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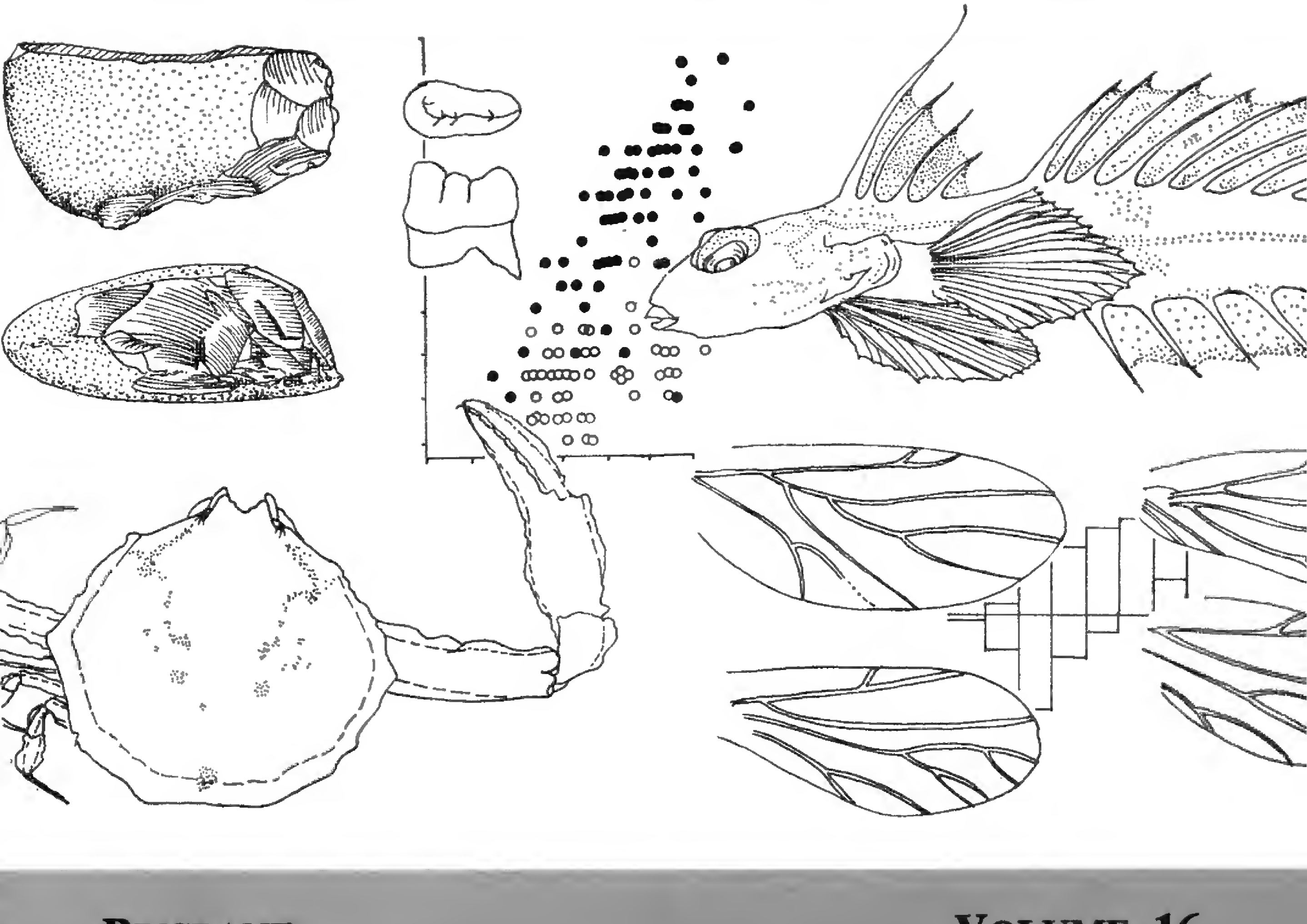

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MORPHOLOGY AND VARIATION OF THE CHEEK TEETH IN *MACROPUS GIGANTEUS* SHAW AND *MACROPUS AGILIS* (GOULD)

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ABSTRACT

The cheek teeth in the Grey Kangaroo, *Macropus giganteus* Shaw, and the Sandy Wallaby, *M. agilis* (Gould) have been described and the variation investigated. The results generally indicate considerably less variation in molar teeth and in the deciduous, molariform premolar, DP$^3_3$, than in the remaining premolar teeth in the series, P$_2$ and especially P$^3_3$. In the cheek teeth, sexual dimorphism in metrical features is shown to be a factor warranting consideration in macropodid species.

The present investigation was initiated to provide adequate information on cheek teeth variation in large, sexed samples of selected, extant macropodids. The necessity for this type of study has become increasingly apparent in connection with investigations on extinct macropodid faunas. To facilitate an assessment of possible size and morphological variation and the determination of species limits associated with this largely Upper Cainozoic taxonomic research, an accurate knowledge of variation present in extant species is of paramount importance.

The study has been restricted to cheek teeth because these are relatively abundant and well preserved elements in the fossil deposits and, for the most part, fossil species are defined by the morphology of their cheek teeth. These skeletal elements are frequently in sufficiently large numbers to allow meaningful statistical analyses and comparisons to be undertaken (Bartholomai, 1967).

The species *M. giganteus* and *M. agilis* have been selected for study for a number of reasons. Most important is the existence of closely related material in Pleistocene deposits, particularly in the fluviatile deposits of the Darling Downs area, southeastern Queensland, and the results will be of direct value for comparison in this regard. Large, sexed samples of *M. giganteus* and *M. agilis* are available, mainly as a result of investigations on living macropodids currently being undertaken by the Queensland Department of Primary Industries. Samples considered have been collected from restricted areas, *M. giganteus* from the environs of Warwick, southeastern Queensland, and *M. agilis* from the Townsville area, mid-eastern Queensland. Use of these has obviated the necessity to consider possible geographical variation. Results are thus of greater value for use in comparisons with geographically and stratigraphically restricted fossil samples. Finally, the selection has allowed an assessment of sexual dimorphism to be undertaken within the 'kangaroo' and 'wallaby' groups within the Family Macropodidae.

Limited information has previously been available on the subject (Tedford, 1967), but for the most part the statistical results were based on small, geographically diversified samples, reducing their value for the purposes intended.

Primary data sheets have been lodged in the Library of the Queensland Museum, and the specimens from which data were derived are being progressively transferred and registered into the neontological collections of the Queensland Museum. All measurements throughout are in millimetres.

The author wishes to express his appreciation to Dr T. H. Kirkpatrick of the Queensland Department of Primary Industries, for making available for study the skull remains here considered.

CHEEK TEETH IN *MACROPUS GIGANTEUS* SHAW, 1790

P^2 relatively elongate, broader posteriorly than anteriorly, markedly constricted mesially in occlusal view. Paracone and metacone well developed, high, connected by secant ridges ascending into mesial constriction, giving longitudinal crest a well defined bifid appearance in lateral view; slight cuspule frequently present towards limit of anterior metacone ridge, accompanied by slight, vertical labial and lingual ridges; protocone low, moderately well defined, with low anterior ridge usually curving labially to unite with anterior ridge from paracone at anterior limit of crown; posterior ridge from protocone less well defined, ascending at lingual limit of mesial crown constriction, usually uniting with low, broad ridge which descends from postero-lingual portion of paracone; protocone ridge occasionally unites directly at that point; hypocone relatively strongly developed, well defined, occasionally connected labially by weak ridge to base of metacone; connecting ridge more frequently ascends from anterior hypocone ridge which curves to postero-lingual base of paracone; posterior ridge from hypocone curves labially to unite with posterior ridge from metacone at posterior margin of crown. Lingual basin irregular, divided into anterior, mesial, and posterior pockets; occasionally additional minor pocket developed mesially. Slight cuspule or ridge sometimes present at antero-lingual base of hypocone. Small cuspule occasionally present labiad to and below metacone; where absent, cuspule frequently replaced with slight ridge to metacone.

DP^3 molariform, subrectangular in basal outline, slightly constricted across median valley; lophs relative high, but metaloph higher than protoloph, bowed anteriorly, with metaloph broader than protoloph. Anterior cingulum moderately low, usually broad, short, ascending lingually, with only slight indication of presence of forelink usually seen near axis of crown. Ridge usually ascends from paracone to unite with labial limit of cingulum; occasionally anterior paracone ridge descends within labial cingular limit. Midlink strong, moderately high, curving postero-labially from protocone, uniting with short ridge from point on metaloph slightly linguad to axis of crown; junction frequently puckered. Median valley V-shaped, occasionally more broadly U-shaped in lingual moiety; slight ridges acsend towards base of valley from paracone and metacone; lingually, valley occasionally with low, broad ridge transverse to crown axis. Ridge from hypocone strong, ascending posteriorly to near postero-labial base of crown; posterior ridge from metacone weak. Slight fossette developed above axis of crown; slight vertical groove often present on hypocone ridge, close to hypocone.

P^3 comparatively small, subtriangular in basal outline being broader posteriorly than anteriorly, with slight mesial constriction lingually. Paracone and metacone well developed, relatively high, connected by secant ridges which normally ascend into mesial cleft, giving crest a marked bifid appearance in lateral view; posterior portion frequently better developed than anterior; subsidiary cuspule occasionally present, associated with a pair of vertical labial and lingual ridges, towards limit of anterior metacone ridge; this cuspule rarely better developed; slight pockets also very rarely developed on both anterior and posterior moieties of crests. Anterior ridge from paracone ascends towards base of crown, associated with low ridge around anterior margin where this developed, while posterior ridge from metacone curves lingually to below posterior base of crown. Hypocone less well defined than other cusps, usually connected labially to base of metacone by relatively strong ridge; where this ridge absent, base of metacone connected to anterior ridge from hypocone which ascends into lingual constriction of crown; posterior ridge from hypocone curves labially to below posterior margin of crown. Low, variable ridge developed basally, postero-lingual to paracone. Slight posterior fossette frequently present, but lingual basin largely undeveloped.

$M^1 < M^2 < M^3 < M^4$; molars subrhomboidal in basal outline, slightly constricted across median valley; lophs relatively high, bowed anteriorly, frequently puckered at unworn crest; metaloph broader than protoloph in M^1 and M^2, often approximately equal in M^3, and narrower in M^4; metaloph higher than protoloph. Anterior cingulum relatively low, moderately broad, short, ascending lingually, with forelink well developed, frequently very strong, linguad to axis of crown. Slight but variable ridge usually ascends from paracone to unite with labial limit of cingulum; occasionally ridge may disappear before reaching base of protoloph. Slight, vertical accessory ridges sometimes present on anterior surface of protoloph. Midlink strong, moderately high, curving postero-labially from protocone, uniting with short ridge from point on metaloph slightly linguad to axis of crown; junction frequently puckered. Median valley V-shaped, occasionally more broadly U-shaped in lingual moiety; ridges ascending into valley from paracone and metacone usually poorly developed, especially that from metacone; lingual base of valley occasionally with low, broad ridge transverse to crown axis; lingual margin of median valley rarely with low ridge. Ridge from hypocone strong, ascending postero-labially to above postero-labial base of crown; posterior ridge from metacone weak. Slight fossette developed above axis of crown, while slight vertical groove often present on hypocone ridge, close to hypocone.

P_2 relatively small, subtriangular in basal outline, broader posteriorly than anteriorly, slightly constricted mesially in occlusal view. Longitudinal crest usually markedly bifid in lateral view, comprising secant ridges descending posteriorly from anterior cuspid and slightly curving lingually from postero-labial cuspid; occasionally additional cuspule present at anterior limit of posterior moiety of crest, this rarely elevated to produce near trenchent crest; cuspule associated with variable set of vertical labial and lingual ridges. Anterior ridge from anterior cuspid descends slightly lingually to variable but sometimes well elevated cuspule above base of crown; basal swellings associated with cuspule better developed lingually, with small basal tubercle frequently present postero-lingual to anterior cuspid. Postero-lingual cuspid well defined, high, with strong ridge descending labially to posterior cuspid of crest; anterior ridge from postero-lingual cuspid descends mesially to curve labially and unite with base of crest at position of cleft, defining relatively deep, posterior basin; slight variable ridges frequently present into basin. Occasionally small basal tubercle developed antero-lingual to internal cuspid.

DP_3 molariform, subtriangular in basal outline, moderately constricted across talonid basin, with lophids relatively high, strongly convex posteriorly. Hypolophid much broader than protolophid. Trigonid basin relatively narrow, its length being less than distance between lophids, with lingual portion near planar but with basin strongly descending labially. Forelink moderately strong, relatively low, descending slightly lingually from protoconid then anteriorly to antero-labial margin of high anterior cingulum. Midlink high, strong, descending antero-lingually from hypoconid and curving anteriorly, frequently abruptly, uniting with moderately well defined ridge from protoconid above talonid basin; junction often plicate; midlink crosses talonid slightly labiad to axis of crown. Talonid basin near planar and V-shaped lingually somewhat descending and U-shaped labially; labial moiety occasionally with slight, broad transverse ridge. Posterior surface of hypolophid generally convex but usually more angular postero-lingually; slight groove descends postero-lingually from position mesiad to hypocone.

P_3 relatively small, subtriangular to subovate in basal outline, usually broader posteriorly and slightly constricted mesially. Anterior margin of crown near vertical. Anterior cuspid with trenchent ridge usually descending to unite with descending ridge from postero-labial cuspid slightly posterior to mid-point of crown; crest usually bifid in lateral view, but

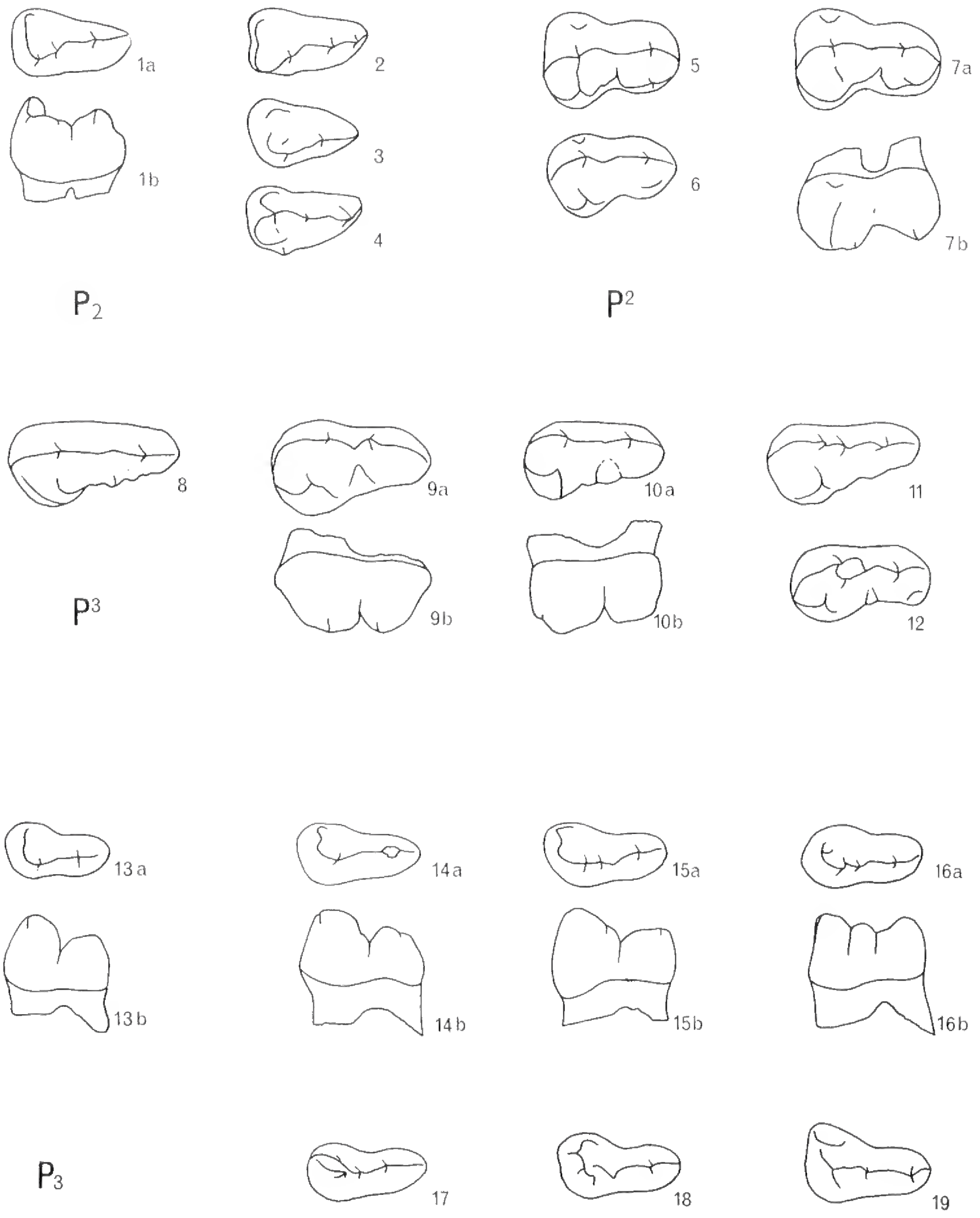

FIG. 1: Some variation in the morphology of deciduous and permanent premolars in the Grey Kangaroo, *Macropus giganteus* Shaw. P_2: 1, J20368; 2, J20847; 3, J20901; 4, J20983. P^2: 5, J20847; 6, J20901; 7, J20368. P^3: 8, J20388; 9, J20390; 10, J20396; 11, J20389; 12, J20397. P_3: 13, J20397; 14, J20385; 15, J20388; 16, J20398; 17, J20384; 18, J20389; 19, J20390. a = occlusal view; b = lateral view. All specimens in the Queensland Museum.

occasional low cuspid developed at base of cleft, associated with set of vertical labial and lingual ridges; this cuspule rarely better developed to give crest a trifid appearance in lateral view; posterior ridge from anterior cuspid occasionally with pocket developed along occlusal surface. Posterior ridge from postero-labial cuspid curves lingually, usually to unite with high, poorly defined postero-lingual cuspid, but occasionally descending to postero-lingual base of crown.

$M_1 < M_2 < M_3 < M_4$; molars subrectangular in basal outline, slightly constricted across talonid basin; lophids relatively high, bowed posteriorly, frequently puckered at unworn crest; hypolophid broader than protolophid in M_1 and M_2, often approximately equal in M_3 and narrower in M_4; hypolophid higher than protolophid. Anterior cingulum relatively high, usually indented anteriorly, moderately broad, its length approximately equalling distance between lophids; cingulum descends slightly lingually and markedly labially. Forelink high, strong, descending antero-lingually from protoconid then anteriorly or slightly labially to point labiad to mid-point of cingulum. Trigonid basin better developed lingually than labially, with antero-labial fossette normally present in labial moiety. Anterior and posterior ridges from metaconid poorly developed. Midlink strong, relatively high, descending antero-lingually from hypoconid then anteriorly above talonid basin to unite with very short ridge from below or slightly linguad to protoconid; junction often puckered. Labial moiety of talonid V-shaped, lingual portion U-shaped; occasional, low, transverse ridge present in base of lingual portion of basin; talonid slopes labially and lingually from midlink. Anterior ridge from entoconid poorly developed. Posterior surface of hypolophid with moderately deep, broad diagonal groove from near hypoconid to near postero-lingual base of crown.

CHEEK TEETH IN *MACROPUS AGILIS* (GOULD, 1842)

P^2 elongate, slightly broader posteriorly than anteriorly, slightly convex labially and concave lingually in occlusal view. Paracone and metacone well developed, high, connected by high secant longitudinal crest; crest straight or slightly concave labially in occlusal view, transected about one-half way between cusps by well defined set of vertical labial and lingual ridges, with production of cuspule at crest. Very weak second set of ridges sometimes present close to metacone. Occasionally labial ridge from cuspule bifurcates basally. Anterior and posterior ridges from paracone and metacone act as continuation of longitudinal crest, ascending and curving lingually towards base of crown. Protocone low, poorly defined; anterior ridge from protocone curves labially below base of crown as extension of lingual cingulum; posterior ridge from protocone forms low lingual cingulum; cingulum slightly sinuous in lateral view; lingual basin shallow, crossed by low transverse ridges from cuspules on cingulum to base of longitudinal crest; hypocone better defined but low, with its anterior ridge contributing to lingual cingulum; posterior hypocone ridge curves labially below base of crown to unite with posterior metacone ridge; labially, low ridge connects hypocone to lingual ridge ascending from metacone. Postero-lingual fossette shallow.

DP^3 molariform, subrectangular to subtriangular in occlusal view, slightly constricted across median valley; lophs relatively low, but with metaloph higher than protoloph, bowed anteriorly with metaloph considerably broader than protoloph. Anterior cingulum relatively low and narrow, short, ascending lingually with no indication of presence of forelink; ridge ascends from paracone to limit of cingulum forming moderately high secant area in functional continuity with longitudinal crest of P^2. Midlink relatively strong, low, curving postero-labially from protocone to metaloph, near axis of crown; slight contribution to midlink from metaloph. Median valley V-shaped, occasionally more broadly

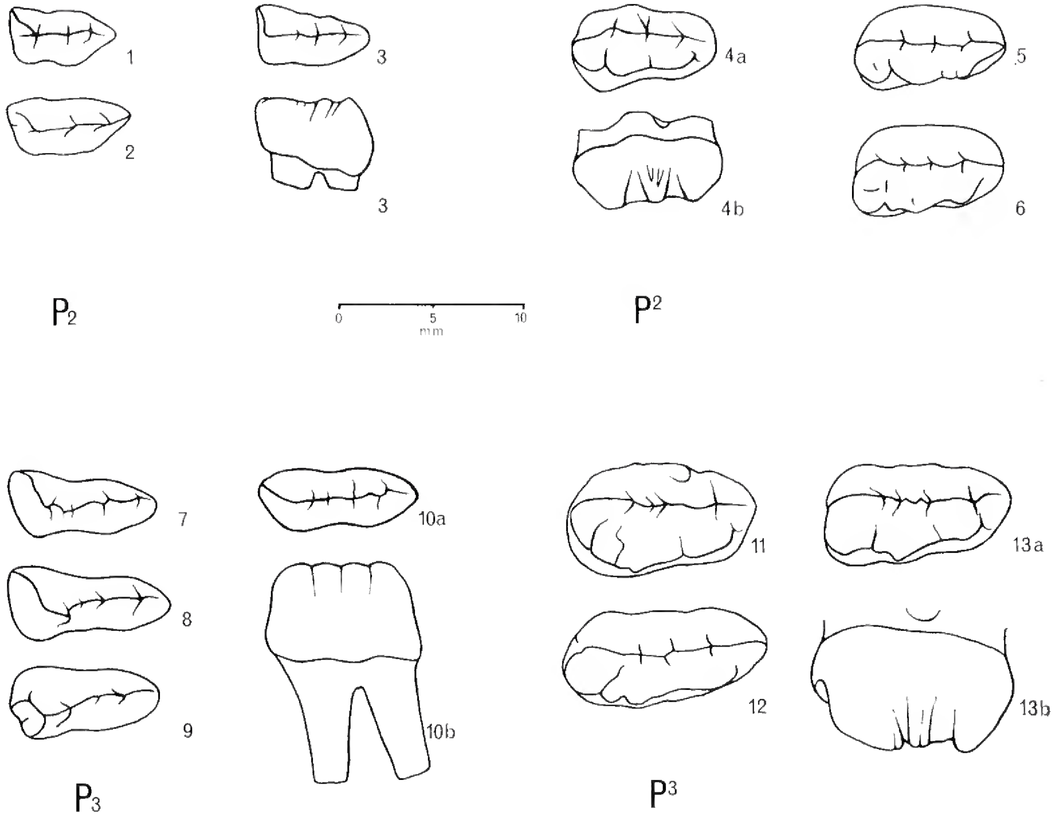

FIG. 2: Some variation in the morphology of deciduous and permanent premolars in the Sandy Wallaby, *Macropus agilis* (Gould). P_2: 1, J14813; 2, J14606; 3, J14678. P^2: 4, J14678; 5, J14813; 6, J14632. P_3: 7, J14597; 8, J14594; 9, J14579; 10, J14622. P^3: 11, J14594; 12, J14602; 13, J14622. a = occlusal view; b = lateral view. All specimens in the Queensland Museum.

U-shaped in lingual moiety. Posterior ridge from paracone and anterior ridge from metacone curve into valley uniting to form accessory structure across labial moiety of valley. Posterior ridge from hypocone strong, curving across posterior surface of crown towards postero-lingual margin; posterior ridge from metacone weak; posterior fossette usually well defined.

P^3 relatively large, subovate to subtriangular in basal outline, being broader posteriorly than anteriorly; crown slightly convex labially, slightly concave lingually. Paracone and metacone well developed, high, connected by high secant longitudinal crest which is straight or slightly concave labially; crest normally transected by two sets of vertical labial and lingual ridges, with set near mid-point of crest usually best developed. Occasionally, third set of very slight ridges present near metacone; slight cuspules present along crest, associated with transecting ridges. Anterior and posterior ridges from paracone and metacone respectively ascend towards base of crown, with that from metacone curving lingually. Protocone poorly defined, low, with anterior ridge disappearing below antero-lingual base of crown. Posterior ridge from protocone forms low lingual cingulum; cingulum normally slightly sinuous in occlusal and lateral views. Lingual basin shallow, usually slightly broader posteriorly, crossed occasionally by slight ridges to base of longitudinal crest; occasionally transverse ridge close to hypocone stronger developed. Hypocone much stronger than protocone, moderately high, with anterior ridge contributing to lingual cingulum; posterior ridge curves labially to unite with posterior ridge from metacone; labial ridge from hypocone relatively strong, uniting with ridge from metacone at base of longitudinal crest. Postero-lingual fossette well defined.

$M^1 < M^2 < M^3 < M^4$; molars subrectangular in basal outline, slightly constricted across median valley; lophs relatively low, bowed anteriorly, frequently puckered at unworn loph crests; metaloph broader than protoloph in M^1 and M^2, often approximately equal in M^3, and narrower in M^4; metaloph higher than protoloph. Anterior cingulum low, broad, short, ascending lingually, with forelink normally absent; occasionally low ridge crosses as forelink from base of protoloph to cingulum approximately below axis of crown, but this never very strong. Strong ridge ascends from paracone to labial limit of cingulum. Midlink strong, low, curving postero-labially from protocone, uniting with short ridge from near mid-point of metaloph. Median valley usually V-shaped; ridges ascending into valley from paracone and metacone usually weak, but occasionally these unite across labial moiety providing subsidiary link. Posterior ridge from hypocone strong, ascending labially to point slightly labiad to axis of crown above base of crown; posterior ridge from metacone somewhat weaker, curving lingually to unite with hypocone ridge, forming margin to well defined posterior fossette.

P_2 relatively elongate and comparatively large, subovate to subtriangular in basal outline, usually slightly broader posteriorly than anteriorly; frequently crown slightly constricted at posterior one-third, but occasionally labial surface convex and lingual concave. Longitudinal crest well defined, high, secant, with anterior and posterior cuspids well defined; crest usually transected mesially by a single set of vertical or near vertical labial and lingual ridges but occasionally a less well developed set may be present close to posterior cuspid; cuspules developed at crest associated with transecting ridges. Posterior extension of crest curves lingually before descending to postero-lingual base of crown; occasionally slight posterior ridge from posterior cuspid of crest also present. Base of crown rarely tumid, particularly labially.

DP_3 molariform, subtriangular in basal outline, very slightly constricted across talonid basin; lophids relatively low, bowed posteriorly, with hypolophid broader than protolophid. Trigonid basin relatively narrow, its length being less than distance between lophids, with lingual portion near planar but with basin strongly descending labially. Forelink low, strong, descending labially from protoconid to point on anterior cingulum labiad to axis of crown; anterior cingulum moderately low. Metaconid with moderately strong ridge descending anteriorly into trigonid and occasionally to lingual limit of cingulum. Midlink strong, low, descending anteriorly from hypocone to unite with short ridge from protolophid somewhat labiad to axis of crown. Talonid basin near planar, V-shaped. Postero-lingual margin of crown usually somewhat angular.

P_3 relatively large, elongate, subovate to subtriangular in basal outline, usually slightly broader posteriorly than anteriorly; frequently crown slightly to moderately constricted at posterior one-third. Longitudinal crest well defined, high, secant, with anterior and posterior cuspids well defined; crest normally transected by two sets of vertical or near vertical labial and lingual ridges of which the anterior set are better developed; cuspules are present at crest associated with transecting ridges; rarely crest puckered in unworn teeth. Posterior extension of crest slightly to strongly developed, either gently curving lingually to descend to base of crown or verging to abruptly curving lingually before descending. Base of crown rarely tumid labially.

$M_1 < M_2 < M_3 < M_4$; molars subrectangular in basal outline, very slightly constricted across talonid basin; lophids relatively low, bowed posteriorly, rarely puckered at unworn crest; hypolophid broader than protolophid in M_1 and M_2, often approximately equal in M_3, and narrower in M_4; hypolophid higher than protolophid. Anterior cingulum moderately low, relatively narrow, its length being slightly less than distance between lophids. Trigonid basin with lingual portion near planar, but markedly descending in labial portion. Forelink usually relatively low, strong, curving antero-lingually from protoconid to point on cingulum slightly labiad to axis of crown; rarely slight suggestion of accessory link present towards base of protolophid. Anterior ridge from metaconid usually very poorly developed or absent. Midlink relatively low, strong, descending from hypoconid to unite with slight ridge from protolophid labiad to axis of crown; junction occasionally incomplete or puckered. Labial moiety of talonid basin V-shaped but lingual portion frequently more broadly U-shaped. Rarely low fold present towards base of hypolophid close to midlink. Posterior surface of hypolophid normally gently convex.

TABLE 1

SUMMARY OF MEASUREMENTS FOR COMPLETE SAMPLE OF *Macropus giganteus* SHAW

Character	Maxillae					Mandibles				
	n	O.R.	$\bar{X}$	s	V	n	O.R.	$\bar{X}$	s	V
P$^2_2$ length	55	6.3– 7.8	7.0	0.2893	4.13	50	5.4– 7.2	6.5	0.3502	5.39
maximum breadth . .	55	4.0– 5.6	4.8	0.2963	6.17	49	3.1– 3.9	3.5	0.1958	5.59
DP$^3_3$ length	65	7.5– 0.1	8.5	0.3801	4.47	50	7.9– 9.7	8.7	0.3382	3.89
breadth protoloph(-id) . .	65	5.7– 7.2	6.5	0.3799	5.84	48	4.2– 5.2	4.6	0.2208	4.80
P$^3_3$ length	42	6.1– 8.2	7.3	0.4949	6.78	40	5.1– 7.0	6.1	0.4629	7.59
maximum breadth . .	41	3.1– 4.6	3.9	0.3599	9.23	40	2.3– 3.7	3.1	0.3522	11.36
M$^1_1$ length	134	8.0–11.0	9.9	0.5362	5.42	100	8.6–11.7	10.2	0.5391	5.29
breadth protoloph(-id) . .	134	6.6– 8.7	7.5	0.4248	5.66	99	4.7– 6.8	5.9	0.3185	5.40
M$^2_2$ length	130	9.6–13.0	11.1	0.6506	5.86	106	8.9–13.2	11.7	0.7081	6.05
breadth protoloph(-id) . .	130	7.4– 9.7	8.4	0.4513	5.37	109	5.7– 7.9	7.0	0.3947	5.64
M$^3_3$ length	92	10.3–14.0	11.9	0.6239	5.24	77	11.4–14.3	12.6	0.6479	5.14
breadth protoloph(-id) . .	92	8.1–10.1	9.0	0.4876	5.42	83	6.6– 8.5	7.5	0.4327	5.77
M$^4_4$ length	59	11.2–14.0	12.6	0.6113	4.85	57	11.8–14.9	13.2	0.7833	5.93
breadth protoloph(-id) . .	58	8.4–11.1	9.4	0.5289	5.62	59	6.7– 8.7	7.7	0.5219	6.78

TABLE 2

SUMMARY OF MEASUREMENTS FOR COMPLETE SAMPLE OF *Macropus agilis* (GOULD)

Character	Maxillae					Mandibles				
	n	O.R.	$\bar{X}$	s	V	n	O.R.	$\bar{X}$	s	V
P^2_2 length	28	6.5– 7.8	7.1	0.3442	4.85	29	5.4– 6.8	6.0	0.3813	6.36
maximum breadth	15	3.8– 4.6	4.2	0.2170	5.17	29	2.5– 5.3	2.9	0.2179	7.51
DP^3_3 length	29	6.4– 7.7	7.0	0.3422	4.89	30	5.4– 7.6	6.5	0.4223	6.50
breadth protoloph(-id)	27	4.9– 5.5	5.2	0.1628	3.13	29	3.6– 4.5	3.9	0.2205	5.65
P^3_3 length	122	8.3–10.5	9.2	0.4496	4.89	133	6.8– 9.1	7.8	0.4272	5.48
maximum breadth	115	4.0– 5.9	4.8	0.3497	7.29	131	2.3– 4.0	3.1	0.3163	10.20
M^1_1 length	118	6.4– 8.5	7.5	0.4084	5.45	111	6.3– 8.3	7.3	0.4789	6.56
breadth protoloph(-id)	125	5.6– 6.9	6.3	0.2655	4.21	135	4.0– 5.7	4.9	0.2665	5.44
M^2_2 length	138	7.6– 9.9	8.9	0.4923	5.53	139	7.5–10.0	8.8	0.5009	5.69
breadth protoloph(-id)	153	6.3– 8.3	7.2	0.3335	4.63	149	5.2– 6.5	5.8	0.2641	4.55
M^3_3 length	134	8.8–11.1	10.0	0.4866	4.87	128	8.6–10.0	10.0	0.4894	4.89
breadth protoloph(-id)	133	7.0– 8.9	7.9	0.3707	4.69	132	5.5– 7.5	6.4	0.3491	5.45
M^4_4 length	80	9.2–11.8	10.6	0.04660	4.40	79	9.5–11.7	10.8	0.5164	4.78
breadth protoloph(-id)	69	7.2– 9.2	8.1	0.4039	4.99	80	5.8– 7.7	6.6	0.3279	5.42

TABLE 3

Summary of Measurements for Sexed Samples of *Macropus giganteus* Shaw

Character	Male Sample					Female Sample				
	n	O.R.	$\bar{X}$	s	V	n	O.R.	$\bar{X}$	s	V
P^2 length	22	6.5– 7.7	7.0	0.2802	4.00	33	6.3– 7.8	7.0	0.2973	4.25
maximum breadth	22	4.6– 5.6	5.0	0.2213	4.43	33	4.0– 5.6	4.7	0.3051	6.49
DP^3 Length	26	8.0– 9.1	8.6	0.3440	4.00	39	7.5– 9.0	8.3	0.3814	4.60
breadth protoloph	26	5.9– 7.2	6.6	0.4014	6.08	39	5.7– 6.7	6.2	0.2377	3.83
P^3 length	16	6.5– 8.2	7.5	0.5170	6.89	26	6.1– 8.1	7.2	0.4698	6.53
maximum breadth	16	3.4– 4.6	4.1	0.4242	10.35	25	3.1– 4.6	3.8	0.2805	7.38
M^1 length	55	9.1–11.0	10.1	0.4107	4.07	79	8.0–10.5	9.7	0.5180	5.34
breadth protoloph	55	6.7– 8.7	7.8	0.4291	5.50	79	6.6– 8.0	7.4	0.3116	4.21
M^2 length	48	10.0–13.0	11.4	0.6855	6.01	82	9.6–12.1	10.9	0.5748	5.27
breadth protoloph	47	7.9– 9.7	8.8	0.4310	4.90	83	7.4– 9.0	8.3	0.3514	4.23
M^3 length	34	11.6–14.0	12.3	0.5626	4.57	58	10.3–13.6	11.8	0.5557	4.71
breadth protoloph	34	8.5–10.1	9.4	0.4022	4.28	58	8.1– 9.7	8.7	0.3811	4.38
M^4 length	22	11.9–14.0	13.0	0.5131	3.95	37	11.2–13.4	12.3	0.4717	3.83
breadth protoloph	22	9.1–11.1	9.9	0.4196	4.24	36	8.4– 9.9	9.2	0.3817	4.15
P_2 length	18	5.9– 7.2	6.6	0–3418	5.18	32	5.4– 6.9	6.5	0.3198	4.92
maximum breadth	18	3.3– 3.9	3.6	0.1984	5.51	31	3.1– 3.8	3.5	0.1905	5.44
DP_3 length	18	8.3– 9.7	8.9	0.3298	3.71	32	7.9– 9.1	8.6	0.2961	3.44
breadth protolophid	17	4.2– 5.2	4.7	0.2511	5.34	31	4.2– 4.9	4.6	0.1732	3.77
P_3 length	18	5.6– 7.0	6.3	0.4517	7.16	22	5.1– 6.7	5.9	0.3969	6.73
maximum breadth	18	2.6– 3.7	3.2	0.3316	10.36	22	2.3– 3.7	3.0	0.3358	11.19
M_1 length	40	9.7–11.7	10.5	0.4346	4.14	60	8.6–11.2	10.0	0.5471	5.47
breadth protolophid	38	5.6– 6.8	6.1	0.2854	4.68	61	4.7– 6.4	5.8	0.2692	4.64
M_2 length	40	11.2–13.2	12.0	0.5088	4.24	66	8.9–13.0	11.4	0.7041	6.18
breadth protolophid	41	6.6– 7.9	7.3	0.3227	4.42	68	5.7– 7.6	6.8	0.3394	4.99
M_3 length	29	12.2–14.3	13.0	0.5027	3.87	48	11.4–14.0	12.3	0.5652	4.60
breadth protolophid	32	7.4– 8.5	7.9	0.2769	3.51	51	6.6– 8.1	7.3	0.3831	5.25
M_4 length	21	12.6–14.9	14.0	0.5692	4.07	36	11.8–14.0	12.8	0.5484	4.28
breadth protolophid	21	7.5– 8.7	8.2	0.3170	3.87	38	6.7– 8.3	7.5	0.3875	5.17

TABLE 4

Summary of Measurements for Sexed Samples of *Macropus agilis* (Gould)

