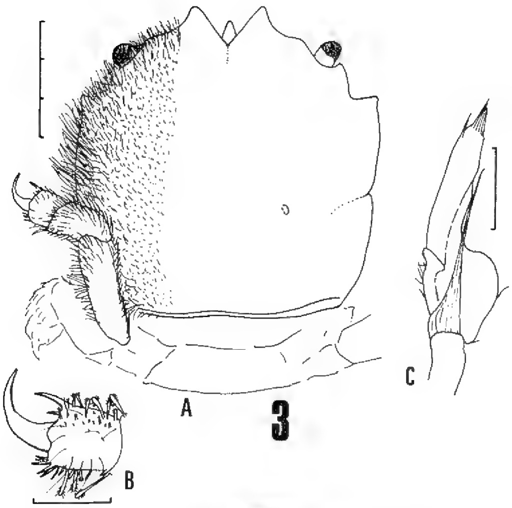
FIG. 3: *Cryptodromia hilgendorfi* A.M., P15707. A, carapace; B, dactylus and propodus of last leg; C, male pleopods.

FIG. 4: *Kraussia* sp., W3123. A, carapace; B, cheliped.

FIG. 5: *Dorippe australiensis*, W2719. A, carapace; B, male abdomen; C, male pleopods.

FIG. 6: *Matuta inermis*, W2649. A, carapace; B, male pleopod.

FIG. 7: *Matuta planipes*, W2608.
Scale divisions 1 mm, or 0.5 mm (broken line).



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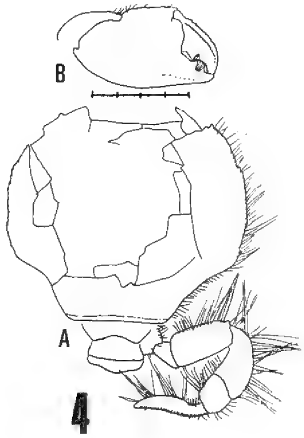

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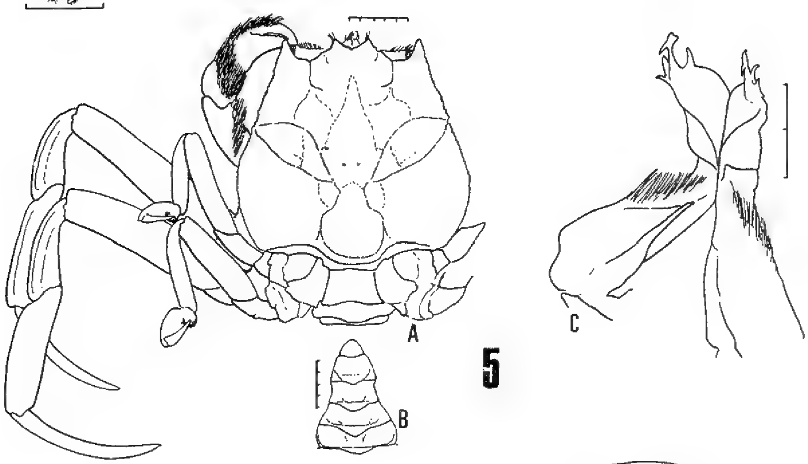

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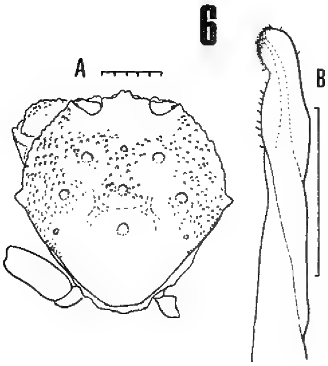

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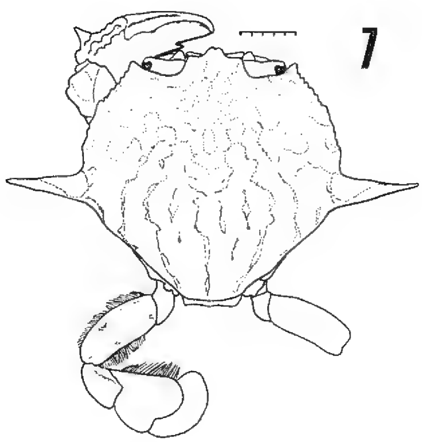

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Family CALAPPIDAE

Calappa philargius (Linnaeus)

Cancer philargius Linnaeus, 1758, p. 626.

Calappa philargius (Linnaeus): Utinomi, 1967, p. 70, pl. 35, fig. 8. Tyndale-Biscoe and George, 1962, p. 69, fig. 2.4.

TRAWLED: Two, due E. of South Passage between Moreton I. and Stradbroke I., coll. professional trawlers, Dec. 1966, Q.M., W2653. (Note: This lies outside Moreton Bay; a specimen from within the Bay has been seen by one of us (W.S.), but unfortunately no record was kept).

DISTRIBUTION: Red Sea to Japan and Samoa; Eastern and Western Australia (Tyndale-Biscoe and George, 1962).

Matuta granulosa Miers

Matuta granulosa Miers, 1877, p. 245, pl. 39, figs. 8, 9. Tyndale-Biscoe and George, 1962, pp. 71–2, fig. 4.2.

DREDGED: One, ½ mile SE. of Toorbul Pt red beacon, **1A**, 4 fm, mud, 29.x.1962. One, 5½ miles E. of Reef Pt, Scarborough, **2B**, 6 fm, grit, 15.xii.1964. Damaged juvenile, 8 miles E. of Scarborough, rising shallowing banks, **2C**, 5 fm, fine sand, 10.xi.1961. One, S. edge of Dring Banks, **2D**, 10 fm, 29.iv.1964, Q.M., W2651.

TRAWLED: Ovigerous female, northern Moreton B., early Nov. 1966, Q.M., W2655. One, 5½ miles E. of Reef Pt, Scarborough, **2B**, 6 fm, grit, 15.xii.1964, Q.M., W2810. Two in deep water off Tangalooma, **2D**, L. Wale, Q.M., W2650. Two, ½ mile W. of St Helena I., **4B**, Nov. 1966, L. Wale, Q.M., W2652.

DISTRIBUTION: Indian Ocean; Queensland and Western Australia (Tyndale-Biscoe and George, 1962).

Matuta inermis Miers

(Fig. 6)

Matuta inermis Miers, 1884, p. 256, pl. 26, fig. C; 1886, p. 296. Tyndale-Biscoe and George, 1962, p. 72.

DREDGED: Nine, ½ mile NW. of Cowan Cowan red light, **1D**, 22 fm, dead coral and shell, 29.viii.1967, Q.M., W2843. Sixteen, ½ mile offshore at end of Tangalooma Gutter, **2D**, 8–12 fm, 1.vi.1962, Q.M., W2649 W2780 W2781.

DISTRIBUTION: Western and northern Australia to Moreton B. (Tyndale-Biscoe and George, 1962).

Matuta planipes Fabricius

(Fig. 7)

Matuta planipes Fabricius, 1798, p. 369. Sakai, 1937, p. 101, pl. 13, fig. 4. Utinomi, 1967, pp. 69–70, pl. 35, fig. 4. Tyndale-Biscoe and George, 1962, p. 71, fig. 2.11.

DREDGED: One, Pearl Channel, ¼ mile SW. of NW.7 Light, **1C**, 5 fm, clean hard sand, 5.x.1967, Q.M., W2933. One, ½ mile E. of M4 Beacon, **1D**, 6½ fm, hard sand, 29.viii.1967. Two, 1½ miles W. of Tangalooma white light, **2D**, 9½ fm, hard sand, 29.viii.1967. One, ½ mile offshore at end of Tangalooma Gutter, **2D**, **12** fm, 1.vi.1962. One, ½ mile outside Tangalooma Gutter, **2D**, 10 fm, 1.vi.1962. One, ½ mile offshore outside Tangalooma Gutter, **2D**, 8 fm, 1.vi.1962, Q.M., W2608. Two, Mt Cotton Reach, Rous Channel, **4D**, sand and shell grit, 2.vi.1962.

DISTRIBUTION: Indian Ocean, East India, Japan; east, north and northwest coasts of Australia. (Tyndale-Biscoe and George, 1962).

Family LEUCOSIDAE

Nursia plicata sinuata Miers

(Figs. 8, 9)

Nursia plicata (Herbst): Bell, 1855, pp. 307–8, pl. 34, fig. 4 (part only, including figured specimen; Bell's material also included specimens of *N. lar*, see below).

[non] *Cancer plicata* Herbst, 1803, pp. 2–3, pl. 59, fig. 2.

Nursia sinuata Miers, 1877, pp. 239–40. Grant and McCulloch, 1906, p. 24.

DREDGED: One, 1 mile offshore E. of Redcliffe water tower, **2A**, 3 fm, mud and shell, 15.xii.1964, Q.M., W2802. One, ¼ mile NW. of M1 Red Buoy, **2C**, 7½ fm, hard sand and shell, 29.viii.1967, Q.M., W3118. One, 2½ miles E. of Scott Pt, **3A**, culch, 6.ii.1968, Q.M., W2958. Three, ¼ mile W. of N. end of St Helena I., **4B**, 2½ fm, culch, 18.vii.1967, Q.M., W3116 W3117. One, 1½ miles E. of St Helena I., **4C**, 4 fm, 13.vii.1967, Q.M., W3115. One, 1½ miles SW. of South West Rocks, **6C**, 2 fm, culch, 6.x.1967, Q.M., W3113. One, 1 mile E. of Victoria Pt, **6C**, 3 fm, culch, 13.x.1967, Q.M., W3114.

The ambiguity of Miers' (1877, p. 240) comments under '*Nursia plicata?*' has been noted by Grant and McCulloch (1906) and Tesch (1918, p. 237), but this can be resolved as follows. Bell (1855) stated that all the material known by him as *N. plicata* came from India. Miers refuted this, claiming that the '*N. plicata*' material examined by Bell at the British Museum was a heterogenous collection of Indian and Australian material. The Indian material included the type of *N. hardwickii* Leach, which was figured by Miers, 1877, pl. 38, fig. 28. (Rathbun (1910, p. 306) subsequently synonymised *N. hardwickii* with *N. lar* (Fabricius) and justification for this is provided by the fact that both are described as having totally smooth cheliped arms).

Miers recognised two species in Bell's material of '*N. plicatus* (Herbst)'. The Indian specimens with smooth cheliped arms (*N. lar*) he listed as '*Nursia plicata?*', the Australian material with granulate arms he described as a new species, *N. sinuata* Miers, 1877. He admitted not having seen Herbst's (1803, pl. 59, fig. 2) figure of *Cancer plicatus* and suggested that one of the two species he discussed should be referred to that species. Herbst's figure in fact shows distinctly granulate cheliped arms, and on that basis *N. sinuata* would have been, by Miers' criterion, the synonym of *N. plicata*.

Alcock (1896, pp. 180–1) discusses *N. plicata* and states that, in fully grown males, the chelipeds are 1.75 times the carapace length and that the maximum size of his specimens

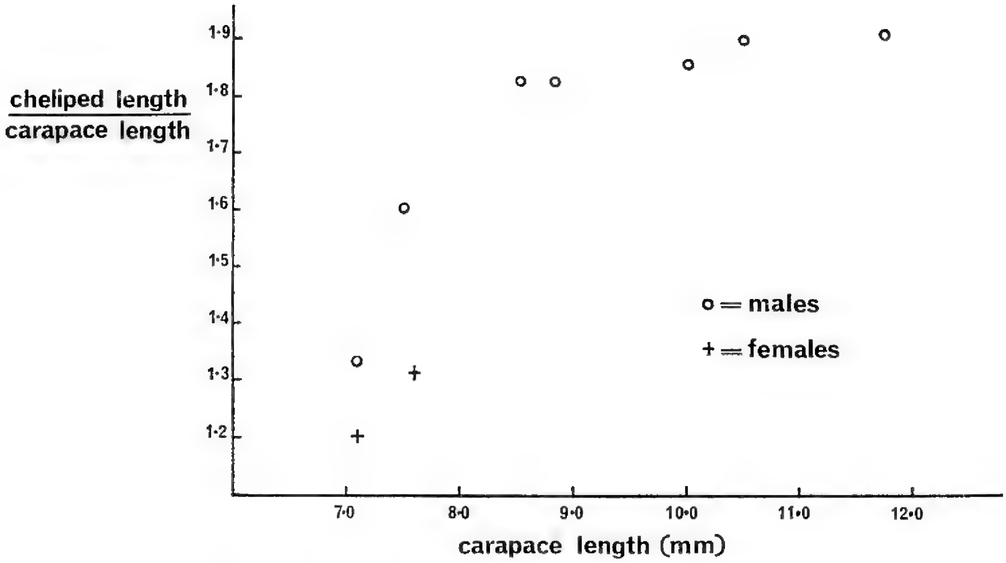


FIG. 8: Variation of length of cheliped with carapace length, *Nursia plicata sinuata*.

is 15 mm carapace length. In the present specimens the chelipeds of males range from 1.3 to 1.9 times the carapace length, but (see fig. 8) a ratio of 1.75 is passed at a carapace length of 8–9 mm. The present specimens further differ from Alcock's description and Herbst's figure in that:

(1) The lobes on the posterior margin of the carapace are not distinctly semicircular.

(2) The hepatic ridges, while discernable, are not distinct.

Because of these differences Miers' name is here retained but, because the differences are slight and the extent of the variability of both groups has not been adequately assessed, full specific status is not admitted. Male pleopods of *N. plicata sinuata* agree well with Stephensen's (1945, p. 70, fig. 6c) description and figure of material from the Iranian Gulf.

Variability shown by the present specimens includes:

(1) Front very obscurely or quite distinctly bilobed, or obscurely quadrilobate with two small median denticles.

(2) Posterior margin with two lobes sharp or rounded, distinctly separated or united so that the posterior margin is only shallowly concave.

(3) Length of chelipeds increases with length of carapace as in fig. 8.

(4) Development of carapace marginal lobes.

Ihle, 1918, pp. 235–6, gives a key to the species of *Nursia* but omits to differentiate between the five species in which the hepatic and posterior transverse ridges are developed. These can be distinguished by the following key (see also Alcock, 1896, pp. 179–80).

1. Front convex, projecting well beyond eyes 2
Front not projecting, cut into lobes 3

2 (1). Outer face of wrist sharply cristate; snout ovate-pointed ....
.... *N. nasuta* Alcock, 1896
(See Alcock, 1896, p. 183, pl. 7, fig. 6).
Outer face of wrist bluntly and inconspicuously carinate, snout semicircularly rounded .... *N. blanfordi* Alcock, 1896
(See Alcock, 1896, pp. 182–3, pl. 7, fig. 5).

3 (1). Cheliped arms smooth on upper face, with smooth sharp anterior margin
.... *N. lar* (Fabricius, 1798)
(= *N. hardwickii* Leach; see Miers, 1877, pl. 38, fig. 28).
Cheliped arms granulate on upper face, with granulate rounded anterior margin 4

4 (3). Arms short (1.75 times cl. in large males); posterior carapace lobes semicircular
.... *N. plicata plicata* (Herbst, 1883)
(See Herbst, 1803, pp. 2–3, pl. 59, fig. 2. Alcock, 1896, 180–1).
Arms longer (*c.* twice cl. in large males); posterior carapace lobes often rounded but not semicircular............*N. plicata sinuata* Miers, 1877
(See Miers, 1877, pp. 239–40. Bell, 1855, pl. 34, fig. 4)

Distribution: *N. plicata sinuata* is known only from Queensland; from Moreton B. (Miers, 1877, type locality) and Port Curtis (Grant and McCulloch, 1906). *N. plicata* s.s. from the Iranian Gulf, India, Hong Kong, and Japan (see Sakai, 1965).

Nursia abbreviata Bell

(Fig. 10)

Nursia abbreviata Bell, 1855, p. 308, pl. 34, fig. 5. Alcock, 1896, pp. 184–5.

Dredged: One, ¾ mile S. of Coochiemudlo I., 7C, 3 fm, culch, 13.x.1967, Q.M., W3122.

This 9 mm ovigerous female agrees well with published figures and descriptions but differs from Bell's figure in the following minor features.

(1) Posterior margin of carapace even less distinctly bilobate.

(2) Cardiac region with a granular elevation but this is not connected to the mid-gastric tubercle by a distinct ridge. In this, the present specimen agrees with those described by Alcock (1896, p. 184).

(3) The inner margin of the exognath of the third maxilliped is less distinctly curved.

(4) The carapace margins conceal more of the ambulatory meri.

(5) The legs are not banded as shown in Bell's figure and mentioned by Alcock.

DISTRIBUTION: From the Indian Ocean (Bell, 1855, type locality) and Karachi (Alcock, 1865). Not previously from Australia.

Myra affinis Bell

(Fig. 11)

Myra affinis Bell, 1855, pp. 296–7, pl. 32, fig. 2. Alcock, 1896, p. 205. Tyndale-Biscoe and George, 1962, p. 88, fig. 7.10.

DREDGED: One, 3½ miles NE. of Hope Beacon, **5C**, 4½ fm, muddy sand, 30.viii.1967, Q.M., W2948.

DISTRIBUTION: Red Sea to Japan, the Philippines, and northeastern and northwestern Australia.

Myra australis Haswell

(Fig. 12)

Myra australis Haswell, 1879a, pp. 50–1, pl. 5, fig. 3; 1882b, p. 122. Tyndale-Biscoe and George, 1962, pp. 88–9, figs. 7.11, 8.9b, 8.10a.

DREDGED: One, NNW. of red beacon on W. end of Green I., **4B**, 4 fm, gritty sandy mud, 18.vii.1967, Q.M., W2925. One, 1 mile N. of Cleveland Light, **5C**, 3 fm, gritty mud, 18.vii.1967, Q.M., W2926. One, west of Hanlon Light, **5D**, gritty sand with mud, 12.x.1961, Q.M., W2606.

Tyndale-Biscoe and George (1962, pp. 88–9) have confirmed that *M. australis* is a distinct species and list points of difference between this species and *M. affinis*. The present specimens confirm these differences.

DISTRIBUTION: Malay Peninsula to northwestern and northeastern Australia.

Arcania novemspinosa (Adams and White)

(Fig. 13)

Iphis novem-spinosa Adams and White, 1849, pp. 56–7, pl. 13, fig. 1.

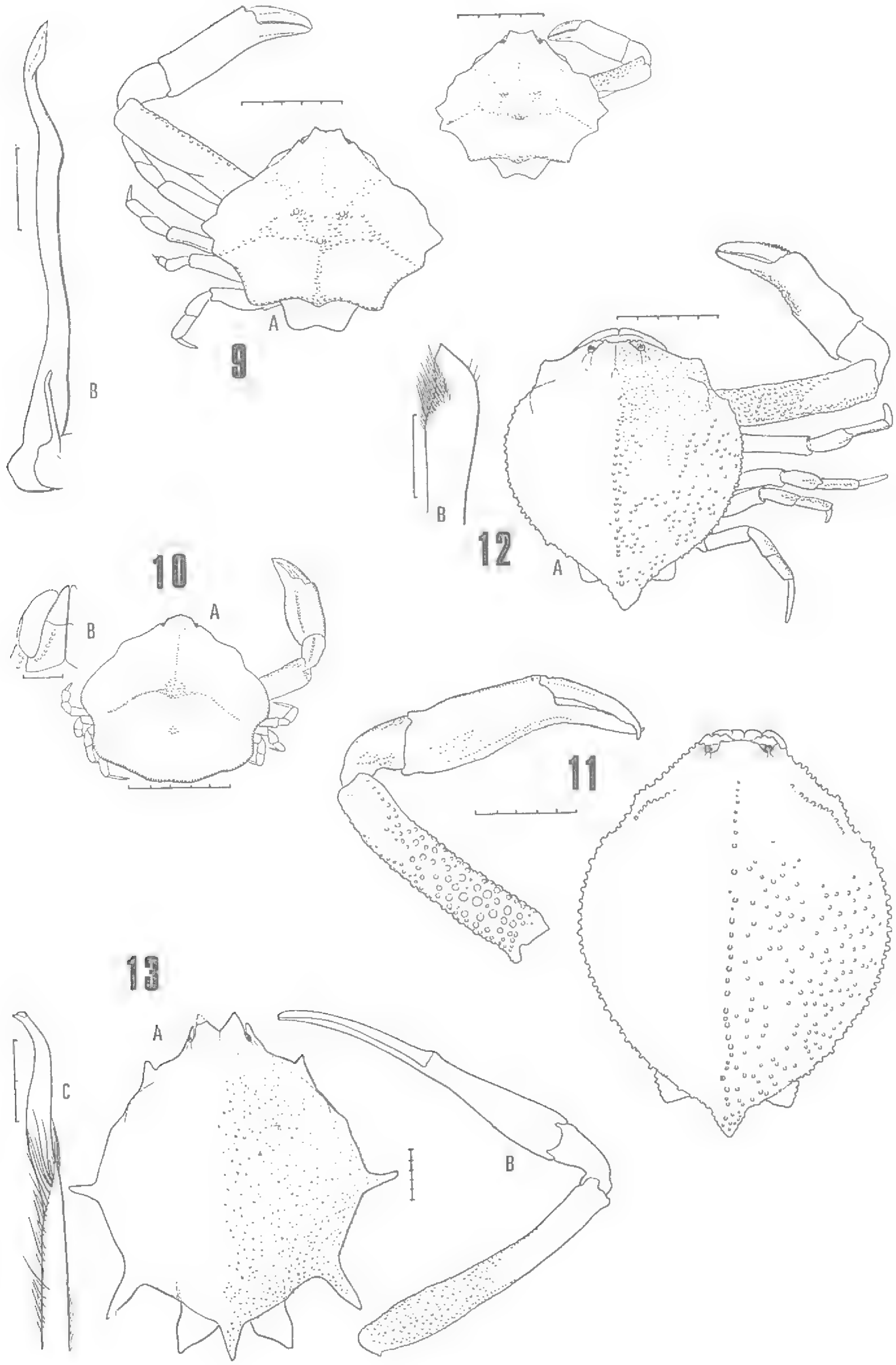
FIG. 9: *Nursia plicata sinuata* A, carapace, W3116; B, male pleopod, W3116; C, carapace, W3117.

FIG. 10: *Nursia abbreviata*, W3122. A, carapace; B, third maxillipeds.

FIG. 11: *Myra affinis*, W2948.

FIG. 12: *Myra australis*, W2926. A, carapace, B, male pleopod.

FIG. 13: *Arcania novemspinosa*, W2938. A, carapace; B, cheliped; C, male pleopod.
Scale divisions 1 mm.


9
A
B
10
A
B
11
12
A
B
13
A
B
C

Arcania novem-spinosa (Adams and White): Alcock, 1896, pp. 267–8. Tyndale-Biscoe and George, 1962, p. 76.

DREDGED: One, 2 miles SE. of Sandy I., **6C**, 2½ fm, shelly sand, 6.x.1967, Q.M., W2938.

This specimen agrees well with published descriptions, yet differs from Adams and White's figure in that the median posterior spine is not markedly longer than the lateral spines and the two processes on the posterior margin of the carapace are broadly flattened triangles with the base more than half the length.

DISTRIBUTION: India to the Phillippines and northwestern and northeastern Australia (Tyndale-Biscoe and George, 1962).

Pseudophilyra tridentata Miers

(Fig. 14)

Pseudophilyra tridentata Miers, 1879a, p. 41, pl. 2, fig. 4. Ihle, 1918, p. 268 (in key). Sakai, 1937, p. 151, pl. 14, fig. 7. Tyndale-Biscoe and George, 1962, p. 87, fig. 7.6.

DREDGED: One, 4¾ miles E. of Mud I., **4D**, 3 fm, gritty sand, 30.viii.1967, Q.M., W3112.

DISTRIBUTION: Persian Gulf to Japan; Western Australia, Torres Strait (Tyndale-Biscoe and George, 1962).

Leucosia ocellata Bell

(Fig. 15)

Leucosia ocellata Bell, 1855, p. 289, pl. 31, fig. 1 Miers, 1886, p. 325. Tyndale-Biscoe and George, 1962, p. 86, figs. 7.4 (pleopod), 8.8a, b.

DREDGED: One, ¼ mile NW. of M1 Red Buoy, **2C**, 7½ fm, hard sand and shell, 14.viii.1967, Q.M. W2836. One, between Green I. south beacon and Huybers Beacon, **5B**, 3½ fms, muddy grit, 13.xii.1962. One, ½ mile W. of Naval Reserve Bank beacon, **5C**, 4½ fms, sandy mud, 24.ix.1962. One, W. of Hanlon Light, **5D**, gritty sand with mud, 12.x.1961, Q.M., W2601. One, 1 mile ENE. of Cleveland Light, **6C**, 6½ fm, gritty sand, 12.ii.1968, Q.M., W2959. Two, 1½ miles SW. of South West Rocks, Peel I., **6D**, 6.x.1967, 2 fm, culch, Q.M., W2916. One, ½ mile NW. of Pat's Pt, **6D**, 5 fm, gritty mud, 13.x.1967, Q.M., W2915. Two, 2¼ miles SW. of Goat I., **6D**, 6 fm, gritty muddy sand, 12.x.1967, Q.M., W2914. One, off South West Rocks, **6D**, 5–6 fms, 5.x.1961, Q.M., W2731.

TRAWLED: One, Redland B., **7C**, early 1961, O. Wiseman.

Identification of specimens has been confirmed by Dr. R. George.

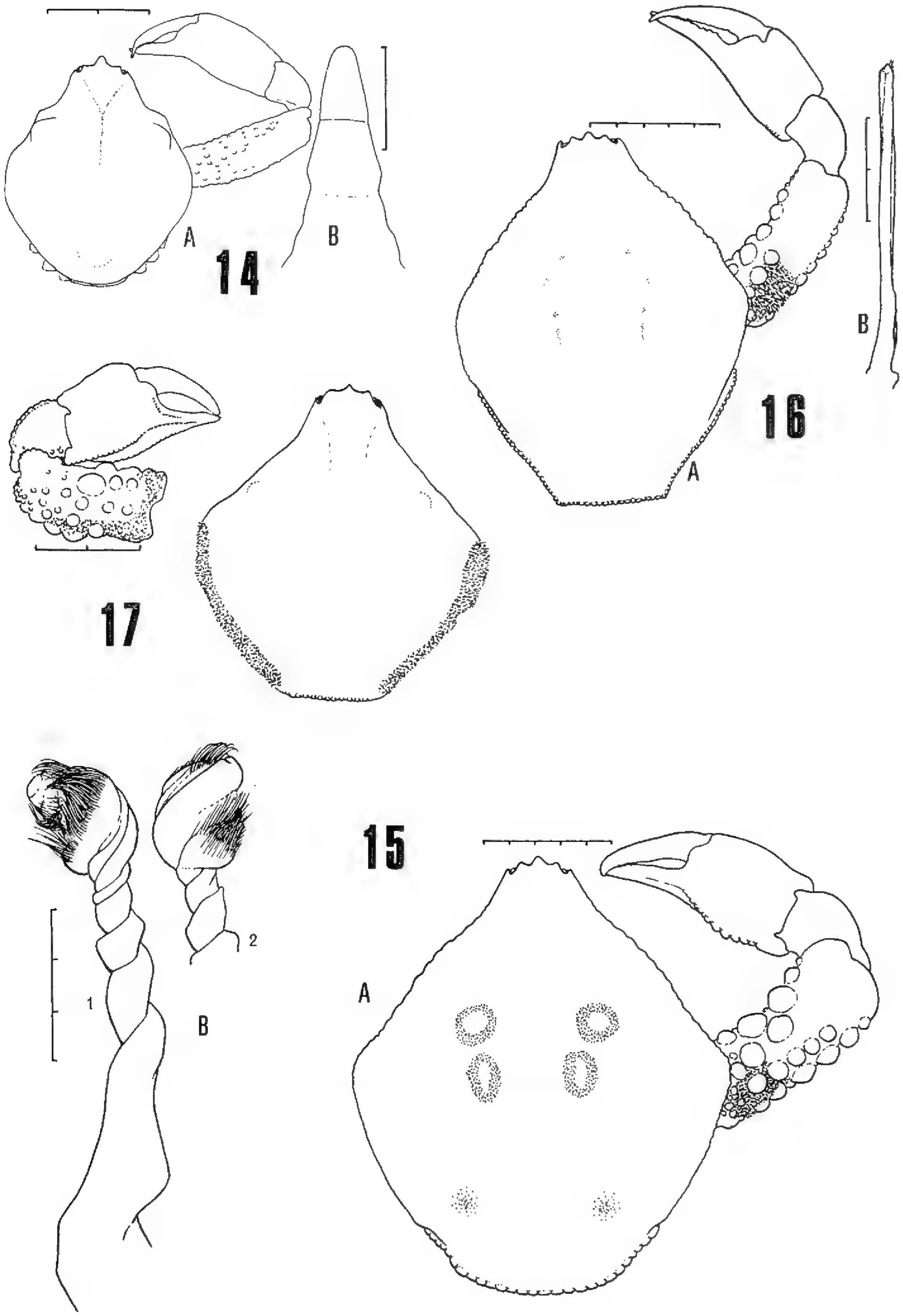
DISTRIBUTION: Arafura Sea; eastern and western Australia.

FIG. 14: *Pseudophilyra tridentata*, W3112. A, carapace; B, male abdomen.

FIG. 15: *Leucosia ocellata*, W2959. A, carapace; B, male pleopod (1, abdominal view; 2, sternal view).

FIG. 16: *Leucosia pubescens*, W2894. A, carapace; B, male pleopod.

FIG. 17: *Leucosia whitei*, W2807.
Scale divisions 1 mm.


A
B
14
B
16
A
17
15
A
B
1
2

Leucosia pubescens Miers

(Fig. 16)

Leucosia pubescens Miers, 1877, pp. 238–9, pl. 38, figs. 22–4. Alcock, 1896, pp. 233–4. Ihle, 1918, pp. 282–3. Stephensen, 1945, p. 95, fig. 17 A-B (pleopod). Tyndale-Biscoe and George, 1962, p. 84, fig. 7.1 (pleopod).

Leucosides pubescens (Miers): Buitendijk, 1939, p. 230.

DREDGED: Two, ½ mile SE. of Toorbul Pt red beacon, **1A**, 29.x.1962. One, ¼ mile NE. of Old Pile Light, **3B**, 2 fm, mud and culch, 15.vi.1967, Q.M., W2800. One (juv.), ½ mile W. of Naval Reserve Bank beacon, **5C**, 4½ fm, sandy mud, 24.ix.1962. One, 1 mile NW. of Snipe I., **7C**, 3 fm, gritty mud, 13.x.1967, Q.M., W2917. One (juv.), 1 mile off Redland B. jetty towards Snipe I., **7C**, muddy grit and mud, 26.iv.1962, Q.M., W2602.

TRAWLED: One, 4½ miles E. of Otter Rock beacon, **3B**, 3–4 fm, sandy grit, 10.xi.1961, Q.M., W2603. One between Peel I. and Green I., **5C**, 1.xi.1961, L. Wale. Four, *c.* ½ mile off Redland B. jetty in water airport area, **7C**, 4–6 fm, muddy grit, 26.iv.1962.

Although these specimens agree well with Miers' (1877) description, his figure (fig. 22) shows the anterolateral margins of the carapace to be more rounded. They key out without hesitation to this species in Alcock's key (1896, pp. 211–4) and male pleopods agree well with Tyndale-Biscoe and George's figure (1962, fig. 7.1).

The shape of the granulate posterior margin of the carapace varies with size. In small specimens (to *c.* 6.5 mm cw.) the margin is concave, the lateral angles acute. The angles are still prominent in 11.5 mm specimens but barely discernable at 14 mm. A similar variation has been reported by Alcock (1896, p. 233) for *L. vittata.*

DISTRIBUTION: Indian Ocean from Red Sea to India, East Indies and Western Australia (Tyndale-Biscoe and George, 1962). Not previously from eastern Australia.

Leucosia whitei Bell

(Fig. 17)

Leucosia whitei Bell, 1855, pp. 289–90, pl. 31, fig. 2. Alcock, 1896, pp. 225–6. Barnard, 1950, p. 386, fig. 71 h. Tyndale-Biscoe and George, 1962, p. 77, pl. 1, figs. 6, 9, pl. 2, figs. 6, 9. McNeill, 1968, pp. 41–2.

Leucosia cheverti Haswell, 1879a, p. 47, pl. 5, fig. 2; 1882b, p. 120.

DREDGED: One, S. end of Pearl Channel, **1C**, 4½ fm, sand, 6.vii.1962, Q.M., W2807.

In spite of McNeill's (1968, p. 42) notes on the now unavailable type material of *L. chevertii* Haswell, there seems to be no justification for considering these two to be distinct species. McNeill's description of the tuberculation of the chelae of *L. chevertii* is not inconsistent with Bell's figure of *L. whitei* and there remains only the degree of development of the frontal teeth and the granulation of the hepatic region of the carapace, both of which, as Tyndale-Biscoe and George (1962, p. 77) have noted, were shown to be very variable by Miers (1884, p. 249). The present specimen, with its very distinctly tridentate front and its single smooth hepatic elevation, bridges both 'species'.

DISTRIBUTION: Indo-Pacific from East Africa, Andamans, East Indies to northeastern and western Australia (Tyndale-Biscoe and George, 1962).

Tribe BRACHYGNATHA

Family MAJIDAE

Paratymolus latipes Haswell

Paratymolus latipes Haswell, 1880b, p. 303, pl. 16, figs. 3–5; 1882b, p. 143. Griffin, 1966, p. 276 (in key).

Paratymolus latipes Haswell var. *quadridentata* Baker, 1906, pp. 107–8, pl. 1, fig. 2.

Paratymolus latipes quadridentata Baker: Hale, 1927, p. 123, fig. 119.

DREDGED: One (juv.), 1 mile W. of Pearl Channel buoy, **2B**, 6 fm, 6.vii.1962 (ident. F. A. McNeill).

DISTRIBUTION: Southeastern, southern and southwestern Australia (Griffin, 1966).

Achaeus brevirostris (Haswell)

(Fig. 18)

Stenorhynchus brevirostris Haswell, 1879b, p. 408; 1880a, p. 432, pl. 27, fig. 5.

Achaeus affinis Miers, 1884, p. 188.

Achaeus brevirostris (Haswell): Griffin and Yaldwyn, 1965, pp. 46–8. Griffin, 1966, p. 276 (in key).

DREDGED: One, ¼ mile W. of black beacon on SW. side of St Helena I., **4B**, 2 fm, mud, 18.vii.1967, Q.M., W2851.

DISTRIBUTION: Northern and eastern Australia, Indian Ocean, Indo-Malaya, sublittoral to shallow offshore (Griffin, 1966).