Character	Male Sample					Female Sample				
	n	O.R.	$\overline{X}$	s	V	n	O.R.	$\overline{X}$	s	V
P^2 length	18	6.8– 7.8	7.2	0.3067	4.62	10	6.5– 7.4	6.9	0.3179	4.61
maximum breadth	11	3.8– 4.6	4.2	0.2408	5.73	4	4.0– 4.4	4.2	0.4000	9.52
DP^3 length	19	6.6– 7.7	7.1	0.3511	4.95	10	6.4– 7.3	6.9	0.2600	3.77
breadth protoloph	18	4.9– 5.5	5.2	0.3307	6.36	9	4.9– 5.3	5.1	0.1414	2.77
P^3 length	61	8.6–10.5	9.3	0.4659	5.01	61	8.3–10.0	9.2	0.4260	4.63
maximum breadth	56	4.1– 5.9	4.9	0.3535	7.21	59	4.0– 5.6	4.8	0.3546	7.39
M^1 length	63	6.6– 8.5	7.7	0.3570	4.64	55	6.4– 8.5	7.4	0.4048	5.47
breadth protoloph	67	5.8– 6.9	6.3	0.7435	11.80	58	5.6– 6.8	6.1	0.8056	13.21
M^2 length	71	7.6– 9.9	9.1	0.4406	4.84	67	7.8– 9.6	8.6	0.4296	5.00
breadth protoloph	78	6.5– 8.3	7.3	0.3114	4.27	75	6.3– 7.7	7.1	0.3029	4.27
M^3 length	66	9.1–11.1	10.2	0.4288	4.20	68	8.8–10.9	9.8	0.4593	4.69
breadth protoloph	66	7.3– 8.9	8.0	0.3327	4.16	67	7.0– 8.4	7.7	0.3283	4.26
M^4 length	36	10.2–11.8	10.8	0.3633	3.36	44	9.2–11.5	10.4	0.4560	4.38
breadth protoloph	27	7.5– 9.2	8.4	0.3597	4.28	42	7.2– 8.7	8.0	0.3334	4.56
P_2 length	19	5.4– 6.8	6.1	0.3770	6.18	10	5.4– 6.7	6.0	0.3887	6.48
maximum breadth	19	2.6– 3.3	3.0	0.2092	6.97	10	2.5– 3.2	2.9	0.2236	7.71
DP_3 length	20	5.4– 7.6	6.5	0.4656	7.16	10	5.9– 7.1	6.4	0.3214	5.02
breadth protolophid	19	3.6– 4.5	4.0	0.2271	5.68	10	3.6– 4.0	3.8	0.1493	3.93
P_3 length	65	6.8– 9.1	7.9	0.4756	6.02	68	7.0– 8.2	7.7	0.3212	4.17
maximum breadth	64	2.6– 4.0	3.2	0.2969	9.28	67	2.3– 3.9	3.0	0.2920	9.73
M_1 length	64	6.4– 8.3	7.5	0.4460	5.95	47	6.3– 8.0	7.2	0.4795	6.66
breadth protophid	73	4.5– 5.7	5.0	0.2229	4.46	62	4.0– 5.2	4.8	0.2539	5.29
M_2 length	76	7.8–10.0	8.9	0.4549	5.11	63	7.4– 9.5	8.6	0.4738	5.51
breadth protolophid	79	5.3– 6.5	5.9	0.2709	4.59	70	5.2– 6.2	5.7	0.2362	4.14
M_3 length	62	9.1–10.9	10.2	0.3383	3.32	66	8.6–10.9	9.7	0.4865	5.02
breadth protolophid	66	5.9– 7.5	6.6	0.3033	4.60	66	5.5– 7.1	6.3	0.3163	5.02
M_4 length	33	10.2–11.7	11.0	0.3630	3.30	46	9.5–11.1	10.3	0.4000	3.88
breadth protolophid	32	6.1– 7.7	6.8	0.3631	5.34	48	5.8– 6.9	6.5	0.2315	3.56

TABLE 5

Comparison of Sexed Samples of *Macropus giganteus* by Student's t-test

Maxillae			Mandibles		
Character	t	P	Character	t	P
P^2 length			P_2 length	3.27	0.001–0.01
maximum breadth	3.96	<0.001	maximum breadth	2.63	0.01–0.02
DP^3 length	3.34	<0.001	DP_3 length	3.64	<0.001
breadth protoloph	5.03	<0.001	breadth protolophid	1.62	0.1–0.2
P^3 length	1.93	0.05–0.1	P_3 length	3.67	<0.001
maximum breadth	2.72	0.001–0.01	maximum breadth	1.88	0.05–0.1
M^1 length	4.77	<0.001	M_1 length	4.84	<0.001
breadth protoloph	6.25	<0.001	breadth protolophid	4.88	<0.001
M^2 length	4.45	<0.001	M_2 length	4.69	<0.001
breadth protoloph	7.15	<0.001	breadth protolophid	7.58	<0.001
M^3 length	4.14	<0.001	M_3 length	5.51	<0.001
breadth protoloph	6.02	<0.001	breadth protolophid	7.68	<0.001
M^4 length	5.33	<0.001	M_4 length	7.85	<0.001
breadth protoloph	6.52	<0.001	breadth protolophid	7.07	<0.001

TABLE 6

Comparison of Sexed Samples of *Macropus agilis* by Student's t-test

Maxillae			Mandibles		
Character	t	P	Character	t	P
P^2 length	2.45	0.02–0.05	P_2 length	0.21	0.8–0.9
maximum breadth	—	—	maximum breadth	0.38	0.7–0.8
DP^3 length	1.58	0.1–0.2	DP_3 length	0.61	0.5–0.6
breadth protoloph	0.90	0.3–0.4	breadth protolophid	2.51	0.01–0.02
P^3 length	0.39	0.7–0.8	P_3 length	0.90	0.3–0.4
maximum breadth	0.48	0.6–0.7	maximum breadth	1.23	0.2–0.3
M^1 length	1.35	0.1–0.2	M_1 length	1.07	0.2–0.3
breadth protoloph	0.46	0.6–0.7	breadth protolophid	1.54	0.1–0.2
M^2 length	2.14	0.02–0.05	M_2 length	1.20	0.2–0.3
breadth protoloph	1.28	0.2–0.3	breadth protolophid	1.51	0.1–0.2
M^3 length	1.27	0.2–0.3	M_3 length	2.13	0.02–0.05
breadth protoloph	1.65	0.05–0.1	breadth protolophid	1.76	0.05–0.1
M^4 length	1.29	0.2–0.3	M_4 length	2.53	0.01–0.02
breadth protoloph	1.49	0.1–0.2	breadth protolophid	1.42	0.1–0.2

DISCUSSION

Early palaeontological investigations, such as those of Owen (1874) or De Vis (1895), which frequently present the best comparative discussions of the dentition in the subfamily Macropodinae, have tended to stress the value of the premolars in defining the species described. More recent investigations involving dentition also tend to emphasize the value of the morphology and size of the premolars in taxonomic considerations. In this connection, Tate (1948) has argued largely on the basis of the permanent premolar for the inclusion of the wallabies within the fossil genus *Protemnodon* Owen, a conclusion no longer tenable. In the present study, species are referred to *Macropus*, following Calaby (1966).

The emphasis on premolars has largely resulted from the greater interspecific variation usually exhibited by these teeth. The molars are normally adequately described but they are frequently considered to possess insufficient features showing significant interspecific differences to justify any great value being placed on them. Where fossil species have been defined on the morphology of their molar teeth, the importance of the work has often been reduced by inadequate knowledge of intraspecific variation both in the species being described or in the living species drawn upon for comparison.

In examining in detail the morphology and size of the cheek teeth in the living Grey Kangaroo, *Macropus giganteus*, and the Sandy Wallaby, *M. agilis*, the most obvious impression is that intraspecific variation is fairly consistently high in the deciduous and permanent premolars, P_2^2 and to a greater extent in P_3^3. Variation is present in the molars and may infrequently be more extreme in the deciduous molariform premolar and anterior molar, but in these the basic hypsobrachyodont condition (hypsodont of Bensley, 1903) is usually only slightly affected by accessory structures, and the differences are frequently only a matter of degree of development. Notwithstanding these considerations, P_2^2 and P_3^3 do exhibit marked interspecific variation and there appears to be every advantage in maintaining a measure of dependence upon the taxonomic value of the morphology of these teeth. It is believed, however, that as many features as possible of the remaining cheek teeth should also be considered conjointly, together with an assessment of the variation likely to be encountered in the teeth and other morphological characters in the species concerned.

Apart from purely morphological variation encountered in the cheek teeth (see figures 1 and 2) in *M. giganteus* and *M. agilis*, intraspecific size variation is considerable and this must be taken into account in any taxonomic assessment. The summaries of measurements provided for each species includes an evaluation of size variation in each sample as a whole as well as for individual sexed samples, treated as if each was drawn from a natural population. In these, variation as defined by the Coefficient of Variation, V, is calculated to be from 3.44–11.36 in *M. giganteus* and 2.77–13.21 in *M. agilis*. By far the bulk of values fall between 4.00–6.00 in each species.

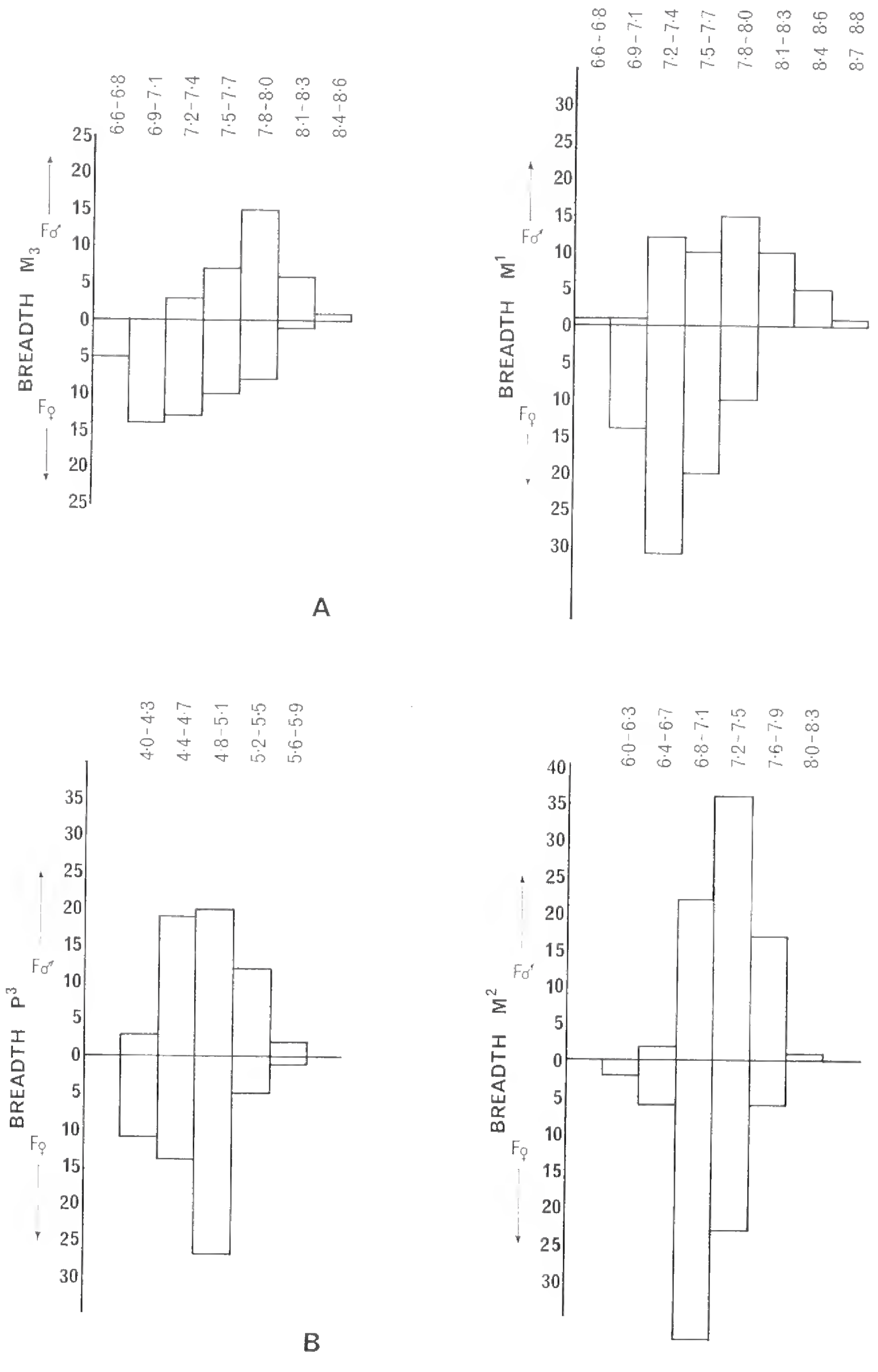

FIG. 3: Histograms for representative sexed samples of A, *Macropus giganteus* and B, *M. agilis*, illustrating the distribution of some dimensions in the cheek teeth.

Bartholomai (1967) has shown that in the fossil species *Troposodon minor* (Owen), V mostly falls between values of 4.00–7.00, but in this case the specimens comprising the sample were drawn from differing stratigraphic levels within the Upper Cainozoic deposits of the Darling Downs area and this fact most likely accounts for many of the slightly higher values than are present in the living macropodines. Studies on other Australian fossil macropodid samples by Merrilees (1965, 1967), Bartholomai (1970), and, in part, Tedford (1967) have yielded basically similar results for V to those in *T. minor*. Tedford's (1967) results for V in *M. ferragus*, however, are generally much higher than have so far been observed in recent or fossil macropodids suggesting mixing of this sample. Simpson *et al.* (1960) state that 'as a matter of observation, the great majority of them (values for V in mammals) lie between 4 and 10, and 5 and 6 are good average values.' Thus the bulk of the results for the living species of macropodines here considered conform with values of V for linear dimensions calculated for other mammal groups, and these are closely approximated by fossil results.

Values for V presented for some molar teeth dimensions in recent *M. canguru* in Tedford (1967) are generally higher than those for the present sample of *M. giganteus*. Differences apparent most probably relate to the fact that the material considered by Tedford was drawn from what is now believed to be two species (Kirsch and Poole, 1967), *M. fuliginosus* the Kangaroo Island and western mainland species of Grey Kangaroo and *M. giganteus*, the eastern Grey Kangaroo. Further, the material considered was collected from widely separated localities and some geographical variation may have been included.

An interesting situation exists between *M. giganteus* and *M. agilis* when the results of tables 5 and 6 are compared. These represent a comparison of means of the sexed samples for each species by use of Student's t test. Results for *M. agilis*, a member of the 'wallaby' group, approach significance at the 5% level in the lengths of P^2, M^2, and M_3 and at the 2% level in the protolophid breadth of DP_3 and the length of M_4. In *M. giganteus*, representing the 'kangaroo' group, the results are generally highly significant at the 0.1% level and only rarely are these not significant or do they only approach significance. Sexual dimorphism is therefore generally present in the Grey Kangaroo at least in the characters considered. This point could have significance where initial sorts of fossil material are being made utilizing frequency distributions. Bimodality in such distributions is thus likely within a single species but as can be seen in figure 3 the degree of separation of the modes is not necessarily excessive.

Kirkpatrick (1965) has shown that it is not uncommon for individuals of *M. giganteus* to possess a fifth molar tooth in the cheek teeth series. No evidence of the existence of M^5_5 was found in the sample used in the present study and results are not believed to have been complicated by this additional factor. While progression of the tooth row is evident in *M. agilis*, the P^3_3 are retained until late in life and identification of teeth is uncomplicated. In *M. giganteus*, however, there is actual loss of anterior teeth at an early age (Kirkpatrick, 1964), necessitating greater care in determination of molars after the permanent premolars have been ejected.

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DASYURUS DUNMALLI, A NEW SPECIES OF FOSSIL MARSUPIAL (DASYURIDAE) IN THE UPPER CAINOZOIC DEPOSITS OF QUEENSLAND

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ABSTRACT

A new species of fossil marsupial native cat, *Dasyurus dunmalli*, is described from the Chinchilla Sand of possible Pliocene age, while further material derived from the Pleistocene fluviatile deposits of the eastern Darling Downs is referred to the extant *D. viverrinus* Shaw, 1800. The presence of *Dasyurus* is noted in the cave and fissure-fill deposits at Cement Mills, Gore.

Small dasyurids are poorly represented in collections of fossil marsupials from the Upper Cainozoic deposits of Queensland. A number are present however, which are referable to the genus *Dasyurus* Geoffroy. Lydekker (1887) recorded the presence of *D. viverrinus* Shaw from the Pleistocene fluviatile deposits of the Darling Downs area, southeastern Queensland, but no definitive study has been undertaken on the limited sample available. The present study was prompted by the recent discovery of additional material and the existence of previously unreported specimens in the collections of the Queensland Museum and is in keeping with a general study of the Upper Cainozoic faunas of Queensland. Although part of the sample is poorly localized, it is evident that the specimens have been derived both from the Chinchilla Sand of possible Pliocene age and from the Pleistocene fluviatile deposits. A single specimen has also been recovered from the Pleistocene cave and fissure-fill deposits at Cement Mills, Gore, southeastern Queensland.

Studies in recent years in the Diprotodontidae, Macropodidae and Phalangeridae have indicated that there are frequently, but not invariably (Bartholomai, 1967), taxonomic differences at the specific level between samples from the possibly Pliocene and Pleistocene deposits in the Darling Downs area and it was considered valuable to ascertain if any distinction exists within the genus *Dasyurus* of the Dasyuridae.

The author wishes to express his appreciation to Mr W. Dunmall of Dalby, southeastern Queensland, for the donation of recently collected specimens from Chinchilla to the Queensland Museum.

Family DASYURIDAE

Subfamily DASYURINAE

Genus **Dasyurus** Geoffroy

Dasyurus dunmalli sp. nov.

(Pl. 1, figs. 1–4)

Material: F6579, holotype, partial left mandibular ramus with base of C_1, P_1–P_3, M_1–M_3 with protoconid shattered in M_2 and M_3, adult, Chinchilla Sand at Chinchilla Rifle Range (Rifle Range number 78, Par. of Chinchilla), from side gully leading into middle gully system, Darling Downs, SE.Q.

F742, partial right mandibular ramus with C_1, alveoli for P_1–P_3, M_1–M_3, M_4 broken, adult, Darling Downs. F6580, partial left mandibular ramus with alveoli for P_2–P_3, M_1, Chinchilla Sand at Chinchilla Rifle Range, from side gully leading into middle gully system, Darling Downs.

Diagnosis: This species is morphologically very similar to the living *Dasyurus viverrinus* Shaw but is distinguished by the presence of an additional, very small premolar immediately anterior to M_1. Although this tooth is readily lost, an alveolus is consistently present in specimens in which that portion of the ramus is preserved.

Description: Ramus shallow anteriorly, deepest below posterior molars. Symphysis elongate, relatively deep, ovate, extending posteriorly to below anterior root M_1; geniohyal pit shallow. Mental foramina usually positioned below P_2 and M_1 closer to ventral margin of ramus than dorsal; occasionally third foramen present below M_1–M_2.

Canine large with strongly upcurved root and recurved, piercing crown. Laterally, crown rounded, but lingual surface markedly angular anteriorly and posteriorly, with antero-lingual portion more strongly angular; mesially, lingual surface convex. Enamel margin raised higher antero-lingually than elsewhere around tooth, with slight basal cingulum present paralleling enamel margin.

$P_1 < P_2 > P_3$; all premolars basically similar morphologically, the major differences being in size and in the presence of only a single root in P_3 compared with a divided root in P_1 and P_2. First premolar relatively small, in close juxtaposition with postero-labial surface of C_1 and positioned with its anterior margin more anterior than posterior surface of the canine. Single high cuspid present, positioned above anterior moiety of crown; anterior ridge from cuspid relatively steep, but posterior ridge descends more gently to near horizontal posterior occlusal surface of tooth; slight basal cingulum present labially and lingually, strongest postero-labial and postero-lingual to cuspid. In occlusal view, crown moderately convex labially but only slightly convex or flattened lingually. P_2 morphologically similar to P_1 but cuspid positioned slightly more anteriorly. P_3 very small, more ovate in occlusal view, with basal cingulum well defined.

$M_1 < M_2 < M_3 > M_4$; molars high crowned with sharp, generally distinct cuspids and well defined basins. Protoconid best developed, strong, generally widely separated from paraconid and united with this cuspid by strong, secant ridge; M_1 with paraconid reduced to slight cuspule towards base of anterior ridge from protoconid. Metaconid generally well defined, lower than protoconid, usually well separated from that cuspid; metaconid weak in M_1, positioned close to protoconid. Trigonid basin almost non-existent in M_1, but well developed in M_2–M_4. Hypoconid somewhat stronger than entoconid, but both cuspids low compared with protoconid; hypoconid connected to base of protoconid by relatively strong, secant ridge; similar ridge curves postero-lingually to unite usually with hypoconulid then to entoconid; hypoconulid very weak in M_1, becoming stronger posteriorly, but apparently absent or very weak in M_4; entoconid less distinctly united to base of metaconid. Talonid basin low, well defined. Slight antero-labial cingulum ascends from below protoconid to below paraconid; usually less well defined antero-lingual cingulum present. Posterior cingulum slight.

TABLE 1

MEASUREMENTS (mm) FOR *Dasyurus dunmalli* SP. NOV.

Specimen	P_1	P_2	P_3	M_1	M_2	M_3	M_4
F6579*	3.4×1.9	3.8×2.1	1.8×1.5	4.8×2.6	5.7×3.0	6.1×3.6	—
F740	3.5×1.8	4.1×2.0	—	4.4×2.3	5.1×2.8	5.5×3.2	—
F741†	—	—	—	—	—	5.2× —	4.9×2.6

* holotype † Doubtfully referred to *D. dunmalli*.

DISCUSSION: Dasyurines are poorly represented as fossils in collections from the Upper Cainozoic deposits of Queensland. Smaller forms are particularly poorly known, but larger forms are comparatively better represented. Two species of *Sarcophilus* Geoffroy and Cuvier have been recorded from Queensland, *S. laniarius* Owen, originally described from the Wellington Caves, New South Wales (Owen, 1838) and locally present in Pleistocene fluviatile and cave deposits and *S. prior* de Vis, 1884, based on the proximal articular surface of a right tibia with portion of the shaft, from the Chinchilla Sand at Chinchilla. The smaller dasyurine, *Dasyurus viverrinus* Shaw has been recorded from Gowrie, Darling Downs by Lydekker (1887), but at that time was known only from a single mandibular fragment, British Museum (Natural History) specimen number M1906. Longman (1925) indicated the presence of *Antechinus flavipes* Thomas in the Pleistocene cave earth deposits at Marmor, mid eastern Queensland.

TABLE 2

MEASUREMENTS (mm) FOR *Dasyurus viverrinus* SHAW (FOSSIL SAMPLE)

Specimen	P_1	P_2	M_1	M_2	M_3	M_4
F737	—	—	—	4.8×2.6	5.4×2.9	5.5×2.9
F738	—	—	—	—	5.8×3.0	5.6×2.8
F739	3.8×1.4	3.9×1.7	4.9×2.4	5.6×2.8	5.8×3.0	5.4×3.0

D. dunmalli sp. nov. is currently known only from fragmentary mandibular rami and as yet, no maxillary specimens referable to the genus *Dasyurus* Geoffroy have been recovered from the Upper Cainozoic deposits of Queensland. Although only portion of the sample referred to *D. dunmalli* is accompanied by locality information more specific than 'Darling Downs' preservation of the remaining specimens is typical of derivation from the Chinchilla Sand of possible Pliocene age (Woods, 1956). It is thus highly likely that the species is restricted to that Formation.

One aged specimen, F741, a partial left mandibular ramus with M_2–M_4, from the Chinchilla Sand at Chinchilla has been doubtfully referred to *D. dunmalli*. This specimen does not present that portion of the ramus containing the diagnostic feature of the species. Measurements for this ramus are included in table 1.

In addition to the material described as *D. dunmalli*, there exists in the collections of the Queensland Museum, a series of mandibular fragments numbered F736–9 inclusive which are morphologically identical with the living *D. viverrinus*. Again, the specimens generally possess limited locality information with the exception of F736, from Clifton, Darling Downs. The remainder all have preservation consistent with their derivation from the Pleistocene fluviatile deposits of the eastern Darling Downs. A single mandibular fragment, F3703, referable to the genus *Dasyurus* has been recovered from the cave and fissure-fill deposits at Cement Mills, Gore, southeastern Queensland. Although this specimen lacks teeth, the proportions of the ramus and its morphology suggest that it also is most likely of *D. viverrinus*. Measurements for the series of specimens from the Pleistocene fluviatile deposits are presented in table 2, while table 3 presents for comparison, mandibular measurements from a recent sample of *D. viverrinus*.

Apart from the presence of the minute additional third premolar, or its alveolus, in all specimens of *D. dunmalli* in which that portion of the ramus has been preserved, no other consistent morphological differences are evident between this species and the fossil and recent samples of *D. viverrinus*. The proportions of the first and second premolars are

TABLE 3

MEASUREMENTS (mm) FOR *Dasyurus viverrinus* SHAW (RECENT SAMPLE)

Specimen	Sex	P_1	P_2	M_1	M_2	M_3	M_4
J17769	♂	4.1×1.5	4.6×1.9	5.4×2.4	5.8×3.0	5.7×3.1	6.0×3.0
J7996	♂	3.9×1.4	4.3×1.7	5.0×2.3	5.5×2.8	5.7×3.2	5.7×3.1
J8787	♂	4.0×1.5	4.3×1.5	4.6×2.3	5.5×2.8	5.7×3.0	5.6×3.0
J20313	♂	4.0×1.7	4.5×1.9	4.9×2.4	5.3×3.1	5.7×3.0	5.7×3.1
J20414	—	3.7×1.7	4.2×1.8	4.7×2.4	5.6×2.8	5.8×3.1	5.4×2.9
J20413	—	4.1×1.7	4.2×1.8	4.8×2.3	5.8×2.9	5.8×3.3	—
J20379	♂	3.6×1.4	3.9×1.5	4.4×2.2	5.3×2.5	5.6×2.7	5.2×2.4
J20380	♀	3.7×1.3	4.0×1.6	4.6×2.2	5.0×2.6	5.2×2.8	5.0×2.6
J20381	—	4.2×1.5	4.3×1.6	5.0×2.2	5.7×2.8	6.0×3.0	5.6×2.6
J20382	♀	4.0×1.5	4.2×1.6	4.7×2.4	5.1×2.9	5.6×3.1	5.5×2.8
J20383	—	3.6×1.4	4.0×1.5	4.2×2.2	4.8×2.4	5.3×2.7	5.0×2.5

somewhat different but the sample of *D. dunmalli* is too small to ascertain whether this difference can be accommodated by normal variation within the species. Comparison of the tables of measurements indicates that in other metrical features, differences are negligable. Unlike many of the Pleistocene forms, gigantism was not a feature of *Dasyurus*.

Two Quaternary fossil species of *Dayurus* are known from elsewhere in Australia; *D. affinis* McCoy, defined by McCoy (?1862) from Victoria, and *D. bowlingi* Spencer and Kershaw from King and Deal Islands, Bass Strait (Spencer and Kershaw, 1910). The syntypes of *D. affinis* have been figured by Gill (1953) and lack any trace of the presence of P_3. The species appears to be morphologically close to *D. maculatus*, but Ride (1964) suggests that while it is nearly as large as the living species, it differs in its proportions. Spencer and Kershaw (1910) provide adequate information to show that *D. bowlingi* is larger than *D. maculatus* and morphologically distinct. Size considerations alone serve to distinguish both southern fossil species from *D. dunmalli* and the fossil specimens of *D. viverrinus*.

That fossil representatives of the genus *Dasyurus* should be found containing reduced third premolars is not surprising when the dental characteristics of the family as a whole are considered. In fact, complete loss of P_3 is relatively rare in living members of the family, as shown by Tate (1947). He indicates that this condition is found only within *Dasyuroides* Spencer, *Dasycercus* Peters, *Myoictis melas* (Müller and Schlegel), *Pseudantechinus* Tate, *Dasyurus* (including *Dasyurops* Matschie, *Dasyurinus* Matschie and *Satanellus* Pocock; see Ride, 1964, and Simpson, 1945) and *Sarcophilus*. The majority of living dasyurids trend towards reduction of P_3, with strongest development in P_2. Relatively few forms retain P_3 in its normal, 'primitive' condition, larger than P_2.

Tate (1947) suggests that reduction and loss of P_3 (P_4 in Tate) is evidence of specialisation. This suggestion follows that of Thomas (1887) and Bensley (1903). On the basis of comparison with other dasyurids in which P_3 is vestigial, it appears likely that when maxillary remains of *D. dunmalli* are located the third upper premolar may be more strongly developed.

The species *Glaucodon ballaratensis* Stirton, 1957, from the Pliocene of Victoria, has been suggested by Ride (1964) to be structurally ancestral to *Sarcophilus*. It nevertheless possesses some characters which Ride interprets as suggesting a more remote relationship with *Dasyurus*. The presence of *D. dunmalli* in possibly Pliocene sediments, a form which is only slightly more 'primitive' than living *Dasyurus* supports Ride's conclusions on the relationships within the group. Although no definite information is available on earlier representatives of the *Dasyurus* line, it appears likely that their ancestry must have been at least as early as the Middle Tertiary on the basis of the apparent stage of evolution of *D. dunmalli*. An early dasyuroid fossil has been recorded by Stirton *et al.* (1961) from the possibly Oligocene Etadunna Formation of the Lake Eyre Basin. However, in the absence of additional information on its morphology, no purpose can be served by further speculation on the relationships of this form to support or reject Ride's (1964) treatment of it within the Thylacinidae.

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PLATE 1

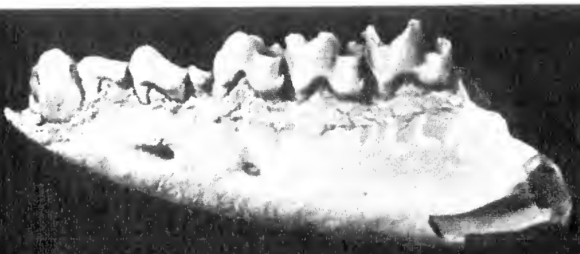
Dasyurus dunmalli sp. nov.

FIG. 1: Lateral view of holotype, F6579, Chinchilla Rifle Range (Rifle Range No. 78, Par. of Chinchilla), SE.Q., ×2.

FIG. 2: Stereopair of F6579, ×2.

FIG. 3: Stereopair of F742, Darling Downs, SE.Q., ×2.

FIG. 4: Lateral view of F742, ×2.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NEW RECORDS AND NEW SPECIES OF CRABS (CRUSTACEA: BRACHYURA) TRAWLED OFF SOUTHERN QUEENSLAND: DROMIACEA, HOMOLIDEA, GYMNOPLEURA, CORYSTOIDEA, AND OXYSTOMATA

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ABSTRACT

Twenty-seven species trawled off southern Queensland are listed and three new species belonging to the genera *Mursia*, *Ebalia*, and *Cryptocnemus* are described. Within the groups considered, offshore southern Queensland shows much greater affinity with Japan than with the adjacent shallower Moreton Bay.

While the crabs of Moreton Bay have been intensively surveyed (see Campbell and Stephenson, 1970) the area immediately outside the Bay has received little attention. Several expeditions have collected from northern Queensland (see Dall and Stephenson, 1953, p. 22) but until recently only the F.I.S. 'Endeavour' had undertaken exploratory offshore dredging and trawling in southern Queensland. From this survey, Rathbun (1923) recorded three crabs belonging to the families under consideration (see List of Species).

In July and August, 1968, the 'Nimbus' under the direction of Dr. A. J. Bruce, collected by trawl from 60 stations off southern Queensland between Double Island Point and Cape Moreton at distances of up to 40 miles offshore. The depths of the areas investigated ranged from 25 to 204 fm. The portunid crabs collected by Dr. Bruce were recorded by Stephenson and Cook, 1970, and this collection also forms the basis of the present report. This material is supplemented by collections made by Mr. D. Harris on commercial trawling grounds off Cape Moreton in 60–65 fm, by Mr. F. Wallace from off Caloundra, and by Mr. B. Beutel.

All material is housed in the Queensland Museum; station numbers refer to the 'Nimbus' 1/68 cruise; dimensions unless otherwise stated are of carapace width; all drawings were made with the aid of a camera lucida; and abbreviations are used for crapace width (cw.) and carapace length (cl.).

LIST OF SPECIES TRAWLED FROM SOUTHERN QUEENSLAND

Species in **bold face** have not previously been recorded from off the Queensland coast south of Bustard Head (24°S.) and are dealt with in this paper. In the case of species not dealt with the bracketed reference refers to a previous record from this area. Bracketed numerals and letters following all species refer to their known overall distribution using the notation listed by Campbell and Stephenson, 1970, p. 295. Species marked thus "†" were not taken in the present collections.

Tribe DROMIACEA

Family DROMIIDAE

Dromia intermedia Laurie	[2, j.]
†*Dromidiopsis edwardsi* Rathbun [Rathbun, 1923, p. 145: SE. of Double Island Pt., 33 fm]	[2]
Cryptodromia areolata Ihle	[4, j.]

Tribe HOMOLIDEA

Family HOMOLIDAE

Homola orientalis Henderson	[2, a.j.]

Family LATREILLIDAE

Latreillia australiensis Henderson	[5]

Tribe GYMNOPLEURA

Family RANINIDAE

Lyreidus tridentatus de Haan [Griffin, 1970, pp. 94–104, figs, pl.: N. of Cape Moreton, 20–100 fm]	[3, h.j.nz.]
Ranina ranina (Linnaeus)	[1, a.j.h.]

Tribe CORYSTOIDEA

Family CORYSTIDAE

Gomeza bicornis Gray	[2, a.j.]
Jonas leuteanus Ward	[5]

Tribe OXYSTOMATA

Family DORIPPIDAE

Dorippe frascone (Herbst) [Rathbun, 1923, p. 138 (as *D. dorsipes*): SE. of Double Island Pt., 33 fm]	[2, a.j.]

Family CALAPPIDAE

Calappa japonica Ortmann	[2, a.j.]
C. philargius (Linnaeus) [Campbell and Stephenson, 1970, p. 246: Moreton Bay]	[1, j.]

Mursia australiensis sp. nov.	[5]
Matuta planipes Fabricius [Rathbun, 1923, p. 138: off Point Inskip, 10 fm]	[2, j.]
Family LEUCOSIDAE	
Ebalia brevimana sp. nov.	[5]
E. longimana Ortmann	[4, j.]
Merocryptus lambriformis A. Milne Edwards	[3, j. nz.]
Myra kessleri (Paul'son)	[2, nc.]
M. affinis Bell [Campbell and Stephenson, 1970, p. 250: Moreton Bay]	[2]
Arcania (?) **heptacantha** (de Haan)	[2, j.]
A. undecimspinosa de Haan	[2, j.]
A. elongata Yokoya	[4, j.]
Randallia eburnea Alcock	[2, j.]
Ixa inermis Leach	[4]
Ixoides cornutus MacGilchrist	[2, j.]
Leucosia unidentata de Haan	[2, j.]
Cryptocnemus hemispheroides sp. nov.	[5]

Family DROMIIDAE

Dromia intermedia Laurie

Dromia intermedia Laurie, 1906, p. 351. Ihle, 1913, p. 23, pl. 1, figs. 1–3. Sakai, 1936, pp. 10–11, pl. 6, fig. 1.

MATERIAL: Female, off Caloundra, trawled, R. Elks, W3386.

This specimen agrees well with published figures and descriptions, differing only in having the anterolateral teeth of the carapace more acute and forwardly projecting.

DISTRIBUTION: From Ceylon and India to Japan and now Australia.

Cryptodromia areolata Ihle

Cryptodromia areolata Ihle 1913, p. 47, pl. 2, figs. 10–11. Sakai, 1936, p. 26, pl. 1, fig. 1; 1965, pp. 8–9, pl. 3, fig. 4. Takeda and Mijake, 1970, pp. 202–3.

MATERIAL: Female, 27°00′ S., 153°39′ E., trawled 100 fm, 'Nimbus' stn 26, 28.vii.1968, W3330. Male, 2 females, off Cape Moreton, trawled 65 fm, D. Harris, W3329. Female, 26°49′ S., 153°37′ E., trawled 100 fm, 'Nimbus' stn 19, 27.vii.1968, W3322.

DISTRIBUTION: From Timor I. (Ihle, 1913) and Japan (Sakai, 1936, 1965), and now southern Queensland; 15–100 fm.

Family HOMOLIDAE

Homola orientalis Henderson

Homola orientalis Henderson, 1888, pp. 19–20, pl. 2, fig. 1. Rathbun, 1923, pp. 143–4, pl. 37. Sakai, 1936, pp. 46–7, pl. 9, fig. 1.

Thelxiope orientalis (Henderson): Sakai, 1965, p. 15, pl. 6, figs. 3, 4 (synon.)

MATERIAL: One male, one female, 26°27′ S., 153°50′ E., trawled 148–9 fm, 'Nimbus' stn 55, 5.viii.1968, W3324.

DISTRIBUTION: From east Africa to the Philippines, Japan and Australia; previously within Australia from Bass Strait and Victoria; 50–300 fm.

Family LATREILLIDAE

Latreillia australiensis Henderson

Latreillia australiensis Henderson, 1888, pp. 24–5, pl. 2, fig. 4. Whitelegge, 1900, p. 165. Rathbun, 1923, pp. 139–40.

MATERIAL: Male (fragmented), two females, off Cape Moreton, trawled 65 fm, D. Harris, W3327.

DISTRIBUTION: Southeastern Australia from Bass Strait to Port Jackson and now southeast Queensland; 30–150 fm.

Family RANINIDAE

Ranina ranina (Linnaeus)

Cancer raninus Linnaeus, 1758, p. 625.

Ranina dentata de Haan, 1841, p. 139, pls. 34, 35, figs. 1–4. Haswell, 1882, p. 144.