Achaeus fissifrons (Haswell)

(Fig. 19)

Stenorhynchus fissifrons Haswell, 1879b, p. 409; 1882b, p. 2.

Achaeus tenuicollis Miers, 1886, p. 9, pl. 1, figs. 3a–c. Stephensen, 1945, p. 97, figs. 18A, B.

Achaeus elongatus Sakai, 1938, p. 223, fig. 13.

Achaeus fissifrons (Haswell): Griffin and Yaldwyn, 1965, pp. 38–44, figs. 1–8 (lit. and synon.).

DREDGED: Two, due E. of Jumpin Pin Bar, 47 fm, amongst fan corals, 1.vii.1961, Q.M., W2624. (Outside Moreton B.).

TRAWLED: One, 1 mile E. of Goat I., **6D**, 4 fm, 24.ix.1962.

DISTRIBUTION: New Zealand, southern and eastern Australia, north to Japan. Perhaps extending west to the Andaman Islands and Iranian Gulf in the Indian Ocean area (Griffin and Yaldwyn, 1965).

Achaeus lacertosus Stimpson

(Fig. 20)

Achaeus lacertosus Stimpson, 1857, p. 218; 1907, p. 20, pl. 3, fig. 7. Grant and McCulloch, 1906, p. 26, pl. 3, fig. 1. Barnard, 1950, p. 19, figs. 3a, 3b. Griffin and Yaldwyn, 1965, pp. 44–6 (lit. and synon.).

Achaeus breviceps Haswell, 1880a, p. 433.

Achaeus spinifrons Sakai, 1938, p. 212, fig. 6.

DREDGED: One, 3 miles NW. of M3 beacon, **1B**, 6 fm, gritty sand, 5.x.1967, Q.M., W2918. One, ¼ mile W. of N. end of St Helena I., **4B**, 2½ fm, culch, 18.vii.1967, Q.M., W2928.

DISTRIBUTION: Eastern, northern and western Australia, Japan, India and east coast of Africa (Griffin and Yaldwyn, 1965).

Naxia deflexifrons (Haswell)

(Fig. 21)

Microhalimus deflexifrons Haswell, 1880, pp. 435–6, pl. 25, fig. 2; 1882, p. 7.

Naxia (*Microhalimus*) *deflexifrons* (Haswell): McCulloch, 1918, pp. 330–2, pl. 10, figs. 1–4.

Naxia deflexifrons (Haswell): Griffin, 1966, p. 274 (in key).

DREDGED: One, NE. up Rainbow Channel from Myora Light, **5D**, 6–8 fm, coarse sand, 12.x.1961, Q.M., W2622.

DISTRIBUTION: Australia, Port Jackson (McCulloch, 1913).

Hyastenus brockii de Man

(Fig. 24)

Hyastenus Brockii de Man, 1887b, pp. 221–3, pl. 7, figs. 1, 1a, 1b.

Hyastenus brockii de Man: Griffin, 1966, p. 282 (in key).

DREDGED: One, NE. up Rainbow Channel from Myora Light, **5D**, 6–8 fm, coarse sand, 12.x.1961, Q.M., W2625. One, ¼ mile NW. of M1 Buoy, **2C**, 7½ fm, hard sand with shell, 29.viii.1967.

FIG. 18: *Achaeus brevirostris*, W2851. A, carapace; B, lateral view of carapace; C, dactylus of last leg.

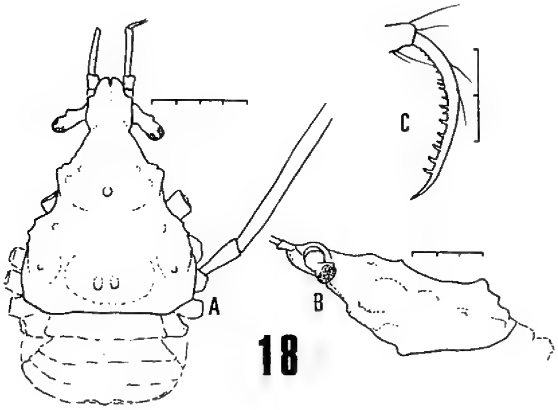
FIG. 19: *Achaeus fissifrons*, W2624. A, carapace; B, lateral view of carapace.

FIG. 20: *Achaeus lacertosus*, W2928. A, carapace; B, lateral view of carapace; C, dactylus of last leg.

FIG. 21: *Naxia deflexifrons*, W2622, A, carapace; B, lateral view of carapace; C, propodus and dactylus of last leg.

FIG. 22: *Phalangipus australiensis*, W2620. A, carapace; B, C, D, lateral, dorsal and ventral views of orbit.

FIG. 23: *Phalangipus longipes*, W2797. A, carapace; B, C, D, lateral, dorsal and ventral views of orbit. Scale divisions 1 mm.



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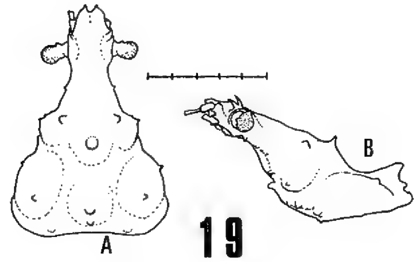

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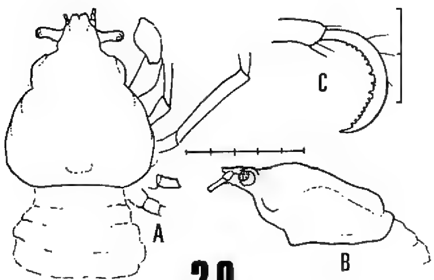

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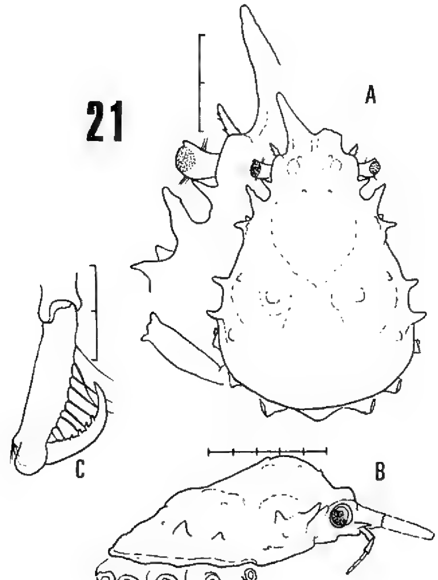

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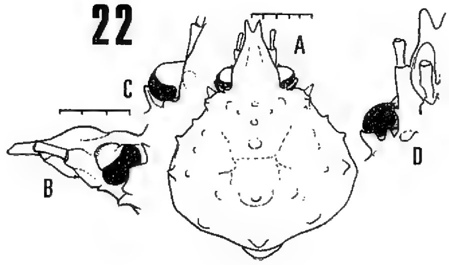

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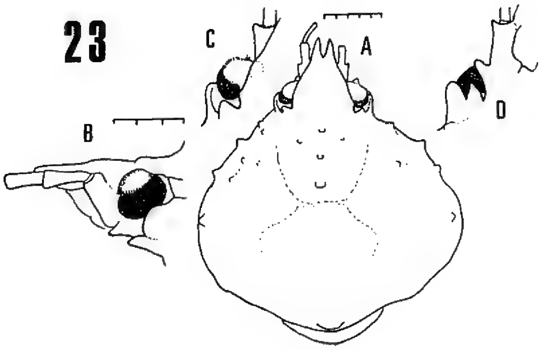

23

DISTRIBUTION: Indian Ocean, Indo-Malaya. In Australia previously known only from Torres Strait (Griffin, 1966).

Hyastenus convexus Miers

(Fig. 25)

Hyastenus (*Chorilia*) *convexus* Miers, 1884, p. 196, pl. 18, fig. B.

Hyastenus convexus Miers: Griffin, 1966, p. 282 (in key).

DREDGED: One, ¼ mile NW. of M1 Red Buoy, **2C**, 7½ fm, hard sand and shell, 29.viii.1967, Q.M., W2950.

DISTRIBUTION: Indian Ocean, Indo-Malaya, Philippines; northwestern to north-eastern Australia (Griffin, 1966).

Hyastenus diacanthus (de Haan)

(Fig. 26)

Pisa (*Naxia*) *diacantha* de Haan, 1839, p. 96, pl. 24, fig. 1.

Hyastenus diacanthus (de Haan): Alcock, 1895, p. 210. Sakai, 1938, pp. 279–80, pl. 29, fig. 2. Sakai, 1965, p. 81, pl. 36, fig. 1. Griffin, 1966, p. 281 (in key).

DREDGED: Two, 1¼ mile W. of Rous Channel Light, **4C**, 8–14 fm, 13.xii.1962. Present, ½ mile SE. of Hope Banks, **5C**, 3 fm, sandy mud, 1.vi.1962. One, 1 mile SE. of Hope Banks, **5C**, 5–6 fm, muddy grit, 1.vi.1962. Present, 1 mile W. of Naval Reserve Bank beacon, **5C**, 4½ fm, sandy mud, 24.ix.1962. Present, 2½ mile NNE. of Cleveland Light, **5C**, 5 fm, muddy sand, 24.ix.1962. One, between Hanlon Light and Naval Reserve Bank beacon, **5D**, muddy grit, 12.x.1961. Four, from Hanlon Light east, **5D**, gritty sand with mud, 12.x.1961, (2 ident. by F. A. McNeill). Eight, 1¼ miles SE. of Hope Banks, **5C**, 5 fm, clean sand with shell, 30.viii.1967, Q.M., W2847. One, 2¼ miles NW. of Hanlon Light, **5C**, 4½ fm, sandy mud (mostly sand), 30.viii.1967. One, 3½ miles NE. of Hope Beacon, **5C**, 4½ fm, muddy sand, 30.viii.1967, Q.M., W2845. Three, 1 mile SW. of South West Rocks, **6C**, 4 fm, culch, 6.x.1967, Q.M., W2919 W2929. Three, 1½ miles E. of Cleveland Light, **6C**, 2½ fm, culch, 6.ii.1968, Q.M., W2965. Two, SW. corner of Peel I., **6D**, muddy sand, 24.ix.1962. Present, off SW. point of Peel I., **6D**, 5–6 fm, 5.xii.1962. One, off SE. corner of Peel I., **6D**, 12.x.1961. One, between two S. beacons, Peel I., **6D**, 3 fm, muddy grit, 12.x.1961. One, near Pat's Pt, **6D**, 6½ fm, shell, 25.v.1962. One, S. of Dunwich in channel, **6D**, 4½ fm, shell, 25.v.1962. One, ½ mile W. of 'House' on Macleay I., **7D**, 3½ fm, muddy sand with shell, 13.x.1967, Q.M., W2930.

TRAWLED: Twelve, between Peel I. and Green I., 1.xi.1961.

DISTRIBUTION: Widespread Indo-West Pacific. (Griffin, 1966, p. 281).

Hyastenus sp.

(Fig. 27)

DREDGED: One, ¾ mile NW. of M1 Red Buoy, **2C**, 7½ fm, sand with broken shell, 29.viii.1967, Q.M.-W2839. One, ¼ mile NW. of M1 Red Buoy, **2C**, 7½ fm, hard sand with shell, 29.viii.1967, Q.M., W3106.

ADDITIONAL MATERIAL: Male, Arnhem B., Northern Territory, 10 fm, sand and mud, V. Wells, Q.M. W2734.

These specimens differ from those listed under *Hyastenus diacanthus* in the following particulars:

(1) The carapace is much flatter, particularly in the gastric region, and is without dorsal tubercles.

(2) The rostral spines are shorter, being 0.22–0.29 times postrostral carapace as against 0.33 to 0.5 times in *H. diacanthus.*

(3) There is a wide, U shaped sinus between the basal antennal joint and the post-orbital cup.

(4) The terminal segment of the male abdomen is distinctly longer than broad.

In these particulars the specimens approach *H. planasius* (Adams and White) but in that species the rostral spines are shorter (one-sixth carapace length) and are parallel, the basal antennal joint bears a distinct tooth visible in dorsal view, and the male pleopod has a distinct but not greatly elongate terminal process (see Buitendijk, 1939, fig. 13).

Buitendijk (1939) figures male pleopods of several species of *Hyastenus*, and shows two quite different pleopod forms for each of two cotypes of *N. diacanthus.* The 35 mm specimen has a pleopod with a long filiform terminal appendage, whereas in the 34 mm specimen this appendage is not developed. Buitendijk ascribes this difference to age, but in all of the ten males, ranging from 20 to 70 mm total carapace length, examined in the present study the pleopods are without a long filiform appendage, and larger specimens tend more towards Buitendijk's figure of *H. aries* (fig. 1). In the single 20.5 mm male here listed as *Hyastenus* sp. the pleopod has a very long filiform appendage exactly as figured by Buitendijk (figs. 5–7).

Two distinct species close to *H. diacanthus* (de Haan) are therefore represented in Moreton Bay and it would seem possible that the material which de Haan described as *H. diacanthus* also in fact consisted of specimens of these same two species. Further investigation of this problem, including an examination of de Haan's 35 mm male in relation to features 1–5 listed above, and the selection of a lectotype, would involve a more detailed study of the genus than can be attempted here.

DISTRIBUTION: Northern and northeastern Australia; Japan.

Hyastenus oryx A. Milne Edwards

(Fig. 28)

Hyastenus oryx A. Milne Edwards, 1872, pp. 250–2, pl. 14, fig. 1. Haswell, 1882b, p. 20. de Man, 1887b, pp. 224–5, pl. 7, fig. 2. Buitendijk, 1939, p. 244, figs. 11, 12 (male pleopod). Griffin, 1966, p. 281 (in key). McNeill, 1968, p. 46.

DREDGED: Five, 2 miles N. of Cowan Cowan Light, **1D**, 3 fm, clean sand with weed, 5.x.1967, Q.M., W3107.

DISTRIBUTION: Indian Ocean, Indo-Malaya, New Caledonia; southwestern to northern and northeastern Australia (Griffin, 1966).

Hoplophrys ogilbyi McCulloch

Hoplophrys ogilbyi McCulloch, 1908, pp. 51–3, pl. 12, figs. 2, 2a. Griffin, 1966, p. 283 (in key).

HOLOTYPE: Female 9.5 mm, Moreton B., 8 fm, on *Spongodes*, J. D. Ogilby, Q.M., W223.

Not taken in present conditions.

DISTRIBUTION: Indo-Malaya, possibly Japan; in Australia only from More'on B. (Griffin, 1966).

Phalangipus australiensis Rathbun

(Fig. 22)

Phalangipus australiensis Rathbun, 1918, pp. 15–16, pl. 6. Griffin, 1966, p. 280.

TRAWLED: One, ½ mile E. of Hope Beacon, **5C**, 4½ fm, gritty mud, 18.vii.1967, Q.M., W2890. Two, 1 mile N. of Cleveland Light, **5C**, 3 fm, gritty sand, 18.vii.1967, Q.M., W2854. Six, midway between Goat I. and Pat's Pt, **6D**, 12.x.1961, Q.M., W2620 (2 spems).

DISTRIBUTION: Previously known only from Platypus Bay, Queensland. (Griffin, 1966).

Phalangipus longipes (Linnaeus)

(Fig. 23)

Cancer longipes Linnaeus, 1758, p. 629; 1767, p. 1047.

Egeria Herbstii H. Milne Edwards, 1834, p. 292.

Phalangipus herbstii (H. Milne Edwards): Rathbun, 1918, p. 16 (in table).

Phalangipus longipes (Linnaeus): Griffin, 1966, pp. 270, 280 (in key).

TRAWLED: One, 1 mile E. of Otter Rock beacon, **3A**, 3½ fm, mud, 23-4.v.1967, Q.M., W2797.

FIG. 24: *Hyastenus brockii*, W2625.

FIG. 25: *Hyastenus convexus*, W2950.

FIG. 26: *Hyastenus diacanthus*, W2847.

FIG. 27: *Hyastenus* sp., W2734.

FIG. 28: *Hyastenus oryx*, W3107.

A, carapace; B, lateral view of carapace; C, male pleopod. Scale divisions 1 mm.

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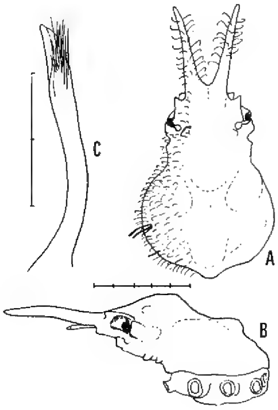

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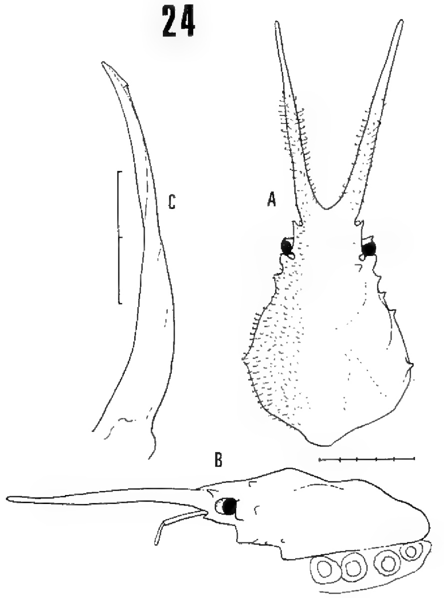

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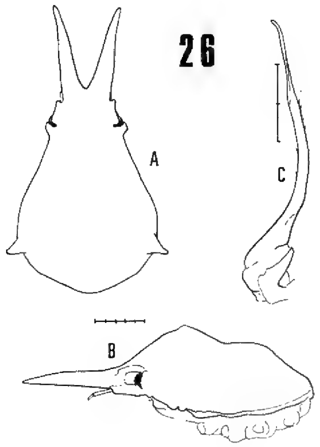

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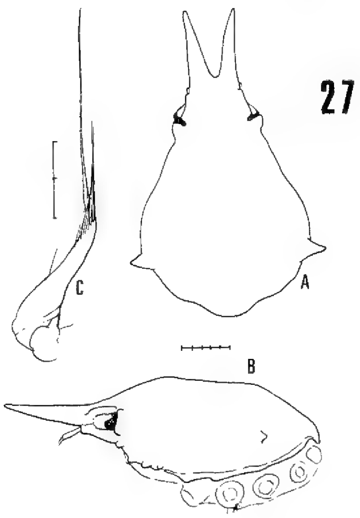

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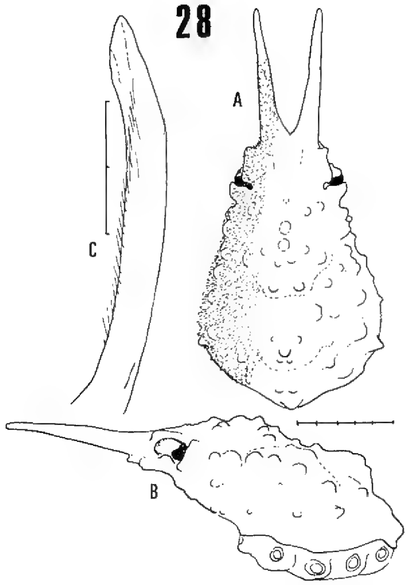


Features not mentioned by Rathbun (1918) nor by Griffin (1966) but useful in discriminating between this species and *P. australiensis* are the angle which the basal antennal joint makes with the rostrum in lateral view and the relative acuteness of the lower angle of the postorbital lobe (see figs. 22B, 23B).

DISTRIBUTION: Northeastern and northern Australia, Indian Ocean (Griffin, 1966).

Phalangipus spp.

The following material was recorded but not retained, and is consequently not available for specific determination.

DREDGED: One, $\frac{1}{2}$ mile SE. of Toorbul Pt red beacon, **1B**, 4 fm, mud, 29.x.1962. One, $\frac{1}{2}$–$\frac{3}{4}$ mile W. of M3 Buoy, **2C**, 10 fm, 29.x.1962. One, $\frac{1}{2}$ mile NW. of M1 Buoy, **2C**, 7$\frac{1}{2}$ fm, sand with broken shell, 29.viii.1967. One, 1$\frac{1}{2}$ mile N. of M2 Buoy, **2C**, 17$\frac{1}{2}$ fm, clean hard sand, 29.viii.1967. One, black beacon on S. of St Helena I. on Nazareth House, **4C**, clay and mud, 13.xii.1962. One, N. edge of Green I. on Lytton Hill, **4C**, 10–11 fm, muddy sand, 13.xii.1962. One, 1$\frac{1}{2}$ mile E. of S. end of St Helena I., **4C**, 4 fm, 18.vii.1967. One, 3 miles SW. of centre of St Helena I., **4C**, 7$\frac{1}{2}$ fm, clean hard sand, 30.viii.1967. One, 3 miles N. of Cleveland Pier, **5C**, 4$\frac{1}{2}$ fm, muddy sand, 24.ix.1962. Present, $\frac{1}{2}$ mile W. of Naval Reserve Bank beacon, **5C**, 4$\frac{1}{2}$ fm, sandy mud, 24.ix.1962. One, 2$\frac{1}{4}$ mile NW. of Hanlon Light, **5C**, 4$\frac{1}{2}$ fm, sandy mud (mostly sand), 30.viii.1967. One, 1$\frac{3}{4}$ mile WSW. of Hanlon Light, **5C**, 4$\frac{1}{2}$ fm, sandy mud, 30.viii.1967. Four, 2$\frac{3}{4}$ mile WNW. of Hanlon Light, **5C**, 5$\frac{1}{2}$ fm, gritty sandy mud, 30.viii.1967. Three, 1 mile WSW. of tip of Peel I., **5C**, 4 fm, culch, 6.x.1967. One, 1$\frac{1}{2}$ mile NNW. of Cleveland Light, **5C**, 3$\frac{1}{2}$ fm, gritty muddy sand, 6.x.1967. One, NW. of Hanlon Light, between Hanlon Light and Naval Reserve Bank beacon, **5D**, 6 fm, muddy sand, 12.x.1961. Two, from Hanlon Light east, **5D**, gritty sand with mud, 12.x.1961. Present, $\frac{1}{2}$ way between Cleveland and Peel I. jetties, **6C**, muddy grit, 24.ix.1962. One, 1$\frac{1}{2}$ mile SW. of S. tip of Peel I., **6C**, 5$\frac{1}{2}$ fm, shelly sand, 6.x.1967. One, 1 mile SSW. of S. tip of Peel I., **6D**, 2 fm, culch, 6.x.1967.

TRAWLED: Forty-five, 1 mile E. of Otter Rock beacon, **3A**, 3$\frac{1}{2}$ fm, muddy, 1.iii.1967. Seven, 1 mile E. of Otter Rock beacon, **3A**, 3$\frac{1}{2}$ fm, mud, 8.iii.1967. One, 1 mile E. of Otter Rock beacon, **3A**, 3$\frac{1}{2}$ fm, mud, 17–18.v.1967. Fifty-three 1 mile E. of Otter Rock beacon, **3A**, 3$\frac{1}{2}$ fm, 23.ii.1967. Five, between Peel I. and Green I., **5C**, 1.xi.1961. Twelve, S. of Peel I., **6D**, 2–4$\frac{1}{2}$ fm, 24.ix.1962. Common, 1 mile E. of Goat I., **6D**, 4 fm, 24.ix.1962.

Chlorinoides longispinus (de Haan)

Maia (*Chorinus*) *longispinus* de Haan, 1839, p. 94, pl. 23, fig. 2.

Paramithrax Coppingeri Haswell, 1882a, pp. 750–1; 1882b, pp. 15–16.

Paramithrax (*Chlorinoides*) *longispinus* (de Haan): Miers, 1884, p. 522.

Chlorinoides longispinus (de Haan): Miers, 1886, p. 53. Griffin, 1966, p. 286 (in key).

Acanthophrys longispinus (de Haan): Sakai, 1938, p. 308, pl. 31, fig. 2; 1965, p. 87, pl. 40, fig. 1.

DREDGED: One, $\frac{1}{2}$ mile SE. of Toorbul Pt red beacon, **1A**, 29.x.1962. Five, 2$\frac{1}{2}$ mile E. of Scott Pt, **3A**, 3 fm, culch, 6.ii.1968, Q.M., W2956. One, $\frac{1}{2}$ mile E. of Otter Rock beacon, **3A**, 3 fm, mud and shell, 31.viii. 1967, Q.M., W2842. One, $\frac{1}{4}$ mile W. of black beacon, SW. side of St Helena I., **4B**, 2 fm, mud, 18.vii.1967, Q.M., W2852. Six, 1$\frac{1}{2}$ mile E. of S. end of St Helena I., **4C**, 4 fm, Q.M., W2940. One, Hanlon Light east, **5D**, gritty sand with mud, 12.x.1961, Q.M., W2623. One, 1 mile SW. of South West Rocks, **6C**, 4 fm, culch, 6.x.1967, Q.M., W2939. Five, S. of Peel I., **6D**, 3–6 fm, 17.vii.1961. One, between south beacons Peel I., **6D**, 3 fm, muddy grit, 12.x.1961. Five, 4½ mile S. of Dunwich, **6D**, 6½ fm, shelly bottom, 25.v.1962, O. Wiseman.

TRAWLED: One, 1 mile E. of Otter Rock beacon, **3A**, 3½ fm, mud, 17–18.v.1967, Q.M., W2790. Two, between Peel I. and Green I., **5C**, 1.ix.1962, L. Wale. One, 1 mile E. of Goat I., **6D**, 4 fm, 24.ix.1962.

DISTRIBUTION: Indo-West Pacific Japan to Mozambique; eastern and northern Australia (Griffin, 1966).

Micippa thalia (Herbst)

Cancer thalia Herbst, 1803, p. 50, pl. 58, fig. 3.

Micippa thalia (Herbst): de Haan, 1839, p. 98, pl. 23, fig. 3. Alcock, 1895, pp. 251-2 (lit. and synon.). Sakai, 1965, p. 90, pl. 42, fig. 3. Griffin, 1966, p. 287 (in key).

DREDGED: Three, ¾ mile NW. of M1 Buoy, **2C**, 7½ fm, hard sand and broken shell, 29.viii.1967, Q.M., W2941 W2943. One, ¼ mile NW. of M1 Buoy, **2C**, 7½ fm, hard sand and shell, 29.viii.1967, Q.M., W2949.

DISTRIBUTION: East coast of Africa and the Red Sea to East Asia and Australia. (Griffin, 1966).

Family PARTHENOPIDAE

Parthenope (Parthenope) longimanus (Linnaeus)

(Fig. 31)

Cancer longimanus Linnaeus, 1758, p. 629.

Lambrus longimanus: Leach, 1815, p. 310 (name only, with reference to *Maja longimana*, Bosc.).

Lambrus longimanus: H. Milne-Edwards, 1834, p. 354.

Lambrus longimanus?: Miers, 1879b, pp. 20-1.

Lambrus longimanus?: Haswell, 1882b, p. 31.

Lambrus longimanus, H. Milne-Edwards: de Man, 1887a, p. 21.

Lambrus longimanus, Leach: Alcock, 1895, pp. 260–1.

Lambrus (*Lambrus*) *longimanus*, A. Milne-Edwards: Flipse, 1930, pp. 21–2, fig. 23 (male pleopods).

Lambrus (*Lambrus*) *longimanus*, Leach: Sakai, 1938, pp. 329–30.

Lambrus (*Lambrus*) *longimanus* (A. Milne-Edwards): Stephensen, 1945, p. 113, fig. 23A–B (male pleopods).

As is indicated by the above, very incomplete, synonymy, the authorship of this name has been the subject of considerable controversy due to many inadequate descriptions in the early literature. It has been variously attributed to Linnaeus, with and without a query; to H. Milne-Edwards, who gave probably the earlist recognisable description; to Leach, with no apparent justification whatsoever; and to A. Milne-Edwards, apparently in error. The name became available when published with a description (admittedly inadequate) by Linnaeus, 1758, and takes authorship from that publication. Linnaeus' description although vague must surely be of a species of *Parthenope* and *Parthenope longimanus* if used with any more recent authorship (e.g. on the grounds that the present species may not be conspecific with that described by Linnaeus) would be a junior secondary homonym.

TRAWLED: One, Moreton B., presumably trawled, L. Wale, Dec. 1961, Q.M., W2613.

DISTRIBUTION: East coast of Africa to Formosa and Australia (Flipse, 1930; Sakai, 1938).

Parthenope (Parthenope) nodosa (Jacquinot and Lucas)

(Fig. 29)

Lambrus nodosus Jacquinot and Lucas, 1853, p. 13, pl. 1, fig. 2. Miers, 1876, p. 12; 1884, pp. 200–1. Haswell, 1880a, p. 451; 1882b, p. 34. Filhol, 1885, p. 370, pl. 41, fig. 1–3.

Parthenope (*Parthenope*) *nodosa* (Jacquinot):Rathbun, 1924, pp. 7–8.

DREDGED: One, SW. edge of Hope Banks, **5C**, 6–8 fm, sandy grit, 13.xii.1962, Q.M., W2735. One, ½ mile W. of N. end of St Helena I., **4B**, 2½ fm, culch, 18.vii.1967, Q.M., W2937. Three, ¼ mile NW. of M1 Red Buoy, **2C**, 7½ fm, hard sand and shell, 29.viii.1967, Q.M., W2838 W2841. Two, ¾ mile NW. of M1 Red Buoy, **2C**, 7½ fm, sand and broken shell, 29.viii.1967, Q.M., W2835 W2944. One, 4¾ mile E. of Mud I., **3D**, 3 fm, gritty sand, 30.viii.1967, Q.M., W2844. One, SE. corner of Peel I., **6D**, muddy grit, 12.x.1961, Q.M., W2610. One, Pat's Pt to Dunwich, **6D**, 6½ fm, shell bottom, 25.v.1962, O. Wiseman, Q.M., W2737. Two, 2¼ mile SW. of Goat I., **6D**, 6 fm, gritty muddy sand, 12.x.1967, Q.M., W2931 W2936.

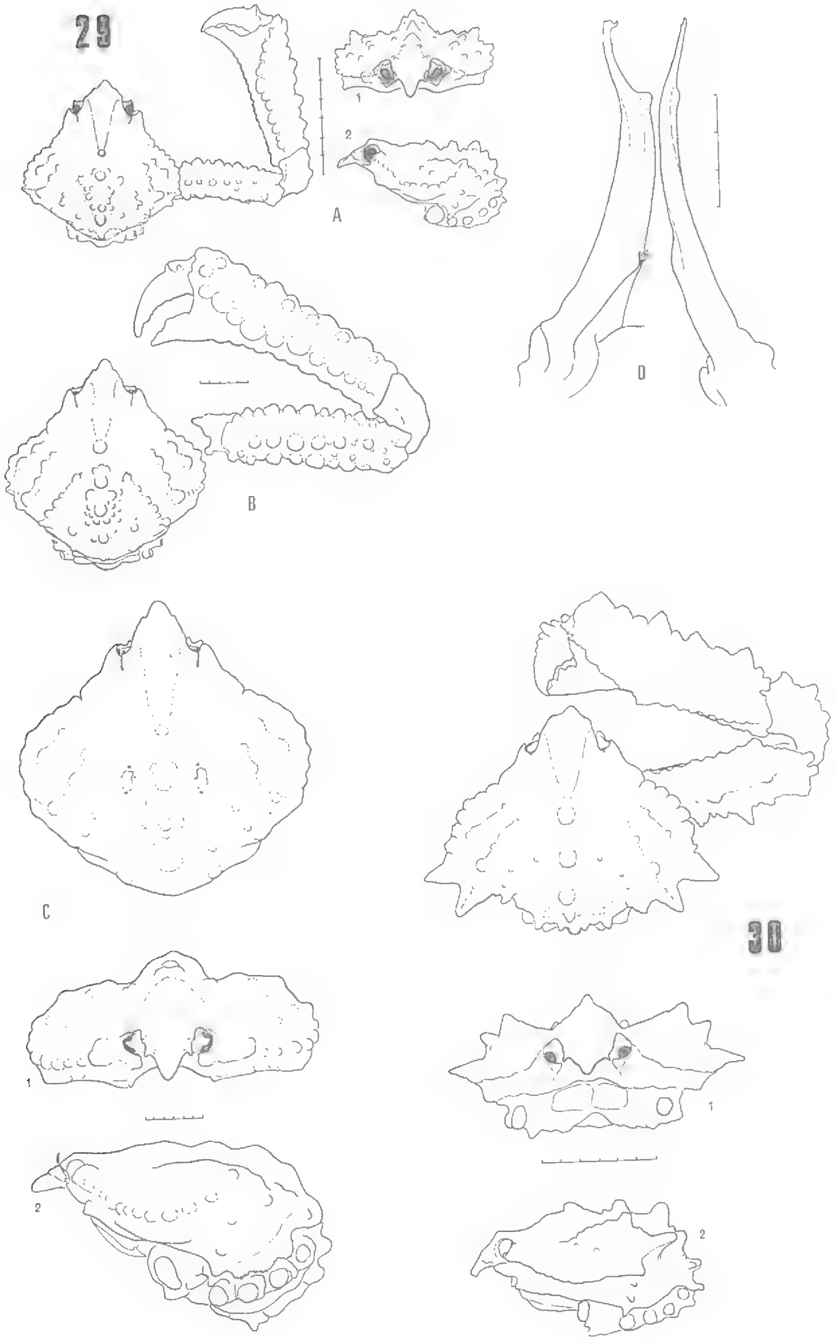
TRAWLED: Four, 1 mile E. of Goat I., **6D**, 4 fm, 24.ix.1962, Q.M., W2612 W2745.

Small specimens of this species differ quite markedly from those with a carapace width exceeding *c.* 10 mm, and it would be difficult to recognise them as *P. nodosa* were it not for the continuous gradation within the series available. The tubercles on the chelipeds do not have the typical rounded appearance but are sharp and flattened; the meri, and more particularly the propodi, are more sharply angled, the upper surfaces of the propodi tending to be smooth and flat; the tubercles on the carapace are much more acute and more distinct, forming almost crestlike rows.

Miers (1884, p. 201) suggested that *P. intermedia* (Miers, 1879) might represent a young stage of *P. nodosa.* Balss 1922 (fide Sakai, 1938, p. 330) has shown *P. intermedia* to be in fact, a young stage of *P. valida* de Haan. The present small specimens differ from small *P. valida* in having the carapace as long as broad, three rows of tubercles on each

FIG. 29: *Parthenope nodosa.* A, carapace, W2610; B, carapace, W2745; C, carapace, W2963; D, male pleopods, W2963.

FIG. 30: *Parthenope valida*, W2712.
1 = frontal view, 2 = lateral view. Scale divisions 1 mm.


29
A
1
2
B
D
C
1
2
30
1
2

branchial region instead of a single row, and no strong backwardly directed teeth on the lateral posterior margins of the carapace.

The large circular red spot on the inner face of the hand at the base of the fingers is a convenient feature for field identification.

Miers (1877) record of this species from New Zealand was neither confirmed nor denied by Bennett (1964), but because of the inaccuracy of Miers's locality data in that publication some confirmation seems desirable before New Zealand can be included in the distribution of *P. nodosa.*

DISTRIBUTION: Northern Australia, from Cape Jaubert, W.A., to Moreton B.

Parthenope (Platylambrus) valida de Haan

(Fig. 30)

Parthenope (*Lambrus*) *validus* de Haan, 1839, p. 90, pl. 21, fig. 2, pl. 22, fig. 1.

Lambrus intermedius Miers, 1879a, pp. 29–30; 1886, p. 96, pl. 10, fig. 4.

Lambrus (*Platylambrus*) *validus* (de Haan): Sakai, 1938, pp. 330–1, pl. 33, fig. 4, pl. 39, fig. 1.

Lambrus validus (de Haan): Sakai, 1965, pp. 93–4, pl. 43, figs. 1, 2, 3 (juv.). Utinomi, 1967, p. 80, pl. 40, fig. 9.

TRAWLED: One, E. of Goat I., **6D**, 24.ix.1962, Q.M., W2712.

This small (12 mm cl.) specimen is readily distinguished from small *P. nodosa* by its broad (15.5 mm) carapace and the two very strong spines on each posterolateral angle of the carapace.

DISTRIBUTION: Singapore, Japan, and NE. Australia to Samoa (Sakai, 1965)

Parthenope (Rhinolambrus) longispinus (Miers)

(Fig. 32)

Lambrus longispinus Miers, 1879b, pp. 18–19.

Lambrus spinifer Haswell, 1880a, pp. 451–2, pl. 27, fig. 1.

Lambrus (*Rhinolambrus*) *longispinis* Miers: Alcock, 1895, pp. 266–7. Flipse, 1930, p. 28.

Parthenope (*Rhinolambrus*) *longispinis* (Miers): McNeill, 1968, p. 48.

[non] *Lambrus* (*Rhinolambrus*) *longispinis* Miers: Sakai, 1938, pp. 333–4, pl. 39, fig. 2 (= *P. contraria*, see Sakai, 1965, p. 96).

DREDGED: Two, ¼ mile NW. of M1 Red Buoy, **2C**, 7½ fm, hard sand and shell, 29.viii.1967, Q.M., W2978.

This species is close to *P. contraria* which also occurs in Moreton Bay (but has not appeared among present trawled or dredged material) and existing keys stress the difference in length of the chelipeds in relation to carapace length—3 × in *P. contraria*, 2.5 × in *P. longispinus*. This seems to be reliable only with large males of *P. contraria* and the differences listed by Sakai, 1965, p. 96 must be used to separate these species. To these differences it might be added that the rostrum of *P. contraria* carries spinules laterally and a transverse row of four spinules at its base (see fig. 33).

DISTRIBUTION: India to Japan, Australia, and Samoa (McNeill, 1968).

Parthenope (Pseudolambrus) harpax (Adams and White)

(Fig. 34)

Lambrus harpax Adams and White, 1848, pp. 25–6, pl. 6, fig. 3. Haswell, 1880a, p. 450.

Lambrus (*Parthenope*) *Sandrockii* Haswell, 1880a, pp. 452–3, pl. 27, fig. 2.

Lambrus (*Parthenopoides*) *harpax* Adams and White: Miers, 1884, pp. 202–3.

Lambrus (*Parthenolambrus*) *harpax* Adams and White: Alcock, 1895, pp. 278–9.

Parthenope (*Pseudolambrus*) *sandrockii* (Haswell): Rathbun, 1924, p. 8.

[?] *Lambrus* (*Pseudolambrus*) *harpax* Adams and White: Sakai, 1938, pp. 338-9, pl. 33, fig. 6.

DREDGED: One, 1 mile SE. of Hope Banks, **5C**, 5 fm, muddy grit, 1.vi.1962. One, S. end of Rainbow Channel, **5D**, 2.vi.1967. One, E. of Hope Banks, **5C**, 5 fm, clean sand with shell, 30.viii.1967, Q.M., W2947. One, 3½ mile NE. of Hope Beacon, **5C**, 11 fm, sandy mud, mostly sand, 30.viii.1967, Q.M., W2891. Two, 2½ mile SW. of South West Rocks, **6C**, 4 fm, culch, 6.x.1967, Q.M., W2934 W2935. One, S. of Peel I., **6D**, 3–6 fm, 17.vii.1961, Q.M., W2614. One, between two S. beacons Peel I., **6D**, 3 fm, muddy grit, 12.x.1961, Q.M., W2616.

TRAWLED: Nine, 1 mile E. of Goat I., **6D**, 4 fm, 24.ix.1962, Q.M., W2615 W2746.

Haswell (1880a, p. 450) described two varieties of this species, variety 'a' similar to Adams and White's illustration, variety 'b' with long post orbital gastric and cardiac spines. Miers (1884) describes a smooth and a granulate form, attributing the differences noted to age. He also synonymises *Parthenope sandrockii* (Haswell) with this species, and this was questioned by Rathbun (1924, p. 8). The present series contains specimens which agree well with Adams and White's figure and with Haswell's figure of *P. sandrockii* and shows a range of variation which includes all the features mentioned. This variation seems independent of size.

Although a great deal has been written on variability within this species (e.g. Haswell, 1880; Miers, 1884) keys have subsequently (Flipse, 1930; Sakai, 1938) been based on extremely variable features and some additional comment seems justified. Variations in "Key" features shown by this series include:–

(1) Hepatic region: margin very convexly rounded or only very slightly convex, entire or scarcely notched or with two to six small or large, smooth or serrated teeth separated by V-shaped notches or narrow slits; not at all separated from outer orbital angle or separated by a notch which may be larger and more conspicuous than the orbit.

(2) Carapace: 1.00 to 1.15 times as broad as long.

(3) Carapace surface: mostly smooth, or with few or many granules which may be small or large, discrete or more or less coalesced, with or without distinct deep punctae between them.

(4) Post frontal, cardiac, and gastric regions: bearing very long or short tubular spines or with only rounded granules.

(5) Chelipeds: 1.5 to 2.0 times the length of the carapace with or without an enlarged tooth or winged expansion anteriorly in the proximal third of the arm.

With varibiality of this magnitude, Flipse's key does not function, and doubt must be shed on the validity of his *P. bicornis* and *P. lobatus*. The distinctions given by Sakai (1938, p. 338) for *P. beaumontii* and *P. harpax* are no longer adequate. The specimens identified by him as these species probably all belong to *P. beaumontii*: the front is too anteriorly projecting, and the posterolateral teeth do not have the characteristic complexity of *P. harpax*.

DISTRIBUTION: Amirante I., Andaman I., to Gulf of Thailand, and Australia.

Cryptopodia queenslandi Rathbun

(Fig. 35)

Cryptopodia queenslandi Rathbun, 1918, pp. 26–7, pl. 12.

DREDGED: One, E. Moreton B., 2.vi.1962, T. Hailstone. One, 200 yd S. of North Reef Light, **2A**, 3 fm, 29.x.1962. One, 5 miles W. of Tangalooma, **2C**, 10 fm, sandy mud, 10.xi.1961, Q.M., W2617. One, ½ mile NW. of M1 Buoy, **2C**, 7½ fm, sand with broken shell, 29.viii.1967. One, 2½ mile E. of Scott Pt, **3A**, 3 fm, culch, 6.ii.1968, Q.M., W2963. One, ½ mile W. of Naval Reserve Bank beacon, **5C**, 4½ fm, sandy mud, 29.ix.1962. One, ½ mile E. of Hope Banks beacon, **5C**, 4½ fm, gritty mud, 18.vii.1967, Q.M., W2859. One, ½ mile NE. of Hope Banks beacon, **5C**, 3½ fm, gritty muddy sand, 6.x.1967, Q.M., W2922.

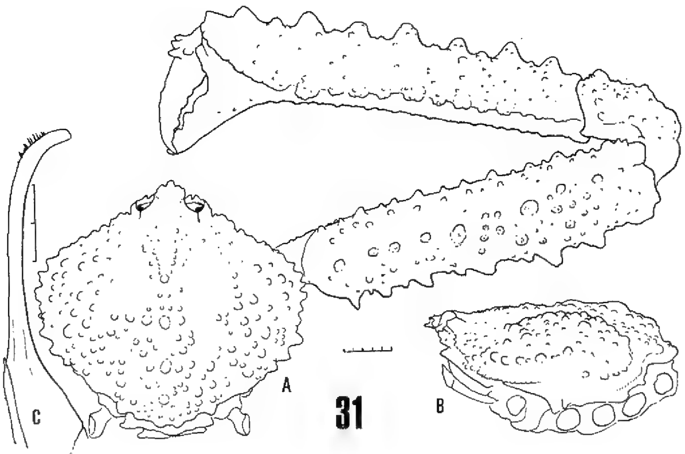
FIG. 31: *Parthenope longimanus*, W2613. A, carapace; B, lateral view of carapace; C, male pleopod.

FIG. 32: *Parthenope longispinus*, W2978. A, carapace; B, frontal view; C, lateral view; D, rostrum.

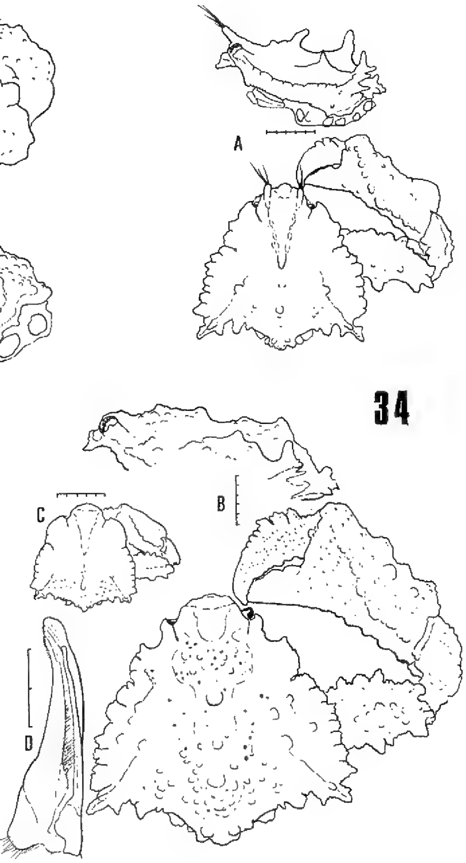
FIG. 33: *Parthenope contraria*, W2611, rostrum.

FIG. 34: *Parthenope harpax*. A, W2891, dorsal and lateral views; B, W3065, dorsal and lateral views; C, W2614; D, male pleopod, W2746.

FIG. 35: *Cryptopodia queenslandi*, W2964. A, carapace; B, male pleopod.
Scale divisions 1 mm.

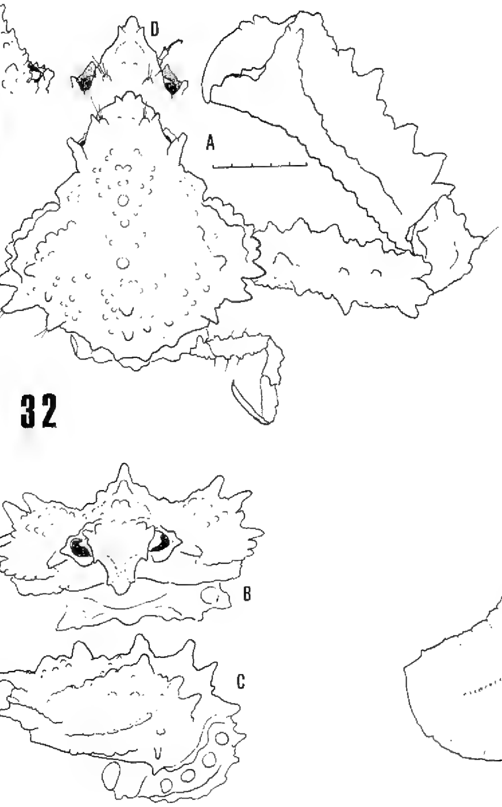


31

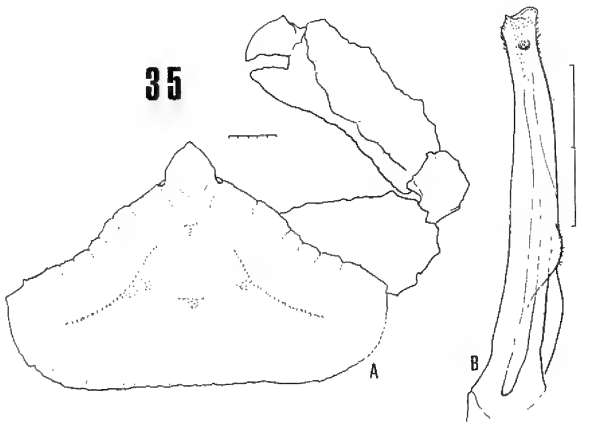


34

33



32



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TRAWLED: One, northern Moreton B., late January 1962, L. Wale. One, 1 mile E. of Goat I., **6D**, 4 fm, 29.ix.1962.

DISTRIBUTION: Type locality, 20 mile NE. of C. Gloucester, Qd, 35 fm (Rathbun, 1918).

Family PORTUNIDAE

Libystes paucidentatus Stephenson and Campbell

Libystes paucidentatus Stephenson and Campbell, 1960, pp. 86–7, fig. 1B, 2D; pl. 1, fig. 4; pl. 5D.

DREDGED: One, 1 mile W. of red buoy S. of Toorbul Pt, **2B**, 3 fm, sandy mud, 6.vi.1967. One, 6 mile E. of Garnet Rock, **2B**, 6½ fm, 31.viii.1967. One, ½ mile E. of Green I., beacon S. of Green I. in line with Manly Water Tower, **5B**, 13.xii.1962.

PAST RECORDS: Male (18 mm), Redland B., **7C**, in gritty mud, MLW, 11.viii.1958. Male (14.5 mm), 2 females (15, 16 mm), Redland B., **7C**, in gritty mud, MLW, 7.i.1959. (Stephenson and Campbell, 1960, p. 86). Female (20 mm), trawled between Peel I. and Green I., **5C**, 1.ii.1961, coll. L. Wale. Female (17.5 mm), trawled Moreton B., late 1962, coll. L. Wale. (Rees and Stephenson, 1966, p. 30).

DISTRIBUTION: Moreton B.

Podophthalmus vigil (Fabricius)

Portunus vigil Fabricius, 1798, p. 368.

Podophthalmus vigil (Fabricius): Stephenson and Campbell, 1960, pp. 115–6, figs. 1(L), 2(O); pl. 5, fig. 1; pl. 5(O).

TRAWLED: One, in S. Moreton B., early, 1962, coll. O. Wiseman. Two, between Mud I. and Moreton I., **3C**, 14.xii.1962.

PAST RECORDS: Moreton B. (Bribie I., Pearl Banks, Woody Pt, Peel I., Victoria Pt, Stradbroke I.), trawled 5–10 fm, sandy mud and weed. (Stephenson and Campbell, 1960, p. 115).

DISTRIBUTION: Within Australia from Brisbane River, Southport and Western Australia. Also from Indian Ocean, Red Sea, Iranian Gulf to Formosa, Philippines and Hawaii. (Stephenson and Campbell, 1960).

Portunus gracilimanus (Stimpson)

Amphitrite gracilimanus Stimpson, 1858, p. 38; 1907, p. 77, pl. 10, fig. 3.

Portunus gracilimanus (Stimpson): Stephenson and Campbell, 1959, pp. 115–6, figs. 2M, 3M; pl. 4, fig. 1; pls. 4M, 5M. McNeill, 1968, p. 55.

TRAWLED: One, 1 mile E. of Otter Rock beacon, **3A**, 3½ fm, mud, 1.iii.1967, Q.M., W2576. One, 1 mile E. of Otter Rock beacon, **3A**, 3½ fm, mud, 23.ii.1967. One, 1½ mile ENE. of Mud I., **3C**, 5½ fm, mud, 3–4.viii. 1967.

DISTRIBUTION: From Andamans, east coast of India, Hong Kong, Malaya to New Guinea, Australia (Northern Territory, Queensland). (Rees and Stephenson, 1966).

Portunus hastatoides Fabricius

Portunus hastatoides Fabricius, 1798 p. 368. Stephenson and Campbell, 1959, pp. 101–2, figs. 2D, 3D; pl. 1, fig. 4; pls. 4D, 5D. McNeill, 1968, p. 55.

DREDGED: Five, ½ mile ENE. of Pile Light, **3B**, 6 fm, mud, 25.v.1967. One, 1½ mile NW. of Pile Light, **3B**, 5 fm, mud, 25.v.1967. One, 4½ mile NW. of sand hills on Moreton I., **3D**, 11½–12 fm, 1.vi.1962. Two, ¾ mile SW. of south beacon off Mud I., **4B**, 4½ fm, 25.v.1967. One, 2 mile N. of E. end of Mud I., **4C**, 6½ fm, mud, 25.v.1967. One, 1–2 miles W. of S. end of Moreton I., **4D**, 17–18 fm, 7.iv.1961. Seven, N. end of Rous Channel, **4D**, 2.vi.1962.

TRAWLED: Seven, NE. corner of Moreton B., 7–8.iv.1961. Four, 8 mile E. of Scarborough, **2B**, 4½ fm, sand, 10.xi.1961. Five (including 2 ovig. females) N. Moreton B., late January, 1962. One ovig. female, near Shark Spit, **2D**, 12 fm, 23.ii.1962. One hundred and twenty-eight, 1 mile E. of Otter Rock beacon, **3A**, 3½ fm, mud, 23.ii.1967, 31.iii.1967, 8.iii.1967, 19–20.iv.1967, 17–18.v.1967, 23–24.v.1967. One, 3 mile ESE. of Woody Pt, **3A**, 3 fm, mud, 9.iv.1968. Two hundred and nine, 1½ miles ENE. of Mud I., **3C**, 5½ fm, mud, A. Jones, 9–10.viii.1967, 7.ix.1967, 30–1.x.1967. Two, S. of Peel I., **6D**, 6 fm, 4.xii.1961.

PAST RECORDS: Moreton B. (Woody Pt, Pearl Banks). Trawled and dredged in soft mud, sandy mud, and shelly mud, 3–9 fm. (Stephenson and Campbell, 1959).

DISTRIBUTION: From the coast of Zululand to Japan and the Philippines, including the northern coasts of Australia. (Stephenson and Campbell, 1959).

Portunus pelagicus (Linnaeus)

Cancer pelagicus Linnaeus, 1767, p. 1042.

Portunus pelagicus (Linnaeus): Stephenson and Campbell, 1959, pp. 96–8, figs. 2A, 3A; pl. 1, fig. 1; pls. 4A, 5A. McNeill, 1968, p. 54. Stephenson, 1968a, pp. 83–9, pl. 11; 1968b, pp. 385–99, fig. 2C, D.

DREDGED: One, 2½ miles E. of Scott Pt, **3A**, 3 fm, culch, 6.ii.1968. Six, 1½ miles S. of Dunwich near black beacon, **6D**, 2½–3½ fm, 11.iv.1962. One, 2 miles ESE. of Caboolture River, **1A**, 2 fm, mud with shell, 6.vi.1967.

TRAWLED: Everywhere in Moreton Bay, but never in large quantities, April to November, 1961. Two thousand, eight hundred and ninety two, 1 mile E. of Otter Rock beacon, **3A**, 3½ fm, mud, 23.ii.1967, 1.iii.1967, 8.iii.1967, 19–20.iv.1967, 23–4.v.1967. One thousand two hundred and seventeen 1½ miles ENE. of Mud I., **3C**, 5½ fm, mud, 3–4.viii.1967, 9–10.viii.1967, 7.ix.1967, 25–6.ix.1967, 30–1.x.1967, 22–3.i.1968. Several, S. of Peel I., **6D**, 5.xii.1962.

PAST RECORDS: Trawled commercially throughout Moreton B. Common in shallow, sandy-muddy, inshore waters, but much less common in clearer offshore waters. (Stephenson and Campbell, 1959).

DISTRIBUTION: Within Australia abundantly and widely recorded. Also from Mediterranean and East Africa to Japan, the Philippines, Tahiti and New Zealand.

Portunus rubromarginatus (Lanchester)

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

Portunus rubromarginatus (Lanchester): Stephenson and Campbell, 1959, pp. 112–3, figs. 2K, 3K; pl. 3, fig. 3; pls. 4K, 5K.

DREDGED: One, ¼ mile NW. of M1 Buoy, **2C**, 7½ fm, hard sand with shell, 14.viii.1967. One, 1¾ mile SE. of M3 Buoy, **2C**, 4½ fm, clean hard sand with weed, 29.viii.1967. One, ½ mile offshore, outside Tangalooma Gutter, **2D**, 8 fm, 1 vi.1962. One, in channel between Ridge Shoal and Dring Banks, **2D**, 9 fm, fine sand, 29.iv.1964. One, 1½ mile W. of Tangalooma White Light, **2D**, 9½ fm, hard sand, 14.viii.1967. One, 2 mile NNW. of Shark Spit, **2D**, 10 fm, clean hard sand, 29.viii.1967. One, 1½ mile E. of Cleveland Light, **6C**, 2½ fm, culch, 12.ii.1968.

TRAWLED: One, S. of Peel I., **6D**, 2–4½ fm, 24.ix.1962. One, 1 mile E. of Goat I., **6D**, 4 fm, 24.ix.1962. Three, between Mud I. and Moreton I., **3C**, 14.xii.1962. One, 1 mile E. of Otter Rock beacon, **3A**, 3½ fm, mud, 1.iii.1967, Q.M., W2576. Seven, 1 mile E. of Otter Rock beacon, **3A**, 3½ fm, mud, 19–20.iv.1967, 17–18.v.1967. Seven, 1½ mile ENE. of Mud I., **3C**, 5½ fm, mud, 3–4.viii.1967, 22–3.i.1968.

PAST RECORDS: Moreton B. (Dunwich, Woody Pt), trawled sandy mud, 3–12 fm (Stephenson and Campbell, 1959).

DISTRIBUTION: South China Sea, Hong Kong, Malay Archipelago, and Northern half of Australia. (Stephenson and Campbell, 1959).

Portunus sanguinolentus sanguinolentus (Herbst)

Cancer sanguinolentus Herbst, 1796, p. 161, pl. 8, figs. 56, 57.

Portunus sanguinolentus (Herbst): Stephenson and Campbell, 1959, pp. 98–9, figs. 2B, 3B; pl. 1, fig. 2; pls. 4B, 5B. Stephenson, 1968b, pp. 385–99, fig. 2B.

TRAWLED: Eight miles E. of Scarborough, **2C**, 4½ fm, sand, 10.xi.1961. Five, 1 mile E. of Otter Rock beacon, **3A**, 3½ fm, mud, 1.iii.1967, 8.iii.1967, 17–18.v.1967, 23–24.v.1967. Sixteen, 1½ mile ENE. of Mud I., **3C**, 5½ fm, mud, 22–3.i.1968.

PAST RECORDS: Moreton B. (Deception B., Woody Pt, Sandgate) (Stephenson and Campbell, 1959).

DISTRIBUTION: Within Australia recorded from Queensland, New South Wales, South Australia and Western Australia. Also from East Africa to Hawaii. (Stephenson and Campbell, 1959).

Charybdis callianassa (Herbst)

[?] *Cancer callianassa* Herbst, 1789, pl. 54, fig. 7 (fide Leene, 1938).

Charybdis (*Charybdis*) *callianassa* (Herbst): Leene, 1938, pp. 81–4, figs. 41–3. Stephenson, Hudson and Campbell, 1957, pp. 493–5, figs. 1B–D, 2C, 3D; pl. 1, fig. 2; pl. 4A.

DREDGED: One, 2 miles SW. of Toorbul Pt red beacon, **2A**, 2½ fm, mud with shell, 6.vi.1967. Two, 8 miles E. of Scarborough, **2C**, 8–10 fm, rising shallowing banks, 10.xi.1961. One, 4½ miles E. of Otter Rock beacon, **3B**, on sandy ground, 10.xi.1961. One, ½ mile ENE. of Pile Light, **3B**, 6 fm, mud, 25.v.1967.

TRAWLED: Very common, NE. end of Moreton B., 7–8.iv.1961. Dominant form in trawl, 8 miles E. of Scarborough, **2C**, 4½ fm, sand, 10.xi.1961. One ovig. female, 1 mile W. of Porpoise B., Moreton I., **2D**, 12–13 fm, 22.ii.1962. Six hundred and forty nine, 1 mile E. of Otter Rock beacon, **3A**, 3½ fm, mud, 23.ii.1967, 1.iii.1967, 8.iii.1967, 19–20.iv.1967, 17–18.v.1967, 23–4.v.1967. One, 2 miles ESE. of Woody Pt, **3A**, 3 fm, mud, 9.iv.1968. Twenty nine, 1½ miles ENE. of Mud I., **3C**, 5½ fm, mud, 9–10.viii.1967, 7.ix.1967, 30–31.x. 1967, 22–3.i.1968. Very common in trawl, 3 miles NE. of Mud I., **3C**, 6 fm, mud, 10.xi.1961

PAST RECORDS: Moreton B. (Scarborough, Woody Pt, Pat's Pt), trawled in sandy mud and shells, 3–6 fm. Common amongst penaeid prawn catches in Moreton B. (Stephenson, Hudson and Campbell, 1959).

DISTRIBUTION: Karachi to both Western and Eastern Australia.

Charybdis feriatus (Linnaeus)

Cancer feriatus Linnaeus, 1758, p. 627.

Charybdis (*Charybdis*) *cruciata* (Herbst): Leene, 1938, pp. 24–7, fig. 1, 2. Stephenson, Hudson and Campbell, 1957, pp. 495, 497, figs. 2E, 3F; pl. 1, fig. 3; pl. 4B.

TRAWLED: One, NE. end of Moreton B., 10–20 fm, 7–8.iv.1961. Two, 8 miles E. of Scarborough, **2C**, 4½ fm, sandy, 10.xi.1961.

PAST RECORDS: Moreton B. (Beechmere, Deception B., Scarborough, Woody Pt, Pat's Pt, Cleveland), trawled 5–10 fm, sandy mud. Common from September to February, caught with *Portunus pelagicus*. (Stephenson, Hudson and Campbell, 1957).

Holthuis, 1962, pp.23–45, discusses the need for changing the long-accepted name of this species.

DISTRIBUTION: Madagascar, South Africa, India to Japan and Australia.

Charybdis hellerii (A. Milne-Edwards)

Goniosoma hellerii A. Milne-Edwards, 1867, p. 282.

Charybdis (*Charybdis*) *hellerii* (A. Milne-Edwards): Leene, 1938, pp. 44–9, figs. 15–17.

Charybdis (*Charybdis*) *hellerii* (A. Milne-Edwards): Stephenson, Hudson and Campbell, 1957, pp. 497–8, figs. 1A, 2I, 3J; pl. 1, fig. 4; pls. 4C, 5B.

TRAWLED: One, 1 mile E. Otter Rock beacon, **3A**, 3½ fm, mud, 19–20.iv.1967.

PAST RECORDS: Male, 77 mm, end of N. jetty, Wynnum, **5B**, 16.ix.1952. Also from Scott's Pt, Woody Pt, dredged 3–7 fm. (Stephenson, Hudson and Campbell, 1957).

DISTRIBUTION: Mediterranean to Hawaii, including Australia.

Charybdis incisa Rathbun

Charybdis (*Charybdis*) *incisa* Rathbun, 1923, pp. 131–2, pl. 33, figs. 1–3. Rees and Stephenson, 1966, pp. 31–2, pl. 7A.

PAST RECORDS: Female (c. 18 mm), Rainbow Channel, NE. of Myora Light, Moreton B., dredged coarse sand, **5D**, 6–8 fm, 12.x.1961. (Rees and Stephenson, 1966).

DISTRIBUTION: Only from southern Queensland and the west coast of Ceram.

Charybdis moretonensis Rees and Stephenson

Charybdis (Charybdis) moretonensis Rees and Stephenson, 1966, pp. 37–9; pl. 7D.

PAST RECORDS: Female (*Sacculina* infested, damaged, c. 35 mm), trawled 3½ mile S. of Woody Pt pier, **3A**, 3½ fm, 26.x.1952, E. M. Grant, A.M. P13081. (Rees and Stephenson, 1966).

DISTRIBUTION: Known only from the holotype collected in Moreton Bay.

Charybdis natator (Herbst)

Cancer natator Herbst, 1789, pl. 40, fig. 1 (fide Leene, 1938).

Charybdis (Charybdis) natator (Herbst): Leene, 1938, pp. 93–7, figs. 50, 57. Stephenson, Hudson and Campbell, 1957, pp. 501–2, figs. 2G, 3H; pl. 2, fig. 4; pl. 4J.

TRAWLED: Ten, 1 mile E. of Otter Rock beacon, **3A**, 3½ fm, 23.ii.1967, 1.iii.1967, 19–20.iv.1967.

PAST RECORDS: Moreton B. (Woody Pt, Cleveland, Myora, Pearl Banks, Peel I., Cowan Cowan), at low water, in sand, mud and weeds, also live coral; trawled 4–33 fm. (Stephenson, Hudson and Campbell, 1957).

DISTRIBUTION: Southeast Africa to Japan and Australia.

Charybdis truncata (Fabricius)

Portunus truncata Fabricius, 1798, p. 365.

Charybdis (Goniohellenus) truncata (Fabricius): Leene, 1938, pp. 118–21, figs. 66, 67. Stephenson Hudson and Campbell, 1957, pp. 503–4, figs. 2D, 3E; pl. 3, fig. 3; pl. 4I.

Charybdis truncata (Fabricius): Stephenson and Rees, 1968, p, 292.

TRAWLED: One ovig. female, trawled near Shark Spit, **2D**, 12 fm, 23.ii.1962. Sixty-eight, 1½ mile ENE. of Mud I., **3C**, 5½ fm, mud, A. Jones, 3–4.viii.1967, 9–10.viii.1967, 7.ix,1967, 25–6.ix.1967, 30–1.x.1967, 22–3.i.1968.

PAST RECORDS: Male (35 mm) trawled 7 miles E. of Scarborough, 2B, 7½ fm, sandy mud, 10.xi.1966. Seventy (including eighteen ovig. females) between Mud I. and sand hills on Moreton I., 5½–18 fm, 19.xii. 1966. (Stephenson and Rees, 1968).

DISTRIBUTION: From India to Japan including eastern and western Australia.

Charybdis yaldwyni Rees and Stephenson

Charybdis (Charybdis) yaldwyni Rees and Stephenson, 1966, pp. 32–5; pl. 7c, fig. 1D–8. Stephenson and Rees, 1968, pp. 292–3.

DREDGED: One, between Peel I. and Green I., **5C**, 1.xi.1961, coll. L. Wale.

TRAWLED: One, Moreton B., late 1962, coll. L. Wale. Male, ovig. female, 8 miles E. of Scarborough, **2C**, 4½ fm, sand, 10.xi.1961. Three, 1 mile E. of Otter Rock, **3A**, 3½ fm, mud, 17–18.v.1967, 23–4.v.1967. Forty-nine, 1½ miles ENE. of Mud I., **3C**, 5½ fm, mud, 3–4.viii.1967, 30–1.x.1967, 22–3.i.1968. Three, between Mud I., and Moreton I., **3C**, 14.xii.1962.

PAST RECORDS: Male (42 mm), female (*c.* 36 mm), Pat's Pt, Moreton B., trawled, 4 fm, mud, 24.x.1950, T. C. Marshall. Male (29.5 mm), trawled, 3½ miles S. of Woody Pt Pier, **3A**, 3½ fm, 2.vi.1952, E. M. Grant. Two females (36.5, 42.5 mm) data as above, 26.x.1952, E. M. Grant. Ovig. female (44 mm), off SE. edge of Pearl Channel, **1C**, 6 fm, 20.xi.1952, E. M. Grant. Three males (35–44.5 mm), trawled between Mud I. and Moreton I., **3C**, 14.xii.1962. (Rees and Stephenson, 1966). Seven males (32.5–40 mm), six ovig. females (39–43.5 mm) trawled 4 miles W. of small sand hill on Moreton I., **3D**, 10–12½ fm, sandy mud, 19.xii.1966. (Stephenson and Rees, 1968).

DISTRIBUTION: Northern Australia, from Exmouth Gulf to Moreton Bay.

Thalamita admete (Herbst)

Cancer admete Herbst, 1803, pp. 40–1, pl. 57, fig. 1.

Thalamita admete (Herbst): Stephenson and Hudson, 1957, pp. 320, 324–6, figs. 2I, 3I; pl. 1, fig. 1; pls 7A, 10A. Stephenson and Rees, 1967, pp. 56–61, fig. 20. McNeill, 1968, p. 51.

DREDGED: One juv., ½ mile NE. of North Reef Light, **2A**, 4½ fm, 14.ii.1962.

PAST RECORDS: Moreton B. (Peel I., Dunwich, Bird I.), all intertidal recordings. (Stephenson and Hudson, 1957).

DISTRIBUTION: From Red Sea, Durban, Mauritius through Indian Ocean to Australia, Japan, Fiji and Hawaii.

Thalamita sima H. Milne-Edwards

Thalamita sima H. Milne-Edwards, 1834, p. 460. Stephenson and Hudson, 1957, pp. 352–4, figs. 2C, 3C; pl. 5, fig. 2; pls. 8(O), 9(G). McNeill, 1968, p. 53.