Ranina ranina (Linnaeus): Sakai, 1937, p. 178, pl. 16, fig. 4; 1965, p. 4, pl. 2, fig. 1. Barnard, 1950, pp. 397–8, fig. 75a–d. Healy and Yaldwyn, 1970, p. 76, pl. 36.

MATERIAL: Male, between Cape Moreton and Mooloolaba, trawled, F. Wallace, W3389. Male, 8 miles SE. of Cape Moreton, W1964.

Although this species was not recorded from Moreton Bay by Campbell and Stephenson, 1970, there are several specimens in the Queensland Museum collections taken from Moreton Bay, Bribie I., and Amity.

DISTRIBUTION: From South Africa to Japan, Hawaii, and Australia. Within Australia from western, northern, and eastern Australia to southern New South Wales.

Family CORYSTIDAE

Gomeza bicornis Gray

Gomeza bicornis Gray, 1831, p. 39. Hale, 1927, pp. 145–6, fig. 147. Barnard, 1950, p. 305, fig. 57d–g.

MATERIAL: Female, between Cape Moreton and Mooloolaba, trawled, F. Wallace, W3390. Female, 5–6 miles E. of Pt Cartwright Light, trawled 19–21 fm, sand, coral and shell, 6.iii.1970, F. Wallace, W3391.

DISTRIBUTION: From South Africa to Ceylon, Japan, and within Australia from South Australia and southeast Queensland.

Jonas leuteanus Ward

Jonas leuteanus Ward, 1933, pp. 379–80, pl. 23, fig. 8.

MATERIAL: Female, 5–6 miles E. of Pt Cartwright Light, trawled 19–21 fm, sand, coral and shell, 7.iii.1970, F. Wallace, W3392.

DISTRIBUTION: Lindeman I., Cumberland Group, Queensland (type locality) and southeast Queensland.

Family CALAPPIDAE

Calappa japonica Ortmann

Calappa japonica Ortmann, 1892, p. 566, pl. 26, fig. 8. Sakai, 1937, p. 96, pl. 18, fig. 4; 1965, p. 57, pl. 23, fig. 1. Barnard, 1950, pp. 352–3, fig. 66 n–p.

Calappa exanthematosa Alcock and Anderson, 1894, pp. 177–8. Alcock, 1899, pp. 21–2.

MATERIAL: Male, off Cape Moreton, trawled 70 fm, B. Beutel, March 1966, W2414. Female, off Cape Moreton, trawled 65 fm, D. Harris, W3362 (dry coll.).

DISTRIBUTION: South Africa to India, Japan, and now Australia; 17–70 fm.

Mursia australiensis sp. nov.

(Fig. 1; pl. 2A, B)

Mursia armata de Haan: Whitelegge, 1900, pp. 160–1.

[non] *Mursia armata* de Haan, 1837, p. 73, pl. 19, fig. 2.

[?] *Mursia spinimanus* Rathbun: Rathbun, 1911, p. 198, pl. 15, fig. 3.

[non] *Mursia spinimanus* Rathbun, 1906, p. 888, pl. 16, fig. 1.

HOLOTYPE: Male, 26 mm cl., 42.8 mm cw. including spines, 31 mm cw. excluding spines, off Cape Moreton, trawled, April 1964, D. Harris, W2379.

PARATYPES: Two males, 21, 22 mm cl., 26°31′ S., 153°40′ E. (*c.* 30 miles NE. of Caloundra), trawled 75.5 fm, 'Nimbus' stn 10, 26.vii.1968, A. J. Bruce, W3297. Male, 25.5 mm cl., 26°48′ S., 153°32.5′ E. (*c.* 20 miles E. of Caloundra), trawled 55 fm, 'Nimbus' stn 17, 27.vii.1968, A. J. Bruce, W3298. Three males, 24, 25, 29 mm cl., 18 miles N. of Cape Moreton, trawled 62–5 fm, sand and shell, FV 'Gemini', 19–20.iii.1970, F. Wallace, W3299. Three males, 28–29 mm cl., off Cape Moreton, trawled 65 fm, D. Harris, W3300 (dry coll.). Ten males, 16.5–27.5 mm cl., female, 23 mm cl., off Cape Moreton, trawled 65 fm, D. Harris, W3301.

DESCRIPTION

Carapace broader than long (cw. excluding lateral spines 1.15 to 1.18 times cl. in males, 1.13 times in only available female); coarsely granulate over entire surface (except frontal region which is less distinctly granulate) with 7 rows of tubercles radiating backwards from behind fronto-orbital region; front narrow (5.4–5.9 times in cl., 2.5–2.8 times in fronto-orbital width), three lobed, middle lobe projecting well forward of lateral lobes variably separated from the lateral lobes (see fig. 1c); anterolateral margins very convex, sub-parallel in posterior fifth, with some ten distinct sharp granules decreasing in size posteriorly; lateral spine moderately long (3.4–4.2 times in cl. in males, 4.75 times in female), slender, directed slightly posteriorly (posterior margin of spine lies in front of a line joining tips of spines), curved markedly or only slightly upwards (maximum of *c.* 30° to horizontal in posterior view, almost horizontal in female); posterolateral margins slightly shorter

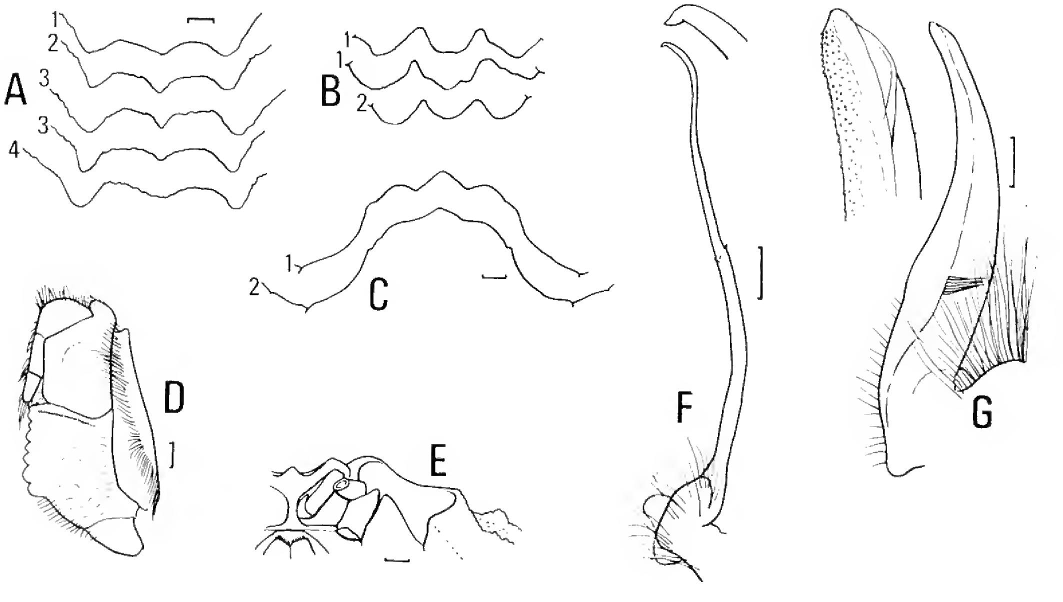

FIG. 1: *Mursia australiensis.* A–C, variation in posterior carapace margin (A), abdominal crest (B), and front (C); D, third maxilliped; E, ventral view of front and orbit; F, second (right) male pleopod; G, first (right) male pleopod.

Specimens illustrated: A–C, 1 = W3298, 2 = W3301, 3 = W3299, 4 = W3300; D–G, holotype. Scale divisions 1 mm.

than or subequal to anterolateral margins; posterior margin short (4.6–5.4 times in cl.), with three spines of which the laterals are largest (larger than anterolateral spinules) the median varying from only slightly smaller than the laterals to a low obtuse protruberence.

Inner suborbital lobe triangular, with outer margin straight; separated from outer orbital cup by a V-shaped sinus.

Merus of cheliped with three spines distally, the upper smallest but always distinct (larger than anterolateral spinules), the lower largest (at least 2/3 lateral spine). Upper face of wrist and outer face of chela coarsely granulate; outer face of chela with 9 tubercles in 3 rows and 3 further tubercles near base of dorsal serrate crest; lower row with proximal tubercle very acute and highest (triangular with concave sides), second tubercle lower and broader based (triangular with convex sides), distal tubercle low, rounded, and granulate; lower margin of chela finely serrate, becoming coarser distally; inner face of dactyl with row of some 25–30 stridulatory tubercles becoming smaller proximally and distally.

Ambulatory legs long (first leg 1.5–2.1 times cl.).

Abdomen of both sexes with three subequal flattened lobes on second segment well separated by V- or U-shaped sinus and with finely granulate margins. Penultimate segment of male abdomen as long as wide, lateral margins subparallel but slightly sinuous with slight protruberences at latero-distal angles; ultimate segment longer than wide, triangular, with slightly concave lateral margins.

First male pleopod stout, evenly tapering to a blunt tip, with fine spinules distally. Second male pleopod long, slender, with distal third abruptly narrower, horny, sinuous, with extreme tip conical, pointing laterally.

Colour, after alcohol preservation, pale biscuit with varying amount of rose pink on carapace sometimes concentrated in granules and often darker towards the lateral spines, on the frontal region, and in the upper outer face of the chelae. Inner face of chelae with darker red patch at base of dactyl.

Discussion

Sakai (1965, pp. 51–5) lists the 7 known Indo-Pacific species and subspecies of this genus and describes or figures 5 of these.

M. armata differs from other species, including the present one, in having the anterolateral carapace margins only slightly convex, the lateral teeth more than half the carapace length. In *M. curtispina*, *M. trispinosa*, *M. aspera*, and *M. hawaiiensis* the second male pleopod is considerably recurved distally, forming a complete loop in *M. trispinosa*. In the present species the second pleopod is slightly undulating distally, outcurved at the tip. The ornamentation of the outer face of the chela of the present species differs markedly from Sakai's figures (fig. 8a–d) of these four species.

M. bicristimana Alcock and Anderson (see Alcock, 1899, pp. 23–4, pl. 3, fig. 3) differs from *M. australiensis* in having 2, not 3, teeth on the posterior carapace margin, the lateral carapace teeth forwardly directed; the three lobes of the second abdominal segment barely separated by narrow grooves, the median lobe much wider than the laterals; and the three ventral teeth of the outer face of the chela joined by a crest.

M. spinimanus differs in having the posterolateral margins of the carapace much more convergent posteriorly, the surface of the carapace less distinctly tuberculate and more finely granulate, the carapace broader (cw. 1.3 times cl.) and the suborbital notch V-shaped. Rathbun (1911, p. 198) identified a small female from Saya de Malha (Indian Ocean) as *M. spinimanus*. This specimen differs from *M. spinimanus* in granulation and tuberculation of carapace and in carapace shape. It is tentatively placed in synonymy with the present species, the only difference observable from Rathbun's figure (pl. 15, fig. 3) being the straight (as opposed to slightly curved) lateral carapace teeth.

M. australiensis is closest to *M. curtispina* Miers but comparison with Miers's figure and description (1886, pl. 24, fig. 1, pp. 291–2) shows the following differences:

(1) Miers's figure shows a much broader front (3.75 times in cl. as against 5.4 to 5.9 times in *M. australiensis*).

(2) The lateral carapace spines are shorter in Miers's figure (6 times in cl. as against 3.4 to 4.7 times in *M. australiensis*) and are not obliquely directed backwards.

(3) The suborbital notch is narrow and V-shaped in Miers's fig. 2a. In *M. australiensis* it is broadly V-shaped and the suborbital tooth is triangular.

(4) The teeth on the posterior carapace margin are smaller and more widely separated in Miers's figure, the posterior margin is shorter (3.9 times in cl. as against 4.6 to 5.4 times in *M. australiensis*).

Sakai (1965) has compared Miers's holotype with specimens from Japan but although he identifies the Japanese specimens with Miers's species his figure (pl. 21, fig. 2) shows the following differences from that of Miers.

(1) Front 5.0 times in cl.

(2) Lateral carapace spines 4.6 times in cl.

(3) Posterior surface of carapace indistinctly granulate.

(4) Posterior margin of carapace shorter (4.9 times in cl.).

These differences could be due to subspecific variation within *M. curtispina* or to inaccuracies in Miers's illustration.

The Japanese specimens described by Sakai differ from *M. australiensis* in the following particulars:

(1) Front 5.0 times in cl. as against 5.4–5.9 times.

(2) Posterior surface of carapace indistinctly granulate.

(3) Posterior carapace teeth smaller and more widely separated.

(4) Two distal spines of lower series of outer face of chela are more acute and more prominent.

(5) The second male pleopod is strikingly recurved distally.

(6) The lateral carapace spines are less obliquely directed backwards.

Until material from a wider range of localities throughout the central Indo-west Pacific is compared, and the presence or absence of intergradation between Japanese and Fijian *M. curtispina* and *M. australiensis* is demonstrated it could be considered that the latter is best regarded as a subspecies of the former. The decision to treat *M. australiensis* as specifically distinct was based, in part, on the degree of difference which exists between the five species of *Mursia* recorded by Sakai (1965) as occurring together in Japan. Although two of these (*M. trispinosa* Parisi and *M. hawaiiensis* Rathbun) were regarded by Sakai as subspecies of *M. curtispina*, their coexistence without apparent intergradation requires their recognition as distinct species. The differences between these five species in such features as carapace shape, chela ornamentation and second male pleopod configuration are no greater than the differences between *M. australiensis* and *M. curtispina* listed above.

Family LEUCOSIDAE

Ebalia brevimana sp. nov.

(Fig. 2A–H; pl. 3A)

HOLOTYPE: male, cw. 8.4 mm, 26°27′ S., 153°50′ E., trawled 148 fm, 'Nimbus' stn 55, 5.viii.1968, A. J. Bruce, W3395.

DESCRIPTION

Carapace slightly longer than broad (cl. 8.6 mm, cw. 8.4 mm) with regions indistinctly defined by shallow grooves, with six tubercles disposed as in figure 2A (one intestinal, one cardiac, two branchial and two gastric); hepatic regions with low rounded swelling overlying the small anterolateral tooth; branchial regions swollen, rounded, giving the carapace an

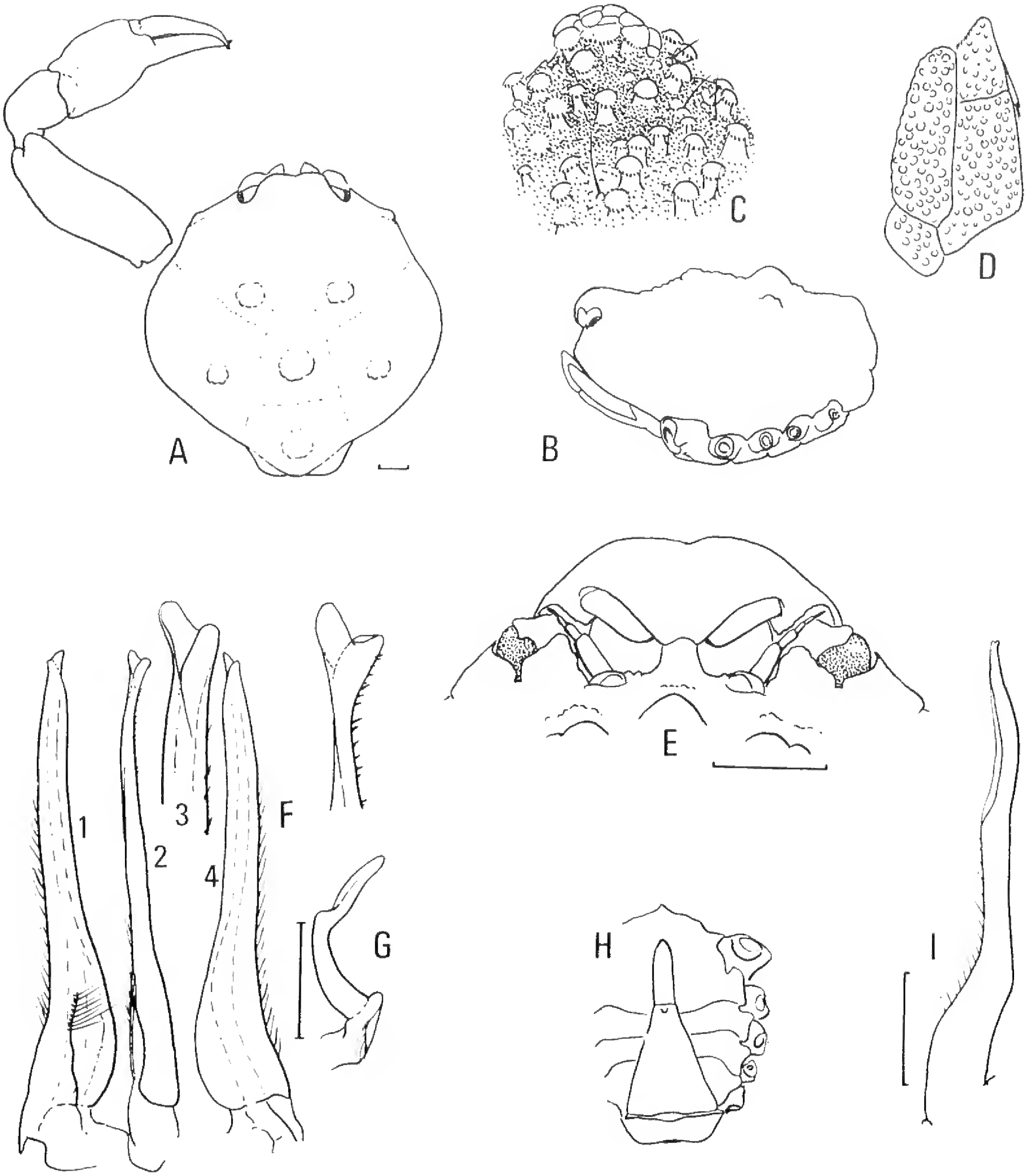

FIG. 2: A–H. *Ebalia brevimana*, holotype. A, carapace, dorsal view; B, carapace, lateral view; C, mushroom-shaped granules on carapace; D, third maxilliped; E, front; F, first male pleopod (1, abdominal face; 2, median face; 3, median face; 4, sternal face; 5, left pleopod in situ, latero-abdominal face); G, second male pleopod; H, male abdomen. Scale divisions 1 mm.
I, male pleopod, *E. tuberculosa*, 8.5 mm cw., Aust. Mus. P5524.

almost circular outline in dorsal view; front with two rounded lobes separated by shallow median depression; frontal lobes very rounded in lateral view; posterior margin with two rounded lobes laterally, little wider than frontal lobes, shallowly separated by the concave posterior margin which is partly obscured in dorsal view by the large intestinal protruberance. Surface of carapace with large scattered fimbriate mushroom-like granules which are confluent on the larger carapace tubercles, interspersed with fine scattered hairs on low granules.

Chelipeds short, 1.25 times carapace length, propodus as long as merus, dactylus only slightly shorter than palm, length of palm *c.* 1.5 times height. Surface of all segments smooth, formed by confluent discoid fimbriate tubercles. Both fixed and movable fingers with thin keel on outer edges, more prominent on third finger; and with raised longitudinal row of granules extending to hooked tips; teeth fine, interlocking distally with narrow gape proximally. Male abdomen with first and second segments distinct; third to sixth fused, with sharp spinous tubercle distally; seventh segment elongate, with lateral margins subparallel for most of their length, tip paraboloid.

Third maxilliped merus approximately half total length of ischium, *c.* 0.65 times marginal length. Maxillipeds (and whole ventral surface) covered with mushroom-shaped granules not elongated into spines anteriorly. First male pleopod with almost straight shank, tapering evenly, and flattened distally proximal to the asymmetrically bilobed aperture; with moderate setae on the lateral face and very short setae distally on the sternal face. Second male pleopod short, with terminal process almost as long (*c.* 0.9 ×) as shank.

Colour, after alcohol preservation, faded to pale biscuit with few small pale orange spots scattered on carapace.

DISCUSSION

This species, with its six dorsal carapace tubercles, is close to *E. tuberculosa* (A. Milne Edwards) (see Haswell, 1880, p. 54, pl. 6, fig. 3, as *Phlyxia granulosa*; Miers, 1886, p. 306, pl. 25, figs. 1, 1a; Hale, 1927, p. 197, fig. 198; Rathbun, 1923, p. 134, pl. 35, figs. 1–2; Sakai, 1937, pp. 111-2, fig. 11a–d; 1965, p. 28, pl. 13, fig. 2; Barnard, 1950, p. 368, figs. 70h–k; Takeda and Mijake, 1970, pp. 211–2 (synon.)). It differs from that species in the following particulars.

(1) Carapace more rounded in dorsal view, front less produced (variable in *E. tuberculosa* but not as in present species, see Barnard, 1950, and compare Sakai, 1965 with Miers, 1886).

(2) Posterior carapace lobes indistinctly separated, with intestinal prominence overlapping posterior margin in dorsal view (variable in *E. tuberculosa* but not approaching present species; compare Sakai, 1965, with Hale, 1927).

(3) Chelipeds are shorter, chelae shorter in relation to finger length and to height of chelae (variable in *E. tuberculosa* but not approaching present species; compare Sakai, 1937, with Miers, 1886, Hale, 1927, Sakai, 1965).

(4) Male abdomen with sixth segment fused to preceding segments, with tubercle on sixth segment. (Sakai, 1937, and Barnard, 1950, fig. j (side view) show distinct sixth segments whereas Haswell, 1880, and Barnard, 1950, fig. j (ventral view) show fused segments. Sakai and Barnard show a tubercle on the posterior margin of the seventh segment. Haswell shows one on the sixth segment. While Barnard's ventral view figure is obviously in error (see also Stebbing, 1920, pl. 26a; 1921, pl. 18a) Haswell's figure suggests a close agreement in this feature with the present species although in all other respects his figure represents typical *E. tuberculosa*. The type material of Haswell's *Phlyxia granulosa* consists of four dried specimens mounted on glass plates. Dr D. J. G. Griffin of the Australian Museum, Sydney, reports that the abdomen of the single male can not be examined because of the mounting medium; that these specimens appear to be conspecific with specimens of E. *tuberculosa* from the same locality (off Sydney) in which the abdominal formula of males is 1 + 2 + R + 6 + T; and that the type specimens are not conspecific with the present species. It would appear that Haswell's drawing of the male abdomen is incorrect).

(5) First male pleopod with straight, evenly tapering shaft, with bilobed tip. (Sakai, 1937, and Barnard, 1950, illustrate male pleopods of specimens of *E. tuberculosa* from Japan and South Africa respectively. These agree essentially with each other and with specimens of *E. tuberculosa* from off Botany Bay, N.S.W., illustrated in fig. 2l).

E. salamensis Doflein, 1904; *E. japonica* Rathbun, 1932; *Nursia scandens* Stebbing, 1920; and *N. postulans* Stebbing, 1921, have been synonymised with *E. tuberculosa* (see Sakai, 1965). Examination of the original descriptions of these nominate species show that they do not belong to the present species and are correctly synonymised with *E. tuberculosa*.

Ebalia longimana Ortmann

(Fig. 3)

Ebalia longimana Ortmann, 1892, p. 578, pl. 26, fig. 13. Sakai, 1937, pp. 109–11, fig. 10, pl. 13, fig. 6; 1965, pp. 29–30, pl. 13, figs. 5, 6 (synon.).

Material: male, 4.5 mm cl., with deformity of left branchial region, 26°30′ S., 153°44′ E., trawled 100 fm, 'Nimbus' stn 49, A. J. Bruce, 30.vii.1968, W3396.

This small specimen agrees well with figures and descriptions of Ortmann and Sakai, differing in having the male pleopods less slender, the chelipeds shorter than in Sakai's illustration of male specimens, approaching those of the illustrated female (Sakai, 1965, pl. 13, fig. 6). Both differences are considered due to the smaller size of this individual.

DISTRIBUTION: Previously recorded only from Japan.

Merocryptus lambriformis A. Milne Edwards

Merocryptus lambriformis A. Milne Edwards, 1873, p. 85, pl. 13, figs. 1–1c. Whitelegge, 1900, p. 162 Rathbun, 1923, p. 133, pl. 32, figs. 2, 3. Sakai, 1937, pp. 113–4, pl. 13, fig. 7; 1965, p. 30, fig. 30, pl. 14, figs. 1, 2. Serène, 1955, p. 145, figs. 1, 2. Bennett, 1964, p. 22, fig. 108.

MATERIAL: Male, 26°49′ S., 153°37′ E., trawled 100 fm, 'Nimbus' stn 19, 27.vii.1968, W3353. Female, off Cape Moreton, trawled, 22.vii.1965, B. Beutel, W2255.

DISTRIBUTION: Japan to Samoa, Australia, and New Zealand. Within Australia from the Great Australian Bight, Bass Strait, Port Hacking, Crowdy Head, and now Queensland; 22–120 fm.

Myra kessleri (Paul'son)

Callidactylus kessleri Paul'son, 1875, p. 80.

Myra kessleri (Paul'son): Ihle, 1918, p. 260 (synon.). Tyndale-Biscoe and George, 1962, p. 89, figs. 7, 9.

Myra darnleyensis Haswell, 1880, p. 52, pl. 5, fig. 4.

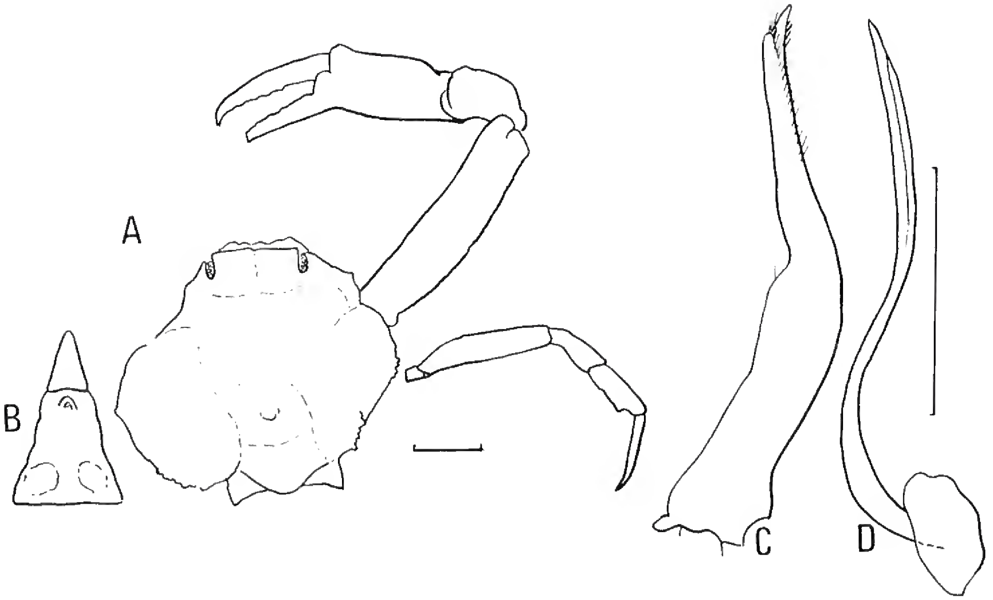

FIG. 3: *Ebalia longimana*. A, carapace; B, male abdomen; C, first male pleopod; D, second male pleopod. Scale divisions 1 mm.

MATERIAL: Male, 25°01′ S., 153°30′ E., 29 fm, Bureau of Mineral Resources stn 1377, W3384.

DISTRIBUTION: From Red Sea (Paul'son 1875) and Seychelles to Indonesia, Australia, and New Caledonia. Previous Australian records are from Dampier Archipelago (Western Australia) and Torres Strait (fide Tyndale-Biscoe and George, 1962).

Arcania (?) **heptacantha** (de Haan)

(Pl. 3B)

Iphis heptacantha de Haan, 1861, p. 27.

Arcania heptacantha (de Haan): de Man, 1907, pp. 398–9, pl. 31, figs. 8–10. Sakai, 1937, pp. 126–7, fig. 18; 1965, p. 41, pl. 16, fig. 6.

MATERIAL: Female, 26°30′ S., 153°15′ E., trawled 26 fm, 'Nimbus' stn 8, 26.vii.1968, W3359. Female, Arnhem Bay, Northern Territory, 10 fm, sand and mud bottom, V. Wells, W2604.

Published figures and descriptions demonstrate some confusion as to the relative status of *A. heptacantha* and *A. septemspinosa* (Fabricius). De Man (1907, pp. 398–9) in attempting a comparison could only suggest that the relative lengths of carapace spines (although shown to be variable by Alcock), and perhaps the depth of the groove separating branchial from cardiac and intestinal regions, were the most likely features that could be used to distinguish the two species. Rathbun (1910, p. 314) described her *A. siamensis* (synonymised with *A. heptacantha* by Sakai, 1937, 1965) as differing from *A. septemspinosa* (which she recorded from the same locality) in having the carapace more subglobular, the branchial regions more swollen, and the marginal spines shorter than in *A. septemspinosa.*

Barnard (1950, p. 385, fig. 71, 71f, g) describes and illustrates specimens which, although he identifies them as *A. septemspinosa*, have short carapace spines. Barnard's specimens are also unusual in having the lateral spines situated on the posterior third of the carapace, the lower posterior spines very close together under the base of the median posterior spine, and the anterolateral margins straight or almost concave. The four very short posterolateral spines of Barnard's illustration bear no resemblance to the long spines figured for *A. septemspinosa* by Sluiter (1881, fig. 1) and by Herbst (1790, pl. 20, fig. 112).

The Australian specimens can not be satisfactorily fitted into the variation shown by these (or this) species without detailed comparisons of material from a range of localities throughout the Indo-Pacific area. They appear closest to *A. heptacantha* as figured by Sakai (1937, 1965) but differ from his specimens in having the lateral carapace spines reaching to the end of the ambulatory meri, the front narrower and more anteriorly projecting (well forward of the lateral pterygostomial spines), and the carapace regions less distinctly marked.

DISTRIBUTION: *A. heptacantha* from the Gulf of Thailand to Japan, and now Australia. *A. septemspinosa* from South Africa (? identity) to India and Hong Kong.

Arcania undecimspinosa de Haan

Arcania undecimspinosa de Haan, 1841, p. 135, pl. 33, fig. 8. Sakai, 1937, p. 123, fig. 15a, pl. 14, fig. 2; 1965, p. 40, fig. 6a, pl. 16, fig. 3.

Arcania granulosa Miers, 1877, p. 240, pl. 38, fig. 29.

MATERIAL: Two males, female, off Cape Moreton, trawled 65 fm, D. Harris, W3348 (dry collection). Two males, 26°31′ S., 153°43′ E., trawled 100–102 fm, 'Nimbus' stn 11, 26.vii.1968, W3358. Four males, two females, off Cape Moreton, trawled 65 fm, D. Harris, W3352. Two females, off Cape Moreton, trawled, B. Beutel, 22.vii.1965, W2256. Female, 26°49′ S., 153°35′ E., trawled 75 fm, 'Nimbus' stn 18, 27.vii.1968, W3360. Female, 26°49′ S., 153°37′ E., trawled, 100 fm, 'Nimbus' stn 19, 27.vii.1968, W3356. Male, off Caloundra, trawled, R. Elks, W3349.

DISTRIBUTION: India to Japan and Australia. Previously recorded from Australia by Miers (1877) from 'Moreton B.', but not recorded from within the bay by Campbell and Stephenson, 1970.

Arcania elongata Yokoya

Arcania undecimspinosa elongata Yokoya, 1933, p. 132, fig. 47. Sakai, 1937, p. 124, figs. 15b, 16; 1965, pp. 40–1, fig. 6b, pl. 16, fig. 2.

MATERIAL: Female, 26°30′ S., 153°15′ E., trawled, 26 fm, 'Nimbus' stn 8, 26.vii.1968, W3358. Male, southern Queensland, E. C. Vallis, W3347 (dry collection).

These specimens differ from *A. undecimspinosa* in all features mentioned by Sakai (1937, pp. 124–5; 1965, pp. 40–1), approaching *A. novemspinosa* in many respects but differing from that species in the sharper granulation (spinulation) of the carapace, more elongate carapace, smaller marginal spines, less projecting front (which is finely spinulate not granulate), absence of prominent proximal spine on posterior margin of arm of cheliped.

In view of the constancy of the distinguishing features over such a wide geographic range *A. elongata* must be given full specific status.

DISTRIBUTION: Previously known only from Japan (Sakai, 1965).

Randallia eburnea Alcock

Randallia eburnea Alcock, 1896, p. 196. Sakai, 1937, pp. 132–3, fig. 22; 1965, p. 42, pl. 17, fig. 1. Tyndale-Biscoe and George, 1962, pp. 87, 94.

MATERIAL: Male, 30 miles due E. of Mooloolaba, 69–70 fm, R. Elks, W2849. Female, 26°31′ S., 153°33′ E., trawled 56 fm, 'Nimbus' stn 9, 26.vii.68, W3355. Female, 26°49′ S., 153°35′ E., trawled 75 fm, 'Nimbus' stn 18, 27.vii.1968, W3354. Six males, southeast Queensland, trawled, D. Harris, W3344 (dry collection). Female, off Caloundra, trawled, R. Elks, 13.viii.1967, W3350. Two males, female, 28 miles N. of Cape Moreton, trawled 62–5 fm, sand and shell, F. Wallace, 7.iv.1970, W3364. Male, 18 miles N. of Cape Moreton, trawled 62–5 fm, sand and shell, F. Wallace, 19.iii.1970, W3368. Male, 5 females, off Cape Moreton, trawled 65 fm, D. Harris, W3380.

These specimens agree with those of Tyndale-Biscoe and George in that the distal third of the first to third dactyls have long hairs and the tooth on the penultimate segment of the male abdomen is well developed. They differ, agreeing with Ihle's description, in having the fused 3rd to 6th abdominal segments all clearly recognisable.

DISTRIBUTION: From India and the Laccadives to Japan, Western Australia, and now Queensland; 15–80 fm.

Ixa inermis Leach

Ixa inermis Leach, 1817, p. 26, pl. 129, fig. 2. Haswell, 1880, p. 59. McNeill, 1942, p. 430; 1968, p. 40. Holthuis and Gottlieb, 1956, pp. 291–6, pl. 5, fig. 1. Healy and Yaldwyn, 1970, p. 82, fig. 43.

[non] *Ixa inermis* Leach: Alcock, 1896, pp. 272–3.

MATERIAL: Male, 26°45′ S., 153°21′ E., trawled 25 fm, 'Nimbus' stn 16, 27.vii.1968, A. J. Bruce, W3397. Male, off Cape Moreton, trawled 65 fm, D. Harris, W3398. Male, female, off Cape Moreton, trawled 65 fm, D. Harris, W3399 (dry collection). Male, 6 miles NE. of Caloundra Light, trawled 21 fm, sand and shell, 27.ii.1970, F. Wallace, W3374. Female, 6–7 miles NE. of Caloundra Light, trawled 22 fm, sand and shell, 3.iii.1970, F. Wallace, W3373. Female, Hervey Bay, Capt. Hoult, G646.

DISTRIBUTION: From the Malay Archipelago and Australia. Previously within Australia from Thursday Island, Low Isles, Cape Grenville, Port Denison, and off Tin Can Bay, 25 fm.

Ixoides cornutus MacGilchrist

Ixoides cornutus MacGilchrist, 1905, p. 255. Sakai, 1937, pp. 137–9, pl. 19, figs. 1–4; 1965, p. 44, pl. 18, fig. 3.

MATERIAL: Five males, off Cape Moreton, trawled, D. Harris, W3343 (dry collection). Male, female, off Cape Moreton, trawled 65 fm, D. Harris, W3361. Male, female, off Cape Moreton, trawled, B. Beutel, 22.vii.1965, W2257. Male, 28 miles N. of Cape Moreton, trawled 62–5 fm, sand and shell, F. Wallace, 7.iv.1970, W3365. Male, female, 18 miles N. of Cape Moreton, trawled 62–5 fm, sand and shell, F. Wallace, 18.iii.1970, W3369.

DISTRIBUTION: From the Iranian Gulf to Hong Kong and Japan (Sakai, 1965), and now eastern Australia.

Leucosia unidentata de Haan

Leucosia unidentata de Haan, 1841, p. 133, pl. 33, fig. 3. Haswell, 1882, p. 118. Alcock, 1896, pp. 215–6. Sakai, 1937, p. 146, fig. 286, pl. 15, fig. 4; 1965, pp. 47–8, pl. 19, fig. 3.

MATERIAL: Female, 18 miles N. of Cape Moreton, trawled 62–5 fm, sand and shell, F. Wallace, 19.iii.1970, W3367. Female, 28 miles N. of Cape Moreton, trawled 62–5 fm, sand and shell, F. Wallace, 7.iv.1970, W3366. Male, 26°31′ S., 153°33′ E., trawled 56 fm, 'Nimbus' stn 9, 26.vii.1968, W3378. Male, 26°17′ S., 153°42′ E., trawled 47 fm, 'Nimbus' stn 2, 25.vii.1968, W3383. Female, 26°48′ S., 153°32.5′ E., trawled

55 fm, 'Nimbus' stn 17, 27.vii.1968, W3379. Male, off Caloundra, trawled, R. Elks, W3377. Male and female, off Cape Moreton, trawled 65 fm, D. Harris, W3376. Fifteen males, five females, trawled off southern Queensland, D. Harris, W3388 (dry collection).

Alcock's description and Sakai's figures indicate that the posterior margin of the carapace is very convexly rounded. While this is true in the females of the present series, in the males this margin is concave, with two slight, well rounded lobes laterally. The pleopods agree well with Sakai's (1937, fig. 28b) illustration except that the distal bristles are much longer (as long as the terminal projection) and the three spirals of the shaft of the pleopod are not as distinctly divided to form six as in Sakai's figure.

DISTRIBUTION: From India to Hong Kong, Japan, Molluccas, Torres Strait, and now southern Queensland.

Cryptocnemus hemispheroides sp. nov.

(Fig. 4; pl. 3C)

HOLOTYPE: female, 8 mm cw., 26°27′ S., 153°50′ E., trawled 148 fm, 'Nimbus' stn 55, 5.viii.1968, W3363.