DREDGED: Eleven, ½ mile SE. of Toorbul Pt red beacon, **1A**, sand, 29.x.1962, One, ½ mile SE. of Toorbul Pt red beacon, **1A**, mud, 29.x.1962. One, 1 mile NNE. of Toorbul Pt red buoy, **1A**, 3 fm, sandy mud, 13.vi. 1967. One, ½ mile ENE. of Toorbul Pt red buoy, **1A**, 3½ fm, muddy sand, 13.vi.1967, Two, 1¾ miles S. of Bulwer Wrecks, **1D**, 3 fm, clean sand with weed, 5.x.1967. Six, 2½ miles E. of Scott Pt, **3A**, 3 fm, culch, 6.ii. 1968. One, 1½ miles E. of St Helena I., **4C**, 4 fm, 13.vii.1967. One, 3 miles SW. of centre of St Helena I., **4C**, 7½ fm, clean hard sand, 30.vii.1967. Two, 1½ miles SW. of Blue Hole beacon, **4D**, 3 fm, gritty sand, 30.viii.1967. Several, ½ mile W. of Naval Reserve Bank beacon, **5C**, 4½ fm, sandy mud, 24.ix.1962. One, 2½ miles NNW. of Cleveland Light, **5C**, 2½ fm, gritty sand with coral, 6.x.1967. Adults and juvs., from Hanlon Light east, **5D**, gritty sand, with mud, 12.x.1961. Several, NW. of Hanlon Light, between Hanlon Light and Naval Reserve Bank beacon, **5D**, muddy sand, 12.x.1961. Two, ½ mile E. of E. edge of Victoria Pt, **6C**, 3½ fm, culch, 12.x.1976. One, 1½ miles E. of Cleveland Light, **6C**, 2½ fm, culch, 12.ii.1968. One, 1 mile WSW. of Goat I., **6D**, 6 fm, gritty muddy sand, 12.x.1967. Two, ¼ mile NW. of Pat's Pt, **6D**, 5 fm, gritty mud, 13.x.1967. Juvs., S. of Peel I., **6D**, 8.iv.1961. Several, S. of Peel I., **6D**, 3–6 fm, 17.vii.1961. Several, sand banks off Dunwich pier, **6D**, 2.vi.1962. One juv., Pat's Pt, W. to Stradbroke I., **6D**, 6½ fm, shell bottom, 23.v.1962. One juv., 4½ miles S. of Dunwich in channel, **7D**, 4½ fm, culch bottom, 25.v.1962.

TRAWLED: One ovig. female, near Shark Spit, **2D**, 12 fm, 23.ii.1962. Six hundred and seventy-four, 1 mile E. of Otter Rock beacon, **3A**, 3½ fm, mud, 23.ii.1967, 1.iii.1967, 19–20.iv.1967, 17–18.v.1967, 23–24.v. 1967. One hundred and twelve, 1½ miles ENE. of Mud I., **3C**, 5½ fm, mud, 9–10.viii.1967, 7.ix.1967, 25–6.ix. 1967, 30–1.x.1967, 22–3.i.1968. Common, 1 mile E. of Goat I., **6D**, 4 fm, 24.ix.1962.

PAST RECORDS: Moreton B. (Redcliffe, Woody Pt pier, Myora Banks, Mud I., Pat's Pt, Rainbow Channel, Cowan Cowan), trawled and dredged, 2½–19 fm. Also intertidal. (Stephenson and Hudson, 1957).

DISTRIBUTION: Within Australia, from Queensland, New South Wales, South Australia, Western Australia, Northern Territory. Also from Mozambique to Red Sea and from Japan and Hawaii to New Zealand.

Family XANTHIDAE

Halimede ochtodes (Herbst)

(Fig. 36)

Cancer ochtodes Herbst, 1783, p. 158, pl. 8, fig. 54.

Galene ochtodes (Herbst): Adams and White, 1849, p. 43, pl. 10, fig. 2.

Polycremnus ochtodes (Herbst): Alcock, 1898, p. 135.

Halimede ochtodes (Herbst): Sakai, 1965, p. 128, pl. 66, fig. 1.

[?] *Medaeus nodosus* A. Milne-Edwards, 1867, p. 271; 1873, p. 212, pl. 8, fig. 2.

Medaeus nodosus A. Milne-Edwards: Haswell, 1882b, pp. 52–3.

DREDGED: One, 5½ miles E. of Reef Pt, Scarborough, **2B**, 6 fm, grit, 15.xii.1964, Q.M., W2803. Two, ¼ mile NW. of M1 Red Buoy, **2C**, 7½ fm, hard sand and shell, 28.viii.1967, Q.M., W2886. Two, ½ mile NW. of M1 Red Buoy, **2C**, 7½ fm, sand and broken shell, 29.viii.1967, Q.M., W2885 W2945. One 1 mile E. of Otter Rock beacon, **3A**, 3½ fm, mud, 17–18.v.1967, Q.M., W2798. One, 4 miles W. of Sand Hills, Moreton I., **3C**, 10–18 fm, sandy mud, 19.xii.1966.

The present collection contains a series of specimens ranging from 10 mm to 40 mm and the species shows considerable, but apparently continuous, variation over this range. In the 10 mm specimen the front is much broader (nearly one third carapace width), the anterolateral margins of the carapace are more strongly and irregularly toothed, and the carapace regions are more distinctly marked. The seven abdominal segments are distinct, but the terminal one is only 1.5 times as long as the penultimate as against more than twice as long in adult *Halimede*.

In almost all respects this small specimen agrees well with Milne Edwards's (1873) figures and description of *Medaeus nodosus*, but differs in having the anterior border of the buccal cavity not distinctly granular. Haswell (1882, p. 52) referred a specimen from Port Denison with a non-granulate buccal cavity margin to *M. nodosus*. Odhner (1925, p. 82) considered this specimen to be *Halimede ochtodes*.

Medaeus nodosus has long been the subject of controversy. Henderson (1893, p. 360) suggested that it should be transferred to *Halimede*. Alcock (1898, p. 124) disagreed with this because of the differences in the male abdomen—his specimen was small and may not have developed the characteristic elongation of the terminal segment. Odhner (1925, p. 81) states that this species undoubtedly belongs in the genus *Halimede*. The holotype of *M. nodosus* was only 12 mm in carapace width and, except for the granulation of the buccal cavity margin, appears to fall within the range of variability shown by *H. ochtodes*.

DISTRIBUTION: From the Red Sea and Japan (Sakai, 1965) to Australia, and possibly New Caledonia (A. Milne-Edwards, 1873).

Liagore rubromaculata de Haan

Cancer (*Liagore*) *rubromaculata* de Haan, 1835, p. 49, pl. 5, fig. 1.

Liagore rubromaculata de Haan: Kemp, 1923, pp. 408–9, pl. 10, fig. 2. Sakai, 1939, p. 446, pl. 55, fig. 3; 1965, p. 128, pl. 66, fig. 2. Buitendijk, 1960, pp. 265–7, fig. 5a (male pleopod).

DREDGED: One, 6 miles E. of Garnet Rock, **2B**, 6½ fm, 31.viii.1967. One, 2–3 miles W. of Sand Hills, Moreton I., **3D**, 10 fm, 14.xii.1962, Q.M., W2642. One, 4 miles E. of Mud I., **4C**, 8–10 fm, muddy grit, 13.vii.1967.

TRAWLED: One, 4½–5 miles off Queen's Beach, Redcliffe, **2B**, 5–6 fm, 29.iii.1966, L. Wale, Q.M., W2720. Two, between Mud I. and Moreton I., **3C**, 14.xii.1962, Q.M., W2723. One, 2 miles NNE. of Pile Light, **3B**, 6 fm, mud, 11.iv.1968.

DISTRIBUTION: From the Persian Gulf to Japan and Australia.

Lophozozymus pictor (Fabricius)

Cancer pictor Fabricius, 1798, p. 335.

Lophozozymus octodentatus (H. Milne Edwards): Alcock, 1898, pp. 106–7 (lit. and synon.). Ward, 1928, pl. 29.

Lophozozymus pictor (Fabricius): Rathbun, 1924, pp. 15–16. Ward, 1932, p. 243. Buitendijk, 1960, pp. 297–8, fig. 7C (male pleopod). Forest and Guinot, 1961, p. 56, fig. 40 (male pleopod). McNeill, 1968, pp. 68–9.

DREDGED: One, W. of Tangalooma, L. Wale.

TRAWLED: One, Moreton B., November 1966, L. Wale, Q.M., W2646.

This species is also common intertidally among rocks and reefs in Moreton Bay.

DISTRIBUTION: Singapore and Malay Archipelago to NW. and NE. Australia, Fiji, Samoa, and Tahiti. (McNeill, 1968).

Cycloxanthops lineatus (A. Milne-Edwards)

Cycloxanthus lineatus A. Milne-Edwards, 1867, p. 269; 1873, p. 209, pl. 6, fig. 5. Alcock, 1898, pp. 124–5.

Cycloxanthops lineatus (A. Milne-Edwards): Sakai, 1965, p. 133, pl. 68, fig. 2 (synon). McNeill, 1968, p. 60.

DREDGED: One, ¾ mile NW. of M1 Red Buoy, **2C**, 7 fm, sand with broken shell, 30.viii.1967, Q.M., W2888.

The characteristic oblique purplish linear markings are not present in this 8.5 mm specimen, nor were they present in McNeill's 10.5 mm specimen from Low Isles. Sakai (1965) notes that this is typical of younger specimens.

DISTRIBUTION: From the Red Sea to Japan, Australia and New Caledonia (Sakai, 1965).

Actaea savignii (H. Milne-Edwards)

(Fig. 37)

Cancer granulatus Audouin, 1826, pl. 6, fig. 2 (preoccupied by *Cancer granulatus* Linnaeus, 1758, p. 627).

Cancer Savignii H. Milne-Edwards, 1834, p. 378.

Actaea savignyi (H. Milne-Edwards): Sakai, 1939, pp. 485–6, fig. 37, pl. 91, fig. 1; 1965, p. 145, pl. 72, fig. 2 (lit. and synon.). Serène, 1961, p. 204 (in key).

DREDGED: One, W. of Tangalooma, L. Wale. One, 2½ miles E. of Scott Pt, **3A**, 3 fm, culch, 6.ii.1968, Q.M., W2966. One, ¾ mile WSW. of Old Pile Light, **3A**, 2 fm, mud and culch, 15.v.1967, Q.M., W2816. One, ¼ mile W. of N. end of St Helena I., **4B**, 2½ fm, culch, 18.vii.1967, Q.M., W2855. One, 1 mile SE. of Hope Banks, **5C**, 5 fm, muddy grit, 1.vi.1962. Two, E. of Hanlon Light, **5D**, gritty sand with mud, 12.x.1961, Q.M., W2643 W2644. One, 1½ miles E. of Cleveland Light, **6C**, 2½ fm, culch, 12.ii.1968, Q.M., W2967. Three, between two beacons S. of Peel I., **6D**, 3 fm, muddy grit, 12.x.1961. One, 4½ miles S. of Dunwich, **6D**, 4½ fm, shelly bottom, 25.v.1962. One, off S.W. point of Peel I., **6D**, 5–6 fm, 5.xii.1962. One, ½ mile N. of 'House' on Macleay I., **6D**, 3½ fm, muddy sand with shell, 3.x.1967, Q.M., W2920.

TRAWLED: One, NE. end of Moreton B., 7–8.iv.1961. Two, 1 mile E. of Otter Rock beacon, **3A**, 3½ fm, mud, 19–20.iv.1967. Two, E. of Pat's Pt, **6D**, 6½ fm, shelly bottom, 25.v.1962.

In small specimens (6 mm) the compound tubercles illustrated by Barnard (1950, fig. 43b) are not well developed. Instead, each tubercle is borne on a flattened plate, separated from other such plates by distinct but fine grooves. With increasing size these

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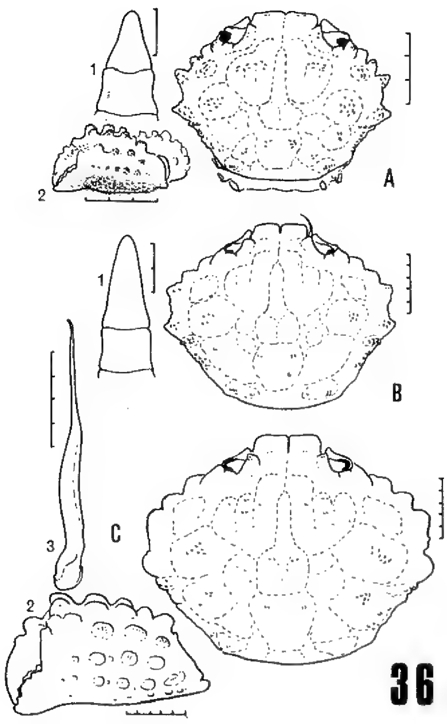
FIG. 36: *Halimede ochtodes*. A, W2885; B, W2945; C, W2803.
(1 = male abdomen, 2 = chela, 3 = male pleopod).

FIG. 37: *Actaea savignii*, W2644. A, carapace; B, male pleopod.

FIG. 38: *Actaea rueppellii*, W2889. A, carapace; B, male pleopod.

FIG. 39: *Banareia inconspicua*, W3111. A, carapace; B, male abdomen; C, chela; D, front.

FIG. 40: *Phymodius* sp., W2887. A, carapace; B, chela.
Scale divisions 1 mm or 0.5 mm (broken line).



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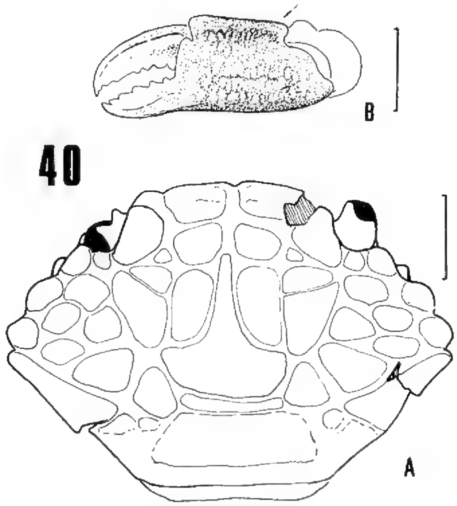

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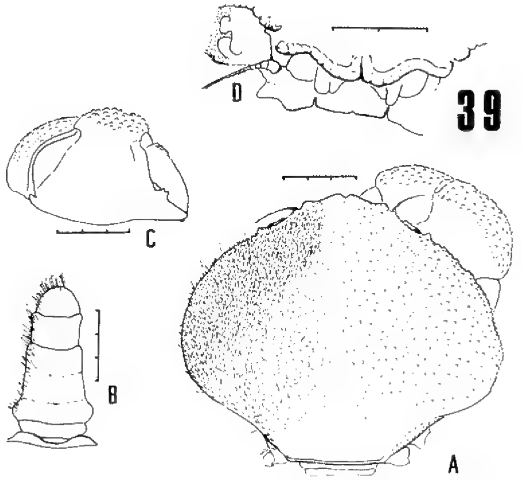

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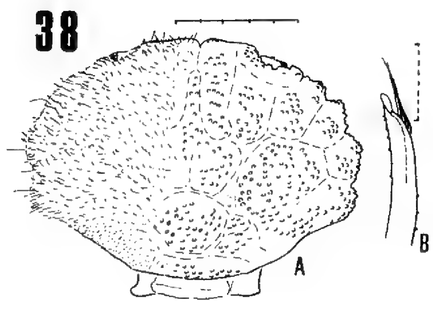

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plates fuse together, the lines of fusion become less distinct, and the originally separate tubercles come together around the base of a central enlarged tubercle to form the characteristic compound tubercles with, in fully grown specimens, no trace of the separate flattened plates that were present in the small specimens.

DISTRIBUTION: From South Africa and the Red Sea to East Asia, Australia and New Caledonia (Sakai, 1965).

Actaea rueppellii (Krauss)

(Fig. 38)

Aegle rüppellii Krauss, 1843, p. 28, pl. 1, fig. 1.

Actaea rüppellii (Krauss): Alcock, 1898, p. 144, (lit. and synon.). Odhner, 1925, pp. 45–6, pl. 3, fig. 6. Barnard, 1950, p. 235, fig. 37d, 43i, j. Sakai, 1965, p. 146, pl. 72, fig. 6.

Actaea ruppelli (Krauss): Serène, 1961, p. 210 (in key).

Actaea rueppellii (Krauss): McNeill, 1968, p. 71.

DREDGED: One, east of Hope Banks, **5C**, 5 fm, clean sand with shell, 30.viii.1967, Q.M., W2889.

This specimen agrees well with Alcock's description, and more closely resembles Odhner's figure than it does Sakai's, in which 3M is shown to be very large and situated more posteriorly than is usual in this genus. The male pleopods resemble Barnard's figure although the terminal hairs are much longer and the tip is not as strongly produced.

DISTRIBUTION: Widely ranging in the Indo-West Pacific from South Africa to Japan, NW. and NE. Australia, Samoa, and Fiji. (McNeill, 1968).

Banareia inconspicua Miers

(Fig. 39)

Banareia inconspicua Miers, 1884, pp. 210–1, pl. 19, fig. C.

DREDGED: One (13 mm male), 2 miles W. of Tangalooma white lights, **2D**, 7 fm, sand and shell, 26.vi. 1968, Q.M., W3111.

This specimen agrees well with Miers's description in the characteristic very indistinct marking of the carapace regions and in all other particulars except that:

(1) The front in frontal view is not as deeply cut into four lobules as is shown in Miers's fig. C.

(2) Chelae, while smooth in the ventral two thirds of the outer face are coarsely granulate in the hirsute upper third. Outer face of carpus is similarly granulate among the pubescence.

These differences could be due to exaggeration by the artist, and to failure to remove pubescence respectively.

DISTRIBUTION: Previously from Darwin and Port Denison (Miers, 1884).

Phymodius sp.

(Fig. 40)

DREDGED: One, ¾ mile NW. of M1 Red Buoy, **2C**, 7 fm, sand and broken shell, 29.viii.1967, Q.M., W2887.

This small (5.5 mm) and very damaged female, while close to *Phymodius monticulosus* Dana (see Barnard 1950, p. 217, fig. 40a–h. Forest and Guinot, 1961, pp. 106–9, pl. 10, figs. 1–6) in many respects, differs from that species in that:

(1) 3M is not divided and is more distinctly ⊥-shaped.

(2) Areoles are more rugosely punctate.

(3) Anterolateral teeth are less acute than seems usual in juvenile *P. monticulosus* (see Forest and Guinot, 1961, pl. 10, figs. 1–3).

DISTRIBUTION: *P. monticulosus* occurs throughout the Indo-West Pacific from South Africa and the Red Sea to Tahiti (see Forest and Guinot, 1961).

Galene bispinosa (Herbst)

Cancer bispinosus Herbst, 1783, p. 144, pl. 6, fig. 45.

Cancer (*Galene*) *bispinosus* (Herbst): de Haan, 1835, p. 49, pl. 5, fig. 2.

Galene bispinosa (Herbst): Alcock, 1898, pp. 136–7. Etheridge and McCulloch, 1916, pp. 10–11, pl. 3, figs. 3, 4 (sub fossil).

DREDGED: One, 4½ miles E. of Pine R. entrance, **3A**, 4½ fm, mud, 14.viii.1967, Q.M., W2860. One, 2½ miles NE. of Pat's Pt, **6D**, 2 fm, sandy mud, 13.x.1967.

TRAWLED: Three, between Mud I. and Moreton I., L. Wale, late 1962. Four, 8 miles E. of Scarborough, **2C**, 4½ fm, sand, 10.ix.1961, Q.M., W3105 (one spem.). Six, 1 mile E. of Otter Rock beacon, **3A**, 3½ fm, mud, 23.ii.1967, 19–20.iv.1967, 17–18.v.1967, 23–4.v.1967. One, 1½ miles ENE of Mud I., **3C**, 5½ fm, mud, 3–4.viii.1967. One, 2 miles SSE. of 'Coffee Pots', **4B**, 3½ fm, mud and shell, 25.v.1967, Q.M., W2819. One, 1–1½ miles E. of St Helena I., **4C**, 4½ fm, 15.ii.1966, Q.M., W2687.

DISTRIBUTION: India to Japan and Australia. Previously in Australia from Bowen and Moreton B. (subfossil). (Etheridge and McCulloch, 1916).

Pilumnus contrarius Rathbun

(Fig. 42)

Pilumnus contrarius Rathbun, 1923, pp. 113–4, pl. 23.

[non] *Pilumnus contrarius* Rathbun: Montgomery, 1931, p. 444 (= *Heteropanope serratifrons* Kinahan, see Bennett, 1964, p. 69).

DREDGED: One, from Hanlon Light east, **5D**, gritty sand with mud, 12.x.1961, Q.M., W2751. One, 1½ miles E. of Cleveland Light, **6C**, 2½ fm, culch, 12.ii.1968, Q.M., W2957.

TRAWLED: One, 1 mile E. of Goat I., **6D**, 4 fm, 24.ix.1962, Q.M., W2752.

DISTRIBUTION: Previously from Bowen, northern Queensland (Rathbun, 1923).

Pilumnus semilanatus Miers

(Fig. 41)

Pilumnus semilanatus Miers, 1884, p. 222, pl. 22, figs. B, b. McCulloch, 1913, p. 325, fig. 43. Rathbun, 1923, pp. 114–5, pl. 24, figs. 1, 2. Hale, 1927, pp. 164–5, fig. 165. McNeill, 1968, p. 64. Takeda and Miyake, 1968, pp. 7–9, fig. 1a–c, pl. 1B.

DREDGED: One, NE. up Rainbow Channel from Myora Light, **5D**, 7 fm, coarse sand, 12.x.1961, Q.M., W2695.

DISTRIBUTION: Port Hedland, Western Australia, and Low Isles to Moreton B., Queensland.

Pilumnus minutus de Haan

(Fig. 47)

Pilumnus minutus de Haan, 1835, p. 50, pl. 3, fig. 2. Sakai, 1939, p. 535, fig. 53a, b, pl. 64, fig. 2, pl. 100, fig. 9; 1965, pp. 158–9. McNeill, 1968, p. 63. Takeda and Miyake, 1968, pp. 40–2, fig. 9d–e.

Pilumnus hirsutus Stimpson, 1858, p. 37; 1907, p. 69, pl. 9, fig. 1. Rathbun, 1923, pp. 110, 122, pl. 28.

BY GRAB: One, South West Rocks, Peel I., **6D**, sandy mud and grit, 10.ix.1969, Q.M., W3134.

DISTRIBUTION: Malay Archipelago and Japan to northeast Australia.

FIG. 41: *Pilumnus semilanatus*, W2695. A, carapace; B, male pleopod.

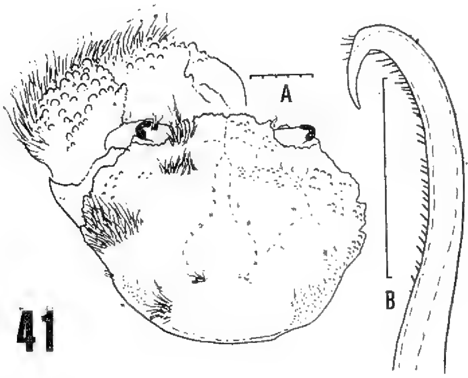
FIG. 42: *Pilumnus contrarius*, W2751. A, carapace; B, male pleopod.

FIG. 43: *Pilumnus spinicarpus*, W2694.

FIG. 44: *Actumnus pugilator*. A, carapace, W2883; B, chela, W2883; C, chela, W2884; D, male pleopod, W2883.

FIG. 45: *Actumnus squamosus*, W2813. A, carapace; B, chela with detail of tubercles; C, male pleopod.

FIG. 46: *Actumnus setifer*, W2645. A, carapace; B, chela.
Scale divisions 1 mm and 0.5 mm (broken line).



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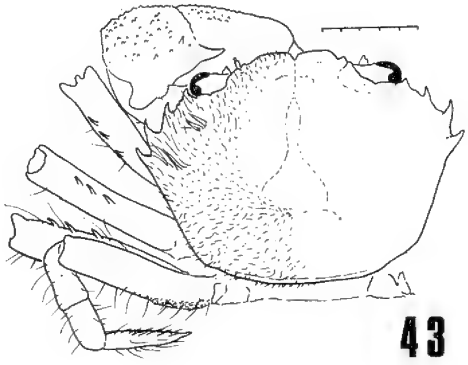

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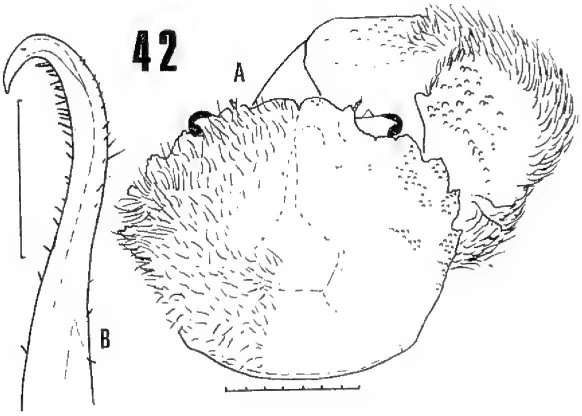

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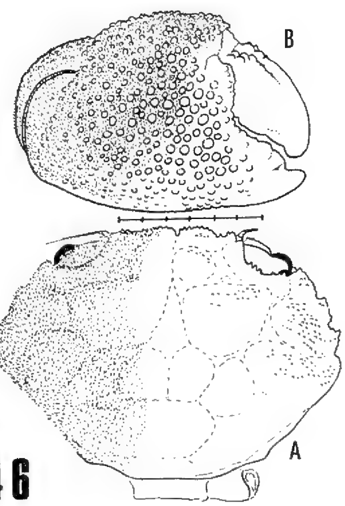

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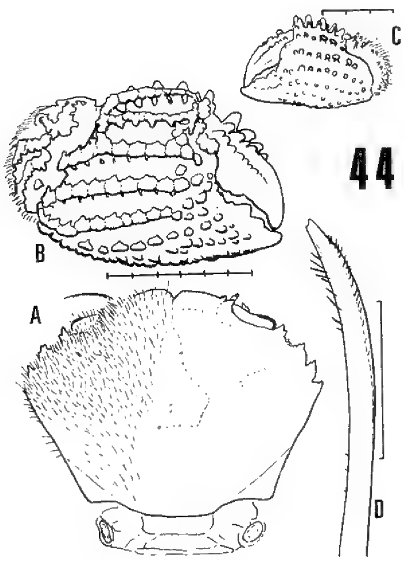

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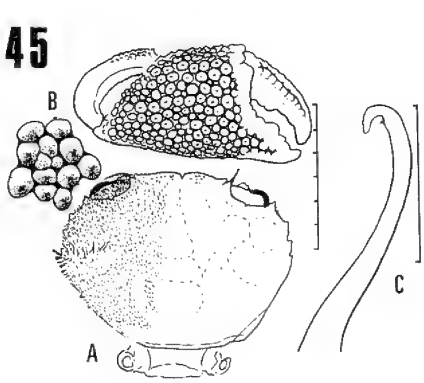

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Pilumnus spinicarpus Grant and McCulloch

(Fig. 43)

Pilumnus cursor: Haswell, 1882b, p. 67.

[non] *Pilumnus cursor* A. Milne Edwards, 1873, p. 244, pl. 9, fig. 4.

Pilumnus spinicarpus Grant and McCulloch, 1906, pp. 15–17, pl. 1, figs. 2, 2a. Rathbun, 1923, p. 123. McNeill, 1968, p. 63.

TRAWLED: One, between Peel I. and Green I., **5C**, 1.xi.1961, Q.M., W2694.

DISTRIBUTION: Queensland coast, from Low Isles to Moreton B.

Actumnus pugilator A. Milne Edwards

(Fig. 44)

Actumnus pugilator A. Milne Edwards, 1873, p. 195, pl. 7, fig. 1. Rathbun, 1923, p. 126, pl. 27, figs. 3, 4. McNeill, 1968, p. 64.

DREDGED: One, ¾ mile NW. of M1 Red Buoy, **2C**, 7½ fm, sand and broken shell, 29.viii.1967, Q.M., W2884. One, ¼ mile NW. of M1 Red Buoy, **2C**, 7½ fm, hard sand and shell, 29.viii.1967, Q.M., W2883. One, 2 miles W. of Tangalooma white lights, **2C**, 7 fm, sand and shell, 26.vi.1968, Q.M., W3110.

In the smaller (7.2 mm) male and on the smaller chela of the 8.2 mm male the ornamentation of the chela consists of rows of tall tubercles, the tops of which are flattened and expanded in the dorsal rows, much as in Rathbun's figure (female 18.6 mm). In the larger male (12 mm) and in the large chela of the 8.2 mm male the flattened tops of these tubercles have become much more expanded and have coalesced in all but the more ventral rows to form crests, as shown in Milne-Edwards's figure.

DISTRIBUTION: New Caledonia (Milne-Edwards, 1873) and Queensland. (McNeill, 1968).

Actumnus squamosus (de Haan)

(Fig. 45)

Pilumnus squamosus de Haan, 1835, p. 50.

Actumnus squamosus (de Haan): A. Milne-Edwards, 1865, pp. 286–7, pl. 18, figs. 6, 6a–c. Sakai, 1965, p. 155, pl. 76, fig. 3 (lit. and synon.).

DREDGED: Two, ¾ mile NW. of M1 Red Buoy, **2C**, 7½ fm, sand and broken shell, 29.viii.1967, Q.M., W2878 W2881. Two, ¼ mile NW. of M1 Red Buoy, **2C**, 7½ fm, hard sand and shell, 29.viii.1967, Q.M., W2879 W2880. One, 3 miles W. of Shark Spit, Moreton I., **2C**, 12½ fm, sand with little mud, 5.x.1967, Q.M., W2932. One, 1 mile W. of Shark Spit, **2D**, 10–14 fm, muddy sand, 4.iv.1968, Q.M., W3109. One,

S. edge of Dring Banks, **2D**, 10 fm, 29.iv.1964, Q.M., W2811. One, $\frac{1}{4}$ mile S. of Dring Banks, **2D**, 10 fm, 29.iv.1964, Q.M., W2813. One, $4\frac{3}{4}$ miles E. of Mud I., **3D**, 3 fm, gritty sand, 30.viii.1967, Q.M., W2882.

DISTRIBUTION: From India to Japan and the Philippines (Sakai, 1965) and Australia.

Actumnus setifer (de Haan)

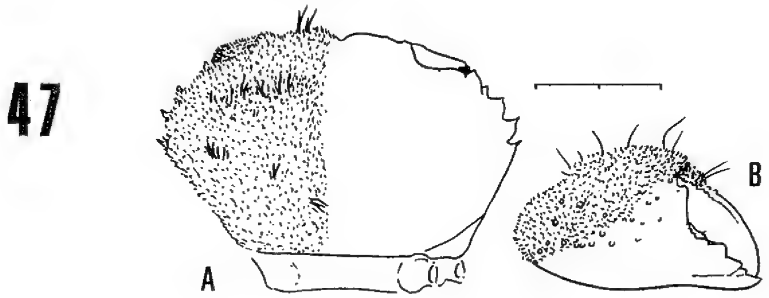
(Fig. 46)

Pilumnus setifer de Haan, 1835, p. 50, pl. 3, fig. 3.

Actumnus setifer (de Haan): Hale, 1927, p. 167, fig. 168. Sakai, 1939, pp. 526, 528, pl. 65, fig. 1. Barnard, 1950, p. 271, fig. 50. McNeill, 1968, p. 64.

DREDGED: One, S. of Peel I, **6D**, 3–6 fm, 17.vii.1961, Q.M., W2645.

DISTRIBUTION: East Africa and the Red Sea to Japan, NW., NE. and S. Australia, Samoa, Fiji and Tahiti (McNeill, 1968).



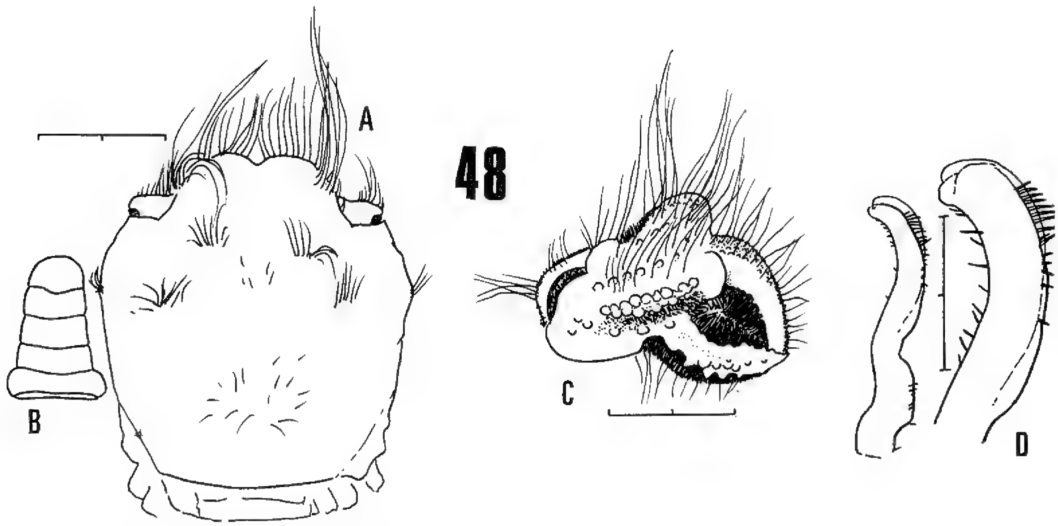


FIG. 47: *Pilumnus minutus*, W3134. A, carapace; B, large chela.

FIG. 48: *Calmania prima*, W3135. A, carapace; B, male abdomen; C, chela; D, male pleopod. Scale divisions 1 mm.

Calmania prima Laurie

(Fig. 48)

Calmania prima Laurie 1906, p. 407, pl. 1, fig. 10. Sakai, 1939, p. 548, pl. 65, fig. 3; 1965, p. 162, pl. 80, fig. 3.

BY GRAB: One, South West Rocks, Peel I., **6D**, sandy mud and grit, 10.ix.1969, Q.M., W3135.

DISTRIBUTION: Ceylon, Japan, and now Australia.

Family GONEPLACIDAE

The sublittoral Goneplacidae of Moreton Bay have been reported on by Griffin and Campbell, 1969. The species recorded from the present survey were:

Rhizopa gracilipes Stimpson
Xenophthalmodes dolichophallus Tesch
Typhlocarcinops tonsurata Griffin and Campbell
Eucrate sexdentata Haswell
Eucrate dorsalis (White)

A further species, *Ommatocarcinus macgillivrayi* White was recorded from sublittoral Moreton Bay but was not taken during the present survey.

More recent collections included a single small female, belonging to the subfamily Hexapodinae, which has not previously been described.

Hexapus granuliferus sp. nov.

(Fig. 49)

Hexapus sexpes (Fabricius): Haswell, 1882b, pp. 71–2.
[non] *Cancer sexpes* Fabricius, 1798, p. 344.

HOLOTYPE: Female, 6.5 mm, ¾ mile SW. of M1 Red Buoy, **2C**, 6½ fm, sandy mud, 24.iv.1968, Q.M., W3108.

PARATYPES: Male, 15.5 mm, Port Jackson, N.S.W., A.M., P714 (dry specimen, identified by Haswell as *H. sexpes*).

Female, 10 mm, Port Jackson, N.S.W., November 1908, A.M., P1410.