DESCRIPTION:

Carapace broader than long (cw. = 8 mm, cl. = 7.1 mm), smooth, dorsally rounded, without ridges or granules on the dorsal surface; margins of carapace with lamellate expansions originating at a distinct tooth on the anterolateral margin, increasing in width posteriorly, edge composed of straight lines which meet to form distinct angles laterally, posterolaterally and at each side of the slightly concave posterior margin.

Front markedly produced, deeply divided into two slightly upturned lobes separated by U-shaped sinus in dorsal view; small but distinct subsidiary lobes halfway along length of median margins of frontal lobes.

Median portion of front between frontal lobes markedly depressed to meet epistome, separating antennulary fossae which extend well up under frontal lobes; antennulary fossae separated from orbits by second segment of antennae; suborbital lobe large.

Anterior extremity of buccal cavern reaches well beyond anterior extremity of pterygostomian region. Merus of third maxilliped much shorter than ischium.

Chela approx. 1.6 times cw. Merus flattened in proximal half with thin flat laminate carinae on both margins, trigonal in distal half with thin carinae on all three margins; carpus trigonal with broadly lamellate carina on outer margin, ridge ending in small distal tooth on upper inner margin, low ridge ending in larger tooth on lower inner margin; propodus flattened, with broad lamellate carina on outer margin and on inner margin extending along edge of fixed finger decreasing in width to near the tip; dactylus as long as propodus excluding fixed finger, with lamellate carina on outer margin decreasing in width to near the tip; cutting edges of fingers with series of low teeth with larger ones interspersed at regular intervals, these latter increasing in size towards the tip on the fixed finger, subequal on the dactylus.

Walking legs decreasing in size posteriorly; merus and propodus flattened, with lamellate carinae on both margins; carpus of first two legs with broad carina on outer margin, of last two legs with two carinae, one on outer margin, one on posterior (upper) face; dactyl very thin, styliform.

Abdomen of female with free segment followed by four discernable segments fused in a circular plate, with terminal segment free, triangular, longer than broad.

Colour, after alcohol preservation, pale, with pale pink-orange spots, one in middle of posterior margin, two posteriorly on dorsal surface with indistinct broken band running anterolaterally from these towards the anterolateral teeth; small white speckles running posterolaterally from orbits in band which ends in medial expansion at level of anterolateral teeth, similar white spots on upper face of cheliped.

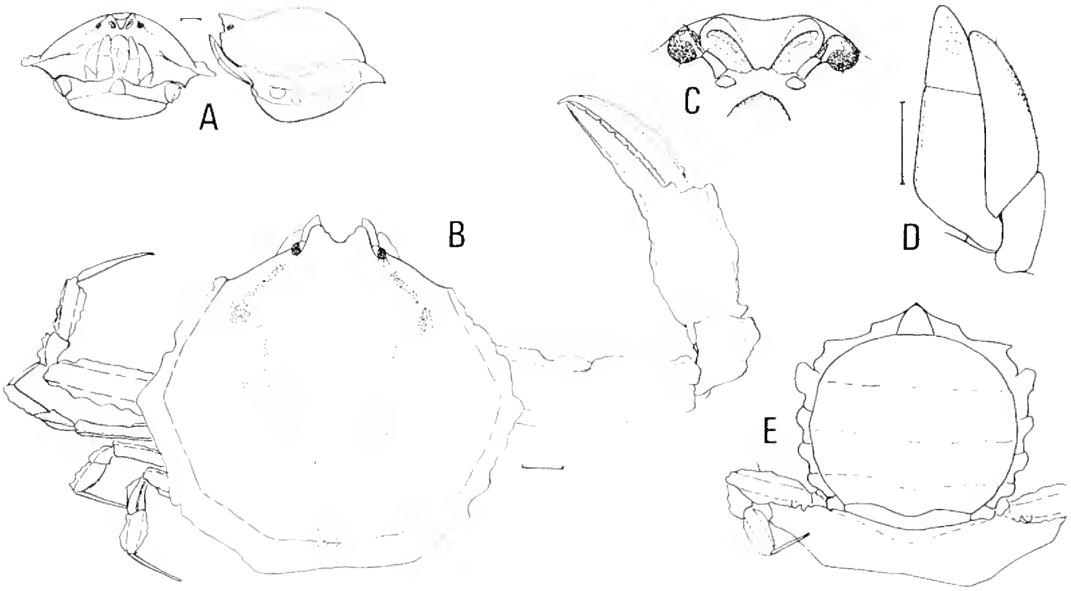

FIG. 4: *Cryptocnemus hemispheroides*. A, carapace, frontal and lateral view; B, carapace, dorsal view; C, front; D, third maxilliped; E, female abdomen. Scale divisions 1 mm.

Discussion

Ihle (1918, p. 317) listed the known Indo-Pacific species of *Cryptocnemus* and (p. 286) provided a key to these species. To this list must be added the subsequently described *C. vincentianus* Hale, 1927, *C. planus* Ward, 1933, and *C. kamekii* Sakai, 1961.

The present species is similar to *C. obolus* Ortmann, 1892, in having the front very distinctly bilobate and the carapace surface smoothly hemispherical without ridges whereas in all other species of *Cryptocnemus* the front is variably produced as a single triangular or rounded lobe, and the carapace usually bears a median ridge from between the orbits to the centre of the carapace (faint ridge extending a short distance back in *C. planus*) with sometimes additional posterolaterally radiating ridges from that point. While these differences also are possibly marked enough to warrant generic separation of *C. obolus* and *C. hemispheroides* from other species of *Cryptocnemus*, examination of all species would be desirable to determine other significant distinguishing features.

C. hemispheroides differs from *C. obolus* (fide, Ortmann, 1892, p. 576, pl. 26, fig. 12; Yokoya, 1933, p. 117; Sakai, 1937, pp. 140–1; 1965, p. 45, pl. 18, fig. 2) in that the two frontal lobes are less acutely projecting and have small subsidiary lobes on their median margins; the expanded carapace edge is not produced into as large a lobe laterally, and the posterior half of this edge is not smoothly rounded but composed of five straight or even slightly concave segments meeting to form distinct angles; the dorsal crest on the anterior margin of the arm of the cheliped is much shorter, occupying only the distal half of the arm.

DISCUSSION

The 27 species of Dromiacea, Homolidea, Gymnopleura, Corystoidea and Oxystomata thus far known from this area probably represent only a small fraction of the total fauna, and only broad comparisons can be made with other areas at this time. Of these 27 species, 7 (26%) are not found outside Australia, 15 (56%) are shared with India and 18 (67%) with Japan. In contrast, of the 18 species of these groups found in Moreton Bay (see Campbell and Stephenson, 1970) 5 (28%) are not found outside Australia, 12 (67%) are shared with India but only 4 (22%) with Japan.

Only 4 (15%) of the 27 species found in the deeper water (>20 fm) off southern Queensland are also present in the predominantly shallow water (<20 fm) of Moreton Bay. Although further collecting may alter these figures it would seem that faunal composition is affected more markedly by a depth change of 20 fm than by spatial separation of some 6000 miles.

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[redacted]

PLATE 2

Mursia australiensis, holotype.

A, dorsal view; B, chela, outer face; C, chela, inner face; D, ventral view.

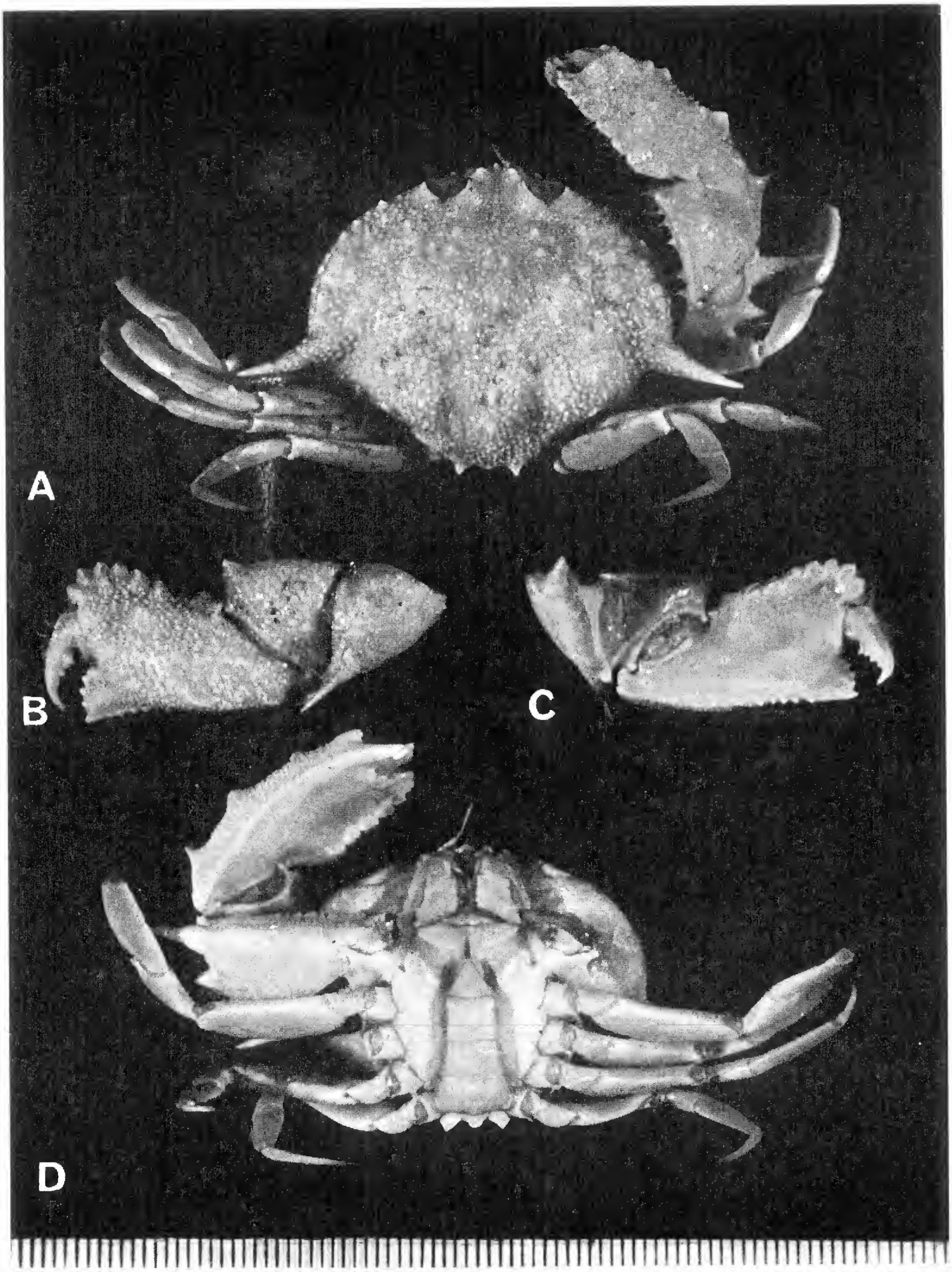
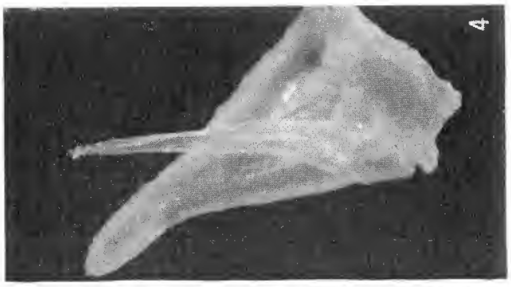

A
B
C
D

PLATE 3

A, *Ebalia brevimana*, holotype. 1, dorsal view; 2, male abdomen; 3, male abdomen, lateral view; 4, male pleopod *in situ.*

B, *Arcania* (?) *heptacantha.*

C, *Cryptocnemus hemispheroides*, holotype.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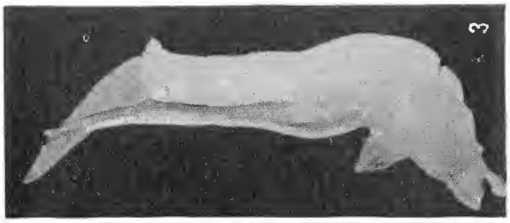
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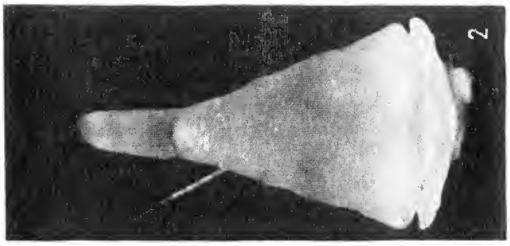
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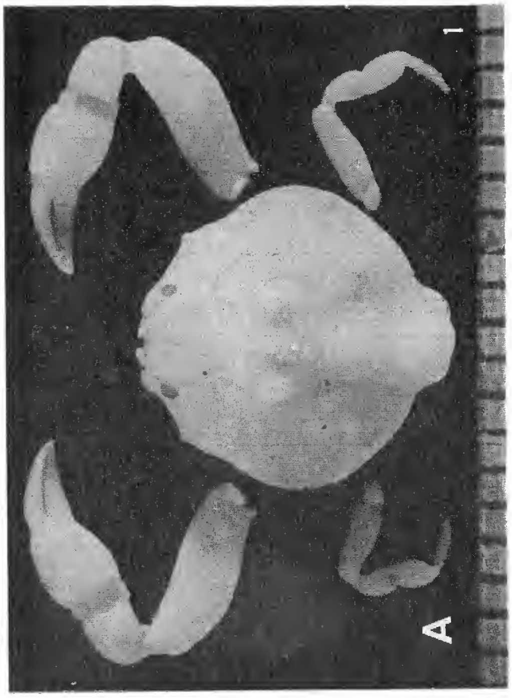
1
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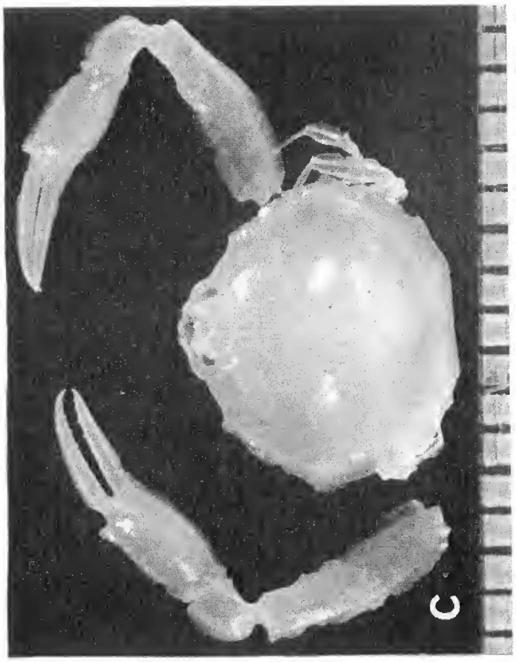
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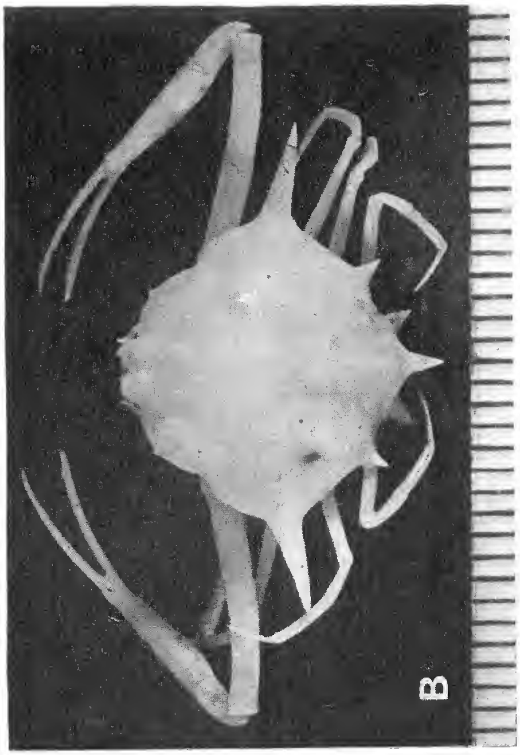
B

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Mem. Qd Mus. (1971) **16**(1): 49–67

AMPHIBIAN AND REPTILE TYPE-SPECIMENS IN THE QUEENSLAND MUSEUM

Jeanette Covacevich
Queensland Museum

ABSTRACT

Types and probable types of 76 nominate species or subspecies in the Queensland Museum collection are listed, including 45 of the 79 described by C. W. De Vis, between 1884 and 1911.

The amphibian and reptile collections of the Queensland Museum commenced in 1875. They were initially documented by a complex and barely workable system of donor, purchase, exchange and collection registers which applied to all specimens. In May 1911, a new and simplified system was introduced and is still in use. Under this all amphibians, reptiles and mammals were accessioned with the prefix 'J' in a single register. Type-specimens received since the current register began have been registered with reasonable efficiency, but mistakes have undoubtedly been made in handling the backlog of older type specimens, some of which were unregistered until the compilation of this list.

In determining whether a particular specimen is or is not the type of a particular nominate species group taxon the following criteria are available.

(1) Designation by the author, with reference to a museum registration number.

(2) Notation in the register indicating that the specimen is a 'Type' (or 'co-type', 'syntype', etc.).

(3) Notation on the label of the jar containing the specimen indicating that the specimen is a type.

(4) Coincidence of data recorded with specimen with that given by original author where date of accession indicates that specimen under consideration would have been available to the author at that time.

(5) Coincidence of measurements and items of description of specific species.

Difficulties arise when evidence based on these criteria is conflicting or inconsistent. Thus many specimens found labelled 'type', 'co-type', or 'syntype' have been included as only 'probable types' because they either differ markedly from the type-description or are accompanied by collection data conflicting with that published. Also listed are several specimens which were not labelled as types but can reasonably be presumed 'types' or, at least, 'probable types' following comparison of specimens and register entries with the type descriptions. One specimen, J76 *Limnodynastes olivaceus* (see p. 51) found labelled 'De Vis type' has not been included because of conflicting locality data and the confirmed existence of the holotype of this species in the British Museum.

De Vis was Curator in charge of the Queensland Museum collections from 1882 until 1905, and as the bulk of his new descriptions were published during this time, it seems reasonable that most of his type-specimens were deposited in this Museum. In one paper (1888, pp. 811–26) he described 18 new species, 17 from Queensland and 1 without locality. Types of 11 are in the collection, so it must be considered probable that all were lodged here and that 7 have been lost. Some, like the type of *L. olivaceus*, may have been sent to the British Museum but often many of the specimens from a particular paper are in the Queensland Museum while others cannot be located and must be presumed lost. De Vis never published register numbers for his frogs and reptiles, rarely stated how many were used for his descriptions or where they were lodged, and must be held largely responsible for the apparent loss of so many of his type specimens.

The syntypes of *Oedura tryoni* De Vis, 1884, were collected from Stanthorpe and would almost certainly have been deposited in the Queensland Museum. These specimens could not be located in a recent search and Bustard (1966, pp. 6–7, pl. 1), has designated as neotype an Australian Museum specimen, R21601.

Type-specimens (including probable types) are listed by family in alphabetical order under the name by which they were first described. All specimens bear 'J' register numbers and, with the exception of the holotype of *Devisia mythodes* Ogilby (mounted specimen), are stored in 75% alcohol with glycerine in screw-top glass jars. Type categories listed by the International Commission on Zoological Nomenclature (1964, p. 77) are followed. A question mark is used to distinguish specimens that are only 'probable types' from those which are definitely type specimens. Current names are given where synonymies have been published. All available collection data from tags with the specimens and from the register is listed. Any discrepancy between this and published data is noted. Where a locality name has been changed the present name is given in parenthesis beside the original. An asterisk beside a date is to distinguish it as a definite date of collection in contrast to other dates which may be of collection, donation, receipt or registration. Most specimens are in good condition but faded with age. A short statement on the condition of each is included. Notes on the types of five species which have been presumed to be in the Queensland Museum collection and one from the Amateur Fisherman's Association of Queensland (A.F.A.Q.) Museum are listed separately.

TYPE-SPECIMENS ERRONEOUSLY ASCRIBED TO THE QUEENSLAND MUSEUM COLLECTIONS

Limnodynastes olivaceus De Vis. A specimen in the Queensland Museum collection (J76, Herbert R.) is labelled 'Type'. Both Parker (1940, p. 55) and Moore (1961, p. 347) state that the holotype of this species is in the British Museum collections. Miss A. G. C. Grandison, Curator of Herpetology at the British Museum writes '. . . we do have a specimen presented by H. Ling Roth, taken at Pt. Mackay, Queensland, which is labelled as the type of *Limnodynastes olivaceus*. It is a female and bears the registration number 85.9.2.25 . . .'. Considering this information and the fact that the holotype was collected at Port Mackay according to De Vis (1885, p. 66) and not, as was J76, from the Herbert River, it seems probable that this specimen, although agreeing reasonably well with the specimen described by De Vis, has been incorrectly labelled as the type.

Ranaster convexiusculus Macleay, **Hylarana nebulosa** Macleay. Types of these species were originally part of the Macleay Museum type collection but have erroneously been presumed to be in the Queensland Museum collection by Goldman, Hill, and Stanbury (1969, pp. 429–30) who quote Moore (1961, p. 354, p. 345). Moore apparently based his statement on Fry (191b, pp. 46–50). A careful check of the collection has shown that these specimens are not in the collection now and they have probably never been here.

Mixophyes iteratus Straughan, **M. balbus** Straughan. According to the original descriptions (Straughan 1968, pp. 54-7) paratypes of these species were deposited in the Queensland Museum. Two paratypes (unregistered, 1 male, 1 female) of *M. iteratus*, collected 'Tweed River, Mount Warning, N.S.W.' are listed as being held here. Thirteen paratypes (unregistered, 10 males, 3 females) of *M. balbus* collected 'Point Lookout, New England National Park, N.S.W., between 4,250 and 4,750 feet altitude' are listed as being held by 'Australian Museum and Queensland Museum'.

The frog collection received from Dr Straughan has been registered, and Queensland Museum holdings of these two species are—

M. iteratus—2 unsexed specimens, J18851, Lynch's Creek, Kyogle, N.S.W.; 1 unregistered specimen without data.

M. balbus—10 unsexed specimens, unregistered, found with tadpoles in jar labelled 'New England sp. nov. *M. balbus*' but with no other data.

Dr H. G. Cogger of the Australian Museum writes '. . . The specimens we have from (Dr Straughan) are as follows:

> *Mixophyes balbus*
>
> Holotype, R25922, Point Lookout, New England National Park, N.S.W. Paratypes, six specimens, R25923–R25928, data as for Holotype.
>
> *Mixophyes iteratus*
>
> Holotype, R25929, Tweed River, Mount Warning National Park, N.S.W. Paratype, one specimen only, R25930, data as for Holotype.
>
> Hence we have only one of the three paratypes of *Mixophyes iteratus* and six of the thirteen paratypes of *Mixophyes balbus*.'

Hyla luteiventris Ogilby. An attempt has been made to locate the holotype of this species in the A.F.A.Q. Museum where, according to the description (see Ogilby, 1906, pp. 31–2), the specimen was deposited. Fry (1912, pp. 97, 99) examined this specimen and synonymised *H. luteiventris* with *H. gracilenta* Peters, but there is no trace of it since then. It was not transferred to the Australian Museum (Cogger, pers. comm.) and as it is no longer in the A.F.A.Q. Museum and the register which might have contained some mention of it has been discarded, it can only be concluded that the holotype has been lost in one of the many reorganizations of that Museum.

TYPE SPECIMENS IN THE QUEENSLAND MUSEUM COLLECTIONS

AMPHIBIA

MICROHYLIDAE

Cophixalus biroi darlingtoni Loveridge, 1948
Bull. Mus. comp. Zool. Harv. **101** (2): 423–4

PARATYPE: J9612; Toromanbanua, 7,500 ft, Bismarck Range, Madang Division, Australian New Guinea, coll. Dr P. J. Darlington, October 1944*. (Good).

LEPTODACTYLIDAE

Crinia darlingtoni Loveridge, 1933
Occ. Pap. Boston Soc. nat. Hist. **8**: 57–8

PARATYPE: J5444; National Park, Macpherson Range, 3–4,000 ft, SE.Q., don. Harvard Museum, 4.iv.1932. (Good).

Crinia tinnula Straughan and Main, 1967
Proc. roy. Soc. Qd **78** (2): 19–21, pl. 1, fig. 1

HOLOTYPE: J13546; male, Rose Creek, Beerburrum, SE.Q., coll. A. R. Main, I. R. Straughan, 31.viii.1965*. (Good).

PARATYPES: J13547–53; 7 males, Rose Creek, Beerburrum, SE.Q., coll. A. R. Main, I. R. Straughan, 31.viii.1965*. (Good).

Heleioporus sudelli Lamb, 1911
Ann. Qd Mus. **10**: 26–7
(=*Heleioporus pictus* Peters after Fry, 1912, p. 106. *Helioporus eyrei* (Gray) after Loveridge, 1935, pp. 15–16. ?*Limnodynastes* sp. after Parker, 1940, p. 42.)
HOLOTYPE: J78; Warwick, SE.Q., coll. Miss J. Sudell. (Faded).

Two specimens originally registered with this number; one sent to Australian Museum 29 February 1912. Measurements of J78 agree with those in description.

Limnodynastes marmoratus Lamb, 1911
Ann. Qd Mus. **10**: 28
(= *Limnodynastes fletcheri* Boulenger after Fry, 1912, p. 106)
HOLOTYPE: J12597; Goondiwindi, SE.Q., coll. J. Lamb, November 1910*. (Faded).
PARATYPES: J12598–601; 4 specimens, Goondiwindi, SE.Q., coll. J. Lamb, November 1910*. (Faded).

These five specimens re-registered from J77 which originally applied to six specimens. One of series sent to Fry at Australian Museum 29 February 1912 according to register. Lamb does not mention how many specimens used in description. J12597 agrees with measurements given and, according to description, 'Type in Queensland Museum'.

Mixophyes fasciolatus schevilli Loveridge, 1933
Occ. Pap. Boston Soc. nat. Hist. **8**: 55-6
(= *Mixophyes schevilli* Loveridge after Straughan, 1968, pp. 57–8, pl. 2, fig. 2)
PARATYPE: J5443; Millaa Millaa, NE.Q., don. Harvard Museum (Harvard collection number 18151), 4.iv.1932. (Good).

Taudactylus diurnus Straughan and Lee, 1966
Proc. roy. Soc. Qd **77** (6): 63–6, pl. 4.
HOLOTYPE: J13398; male, Green's Falls, Maiala National Park, Mt. Glorious, SE.Q., coll. I. R. Straughan, 12.v.1965*. (Good).
PARATYPES: J13399–411; 3 males, 4 females, 6 unsexed (3 juv.), Green's Falls, Maiala National Park, Mt Glorious, SE.Q., coll. I. R. Straughan, 12.v.1965*. (7 good, 5 with bellies slit, 1 with belly slit and skin removed).

HYLIDAE

Hyla becki Loveridge, 1945
Proc. biol. Soc. Wash. **58**: 55–6.
PARATYPE: J9613; Mt. Wilhelm, 7,500–10,000 ft, Bismarck Range, Madang Division, New Guinea, coll. Captain P. J. Darlington, October 1944*. (Good).

Hyla irrorata De Vis, 1884
Proc. roy. Soc. Qd **1**: 128-9
SYNTYPES: J12870–80; 11 specimens, Gympie, SE.Q., coll. H. F. Wallman, 1884*. (All faded and brittle, 3 with broken limbs).

Not knowing of the existence of these syntypes Copland (1961, p. 261) designated J9255 as the 'neotype' of *H. irrorata.* A case to have Copland's designation invalidated is currently being prepared for submission to the International Commission of Zoological Nomenclature.

Hyla vinosa Lamb, 1911
Ann. Qd Mus. **10**: 27
(= *Hyla lesueurii vinosa* Lamb after Fry, 1915, pp. 84–6, pl. 2)

HOLOTYPE: J74; Ithaca Creek, Brisbane, SE.Q., 4.viii.1908*. (Faded, pattern visible)

Moore (1961, p. 345) remarks 'Status uncertain; possibly valid; possibly *Hyla lesueuri*'.

REPTILIA

CHELYDRIDAE

Devisia mythodes Ogilby, 1907
Proc. roy. Soc. Qd **19**: 11–16
(=*Chelydra serpentina* Linnaeus after Loveridge and Shreve, 1947, pp. 120–3)

HOLOTYPE: J20207; Fly River, New Guinea, don. Sir W. Macgregor. (Mounted; tip of tail broken but present; some claws missing).

GEKKONIDAE

Diplodactylus hillii Longman, 1915
Mem. Qd Mus. **3**: 32–3
(= *Diplodactylus conspicillatus* Lucas and Frost after Kluge, 1963, pp. 83–4)

HOLOTYPE: J1994; Port Darwin, N.T., 7.viii.1914. (Tail separate, but present).

Kluge (1967, p. 1045) lists holotype as '. . . Q.M. J2017 (=J14/1994) . . .'. Register entries show holotype registered twice (J1994, J2017)—no specimen now numbered J2017.

Diplodactylus taenicauda De Vis, 1887
Proc. Linn. Soc. N.S.W. **1**: 169-70

SYNTYPE: J232; Chinchilla, SE.Q. (Faded, pattern still visible; fragile, shape distorted).

Apparently only specimen of type series in existence; not specimen measured for description.

Diplodactylus williamsi Kluge, 1963
Proc. Linn. Soc. N.S.W. **88** (2): 230–4, pl. 14

PARATYPES: J270; Warialda, N.S.W., don. Australian Museum, 29.viii.1912. (Good). J2324; Mungindi, SE.Q., don. Mrs Haager, 4.vi.1915. (Faded; tail missing). J6136; Retro Station, Capella, M.E.Q., don. P. C. Allan. (Tail regenerated; belly slit). J6139; Retro Station, Capella, M.E.Q., don. P. C. Allan. (Good, very small). J8430–1; 2 specimens, Murilla Station, near Dalby, SE.Q., don. W. Dunmall, 9.xii.1952. (Good).

Nephrurus levis De Vis, 1887
Proc. Linn. Soc. N.S.W. **1**: 168-9

HOLOTYPE: J246; Chinchilla, SE.Q. (Faded; tail separate, but present).

Measurements of this specimen agree with those given in description. De Vis gives no locality for his material.

Oedura cincta De Vis, 1888
Proc. Linn. Soc. N.S.W. **2**: 811-12
(=*Oedura marmorata* Gray after Cogger, 1957, pp. 172–4)
?SYNTYPE: J226; no data. (Faded, pattern visible).

According to register this specimen is a 'type'. It is not specimen measured for description. Type locality is Charleville, SW.Q.

Oedura coggeri Bustard, 1966
Bull. Brit. Mus. (nat. Hist.) Zool. **14** (1): 9–13, pl. 3
PARATYPES: J1293–5; 3 specimens, Stannary Hills, NE.Q., don. T. L. Bancroft. (Good). J9290; Mt Garnet, NE.Q. (Good).

Oedura monilis De Vis, 1888
Proc. Linn. Soc. N.S.W. **2**: 811
HOLOTYPE: J228; no data. (Faded; tail separate, but present).

Fry (1915, pp. 86-7, pl. 3) redescribes and figures *O. monilis*. Bustard (1967, p. 312) states '. . . I propose to recognise two subspecies of this taxonomic species. Due to its condition . . . impossible to assign the holotype to either'.

Oedura reticulata Bustard, 1969
W. Aust. Nat. **11** (4): 82–6, figs. 1–2
PARATYPES: J13858–9; 2 specimens, Coolgardie district, W.A. (Good).

Perochirus mestoni De Vis, 1890
Proc. Linn. Soc. N.S.W. **4**: 1035–6
(=*Gehyra variegata* (Duméril and Bibron) after Kluge, 1963, p. 84)
HOLOTYPE: J236; Bellenden Ker, NE.Q. (Faded; area immediately behind head damaged).

PYGOPODIDAE

Delma plebeia De Vis, 1888
Proc. Linn. Soc. N.S.W. **2**: 825–6
(= *Delma fraseri* Gray var. *plebeia* De Vis after Kinghorn, 1926, pp. 52–3)
SYNTYPES: J254; Brisbane, SE.Q. (Faded). J12768–70; 3 specimens, Brisbane or Gympie, SE.Q. (Faded: two without tails).

Register entry for J254: 'Type = selected by De Vis from 12/247' [= J247]. J12768–70 re-registered from J247 which originally referred to ten specimens.

Delma tincta De Vis, 1888
Proc. Linn. Soc. N.S.W. **2**: 824–5
SYNTYPE: J241; Normanton, NW.Q. (Faded; tip of tail missing).

Measurements of this specimen fit those given in description. Syntypes from Springsure not located.

SCINCIDAE

Ablepharus timidus De Vis, 1888
Proc. Linn. Soc. N.S.W. **2**: 824

SYNTYPES: J235; Charleville, SW.Q. (Faded). J13601; Charleville, SW.Q. (Faded; bifurcate tail broken but present).

Ctenotus hilli Storr, 1969
J. roy. Soc. W. Aust. **52** (4): 103

PARATYPES: J2613–8; 6 specimens, Darwin, N.T., don. G. F. Hill. (Faded, pattern visible; bellies slit; two with tails separate but present).

Ctenotus pantherinus calx Storr, 1969
J. roy. Soc. W. Aust. **52** (4): 99

PARATYPE: J13000; Roper River, N.T., don. W. Hosmer. (Belly slit).

Ctenotus saxatalis Storr, 1969
J. roy. Soc. W. Aust. **52** (4): 101

PARATYPE: J13001; Mt. Doreen Station, N.T., don. W. Hosmer. (Good).

Egernia lauta De Vis, 1888
Proc. Linn. Soc. N.S.W. **2**: 813–4
(= *Tiliqua luctuosa* (Peters) after Mitchell, 1950, pp. 299–300, fig. 8)

HOLOTYPE: J249; no data. (Good).

Type locality is 'Queensland'.

Egernia whitei modesta Storr, 1968
J. roy. Soc. W. Aust. **51** (2): 55

HOLOTYPE: J464; Chinchilla, SE.Q., 12.xii.1912. (Good).

PARATYPES: J3825; Thomby Station, St George, SE.Q., don. Captain Wilkins. (Some head scales missing). J13207–13; 7 specimens, Chinchilla, SE.Q. (5 good, 1 with most of right forelimb missing, 1 with most of tail missing). J13366; Greymare, Thane, SE.Q. (Some dorsal scales and tail missing).

Heteropus blackmanni De Vis, 1884
Proc. roy. Soc. Qd **1**: 168
(= *Leiolopisma vivax* (De Vis) after Mitchell, 1953, pp. 85–6)

?SYNTYPES: J7773; no data. (Faded; tail missing). J19968–90; 23 specimens, no data. (Faded; many with damaged tails).

J7773 found in jar labelled '. . . probably one of type series. . .'. J19968–90 found in jar labelled 'Cotypes *Heteropus blackmanii*'. Type locality is 'Port Curtis'.

Heteropus lateralis De Vis, 1884
Proc. roy. Soc. Qd **1**: 168
(= *Leiolopisma pectoralis* (De Vis) after Mitchell, 1953, pp. 86–8)

HOLOTYPE: J234; Pine River, SE.Q., don. K. Stokes, E. Humber. (Faded; tip of tail missing).

Prior to Mitchell's examination of this specimen (31 July 1951), no reference to type status in register. Type locality is 'Moreton Bay district' which includes Pine River.

Heteropus pectoralis De Vis, 1884
Proc. roy. Soc. Qd **1**: 169
(= *Leiolopisma pectoralis* (De Vis) after Mitchell, 1953, pp. 86–8)

HOLOTYPE: J1414; Port Curtis, M.E.Q., coll. F. A. Blackman. (Tail missing).
Type locality is 'Warro, Port Curtis'.†

Heteropus rostralis De Vis, 1884
Proc. roy. Soc. Qd **1**: 171
(= *Leiolopisma fuscum fuscum* (Dumeril and Bibron) after Mitchell, 1953 pp. 77–8)
HOLOTYPE: J230; Cardwell, NE.Q. (Good).

Heteropus vertebralis De Vis, 1888
Proc. Linn. Soc. N.S.W. **2**: 821
(= *Leiolopisma vertebralis* (De Vis) after Mitchell, 1953, pp. 80–1)
LECTOTYPE: J248; Chinchilla, SE.Q. (Good).
?PARALECTOTYPES: J13719–22; 4 specimens, Chinchilla, SE.Q., coll. K. Broadbent. (3 good; 1 tail missing).

Register entry for J248 mentions '4 specimens'. Five were present in 1966 when 4 were re-registered (J13719–22). Mitchell (1953, p. 81) refers to '. . . remaining four specimens of the type series . . .'. If original register entry for J248 was correct only 3 of 4 specimens listed are paralectotypes.

Hinulia ambigua De Vis, 1888
Proc. Linn. Soc. N.S.W. **2**: 817–18
HOLOTYPE: J242; Charleville, SW.Q. (Faded, banding visible).

Hinulia tigrina De Vis, 1888
Proc. Linn. Soc. N.S.W. **2**: 817
HOLOTYPE: J245; Geraldton [= Innisfail, NE.Q.], don. Dr Bancroft. (Faded).

Leiolopisma triacantha Mitchell, 1953
Rec. S. Aust. Mus. **11**: 88–9
PARATYPE: J7788; Darwin, N.T., don. G. F. Hill, November 1915*. (Tail separate, but present).

Lygosoma bancrofti Longman, 1916
Mem. Qd Mus. **5**: 49
HOLOTYPE: J2560; Gyranda, Dawson River, M.E.Q., don. Dr Bancroft. (Faded).
Type locality is 'Upper Dawson River district'.

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†Warro (Warroo until 1885) Station, Port Curtis, a property that has not existed for many years, is the type locality for several De Vis reptiles, some of which have apparently been lost. The map (fig. 1, p. 58) shows the area that was Warro when De Vis' new species were collected from this locality.

Frederick Archibald Blackman first leased Warro in 1879 and increased its size slightly in 1886. Since 1896 this area has been divided into several other holdings. Port Curtis was one of the Lands Department administrative districts. It seems reasonable to assume that 'Port Curtis' specimens, received from Blackman and described by De Vis, also came from Warro or near it.

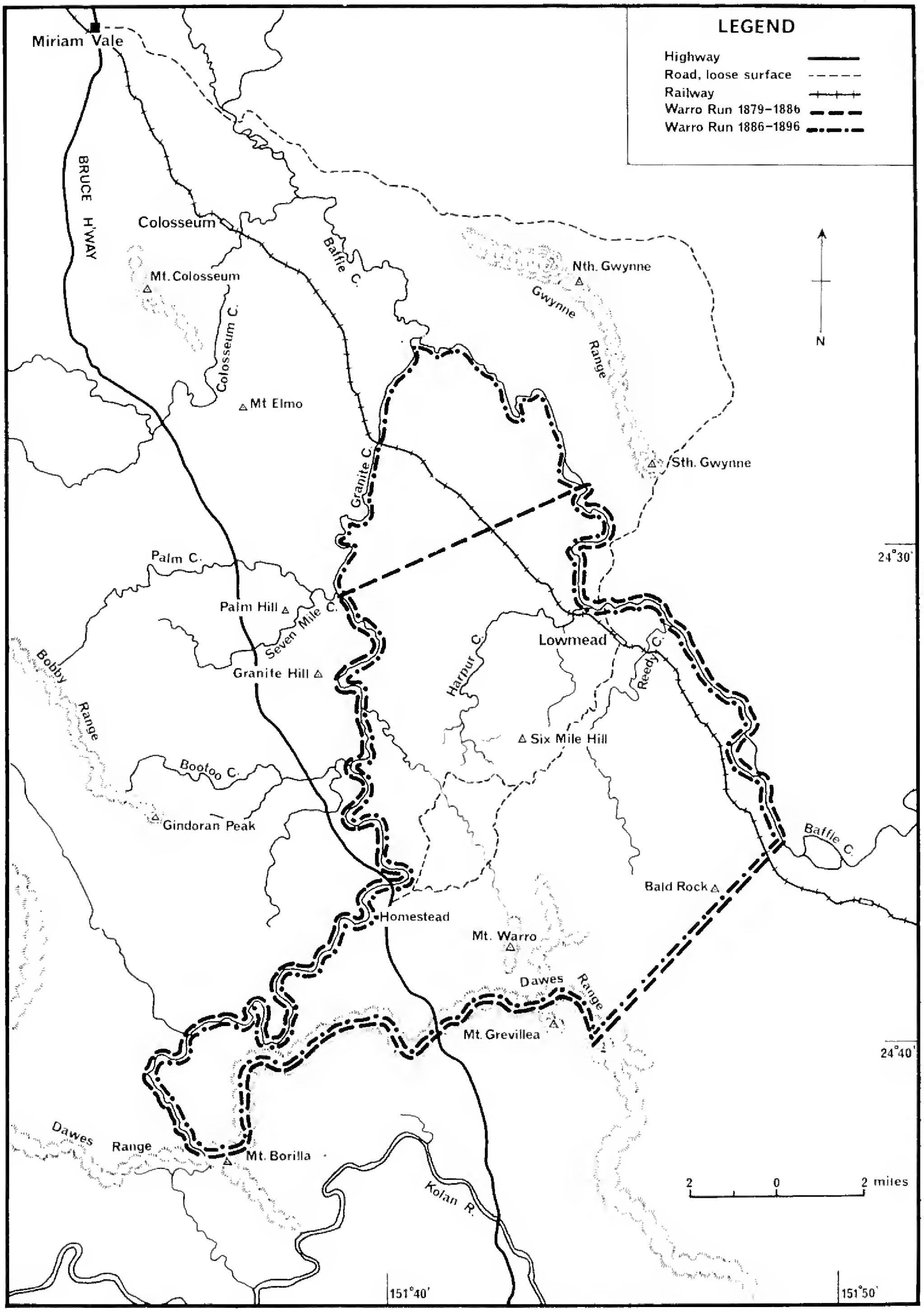

FIG. 1: Map showing boundaries of Warro Station, Port Curtis, 1879–1896

Lygosoma darlingtoni Loveridge, 1933
Occ. Pap. Boston Soc. nat. Hist. **8**: 98–9

HOLOTYPE: J5806; female, Millaa Millaa, Atherton Tableland, NE.Q., don. Harvard Australian Expedition, coll. Dr P. J. Darlington, April 1932*. (Good).

Lygosoma (Hinulia) tryoni Longman, 1918
Mem. Qd Mus. **6**: 38–9

HOLOTYPE: J3023; Springbrok [= Springbrook], SE.Q., coll. H. Tryon. (Good).
PARATYPE: J3024; Macpherson Range, 3,000 ft, SE.Q. (Good).

Type locality 'Macpherson Range, 3,000 ft, SE.Q.' includes Springbrook.

Mocoa spectabilis De Vis, 1888
Proc. Linn. Soc. N.S.W. **2**: 819–20
(= *Lygosoma* (*Leiolopisma*) *spectabile* (De Vis) after Longman, 1918, p. 38)

SYNTYPES: J244; Gympie, SE.Q. (Faded). J255; Gympie, SE.Q. (Faded). J19742–3; 2 specimens, Gympie, SE.Q. (Faded; J19742 tail missing).

J19742–3 re-registered from J255. Measurements of J244 fit those in description.

Ophioscincus frontalis De Vis, 1888
Proc. Linn. Soc. N.S.W. **2**: 823–4

SYNTYPES: J243; Geraldton [= Innisfail, NE.Q.], don. Dr Bancroft. (Slightly faded). J11499; Geraldton [= Innisfail, NE.Q.], don. Dr Bancroft. (Good).
?SYNTYPES: J19737–41; 5 specimens, no data. (J19740 good; others poor).

J19737–41 found unmarked in jar containing J11499 and labelled 'Co-types'.

Rhodona allanae Longman, 1937
Mem. Qd Mus. **11**: 167–8

HOLOTYPE: J6180; Retro Station, Capella, M.E.Q., don. Mrs P. C. Allan. (Good).
PARATYPES: J6040; Retro, Capella, M.E.Q., don. Mrs P. C. Allan, 15.vii.1936. (Tail separate but present). J6238; Retro, Capella, M.E.Q., don. Mrs P. C. Allan, 28.vi.1937. (Faded).
?PARATYPE: J6308; Retro, Capella, M.E.Q., don. Mrs P. C. Allan. (Incomplete, head missing).

Longman (1937, p. 168) states 'Described from three specimens . . .'. Apart from holotype which is designated in description and was marked clearly in reference collection, three specimens (J6040, J6238 and J6308) found in jar with tag marked '*Rhodona allanae* Lgmn. Paratypes'. J6040 is marked as paratype in register. J6238 is probably other paratype because if Longman had used incomplete specimen (J6308) for his description he would probably have mentioned it.

Silubosaurus zellingi De Vis, 1884
Proc. roy. Soc. Qd **1**: 53–4
(= *Egernia stokesii* (Gray) after Longman, 1912, p. 25)

HOLOTYPE: J253; Barcoo, C.Q., don. C. W. de Burgh Birch. (Flattened dorsoventrally).

Sphenomorphus schevilli Loveridge, 1933
Occ. Pap. Boston Soc. nat. Hist. **8**: 96–7

HOLOTYPE: J5805; male, Army Downs, 35 miles north of Richmond, NW.Q., found under concretion containing Plesiosaur, coll. W. E. Schevill, July 1932*.

Tiliqua longicauda De Vis, 1888
Proc. Linn. Soc. N.S.W. **2**: 816
(= *Tiliqua gerrardii* (Gray) after Zietz, 1920, p. 206)

?SYNTYPES: J250; Burpengary, SE.Q., don. Dr Bancroft, 27.viii.1912. (Faded, pattern visible). J1186–7; 2 specimens, Rockhampton, M.E.Q., don. Mr Jaggard, 29.v.1913. (Faded, pattern visible; J1187 belly slit).

Type locality is 'Rockhampton, coll. Mr Jaggard; Johnson River, coll. Mr W. H. Miskin'. As all information (except date which is probably of registration) for J1186–7 agrees with description, these specimens (not J250) are probably syntypes. Approximate measurements of J1187 agree with those given in description.

Tropidophorus queenslandiae De Vis, 1890
Proc. Linn. Soc. N.S.W. **4**: 1034–5

SYNTYPES: J233; Bellenden Ker, NE.Q., don. A. Meston. (Good). J252; Bellenden Ker, NE.Q. (Tip of tail missing).
?SYNTYPES: J19744–51; 8 specimens. (J19745 good, remainder poor).

Register entry for J252 is '8 specimens *Tropidophorus queenslandiae*, De Vis . . . Type collection . . .'. Jar containing specimen tagged J252 also contained 8 untagged specimens which have been re-registered (J19744–51). Assuming register is correct, 7 of these 8 specimens are syntypes from Bellenden Ker and one specimen without data is indistinguishable from type series. De Vis also refers to specimens from Herberton which have not been located.

AGAMIDAE

Calyptoprymnus verecundus De Vis, 1905
Ann. Qd Mus. **6**: 46–7, pl. 15

HOLOTYPE: J462; Solomon Islands. (Some scales missing).

Type locality ' . . . uncertain, but believed to have been brought from one of the Solomon Islands . . .'.

Macrops nuchalis De Vis, 1884
Proc. roy. Soc. Qd **1**: 97–8
(= *Amphibolurus reticulatus* (Gray) after Boulenger, 1885, p. 386)

SYNTYPES: J1405–9; 5 specimens, Delta Station, Bogantungan, M.E.Q., coll. C. W. de Burgh Birch. (J1405 good; remainder either with belly slit or gutted and shrunken.
?SYNTYPE: J1410; ?Queensland. (Good).

All specimens found in jar labelled 'type and cotypes'. Measurements of J1409 agree with those in description.

Tympanocryptis maculosa Mitchell, 1948
Rec. S. Aust. Mus. **9**: 78–80

PARATYPES: J7420–1; female and male, surface of Lake Eyre North, S.A., coll. Dr C. T. Madigan, August–December 1929*. (Good).

VARANIDAE

Varanus punctatus Gray var. **orientalis** Fry, 1913
Rec. Aust. Mus. **10** (1): 18–20, figs. 7–10
(= *Varanus* (*Odatria*) *tristis orientalis* Fry after Mertens, 1958, p, 245)

?PARATYPE: J640; Eidsvold, Upper Burnett River, SE.Q., don. T. L. Bancroft. (Good).

Labelled cotype in register and on tag with specimen. Holotype in Australian Museum.

TYPHLOPIDAE

Typhlops diversus Waite, 1894
Proc. Linn. Soc. N.S.W. **9**: 10–11, pl. 1, figs. 4–6

HOLOTYPE: J2943 (formerly D4432); Mowen, Central Railway, Q. (see Waite, 1918, p. 32, for corrected spelling—Morven), don. F. W. Allpuss, 1.vi.1887. (Shape distorted).

BOIDAE

Aspidites collaris Longman, 1913
Mem. Qd Mus. **2**: 40

HOLOTYPE: J944; Avondale Station, via Cunnamulla, SW.Q., don. E. T. Bignell. (Damaged three to four inches behind head; some scales missing).

Liasis amethistinus kinghorni Stull, 1933
Occ. Pap. Mus. Zool. Univ. Mich. **267**: 3–4

PARATYPE: J5501; Lake Barrine, Atherton Tableland, NE.Q., 2,300 ft, coll. P. J. Darlington. (Head and skin only).

COLUBRIDAE

Neospades kentii De Vis, 1889
Proc. roy. Soc. Qd **6**: 238–9
(= *Myron richardsonii* Gray after Mack and Gunn, 1953, p. 58)

HOLOTYPE: J681; Cambridge Gulf, NW. Australia, don. W. Saville-Kent. (Faded).

Tropidechis dunensis De Vis, 1911
Ann. Qd Mus. **10**: 21–2
(= *Dasypeltis scabra* (Linnaeus) after Cogger, 1966, pp. 893–4)

HOLOTYPE: J191; no data in register. (Faded, no colour or pattern).

Described as an Elapid. Type locality is 'Darro, Darling Downs'.

ELAPIDAE

Brachysoma sutherlandi De Vis, 1884
Proc. roy. Soc. Qd **1**: 139–40
(= *Demansia nuchalis* (Günther) after Mack and Gunn, 1953, p. 60)

HOLOTYPE: J190; no data in register. (Faded, banding visible).

Type locality is 'Carl Creek, Norman River'.

Cacophis warro De Vis, 1884
Proc. roy. Soc. Qd **1**: 139.
(=*Rhynchoelaps warro* (De Vis) after Mack and Gunn, 1953, pp. 66–7)

HOLOTYPE: J188; Warro Station, Port Curtis, ME.Q., coll. F. A. Blackman. (Faded, no pattern).

Diemenia carinata Longman, 1915
Mem. Qd Mus. **3**: 31, pl. 14
(= *Pseudonaja nuchalis nuchalis* Günther after Worrell, 1961, p. 20)

HOLOTYPE: J1508; Cane Grass Station, via Charleville, SW.Q., don. J. Oswald Paynter, 6.iii.1914. (Good).

Denisonia angulata De Vis, 1905
Ann. Qd Mus. **6**: 51
(= *Hoplocephalus bitorquatus* (Jan) after Mack and Gunn, 1953, p. 65)

HOLOTYPE: J194; no data. (Good).

Type locality is 'Queensland'.

Denisonia bancrofti De Vis, 1911
Ann. Qd Mus. **10**: 23–4
(= *Furina diadema* (Schlegel) after Mack and Gunn, 1953, pp. 59–60)

SYNTYPES: J195; Stannary Hills, NE.Q. (Faded, head pattern visible; belly slit; fragile). J12881; Stannary Hills, NE.Q. (Brittle, broken in several places).

Original register entry for J195 refers to two specimens, one of which has been re-registered (J12881). Mack and Gunn (1953, pp. 59–60) list J195 as the holotype and do not mention J12881. Measurements and scale counts as compared in table 1 below suggest that De Vis's measurements are a composite of both specimens.

TABLE 1

MEASUREMENTS AND SCALE COUNTS OF SYNTYPES OF DENISONIA BANCROFTI

	J195	J12881	De Vis' description
Mid-body Scales	15	15	15
Ventrals	195	185	185
Subcaudals	33	34	33
Anal	divided	divided	entire
Total length	180 mm	305 mm	190 mm
Tail	21 mm	40 mm	40 mm

Denisonia fenestrata De Vis, 1905
Ann. Qd Mus. **6**: 50
(= *Glyphodon tristis* (Günther) after Mack and Gunn, 1953, p. 59)

SYNTYPE: J200; Queensland. (Good).

Description refers to two specimens, one apparently lost.

Denisonia frontalis Ogilby var. **propinqua** De Vis, 1905
Ann. Qd Mus. **6**: 51
(= *Denisonia suta* (Peters) after Mack and Gunn, 1953, p. 64)

HOLOTYPE: J198; Queensland. (Faded; neck and mid-body damaged).

Denisonia nigra De Vis, 1905
Ann. Qd Mus. **6**: 50
(= *Denisonia coronoides* (Günther) after Mack and Gunn, 1953, p. 63)

HOLOTYPE: J196; Tasmania. (Good).

Denisonia revelata De Vis, 1911
Ann. Qd Mus. **10**: 22–3
(= *Hoplocephalus bitorquatus* (Jan) after Mack and Gunn, 1953, p. 66)

HOLOTYPE: J2957; Stannary Hills, NE.Q., don. Dr Bancroft. (Faded, head pattern visible; some scales loose).

Furina multifasciata Longman, 1915
Mem. Qd Mus. **3**: 30
(= *Vermicella annulata multifasciata* (Longman) after Storr, 1967, pp. 80–1)

HOLOTYPE: J2019; Port Darwin, N.T. don. G. F. Hill. (Good).

Furina robusta De Vis, 1905
Ann. Qd Mus. **6**: 51–2
(= *Vermicella bertholdi bertholdi* (Jan) after Storr 1967, pp. 82–3)

HOLOTYPE: J205; no data. (Good).

Type locality is 'Coolgardie, W.A.'.

Hoplocephalus ornatus De Vis, 1884
Proc. roy. Soc. Qd **1**: 100
(= *Denisonia maculata* (Steindachner) after Mack and Gunn, 1953, pp. 64–5)

HOLOTYPE: J199; Surat, SE.Q.; wooden tag in jar—'*D. ornat* . . . De Vis Warro (Type)'. (Faded, some of pattern visible).

Register entry for J199 refers to four specimens, three of which cannot be located. Waite and Longman (1920, p. 179) refer to only one specimen as the type of *H. ornatus*. Type locality is 'near Surat'.

Hoplocephalus vestigiatus De Vis, 1884
Proc. roy. Soc. Qd **1**: 138-9
(= *Demanisa olivacea* (Gray) after Mack and Gunn, 1953, p. 61)

HOLOTYPE: J206; no data. (Faded; neck damaged; shape distorted; most of tail missing).

Three untagged specimens found in jar labelled 'J206 Type' and register entry for this number refers to three specimens. De Vis refers to a single specimen 'in damaged condition' and he did not give subcaudal scale count, apparently because tail was incomplete. Only one of the three specimens was damaged and Mack and Gunn (1953, p. 61) regarded this as the holotype. Two undamaged specimens re-registered (J19849–50). Type locality is 'uncertain'.

Micropechis crucifer De Vis, 1905
Ann. Qd Mus. **6**: 52
HOLOTYPE: J197; no data. (Good).

Two specimens (one tagged J197, one untagged), accompanied by paper label '*Micropechis crucifera* De Vis Type' found in jar marked 'Type'. Register entry for J197 refers to one specimen only. Description is of one specimen. Measurements and scale count given by De Vis fit those of J197 reasonably well and do not fit the second specimen which has been re-registered (J13685).

Type locality is 'uncertain, believed to be the Solomon Islands'.

Pseudechis guttatta De Vis, 1905
Ann. Qd Mus. **6**: 49–50
(= *Pseudechis colletti guttatus* De Vis after Worrell, 1961, p. 21)
HOLOTYPE: J189; Cecil Plains, SE.Q. (Gutted).

Pseudechis mortonensis De Vis, 1911
Ann. Qd Mus. **10**: 24
(= *Pseudechis guttatus* De Vis after Mack and Gunn, 1953, pp. 61–2)
?HOLOTYPE: J207; Brisbane suburbs, SE.Q. (Belly slit).

Mack and Gunn (1953, pp. 61–2) remark that this specimen was 'labelled doubtfully as the type . . .'.

Pseudechis wilesmithii De Vis, 1911
Ann. Qd Mus. **10**: 24–5
(= *Oxyuranus scutellatus* (Peters) after Mack and Gunn, 1953, pp. 62–3)
HOLOTYPE: J201; Walsh River, Cape York, don. Dr T. L. Bancroft. (Head and skin only; head badly damaged, apparently when venom glands removed; body scales in good condition; tip of tail missing).

Pseudelaps bancrofti De Vis, 1911
Ann. Qd Mus. **10**: 25
(= *Demansia nuchalis* (Günther) after Mack and Gunn, 1953, p. 60)
HOLOTYPE: J187; Stannary Hills, Atherton Tableland, NE.Q., don. Dr T. L. Bancroft. (Faded, no pattern; body damaged approximately three inches behind head; some scales slipping).

Rhynchelaps latizonatus De Vis, 1905
Ann. Qd Mus. **6**: 49
(= *Vermicella annulata* (Gray) after Mack and Gunn, 1953, pp. 68–9)
HOLOTYPE: J192; no data in register but tag in jar—'Herberton'. (Faded, banding visible).

Type locality is 'Queensland'.

HYDROPHIDAE

Distira nasalis De Vis, 1905
Ann. Qd Mus. **6**: 48
(= *Hydrophis major* (Shaw) after Mack and Gunn, 1953, pp. 58–9)
HOLOTYPE: J203; Queensland coast. (Faded, dorsal pattern visible).

Platurus frontalis De Vis, 1905
Ann. Qd Mus. **6**: 48
(= *Laticauda colubrina* (Schneider) after Longman, 1918, p. 41)
HOLOTYPE: J202; New Guinea. (Good).

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A REVIEW OF THE MEGASCOLECOID EARTHWORM GENERA (OLIGOCHAETA) OF AUSTRALIA.

PART III—THE SUBFAMILY MEGASCOLECINAE

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ABSTRACT

This paper forms the final part of a review in which the earthworm family Megascolecidae has been redefined and its constituent genera have been arranged in new groupings. The subfamily Ocnerodrilinae and its two tribes the Ocnerodrilini and Malabarini represent no departure from the previous classification of Gates beyond their reduction from familial and subfamilial ranks, respectively, but the constitution of the remaining subfamilies here recognized, the Acanthodrilinae and Megascolecinae, differs significantly from that proposed by other workers. The subfamily Acanthodrilinae, which was treated in part II, was amended to include holonephric and meronephric forms in which the prostates varied in number but were never restricted to a pair near or combined with male pores on XVIII. The subfamily Megascolecinae, with which this paper deals, is reserved for worms with the pores of the single pair of prostates close to or combined with the male pores on XVIII and for those with the acanthodrilin arrangement (or an approximation to this) which have exonephric stomate nephridia median to micromeronephridia in posterior segments. The latter condition of the excretory system is diagnostic of the Tribe Dichogastrini. The Dichogastrini corresponds with the Octochaetinae (-idae) of some previous workers after transfer of *Octochaetus* and some other genera to the Acanthodrilinae as the Tribe Octochaetini. Tribes of the Megascolecinae recognized in addition to the Dichogastrini are the Perionychini, which possess holonephridia, and the Megascolecini which have various non-dichogastrin arrangements of meronephridia. The Megascolecinae, their tribes, and all constituent Australian genera are defined and check lists of the species of the latter genera are provided.

In part I of this review (Jamieson, 1971a) a new classification of the megascolecoid earthworms of the world was advanced in synoptic form. In the present work fullered finitions of suprageneric taxa recognized within the subfamily Megascolecinae will be given, and additional evidence for recognizing the proposed groupings will be advanced. The Australian genera will be defined in preparation for their revision and checklists of Australian species will be given. This paper completes a review of the 18 genera and listing of the 247 species comprising the known megascolecoid fauna indigenous to Australia.

SYSTEMATICS

Subfamily MEGASCOLECINAE

Megascolecidae in which the prostates have a single, central lumen or a central lumen receiving lateral canals, and are externally tubular or (racemose prostates) the lumen is branched from its junction with the duct. Purely holonephric or meronephric, or with meronephridia in a varying number of segments anterior to holonephridia. If stomate nephridia are present median to micromeronephridia, no holonephridia are present. Male pores on XVIII or its homeotic equivalent; prostates a single pair with the pores on the same segment as the male pores, with which they are almost always united; or male terminalia acanthodrilin, with prostate pores 2 pairs, on XVII and XIX and male pores intermediate on XVIII; such acanthodrilin worms differing from the Acanthodrilinae in having stomate nephridia median to micromeronephridia in posterior segments and no holonephridia. Homeotic forms (*Tonoscolex*) with combined male and prostatic pores on XVII, differing from Acanthodrilinae with similarly located male terminalia in possessing racemose prostates. Calciferous glands, if present, not arranged as in the Ocnerodrilinae; intestine commencing in or behind XIV; last hearts rarely in XI.

TRIBES: Dichogastrini; Perionychini; and Megascolecini.

DISTRIBUTION: PALAEARCTIC: China, Korea; Japan. NEARCTIC: N. America; Queen Charlotte I. NEOTROPICAL: Mexico; Central and Tropical South America; West Indies; Cuba. ETHIOPIAN: Tropical Africa. ORIENTAL: India, Pakistan and northwards beyond Nepal; Ceylon; Andaman I.; Assam; Annam; Burma; Java; Sumatra; Philippines; Molluccas. AUSTRALIAN: Australia and Tasmania; Norfolk Island; New Guinea. NEW CALEDONIA. NEW ZEALAND and neighbouring islands including Chatham Island. SUB-ANTARCTIC ISLANDS: Auckland I.; Snares I.; Stewart I. FIJI. Endemicity over much of the Pacific, from the Mariannas, Bismarck Archipelago and the Solomons eastwards remains to be established. Some species peregrine, sometimes widely.

TYPE GENUS: *Megascolex* Templeton, 1844.

Tribe DICHOGASTRINI

Megascolecinae which are purely meronephric; with micromeronephridia anteriorly, often with bucco-pharyngeal nephridia; posteriorly with astomate micromeronephridia together with, on each side in each segment, a median nephridium with one or more preseptal funnels, which frequently is enlarged as a megameronephridium. Prostates tubular or less commonly racemose or intermediate, one pair, their pores on XVII, XVIII or XIX, united with or rarely near the male pores; or two pairs, their pores on XVII and XIX, with the male pores intermediate on XVIII or sometimes nearer to or united with the anterior prostatic pores; exceptionally (*Hoplochaetella*) with intestinal enteronephry of the megameronephridia and with two pairs of prostatic pores combined with two pairs of male pores, on XVII and XIX or 17/18 and 18/19.

DISTRIBUTION: PALAEARCTIC: China (?). NEARCTIC: N. America. NEOTROPICAL: Mexico; Central and Tropical S. Africa; West Indies; Cuba. ETHIOPIAN: Tropical Africa. ORIENTAL: India, Pakistan and northwards beyond Nepal; Burma; Ceylon. AUSTRALIA. NEW ZEALAND. FIJI. Some species peregrine, sometimes widely, in warmer regions.

TYPE-GENUS: *Dichogaster* Beddard, 1889b.

GENERA: (see Jamieson, 1971a).

AUSTRALIAN GENERA: *Digaster* Perrier, 1872 (part, including the type-species?); *Didymogaster* Fletcher, 1887a; *Megascolides* (part) McCoy, 1878; *Notoscolex* (part, including the type-species?) Fletcher, 1887a, and *Spenceriella* (*S. gigantea* only?) Michaelsen, 1907a.

REMARKS: The author, in preparing a list of those genera of the Octochaetidae *s.* Gates which have both micromeronephridia and, posteriorly, megameronephridia or at least stomate meronephridia, found that precisely those genera (*Deinodrilus*, *Leucodrilus*, *Hoplochaetina* and *Octochaetus*) which Lee suspected of having their closest affinities with genera placed by Gates (1959) in the Acanthodrilidae stood apart in lacking these features, having neither megameronephridia nor median stomate nephridia though purely meronephric. The other genera of Gates's Octochaetidae were purely meronephric and in the hindbody had median stomate nephridia, often enlarged as 'meganephridia' (megameronephridia) in addition to closed 'micronephridia', with the exception of the two Indian genera *Octochaetona* and *Octochaetoides* which were significantly products of division of *Octochaetus*. The genera with median stomate nephridia comprise the Dichogastrini of the present work.

The homogeneity of the Dichogastrini is supported by Sims's computer analysis and by virtue of their being the core of Gates's Octochaetidae. Although the author recognized the existence of the tribe independently, its validity and delineation on the basis of the type of excretory system is supported by earlier work of Gates (1940b) who dispensed with the 'obsolescent' name Octochetinae and substituted the name '*Hoplochaetella* group' which comprised *Dichogaster* (from which *Millsonia* and *Benhamia* have since been resurrected), *Hoplochaetella*, *Ramiella*, *Eutyphoeus*, *Scolioscolides*, *Barogaster*, *Eudichogaster*, *Lennogaster*, *Pellogaster*, *Rillogaster*, *Priodochaeta* and provisionally also *Priodoscolex*.

References attesting the coexistence of median stomate nephridia with micromeronephridia, with the dubious exceptions of *Priodoscolex* and *Trigaster*, for all genera of the Dichogastrini are set out below. In the examples bearing an asterisk, the median stomate nephridium is known to be enlarged as a megameronephridium. Bibliographic references in parentheses denote the source of information and only coincidentally refer to authors of taxa.

Bahlia: Nephridia are undescribed but the genus is said to be similar to *Eutyphoeus* q.v. (Gates, 1945). *Barogaster*: type-species, *B. barodensis** (Gates, 1939b, p. 158). *Benhamia*: type-species, *B. rosea** (Omodeo, 1958, p. 39); *B. liberiensis** (Omodeo, 1958, p. 45). *Calebiella*: type-species, *C. parva** (Gates, 1945, p. 244). *Celeriella*: in the type-species, *C. duodecimalis*, some meronephridia (four in a segment?) are enlarged almost to the appearance of holonephridia according to Michaelsen (1907a) but in *C. quadripapillata* a single median nephridium on each side, in the hindbody, has a preseptal funnel (Gates, 1958, p. 614). *Dichogaster*: type-species, *D. damonis** (Beddard, 1889a, p. 258); *D. bolaui** (Gates, 1958, p. 619); *D. titillata** (personal observations of a type-specimen). *Didymogaster sylvaticus** (Horan, personal communication). *Digaster** (part(?), see p. 75); *Eudichogaster** (Gates, 1939b, p. 160). *Eutrigaster*: in the type-account (*E. oraedivitis* Cognetti, 1904) nephridia are merely described as diffuse but Omodeo (1955) considers it to belong to the *viridis*-group of *Dichogaster*. *Eutyphoeus*: *E. foveatus**, *E. nicholsoni** and *E. waltoni** (Bahl, 1942, p. 440). *Hoplochaetella*: *H. khandalensis** (Bahl, 1947, p. 122); this genus is exceptional in that the megameronephridia, instead of being exonephric, open into a pair of longitudinal excretory canals which run along the inner surface of the body wall, one on each side of the middorsal line, from segment XX to the anal end, each canal opening separately at the place where the outer body wall passes into the wall of the rectum, a first step in the direction of the enteronephric condition (see also Gates, 1940b). *Lennogaster*: type-species, *L. yeicus*, median stomate nephridium thickened but not enlarged (Gates, 1939b, p. 183). *Megascolides*: type-species, *M. australis** (Spencer, 1888, p. 22; Bahl, 1947, p. 121); *M. raglani** and *M. urewerae** have 'meganephridia' in addition to 'micronephridia' in the posterior segments (Lee, 1959) as do some Indian species (Stephenson, 1923); megameronephridia or median stomate nephridia are not described by Lee for other New Zealand species of this genus but no indication of examination of the posterior end is given. *Millsonia**: entire genus (always?) (Omodeo, 1955); details for *M. inermis** (Omodeo, 1955, p. 222); *M. anomala** shows an interesting approach to the condition in *Hoplochaetella khandalensis*: the large megameronephridia of each side (present in XXI posteriorly) are connected to a longitudinal duct which runs on each side of the nerve cord. This duct opens to the exterior regularly in each intersegment, medianly by a minute pore whereas in *Hoplochaetella* there are no pores in the course of the duct (Omodeo, 1955, p. 220). *Neogaster*: type-species, *N. americanus*, with two pairs of nephridia in each segment (midbody only investigated), the ventral nephridia alone having funnels (Pickford, 1937, p. 608).

Notoscolex (part, including the type-species?): Fletcher's account of the type-species indicates merely that it has parietal (exonephric?) meronephridia. Both *Notoscolex ulladullae** and *N. attenuatus** (Australia) have tufts which in the former are probably and in the latter are certainly pharyngeal. They also have scattered parietal micromeronephridia and, coexisting with those in each of the hindermost segments, a (stomate?) megameronephridium on each side (Boardman, 1931). The Australian species *Notoscolex* (= *Megascolides*) *albertsi** Cognetti, 1910, has enlarged (stomate?) ventral nephridia from segment XXX posteriorly. *Omodeona*: in the type-species, *O. proboscoides**, there is in each of the posterior segments, on each side, a large megameronephridium, shortly lateral of the nerve cord and below the gut. It has a large preseptal funnel and a wide duct which enters the parietes shortly in front of seta *c*. Lateral to the megameronephridium there are, on each side of the body, three or four very small micromeronephridia (personal observations of a syntype).

Pellogaster: type-species, *P. bengalensis**, (Gates, 1939b, pp. 200, 203). *Priodochaeta**: 'meganephridia' with funnels extending to the posterior end; posterior extent of 'micronephridia' uncertain (Gates, 1940a). *Priodoscolex*: Gates (1940b) was uncertain whether this genus should be included in his '*Hoplochaetella* group'. It appears from his account of the genus that each of the posterior meronephridia, rather than merely the medianmost one, is stomate. The description is as follows: Excretory organs: two pairs of closed, exonephric(?) micronephridia (or clusters of micronephridia) on the parietes of III (?), one pair of large clusters on the parietes of IV (?), two pairs of large clusters close to the ventral parietes in IV and V, paired clusters of micronephridia on the anterior faces of the septa in VI–IX (and X–XI?) and XII–XIII; from XIV posteriorly a transversely placed, preseptal band of closed, exonephric micronephridia on each side, the band of two rows; in the posteriormost segments a single transversely placed row of 10–12 small, exonephric micronephridia on each side with a corresponding row of preseptal funnels.

Ramiella: (Gates, 1958, p. 610); *R. parva* and *R. pachpaharensis* (Bahl, 1942, p. 441; contrary to Stephenson who found no septal connections or funnels). The small number of meronephridia, the absence of pharyngeal and of other enteronephry (Bahl, 1942, p. 441) and the absence or rudimentary condition of calciferous glands in *Ramiella* appear to be primitive features and suggest that with the partly holonephric *Howascolex* (Indian section), *Ramiella* is a little-changed representative of the ancestral stock of the Indian and other genera of the Dichogastrinae. *Neogaster americanus*, like the type-species, *Ramiella bishambari*, has only 2 pairs of meronephridia per segment (including the median stomate nephridia) but has well developed calciferous glands.

Ramiellona: like *Ramiella*, this genus lacks enteronephric nephridia. There are several ranks of meronephridia on each side, the median nephridium on each side in posterior segments having a preseptal funnel, *vide R. guatemala*, *R. balantina*, *R. strigosa* and *R. mexicana*, in all of which the median stomate nephridium is not enlarged (Gates, 1962c, pp. 198, 203, 207, 211) and *R. irpex*, in which the median stomate nephridium is described as a meganephridium. (Pickford, 1937, p. 607). *Rillogaster**: (Gates, 1939b, p. 207); Bahl (1942, p. 446) drew attention to the similarity of the excretory systems of *Scolioscolides*, *Barogaster*, *Eudichogaster*, *Lennogaster*, *Pellogaster* and *Rillogaster*.

Scolioscolides: type-species, *S. bergtheili** (Gates, 1937, p. 309; Bahl, 1942, p. 446). *Spenceriella* (part, excluding the type): *S. gigantea** (Lee, 1959, p. 344).

Trigaster: the condition in this genus is not entirely certain. Gates (1962b) states that the nephridia of *T. cavernicola* form at least six longitudinal ranks posteriorly; those of the median rank are larger than the others but funnels are not mentioned and he queries that they may be composite. *Wegeneriona*: Pickford (1937, p. 608) who placed *W. michaelseni* in *Howascolex*, states that this species has two or three pairs of nephridia in each segment of the middle region of the body which she examined, and that the ventralmost nephridium appeared to have a septal attachment though she was unable to state definitely that a septal funnel was present.

Median stomate nephridia also occur in some genera of Gates's Megascolecidae, and the condition presumably indicates phylogenetic relationship with the Dichogastrini, but in the 'megascolecid' genera the stomate nephridia discharge into the intestine, with the notable exception of some species of *Notoscolex* and of *Didymogaster sylvatica*. In these species they remain exonephric and in view of the reduction in significance of the racemose condition of prostates, demonstrated in the present work there seem no barriers to placing them in the Dichogastrini. This step resolves yet another anomaly to which Sims (1966) drew attention, clustering of *Notoscolex* with the octochaetine genera.

The position of *Hoplochaetella* deserves special mention. It alone of the Dichogastrini has intestinal enteronephry of the posterior stomate megameronephridia. This might appear to necessitate placing it in the Megascolecini but the close affinity to octochaetine genera and isolation from 'megascolecid' genera demonstrated by Sims (1966) suggests that there is more justification in grouping it in the Dichogastrini. Its highest coefficient of similarity (16.3%) was with the dichogastrin genus *Lennogaster* in Sim's analysis, the low figure indicating its relatively isolated position. Its two pairs of openings of the male ducts is unique in the megascolecoid earthworms and exceedingly rare in megadrile oligochaetes.

Genus **Digaster** Perrier, 1872, emend. Jamieson, 1963

Terrestrial worms ranging from slender forms little more than an inch long to inch-wide specimens over 5 feet in length. Segments less than 100 to over 300. Pigmentation of the body wall present or absent. Prostomium very variable. Setae 4 pairs per segment, rather widely to closely paired. Clitellum annular or saddle-shaped, embracing part of the region between intersegments 11/12 and 19/20. A pair of pores, each of the united prostatic duct, and sperm duct of its side, present in XVIII. Accessory puberty papillae frequently present in the vicinity of the male pore segment or in the forebody. Female pores 1 pair, or single and median, presetal in XIV. Spermathecal pores 2 pairs, in 7/8 and 8/9 with sometimes (intraspecific variation in *D. longmani*) a third pair in 6/7. Position of the first dorsal pore variable, usually in 5/6 or 11/12.

Two gizzards, in V and VI, or in VI and VII (perhaps in V and VII in the type-species); or 3 gizzards, in V, VI and VII; oesophagus usually highly vascularized and showing partial or complete development of calciferous glands; intestine commencing in XVII and XVIII, exceptionally in XVI. Dorsal blood vessel single; last hearts in XII or less commonly in XIII. Meronephric; some species with tufted enteronephric and/or exonephric nephridia formed by apposition of ducts of micromeronephridia; some species with megameronephridia in addition to micromeronephridia posteriorly. Holandric or metandric; (always?) lacking testis-sacs. Prostates racemose with branched ducts within the gland. Sperm ducts (always?) uniting entally with the prostate ducts. Spermathecae 2 pairs, in VIII and IX, or 3 pairs, in VII, VIII and IX, each (always?) with 1 or more diverticula which are never long tubes.

DISTRIBUTION: Australia: New South Wales, Queensland and Victoria.

TYPE-SPECIES: *Digaster lumbricoides* Perrier, 1872.