DESCRIPTION

CARAPACE: much wider than long (1.7 times), widest posteriorly; dorsal surface vaulted longitudinally, almost flat from side to side; surface entirely covered with close

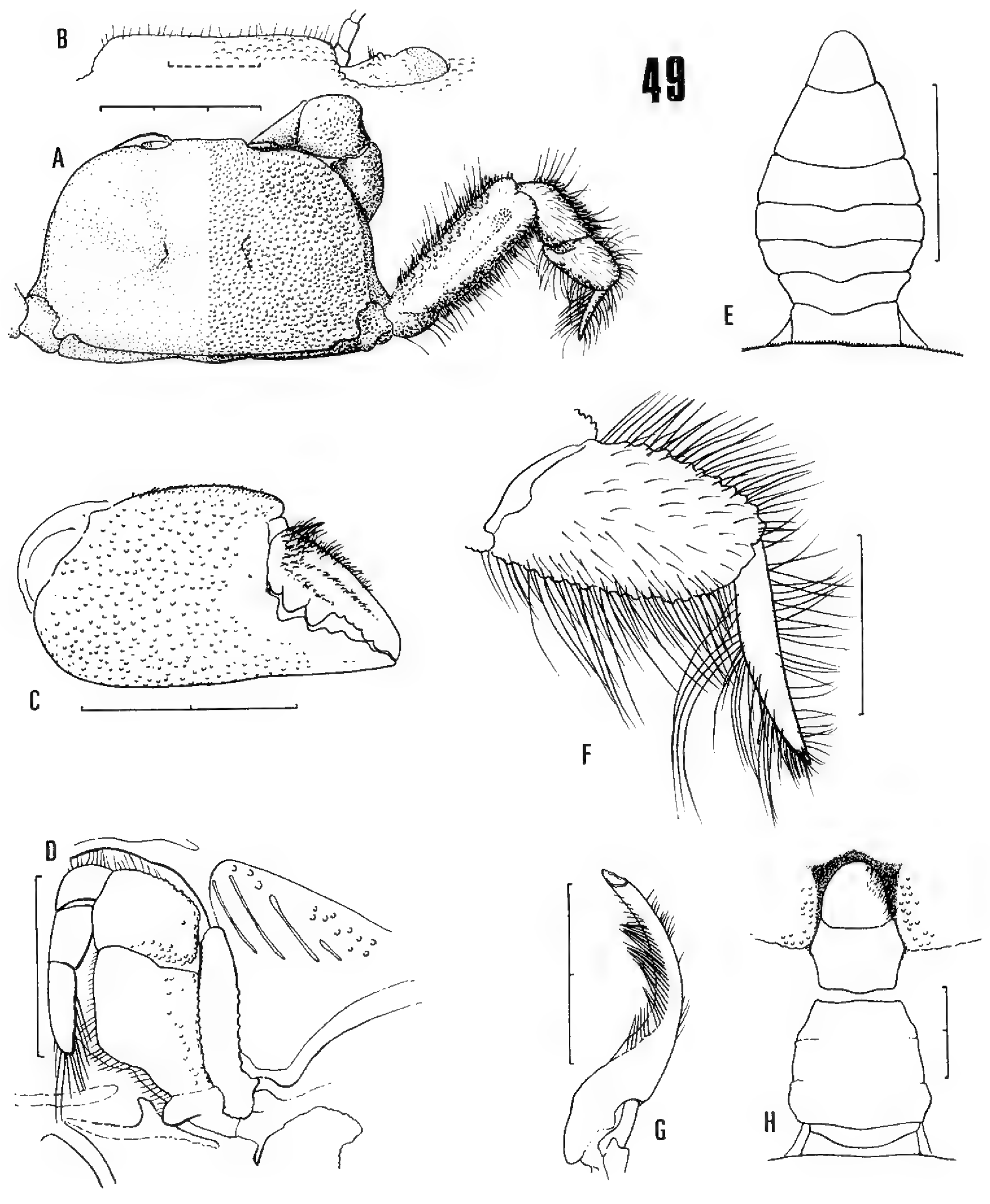


FIG. 49: *Hexapus granuliferus* sp. nov. A–F, holotype, Q.M., W3108. G, H, paratype, A.M., P714. A, carapace; B, front; C, chela; D, third maxilliped and pterygostome; E, female abdomen; F, propodus and dactylus of last leg; G, male pleopod; H, male abdomen. To eliminate parallax due to excessive surface curvature, D, E and H are composites of several drawings.

Scale divisions 1 mm or 0.5 mm (broken lines).

packed granules which are largest anterolaterally, forming distinct row laterally to mark junction of dorsal surface and side walls; side wall visible in dorsal view and strongly produced to meet base of last leg. Carapace regions vaguely indicated by moderately distinct gastro-cardiac grooves which end laterally in deep indentations from which shallow indentations run anteriorly towards the outer orbital angles, anterolaterally, posterolaterally, and posteromedially. Front narrow (5–6 times in carapace width, 2 times in fronto-orbital width), very obscurely divided into two straight-edged lobes by a shallow median impression; anterolateral margins rounded, convex, entire; lateral margins of dorsal surface weakly divergent posteriorly, lateral margins of carapace walls more strongly divergent, with prominent angles at bases of last legs; posterolateral angles with strong flattened lobe over bases of last legs. Orbits well formed, filled by moveable, granulate eyestalks with large, spherical, pale-pigmented cornea.

Third Maxillipeds: with ischium longer than merus, parallel sided for most of its length; merus broader than long (1.4 times), well rounded anterolaterally; palp articulated at anterointernal angle of merus, with all segments sub-cylindrical, dactylus > propodus > carpus; dactylus reaching to, or almost to posteromedial angle of ischium. Pterygostome with three to seven long or short, broken or entire, oblique ridges, and some scattered granules.

Chelipeds: short, robust, outer faces of chela, carpus, and merus granulate. Palm of larger (right) chela longer than high (1.2 times), granules on outer face continued over dorsal face onto projecting granulate rim on inner face parallel to and just below dorsal margin; ventral to this, inner face smooth except for some 5–6 centrally placed granules. Fingers stout, dactyl with two large teeth proximally.

Ambulatory Legs: compressed, tomentose, three in number. Second legs longest, third (last) legs stoutest, with merus granulate and longitudinally furrowed, carpus and propodus granulate near anterior and posterior margins; merus 3 times as long as broad; propodus 1.7 times as long as broad; dactyl shorter than propodus (0.8 times), smooth, backwardly curved throughout entire length.

Abdomen: of male with third, fourth, and fifth segments fused but distinguishable; third broadest, with markedly convex lateral margins; fifth with lateral margins strongly tapered distally; sixth segment broader than long (1.5 times), broadest in middle of length; seventh segment as long as broad, well rounded distally. Anterior border of abdominal fossa with distinct emarginations laterally in 15.5 mm male. Abdomen of female seven segmented.

Sternum, abdomen and ventral faces of ambulatory meri closely granulate. First sternite with T-shaped groove running from tip of abdominal sulcus to base of maxillipeds distinct in smaller female, shallower in larger female and larger male.

MALE PLEOPOD: short, curving to obliquely truncate (possibly fractured) tip. Shaft with long hairs along outer edge of abdominal face and fewer, shorter hairs along inner edge of sternal face.

DISTRIBUTION

Previously recorded from Port Jackson and Port Stephens, dredged in a few fathoms (Haswell, 1882b).

DISCUSSION

STERNAL GROOVES AND THE GENERA *Lambdophallus* AND *Hexapus*: Alcock (1900, pp. 329–40) erected the genus *Lambdophallus* for his new species, *L. sexpes*, in which the male pleopods are bent at right angles, the terminal portion lying in deep grooves which extend laterally across the first sternite just anterior to its posterior margin. Rathbun (1909, p. 113; 1910, pp. 348–9) described *L. anfractus*, placing it in the genus *Lambdophallus* because of the presence of deep grooves in the first sternite extending anterolaterally towards the bases of the maxillipeds. She noted that her species had "a suspicious resemblance to *Hexapus sexpes* de Man (Arch. f. Naturg., LIII, 1, p. 322, pl. XIII, fig. 3, 1887), but the author does not mention a sternal trench." She further doubted that "the species represented by him is the same as *H. sexpes* de Haan or *H. sexpes* A. Milne Edwards which appear also to be distinct from each other."

Tesch (1918, pp. 239, 241) noted that in specimens which he identified as *H. sexpes*, and in de Haan's specimens which he examined at the Leiden Museum, grooves similar to those of *L. anfractus* are present but partly concealed by hairs. He suggested that the apparent absence of these grooves in de Man's specimens could have been due to the larger size of those specimens. This suggestion is supported by the present material as the 6.5 mm female has distinct grooves, the 10 mm female has very shallow but still discernible grooves and in the 15.5 mm male the grooves are almost completely absent, but anterolateral emargination of the abdominal fossa on each side indicates that they may once have been present.

Although sternal grooves have thus been demonstrated in both *Lambdophallus* and *Hexapus*, the continued existence of *Lambdophallus* as a separate genus is justified because in *Lambdophallus* the eyestalks are fixed and the sternal grooves extend laterally from below the junction of the sixth and seventh abdominal segments, running parrallel and close to the posterior margin of the first sternite (see Alcock and McArdle, 1902, pl. 62, fig. 1): in *Hexapus* they run anterolaterally towards the bases of the maxillipeds. Because of this, Rathbun's *L. anfractus* must, as Tesch suggested, be transferred to the genus *Hexapus*.

THE SPECIES OF *Hexapus*: Tesch recognised only one species of *Hexapus*, *H. sexpes*, stating that specimens described by Stebbing (1910, p. 315, pl. 15; S. Africa), Milne Edwards

(1873, pp. 253–4, pl. 12, fig. 1; New Caledonia), de Haan (1835, pp. 63–4, pl. 11, fig. 6, Tab. D; Japan), de Man (1887b, p. 322–5, pl. 13, fig. 3; Amboina) and Rathbun (1909, p. 113; 1910, pp. 348–9; Siam, as *Lambdophallus anfractus*) were conspecific with his own specimens from the central tropic Indo-Pacific. Stebbing's '*H. sexpes*' has since been described as a new species, *H. stebbingi*, by Barnard (1946, p. 366; 1950, pp. 299–300, fig. 56d–f) and considerable differences in published figures and descriptions of '*H. sexpes*' suggest that this name embraces at least two further species.

Milne Edwards's specimen from New Caledonia would appear to differ specifically from others in this genus in the following particulars:

(1) Carapace very broad (cw. twice cl.).

(2) Lateral margins of carapace very strongly divergent posteriorly.

(3) Carapace covered with thick tomentum which conceals the surface.

(4) Front relatively broad (4.5 times in cw.).

(5) Median frontal groove distinct.

(6) Last ambulatory dactyl sinuous, recurved in distal half.

(7) Flagellum of antennae short, with only two swollen basal segments (? error in illustration)

Descriptions and figures of *H. sexpus* from Japan and Amboina given respectively by Sakai (1939, pp. 577–8, pl. 102, fig. 4) and de Man (1887b, pp. 322–5, pl. 13, fig. 3) agree with each other in the following features which also serve to distinguish them from others in the genus:

(1) Lateral margins of carapace sinuous, with distinct lobule in posterior third.

(2) Anterolateral margins of carapace abruptly curved, almost angular.

(3) Front very narrow (6 times in cw.).

(4) Last ambulatory dactyli straight.

(5) Ambulatory meri very broad (last leg l/b=c. 2.5), widest distally.

The brief description and small figure given by de Haan (1835, pp. 63–4, pl. 11, fig. 6, Tab. D) do not appear significantly different from those of de Man and Sakai, and de Man has already said (1887b, p. 323) that his specimens seem closer to those of de Haan than to those of Milne Edwards. Tesch examined specimens from the central Indo-Pacific and compared these with de Haan's type, pronouncing them identical. While Tesch's concept of the continuity of variability within *Hexapus* does not agree with that expressed here it is reasonable to assume that his comparison was valid, particularly so as he refers to the broad ambulatory meri (twice as long as broad) and the straight dactyli. Tesch's figure of the third maxilliped would suggest that this species also differs in having the ischium parallel sided in only the distal half, the merus pointed anteromedially and the exognath tapering distally. Rathbun's *Lambdophallus anfractus* from Siam could also belong to this species as both she and Tesch have suggested, but her figure (1910, fig. 36) does not agree well with those of Tesch (1918, pl. 17, fig. 1) as regards third maxilliped and male abdomen (particularly the penultinate segment).

The South African *H. stebbingi* Barnard is readily distinguished by the lack of a lobe on the posterolateral corners of the carapace above the base of the last legs (a feature apparently shared with '*H. sexpes*: Milne Edwards', from which it differs in carapace shape) and the longitudinal division of the sixth abdominal segment in the males.

This then would suggest the existance of four species of *Hexapus*; *H. stebbingi* (South Africa), *H. granuliferus* (Australia), '*H. sexpes*: Milne Edwards' (New Caledonia), and '*H. sexpes*: de Haan, Tesch, Sakai'=*L. anfractus* Rathbun (central Indo-West Pacific to Japan). The type specimen of *H. sexpes* Fabricius (now no longer extant, see Rathbun, 1910, p. 349) came from India, and Fabricius' brief description is inadequate to assign it to any of these four species. It could in fact equally possibly be conspecific with the Indian *Lambdophallus sexpes* Alcock.

The present species is distinguished from the abovementioned possible species by the following features.

(1) Carapace conspicuously granulate over whole surface, not punctate with granules laterally (hence the specific name).

(2) Dactylus of last leg evenly recurved throughout its entire length.

(3) Merus of last leg c. 3 times as long as broad.

(4) Ischium of third maxillipeds parallel sided for distal three quarters of length.

(5) Eyestalks mobile, cornea spherical.

(6) Chelae with patch of granules on inner face, dactyl with two large teeth proximally.

(7) Male pleopods with long hairs along both sides of shaft.

(8) Posterolateral angles of carapace with flattened lobe over last legs.

The four species could be separated by the following tentative key.

1. Carapace very broad posteriorly (cw.=2 × cl.) with broad front (cl.=2 × fw.); dactyls of last legs sinuous, recurved in distal half.................... .... '*H. sexpes*: A. Milne Edwards' (New Caledonia).

Carapace less broad (cw.=1.8 × cl.) with narrower front (cl.=3 × fw.); dactyls of last legs straight or evenly recurved throughout length........ 2

2 (1). Posterolateral angles of carapace without flattened lobe over bases of last legs; penultimate segment of male abdomen longitudinally divided............ ....*H. stebbingi* Barnard (South Africa).

Posterolateral angles of carapace with flattened lobe over bases of last legs; penultimate segment of male abdomen entire.......................... 3

3 (2). Carapace punctate, lateral margins sinuous; merus of last leg broad (l.=2.5 × w.), dactylus of last leg straight................................. '*H. sexpes*: de Haan, de Man, Tesch, Sakai' (Central Indo-Pacific to Japan).

Carapace granulate, lateral margins divergent posteriorly; merus of last leg narrower (l.=3 × w.), dactylus of last leg evenly recurved............. ....*H. granuliferus* sp. nov.

Family PINNOTHERIDAE

The following species taken during this survey were reported by Griffin and Campbell, 1969, pp. 153–62.

Xenophthalmus pinnotheroides White

Pinnotheres spinidactylus Gordon

Family OCYPODIDAE

Macrophthalmus crassipes H. Milne Edwards

Macrophthalmus crassipes H. Milne Edwards, 1852, p. 157.

Macrophthalmus (*Macrophthalmus*) *crassipes* H. Milne Edwards: Barnes, 1967, pp. 208–11, fig. 2, pl. 1b (synon.).

DREDGED: Three, just N. of Polka Pt, Dunwich, **5D**, 3 fm, F.C. Vohra.

No other sublittoral specimens have been obtained in extensive collecting since Vohra although this species is common intertidally.

DISTRIBUTION: Gulf of Siam, Malaya, China, Caroline Is. and Australia (Barnes, 1967).

Macrophthalmus punctulatus Miers

Macrophthalmus punctulatus Miers, 1884, p. 237, pl. 25, fig. A.

Macrophthalmus (Mopsocarcinus) punctulatus Miers: Barnes, 1967, pp. 229–31, fig. 10, pl. 3b.

DREDGED: Two, just N. of Polka Pt, Dunwich, **5D**, 3 fm, F.C. Vohra.

No other sublittoral specimens have been obtained in extensive collecting since Vohra although this psecies is common intertidally. It seems possible that Vohra's collecting data for this and the preceeding species was incorrect.

DISTRIBUTION: Eastern Australia (Barnes, 1967).

DISCUSSION

COMPARISON WITH SAGAMI BAY FAUNA

Eighty-four species are here recorded from the sublittoral of Moreton Bay. Sakai (1965) has listed 340 crabs from eastern Sagami Bay of which no less than 276 are from the sublittoral. The area of Sagami Bay forming the basis of Sakai's study is roughly half that of the present survey area and the apparent richness of the Japanese fauna could be the result of:

(1) Length of survey. While the present survey was carried out intensively for some six years, previous collecting having been very sporadic, Sakai's material was accumulated over some forty years. The present survey did not, for example, collect specimens of *Calappa philargius*, *Hoplophrys ogilbyi* or *Ommatocarcinus macgillivrayi* although these have been noticed in earlier collecting. It is doubtful that this time factor could account for a great number of species.

(2) Substrate diversity. Although Sakai gives little information on bottom type, reefs and rock seem common, with some coral. Moreton Bay is predominantly mud and sand, with small rocky outcrops and coral only around some of the smaller islands. These have not been sampled by dredge or by trawl because gear would have been extensively damaged, but recent collecting by grab in one such area produced two Xanthids not previously collected in Moreton Bay.

(3) Depth. Sagami Bay material was taken from depths of up to 270 m, whereas the depth of Moreton Bay barely exceeds 30 m, and that in only a very small area off Moreton I. Of Sakai's material, 93 species were recorded from a depth of 30 m or less and, except for the Xanthids, there is a remarkable agreement between the number of species taken in each family from the two areas (see Table I). The greater representation of Xanthids in the Sagami Bay shallow water could be due to the greater abundance of rocky substrate in that area.

TABLE 1

COMPARISON OF SAGAMI BAY AND MORETON BAY CRAB FAUNAS IN MAJOR TAXONOMIC GROUPINGS

Taxonomic Group	Number of species		
	Sagami Bay	Moreton Bay	Sagami Bay 30 m or less
Dromiacea	17	3	7
Dorippidae	11	1	4
Leucosidae	36	9	6
Calappidae	15	5	5
Hymenosomidae	2	0	1
Majidae	47	15	15
Parthenopidae	12	6	5
Corystoidea	10	1	0
Portunidae	30	17	18
Xanthidae	51	17	27
Goneplacidae	15	6	2
Pinnotheridae	9	2	3
Ocypodidae	0	2	0
Grapsidae	1	0	0
Total	256	84	94

While the agreement between the last two columns of table I is very close, two factors prohibit exact comparisons.

(1) The area of Sagami Bay of 30 m depth or less is about one fifth that of Moreton Bay, and the effect that this decrease in sampling area would have on the number of species collected is not known.

(2) Moreton Bay is almost completely ringed by islands and shallow banks whereas Sagami Bay is open to the south. Consequently it could be expected that some of the crabs in the 30 m zone of Sagami Bay would be deep water crabs at the shallow end of their range, and these would have no counterpart in Moreton Bay.

Depth would appear to be the major factor contributing to the greater apparent diversity of the Sagami Bay fauna as compared with that of Moreton Bay. Collections on hand from deeper water outside Moreton Bay do contain many species not represented in the present survey and if the data from the Sagami Bay collections can be applied to southern Queensland it would seem possible that some 200 additional species might be expected from the deeper water at present being trawled commercially off Cape Moreton.

Distribution of Species Within the Indo-West Pacific

In the list of species presented in the introduction the distribution is given in brackets after each species, according to the following notation (modified after Stephenson, 1961, p. 321).

(1) Widespread Indo-West Pacific species ranging from the Indian Ocean to the Islands of the Central Pacific.

(2) Indian Ocean species which occur in the Indian Ocean, extending to the shores of the western Pacific but not to the islands of the central Pacific.

(3) Pacific Ocean species which are centred on the western Pacific Ocean and extend to the eastern shores of the Indian Ocean but not to India itself.

(4) Central Indo Pacific species which do not extend to India in the west nor beyond New Caledonia in the east.

(5) Australian species, not recorded outside Australia (except for extensions to New Caledonia or New Zealand).

a extending to eastern coast of Africa in the west.

j extending to Japan in the north.

h extending to Hawaii in the east.

nc extending to New Caledonia.

nz extending to New Zealand.

s predominantly southern Australian distribution.

Although distribution data is incomplete for some species and some areas, at the present state of our knowledge it would appear that of the 81 species firmly identified 11 are widespread Indo-West Pacific species, 38 occur widely in the Indian Ocean, 2 in the Pacific Ocean, 7 are Central Indo-Pacific species, and 23 are found only in Australia. Of these 23, 4 have been recorded only from Moreton Bay, 15 are essentially northern species and 4 are essentially southern species.

The number of species taken in Moreton Bay which are shared with other areas of major carcinological activity are; Africa (east coast), 16; India, 48; Japan, 26; New Caledonia, 13; New Zealand, 2; Hawaii, 4.

The strong affinity of the Moreton Bay brachyuran fauna with that of the Indian Ocean is at variance with the analysis presented by Griffin and Yaldwyn (1968, p. 178) in regard to the Portunidae, Majidae, and Oxystomata. Their analysis shows that of the tropical Australian species, 43–52% are widespread throughout the Indo-West Pacific, 10–24% are found in the Indian Ocean, 8–15% in the West Pacific, and 4–15% in the central Indo Pacific whereas the corresponding figures for the present report would be 13%, 45%, 2%, 8%.

This apparent anomaly is only partly resolved by a different partitioning of areas. Area 2 of the present analysis includes 15 species distributed from India to Japan, the Philippines, or New Caledonia which Griffin and Yaldwyn could well have listed in their category "widespread" rather than "Indian Ocean". Allowing for this, the figures for the present report would become 31 %, 27 %, 2 %, 8 %. The still very noticable excess of Indian Ocean over Pacific Ocean species cannot wholly be explained by assuming a more comprehensive knowledge of the Indian Ocean shallow water fauna and is not inconsistent with the smaller available areas of shallow water in the Western Pacific and the relative discontinuity of these with the Australian continent.

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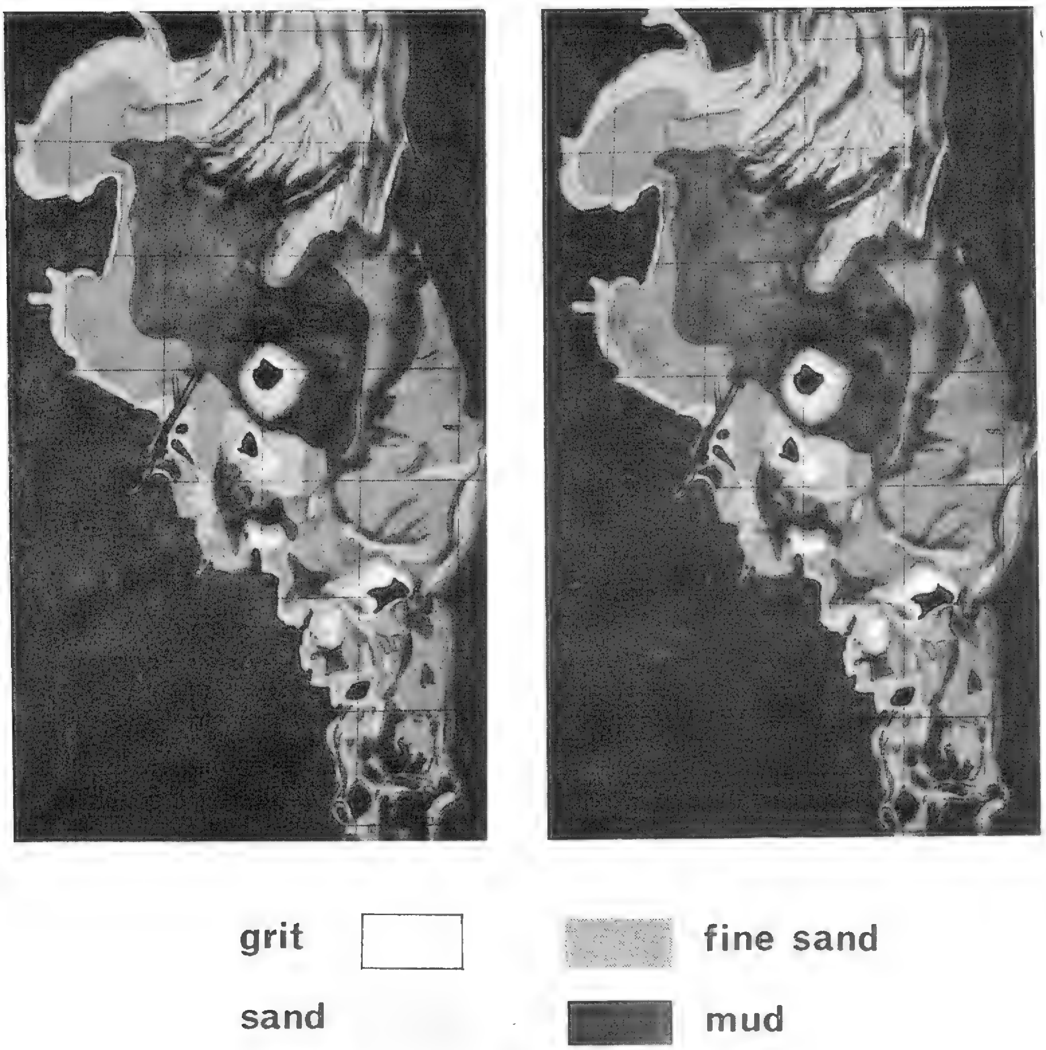
PLATE 22

Stereopair of Moreton Bay showing bottom topography and sediments. The vertical scale has been greatly exaggerated. Bottom sediments have been incorporated from unpublished data provided by Professor W. G. H. Maxwell, University of Sydney.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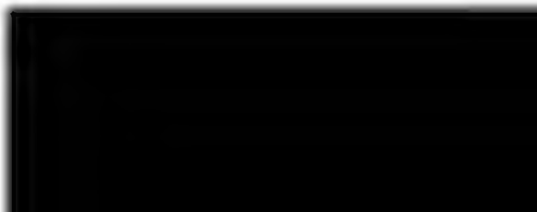

PAGETIA OCELLATA, A NEW CAMBRIAN TRILOBITE FROM NORTH-WESTERN QUEENSLAND

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ABSTRACT

The first description of a new Australian eodiscinid trilobite since 1902 is accompanied by a detailed description of the recognized growth stages. This growth series for *Pagetia ocellata* sp. nov. is the first described for any species of the family and compares closely with those of agnostids. The species closely resembles the North American *P. walcotti* with which it is compared.

Only one species of eodiscinid trilobite, *Pagetia significans* (Etheridge, 1902), has previously been described from Australia although several have been recorded without formal specific designation (Opik, 1957, 1957a, 1967). Collections from the Mount Murray area, northwestern Queensland, contain numerous individuals of a previously unmentioned species. Protaspides have not been identified, but the recognition of a complete series from degree 0 meraspides to mature holaspides has allowed a detailed study of the morphogeny of the species. This series is, to the author's knowledge, the first described for a pagetiid and is similar to the series of eodiscids (Rushton, 1966) and agnostids (Robinson, 1964). The material is from phosphatic limestone near the top of the Beetle Creek Formation 1.5 to 2 miles north of Mount Murray, 50 miles southwest of Duchess, northwestern Queensland. In this limestone the organic material, including the trilobite exoskeletons, has been selectively phosphatized. Removal of the matrix by dissolving it in monochloracetic acid, liberated the specimens.

All specimens used in this study are deposited in the palaeontological collection of the Queensland Museum, Brisbane. The locality number prefixed by L refers to a locality in the Queensland Museum locality catalogue and that prefixed by D to the locality of the Bureau of Mineral Resources as on the preliminary map (accompanying de Keyser, 1968). The terminology and suprageneric classification employed follow those of Howell (1959). The following abbreviations are used in the text: *Cl*, length of cephalon; *Cw*, width of cephalon; *Hl*, length of hypostoma; *Hw*, width of hypostoma;

Ll, length of librigena; *Lw*, width of librigena; *Pl*, length of pygidium; *Pw*, width of pygidium; *exsag.*, exsagittal; *sag.*, sagittal; *tr.*, transverse.

Class TRILOBITA Walch, 1771

Order MIOMERA Jaekel, 1909

Suborder EODISCINA Kobayashi, 1939

Family PAGETIIDAE Kobayashi, 1935

Genus **Pagetia** Walcott, 1916

Pagetia Walcott, 1916, p. 407; Whitehouse, 1936, p. 81; Howell, 1959, p. 0189; Rasetti, 1966, p. 502

TYPE SPECIES (by original designation): *Pagetia bootes* Walcott, 1916, p. 407, pl. 67, figs. 1, 1a–f; *Bathyuriscus–Elrathina* Zone, Middle Cambrian; Burgess Shale Member of the Stephen Formation, north of Field, British Columbia, Canada. Since Walcott did not designate a holotype, a re-examination of the syntypes (United States National Museum paleontological collection Nos. 62855–62861) should be attempted and a lectotype chosen.

DIAGNOSIS: Isopygous trilobite with two thoracic segments; cephalon with moderate relief; broad axial furrow defining somewhat tapered glabella behind a flat depressed preglabellar field; glabellar furrows shallow to obsolete; long horizontal to uptilted spine extending from the rear of the glabella and occipital ring; fixigenae elevated posterolaterally; palpebral lobes undifferentiated to fairly well defined by palpebral furrows; typical functional 'proparian' facial sutures steeply downsloping from the eye to the border furrow; narrow cephalic doublure; hypostoma present; pygidium with strong relief; segmented pygidial axis usually with five tuberculate rings and a spinose terminal section; pleural furrows evident or effaced; geniculation sharp with well developed facets; surface generally smooth sometimes punctate or granulate.

DISCUSSION: Walcott (1916) defined the members of the genus *Pagetia* as "the forms of Eodiscidae in which eyes, free cheeks and facial sutures are developed". This diagnosis is now used to define the family Pagetiidae while the above detailed diagnosis is applied to the nominate genus.

Rasetti (1966) pointed out that *Pagetides* Rasetti, 1945, was the only genus with which *Pagetia* might be confused. While the type species, *Pagetides elegans* Rasetti, 1945 from the Lower Cambrian of Quebec, is easily distinguished in having three thoracic segments, he differentiated between other species of the two genera using a combination of several characters. *Pagetides* has a strongly upturned cranidial spine, a well impressed palpebral furrow, a medially expanded cephalic border, indistinct or obsolete radial markings on the cephalic border, wide almost vertical pygidial doublure, and no caudal spine. Although the species described below has an upturned cranidial spine and well impressed palpebral furrows the combination of all the characters serves to exclude it from *Pagetides*.

The genus *Pagetia* has received a large number of species with widely varying characters and as Rasetti (1966) pointed out, separation of some at the generic level may be desirable. The species described below, along with other Australian species, may not in fact be attributable to either of Rasetti's suggested generic groups. However, at the present time it is practical to describe it as a member of *Pagetia*.

RANGE AND DISTRIBUTION: Species of *Pagetia* range through the Lower and Middle Cambrian and have been recorded from North America, Asia and Australia.

Pagetia ocellata sp. nov.

(Pls. 23, 24)

HOLOTYPE: F6323 from L113 = D640 on Duchess 1 : 250,000 geological map, (sheet F 54–6, Australian National Grid) 1.5 to 2 miles north of Mount Murray at approximately 21° 50′ south latitude, 139° 58′ east longitude, northwestern Queensland; Beetle Creek Formation, early Middle Cambrian. A ptychagnostid in the fauna at this locality suggests a position high in the Beetle Creek Formation, at the base of the *Ptychagnostus gibbus* Zone (Shergold, 1968).

MATERIAL EXAMINED: Several hundred dissociated cephala, thoracic segments, pygidia, hypostomas and librigenae including F6170 to F6326.

DIAGNOSIS: Eodiscinid with eyes and functional facial sutures reaching the margin at an acute angle; marginal extremities of the librigenae pointed; broad cephalic border ornamented with elongate radial pits that do not reach the margin; low, almost obsolete eye ridges present; tumid fixigenae; occipital, axial thoracic and caudal spines present; narrow pygidial border; five axial pygidial rings and terminal section; pleural pygidial furrows effaced or almost so; granulate dorsal exoskeleton; steep geniculation distant from axis; facets well developed.

DESCRIPTION: The carapace is oval, elongate sagittally. The entire dorsal exoskeleton has granulose ornament, but hypostoma and doublure are smooth. Rarely, specimens are found enrolled (pl. 23, figs. 6, 7).

The semicircular cephalon has a straight posterior margin. Numerous elongate pits normal to but not close to the margin ornament the broad cephalic border which narrows slightly posteriorly. The border furrow is wide and shallow anteriorly becoming narrower posterolaterally. Parallel to the posterior margin both the border and border furrow are extremely narrow. The straight-sided glabella is crossed by a weakly incised transglabellar furrow in front of which is a small anterior lobe which tapers rapidly forward. Two pairs of extremely indistinct lateral glabellar furrows are seen on the posterior lobe. The two lateral furrows on each side of the glabella arise out of long (exsag.) lateral con-

DERIVATION OF NAME: From the diminutive of the Latin *oculus*—the eye; *ocellata* refers to a small eye with many spots.

strictions of the posterior lobe. A small depressed preglabellar field separates postero-laterally tumid fixigenae which are crossed by eye ridges arising near the transglabellar furrow and finishing distally at the anterior of the palpebral lobe. A discontinuous occipital furrow is represented by two lateral notches low on the posterior glabellar lobe. The posteriorly directed, broadly based occipital spine which tapers to a fine extremity arises from the posterior glabellar lobe and occipital segment. The broad deep axial furrow widens posteriorly where it is confluent with the border furrow. At these junctions large low tubercles are situated within the furrow. There are no genal spines and the genal angle is truncated. Small well-developed palpebral lobes and furrows are present. These lobes accomodate slightly elongate (exsag.) schizochroal eyes each possessing approximately 20 lenses. Typical "proparian" facial sutures meet the margin anteriorly at 60 degrees and posteriorly at 40 degrees; these extremities are pointed.