SPECIES (All Australian):

1. *Digaster anomala* Jamieson, 1970b
2. *Digaster armifera* Fletcher, 1887a
3. *Digaster bradburyi* Jamieson, 1970b
4. *Digaster brunneus* Spencer, 1900
5. *Perissogaster excavata* Fletcher, 1888a
6. *Digaster gayndahensis* Spencer, 1900
7. *Digaster lamingtonensis* Michaelsen, 1916
8. *Digaster longmani* Boardman, 1932
9. *Digaster lumbricoides* Perrier, 1872
10. *Digaster minor* Spencer, 1900
11. *Perissogaster nemoralis* Fletcher, 1889a
12. *Digaster perrieri* Fletcher, 1889a
13. *Perrisogaster queenslandica* Fletcher, 1889a

REMARKS: The trigastric genus *Perissogaster* Fletcher, 1887a, was included in *Digaster* (Jamieson, 1963) because of the demonstration of intraspecific variation from two to three gizzards in *D. perrieri* and because of general similarity of the two genera. The author (Jamieson, 1970b) demonstrated the dichogastrin condition of posterior nephridia in *Digaster anomala* (a species closely resembling the type-species, *D. lumbricoides*), in *D. bradburyi* and in *D. armifera* and previously demonstrated megameronephridia occurring alongside exonephric micromeronephridia, although funnels were not demonstrated for the megameronephridia, in *D. lamingtonensis*, *D. longmani* and *Perissogaster queenslandica* (*vide* Jamieson, 1963). On the other hand the latter paper showed the type-species of *Perissogaster*, *P. excavata*, and also *P. nemoralis*, to lack stomate nephridia having only dense astomate (exonephric?) micromeronephridia in posterior segments. It thus appears that the latter two species should be placed in a re-established *Perissogaster*, a genus which, from its excretory system, appears to belong in the Megascolecini. Resurrection of *Perissogaster* will be deferred pending further revision of the *Digaster-Perissogaster* complex.

Genus **Didymogaster** Fletcher, 1887

Setae 8 per segment, rather widely paired, all ventral, none penial. Clitellum occupying XIII–XVIII. Prostates 1 pair, with small lobules, their pores (combined with the male pores?) anterior on XVIII. Genital markings present. Female pores paired, median to *a* lines, in XIV. Spermathecal pores conspicuous, 3 pairs intrasegmental in IX, X and XI. First dorsal pores in 4/5.

Gizzards 2, moderately developed in VI and VII. Calciferous glands absent. Intestine commencing in XVII. Dorsal blood vessel single; or double only intrasegmentally. Meronephric with stomate exonephric megameronephridia median to micromeronephridia posteriorly; tufted nephridia absent. Holandric; paired testis-sacs present, confluent medianly and intersegmentally. Seminal vesicles in IX and XII. Ovaries and funnels in XIII. Spermathecae in VII, VIII and IX, 2 segments in front of their pores; each with a small diverticulum.

DISTRIBUTION: Australia: New South Wales. New Zealand (?).

TYPE-SPECIES: *Didymogaster sylvaticus* Fletcher, 1887a.

OTHER SPECIES: None known.

REMARKS: Lee (1959) rightly considered the New Zealand record to be dubious. The type-species was redescribed by Stephenson (1933) and distinction from *Digaster* was upheld by Jamieson (1963). Stephenson did not observe stomate nephridia but these have been demonstrated in this laboratory and in a configuration which indicates that *Didymogaster* must be transferred to the Dichogastrini from the Megascolecidae *s.* Gates though remaining isolated in the extremely unusual location of the spermathecal pores.

This unusual worm is common in the Audley National Park and in adjacent regions of New South Wales where *Livistona* palms occur.

Genus **Megascolides** McCoy, 1878

Setae 8 per segment. Clitellum developed over at least four segments between XII and XIX, usually annular. Male pores 1 pair, on XVIII, combined with the pores of a pair of tubular prostates, not always on papillae. Female pores on XIV; paired, ventrolateral, or unpaired, median ventral. Spermathecal pores 1–5 pairs, anterior to 9/10. Gizzard single, in V, or VI or VII; calciferous glands present or (typically) absent. Dorsal vessel usually unpaired, occasionally paired; 2–5 pairs of hearts, the last in XII or XIII. Meronephridia numerous in each segment; usually in lateral bands, occasionally concentrated in ventrolateral tufts. The median nephridium on each side in each posterior segment typically possessing a preseptal funnel. Holandric; testis-sacs absent. Seminal vesicles in any or all of IX, X, XI, XII. Penial setae present or absent. Spermathecae diverticulate.

DISTRIBUTION: Australia including Tasmania. New Zealand (restricted to northern North Island). North America.

TYPE-SPECIES: *Megascolides australis* McCoy, 1878.

AUSTRALIAN SPECIES:

1. *Megascolides australis* McCoy, 1878 (synonym *Notoscolex gippslandicus* Fletcher, 1888b)
2. *Megascolides diaphanus* Spencer, 1900
3. *Megascolides nokanenaensis* Michaelsen, 1907b
4. *Cryptodrilus polynephricus* Spencer, 1895
5. *Cryptodrilus tenuis* Fletcher, 1889a

REMARKS: The genus is a congeries which requires revision. Separation from *Spenceriella* solely by possessing eight rather than many setae per segment is unsatisfactory. The type-species differs further from that of *Spenceriella* in lacking calciferous glands and in having the last hearts one segment further posteriorly, in XIII, and it remains to be seen whether additional and more significant features separate the two genera. *Megascolides* was distinguished from *Notoscolex* by Michaelsen (1907b) by the unbranched condition of the central canal of the prostates. Earlier (Michaelsen, 1900) he had distinguished it from *Notoscolex* by possesion of a pair of 'meganephridia' in addition to 'diffuse' nephridia in the hindbody and ignored the condition of the prostates which were stated to be tubular or racemose in each genus, though the existence of racemose prostates in *Megascolides* was questioned. The nephridia of the type-species of *Notoscolex* are described as small tufts of glandular tubes attached to the coelomic wall and most conspicuous in some anterior segments (Fletcher, 1887a) but there is no certainty that the *Megascolides*-condition of the nephridia is not found posteriorly, as it is in some *Notoscolex* species and revision of the two genera should be made *paru passu*. The type-species of the *Notoscolex* differs from *Megascolides australis* in possessing calciferous glands but the significance of this difference, at least in Australian earthworms, is uncertain as glands may be present or absent in closely similar species of *Megascolex* (personal observations).

Apart from *M. australis* (the type-species) only *M. nokanenaensis* qualifies for inclusion in *Megascolides*, and in the Dichogastrini, in having megameronephridia in addition to micromeronephridia in posterior segments. Of the remaining species, *M. diaphanus*, *Cryptodrilus tenuis* and *C. polynephricus* have, respectively, two, three and five (stomate?) nephridia on each side in each segment and their affinities are uncertain. They probably have affinities with the Perionychini.

Twenty-two New Zealand species, nearly half of the generic total, are described by Lee (1959). Very few of them are known to have median stomate nephridia and their affinities appear to lie with the Megascolecini as is suggested, though not unequivocally, by the dendrogram given by Lee (in press). It is therefore noteworthy that Gates (1940a) divided the Indian species of *Megascolides* among the genera *Scolioscolides*, and *Barogaster* (Dichogastrini *s. mihi*) and *Travoscolides* (Megascolecini *s. mihi*) and considered affinities of the Assamese species *M. antrophyes* Stephenson, 1924, to lie with the *Tonoscolex-Nelloscolex* group (also Megascolecini *s. mihi*).

N. American species are described by Smith (1937) and Macnab and McKey-Fender (1948).

Genus **Notoscolex** Fletcher, 1887a

Setae 8 per segment; prostates 1 pair, with branched system of ducts, externally racemose or sometimes appearing tubular, their pores (always?) combined with the male pores, on XVIII. Female pores in XIV. Spermathecal pores 1–3 pairs, the last in furrow 8/9 (in certain abnormal species in 7/8).

Gizzard in V or VI. Calciferous glands lacking or one to at least six pairs in the region of XI-XVII. Intestinal origin in one of XV-XIX. Micromeronephridia only present (species to be transferred to the Megascolecini), or (Dichogastrini) these associated with megameronephridia.

Distribution: Australia. New Zealand (1 species). South India and Ceylon.

Type-species: *Notoscolex camdenensis* Fletcher, 1887a. (New South Wales).

Australian Species:

1. *Megascolides albertsi* Cognetti, 1910
2. *Notoscolex attenuatus* Boardman, 1931
3. *Notoscolex brancasteriensis* Michaelsen, 1910b
4. *Notoscolex camdenensis* Fletcher, 1887a
5. *Megascolides cameroni* Spencer, 1892a
6. *Cryptodrilus campestris* Spencer, 1895
7. *Cryptodrilus dubius* Spencer, 1892a
8. *Cryptodrilus fastigatus* Fletcher, 1889a
9. *Notoscolex grandis* Fletcher, 1887a
10. *Notoscolex hortensis* Michaelsen, 1907b
11. *Megascolides hulmei* Spencer, 1892

12. *Megascolides illawarrae* Fletcher, 1889a
13. *Cryptodrilus illawarrae* Fletcher, 1889a (homonym)
14. *Megascolides insignis* Spencer, 1892a
15. *Cryptodrilus irregularis* Spencer, 1895
16. *Notoscolex jenolanensis* Michaelsen, 1907c
17. *Notoscolex leai* Michaelsen, 1910b
18. *Notoscolex leios* Jackson, 1931
19. *Notoscolex maecenatis* Michaelsen, 1907b
20. *Cryptodrilus mediocris* Fletcher, 1889a
21. *Notoscolex modestus* Michaelsen, 1907b
22. *Cryptodrilus mudgeanus* Fletcher, 1889a
23. *Megascolides obscurus* Spencer, 1892a
24. *Cryptodrilus officeri* Spencer, 1895
25. *Notoscolex prestonianus* Michaelsen, 1907a
26. *Megascolides* (?) (*Notoscolex*) *pygmaeus* Fletcher, 1889a
27. *Cryptodrilus queenslandica* Spencer, 1900
28. *Notoscolex rubescens* Michaelsen, 1907b
29. *Cryptodrilus rusticus* Fletcher, 1887a
30. *Crytodrilus saccarius* Fletcher, 1887b
31. *Megascolides simsoni* Spencer, 1895
32. *Cryptodrilus simulans* Fletcher, 1889b
33. *Cryptodrilus singularis* Fletcher, 1889a
34. *Megascolides sinuosus* Spencer, 1892a
35. *Notoscolex* (*Trinephrus*) *suctorius* Michaelsen, 1907b
36. *Notoscolex ulladullae* Boardman, 1931
37. *Megascolides victoriensis* Spencer, 1892a
38. *Cryptodrilus wellingtonensis* Spencer, 1895

REMARKS: The above definition is based on Stephenson (1930) and a discussion of the genus by Gates (1960), who removed *N. pumila* (Stephenson, 1931) as the type of *Lennoscolex*. Gates rightly states that *Notoscolex* is a congeries with no geographical justification and that it is not based on the over-all similarity which is to be expected in species so closely related as to belong in one genus. No attempt can be made here to revise this large genus.

The genus was placed in the Megascolecidae *s. strict.* by Gates (1959) and was retained in the Megascolecinae *s. strict.* by Sims (1966) despite the fact that the example he considered (*N. lunatus* Gates, 1929) showed its closest affinities to lie with *Eudichogaster* (Octochaetidae *s.* Gates; Dichogastrini *s. mihi*). As some Australian species have megameronephridia median to micromeronephridia in posterior segments they must, despite their racemose prostates, be referred to the Dichogastrini, a transfer supported by Sims's computer analysis. The condition of the nephridia in the hind body in the type-species is unknown but its similarity to the dichogastrin *Notoscolex ulladullae* suggests that the two species are strictly congeneric.

Tribe PERIONYCHINI

Male and prostatic pores coincident, or (*Diplotrema* part, New Caledonia) near together, on XVIII; sometimes with a single median combined male and prostatic pore. Prostates one pair, tubular to racemose. Purely holonephric, or with meronephridia in a varying number of segments anterior to holonephridia; never (?) with intestinal enteronephry.

DISTRIBUTION: NEARCTIC: N. America; Queen Charlotte I. NEOTROPICAL: Guatemala; Northern S. America. ORIENTAL: India; Ceylon; Burma. AUSTRALIA (including Tasmania).

NEW ZEALAND (and Chatham I.). NEW CALEDONIA. SUBANTARCTIC ISLANDS: Auckland I.; Snares I.; Stewart I.

Pontodrilus circummundane on sea shores in the warmer parts of the world, including the PALAEARCTIC.

TYPE-GENUS: *Perionyx* Perrier, 1872. (India).

GENERA: (see Jamieson, 1971a).

AUSTRALIAN GENERA: *Diporochaeta* Beddard, 1890; *Fletcherodrilus* Michaelsen, 1891; *Heteroporodrilus* Jamieson, 1970a; *Plutellus* Perrier, 1873; *Pontodrilus* Perrier, 1874; *Pseudoperichaeta* Jamieson, 1970a and *Woodwardiella s. strict.*

REMARKS: *Perionyx* and *Woodwardiella* were the only genera of Gates's Megascolecidae which possessed holonephridia. *Perionyx* Perrier, 1872, restricted by Gates (1960) to oriental species, includes some species in which there are several holonephridia (?) per segment which are not, in Gates's view, to be considered meronephridia as all are stomate. The affinity of these requires further investigation. Where there is a pair of holonephridia, the pores are in a single series on each side or alternate and nephridial vesicles (bladders) are sometimes present. The type-species, *P. excavatus*, lacks vesicles and has nephropores in a rather irregular, approximately midlateral rank on each side.

Comarodrilus Stephenson, 1915 (Cochin, India) is here placed in the Perionychini as it has a pair of 'meganephridia' (presumably holonephridia, a term not employed at that date) in each segment behind XII. In II to XII it possesses parietal and septal micromeronephridia. The nephridia have not been reinvestigated since Stephenson's original description of the type-, and only, species, *C. gravelyi*, and absence of meronephridia behind XII requires confirmation.

With regard to *Diporochaeta*, the nephridia of *Diporochaeta davallia* were described by Jamieson (1970a). It is found, like the closely similar *Pseudoperichaeta smithi*, to have anterior meronephric tufted nephridia with composite ducts but, whereas those of *smithi* are limited to a single segment, those of *D. davallia* extend from segment II for about one third of the length of the intestine; stomate holonephridia are present further posteriorly. Lee (1959) records only holonephridia (with large ovoidal vesicles) for the type-species, *D. intermedia* (Beddard, 1888) which is doubtfully congeneric with *D. davallia*.

Fletcherodrilus Michaelsen, 1891, here separated from *Plutellus* with which it was synonymized by Michaelsen, 1910a, p. 22, has holonephridia only. The form and arrangement of the nephridia and features such as the single median male pore indicate that the type-species, *F. unicus*, is not congeneric with the type-species of *Plutellus*, *P. heteroporus*. In a specimen of *F. unicus* from the Numinbah Valley, Queensland, examined by the writer, the first nephridial bladder opens to the exterior anteriorly in III. In III–VIII, the terminal bladder is a bilobed sac, with ental and ectal chamber, the terminal tubule of the nephridium entering the ental chamber. In segment IX the ectal chamber is beginning to elongate as a diverticulum or caecum. By XV the diverticulum reaches its maximum size, this being almost twice the longitudinal extent of the segment. In XX posteriorly the diverticulum is an only slightly elongate sac and is joined ectally by the widened, bladderlike end of the terminal tubule. The nephropores form a single series on each side, in *d* lines. The prostrate glands are thick, tortuous, short tubes with a wide central lumen. The nephridia of *Heteroporodrilus* are stomate holonephridia the postseptal portions of which commence in II and are equipped with very large subspherical vesicles. The pores show a peculiar alternation which is remarkably constant in the ten species of the genus. *Woodwardiella*, the genus in which *Heteroporodrilus* was previously included, appears from an examination of the type-species which, however, requires confirmation, to have tufted (meronephric?) nephridia in some anterior segments in addition to avesiculate stomate holonephridia and the nephropores are apparently in a single series on each side. A very close relationship between *Heteroporodrilus* and *Plutellus manifestus* has been demonstrated (Jamieson, 1970a). The latter species has subspherical vesicles as in *Heteroporodrilus* but the alternation of pores differs in detail from that in the latter genus and agrees exactly with that described by Perrier (1873) for the type-species of *Plutellus*, *P. heteroporus*. Despite a difference in the arrangement of calciferous glands, the last glands being in XIII in *manifestus* and XII in *heteroporus*, the two species are evidently congeneric, very closely related, and constitute *Plutellus s. strict.* in the present work. Inclusion of *Heteroporodrilus* and *Plutellus* in the same tribe is therefore justified.

Pontodrilus is totally holonephric and its nephridia commence in the region of the clitellum. Nephropores are in a single row on each side (see p. 89). In no species have nephridial vesicles been reported.

Pseudoperichaeta has a pair of anterior meronephric tufts with composite ducts followed in the succeeding segments by stomate, avesiculate holonephridia.

A series thus exists in the Perionychini, though it is not suggested that it is an actual evolutionary lineage, in the direction of increasing development of meronephry. It commences with total holonephry, as in *Perionyx* (most species), *Plutellus*, *Fletcherodrilus*, *Heteroporodrilus*, and supposedly the type-species of *Diporochaeta*, and proceeds to modification of the first pair of nephridia as exonephric (astomate?) meronephric tufted nephridia in *Pseudoperichaeta*, to several pairs of (meronephric?) tufts in *Woodwardiella s. strict.*, and finally to development of astomate tufted nephridia through many anterior segments in *Diporochaeta davallia*. This entire series occurs in Australian species. Australia thus harbours the most primitive known megascolecines. Although *Pontodrilus* (circummundane) is totally holonephric, absence of preclitellar nephridia could conceivably have been preceded by the development of meronephry in that region. This seems unlikely, however, in view of apparent affinities with *Plutellus* and the demonstration by Hague (1923) of anterior holonephridia in juveniles of *Sparganophilus* (Glossoscolecidae) which similarly lacks preclitellar nephridia in the adult and is similarly amphibious. If Stephenson's account of *Comarodrilus* is correct, this Indian genus stands apart from the Australian genera which also have partial meronephry in lacking tufted nephridia.

It may be necessary, when knowledge of the Megascolecinae is more complete, to subdivide the Perionychini into further tribes as association on the presence of holonephridia may represent a grade rather than a clade. However, as the holonephric condition is evidently primitive relative to the meronephric condition, it is reasonable to conclude that the genera of the Perionychini are cladistically more closely related one to the other than they are to exclusively meronephric species. We have seen that some genera are morphologically or phenetically closely linked and that other genera appear to be closely similar. Thus *Heteroporodrilus* and *Plutellus s. strict.* are almost congeneric; *Pseudoperichaeta* and at least one species of *Diporochaeta* and apparently *Woodwardiella s. strict.*, are mutually close. These two groups are sufficiently similar for constituent genera to have been confused in the 'classical' work of Michaelsen and Stephenson. *Pontodrilus* is generally considered to have affinities with *Plutellus s. lat. Fletcherodrilus* is near enough to *Plutellus* to have been synonymized with it by Michaelsen while showing a number of remarkable similarities with *Perionyx* (flattened form of the body; an extreme condition of the tendency of male pores to approach the ventral midline; reddish pigmentation; irregularity of posterior setae as a possible prelude to the perichaetine condition in the latter genus). *Perionyx* in turn is closely similar (Sims, 1966) to *Diporochaeta*. Knowledge of *Plutellus s. lat.*, *Diporochaeta*, *Perionyx* and *Woodwardiella* and of most genera of the Megascolecini is very rudimentary, however, and changes in the internal classiffcation of the Megascolecinae must be expected.

Genus **Diporochaeta** Beddard, 1890, emend. Michaelsen, 1900

Setae, at least in the mid and hind body, numerous (more than 8) per segment Clitellum developed over at least 3 segments, between XIII and XVII; annular for most or all of its length. Male pores 1 pair, on XVIII, combined with the pores of the single pair of prostates, ventrolateral, not always on papillae. Female pores 1 pair, on XIV, ventrolateral. Spermathecal pores paired, or unpaired and midventral in 2–5 intersegments, anterior to 9/10 Nephropores in a single sometimes irregular series on each side. Calciferous glands present or absent. Gizzard sometimes absent; if present, single, in V, VI or VII. Dorsal blood vessel unpaired; hearts 2, 3 or 4 pairs, the last in XI, XII or XIII. Holandric or metandric; testis-sacs absent. Prostates externally tubular or racemose or intermediate but (always?) with a central lumen which may or may not have side branches. Penial setae and copulatory muscles usually absent. Spermathecae with or without diverticula. Possessing holonephridia and with or without anterior tufted exonephric nephridia with composite ducts. Holonephridia with (e.g. type-species) or without terminal vesicles.

Distribution: Australia: Victoria, Tasmania, Queensland. New Zealand, including Stewart, Chatham, Auckland and Snares Islands. South India.

Type-species: *Perichaeta intermedia* Beddard, 1888. (New Zealand).

Australian Species:

1. *Perichaeta alsophila* Spencer, 1892b
2. *Diporochaeta apiocystis* Stephenson, 1933
3. *Diporochaeta arnoldi* Spencer, 1900
4. *Perionyx* (*Diporochaeta*) *athertonensis* Michaelsen, 1916
5. *Perichaeta barronensis* Fletcher, 1887b
6. *Perichaeta bakeri* Fletcher, 1888b
7. *Perichaeta canaliculata* Fletcher, 1888a
8. *Perichaeta copelandi* Spencer, 1892b
9. *Diporochaeta davallia* Spencer, 1900
10. *Perichaeta dendyi* Spencer, 1892b
11. *Perichaeta dicksonia* Spencer, 1892b
12. *Perichaeta dilwynnia* Spencer, 1895
13. *Perichaeta dubia* Spencer, 1892b
14. *Perionyx* (*Diporochaeta*) *erici* Michaelsen, 1916
15. *Diporochaeta euzona* Spencer, 1900
16. *Diporochaeta faucium* Michaelsen, 1907b
17. *Diporochaeta frosti* Spencer, 1900
18. *Diporochaeta grandis* Spencer, 1900
19. *Perichaeta irregularis* Spencer, 1895
20. *Perionyx lacustris* Stephenson, 1924
21. *Diporochaeta lindti* Spencer, 1900
22. *Perichaeta lochensis* Spencer, 1892b
23. *Diporochaeta manni* Spencer, 1900
24. *Diporochaeta mediocincta* Spencer, 1900
25. *Perichaeta moroea* Spencer, 1895
26. *Diporochaeta nemoralis* Spencer, 1900
27. *Perichaeta obscura* Spencer, 1892b
28. *Perionyx* (*Diporochaeta*) *phalacrus* Michaelsen, 1916
29. *Megascolex pritchardi* Spencer, 1900
30. *Diporochaeta richardi* Spencer, 1900
31. *Perichaeta richea* Spencer, 1895
32. *Perichaeta scolecoidea* Spencer, 1895
33. *Diporochaeta sedecimalis* Michaelsen, 1907c
34. *Perionyx* (*Diporochaeta*) *sigillatus* Michaelsen, 1916
35. *Diporochaeta spenceri* Michaelsen, 1907a
36. *Pericheata tanjilensis* Spencer, 1892b
37. *Diporochaeta telopea* Spencer, 1900
38. *Perichaeta* (?) *terraereginae* Fletcher, 1889b
39. *Perichaeta walhallae* Spencer, 1892b
40. *Perichaeta yarrensis* Spencer, 1892b

Remarks: The most recent account of *Diporochaeta* is that of Lee (1959) who described the ten New Zealand species, bringing the total for the genus to approximately 63 species. *D. pellucida* (Bourne, 1894) was transferred by Gates (1940a) to a new genus, *Priodochaeta*. Michaelsen (1900) established *Diporochaeta* in its present form but later (1916, 1924a) combined it with *Perionyx*, at the latter date as a subgenus. Stephenson (1923) separated the two genera, while suggesting a close relationship. Gates (1959) placed *Diporochaeta* in the Acanthodrilidae and *Perionyx* in the Megascolecidae but the two genera are here placed in the same tribe of the subfamily Megascolecinae for reasons given on p. 82.

Morphological heterogeneity in the 40 Australian species is sufficient to suggest that revision of the genus will necessitate establishment of several new genera. Jamieson (1970a) reported the existence of anterior exonephric tufted nephridia in *D. davallia* although the genus is defined by Stephenson (1930) as 'purely meganephridial', the sole supposed distinction from *Spenceriella*. Transfer of *D. davallia* to *Spenceriella* is, however, insupportable as the latter genus is meronephric throughout the body. Some species currently placed in *Plutellus* also have anterior tufts and their distinction from species of *Diporochaeta* which have the same condition solely because their setal arrangement is lumbricine is questionably valid. Revision of *Diporochaeta* requires consideration of such species of *Plutellus* and both genera are concomitantly being reviewed in this laboratory. It appears that *Perionychella* must be resurrected for the type-species *Perichaeta dendyi*.

Genus **Fletcherodrilus** Michaelsen, 1891, emend.

Medium to large terrestrial worms (85–325 mm) with less than 160 segments. With strong purplish parietal pigmentation. Prostomium slightly epilobous. Body not canaliculate First dorsal pore 4/5 or 5/6. Setae in 8 longitudinal rows throughout or *cd* irregular posteriorly; some posterior segments occasionally with one or two supernumerary setae. Ventral setal couples (*ab*) widely paired; dorsal couples (*cd*) distant, further apart than the two couples of a side ($cd>bc$); dorsal median intersetal distance (*dd*) equal to half of the circumference; $dd>4cd$. Penial setae absent. Nephropores in *d* lines throughout. Clitellum annular, occupying 4 to 5 segments beginning on XIII or XIV. The combined opening of the male and prostatic ducts unpaired, midventral on a conical penis-like papilla. Accessory genital markings absent. Female pores anteromedial to setae *a* of XIV, inconspicuous. Spermathecal pores unpaired, midventral, 4 or 5, commencing at 4/5 or 5/6.

Some preclitellar septa thickened. Gizzard well developed, in VI but the post-gizzard oesophagus may not commence until anterior VIII or IX. Calciferous glands lateral, sessile pouches in XIII, XIV and/or XV with laminate internal folds but no partitions. Intestine commencing in XVIII; typhlosole and caeca absent. Dorsal blood vessel continued onto the pharynx. Dorsoventral commissural vessels in VII–XII; those of X–XII forming latero-oesophageal hearts which are unbranched ventrally; those of VII to IX slender, with dorsal but no supra-oesophageal connectives and giving off parietal branches ventrally. Supra-oesophageal vessel in IX (and further forward?)–XII. Subneural vessel absent. Nephridia stomate holonephridia; post-septal bodies commencing in II; each with a fairly large elongate bladder which, after the first few, bears a lateral diverticulum. Testes and funnels free, in X and XI; seminal vesicles 2 to 4 pairs the last on the anterior face of XII. Ovaries and funnel in XIII; ovisacs absent. Prostates thickly tubular with large central lumen; vasa deferentia joining their ducts at mid-length. Spermathecae unpaired, each discharging anteriorly in its segment; duct shorter than the ampulla and bearing, ectally, two (sometimes one) digitiform diverticula.

Distribution: Widespread from the Richmond River, in New South Wales, to the Cape York Peninsula, in Queensland.

Type-species: *Cryptodrilus* (?) *unicus* Fletcher, 1889a.

SPECIES (All Australian):

1. *Plutellus affinis* Stephenson, 1933
2. *Cryptodrilus* (?) *unicus* Fletcher, 1889a
3. *Cryptodrilus fasciatus* Fletcher, 1889b

REMARKS: *Fletcherodrilus* was placed by Michaelsen (1910a) in the synonymy of *Plutellus* because he had found an Indian species, supposedly belonging to the latter genus, in which the spermathecal pores were unpaired. The genus is here re-established as the type-species is clearly not congeneric with the type-species of *Plutellus* (*P. heteroporus*) or its congener *P. manifestus*. The generic account has been augmented from the author's study of material of *F. unicus* from the Numinbah Valley and of *F. facsiatus* from Binna Burra, Queensland. Highly distinctive features of *Fletcherodrilus* are the straight series of nephropores, the presence of diverticula of the nephridial vesicles; the indefinite, lateral calciferous glands and the large ratio *dd*:*u*.

Four species of the genus have been described three of which (*F. unicus* (Fletcher, 1889a); *F. purpureus* (Michaelsen, 1889) and *F. fasciatus* (Fletcher, 1889b)) were first assigned to *Cryptodrilus*. Michaelsen (1891) considered these to be 'varieties' with a new variety, *pelewensis*, of one species *F. unicus*. Later (1900) he placed *purpureus* in the synonymy of '*F. unicus typicus*' and *pelewensis* in *F. unicus fasciatus*. The author agrees that *purpureus* is a synonym of *unicus* but considers that *fasciatus* should be reinstated as a distinct species as the material from Binna Burra, examined in the present study differs from *unicus* in having the gizzard more posteriorly situated and no calciferous glands in XV, two differences noted also by Fletcher in the type-description of *fasciatus*. Michaelsen's var. *pelewensis*, with gizzard in VI and calciferous glands in XIII–XV presumably belongs in *unicus*. It is hoped to settle the question of specific status for *fasciatus* in a separate publication based on additional material which has been acquired since this paper was commenced.

The third valid species, *Plutellus affinis* Stephenson, 1933, differs from the others in having a single diverticulum only to each spermatheca.

Genus **Heteroporodrilus** Jamieson, 1970a

Moderate-sized to large terrestrial worms (52–580 mm long) with less than 300 and usually less than 200 segments. With or without brownish pigmentation. Prostomium variable from prolobous to tanylobous. Body with or without a narrow dorsal groove. First dorsal pore in 5/6 or 6/7 (variable intraspecifically) or rarely in 7/8 or 8/9 (?), exceptionally with a rudimentary pore at 4/5. Setae in 8 regular longitudinal lines, commencing with II. Ventral setal couples widely paired to distant (*aa* equal to or <2.5 *ab*); setae of the dorsal couples (*cd*) widely separated, always further apart than those of each ventral couple and usually a greater interval, rarely slightly smaller, than the interval between the couples of a side (*cd*$>$*ab* and $>$ or rarely slightly $<$*bc*); dorsal median intersetal distance (*dd*)<0.3

of the circumference. Setae *b* and often setae *a* absent in XVIII; *b* rarely replaced by penial setae. Nephropores conspicuous at the anterior borders of their segments, in *d* lines in II–IV or V, in *c* lines for a few segments, then alternating in successive segments between *d* and *c* (or exceptionally mid *bc*) until in X, or less commonly within a segment or two of this, alternation between *b* and *d* commences and is continued to the posterior extremity. Clitellum annular, well developed on XIV–XVI, frequently extending through whole or part of XIII and XVII, rarely impinging on XVIII. A pair of combined male and prostatic pores on XVIII, in *b* lines or less commonly in *ab*. At maturity, accessory genital markings always present in the vicinity of the male pores and frequently in the fore-body, sometimes forming continuous longitudinal series; integumentary only, not represented by intracoelomic glands. Female pores a pair anteromedial to setae *a* of XIV, inconspicuous, though sometimes in a common glandular field. Spermathecal pores 2–4 pairs in or very slightly lateral to *b* lines, the last in intersegment 8/9.

Some preclitellar septa strongly thickened, gizzard vestigial to strong in V. Well developed paired sessile ventrolateral extramural calciferous glands, 3 to 5 pairs, the last always in XIII; the two members of each pair almost contiguous midventrally; the lumen of each gland divided by numerous transverse lamellae. Intestine commencing in XV or, rarely, XVI; typhlosole and caeca absent. Dorsal blood vessel (always?) continued onto the pharynx. Dorsoventral commissural vessels in VI (sometimes V?) to XIII; those of X, or (*oxleyensis*) XI, to XIII with connectives from a pair of efferent vessels which arise from the oesophagus or from its calciferous glands in each of these segments; the efferent (calciferous) vessels discharging thence into a paired or single supra-oesophageal vessel. Commissurals (hearts) of X–XIII differing from those more anteriorly situated in lacking ventral branches. A paired or single suboesophageal vessel between the calciferous vessels continuous to the anterior end of the body as a pair of ventrolatero-oesophageal vessels running median to the hearts. Nephridia stomate holonephridia, their postseptal portions commencing in II; the duct of each with a very large subspherical, thin walled muscular vesicle which lacks diverticula; nephropore with a small sphincter. Testes and funnels in X and XI, free or in unpaired pericardiac testis-sacs; seminal vesicles in IX and XII, rarely (*mediterreus*) in XI and XII. Ovaries and funnels in XIII; ovisacs absent; septal pouches exceptionally present in XIII. Prostates one pair, racemose, sometimes (intraspecific variation) externally approaching a tubular form; vasa deferentia joining their short muscular ducts entally to ectally. Spermathecae discharing anteriorly in their segments; each with a distinct duct, shorter than or slightly longer than the ampulla, bearing one, or less commonly, two or more diverticula which sometimes are branched.

DISTRIBUTION: Australia: In the basins of the Murray-Darling (in the vicinity of the Gwydir, Barwon, Castlereagh, Lachlan and Darling Rivers); of the Wimmera River (southern Victoria); and of some Eastern coastal rivers (Brisbane R., Paramatta R. and headwaters of Mary R. and Albert R.).

TYPE-SPECIES: *Cryptodrilus tryoni* Fletcher, 1889b.

SPECIES (All Australian):

1. *Woodwardiella ashworti* Stephenson, 1933
2. *Cryptodrilus canaliculatus* Fletcher, 1889a
3. *Cryptodrilus cooraniensis* Spencer, 1900
4. *Woodwardiella dioecia* Stephenson, 1933
5. *Cryptodrilus fletcheri* Beddard, 1887
6. *Heteroporodrilus lamingtonensis* Jamieson, 1970a
7. *Cryptodrilus mediterreus* Fletcher, 1888b
8. *Cryptodrilus oxleyensis* Fletcher, 1889a
9. *Cryptodrilus shephardi* Spencer, 1900
10. *Cryptodrilus sloanei* Fletcher, 1889a
11. *Cryptodrilus tryoni* Fletcher, 1889b (synonym *Woodwardiella youngi* Boardman, 1932)

REMARKS: This is undoubtedly a natural assemblage closely related to *Plutellus s. strict.* (see Jamieson, 1970a).

Genus **Plutellus** Perrier, 1873

Seatae 8 per segment. Male pores united with or near the pores of the single pair of tubular prostates on XVIII. Holonephric; nephridia present in front of the clitellum. Female pores a pair, or sometimes single, on XIV. Spermathecal pores paired or single, in one to five intersegments, the last in 8/9.

Gizzard well developed to vestigial, in V–VII; sometimes in two segments, V–VI or VI–VII. Calciferous glands absent or 2–5 pairs present in the region of X–XVI. Intestinal origin in XIV–XIX; typhlosole present or absent. Hearts in X–XI, XII or XIII. Holandric or meroandric; testis-sacs present or absent. Ovaries a single pair, in XIII. Penial setae present or absent. Spermathecae with one or more diverticula.

DISTRIBUTION: Australia, including Tasmania; New Caledonia; New Zealand; Auckland Is.; Queen Charlotte I.; the Pacific coastal strip of the United States; Guatemala; northern South America; India; Ceylon; Burma.

TYPE-SPECIES: *Plutellus heteroporus* Perrier, 1873. (Pennsylvania (?)).

AUSTRALIAN SPECIES:

1. *Plutellus asymmetricus* Michaelsen,1907b
2. *Megascolides attenuatus* Spencer, 1892a
3. *Megascolides bassanus* Spencer, 1895
4. *Plutellus blackwoodianus* Michaelsen, 1907b
5. *Plutellus candidus* Jackson, 1931
6. *Plutellus carneus* Michaelsen, 1907b
7. *Plutellus dalgarangae* Jackson, 1931
8. *Plutellus decatheca* Michaelsen, 1910b
9. *Cryptodrilus ellisi* Spencer, 1895
10. *Megascolides eucalypti* Spencer, 1900
11. *Cryptodrilus frenchi* Spencer, 1892a
12. *Cryptodrilus gippslandicus* Spencer, 1892a
13. *Cryptodrilus hobartensis* Spencer, 1895
14. *Megascolides incertus* Spencer, 1892a
15. *Cryptodrilus insularis* Spencer, 1895 (homonym, see *Pontodrilus*)
16. *Cryptodrilus intermedius* Spencer, 1892a

17. *Plutellus levis* Michaelsen, 1907b
18. *Cryptodrilus lucasi* Spencer, 1892a
18a. *Cryptodrilus macedonensis* Spencer, 1892a
19. *Cryptodrilus manifestus* Fletcher, 1889a
20. *Megascolides manni* Spencer, 1892a
21. *Plutellus mendilai* Michaelsen, 1907b
22. *Cryptodrilus minor* Spencer, 1892a
23. *Plutellus murrayensis* Michaelsen, 1907b
24. *Cryptodrilus narrensis* Spencer, 1892a
25. *Megascolides roseus* Spencer, 1892a
26. *Cryptodrilus rubens* Fletcher, 1888a
27. *Plutellus schumanni* Michaelsen, 1907b
28. *Cryptodrilus semicinctus* Fletcher, 1889b
29. *Megascolides steeli* Spencer, 1900
30. *Plutellus strelitzi* Michaelsen, 1907b
31. *Cryptodrilus tanjilensis* Spencer, 1892a
32. *Notoscolex tasmanianus* Fletcher, 1888b
33. *Plutellus termitophilus* Michaelsen, 1907b
34. *Megascolides tisdalli* Spencer, 1900
35. *Notoscolex tuberculatus* Fletcher, 1888b
36. *Plutellus uncinatus* Stephenson, 1933
37. *Plutellus varicystis* Jackson, 1931
38. *Cryptodrilus victoriae* Spencer, 1892a
39. *Megascolides volvens* Spencer, 1900
40. *Megascolides warragulensis* Spencer, 1900
41. *Plutellus wellingtonensis* Michaelsen, 1907b
42. *Plutellus whistleri* Michaelsen, 1935b
43. *Cryptodrilus willsiensis* Spencer, 1892a
44. *Plutellus woodwardi* Michaelsen, 1907b

REMARKS: The above description considerably augments that of Stephenson (1930) but serves to demonstrate a morphological heterogeneity which is inacceptable, whether on phylogenetic or phenetic grounds, within a single genus. The characters which all species of *Plutellus* supposedly have in common are italicised at the beginning of the description but it should be noted that not even these are applicable to all species currently included in *Plutellus*. Thus Gates (1962c, p. 187) mentions species in which the prostates open to the exterior in XIX or XX, and *P. macedonensis* (Spencer, 1892a) has anterior tufted micromeronephridia (Horan, personal communication).