The narrow doublure shows no trace of terrace lines. The rostral plate is unknown. Although a large number of hypostomas were found at this locality none were attached to the dorsal exoskeleton. The only species of which a comparable number of dorsal exoskeletons was found is the one being described, and the relative size, similarity to the other pagetiid hypostoma described (Opik, 1952), and size range induced the author to consider these hypostomas as belonging to the new species. Their anteroventrally convex anterior border is extended laterally into projections the distal extremities of which are not preserved. A shallow border furrow and narrow border are continuous around the margin except at the anterolateral corners. Maculae are represented by two small low tubercles just ventral to the border furrow and at the posterior of the median body. They are adjacent to slight irregularities at the lateral margin.

Two thoracic segments are present as deduced from morphogeny (see below); no articulated thorax is known. The pleural extremities of the anterior segment are curved slightly posteriorly and those of the posterior segment are curved anteriorly to facilitate enrollment. The well impressed pleural furrows are close to the posterior and anterior edges respectively. A transverse furrow separates the crescentic articulating halfring and the spine-bearing axial ring. The prominent posteriorly directed spine of variable size is apparently larger on the posterior segment since those attached to degree 1 meraspides bear the larger spines. The long (tr.) narrow (exsag.) pleurae are slightly expanded and rounded distally.

The semicircular pygidium is bounded by an extremely narrow border which widens anterolaterally, but narrows again parallel to the anterior margin. The border furrow is shallow and narrow posteriorly becoming deeper and wider anteriorly. The broad poorly impressed axial furrow joins the border furrow anteriorly but encompasses the rear of the axis as a discrete furrow. The axis consists of five rings each exhibiting a slight tubercle at its dorsal crest and a terminal section with a short (sag.), stout, dorsally and posteriorly directed spine. The short (sag.), high, articulating halfring preserved on the anterior margin resembles closely the agnostoid type (Opik, 1968). The pleural regions are only slightly tumid and interpleural and pleural furrows are effaced except for the anterior border

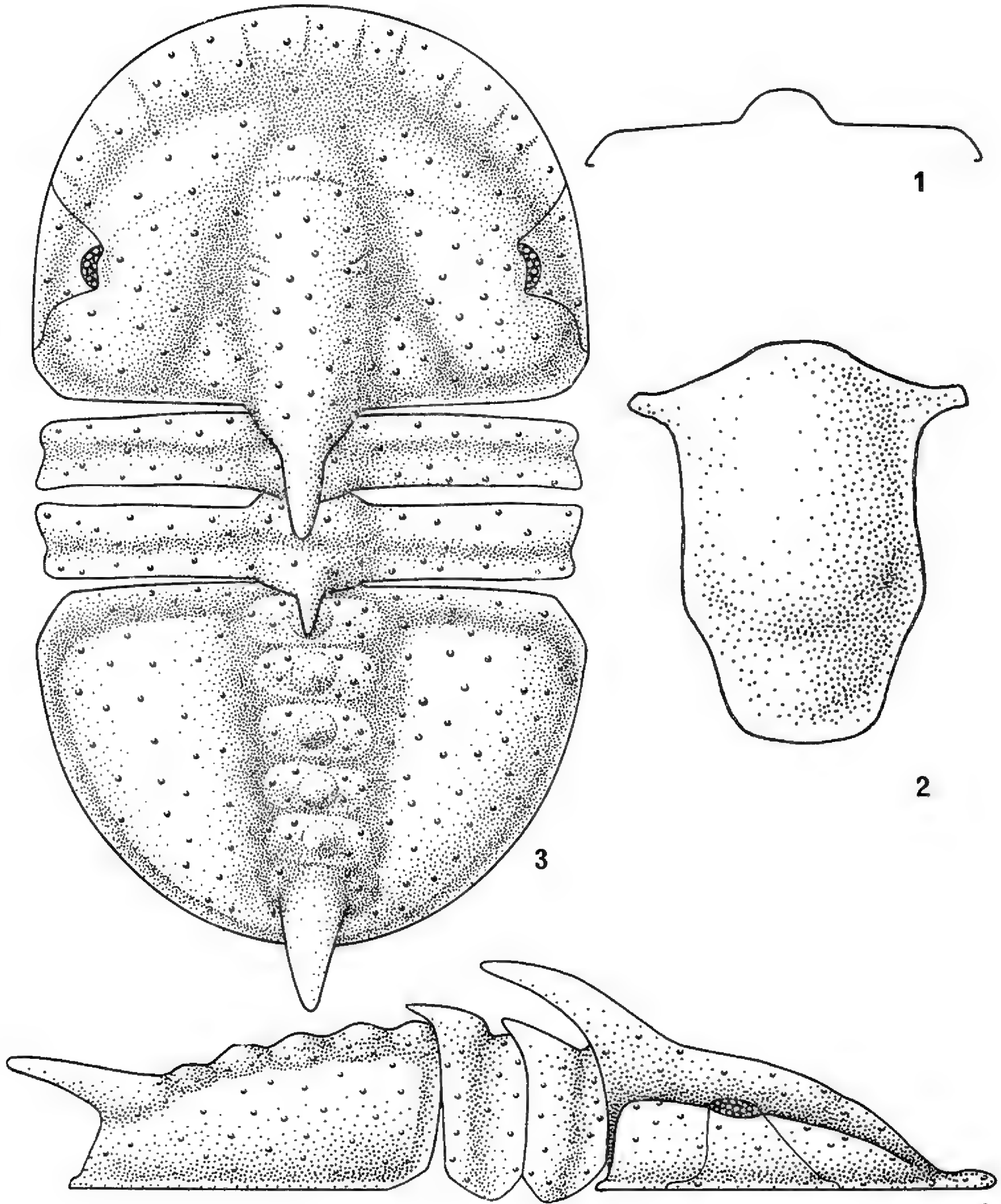


FIG. 1: *Pagetia ocellata* sp. nov. 1, section (tr.) of thorax; 2, ventral view of hypostoma; 3, dorsal view, with thoracic segments slightly separated; 4, right lateral view, with thoracic segments in articulating position.

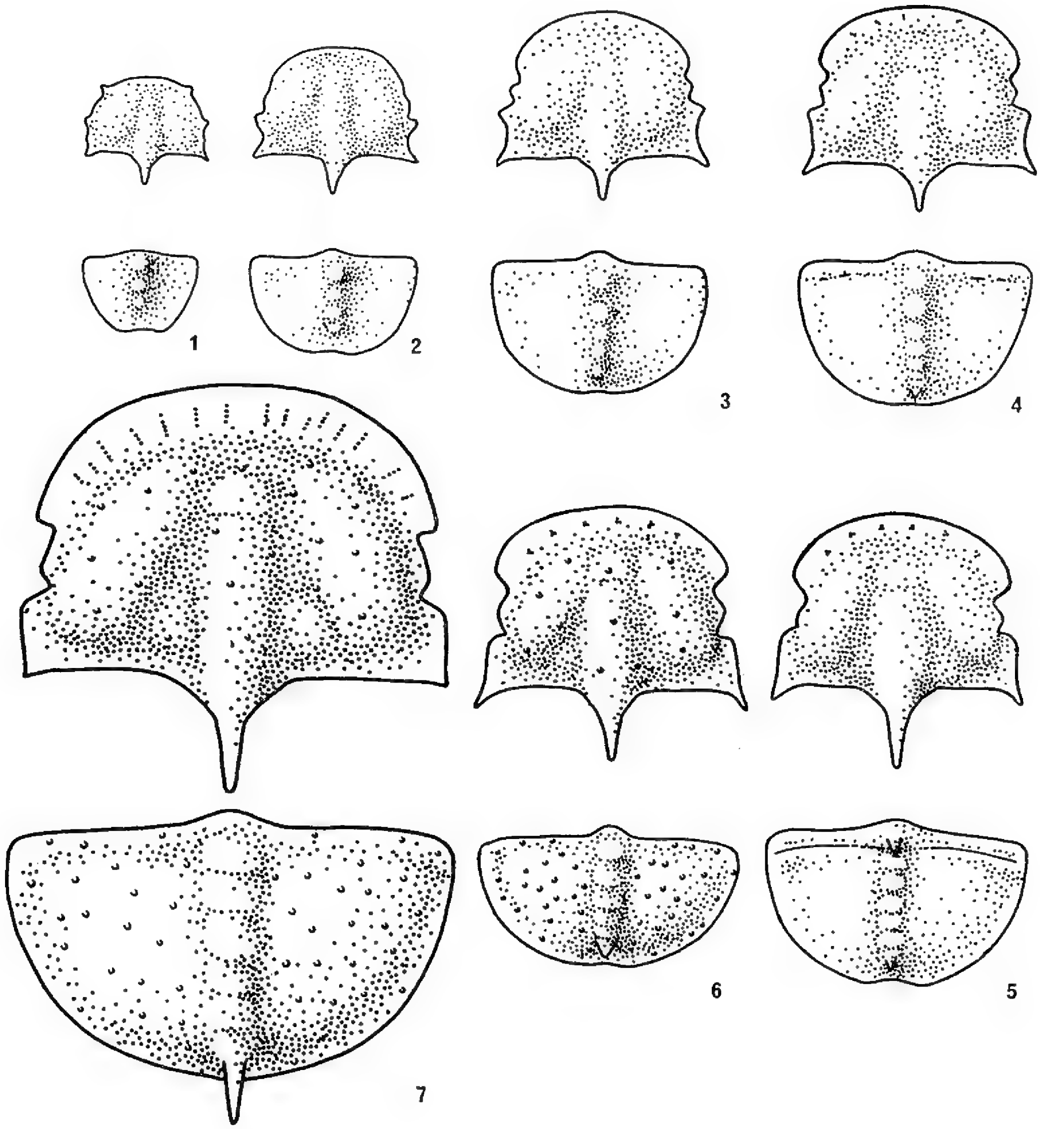


FIG. 2: *Pagetia ocellata* sp. nov. 1, degree 0 meraspid with three pairs of cephalic spines and three axial pygidial rings; 2, degree 0 meraspid with two pairs of cephalic spines and four axial pygidial rings; 3, degree 0 meraspid with five pygidial axial rings; 4, late degree 0 meraspid with seven pygidial axial rings and a slightly spinose terminal section; 5, degree 1 meraspid with six pygidial axial rings and a spinose terminal section; the spinose posterior thoracic segment is still part of the pygidium; 6, early holaspid with five pygidial axial rings and spinose terminal section; the small genal spines are still retained; 7, later holaspid without genal spines but showing elongate cephalic border pits, elongate caudal spine etc.

furrow which is a pleural furrow. Some specimens (pl. 23, fig. 25; pl. 24, fig. 21) exhibit faint pleural furrows with notches in the axial furrow at the proximal end. The fulcral points are distant from the axis and are steeply geniculate.

ONTOGENY: Protaspides have not been recognised to date. However, successive growth stages from the apparently early meraspid are represented. Normal size increase is accompanied by several morphological changes.

(1) Cephalic spines: Earliest meraspides have three pairs of spines—anterior and posterior profixigenal and genal. The genal spines are fine and short in meraspides, but absent in holaspides. Anterior profixigenal spines are present only in earlist meraspides. Posterior profixigenal spines are present in degree 0 meraspides. The profixigenal spines are extremely small and almost imperceptible.

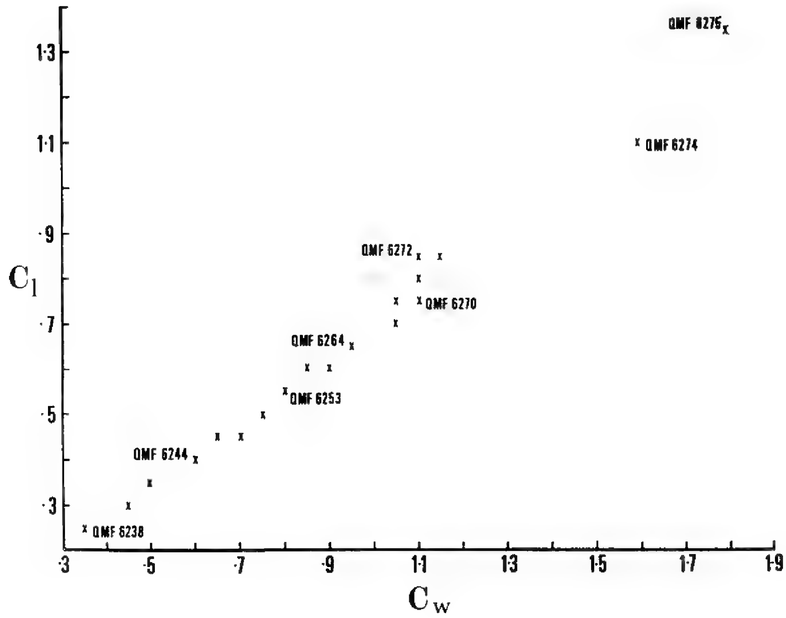
(2) Shape of the librigenae: This changes as a result of change in position of the facial sutures. Elongate (exsag.) and narrow (tr.) in early meraspides, the librigenae become wider (tr.) until in holaspides they are subrectangular. Spines on the marginal extremities of the librigenae decrease in relative size with development.

(3) Relief on cephalon: Elevation of the glabella is very low in meraspides, but in later meraspides and holaspides the glabella and fixigenae are of similar elevation.

(4) Length of cephalic border pits: The cephalic border pits which first appear in developing meraspides do not become elongate until the holaspid stage is reached.

(5) Pygidial axis: The number of pygidial axial rings varies with development. Early degree 0 meraspides exhibit three. As the meraspid develops so the number of rings increases progressively until the last degree 0 meraspid has eight rings. Specimens have been found which exhibit each of the intervening number of rings. The degree 1 meraspides have seven rings and the holaspides six.

The thoracic segments are initiated anteriorly on the pygidium as indicated by an excess of pygidial rings in the late degree 0 and degree 1 meraspides over the number in holaspides and by the presence of transverse sutures on the anterior of the pygidium in meraspides (pl. 24, figs. 14, 15). The comparatively large spines on the anterior pygidial rings of meraspides become the thoracic axial spines when each thoracic segment becomes a discrete segment. Development of the spines in that region is therefore not haphazard as could be inferred if size of the spine and size of the pygidium were correlated, but is allied to the evolution of the thorax.



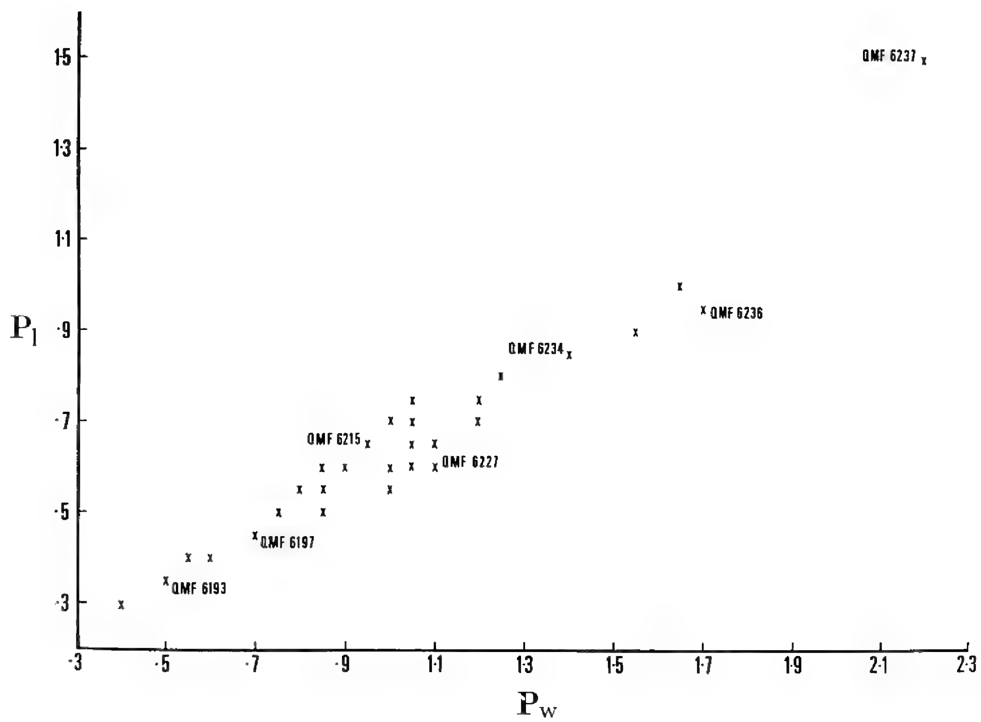


FIG. 3: Dimensions in mm of Queensland Museum specimens of *P. ocellata* sp. nov.

(6) Anterior pygidial axial spine: The anterior pygidial axial ring in meraspides bears a prominent spine while in holaspides it bears only a low tubercle.

(7) Caudal spine: The caudal spine is absent in degree 0 meraspides except where there are eight axial rings. It is present in all later stages.

(8) Width of pygidial axis: The relative width of the pygidial axis varies becoming progressively greater with development.

(9) Relief on pygidium: Relief of the pygidial axis decreases with development, the tubercles on each ring becoming less prominent and the axis fitting more closely into the general convex shape of the pygidium.

(10) Pygidial border: The pygidial border becomes progressively narrower from the meraspides through to the late holaspides especially between early and late holaspides.

(11) Ornament: The granulate ornamentation which is so characteristic of the mature holaspides is absent on all meraspides.

Discussion of Morphogeny: Matthew (1896, pp. 242–4, pl. 17, fig. 8d) described and figured a protaspis of *Microdiscus pulchellus* Hartt, 1884. However, from the figure and description, the specimen seems to be the protaspis of a polymerid trilobite and not an eodiscinid. Clark in 1923 described *Dipharus insperatus* as the type of a pagetiid genus but Shaw (1950) reinterpreted his material as the juvenile form of *Hebediscus attleborensis* (Shaler and Foerste, 1888). To the author's knowledge it is the only previous description of a juvenile pagetiid but does not include any recognition of the growth series.

In the absence of descriptions of the morphogeny of other members of the family the series described in the preceding section is compared to that of eodiscids as described by Rushton (1966) and agnostids as described by Snajdr (1958) and Robison (1964). The morphogenetic series of *Pagetia ocellata* described herein and those of eodiscids (Rushton, 1966) bear several striking similarities to those described for agnostid trilobites while agreeing fairly closely between themselves as well. The protaspid stage is apparently absent. The glabella of the early meraspides does not reach to the anterior margin of the cephalon. The pygidium and cephalon retain their comparative size relationship through meraspid and holaspid stages. The thoracic segments move forward from the anterior of the pygidium. Except for the last these contrast with those of polymerid trilobites and all four features confirm the close relationship of eodiscinid and agnostid trilobites.

Morphogenetic series of other Australian species have been observed and it is anticipated that their description will appear when further material is available.

Remarks: Closely spaced granules over the dorsal exoskeleton serve to distinguish *Pagetia ocellata* sp. nov. from the Australian and Asian pagetiids. Several North American species exhibit this ornament and are comparable in other features as well. *Pagetia* *bigranulosa* Rasetti, 1967, and *P. laevis* Rasetti, 1967, from the *Olenellus* (late Lower Cambrian) Zone of the Taconic sequence in Columbia County, New York State and *P. fossula* Resser, 1939, from the *Glossopleura* (Middle Cambrian) Zone of the Lakeview Limestone, Idaho have fewer than six axial pygidial segments. *P. resseri* Kobayashi, 1943, from the *Plagiura–Poliella* (Middle Cambrian) Zone in the Wasatch Mountains, Idaho is distinguished by having a smooth cephalic exoskeleton. *P. walcotti* Rasetti, 1966, known only from the Burgess Shale of British Columbia was described from three poorly preserved specimens and close comparison with it is not possible. This is unfortunate since it appears to be the most closely related species. Pygidial pleural furrows which are obsolete or almost so in *P. ocellata* are well impressed, palpebral furrows, almost obsolete in *P. walcotti*, are well impressed in *P. ocellata*, the pygidial axis is proportionally narrower than in *P. ocellata* and in contrast to that of *P. ocellata* the glabella is not straight sided but tapers forward; these observations serve to distinguish the two species until more information is available on *P. walcotti*.

Clarkson (1966) stated that trilobites possessing schizochroal eyes do not occur in strata older than the Ordovician. He did not elaborate on this statement nor did he account for Opik's (1961, p. 57) description of schizochroal eyes in *Pagetia significans* (Etheridge, 1902). The species described herein also possesses schizochroal eyes confirming that trilobites with that type of eye also lived in the Cambrian Period.

DISTRIBUTION: This species is known only from the Beetle Creek Formation at the type locality.

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PLATE 23

Pagetia ocellata sp. nov.

All figured specimens are from the same locality as the holotype and all figures are × 22. Figs. 1–26 are dorsal views; 27–31 are ventral views.

FIGS. 1–5: Degree O meraspid cephala of progressively greater development, F6239, F6240, F6244, F6245, F6246, respectively.

FIGS. 6–10: Degree O meraspid pygidia of progressively greater development, F6192, F6195, F6194, F6201, F6200, respectively.

FIG. 11: Late degree O meraspid cephalon, F6248.

FIGS. 12–14: Degree 1 meraspid cephala, F6255, F6264, F6268, respectively.

FIG. 15: Late degree 0 meraspid pygidium, F6207.

FIGS. 16, 17: Degree 1 meraspid pygidia, F6220, F6219, respectively.

FIG. 18: Late degree 1 meraspid pygidium with posterior thoracic segment almost detached, F6218.

FIGS. 19–21: Early holaspid cephala, F6266, F6269, F6270, respectively.

FIG. 22: Holaspid cephalon, F6272.

FIGS. 23–25: Early holaspid pygidia, F6221, F6230, F6224, respectively.

FIG. 26: Holaspid pygidium, F6229.

FIGS. 27–31: Hypostomas, of progressively lesser development, F6191, F6187, F6186, F6175, F6171, respectively.

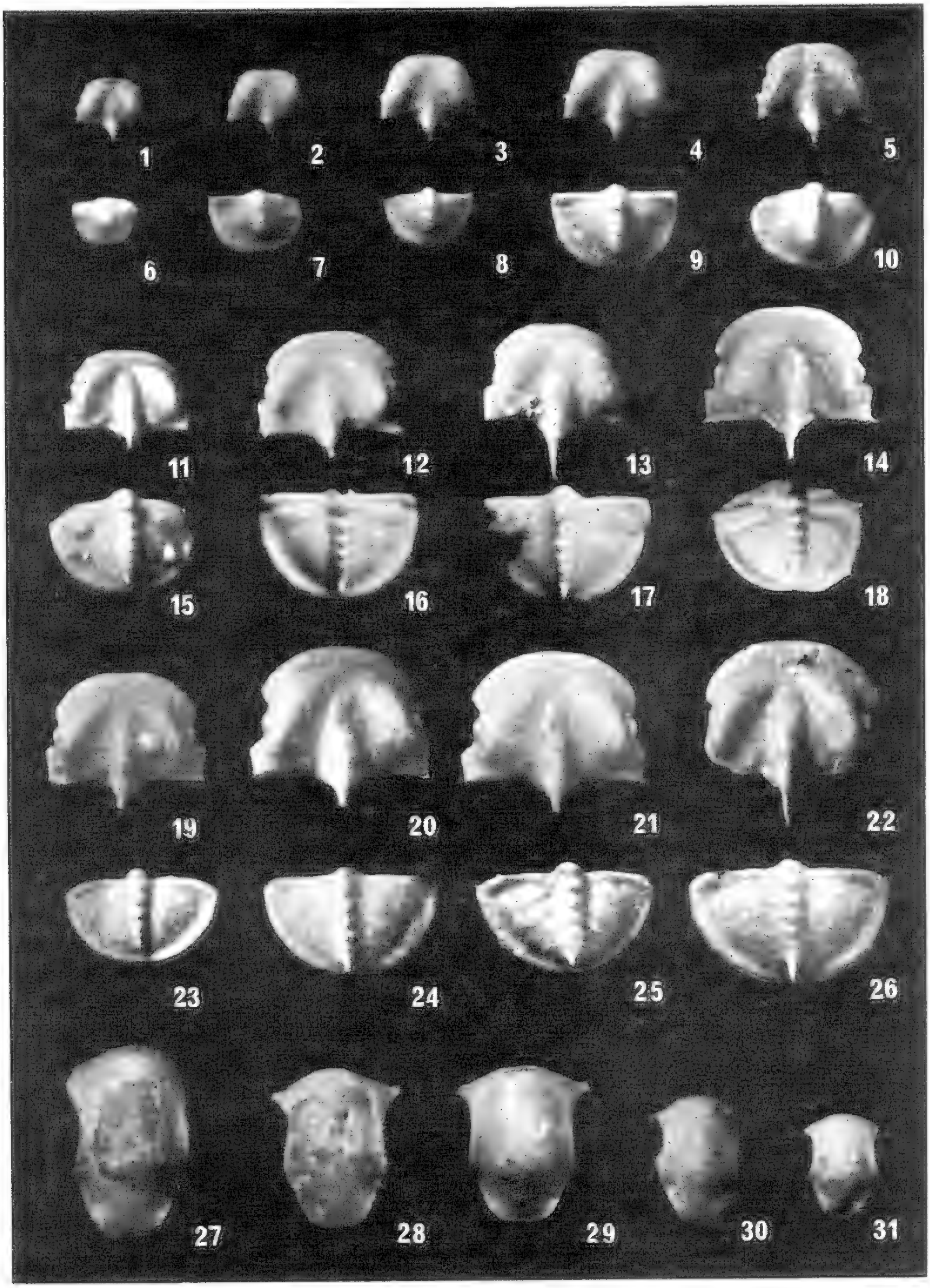
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PLATE 24

Pagetia ocellata sp. nov.

All figured specimens are from the same locality as the holotype and all figures are × 22 unless otherwise stated. Figs. 8–23 are dorsal views.

FIGS. 1–3: Lateral views of left librigenae with ocular surfaces, attached, F6278, F6285, F6289, respectively.

FIGS. 4, 5: Lateral views of right librigenae without ocular surfaces, F6283, F6293, respectively.

FIG. 6: Dorsal view of pygidium of an enrolled degree 0 meraspid and ventral view of the cranidial spine, F6276.

FIG. 7: Oblique posterior view of an enrolled degree 0 meraspid, i.e. posterior of cephalon and anterior of pygidium, F6276.

FIG. 8: Axial and right pleural regions of posterior thoracic segment, F6306.

FIG. 9: Axial and left pleural regions of posterior thoracic segment, F6308.

FIG. 10: Axial and right pleural regions of posterior thoracic segment, F6314.

FIG. 11: Axial and right pleural regions of anterior thoracic segment, F6322.

FIGS. 12, 13: Anterior thoracic segments, F6309, F6299, respectively.

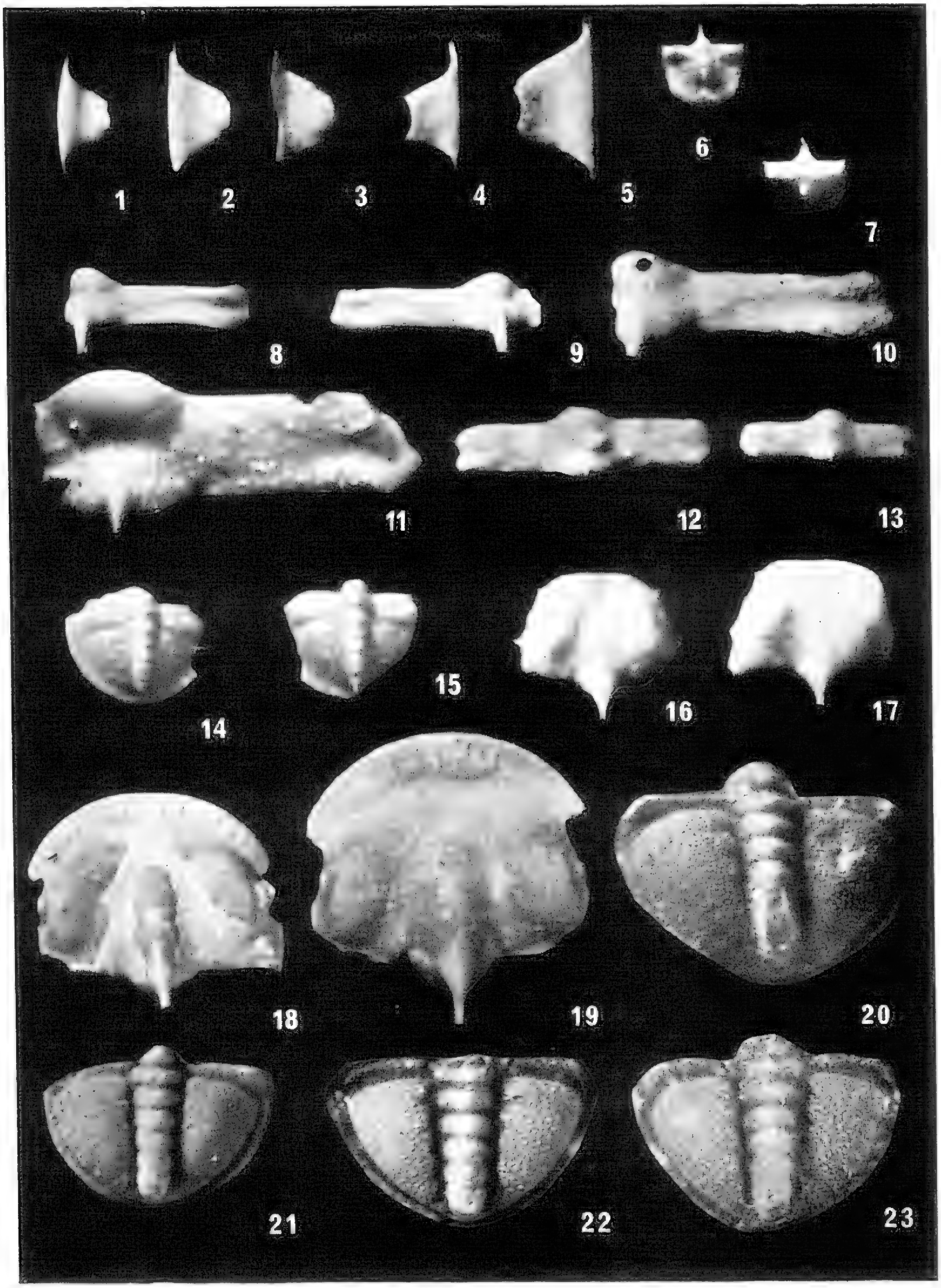
FIGS. 14, 15: Earliest holaspid pygidia with posterior thoracic segment just detached, F6217, F6216, respectively.

FIGS. 16, 17: Early degree 0 meraspides (Pl. 23, figs, 1, 2) showing the three pairs of cephalic spines, F6239, F6240, respectively. × 53.

FIGS. 18, 19: Holaspid cephala, F6274, F6275, respectively.

FIGS. 20, 21, 23: Holaspid pygidia, F6324, F6325, F6326, respectively, × 11.

FIG. 22: Holotype, holaspid pygidium, F6323, × 11.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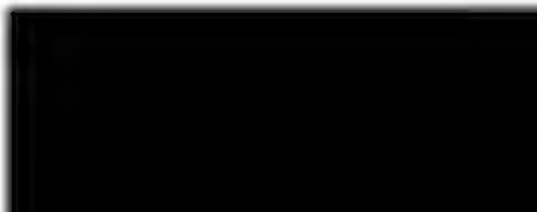

QUEENSLAND PERMIAN SPECIES OF THE SPIRIFERID BRACHIOPODS *PUNCTOSPIRIFER* AND *CLEIOTHYRIDINA*

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ABSTRACT

Two species of *Punctospirifer* occur in the Permian deposits of Queensland; they are *P. australis* (Maxwell) which is transferred from *Spiriferellina* because of its lirate rather than granulose micro-ornament, and *P. etheridgei* sp. nov. Queensland Permian specimens of *Cleiothyridina* are referable to two species herein termed *Cleiothyridina* sp.A and *Cleiothyridina* sp.B. *Cleiothyridina* sp.B includes the Peawaddy Formation specimens referred by Campbell (1953) to both *Cleiothyridina* and *Spirigerella*.

The spiriferids *Punctospirifer* North, 1920, and *Cleiothyridina* Buckman, 1906, are relatively uncommon in the Queensland Permian and because neither genus seems to occur in deposits of Permian age elsewhere in eastern Australia their distributions may be of palaeogeographical importance. Of the eleven spiriferid genera (*Trigonotreta* Koenig, 1825; *Notospirifer* Harrington, 1955; *Subansiria* Sahni and Srivastava, 1956; *Ingelarella* Campbell, 1959a; *Fusispirifer* Waterhouse, 1966; *Sulciplica* Waterhouse, 1968; *Pseudosyrinx* Weller, 1914; *Attenuatella* Stehli, 1954; *Punctospirifer*; *Martinia* McCoy, 1844; *Cleiothyridina*) that occur in the Queensland Permian, three (*Punctospirifer*, *Martinia*, and *Cleiothyridina*) are as yet unknown from the Permian of New South Wales (excluding the Drake area in northern N.S.W.) and five (*Pseudosyrinx*, *Attenuatella*, *Punctospirifer*, *Martinia*, and *Cleiothyridina*) are unrecorded from the Tasmanian Permian. There is an increase in the generic diversity of eastern Australian Permian spiriferids from Tasmania to Queensland, although the absences of genera from some areas may be due to collection failure. Future work will undoubtedly enable more detailed generic distributions to be presented. Meantime it is the purpose of the present paper to describe the Queensland Permian species of *Punctospirifer* and *Cleiothyridina*, and to discuss their distributions and ranges.

Figured and mentioned specimens housed in the collections of the Department of Geology of the University of Queensland and the Queensland Museum are denoted by a number prefixed by the letters UQF and QMF respectively. Localities indexed at the former institution are referred to by a number following the letters UQL.

Subfamily SPIRIFERININAE Davidson, 1884

REMARKS: On page 354 of his General Summary to the British Fossil Brachiopoda, Davidson (1884) used the name 'Sub-Family Spiriferinidae' to embrace the genera *Spirifer*, *Cyrtia*, *Syringothyris*, *Cyrtina*, *Reticularia*, *Martinia*, *Martiniopsis*, *Spiriferina*, *Mentzelia*, *Ambocoelia*, and *Suessia*. Elsewhere in the same volume and in his earlier volumes on the British Fossil Brachiopoda Davidson had used the name Spiriferidae (Davidson, 1858, vol. 2, pt. 4, p. 12; vol. 2, pt. 5, p. 19; 1864, vol. 3, pt. 6, p. 13; 1866, vol. 3, pt. 7, p. 83; 1884, vol. 5, pt. 3, pp. 350, 368, 369, and footnote 2 on p. 373) for this group of genera. For this reason it seems almost certain that Davidson's (1884, p. 354) usage of Spiriferinidae was an inadvertent error. Possibly the first authors to define the category Spiriferinidae (which is based on the generic name *Spiriferina*) as distinct from the Spiriferidae were Hall and Clarke in 1894.