The Australian members of the genus are at present under revision in this laboratory and it is hoped that subdivision among discrete genera of approximately 105 species making up the global record will soon be practicable. Gates (1961) has already suggested that the oriental species, which differ from the type-species in lacking calciferous glands, should be placed in a separate new genus, though he has postponed this step until better characterization of the type-species becomes possible.

If, as in *Heteroporodrilus*, the nephropore arrangement seen in *Plutellus heteroporus* and *P. manifestus* is taken as a generic character, it appears that none of the Australian species other than *manifestus* can be included in *Plutellus*. Oriental *Plutelli*, all of which lack calciferous glands, must presumably be excluded. Whether the American *Plutelli* include species which are congeneric with the supposedly Pennsylvanian *heteroporus* is not known.

The supposedly Pennsylvanian origin of *P. heteroporus* has been queried by Gates (1961, p. 428). In view of the close similarity of *manifestus* (from New South Wales) it now seems likely that the type-species is Australian. Two lots of specimens were mixed in the bottle in the Paris museum containing the types and Perrier described Australian specimens of other genera in the same collections.

Genus **Pontodrilus** Perrier, 1874

Small to moderately large littoral (mainly marine) worms. Pigmentless. Prostomium epilobous, rarely prolobous. Dorsal pores absent. Setae 8 per segment, commencing on II, in regular longitudinal rows or posteriorly irregular. Nephropores inconspicuous, in *b* lines (sometimes in *a* or *c* lines?) throughout the body. Clitellum annular, on XII, XIII–XVII, XVIII. Combined openings of a pair of tubular prostates and male ducts on XVIII, in *ab* or *b*; a male duct joining each prostate gland at its junction with its duct, where the lumina unite, or running in the gland to open into the ental end of the latter. Accessory genital markings present behind the male pores. Female pores a pair on XIV, anterior to setae *a*. Spermathecal pores 2 pairs, in 7/8 and 8/9, in *b*.

Gizzard rudimentary or absent, in front of the testis-segments. Intestine commencing in XIV (?) to XX; calciferous glands, intestinal caeca and typhlosole absent. Dorsal vessel single, complete; dorso-ventral commissural vessels in V–XIII; those of X–XIII (always?) with supra-oesophageal connectives; paired extraoesophageal vessels passing onto the oesophagus in XII–XIII and uniting midventrally in XIV–XV. Supra-oesophageal vessel typically (always?) present. Subneural vessel absent. Nephridia all avesiculate holonephridia; absent from the preclitellar region. Testes and funnels in X and XI; seminal vesicles in XI and XII. Penial setae absent (unless *lacustris* be included). Ovaries in XIII. Spermathecae diverticulate.

DISTRIBUTION: Circummundane on seashores in the tropics and warmer temperate regions (extending into the freshwater littoral in Lake Chilka, India). The lacustrine *P. lacustris* (New Zealand) and the terrestrial *P. agnesae* (India) are excluded from the above definition.

TYPE-SPECIES: *Lumbricus litoralis* Grube, 1855. (Southern France).

AUSTRALIAN SPECIES:

1. *Pontodrilus litoralis* (Grube, 1855)
2. *Pontodrilus bermudensis* Beddard, 1891

REMARKS: The above description augments that of Stephenson (1930).

The following four species can unequivocally be assigned to *Pontodrilus*:

(1) *P. litoralis* (Grube, 1855) (syn.: *P. marionis* Perrier, 1874; *P. crosslandi* Beddard, 1905; *P. albanyensis* Michaelsen, 1907b, Jackson, 1931 (SW. Australia)).

(2) *P. bermudensis* Beddard, 1891 (recorded from the Great Barrier Reef by Stephenson, 1931) (syn.: *Pontoscolex arenicola* Schmarda, 1861 (part); *Cryptodrilus insularis* Rosa, 1891; *Pontodrilus arenae* Michaelsen, 1892; *Pontodrilus hesperidum* Beddard, 1894; *Pontodrilus michaelseni* Eisen, 1895; *Pontodrilus ephippiger* Rosa, 1898 (recorded from SW. Australia by Michaelsen, 1907b); *Pontodrilus laccadivensis* Beddard, 1903).

(3) *P. matsushimensis* Iizuka, 1898 (syn.: *Pontodrilus chathamianus* Benham, 1901).

(4) *P. gracilis* Gates, 1943.

Two further species are only doubtfully assignable to *Pontodrilus*, namely the terrestrial *P. agnesae* Stephenson, 1915, (India) and the lacustrine *Plutellus lacustris* Benham, 1903, (New Zealand) which was referred to *Pontodrilus* by Michaelsen, 1907b. Michaelsen (1922, 1928a) included *Pontodrilus* as a subgenus in *Plutellus* but Stephenson (1930) retained the two genera. Although *Pontodrilus* may have affinities with some species currently included in *Plutellus*, accordance with a restricted *Plutellus* (p. 88) is small and separation of the two genera is here endorsed.

Pontodrilus lacustris shows the following departures from the four *Pontodrilus* species from which the generic definition above has been drawn: it has four pairs of spermathecal pores; the last hearts are in XII; seminal vesicles are in IX and XI and penial setae are present. Each of these features is known to vary intragenerically in other genera but the combination sets *lacustris* apart from the four marine littoral species as does its habitat deep in a glacial lake. On the other hand, Lee (1959) states that '*Plutellus*' *parvus* Lee, 1959, is more similar to *lacustris* than it is to the two other New Zealand species assigned to *Plutellus*. Several features, including presence of calciferous glands in XIII separate *parvus* from *lacustris*, however, and while *parvus* could justifiably be made the type of a new genus, it is questionable that *lacustris* could be placed in the latter. *Pontodrilus lacustris* must therefore be regarded, until *Pontodrilus* and *Plutellus* are revised, as a species *incertae sedis*. The above conclusions are endorsed by the computer dendrogram given by Lee (in press). In it *P. lacustris* clusters with the core of *Rhododrilus* while *Pontodrilus matsushimensis*, a true *Pontodrilus*, clusters with Megascolecini *s. strict.*, *Plutellus parvus* clusters with another group of *Rhododrilus* species which have a high but apparently not generic affinity with the typical cluster. The *Rhododrilus* affinities of *Pontodrilus lacustris* and *Plutellus parvus* may suggest that there are exceptional members of the Acanthodrilini in which association of male and prostatic pores has occurred on XVIII rather than, as in *Rhododrilus*, on XVII but the present definition of the Acanthodrilini will be retained pending further evidence.

Pontodrilus agnesae is too poorly known to be placeable with certainty either in *Pontodrilus* or in the Indian section of *Plutellus s. lat.* and must, again, be regarded as *incertae sedis* at least until the type-series in the British Museum is re-examined.

Genus **Pseudoperichaeta** Jamieson, 1970a

Typically moderate-sized terrestrial worms (<150 mm) with less than 200 segments; tanylobous; dorsal pores commencing in or anterior to 4/5. Setae 8 per segment; some rows irregular posteriorly; the ventral couples widely paired, the dorsal setal couples closely paired but translocated far dorsally so that the dorsal median intersetal distance is less than *cd*. Nephropores in a single series which is slightly oblique relative to the setal lines, on each side. Clitellum annular, occupying approximately 4 whole segments and anterior to a pair of combined male and prostatic pores which are situated on XVIII in *ab*. Accessory genital markings present in the forebody and in the vicinity of the male pores. Female pores anteromedial to setae *a* of XIV. Spermathecal pores 4 pairs, the last in 8/9.

Some anterior septa moderately thickened. Gizzard in V. Extramural calciferous glands absent but oesophagus vascularised and swollen in the region of XIII–XVI. Intestine commencing in XIX. Dorsoventral commissural vessels in V–XII; hearts in X–XII, latero-oesophageal. Nephridia holonephridia (stomate and avesiculate) with the exception of the first pair which are tufted meronephridia, each tuft having a composite duct. Testes and funnels in X and XI, free; seminal vesicles in IX and XII. Prostates racemose. Ovaries and funnels in XIII. Spermathecae diverticulate.

DISTRIBUTION: The Yarra Basin, Victoria.

TYPE-SPECIES: *Cryptodrilus smithi* Fletcher 1889b. (Synonym *Megascolides punctatus* Spencer, 1900).

OTHER SPECIES: None known.

REMARKS: The genus shows affinities with *Woodwardiella s. strict.* and with *Diporochaeta davallia* (see Jamieson, 1970a).

Genus **Woodwardiella** Stephenson, 1925, emend. Jamieson, 1970a

Small to moderate-sized terrestrial worms (20–80 mm) with less than 150 segments. With or without parietal pigmentation. Prostomium variable from proepilobous to tanylobous. Body rarely (*tesselatus*) canaliculate dorsally. First dorsal pore in (3/4) 5/6 or 6/7, exceptionally (*callichaeta*) postclitellar. Setae in 8 longitudinal rows throughout or (*tesselatus*) some rows irregular; ventral setal couples widely paired; setae of the dorsal couples (*cd*) widely separated, little if at all closer together than the two couples of a side; dorsal intersetal distance <0.3 of the circumference. Penial setae present in XVIII or exceptionally (*tesselatus*) absent. Nephropores in a single series on each side. Clitellum annular on (XIII) XIV–XVII (XVIII). A pair of combined male and prostatic pores on XVIII in *a* or *ab*.

Accessory genital markings always present at maturity within the region of segments X–XIV and sometimes in the vicinity of the male pores. Female pores anteromedial to setae *a* of XIV, inconspicuous. Spermathecal pores 2 pairs, in *a* or *ab* lines, in intersegmental furrows 7/8 and 8/9.

Some preclitellar septa moderately thickened. Gizzard well developed, in V. Extramural calciferous glands absent. Intestine (always?) commencing in XVII or XVIII; typhlosole and caeca unknown. Last hearts in XII, commissurals at least sometimes beginning in VI. Supra-oesophageal vessel present (?). Nephridia holonephridia becoming tufted but apparently remaining exonephric in III and IV (*callichaeta*); vesicles unrecorded. Testes and funnels in X and XI; seminal vesicles in IX and XII or in XII only. Ovaries and funnels in XIII; ovisacs unknown. Prostates racemose; vasa deferentia joining the prostate ducts entally. Spermathecae each with a single diverticulum; the duct shorter than the ampulla.

DISTRIBUTION: Southwestern Australia (Swan and Serpentine River Basins); Tasmania (Mt Olympus and, *mortoni*, Dee Bridge); Victoria (Healesville by the Yarra), if W. *healesi* be included.

TYPE-SPECIES: *Woodwardia callichaeta* Michaelsen, 1907b.

SPECIES (All Australian):

1. *Woodwardia affinis* Michaelsen, 1907b (synonym *Woodwardiella magna* Jackson, 1931)
2. *Woodwardia callichaeta* Michaelsen, 1907b
3. *Woodwardia libferti* Michaelsen, 1907b
4. *Woodwardia molaeleonis* Michaelsen, 1907b
5. *Cryptodrilus tesselatus* Spencer, 1895

Species inquirenda

6. *Woodwardia healesi* Michaelsen, 1923
7. *Cryptodrilus mortoni* Spencer, 1895

REMARKS: Species 1–4 occur in southwestern Australia and are undoubtedly closely related. The Tasmanian *W. tesselatus* appears to have close affinities with the latter species but knowledge of all species is insufficient for conclusive demonstration that *tessalatus* is congeneric. To avoid erection of inadequately characterized genera, Jamieson (1970a) included the Victorian *W. healesi* and Tasmanian *W. mortoni* as *species inquirenda.*

Tribe MEGASCOLECINI

Male and prostatic pores coincident on XVIII (rarely XVII); prostates one pair, racemose or (less commonly) tubular. Purely meronephric; median stomate nephridia, if present, opening into the intestine.

DISTRIBUTION: PALAEARCTIC: China; Korea; Japan. ORIENTAL: India; Ceylon; Andaman Is.; Assam; Burma; Annam; Java; Sumatra; Philippines; Moluccas. AUSTRALIAN: Australia and Tasmania; Norfolk Island; New Guinea. NEW CALEDONIA. NEW ZEALAND. Endemicity from the Mariannas, Bismarck Archipelago, the Solomons, and eastwards across the Pacific Ocean remains to be established. Some species (*Pheretima*, *Lampito*) widely peregrine.

TYPE-SPECIES: *Megascolex* Templeton, 1844.

GENERA: (see Jamieson, 1971a).

AUSTRALIAN GENERA: *Digaster* Perrier, 1872 (part only, excluding the type-species?); *Megascolex* Templeton, 1844; *Notoscolex* Fletcher, 1887a (part, excluding the type-species?); *Pheretima* Kinberg, 1866.

REMARKS: The tribe Megascolecini has been delimited so as to include only non-dichogastrin genera of the Megascolecinae which totally lack holonephridia, that is, in which total meronephry has supervened. Again although close mutual similarity of some genera can be discerned, the tribe possibly represents a grade (acquisition of total meronephry) rather than a single clade or monophyletic group and it is noteworthy that from Sims's computer analysis some genera appear to be morphologically closer to Perionychini or Dichogastrini than they are to other genera of the Megascolecini. Nearest neighbours of genera considered in Sims's analysis as shown in the matrix of coefficients of similarity were as follows (D=Dichogastrini, P=Perionychini, M=Megascolecini): *Pheretima-Lampito* (both M); *Didymogaster* (D)-*Heteroporodrilus* (P); *Lampito* (M)-*Heteroporodrilus* (P); *Plutellus s. lat.* (P)-*Acanthodrilus* (but the type-species of *Plutellus* is unquestionably close to *Heteroporodrilus*). Unfortunately the type-genus *Megascolex* was not considered and it appears that it was rarely feasible to use type-species for the various genera. Of the twelve genera of the Megascolecini, six form a group (a *Pheretima*-group) which is unified by a combination of characteristics of the excretory system. The 6 genera are: *Megascolex* (a *campestris*-group of species, excluding the type-species); *Pheretima* (East Asia, including China and Japan; Indonesia; Australia and widely spread); *Lampito* (India); *Nellogaster* (Ceylon, S. India?); *Plionogaster* (?) (Philippines and Moluccas); and, hitherto placed in the Octochaetidae, *Travoscolides* Gates, 1940a (India). In all of these there are tufts of astomate micromeronephridia (with either composite or common ducts) opening into the foregut ('pharyngeal nephridia') together with stomate meronephridia opening into the intestine and consisting of one to many pairs per segment, the intestinal enteronephric nephridia of separate segments being interconnected by one or two longitudinal excretory ducts. In addition a pair to many exonephric micromeronephridia, which in *Travoscolides* and some species of *Megascolex* (e.g. *M. cochinensis*) form tufts, are always present anteriorly and in all but *Travoscolides* extending into the intestinal region (Bahl, 1926b, 1946, 1947; Gates, 1940a, 1943, 1945; Vidya Vati, 1947). Inclusion of *Plionogaster* in the group is questionable as pharyngeal nephridia have not been demonstrated. Despite the unity of the *Pheretima*-group and its distinction in these nephridial characters from the remainder of the genera here included in the Megascolecini, it does not at present seem advisable to separate it taxonomically from the residue.

With regard to the remaining genera, Gates (1939a) suggests that *Tonoscolex* has arisen directly from *Nelloscolex* by constriction off of extramural calciferous pouches, and Bahl (1947) places *Tonoscolex* in a morphological sequence culminating with *Travoscolides*. Thus inclusion of *Tonoscolex* and *Nelloscolex* in the group of genera here termed the Megascolecini has considerable justification. *Megascolex caeruleus* (the type-species) and *M. templetonianus* which lack intestinal enteronephry may be integrated with such a sequence as primitive (simplified ?) forms. If *M. caeruleus* were placed in a separate tribe the tribe containing *Pheretima* would require renaming. Of twenty four species of *Megascolex* which have been closely examined, 19 species have pharyngeal nephridia and intestinal enteronephry, while 5 species, including the type-species, are purely exonephric in the intestinal region but have pharyngeal enteronephry (Bahl, 1942, 1946, 1947; Vidya Vati, 1947). This suggests a basis for restriction of this very large genus to species lacking intestinal enteronephry. The reader is referred to Bahl (1947) for details of the series of progressively more highly developed enteronephry from *Megascolex sarasinorum* etc., through *Tonoscolex*, *Megascolex cochinensis*, *Megascolex campester* to *Pheretima*, in turn, and thence to *Travoscolides*. In *Travoscolides* the two longitudinal supraintestinal canals of *Pheretima* are represented by a single canal which is no longer supraintestinal but has become embedded in the typhlosole. The enteronephric nephridia commence in segment XV, number 20-24 per segment, have preseptal funnels and, in contrast to *Pheretima*, are not accompanied by exonephric nephridia. A pair of pharyngeal tufts, each with a common, not composite, duct is situated in segment V, and in each of eight segments behind this is a pair of similar but exonephric tufts. Several species of *Megascolex*, including *M. cochinensis*, have a similar arrangement of one pair of pharyngeal tufts followed by 8 or 9 pairs of exonephric tufts though with composite ducts.

The excretory system of *Lennoscolex* (type-species *Woodwardiella pumila* Stephenson, 1931) is meronephric and lacks nephrostomes. Behind the clitellum there is a pair of clusters of 4–6 small exonephric nephridia in each segment (Gates, 1960). This small South Indian genus stands apart from the *Pheretima*-group.

Genus **Megascolex** Templeton, 1844

Setae, at least in the middle and hinder parts of the body numerous (more than 8) in each segment. Prostates 1 pair, racemose, their pores on XVIII or, exceptionally, an adjacent segment; sometimes associated with penial setae. Female pores paired or exceptionally unpaired. Spermathecal pores usually 1–5 pairs, between IV and IX (the exceptions are the few cases where the pores are fused in the midline, or where they are numerous on each side in each segment). One gizzard in V, VI, or VII. Calciferous glands present or absent.

Meronephric, with or without enteronephric nephridia. Holandric, rarely metandric; testis-sacs present or absent. Ovaries in XIII. Spermathecae with or without free diverticula.

Distribution: Ceylon and India. Australia. New Caledonia. New Zealand. Norfolk Island. Annam.

Type-species: *Megascolex caeruleus* Templeton, 1844.

Australian Species:

1. *Megascolex albanyensis* Michaelsen, 1907b
2. *Megascolex albidus* Jackson, 1931
3. *Megascolex andersoni* Spencer, 1900
4. *Perichaeta attenuata* Fletcher, 1889a
5. *Perichaeta australia* Fletcher, 1887a
6. *Trichaeta australis* Spencer, 1900 (homonym)
7. *Perichaeta austrina* Fletcher, 1887b
8. *Megascolex bistichus* Michaelsen, 1907b
9. *Megascolex colliensis* Michaelsen, 1907b
10. *Perichaeta coxi* Fletcher, 1887a
11. *Megascolex crateroides* Boardman, 1943
12. *Perichaeta dorsalis* Fletcher, 1888b
13. *Perichaeta enormis* Fletcher, 1889a
14. *Perichaeta exigua* Fletcher, 1888a
15. *Megascolex fardyi* Spencer, 1900
16. *Megascolex fecunda* Fletcher, 1888a
17. *Perichaeta fielderi* Spencer, 1892b
18. *Megascolex fletcheri* Michaelsen, 1907
19. *Megascolex fletcheri* Shannon, 1920 (homonym)
20. *Perichaeta frenchi* Spencer, 1892b
21. *Perichaeta frosti* Spencer, 1892b
22. *Megascolex fuscus* Michaelsen, 1916
23. *Megascolex galei* Michaelsen, 1907b
24. *Perichaeta goonmurk* Spencer, 1892b
25. *Perichaeta gracilis* Fletcher, 1887b
26. *Perichaeta halli* Spencer, 1892b
27. *Perichaeta hamiltoni* Fletcher, 1888a
28. *Megascolex harveyensis* Michaelsen, 1907b
29. *Megascolex heterochaetus* Michaelsen, 1916
30. *Perichaeta hoggi* Spencer, 1892b
31. *Megascolex jenolanensis* Boardman, 1943
32. *Megascolex illidgei* Spencer, 1900
33. *Megascolex imparicystis* Michaelsen, 1907b
34. *Perichaeta indissimilis* Fletcher, 1889a
35. *Megascolex inermis* Stephenson, 1933
36. *Megascolex larpentensis* Spencer, 1900
37. *Perichaeta lateralis* Spencer, 1892b
38. *Megascolex lobulatus* Spencer, 1900
39. *Megascolex longicystis* Nicholls and Jackson, 1926
40. *Perichaeta macleayi* Fletcher, 1889a
41. *Perichaeta macquariensis* Fletcher, 1889b
42. *Megascolex mediaeviae* Michaelsen, 1907b
43. *Megascolex minor* Spencer, 1900
44. *Megascolex mjobergi* Michaelsen, 1916
45. *Megascolex monostichus* Michaelsen, 1907b
46. *Megascolex montanus* Spencer, 1900
47. *Perichaeta monticola* Fletcher, 1888a
48. *Megascolex newcombei* Beddard, 1887
49. *Megascolex parvus* Michaelsen, 1916
50. *Megascolex purpurascens* Michaelsen, 1907b
51. *Perichaeta raymondiana* Fletcher, 1888a
52. *Megascolex rodwayi* Stephenson, 1931
53. *Perichaeta rubra* Spencer, 1892b
54. *Perichaeta steeli* Spencer, 1892b
55. *Perichaeta stirlingi* Fletcher, 1888a
56. *Megascolex swarbricki* Nicholls and Jackson, 1926

57. *Perichaeta sylvatica* Spencer, 1892
58. *Megascolex syndetoporus* Jackson, 1931
59. *Perichaeta tasmanica* Spencer, 1895
60. *Perichaeta tenax* Fletcher, 1887b
61. *Megascolex terangiensis* Spencer, 1900
62. *Megascolex torbayensis* Michaelsen, 1907b
63. *Megascolex whistleri* Michaelsen, 1907b
64. *Megascolex wiburdi* Boardman, 1943
65. *Perichaeta wilsoniana* Fletcher, 1888a
66. *Megascolex zietzi* Michaelsen, 1907c

REMARKS: An attempt is made above to augment the brief description given by Stephenson (1930) but this very large genus remains one of the major problems in oligochaete taxonomy. It is clearly a polyphyletic congeries in need of extensive revision. The type species is from Ceylon. It has 2 pairs of spermathecal pores, in 7/8 and 8/9; the gizzard in V; no calciferous glands; is holandric, though with seminal vesicles in XII only; no penial setae; and each spermatheca has a very small diverticulum concealed in the duct.

Gates (1938) reinstated the genus *Lampito* which Michaelsen (1900) and Stephenson (1930) considered inseparable from *Megascolex*.

Indian species are described by Stephenson (1923, 1924, 1925a, b) and Aiyer (1929); from Ceylon by Michaelsen (1900, 1909a, 1910a) and Gates (1941); from Assam by Stephenson (1922); from Australia by Spencer (1900), Michaelsen (1907b, c; 1916), Shannon (1920), Nicholls and Jackson (1926), Jackson (1931), Stephenson (1933), Boardman (1943); and from New Zealand by Lee (1959).

Some species, for instance the Eastern Australian *Megascolex dorsalis* (Fletcher, 1888b), are very closely similar to the genus *Pheretima*.

Genus **Pheretima** Kinberg, 1866

Digestive system without supraintestinal and calciferous glands (calciferous tissue in low ridges that are not lamelliform in region of XIII?) but with gizzard that develops in VIII. Vascular system with unpaired dorsal, ventral and supraoesophageal trunks, a subneural adherent to the parietes, paired extra-oesophageal trunks median to hearts, (latero-?) oesophageal hearts in some of segments X–XIII. Excretory system meronephric; paired clusters of astomate nephridia in IV–VI with ducts opening into the pharynx; astomate exonephric, very small, V-shaped parietal nephridia numerous in each segment back from III; larger stomate nephridia with funnels in the same segment as body of tubule, on both sides of septa from XVI posteriorly, joining postseptal canals that pass to longitudinal supraintestinal excretory ducts opening at frequent intervals into gut. Setae numerous, in a circle at the equator of each segment from II posteriorly. Ovaries fan-shaped and with several egg-strings. Male pores postclitellar. (Female always intraclitellar?). Testes and male funnels enclosed in testis-sacs; seminal vesicles postseptal. Spermathecae diverticulate and pregonadial. Prostates racemose, of mesoblastic origin, with ducts joined entally by vasa deferentia.

DISTRIBUTION: Andaman Islands. The mainland of Asia from the Chindwin-Irrawaddy axis of Burma east through Yunnan and Szechuan provinces of China, including Korea and Japan, thence south into New Guinea, Java and Sumatra. Endemicity from the Marianas, Bismarck Archipelago, the Solomons, and New Caledonia eastwards remains to be established. Peregrine species throughout the world but none yet recorded from Alaska, Greenland, the Sahara, or Arabia.

TYPE-SPECIES: *Pheretima montana* Kinberg, 1866.

AUSTRALIAN SPECIES:

1. *Perichaeta queenslandica* Fletcher, 1887b

REMARKS: The writer is indebted to Professor G. E. Gates for the above, hitherto unpublished generic description.

Several peregrine species have been found in Australia and Sims and Easton are currently studying these as part of a taxonometric revision of the genus. *Pheretima queenslandica* (Fletcher, 1887b) is questionably indigenous in Australia. In the author's experience introduced species of *Pheretima* are now the most commonly found of all earthworm species where ground has been cultivated or natural vegetation removed.

Pheretima is distinguished from *Megascolex* by the location of the gizzard. It is expected that the revision by Sims and Easton will provide more substantial differences. The Australian *Megascolex dorsalis* despite its more anterior gizzard appears to the author to have closer affinities with *Pheretima* than with the type-species of *Megascolex*. *Pheretima* is the largest genus in the Oligochaeta, with some 800 recorded species, a number which will be very greatly reduced by synonymy in the above-mentioned revision. The anatomy of *Pheretima posthuma*, including that of the excretory system, has been described in great detail by Bahl (1926a). Gates (1960) after many years of study of a large number of species found no departure in the excretory system from the *posthuma*-type but it remains to be seen whether the whole genus is uniform in this respect.

Michaelsen (1928b, 1934) recognized six subgenera as follows (slightly modified):

> *Archipheretima*: No distinct creeping-sole on the ventral surface of the body. Clitellum occupying more than 3 segments. Intestine without caeca. Holandric. Spermathecae not multiple. Borneo, Philippines.

Pheretima: No distinct creeping-sole. Clitellum restricted to XIV–XVI. Intestine usually with caeca. Holandric with or without copulatory bursae. Spermathecae only exceptionally multiple. Southeast Asiatic and Malayan regions.

Metapheretima: No distinct creeping-sole. Clitellum restricted to XIV–XVI. Metandric. No copulatory bursae. New Guinea, New Britain, North Queensland.

Parapheretima: No distinct creeping-sole. Clitellum restricted to XIV–XVI. Intestine with or without caeca. Holandric. Copulatory bursae present, into which open glands with muscular walls. New Guinea.

Planapheretima: A distinctly differentiated creeping-sole on the ventral surface marked by an extremely dense crowding of setae. Clitellum occupying more than three segments. Intestine without caeca. Holandric. No copulatory bursae. Spermathecae not multiple. Borneo.

Polypheretima: No distinct creeping-sole. Clitellum restricted to the three segments XIV–XVI. Intestine without caeca. Holandric. Copulatory bursae present or absent. Spermathecae multiple, in pairs of transverse groups of 2 or more. Caroline Islands, Sangir Islands (introduced?). Celebes. Borneo. Malay Peninsula. Lombok. Aru Islands (introduced?). New Guinea.

The validity of these subgenera seems somewhat questionable.

Genus **Spenceriella** Michaelsen, 1907b

Prostomium zygolobous, prolobous or epilobous. Setae more than 8 per segment throughout the body or in the postclitellar region; where multiplied, 12–72 per segment. Penial setae absent. Clitellum annular or saddle-shaped, occupying 3–6 segments in XIII–XVIII. Genital markings present. Prostates 1 pair, tubular though often with lateral canaliculi from the central lumen, their pores combined with the male pores on XVIII. Female pore unpaired, midventral, or paired, in XIV. Spermathecal pores 1–3 pairs, in 6/7, 7/8–8/9, or 7/8 only. Dorsal pores (always?) present; location of the first pore variable.

Gizzard large, in V. Discrete (but not stalked?) calciferous glands 4 pairs, in X–XIII, or forming a single or somewhat intersegmentally constricted dilatation on each side in 2–3 of segments XI–XIV; always present in XIII. Intestine commencing in XVI or (*maplestoni*) XVII. Hearts 3–7 pairs, the last in XII or XIII. Supra-oesophageal vessel (always?) present. Meronephridia in broad or narrow lateral parietal bands; pharyngeal nephridia present in Australian species only. Holandric or metandric; testis-sacs absent. Seminal vesicles IX and XII, XI and XII or XII only. Ovaries and funnels in XIII. Spermathecae each with (*notabilis*) a long tubular diverticulum or with 1 or 2 small diverticula.

Distribution: Australia: Victoria. New Zealand: northern districts and neighbouring coastal islands.

Type-species: *Diporochaeta notabilis* Spencer, 1900.

Australian Species:

1. *Diporochaeta maplestoni* Spencer, 1900
2. *Diporochaeta notabilis* Spencer, 1900

Remarks: Michaelsen (1907b) erected *Spenceriella* for four species formerly placed in *Diporochaeta* but distinguishable by their meronephry, viz. *D. notabilis* and *D. maplestoni* (Australia), both of Spencer, 1900, and *D. gigantea* and *D. shakespeari* (New Zealand), both of Benham, 1906. His tentative inclusion of *Perichaeta lateralis* Spencer, 1892b, appears unwarranted as it has 'leaf-shaped' prostates which, though branching of the ducts is not recorded, seem to necessitate inclusion in *Megascolex* as at present defined. Subsequently (1907b) he added an Indian species, *S. duodecimalis*. *S. shakespeari* was shown by Lee (1962) to be a synonym of *S.* (= *Megascolex*) *antarctica* Baird, 1871. Michaelsen (1916) transferred the New Zealand species to *Megascolex* because of lateral branching of the central prostatic lumen in *S. shakespeari*. Stephenson (1923) accepted this change but later (1930) again included the New Zealand species. Gates (1958) erected *Celeriella* for the Indian species, a genus retained in the present work. Lee (1959) was unaware of Gates's paper and retained the Indian species in *Spenceriella* while adding two further New Zealand species, *S. argillae* and *S. pallida*. His definition of the genus is partly erroneous with regard to the Australian species and a new definition of the genus has therefore been given above.

S. gigantea (Benham, 1906) from New Zealand, is known to have median megameronephridia posteriorly and thus qualifies for inclusion in the Dichogastrini. It may be placeable in a perichaetine section of *Megascolides*.

Even after exclusion of *S. gigantea*, *Spenceriella* shows more heterogeneity than seems acceptable in a single genus and clearly requires revision. The type-species is unique in the diverticulate form of its calciferous glands and both Australian species differ from the New Zealand species in their shorter clitellum, significantly smaller numbers of setae per segment (maximally 14 and 24) and, if Spencer's account be correct, in possessing enteronephric pharyngeal nephridia.

Affinities with *Diporochaeta* and *Megascolides* are discussed under those genera.

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REVISION OF THE CALLIONYMID FISHES REFERABLE TO THE GENUS *CALLIONYMUS* FROM AUSTRALIAN WATERS

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ABSTRACT

The genus *Callionymus* Linnaeus from Australian waters is revised. *C. ocelligena* McCulloch is considered a synonym of *C. calcaratus* Macleay, *C. limiceps sublaevis* McCulloch has been raised to specific level, *C. macdonaldi* Ogilby has been redescribed, *C. kaianus moretonensis* has been described as a new subspecies, and *C. punctatus* Langsdorff has been added to the known callionymids of Australia.

The systematic treatment of callionymids in general has been poor due to the lack of appreciation of their sexual dimorphism and the scarcity of specimens in museum collections. A world wide revision is needed and regional revisions such as this may provide a basis for more extensive treatment.

Lack of knowledge concerning sexual dimorphism has resulted in several species being erected erroneously in Australian waters. Also many attempts, particularly by earlier Australian workers, to subdivide the genus *Callionymus* has further complicated the situation, with almost every Australian species being typed as a new genus at one time or another. These attempts have met with little success and are not generally accepted. As more taxonomic work is done on this group, some Australian species may be synonymized with other Indo-Pacific species. The possibility of additional species being added to the known Australian callionymid fauna is ever present as exploratory sampling is lacking along much of the coastline and few localities have been sampled deeper than 180 m.

McCulloch (1929) listed 14 species within the genus *Callionymus* from Australia. One of these species has since been placed in the genus *Synchiropus* (Schultz *et al.*, 1960). Mees (1963) synonymised two species and added several others to the known callionymid fauna of Western Australia.

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In this work, it has been possible to synonymise two species, raise one subspecies to the specific level with further information on biology and distribution, redescribe one species, describe one new subspecies, and add two species to the callionymid fauna of Australia. Corrections have been made of erroneous reports of species upon re-examination of misidentified museum material.

Material examined in this study was collected from Moreton Bay with an 8 fathom Siebenhauser otter trawl (1½" mesh, measured stretched) operated aboard the R/V *Wanderer* II, and at various locations offshore along the Queensland coast with standard commercial prawning gear operated aboard several vessels, mostly the L. F. B. *Bossanova* and the L. F. B. *Jodi*. Some material was also beach seined. Fathoms have been used rather than meters when reporting depth distribution to be consistent with earlier records. Additional material was examined from the collections of various museums. List of abbreviations of museums and collections are as follows:

AM	Australian Museum, Sydney
BM	British Museum (Natural History), London
CAS	California Academy of Sciences, San Francisco
QM	Queensland Museum, Brisbane
SAM	South Australian Museum, Adelaide
USNM	U.S. National Museum of the Smithsonian Institution, Washington
P	Western Australian Museum, Perth
KU	Kyoto University, Maizuru, Japan
F	Dept. Agriculture, Stock and Fisheries, Research and Survey Station, Kanudi, Papua
FMNH	Field Museum of Natural History, Chicago
SU	Stanford University, Stanford

All lengths are standard length (SL) and all measurements are in mm. All measurements are direct measurements. Most of the measurements used are self explanatory. The following definitions have been used for some that are not self evident or characteristic of callionymids: head length is measured from the tip of the snout to the gill opening; head width is measured at the base of the preopercular spines; snout length is measured from the tip of the snout to nostrils; postorbital length of head is measured from the rear edge of eye to posterior edge of gill openings; length of caudal peduncle is measured from the base of the last anal ray to the midbase of the caudal fin; body depth is greatest body depth. Head width should be considered a crude measurement which is dependent upon the condition of the branchial chamber at the time of preservation.

KEY TO SPECIES AND SUBSPECIES OF CALLIONYMUS FOUND IN AUSTRALIAN WATERS

1. Preopercular spine stout, recurved, bent or angular with recurved tip and spines along inner margin 2

Preopercular spine slender (possibly stout), spear-like, straight or very slightly curved with serrations or teeth along inner margin; basal antrorse spine present.. 10

2 (1). Antrorse spine present on base of preopercular spine.................... 4

Basal antrorse spine absent 3

3 (2). DIV, $7\frac{1}{2}$; anal $6\frac{1}{2}$; preopercular spine curved upwards, with 2 hooks ....*C. papilio*

DIV, $8\frac{1}{2}$; anal $7\frac{1}{2}$; preopercular spine curved upwards, with 2 hooks ....*C. calauropomus*

DIV, $8\frac{1}{2}$ or $9\frac{1}{2}$; anal $7\frac{1}{2}$; preopercular spine curved upwards, with 3 hooks .... *C. phasis*

4 (2). DIV, $8\frac{1}{2}$; anal $7\frac{1}{2}$; preopercular spine with 3 hooks............*C. calliste*

DIV, $9\frac{1}{2}$ (rarely $8\frac{1}{2}$ or $10\frac{1}{2}$); anal $9\frac{1}{2}$ (rarely $7\frac{1}{2}$, $8\frac{1}{2}$ or $10\frac{1}{2}$); preopercular spine with 2–5 hooks 5

5 (4). Preopercular spine with 2 hooks 6

Preopercular spine with 3–5 hooks.................................. 8

6 (5). Preopercular spine slightly curved upwards with a barbed tip; first dorsal with a large black blotch between 2nd and 4th spines, first dorsal spine filamentous...................... *C. kaianus moretonensis* sub sp. nov.

Preopercular spine curved inwards.................................. 7

7 (6). Upper surface of cranium and supraorbital region rugose......*C. limiceps*

Upper surface of cranium and supraorbital region smooth and covered by integument .... *C. sublaevis*

8 (5). Raised crests and circular pits along each side of the occiput; first dorsal in males grey, in females black with anterior spines white to grey.......... .... *C. macdonaldi*

No raised crests or circular pits along each side of the occiput; first dorsal with dark blotch.. 9

9 (8). Preopercular spine broad; blotch on dorsal large, light in males and dark on a white background in females......................... *C. calcaratus*

Preopercular spine long, approximately the length of eye; dorsal blotch of concentric shape in males, in females the first dorsal is dark grey to dusky .... *C. punctatus*

10 (1).	DIV, 8½; anal 7½; preopercular spine more or less straight with 5-12 small serrations	11
	DIV, 9½; anal 9½ or 8½; preopercular spine with 6–16 coarse spines or barb-like serrations	12
11 (10).	Snout slightly shorter than eye; only 1st pectoral ray simple . . . . . . *C. rameus*	
	Snout larger than eye; 1st and 2nd pectoral rays simple . . . . *C. goodladi*	
12 (10).	First dorsal on line with gill openings; 1st and 2nd pectoral rays always simple . . . . *C. grossi*	
	First dorsal not on line with gill openings; sometimes only 1st pectoral ray simple	13
13 (12).	Caudal short, does not equal body less head . . . . *C. belcheri*	
	Caudal elongate, equals body less head	14
14 (13).	Two bony bucklers, one on each side of occiput, with smooth ridges or tubercles radiating from their centres; median area behind eyes covered with smooth integument . . . . *C. japonicus japonicus*	
	Two bony bucklers, one on each side of occiput, with rugose ridges radiating from their centres; median area behind eyes covered in bony rugosities . . . . *C. japonicus scaber*	

Callionymus japonicus japonicus Houttuyn

Callionymus japonicus Houttuyn, 1782, p. 311.
Callionymus reevesi Richardson, 1844, p. 60.
Callionymus longicaudatus Temminck and Schlegel, 1845, p. 151.
Callionymus Belcheri Bleeker, 1879, p. 85 [not *C. belcheri* Richardson, 1844]
Calliurichthys japonicus: Jordan and Fowler, 1903, pp. 942–3. McCulloch, 1929, p. 338.
Callionymus numeri Tanaka, 1917, p. 12.
Callionymus, Calliurichthys japonicus [*sic*]: McCulloch, 1926, pp. 196–7.
[?]*Callionymus affinis* Ogilby, 1910b, p. 134 [not *C. affinis* Regan, 1908]
Callionymus affinis: McCulloch, 1929, p. 339.