Genus **Punctospirifer** North, 1920

TYPE SPECIES (by original designation): *Punctospirifer scabricosta* North, 1920 from the Ashfell Sandstone in the Ravenstonedale district, England.

DIAGNOSIS: Shell biconvex, with distinct sulcus and fold; both valves possess cardinal areas and simple plications on their flanks; the ventral area is striated parallel to and perpendicular to the cardinal margin; ventral valve sub-pyramidal; the surfaces of the valves bear imbricating growth lamellae and a micro-ornament of radial and concentric lirae; in the ventral valve dental lamellae and a median septum are well developed.

REMARKS: The diagnosis is based on Campbell's (1959b) redescription of *Punctospirifer scabricosta*. *Punctospirifer scabricosta* possesses a lirate micro-ornament (Campbell, 1959b, pl. 60, fig. 1) that is quite distinct from the granulose micro-ornament (Campbell, 1959b, pl. 60, fig. 3) of the type species of *Spiriferellina*.

RANGE IN QUEENSLAND PERMIAN: Early Lower Permian (Sakmarian) to late Lower Permian or early Upper Permian.

Punctospirifer australis (Maxwell, 1964)

(Pl. 25, figs. 3–5, 11, 20)

Spiriferellina sp. Campbell, 1953, pl. 2, figs. 9–11.

HOLOTYPE: UQF42868 from the Burnett Formation of UQL1932.

DIAGNOSIS: Shell rounded in outline and widest at or just in front of the cardinal margin; ventral valve sub-pyramidal; sulcus widens rapidly anteriorly and is bordered by prominent plications; there are two or three additional plicae on each flank; fold rounded and on each side of it there are usually three plications; generally the innermost of these are much more prominent than the others; the external surfaces of the valves are covered with concentric lamellae, and radial and concentric lirae; the lirae form a reticulate pattern; the radial lirae number 10 to 15 per millimetre; ventral septum thin, extending for less than a half of the length of the valve; dental plates less than half as long as the septum; in the posterior half of the dorsal valve there is a low median ridge; the shell is punctate, there being between 20 and 30 punctae per square millimetre in the anterior half of the sulcus.

DESCRIPTION: see Maxwell (1964).

REMARKS: *Punctospirifer australis* is transferred from *Spiriferellina* to *Punctospirifer* because of its lirate (pl. 25, fig. 20) rather than granulose micro-ornament.

DISTRIBUTION: *Punctospirifer australis* occurs in the Burnett Formation, the Cattle Creek Formation (UQL238), the Barfield Formation (UQL850), and the Peawaddy Formation (Campbell, 1953, p. 3; UQL239). No micro-ornament is preserved on the specimens from the last three formations but otherwise the specimens are very similar to Maxwell's specimens of *P. australis*. A specimen not figured herein (UQF54615) from the Tiverton Formation at UQL3127 may also be a representive of *P. australis*.

AGE: Upper Sakmarian to either late Lower Permian or early Upper Permian. Runnegar (1967) considers that the fauna of the Burnett Formation is probably a correlative of the fauna in the Allandale Formation in the Sydney Basin for which Dickins (1969) suggests an upper Sakmarian age. The fauna in the Peawaddy Formation (Fauna IV of Dickins *in* Malone *et al.*, 1964) is equated with faunas of supposed Kungarian age by Waterhouse (1963) and Runnegar (1967), and with faunas of Kazanian age by Dickins (1964).

Punctospirifer etheridgi sp. nov.

(Pl. 25, figs. 6–10, 12–19, 21, 22)

Spiriferina duodecemcostata (McCoy); Etheridge *Jr*, 1892, pl. 44, fig. 12.

HOLOTYPE: UQF54612 from the Tiverton Formation at UQL3127.

PARATYPES: QMF6329–6332 and UQF54610, UQF54611 and UQF54614 from the Tiverton Formation at the same locality as the holotype.

DIAGNOSIS: Shell more transverse than *P. australis* with four to six plications on each of the flanks of the valves; ventral septum strong and about one half as long as the valve:

dental plates wedge-shaped, extending approximately to the mid-length of the septum; there is a low median ridge in the posterior part of the dorsal valve; micro-ornament on the shell comprises concentric lamellae and radial and concentric lirae.

DESCRIPTION: The shell is small and transverse with a uniplicate commissure. It is widest at or in front of the cardinal margin. The ventral valve is sub-pyramidal with a high apsacline area and moderately convex flanks. There are four, five, or six sub-angular plications on each flank and those limiting the sulcus are not as divergent as in *P. australis*. On the dorsal valve there are usually five plications on each side of the fold. Ornamentation on the valves consists of concentric growth lamellae and radially and concentrically arranged lirae. The lirae form a reticulate pattern and the radial elements have a concentration of 20–25 per millimetre (pl. 25, figs. 21, 22).

In the ventral valve the septum is about one half as long as the valve, and it is generally thicker than the septum of *P. australis*. Commonly the anterior edge of the septum is swollen (pl. 25, fig. 17). No punctae occur in the septum. The adminicula lie in the furrows bordering the sulcus and may extend to the mid-length of the septum. Umbonal cavities are sometimes slightly thickened and some callus may be deposited in the delthyrial cavity. The field of muscular attachment in the ventral valve is an elliptical area between the adminicula and it extends to the anterior edge of the septum. The areas of diductor muscle attachment lie on the floor of the valve whereas the adductors were connected partly to the floor of the valve and partly to the septum.

In the posterior part of the dorsal valve there is a low ridge separating the scars of adductor muscle attachment. The latter comprise a pair of large anterior adductors and a pair of smaller posterior adductors. The cardinal process consists of a series of delicate

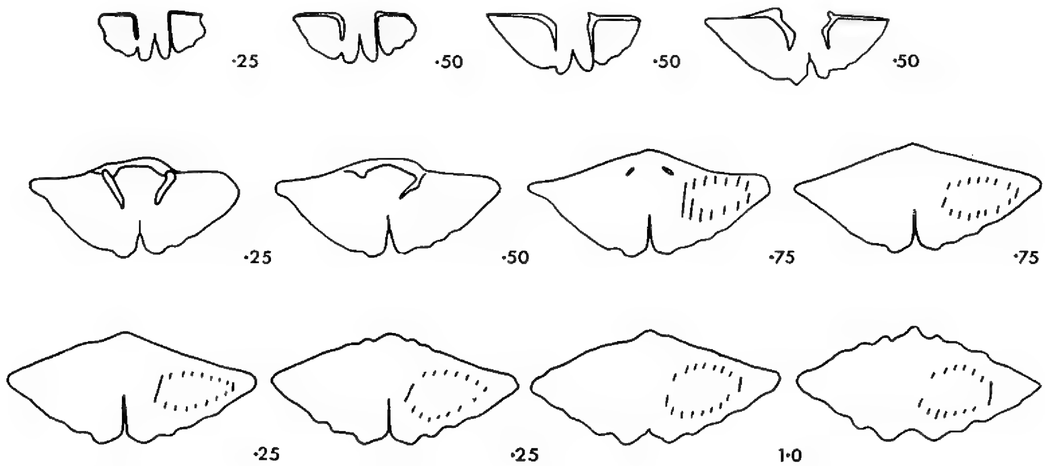

FIG. 1: Serial sections of a topotypical specimen of *Punctospirifer etheridgei* sp. nov. The intervals between successive sections are shown on the diagram in millimetres.

lamellae aligned parallel to the median plane of the shell. The crural bases arise from the inner sides of the inner socket ridges and extend anteriorly to form laterally directed spiral brachidia. Serial sections of a specimen of *P. etheridgei* are illustrated in figure 1. The shell of *P. etheridgei* is punctate and in the anterior part of the sulcus of the holotype the punctae number between 20 and 30 per square millimetre. Punctae are present throughout the shell comprising the areas of the valves.

COMPARISON: Shells of *Punctospirifer etheridgei* are distinguished from those of *P. australis* by their more transverse outlines, their more plicate flanks, their generally narrower sulci, the normally longer and thicker septa in their ventral valves, and the less prominent and divergent plications along the margins of their sulci.

DISTRIBUTION: In addition to its occurrence at the type locality this species is known from the Wallaby Beds in the Stanthorpe Road Fault Block south of Warwick (UQL3030), and in the Buffel Formation. Small specimens of *Punctospirifer* (pl. 25, fig. 19) from the Wallaby Beds are almost indistinguishable from specimens of *P. australis* from the Burnett Formation.

AGE: Lower Permian, probably lower Artinskian (Aktastinian). Work by Dear (1966) and Armstrong *et al.* (1967) suggests that the fauna of the Tiverton Formation (i.e. Fauna II of Dickins *in* Malone *et al.*, 1964) is of lower Artinskian age. The faunas in the Wallaby Beds and the Buffel Formation are correlative with Fauna II and are also considered to be of Lower Artinskian age (see Runnegar, 1967).

Subfamily ATHYRIDINAE McCoy, 1844

Genus **Cleiothyridina** Buckman, 1906

TYPE SPECIES (by original designation): *Cleiothyridina deroissyi* Leveille, 1835.

RANGE IN QUEENSLAND PERMIAN: Lower Artinskian to late Lower Permian or early Upper Permian.

Cleiothyridina sp.A

(Pl. 25, fig. 2)

DESCRIPTION: There is only one specimen of this species from the Tiverton Formation at UQL3127. The specimen is an external mould of a dorsal valve and part of a ventral valve. The dorsal valve has a strong median convexity but lacks a real fold. It is widest posterior to its mid-length and is approximately as wide as it is long. Imbricating growth lamellae cover the entire valve and each lamella gives rise to flat spines, which number about three per millimetre along a lamella. The commissure of the specimen is gently uniplicate although on the visible part of the ventral valve there is no sulcus.

AGE: Armstrong *et al.* (1967) consider that the fauna in the Tiverton Formation (i.e. Fauna II of Dickins *in* Malone *et al.*, 1964) is probably of Lower Artinskian (Aktastinian) age.

Cleiothyridina sp.B

(Pl. 25, fig. 1)

Cleiothyridina sp. nov. Campbell, 1953, p. 16, pl. 3, figs. 11–16.

Spirigerella sp. nov. Campbell, 1953, p. 15, pl. 6, figs. 1–6.

Cleiothyridina sp. Hill and Woods, 1964, pl. P7, figs. 11, 12.

DESCRIPTION: Campbell (1953, p. 16) described specimens of *Cleiothyridina* from the Peawaddy Formation. Dorsal valves of the specimens are less convex medially than the dorsal valve of *Cleiothyridina* sp.A, and commonly they bear a median flattening or furrow (Hill and Woods, 1964, pl. P7, fig. 11). The ventral valve also bears a faint sulcus (Hill and Woods, 1964, pl. P7, fig. 12). The external surface of the shell is covered with imbricating growth lamellae which give rise to flat spines that extend forward, approximately in the same plane as their parent lamella. The spines number about three per millimetre along a lamella.

An external mould of a fragment of a valve from the *Strophalosia clarkei* bed has a distinct median depression and could be a representative of *Cleiothyridina* sp.B (pl. 25, fig. 1). However the fragment is too small to enable positive identification.

Campbell (1953, p.15) included seven specimens from the Peawaddy Formation in *Spirigerella* sp. nov. These were collected from the same locality which yielded the specimens that Campbell identified as *Cleiothyridina* sp. nov. All of Campbell's specimens of *Spirigerella* sp. nov. are decorticated shells lacking obvious external ornament whereas his *Cleiothyridina* specimens have the lamellose-spinose ornament that is characteristic of *Cleiothyridina*. From Campbell's descriptions and figures it is clear, apart from details about their ornament, that his specimens of *Cleiothyridina* and *Spirigerella* are very similar. Internally the Peawaddy specimens of these genera are almost identical and the external differences described by Campbell seem to be the result of differing states of preservation. On a number of the specimens (i.e. UQF14220, 14221, 14223) which Campbell included in *Spirigerella* sp. nov. there is an ornament of growth lamellae and on one of these specimens (UQF14223) the lamellae extend for one millimetre from the surface of the shell. The lamellae are visible in patches of matrix adhering to the exteriors of the shells. The lamellae are quite numerous and their concentrations vary from three per millimetre at about the midlength of one shell (UQF14223) to eight per millimetre at the lateral margin of the same shell. Some of the lamellae on the above shell give rise to fine spinose projections. In view of the existence of lamellae on a number of the apparently smooth specimens of *Spirigerella* described by Campbell there is little doubt that Campbell's *Cleiothyridina* and *Spirigerella* specimens from the Peawaddy Formation are conspecific.

AGE: Late Lower Permian or early Upper Permian.

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PLATE 25

FIG. 1: *Cleiothyridina* sp. cf. sp.B. Exterior of part of a ventral valve. UQF54618 from the *Strophalosia clarkei* bed at UQL3135. × 0.9.

FIG. 2: *Cleiothyridina* sp.A. Dorsal view of dorsal valve and umbonal part of ventral valve. UQF54616 from the Tiverton Formation at UQL3127. × 0.9.

FIG. 3: *Punctospirifer australis* (Maxwell, 1964). Internal mould of ventral valve. UQF42868 (holotype) from the Burnett Formation at UQL1932. × 1.8.

FIG. 4: *P. australis* (Maxwell). Ventral valve. UQF13672 from the Peawaddy Formation at UQL239. × 1.8.

FIG. 5: *P.* sp. cf. *australis* (Maxwell). Ventral valve. UQF13691 from the Cattle Creek Formation at UQL238. × 1.8.

FIGS. 6–8: *Punctospirifer etheridgei* sp. nov. Internal moulds of dorsal valves. UQF48263, UQF58082, and UQF54619 respectively, all from the Wallaby Beds at UQL3030. All × 1.8.

FIG. 9: *P. etheridgei* sp. nov. Posterior view of internal mould of ventral valve showing high apsacline area. QMF6331 from the Tiverton Formation at UQL3127. × 1.8.

FIG. 10: *P. etheridgei* sp. nov. Internal mould of dorsal valve. UQF54610 from the Tiverton Formation at UQL3127. × 1.8.

FIG. 11: *P. australis*) Maxwell). Ventral view of shell. UQF12562 from the Barfield Formation at UQL850. × 1.8.

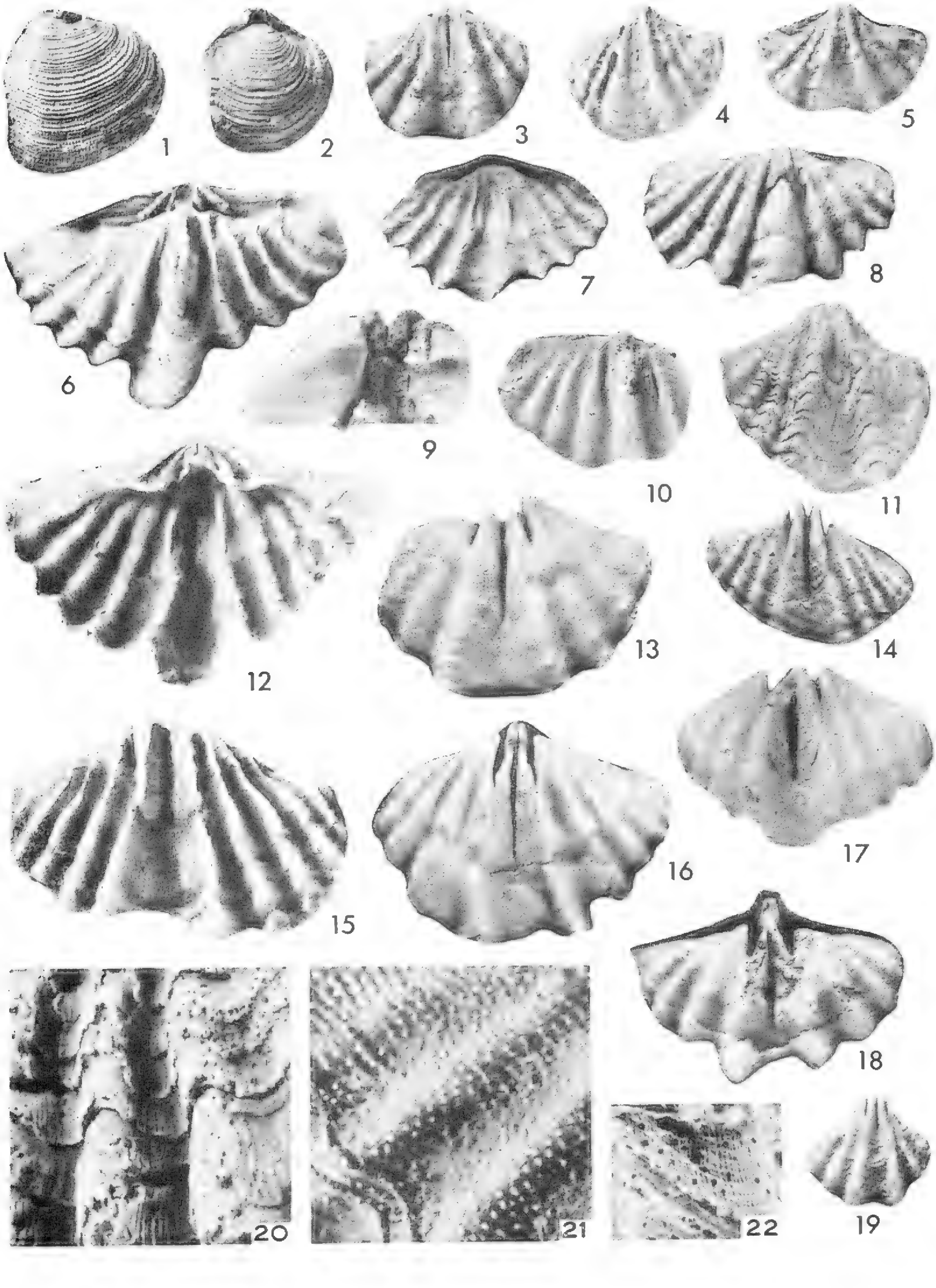
FIG. 12: *P. etheridgei* sp. nov. Latex cast of interior of dorsal valve. UQF8515 from the Wallaby Beds near Rokeby Homestead near Warwick, Queensland. × 1.8.

FIGS. 13–18: *P. etheridgei* sp. nov. Internal moulds of ventral valves. 13, UQF54614 from the Tiverton Formation at UQL3127. 14, 15, UQF54620 and UQF48266 respectively, both from the Wallaby Beds at UQL3030. 16, UQF54612 (holotype) from the Tiverton Formation at UQL3127. 17, QMF6332 from the Tiverton Formation at UQL3127. 18, Bureau of Mineral Resources specimen CPC9030 from the Buffel Formation at Bureau of Mineral Resources locality T1. All × 1.8.

FIG. 19: *Punctospirifer* sp. Ibternal mould of small ventral valve. UQF58081 from the Wallaby Beds at UQL3030. × 3.6.

FIG. 20: *P. australis* (Maxwell). Latex cast of external surface of shell showing micro-ornament. The small holes are the distal extremities of punctae. UQF42873 (paratype) from the Burnett Formation at UQL1932. × 9.

FIGS. 21, 22: *P. etheridgei* sp. nov. 21, External mould of micro-ornament of radial lirae. The pillars of sediment on the external mould are the infillings of punctae. 22, Latex cast from external mould, part of which is shown in Figure 21. The small holes are the distal extremities of punctae. UQF54611 from the Tiverton Formation at UQL3127. Both × 9.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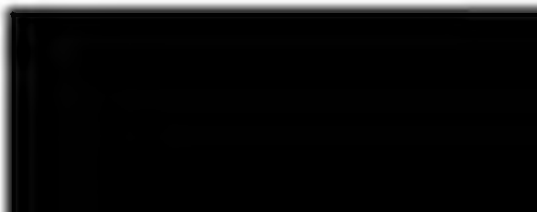

THE STATUS OF *PILUMNUS TERRAEREGINAE* HASWELL (CRUSTACEA, DECAPODA, XANTHIDAE) AND A GIANT NEW *PILUMNUS* FROM QUEENSLAND WATERS

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ABSTRACT

Pilumnus terraereginae Haswell is shown to be a species distinct from *P. tomentosus* Latreille; the latter is distributed around southern Australia, the former is known from northeastern and northwestern Australia. *P. terraereginae* is figured and compared with similar species. A new species of *Pilumnus*, allied to *P. sinesis* Gordon from the South China Sea, is described from shallow water in the Bundaberg–Gladstone area, Queensland. The species, which is extremely large, is covered by long stiff yellow hairs and the wrists and hands of the chelipeds bear large, pointed black spines in rows.

Many previous workers on xanthid crabs (Balss, 1933; Sakai, 1965) have considered *Pilumnus terraereginae*, originally described by Haswell (1882a) from Port Molle in Queensland, to be the same species as the apparently widespread Indo-Pacific *P. tomentosus* Latreille. Within Australia the latter has been recorded from several localities around southern Australia (Whitelegge, 1900; Rathbun, 1923). *P. terraereginae*, on the other hand, has been recorded from parts of Queensland (Grant and McCulloch, 1906) and from northwestern Australia (Nobili, 1899). Rathbun (1923) considered the two species separately in her key to Australian species of the genus. Amalgamation of *P. terraereginae* with *P. tomentosus* would result in the one species being accorded a virtually circum-Australian distribution. Only one other species of decapod crustacean, the portunid swimming crab *Portunus pelagicus* Linnaeus, is known to have such a distribution (Griffin and Yaldwyn, 1968). Examination of the type material of *P. terraereginae* and of other recently collected specimens of this species and comparison of them with numerous specimens of *P. tomentosus* shows that the two are distinct.

Between 1963 and 1965, Mrs. Charlotte Wright, then of Lady Elliott Island, Queensland, sent a large collection of decapod Crustacea from the Bundaberg–Lady Elliott

Island area to the Australian Museum. Included in this important collection were two large specimens of a species of *Pilumnus* dredged in shallow water about 30 miles east of Bundaberg. Additional specimens of the same species have been taken near Port Curtis and form part of the Melbourne Ward collection. These specimens represent a new species which is described and illustrated here.

All the material on which this report is based is in the collections of the Australian Museum (Aust.Mus.), Sydney with the exception of two paratypes of the new species of *Pilumnus* which are in the Queensland Museum (Qd.Mus.); the registered number of each lot of specimens is given in brackets. Measurements given are carapace width (c.w.) exclusive of spines, and carapace length (c.l.); they were made to the nearest 0.1 mm with dial calipers.

Family XANTHIDAE

Genus **Pilumnus** Leach

Pilumnus terraereginae Haswell

(Figs. 1, 3a, b; pl. 26)

Pilumnus terraereginae Haswell, 1882a, pp. 752–3; 1882b, p. 68, pl. 1 fig. 5. Nobili, 1899, p. 260. Grant & McCulloch, 1906, p. 15, pl. 1 fig. 1.

[non] *Pilumnus terraereginae*; Grant in Sayce, 1902, p. 154 (?=*P. etheridgei* Rathbun).

TYPES: In the original description no particular specimen is mentioned as the type. Thus, all Haswell's material is to be considered syntypic. From the four dry specimens, in the Australian Museum, mounted on a rectangular glass sheet with a printed label "*Type* PILUMNUS TERRAEREGINAE, *Haswell*, *Loc.* Port Molle, Queensland" and registered as P730 (this number is also printed on the label), I select as LECTOTYPE the male in the upper right hand corner, c.w. 10·6 mm. The remaining three specimens, all males, c.w. 8·1–10·5 mm, are designated as PARALECTOTYPES. Two of the paralectotypes have legs detached and one has some legs glued next to it.

ADDITIONAL MATERIAL (all in Aust. Mus.)

QUEENSLAND: Port Molle (old collection), 1 male, c.w. 14·9 mm (P2256). Bowen Jetty, Port Denison, from pile, E. H. Rainford, February 1924, 1 female, c.w. 9·6 mm (P7013). Port Denison, E. H. Rainford, July 1918, 3 males, 2 females, c.w. 6·1–15·7 mm (P4207). Masthead Island, Capricorn Group, D. B. Fry, January 1911, 1 male, c.w. 9·7 mm (P2592). Port Curtis, pres. Mrs F. E. Grant, 1 female, c.w. 15·2 mm (G5635). Port Cartwright, A. A. Livingstone, 2.viii.1922, 1 male, 5 females (1 ovig.), c.w. 7·2–14·2 mm, ovig. female 11·7 mm (P6367). Caloundra, A. A. Livingstone, 11–14.viii.1922, 1 male, 1 female, c.w. 8·1, 11·4 mm (P6368).

NEW SOUTH WALES: Near Yamba, mouth of Clarence River, A. A. Cameron, March 1940, 1 ovig. female, c.w. 9·1 mm (P11303). Yamba, pres. A. A. Cameron, 1939, 1 female, c.w. 11·8 mm (P11245). Woody Head, near Yamba, A. A. Cameron and Joyce Allan, 1941, 2 females, c.w. 10·5–19·0 mm (P11358). Angowrie, near Yamba, A. A. Cameron, January 1940, 1 ovig., female, c.w. 12·3 mm (P11263).

DESCRIPTION: Carapace broader than long, anterolateral margins as long as posterolaterals. Surface of carapace, chelipeds and ambulatories with long and short simple hairs. Dorsal surface of carapace with closely spaced hairs on the anterior half to two-thirds; surface of carapace beneath hairs granular except between level of posterior border of orbits and front; granules round, generally blunt, larger, more pointed and more closely spaced laterally.

Front deflexed, divided by V-shaped notch medially, edge bearing small tubercles which are larger and sharper medially. Orbits with similar closely spaced tubercles dorsally and sharper ones ventrally; external orbital angle short, sharp.

Anterolateral margins with three moderately long, sharp spines behind small external orbital spine, one small sharp tubercle behind, and sometimes in front of, first and second spines; external orbital angle with one small spine behind it.

Subhepatic regions with several small tubercles close to anterolateral margin and a group near lower border of orbit. A group of tubercles at anteromedial corner of pterygostomian regions.

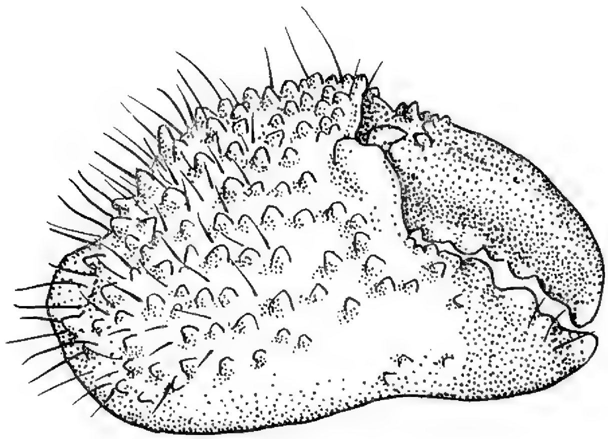

FIG. 1: Major (right) chela of *Pilumnus terraereginae* Haswell (male, c.w. 15·1 mm, Aust. Mus. P4207), outer face.

Third maxillipeds smooth and naked except for minutely granular areas near lateral and towards mediodistal border of merus.

Chelipeds tuberculate and hairy. Merus with a compressed lobe dorsally subdistally, hairs on posterior surface distally. Carpus with moderately dense, long and short hairs and tubercles dorsally and laterally, tubercles larger and more pointed distally. Palm of major chela with long and short hairs on dorsal third or slightly more of outer surface, and large tubercles over all of outer surface, except ventrally, a line of low indistinct tubercles along middle of ventral surface; tubercles larger and sharper dorsally. Palm of minor chela with long hairs over almost all of outer surfaces and large tubercles more or less in rows over all of outer surface; tubercles larger, less stout and more pointed dorsally. Fingers of both chelae with inner cutting edges strongly toothed; dactyls with tubercles dorsally proximally, those on minor chela extending in three rows along half length of dactyl; fixed finger of major chela with one or two small tubercles proximally, that of minor chela with a row of tubercles extending on to outer surface from palm.

Ambulatory legs without spines or tubercles; merus with hairs on dorsal edge and a few scattered along posterior surface; carpi and following segments with long and short hairs dense on all surfaces.

Abdomen of male with last segment longer than wide, sub-triangular, apically rounded.

First pleopod of male sinuous, slender, tapering, strongly curved apically; aperture terminal, on abdominal surface at end of groove which is wholly abdominal; a line of hairs on medial surface midway along curving across sternal surface to lateral surface at tip, a line of hairs near tip on medioabdominal surface.

REMARKS: This species resembles *P. tomentosus* in the arangement and types of hairs on the carapace, chelipeds and legs and both have the tubercles on the major chela covering most of the outer surface of the palm (see Griffin and Yaldwyn, in press). However, there are very marked differences between the two. In *P. tomentosus*, the anterolateral lobes are broad and bear supplementary spines (a feature mentioned by Latreille (1825, p. 125) in his original description of *P. tomentosus*), the surface of the carapace beneath the hairs is smooth, the front is strongly deflexed, the tubercles on the palms of the chelae are noticeably less closely-spaced dorsally than elsewhere, the ventral edges of the chelae are tuberculate, the ambulatories are more hairy than in *P. terraereginae* and the meri sometimes bear spinules. Finally, *P. terraereginae* is a smaller species than *P. tomentosus* and has a differently shaped first pleopod in the male, the apex being weakly curved distally whereas in *P. tomentosus* the tip is strongly recurved and slender.

P. tomentosus has been recorded from Australia, Indonesia, Samoa and Japan by Balss (1933). The specimen he figures (from Timor) (pl. III figs. 14 ,15) possesses tubercles on the posterior surfaces of the ambulatory meri, a prominent spine on the internal angle of the carpus of the cheliped and the tubercles on the outer surface of the palm of the chela extend on to the ventral edge. None of these three features are found in either *P. terraereginae* or *P. tomentosus*. The Japanese specimens figured by Sakai (1939, pl.54 fig. 1; 1965, pl.78 fig. 2) also possess granular ambulatory meri. Takeda and Miyake (1968) also include *P. terraereginae* in the synonymy of *P. tomentosus* and figure the first pleopod of a male from Japan. This differs from the male first pleopod of Australian *P. tomentosus* (see Griffin and Yaldwyn, in press) in having the tip bent at a right angle to the shaft instead of recurved and in having shorter and more numerous setae along the shaft.

Japanese and Indonesian specimens therefore represent a species distinct from *P. terrae-reginae* and *P. tomentosus*.

Pilumnus nigrispinifer n.sp.

(Figs. 2, 3c, d; pl. 27)

HOLOTYPE: Male (dry), c.l. 50·1 mm, c.w. 60·0 mm, dredged 30 miles east of Bundaberg, Queensland, about 15 fm, D. Hall, 1964 (Aust. Mus. P16440).

PARATYPES: Male (in spirit), c.w. 46·5 mm, same locality data as holotype (Aust.Mus.P16441). One female (dry), c.w. 38·8 mm, trawled near Polmaize Reef and Rock Cod Shoal, off Port Curtis, Queensland, 20 fm, Melbourne Ward collections (Aust.Mus.P16442); two males, same data, c.w. 30·6, 38·6 mm (Qd. Mus. W3061).

DESCRIPTION: Carapace globose, broader than long, anterolateral margins as long as posterolateral margins. Surface of carapace, chelipeds and legs bearing very long, simple, stiff hairs; posterolateral parts of carapace naked; surface of carapace beneath hairs smooth.

Front about one-third greatest width of carapace, divided into two medial lobes edged with small tubercles and separated medially by a very narrow slit, and a narrow lateral lobe terminating in a spine. Orbits bordered by tubercles dorsally and ventrally, two spines arising one above the other at external orbital angle; suborbital border with a closed fissure adjacent to external orbital angle, supraorbital border with two very shallow notches.

Anterolateral margins with three short, sharp, slender, broad-based spines behind external orbital angle. All spines without supplementary spines or tubercles.

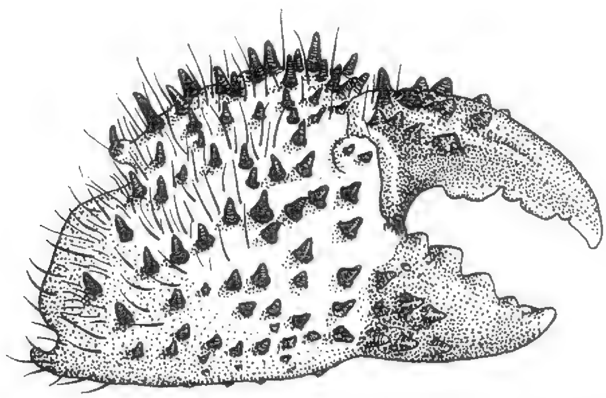

FIG. 2: Major (right) chela of *Pilumnus nigrispinifer* n. sp. (holotype, male), outer aspect.

Subhepatic regions with several tubercles, one larger than others close to margin and visible in dorsal view behind external orbital angle. Suborbital regions with a group of tubercles adjacent to basal antennal article.

Third maxillipeds minutely granular.

Chelipeds spinous and hairy. Merus with a distal subdorsal spine and a row of small, sharp tubercles along anterodorsal and anteroventral edges; a few long hairs on lateral surface distally. Carpus with long sharp spines in longitudinal rows on dorsal and lateral surfaces and long hairs arising between the spines. Palms of both chelae bearing long hairs over more than half outer surface and with stout sharp spines more or less in about eight longitudinal rows over whole of surface, dorsal rows further apart and comprising longer and more slender spines; blunt tubercles along ventral edge towards inner surface. Both fingers of both chelae with sharp tubercles extending in rows on to outer surface, three rows of longer spines on dorsal surface of dactyls. Inner cutting edge of fingers with broad blunt teeth.

Ambulatory legs short and stout, all surfaces covered by long lairs but without tubercles or spines.

Abdomen of male with last segment very narrowly subtriangular, apically rounded.

First pleopod of male proximally stout and curved, otherwise straight, slender and tapering abruptly apically, aperture terminal, abdominal, groove wholly abdominal, a line of hairs along lateral surface terminating close to tip as diffuse tuft, a few hairs on medial surface alongside aperture.

Colour: Upper surfaces of body and of chelipeds and legs pale rusty red to orange, under surfaces of body slightly paler, under surfaces of appendages pale yellow to buff. Spines on chelipeds dark chocolate-brown to black, fingers also dark brown to black, edges of teeth and tips of fingers pale yellow. Hairs brown to yellow.

Remarks: This species is immediately distinguished by its large size and the long black spines on the chelipeds. In many features there is a very close similarity between *P. nigrispinifer* and *P. sinensis* Gordon* from Hong Kong (Gordon, 1931). These similarities include the general shape, armature and hairiness of the carapace, chelipeds and legs, the shape of the abdomen and the straight first pleopod in the male. Comparison of *P. nigrispinifer* with the original descriptions of *P. sinensis* and a specimen recently collected by the Fisheries Research Station, Hong Kong (male, c.w. 39·6 mm, South China Sea, 20°48.0′N., 112°31.5′E. to 20°44.0′N., 112°31.0′E., Granton trawl at 39–40 fm on sandy

*The first description of this species was published by Gordon in 1931 (*Ann. Mag. nat. Hist.*, ser. 10 vol. 6, pp. 523–4). The two descriptions differ slightly in detail and are both headed "*Pilumnus sinensis* sp.n.'

mud with starfish and sponges, 8.xii.1963, Aust.Mus. P16443) shows that the two species differ in the following features. In *P. nigrispinifer* the median frontal lobes have a straighter edge, they do not project so far forward and are separated by a very narrow fissure (not a V–shaped notch), the suborbital border bears tubercles only (not spines medially and tubercles laterally), the spines on the carpus and palm of the chela are straight (not curved), they are very short on the ventral edge of the palm and there is no difference in the number of spines on the palm between males and females. Finally, the tip of the first pleopod in the male tapers to a blunt point in *P. nigrispinifer* but is obliquely subtruncate in *P. sinensis*. Gordon states that the carapace bears long hairs anteriorly; they actually occur also mid-dorsally on the posterior half as in *P. nigrispinifer*.

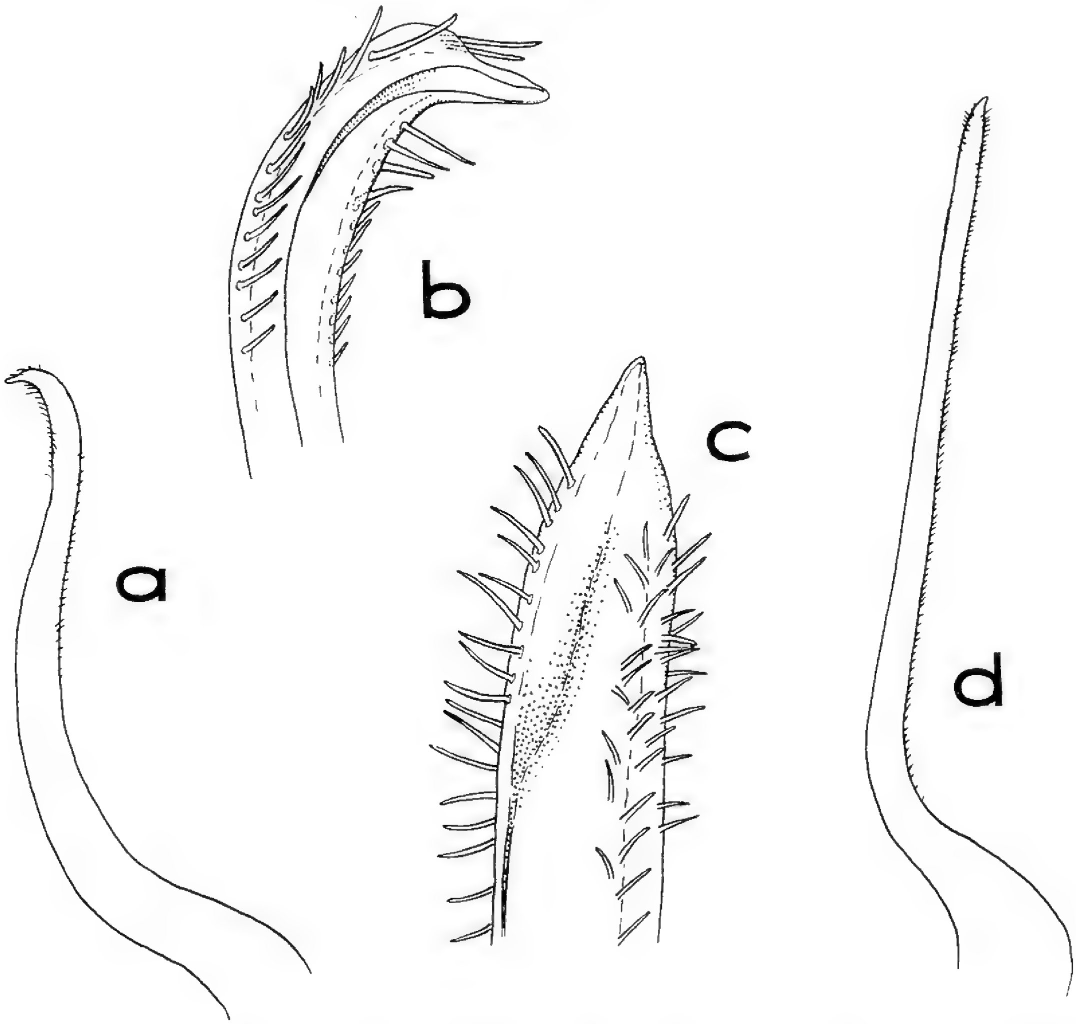

FIG. 3: Male first pleopod of *Pilumnus terraereginae* Haswell (male c.w. 15·7 mm, Aust. Mus. P4207) (a, b) and *Pilumnus nigrispinifer* n.sp. (paratype, male, c.w. 46·5 mm, Aust. Mus. P16441) (c, d). a, d, whole pleopod, sternal aspect; b, c, tip in abdominal aspect.

ACKNOWLEDGEMENTS

I wish to thank Dr. J. C. Yaldwyn, formerly of the Australian Museum, for bringing the specimens of the new species to my attention and for his advice and criticism. I am grateful also to Anthony Healy of Sydney for taking the photographs which accompany this paper.

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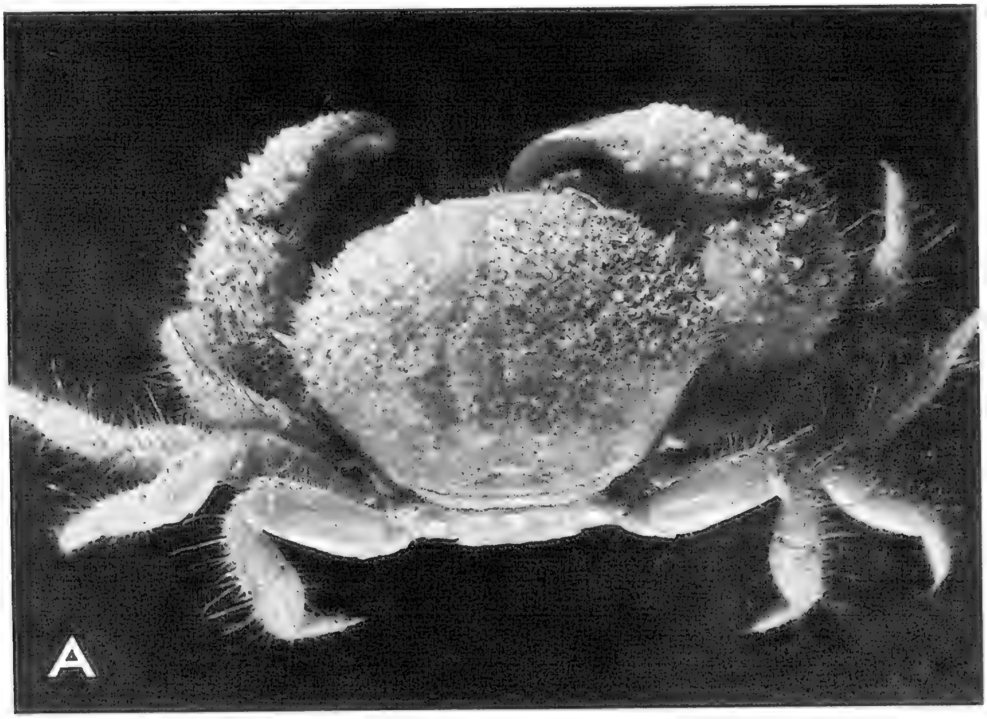
PLATE 26

Pilumnus terraereginae Haswell. Male, c.w. 15.7 mm (Aust. Mus. P4207).

A, dorsal view.

B, ventral view.

(Photos—Anthony Healy).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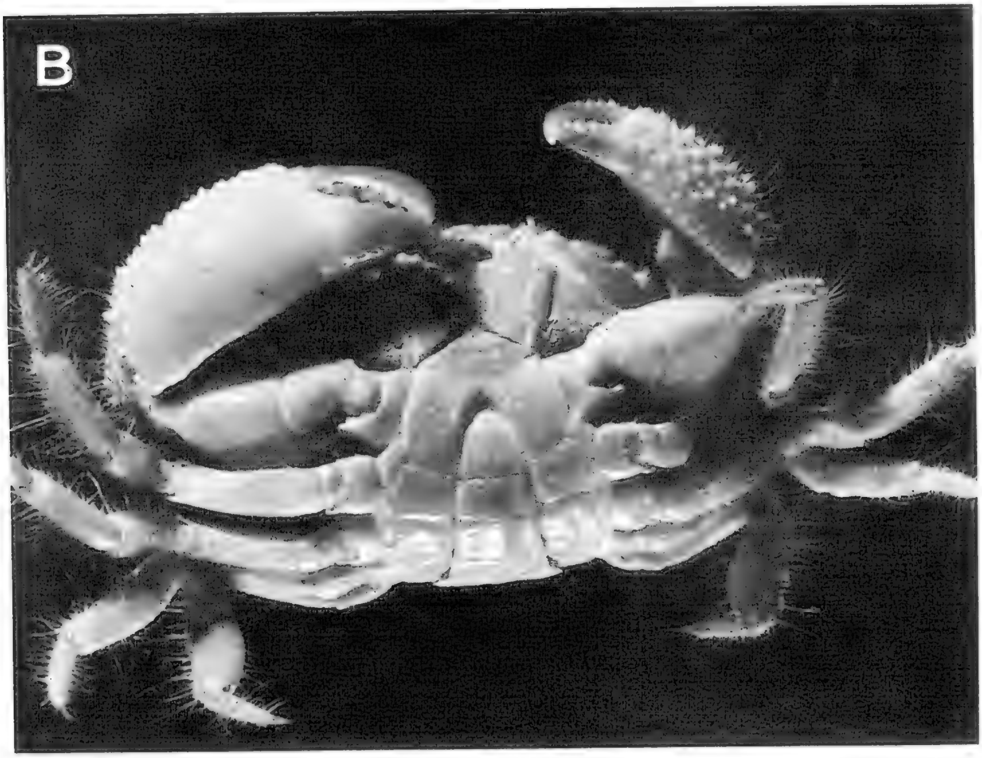
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PLATE 27

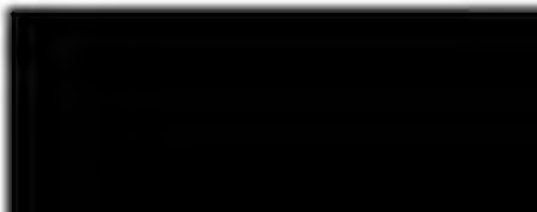
Pilumnus nigrispinifer n.sp. Holotype, male (Aust. Mus. P16440).

A, dorsal view (hairs removed from right half of carapace)

B, ventral view.

(Photos—Anthony Healy).


A
B



NEW RECORDS OF PORTUNIDS FROM SOUTHERN QUEENSLAND

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The portunid fauna of Australia, and particularly that of Queensland, has been worked upon intensively for over a decade (Stephenson and Hudson, 1957; Stephenson, Hudson and Campbell, 1957; Stephenson and Campbell, 1959, 1960; Stephenson, 1959, 1961; Rees and Stephenson, 1966; Stephenson and Rees, 1968a, b, c). As a result recordings of portunids new to Australia and to Queensland might only be expected at infrequent intervals. Griffin (1969) has, surprisingly, recorded two species new to Australia and one new to Queensland from One Tree Island in the Capricorn Group. These records are of *Charybdis obtusifrons* Leene, *Thalamitoides quadridens* A. Milne Edwards, and *Portunus longispinosus* (Dana) respectively.

The present work adds two new Australian records, and two new Queensland records, and results from collections from a relatively unexplored region, albeit one not very distant from Brisbane. The collections were made by Dr. A. J. Bruce, and were sorted from 60 trawled collections made on the 1/68 cruise of the "Nimbus". The area of investigation lay between Moreton Island and Double Island Point, at distances of up to 40 miles offshore.

The extension of prawn trawling in recent years from Moreton Bay to offshore waters has already revealed interesting material, including amongst the portunids large numbers of *Charybdis bimaculata* (Miers), the "cold water" *Macropipus corrugatus* (Pennant) (see Rees and Stephenson, 1966), and the previously undescribed *Charybdis rufodactylus* Stephenson and Rees, 1968a. Amongst the fishes from the area, Thomson (1967) has described two new species, (*Kanekonia aniara* and *Aulopus curtirostris*) and a first Queensland record. Interesting stomatopods from offshore waters have also been collected, and two species in the authors' collections merit further study. It appears almost certain that intensive benthic collecting of offshore areas by trawl, dredge and grab would reveal a wealth of new material.

Relevant material from Dr. Bruce's collections is listed below. The ultimate entry under each recording is the registered number in the collections of the Queensland Museum; the Station numbers refer to the "Nimbus" 1/68 Cruise, and dimensions are of carapace breadth.

Parathranites orientalis Miers

Lupocyclus (*Parathranites*) *orientalis* Miers, 1886, pp. 186–7, pl. 17, fig. 1, fig. 1a–c.

Parathranites orientalis (Miers). Alcock, 1899, pp. 17–18. Sakai, 1939, pp. 376–7, pl. 43, fig. 2. Barnard, 1950, pp. 148–50, figs. 29 i–l. Stephenson, 1961, pp. 97–8, figs. 1B, 2H, pl. 1, fig. 2, pl. 4B. Crosnier, 1962, p. 22, fig. 24. Sakai, 1965, p. 113, pl. 51, fig. 1. Stephenson and Rees, 1967a, pp. 7–8 (record only).

One male (24.5 mm), one female (20 mm), Sta. 11, 26°31′S., 153°43′E., 100–102 fm, 26.vii.1968, W3085. One male (25 mm), Sta. 19, 26°49′S., 153°37′E., 100–100.5 fm, 27.vii.1968, W3086. Two males (23.5–24 mm), Sta. 26, 27°00′S., 153°39′E., 100 fm, 28.vii.1968, W3087. One male (14 mm), Sta. 29, 26°30′S., 153°44′E., 100.5 fm, 29.vii.1968, W3088.

Previously recorded from Madagascar; Seychelles; India; Andamans; Kai Is.; Admiralty Is.; eastern Australia (230 m, off Port Stephens, New South Wales) and Solomon Bank. New Queensland record.

Lissocarcinus arkati Kemp

Lissocarcinus arkati Kemp, 1923, pp. 405–8, pl. 10, fig. 1. Chopra, 1931, pp. 310–11 (under *L. ornatus*). Gordon, 1931, p. 533. Leene, 1938, pp. 6–7. Sakai, 1939, p. 381, pl. 80, fig. 4. Crosnier, 1962, pp. 23–5, figs. 28, 32.

One ovig. female (22 mm), Sta. 8, 26°30′S., 153°15′E., 25.5–26.5 fm, 26.vii.1968, W3089.

Previously recorded from Madagascar; mouth of River Hughli, India; Hongkong; Gier Sta. at *c*. 106°44′E., 3°22′S. (S. of Java); and Japan. New Australian record.

Thalamita macropus Montgomery

Thalamita macropus Montgomery, 1931, pp. 431–2, pl. 24, fig. 4, pl. 28, fig. 2 (inaccurate in fig. 2a). Stephenson and Hudson, 1957, pp. 343–4, figs. 2J, 3J, pl. 4, fig. 1, pls. 7J, 10H. Stephenson, 1961 p. 122.

One male (10.5 mm), Sta. 24, 27°00′S., 153°33′E., 51–52 fm, 26.vii.1968, W3090.

Previously recorded only in Australia from Albrolhos Is., Cape St. Cricq (Shark Bay), W. Australia; Port Stephens, Norah Hd., Pt. Gibbon, Manly, New South Wales. New Queensland record.

Lupocyclus philippinensis Semper

Lupocyclus philippinensis Semper, 1880, p. 68. Balss, 1922, p. 113. Sakai, 1939, pp. 383–4, pl. 80, fig. 3. Leene, 1940, pp. 174–6, fig. 5, pl. 3.

One female (15 mm), Sta. 8, 26°30′S., 153°15′E., 25·5–26·5 fm, 26.vii.1968, W3091. One male (23 mm), one female (16 mm), Sta. 17, 26°48′S., 153°32.5′E., 55 fm, 27.vii.1968, W3092.

Previously recorded from Madras to Philippines and Japan. New Australian record.

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DISTRIBUTION, HABITS AND SEXUAL DIMORPHISM OF THE WESTERN GRASS-WREN *AMYTORNIS TEXTILIS BALLARAE* CONDON IN NORTH-WESTERN QUEENSLAND.

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ABSTRACT

Males of *A.t. ballarae* Condon, 1969, described from females differ from the type in plumage colouration. Observations have been made of this subspecies in the Mount Isa district, and habitat, behaviour, nest and call notes are described and distribution discussed.

Keast (1958) has given the northern and eastern limits of distribution of *Amytornis textilis* (Dumont) as the Macdonnell and James Ranges in the Northern Territory. Therefore the sighting of a Grass-Wren in Argylla Ranges near Mary Kathleen in 1966 was an important extension of known range and an additon to the list of birds in Queensland.

The sighting was confirmed when an adult female specimen was collected by Carruthers in July 1966 at Ballara near the location of the first sighting. On the basis of this specimen, Qd Mus. O10692, and a second specimen, Qd Mus. O11011, Condon (1969) has given subspecific status to this northwestern Queensland population with the name *Amytornis textilis ballarae.*

Observations and detailed study of this northeastern race of the Western Grass-Wren continued throughout 1967 and 1968. Subsequent collection of two adult male specimens by Carruthers has revealed marked sexual dimorphism. Examination of the holotype, paratype and the two male specimens together with field observations on nesting habits and habitat preferences have been made.

The findings of this field study by R. K. Carruthers and W. Horton together with a description by D. P. Vernon of the first two male specimens collected in Queensland and a table of weights and measurements is presented in this paper.

Amytornis textilis ballarae Condon

Amytornis textilis ballarae Condon, 1969, pp. 205-6.

Material Examined

Adult female, 6 miles S. of Mary Kathleen, near Ballara copper mine, 17 July, 1966, Qd Mus. O10692, holotype.

Adult female, Sybella Creek, 12 miles SSW. of Mount Isa, 27 October, 1966, Qd Mus. O11011, paratype. This specimen compares closely in both dorsal and ventral plumage with the holotype.

Adult male, near Mica Creek, 6 miles SW. of Mount Isa, M.R. 139°27′E., 20°50′S., 23 March, 1968, Qd Mus. O11078.

Adult male, ½ mile N. of Mount Isa–Cloncurry road, 8 miles E. of Mount Isa, 6 April, 1968, Qd Mus. O11079.

Description of Males:

The two specimens are considered adult, their skulls being fully ossified and the gonads large (5 $\times$ 3 mm).

The dorsal plumage of the back and rump agrees with the holotype in general colour ("Liver Brown" of Ridgway, 1912, pl. XIV, see Condon, 1969). The dorsal plumage of the tail of all four specimens is dark brown, ("Chestnut Brown" of Ridgway, 1912, pl. XIV), with the edges of each feather paler brown on the ventral surface. The four specimens all show slight but definite barring on the under tail coverts. These feathers are ochraceous to light brown, barred umber brown.

Marked sexually dimorphic characters are obvious on study of the ventral plumage, (see pl. 28, fig. 1). Condon (1969) says "In all subspecies females are more rufous on the flanks than males". This dimorphism is most obvious in *A. t. ballarae* as the two male specimens differ from the holotype in that the flanks are not rufous but pale grey, ("Pale Smoke Grey" of Ridgway, 1912, pl. XIV). The mid-breast and central belly feathers of the males are ochraceous ("Deep Olive–Buff" of Ridgway, 1912, pl. XL), being lightly but distinctly barred umber brown, whereas this character is not evident in the holotype and only slightly evident in the paratype. The base of the bill of the two male birds are bluish grey ("Deep Gull Grey" of Ridgway, 1912, pl. LIII), which merges to dark umber brown whereas in the females the base is "dark grey". The upper mandibles of all four specimens are dark umber brown.

The two male specimens are larger than the females as is shown in Table 1.

TABLE 1

MEASUREMENTS IN MM AND WEIGHTS IN GM OF SPECIMENS OF *A.t. ballarae*

Sex	Specimen	Total length	Wing-span	Tail length	Wing	Tarsus	Culmen exposed	Culmen total	Weight
Females	O10692	147	180	75	60	23	10.4	14	—
	O11011	159	171	76	59	23	10.4	14	19
Males	O11078	163	191	79	59	25	10.5	14.5	22.6
	O11079	168	189	80	61	25	10.5	14	22.2

OBSERVATIONS

The Grass-Wren was first seen in Queensland by Mr. and Mrs. W. Horton on 2 July 1966, 12 miles south of Mary Kathleen among rocks beside the bush track to Ballara. This area has an open woodland vegetation of Snappy Gum (*Eucalyptus brevifolia*) and Spinifex (*Triodia* spp.), with steep hills and rock outcrops of dark, strongly metamorphosed acid and basic volcanics which on weathering tend to form ridges of piled "tors" in a similar manner to granite. On a second visit to this area on 15 July 1966 a single bird and a flock of eight to ten birds were seen and one specimen collected. This specimen, Qd Mus. O10692, is the holotype of *A. t. ballarae*.

On 7 August 1966 a nest of *A. t. ballarae* with one egg was discovered near Brown's Waterhole on Sybella Creek about 12 miles SSW. of Mount Isa. This area is less rugged than Ballara, with rolling hills and considerably less outcrop. The vegetation is similar but the Spinifex is shorter and more open. Photographs of the nest and the parents in the vicinity of the nest were obtained on 13 August and during this period the egg hatched. Other observations were made of the nesting birds on 21 and 28 August 1966. The young bird had left the nest by the 28th but was still in the area with the parents.

Subsequent sightings are listed below:

September 1966: Sybella Creek 1 mile west of Brown's Waterhole; rugged granite country with varied vegetation of stunted Snappy Gum, Western Box, (*Eucalyptus argillacea*), Silver-leafed Box (*E. pruinosa*), a varied shrub layer of *Acacia*, a number of unidentified species and a grass layer of dense Spinifex.

October 1966: Sybella Creek, female collected Qd. Mus. O11011; young bird caught by hand and banded.

1967: Several sightings in range of hills between Sybella Creek and Mount Isa, west of the Golf Club.

February 1967: 100 miles ESE. of Mount Isa, granite rock, less rugged than at Sybella Creek with woodland of Snappy Gum and Spinifex.

August 1967: Thorntonia Station, 90 miles NW. of Mount Isa; hilly limestone area with restricted rock outcrop; Snappy Gum-Spinifex woodland; unconfirmed sighting, S. H. Midgley.

March 1968: Sybella Creek, 12 miles SW. of Mount Isa.

23 April 1968: ½ mile north Mount Isa–Cloncurry road, 8 miles east of Mount Isa, male collected Qd Mus. O11079, rugged country.

1 June 1969: Kennedy's Creek, ¼ mile SSW. of Mount Isa; pair seen in rugged gully.

Probably the area of highest population density found was a section of quartzite ridges about 6 miles SSW. of Mount Isa. Mica Creek cuts a sharp "V" valley through these north-south ridges. The nature of the rock and angle of bedding has permitted the secondary drainage systems to cut a series of sharp gorges between the ridges. Unlike many other areas where the Grass-Wren has been found, the rocks here were light coloured, verging from off-white to light grey or light brown quartzites and shales with numerous pure white quartz intrusions.

While the species is apparently able to live without access to water, the existence of near permanent springs in the Mica Creek environs could be one reason for the concentration. However, they have never been observed in the immediate vicinity of the springs.

Distribution in Northwestern Queensland

From the sightings obtained it has been concluded that *A. t. ballarae* will be found throughout the rugged hilly Spinifex country of northwestern Queensland (fig. 1). Because of variations in the nature of the country, distribution is not uniform and probably is not continuous. Very thorough and widespread examination has revealed no indication of the species in the flat to gently sloping mature valley floors even where dense Spinifex exists.

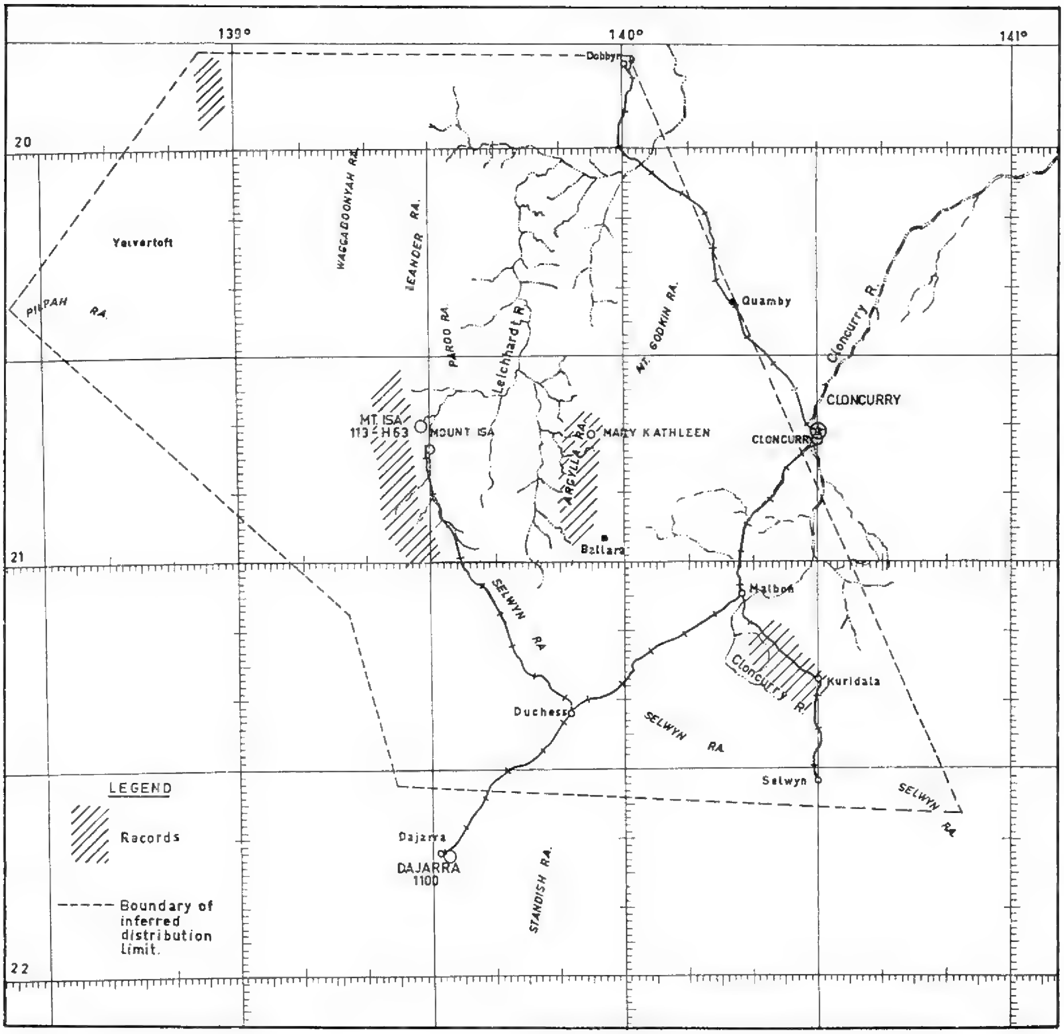

FIG. 1: Observed and inferred distribution of *A.t. ballarae.*

Human activity does not appear to have affected distribution to date, although fire could pose a serious threat. Several areas of apparently ideal habitat were examined twelve months after major fires had passed through, without finding any trace of the Grass-Wrens.

BEHAVIOUR

The Mount Isa race appears to be similar in behaviour to other members of the species and the family. It has an erect wren-like stance (pl. 28, fig. 2) and is normally terrestrial. Occasionally it will perch in a low bush, probably to obtain a better view, particularly where the terrain is flat. It tends to hop rather than fly and this is very noticeable when it is in rough country and when it is moving up-hill. In areas of piled "tors" and broken rock it will run through internal crevices and travel for a considerable distance through the rock piles. Travelling down the slopes it more frequently flies, covering up to 70 yards in a flight. When pursued it scurries like a rat, tail down and with great speed through the Spinifex. It is very difficult to follow. Solitary birds are occasionally seen but it is more usual to see pairs or small parties of four to ten birds.

Nesting

In the Mount Isa district, nesting occurs in the period late July to September or October. With the breeding pair observed, nesting, started in late July 1966 some four months after the last appreciable rain. Good rain did fall in late August 1966 and some nesting took place following this rain but there is no evidence to suggest that the rain provided the stimulus. The Variegated Wren, *Malurus lamberti*, and the Spinifex-bird, *Eremiornis carteri*, also nest in the period July to October, but do not depend on rain as a breeding stimulus. The nest described was found one mile west of Brown's Waterhole near Sybella Creek. It was constructed of a mixture of grasses neatly lined with fine grass. The entrance was on the up-hill side shielded by Spinifex spines and faced south. The nest was roomy and the top was sufficiently thick to provide a complete shield from the sun. In this latter respect, this differs from the nest of *A. textilis* described by Serventy and Whittell (1962, p. 332).

The nest was situated in a Spinifex clump about 5 feet from the base of a Snappy Gum and received shade after noon. The birds always approached the nest from the ground and while under observation each approach tended to be from a different direction. Frequently they approached through the Spinifex clump itself. Exit from the nest was always rapid, usually by a long hop to the ground. With the young in the nest, visits were infrequent and 30 minute absences were common. Both parents took part in feeding the young. There is an abundance of insects and spiders all the year, particularly in the Spinifex. Insects were de-winged on a rock before feeding to the chick, and after feeding both birds were seen to remove the faecal sacs. Very occasionally one of the birds sat in the nest for 20 or 30 minutes.

Call Notes

The most common call, probably a feeding call, is a faint high-pitched peep or squeak. This is normally heard before the birds are seen. It makes a somewhat louder but similar squeak when first alarmed but once thoroughly alarmed it often remains completely silent. On several occasions, it has been heard to give a complex, most attractive and reasonably loud song which has resemblance to the song of the Weebill or Mistletoe-bird but includes two sharp louder final notes somewhat reminescent of the Rufous Whistler. This song may only be given by the male. On several occasions the birds have responded to squeaking calls allowing very close observation.

Discussion

The discovery of this isolated northwest Queensland population of *A. textilis* opens up the question of further extensions of range of the species. Without confirmation Keast (1958) would not accept "the 'sight' records of Keartland (1904) for the Margaret R. in the north-west of Western Australia nor those of Jarman (see Condon 1951) for Barrow Creek in Central Australia". However these should now be accepted as highly probable. Jarman (1953) records specimens observed at Standley Chasm, Palm Valley and near Ayre's Rock and Shane Parker (pers. com.) reports that sightings have recently been obtained of a cinnamon-breasted race from the vicinity of Tennants Creek.

With the preference shown by the northern and eastern races of *A. textilis* for rugged Spinifex country the following are suggested as areas where it is likely that other populations exist.

(1) Reynolds Range — 100 miles N.N.W. of Alice Springs.

(2) Fosters and Watt Ranges — Barrow Creek area.

(3) Murchison and Davenport Ranges — N. and E. of Wauchope.

(4) Fergusson, Harts and Jervois Ranges — E. of Alice Springs.

(5) Tarlton, Adam, Cairns and Toko Ranges — 200 to 300 miles ENE. of Alice Springs.

It is of interest to note that the Fergusson, Harts, Jervois, Tarlton, Adam and Toko Ranges probably at one time formed a connecting habitat link between the Central Australian ranges and the north west Queensland highlands. This is now cut by the senile Georgina valley but appears to be the most likely migration route for the ancestral stock of *A. t. ballarae*.

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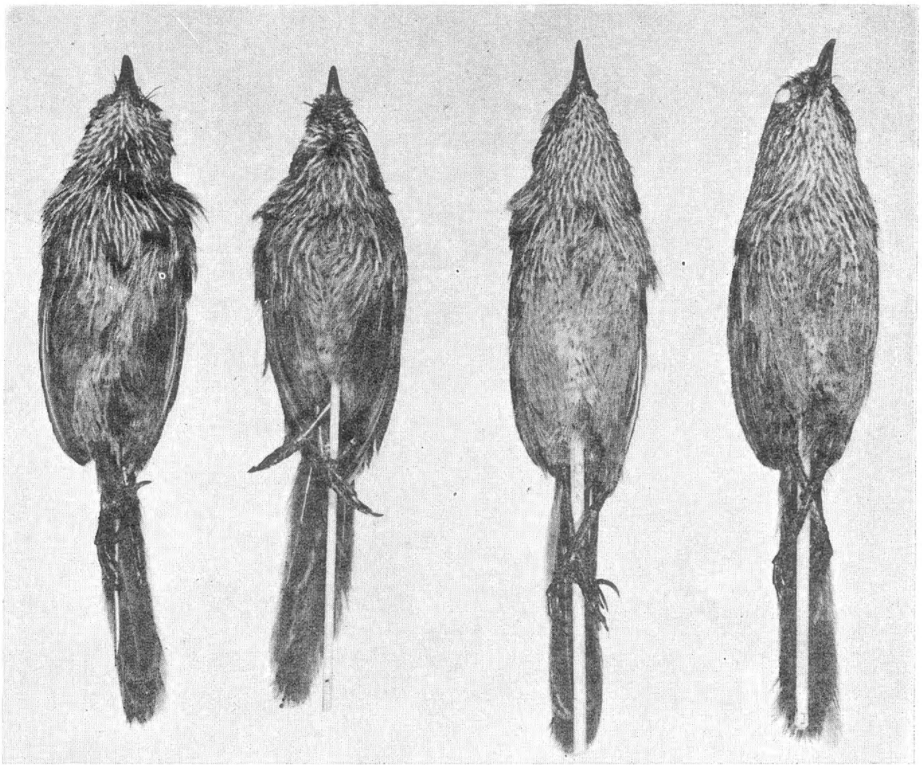
PLATE 28

FIG. 1: Sexual dimorphism in *A.t. ballarae*. Monochrome print limitations make colour differences appear less marked.

a, female, O10692, holotype
b, female, O11011, paratype
c, male, O11078
d, male, O11079

FIG. 2: *A.t. ballarae*, one mile W. of Brown's Waterhole, Sybella Creek, SW. of Mount Isa.



a. b. c. d.

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