MATERIAL EXAMINED: 2 specimens, 106 and 175 mm SL (Research and Survey Kanudi, unregistered and F01705 respectively), from waters N. of Cape York Peninsula off Yule I. and Bramble Cay, Gulf of Papua.

DESCRIPTION: Dorsal IV, 9½; anal 8½; pectoral ii16ii or i16iii; ventral I,5; caudal ii6ii or i6iii; body compressed in front and elongate; snout pointed; preopercular spine strong and straight with 7-16 barb-like serrations along inner margin; caudal elongate, equals body less head; 1st or 2nd or both dorsal spines filamentous in males; occiptal region with a pair of elevated crests (bony bucklers) separated by smooth integument of head.

Head length 4.19 to 4.58; head width 5.60 to 6.25; length of pectoral fin 5.22 to 6.04; body depth 11.00 to 11.14; all in standard length. Eye 3.06 to 3.74; snout 2.87 to 2.99; pectoral fin length 1.24 to 1.32; all in head length. Eye 1.02 to 1.30 in snout.

COLOUR IN ALCOHOL: As described by Jordan and Fowler (1903).

SEXUAL DIMORPHISM: Marked sexual dimorphism exists in colouration and fin shape. In the male the anterior dorsal spines are produced into long filaments and the median caudal rays are produced. Snout length is also greater in the male. All the dorsal spines are short in the female. The median caudal rays are produced in the female but are usually shorter than the body while those of the male are characteristically longer. The snout is blunt in female specimens. Colour differences between sexes are quite evident with a deep brown to black blotch on the chest and the branchiostegals greyish brown to black in the male. The female undersurface is pure white and the chest blotch is absent.

REMARKS: Since no specimen of *C. affinis* was available for examination, I can not be sure that it would be placed under *C. j. japonicus*. McCulloch (1926) synonymized *C. affinis* with *C. j. japonicus* from an examination of the only existing specimen (now appears to have been lost) and since he described *C. j. scaber* it seems unlikely that it would be placed under this subspecies. Other subspecies may be erected when an examination is completed on a world wide basis.

DISTRIBUTION: Previously from south of New Guinea, station 188 (Günther, 1880) and off Cape Moreton, SE. Queensland (Ogilby, 1910b; McCulloch, 1929).

Callionymus japonicus scaber McCulloch

Callionymus japonicus scaber McCulloch, 1926, p. 197.
Callionymus longicaudatus Waite, 1898, p. 60. McCulloch, 1923, p. 8.

MATERIAL EXAMINED: 85 specimens, 91–193 mm SL, coastal south Queensland (20 miles SE. of Double Island Point, 32–3 fm; E. of Noosa, 41–46.5 fm; and off Caloundra, 41–46.5 fm). One specimen, off Caloundra, QM 18209.

DESCRIPTION: Dorsal IV, 9½; anal 8½; pectoral i16ii, ii16i, iii16i, i17i or ii17i; ventral I, 5; caudal i7ii; ridges or bucklers (elevated crests) are very rough and the area behind the eyes is covered with similar bony rugosities; preopercular spine with 9–12 serrations along inner margin; otherwise same as *C. j. japonicus*.

Head length 4.24 to 4.81; length of pectoral fin 5.00 to 5.77; head width 4.36 to 5.58; depth of body 8.47 to 13.30; all in standard length. Eye length 3.00 to 3.60; snout 2.73 to 3.46; pectoral fin 1.18 to 1.20; all in head length. Eye 1.00 to 1.11 in snout.

Colour in Alcohol: These specimens agree with the colour description of Jordan and Fowler (1903) except that the following slight differences were noted. Remarks in parentheses refer to Jordan and Fowler's description. Light grey above (deep rich brown) with numerous rounded spots of grey and brown (pale brown) margined with dark brown; ventral surface white to yellowish (pure white), males have a dark brown to black (rich brown) blotch on the chest, branchiostegals greyish in males and white in females.

Sexual Dimorphism: As for *C. j. japonicus*.

Remarks: Slight differences were noted in the proportions of the head length and of the eye in snout from the material reported upon by Jordan and Fowler (1903) but these were within the ranges given in de Beaufort and Chapman (1951) for *C. j. japonicus*. The differences in head length could be due to the method of taking measurements as the criteria for measurements are not mentioned by any of the above workers. Munro, 1967, and de Beaufort and Chapman, 1951, both report 7 to 8 serrations along the inner margin of the preopercular spine in *C. j. japonicus*. My material (*C. j. scaber*) ranged from 9 to 12 (usually 10) serrations.

Distribution: Previously from Lord Howe I., off New South Wales (type locality) (McCulloch, 1926), and now SE. Queensland.

Callionymus kaianus moretonensis subsp. nov.

(Figs. 1–5)

Holotype: Adult female, 158.3 mm SL, 7 miles E. of Cape Moreton, southeast Queensland (approximately 27°02′S lat. 153°36′E long.) 68–72 fm, collected by L.F.B. *Bossanova* at night on 4 August 1969, AM I15608.00.

Paratypes: Five, 95.2–149.0 mm SL, AM I15608-002–6; four, 130.9–164.9 mm SL, CAS 24764–67; all collected with the holotype. Two, 30 miles E. of Mooloolaba, 60–70 fm, 12–14 August 1967, R. Elks, QM I9156–7. One, southern Queensland, Department of Fisheries, QM I3428.

In addition, 894 specimens (74–162 mm SL) used in biological studies were recorded from southern Queensland off shore (7 miles E. of Cape Moreton 65–80 fm; 18 miles E. of Caloundra, 56–60 fm; ENE. of Noosa, 54–8 fm; 62–8 fm; E. of Mooloolaba, 59–67 fm). A few of these specimens will be deposited in the Queensland Museum and the United States National Museum.

DESCRIPTION: Spinous dorsal fin IV; second dorsal elements $9\frac{1}{2}$ (last ray branched at base); anal fin elements $9\frac{1}{2}$ (last ray branched at base); pectoral rays i17ii (19 specimens), i18ii (20 specimens); ventral rays I,5; caudal rays i7ii.

Measurements (mm) of holotype: Head length 42.4, greatest body depth 20.8, least depth of caudal peduncle 6.9, snout 9.3, bony interorbital 1.0, eye 13.1, postorbital length

TABLE 1

MEASUREMENTS IN PERCENT OF STANDARD LENGTH OR HEAD LENGTH (*) OF THE HOLOTYPE AND NINE PARATYPES OF *Callionymus kaianus moretonensis*

Sex Catalogue no.	♀ AM 115608 -001 holo-type	♂ AM 115608 -002	♂ AM 115608 -003	♂ AM 115608 -004	♀ AM 115608 -005	♂ AM 115608 -006	♂ CAS 24764	♂ CAS 24765	♀ CAS 24766	♀ CAS 24767
Standard length (mm)	158.3	124.6	149.0	140.5	95.2	128.6	130.9	134.0	141.7	164.9
Head length	26.7	29.6	26.5	27.9	31.6	27.6	28.9	28.9	28.1	27.6
Greatest body depth	13.1	12.2	9.5	11.3	12.8	11.5	10.5	10.2	12.0	13.2
Least depth of caudal peduncle	4.3	3.0	3.6	3.8	3.5	2.8	4.1	4.0	3.2	3.9
Snout*	21.9	17.3	17.2	17.8	17.2	16.0	18.2	15.2	15.7	18.4
Bony interorbital*	2.3	2.1	3.7	2.0	1.6	2.2	2.1	1.5	2.0	3.5
Eye*	30.8	30.3	35.4	35.8	35.2	34.2	32.1	33.5	32.3	29.1
Postorbital length of head	10.9	11.8	10.8	11.5	13.9	10.3	11.2	10.5	11.2	12.6
Length of caudal peduncle	16.8	21.5	18.2	18.6	17.8	18.4	19.4	20.9	18.4	18.2
Snout tip to origin of first dorsal	26.8	26.9	25.9	27.3	28.8	26.3	26.7	26.1	26.9	25.6
Snout tip to anal origin	42.5	43.5	45.8	45.7	47.4	45.9	46.0	45.4	48.2	44.2
Length of first dorsal spine	25.9	22.9	24.0	20.7	31.5	22.6	19.9	21.1	21.0	22.4
Longest soft dorsal ray	17.9	20.7	18.1	18.6	21.1	18.5	19.0	17.8	19.8	20.4
Longest pectoral ray	17.6	19.5	17.4	17.5	21.1	18.8	18.2	18.2	20.3	20.0
Longest pelvic ray	23.6	23.6	21.2	20.2	24.2	22.7	23.5	24.0	23.4	23.2
Longest caudal fin ray	41.6	54.7	43.2	46.1	49.6	48.6	50.1	48.8	50.3	43.3
Tip of snout to rear edge of maxillary*	28.8	22.7	25.0	26.2	21.9	23.5	25.0	20.7	21.0	24.5
Length of preopercular spine	6.5	7.2	7.5	7.5	8.2	8.3	8.6	6.9	7.6	6.6

of head 17.3, length of caudal peduncle 26.6, snout tip to origin of first dorsal 42.5, snout tip to anal origin 67.3, length of first dorsal spine 41.1, longest soft dorsal ray 28.4, longest pectoral ray 27.9, longest pelvic ray 37.5, longest caudal fin ray 66.0, tip of snout to rear edge of maxillary 11.4, length of preopercular spine 10.3. Additional measurements are given in table 1.

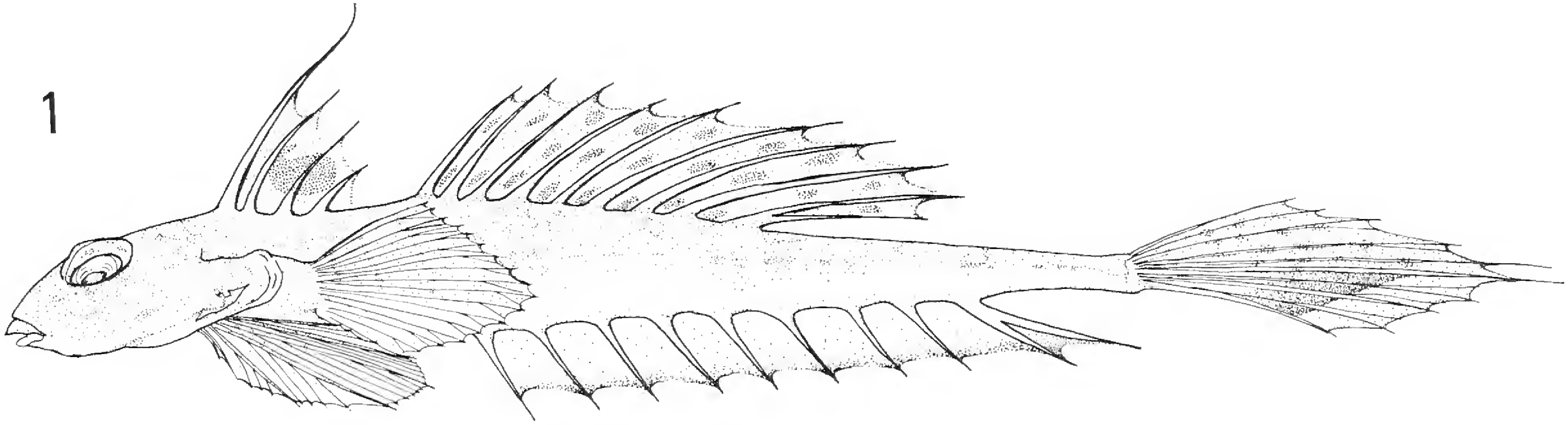
Body elongate, compressed in front with greatest depth near 2nd and 3rd spine of first dorsal; body broader than deep tapering posteriorly. Head compressed, greatest depth about one-half width at preopercular spine; snout rounded, compressed above, greatest depth about one-half width; eyes close together, directed upward, 29.1 to 35.8% of head length; mouth small, inferior, jaws unequal, maxillary reaching nostril; dentition villiform, in approximately 8 bands upper jaw and 6 bands lower; preoperculum with a strong spine with a slightly recurved barbed tip with 2 barbs near tip and a strong basal antrorse spine (fig. 2). Gill openings small, slit-like, on upper surface of body approximately midway between origin of first dorsal fin and preopercular spine base and as far apart as outer margins of eyes.

Spinous dorsal inserted approximately midway, but nearer posterior margin of eye than origin of soft dorsal, spines long, the first produced into a long filament, decreasing in length posteriad; origin of soft dorsal just anterior to a vertical line through anal papilla; anal originating under 3rd dorsal ray, lower than soft dorsal, the last ray branched and produced; pectorals between origin of 3rd spinous dorsal and 4th dorsal ray, broad, with median rays longest; pelvics large, broad and longer than pectorals, originating before the gill openings and extending to about mid pectoral length and joined to base of pectoral by a broad membrane; caudal long, graduated above and below the median rays which are produced; caudal peduncle long and compressed, depth less than the eye.

COLOUR IN ALCOHOL: Background colouration dorsal greyish; ventral yellowish white, head and body marbled dorsally with brown markings, sides of body with 2 to 3 irregular brown blotches; dark brown blotch at pectoral base; first dorsal dusky to greyish with a large black irregular occellated spot between 2nd and 4th spine; second dorsal with numerous brown spots regularly dispersed between the rays (2 on each membrane between 1st and 3rd ray, 3 on rest of membrane except 1 or 2 between last branched ray). Anal blackish distally, clear basally; caudal with blackish streak along ventral rays otherwise irregularly marked with brown spots; pectorals clear; pelvics dusky to yellowish basally, upper rays with brown bands. Life colouration not known.

SEXUAL DIMORPHISM: Little sexual dimorphism exists in this subspecies. No colour differences could be detected between sexes. The median caudal rays are produced and are longer in males. The first dorsal spine is slightly longer in males being produced in both males and females (fig. 3). Considerable sexual dimorphism is present in the length of the anal papilla as would be expected (fig. 4). The lack of sexual dimorphism in the other fins is here demonstrated by the example of the last anal ray in fig. 5. Ochiai *et al.* (1955) reported

1



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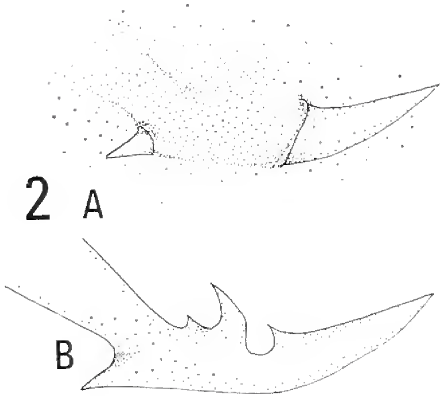

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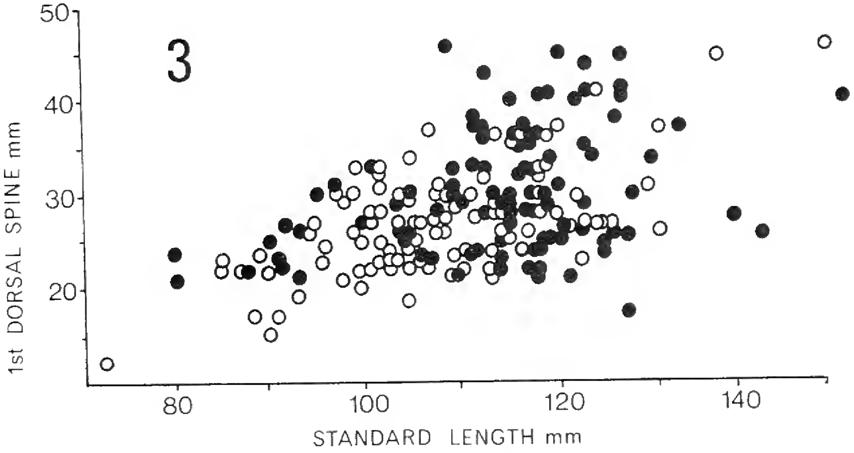

FIG. 1: *Callionymus kaianus moretonensis* subsp. n. holotype, female 158.3 mm from off Cape Moreton, southeast Queensland.

FIG. 2: Preopercular spine of *C. k. moretonensis*. A, spine as it appears partly covered by integument; B, spine with integument removed.

FIG. 3: Sexual dimorphism of the first dorsal spine in *C. k. moretonensis*. Dark circles males (n=102), open circles females (n=104).

greater sexual dimorphism in the length of the first dorsal spine in *C. k. kaianus* from Japanese waters than was found in this subspecies.

REMARKS: Juveniles of 80 to 100 mm have only two spots on each membrane of the second dorsal and have the tip of the preopercular spine not barbed or only slightly barbed. At around 110 to 112 mm the barbed tip becomes more pronounced. Ochiai *et al.* (1955) reported the lack of barbed preopercular spine tips in young *C. k. kaianus*.

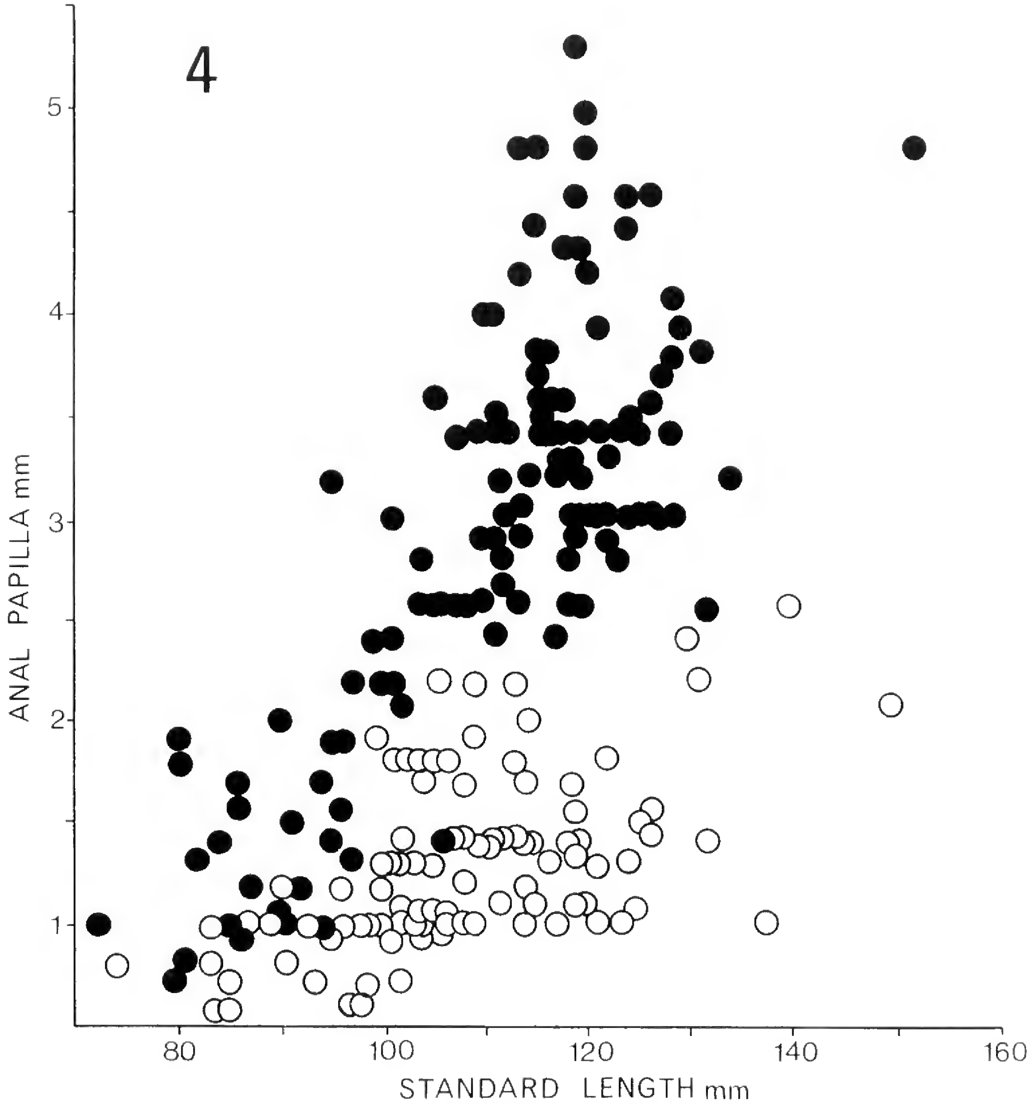

FIG. 4: Sexual dimorphism of the anal papilla in *C. k. moretonensis*. Dark circles males (n=130), open circles females (n=85).

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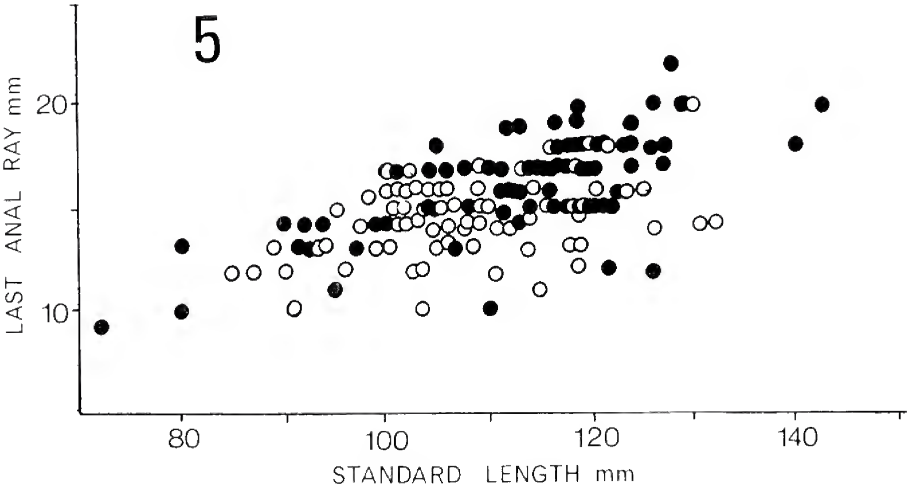

FIG. 5: Sexual dimorphism of the last anal ray in *C. k. moretonensis*. Dark circles males (n=81), open circles females (n=79).

Dr Alwyne Wheeler kindly examined the type specimen of *C. k. kaianus* (BM 1879.5. 14.565) and sent me data and photographs for comparison with *C. k. moretonensis*, one specimen of *C. k. kaianus* was examined from Japan (KU 23274).

C. kaianus moretonensis can be readily distinguished from *C. k. kaianus* by the difference in body markings; regular pattern of spots on second dorsal versus irregular blotches in *C. k. kaianus*; the more anterior position of the lunate spot on spinous dorsal; the black band always present on the distal portion of the anal fin; and by a more slender preopercular spine.

ETYMOLOGY: The subspecific name *moretonensis* is taken from the type locality, Cape Moreton.

DISTRIBUTION: Known only from southern Queensland offshore.

Callionymus punctatus Langsdorff

(Fig. 6)

Callionymus punctatus Richardson, 1846, p. 210.

Callionymus richardsoni Bleeker, 1854, p. 414.

Callionymus curvicornis Günther, 1861, p. 145.

Callionymus valenciennesi Schlegel, 1845, p. 153.

Material Examined: 432 specimens, 57–105 mm SL, Moreton Bay (Shark Spit, Moreton I., 16 fm; 1 mile E. of Otter Rock, near Redcliffe, 3.5 fm; 4 miles E. of Redcliffe, 5 fm; 4.5 miles E. of Queens Beach, 5–6 fm; 6 miles E. of Scarborough, 8–9 fm; 1.5 to 2 miles E. of Bishop I., 2.5–3 fm; E. of St Helena I., 2.5–5 fm; E. of St Helena I. and Mud Islands, 4 fm; 7.5 miles W. of Tangalooma, Moreton I., 5 fm) and Gulf of Carpentaria 16°40′S, 139°42′E (one specimen, AM I15557–217). Museum material examined consisted of 34 specimens: USNM 177165, 71076(12); CAS 24868(2); KU 22093–94; SU 7758(3), 7948(6), 7759(3), 7854(3); FMNH 44956; AM I15557–217.

Description: Dorsal IV, $9\frac{1}{2}$ ($8\frac{1}{2}$ or $10\frac{1}{2}$ rarely); anal $8\frac{1}{2}$ ($7\frac{1}{2}$, $9\frac{1}{2}$, or $10\frac{1}{2}$ rarely); pectoral i13i2i (1 specimen), i14ii, i15i, or i15ii; ventral I,5; caudal i7ii, ii7ii or ii7iii; preopercular spine nearly as large as eye with 3 or 4 spines besides recurved tip and an antrorse spine at base; snout pointed, larger than eye; last soft dorsal and anal rays extend beyond caudal base; dorsal spines not filamentous; caudal long with median rays longest; first dorsal in male grey with irregular dusky blotches and a darker blotch (black in some specimens) between 3rd and 4th spine; first dorsal in female dark grey to dusky.

Head length 3.58 to 4.00; greatest body depth 9.00 to 10.66; postorbital length of head 10.13 to 11.40; length of caudal peduncle 5.79 to 6.50; snout tip to origin of first dorsal 2.90 to 3.14; snout tip to anal origin 1.91 to 2.00; longest soft dorsal ray 3.94 to 5.58; longest pectoral ray 3.94 to 4.34; longest pelvic ray 4.04 to 4.79; longest caudal fin ray 2.63 to 3.12; all in standard length. Least depth of caudal peduncle 4.80 to 5.48; snout 3.08 to 4.00; eye 3.04 to 3.43; length of first dorsal spine 1.53 to 2.44; tip of snout to rear edge of maxillary 3.16 to 3.87; length of preopercular spine 3.40 to 4.14; all in head length. Bony interorbital 8.75 to 12.43 in eye.

Colour in Alcohol: As described by Ochiai *et al.* (1955). Background colouration of dorsal surface light brown, ventral surface yellowish to white; numerous light to dark brown streaks along the side of the body in males, may be faint or absent in females; first dorsal in males grey with irregular dusky to black blotches and a darker blotch (black in some specimens) between 3rd and 4th spines, fin edged in black; first dorsal in females dusky to black with anterior spines grey in Australian material, differing from Japanese specimens in lacking the occellated black blotch on the membrane between the 3rd and 4th

6

Fig. 6: Some examples of variation in right and left preopercular spines of *Callionymus punctatus*.

spines; anal with a dark distal streak in males and white in females; caudal rays mottled with dark brown spots; ventral dusky distally and basally lighter (much lighter in females); upper pectoral rays spotted with brown, lower rays white.

SEXUAL DIMORPHISM: Besides the colour differences mentioned above, the length of the last dorsal rays, anal papilla, and caudal fin rays are greater in males. Spinous dorsal spines appear to be slightly larger in males. Some male specimens exhibit the female first dorsal colour pattern of the described material from Japan with the occellated black blotch between the 3rd and 4th spines. This has also been discussed by Ochiai *et al.* (1955) and Jordan and Hubbs (1925).

REMARKS: This is the first report of this species from Australian waters and it appears to be very abundant wherever it occurs. Considerable variation occurs in the preopercular spine in this species (fig. 6).

DISTRIBUTION: Moreton Bay and Gulf of Carpentaria.

Callionymus phasis Günther

Callionymus phasis Günther, 1880, p. 28. Macleay, 1884, p. 35. Waite, 1904, p. 51. McCulloch, 1922, p. 103; 1923, p. 9; 1926, p. 212; 1927, p. 77; 1929, p. 338; 1934, p. 77. Norman, 1937, p. 56. Ochiai *et al.*, 1955, p. 104–6. Mees, 1963, p. 98–9. Schultz *et al.* 1960, p. 403.

Callionymus apricus McCulloch, 1926, p. 209; 1929, p. 339. Waite, 1927, p. 231.

Yerutius apricus: Whitley, 1931, p. 115; 1948a, p. 27. Scott, 1962, p. 170.

MATERIAL EXAMINED: One specimen, 47 mm SL, collected 1921, AM IA.431.

DESCRIPTION: Dorsal IV, $8\frac{1}{2}$ or $9\frac{1}{2}$; anal $7\frac{1}{2}$; pectoral i17i; ventral I,5; caudal ii7ii; all dorsal rays divided; preopercular spine curved upwards at tip with 2 hooks along the inner margin and no antrorse spine at base; eyes large, high above profile of head; inter-orbital very narrow; origin of first dorsal only a little behind gill aperture.

Head length 3.14; pectoral fin length 4.27; head width 3.62; body depth 5.88; all in standard length. Eye 3.00; pectoral length 1.37; snout 5.00; all in head length. Eye 0.60 in snout.

COLOUR IN ALCOHOL: All colour markings faded, background colouration grey.

REMARKS: Ochiai *et al.* (1955) recorded *C. phasis* as new to Japanese waters, basing this record on a 44 mm SL specimen (KU24847) which on examination proves to be

C. calliste and not *C. phasis*. Because this specimen was called *C. phasis*, juveniles of *C. phasis* were thought to have simple dorsal rays, but since this misidentified specimen was the only evidence for this, *C. phasis* should be considered to have divided dorsal rays until proven otherwise.

DISTRIBUTION: Known from Twofold Bay, New South Wales; South of Drana Range, Gippsland, Victoria, 80 fm; Tasmania along eastern coast and the Great Australian Bight south from Eucla (Mees, 1963; Australian Museum record).

Callionymus grossi Ogilby

Callionymus grossi Ogilby, 1910a, p. 43. McCulloch, 1929, p. 338. Schultz, 1960, p. 403. Palmer, 1962, p. 548. Mees, 1963, p. 97. Marshall, 1965, p. 380. Johnson, 1970, p. 294.

Callionymus, Calliurichthys, grossi [*sic*]: McCulloch, 1923, p. 8; 1926, p. 195. McCulloch and Whitley, 1925, p. 173.

Callionymus Calliurichthys, nasutus [*sic*] McCulloch, 1926, p. 197.

Callionymus nasutus: Marshall, 1951, p. 5; 1965, p. 380.

Callionymus (*Calliurichthys*) *nasutus* [*sic*]: Mees, 1959, p. 9.

Calliurichthys nasutus: Whitley, 1962, p. 226.

MATERIAL EXAMINED: 142 specimens, 45–146 mm SL, from the Gulf of Carpentaria 16°52′S, 139°39′E; Bowen; Cockle Bay, Magnetic I.; south coastal Queensland (6–10 miles N. of Noosa, 20 fm; 10 miles N. of Noosa, 21–2 fm; and E. of Caloundra, 15 fm); and Moreton Bay (1 mile W. of Shark Spit, Moreton I., 13–17 fm; off Sand Hills, Moreton I., 7.5–17 fm; 3 miles SW. of Tangalooma, Moreton I., 15 fm; off Lucinda Bay, Moreton I., 12–17.5 fm; E. of Mud I., 4–5 fm; 2 miles E. of Mud I., 6–8 fm; 2.5 miles E. of the southern tip of Mud I., 7–8 fm; 1 mile E. of SE. corner of St Helena I., 5 fm; ENE. of St Helena I., 5 fm; 4 miles E. of St Helena I., 5–6 fm). The following museum specimens were examined. Queensland Museum: I1579 (paratype, Bulwer, Moreton Bay), I7248 (Cockle Bay, Magnetic I.), I4239 (Bowen, N. Qld), I6855 (Mud I., Moreton Bay), Australian Museum: IB.326 (Shark's Bay), I15557-219.

DESCRIPTION: Dorsal IV, $9\frac{1}{2}$; anal $8\frac{1}{2}$; pectoral ii13i, ii13ii, ii13iii, ii14i or ii14ii; ventral I,5; caudal i7ii or ii7ii; preopercular spine straight with 9–16 serrations (antrorse teeth) along inner margin and an antrorse spine at base; origin of first dorsal in line with gill openings; first and second pectoral rays simple; first dorsal fins elongated in both sexes.

Head length 4.00 to 4.80; pectoral fin length 4.88 to 5.64; head width 5.00 to 5.58; body depth 9.39 to 11.18; all in standard length. Eye 3.12 to 3.88; pectoral length 1.08 to 1.41; snout 2.21 to 3.12; all in head length. Eye 1.00 to 1.65 in snout.

COLOUR IN ALCOHOL: Slight variations occur from the type material described by Ogilby (1910a). Ogilby (1910a) reported that a female (?) specimen was darker in colouration whereas the background colouration in males and females is similar in my material. Slight differences do occur between the markings of males and females. In general the markings on female specimens are not as distinct as in males—the spotting on the soft dorsal and caudal is faint in females; females lack the blue spot on the membrane posterior to the 4th spine and some of the oblique crossbands are absent and others faint on the spinous dorsal.

SEXUAL DIMORPHISM: In addition to colour differences, sexual dimorphism occurs in snout length, anal papilla length and apparently in caudal fin length, all being longer in males. Both sexes have elongated spinous dorsal fins.

REMARKS: Mees (1963) reported one specimen having an anal count of 7½ and that serrations on the preopercular spines of his material ranged from 10 to 18. Ogilby (1910a) originally reported 7 to 9 antrorse spines present. Examination of one paratype revealed 9 antrorse spines. A small female specimen 45 mm in standard length had only 6 and one female 71 mm had 7 serrations and like many callionymids the number of spines along the inner margin of the preopercular spine is probably a function of size and growth. One 22 mm specimen (AM IB.326) collected by Mr G. P. Whitley from Shark's Bay, Western Australia and identified by him as *C. calcaratus* upon examination by me appears to be *C. grossi*. The preopercular spine is straight and has only 3 antrorse teeth along the inner margin. It has an elongated spinous dorsal with IV, 9½ and anal count of 8½. This specimen and the 45 mm specimen mentioned above had none of the crossbanding on the first dorsal and lack spots on the dorsal and caudal fins, the membranes being mostly clear with a few darker mottlings. The body marking of the 45 mm specimen was characteristic of the adult colour pattern. Crossbanding on the spinous dorsal was more distinct in the 71 mm specimen; a few spots occurred on soft dorsal and caudal but fin membranes still had some clear areas.

DISTRIBUTION: From north and south coastal Queensland (Dunk I., 70 miles SE. of Cairns, 13 fm; off Townsville, 11 fm; near Lucinda, 9 fm (Johnson, 1970); Gulf of Carpentaria, 16°52′S, 139°39′E; Torres Straits; Lindeman I.; Point Denison (Aust. Mus. unpublished records, Paxton, pers. comm.); 13 miles SE. of Cape Capricorn (McCulloch, 1926, type locality of *C. nasutus*.)). In Western Australia from Shark Bay, Exmouth Gulf (Mees, 1963) and the Monte Bello Islands (Palmer, 1962).

Callionymus calauropomus Richardson

(Figs. 7–12)

Callionymus calauropomus Richardson, 1844–48, p. 10, pl. 7, figs. 4, 5. Günther, 1861, p. 147; 1880, p. 28. Castelnau, 1873, p. 49. Macleay, 1881a, p. 627; 1881b, p. 262. Tenison-Woods, 1883, p. 19. Lucas, 1890 (June), p. 29. McCoy, 1890, p. 333, pl. 192. Woodward, 1902, p. 271; 1903, p. 153. Waite, 1904, p. 51; 1921, p. 142; 1923, p. 165. Stead, 1906, p. 209; Ogilby, 1910a, p. 48. McCulloch and Waite, 1918, p. 48. Glauert, 1921, p. 46. McCulloch, 1922, p. 103; 1923, p. 12; 1926, p. 209; 1927, p. 77. McCulloch and Whitley, 1925, p. 173. Whitley, 1948a, p. 27. E. O. G. Scott, 1953, p. 157. Fowler, 1959, p. 493. T. D. Scott, 1962, p. 169. Mees, 1963, p. 95.

Callionymus achates De Vis, 1883, p. 620. Macleay, 1884, p. 35.

Callyonymus calauropomus: Castelnau, 1875, p. 21.

Foetorepus achates: Whitley, 1931, p. 323.

Synchiropus calauropomus: Schultz 1960, p. 405.

MATERIAL EXAMINED: 227 specimens, 78–133 mm SL from coastal southern Queensland (8 miles N. of Cape Moreton, 40 fm; E. of Caloundra, 41–42.5 fm). One specimen from Port Jackson, N.S.W. (QM I9927).

DESCRIPTION: Dorsal IV, 8½; anal 7½; pectoral i16i, i17i, i17ii or i18ii; ventral I,5; caudal ii7iii or iii7iii; all dorsal rays divided (first sometimes simple); preopercular spine terminates in two hooks, bent upwards, no basal antrorse spine; only first ray of pectoral unbranched; origin of first dorsal nearly on line with gill openings.

Head 3.30 to 3.50; head width 3.67 to 5.35; length of pectoral fin 4.68 to 5.50; body depth 6.32 to 7.67; all in standard length. Eye 3.38 to 4.26; snout 3.48 to 5.68; pectoral fin 1.42 to 1.57; all in head length. Eye 0.60 to 1.19 in snout.

COLOUR IN ALCOHOL: Brown to grey above, white to yellow below; mottled with brown spots from eye along lateral line to caudal fin in male, lacking in female; a few spots radiate out on caudal rays; anal, pelvic, and dorsal black to dusky and pectoral pale in males; dorsal, pectoral, pelvics, caudal and anal dusky to white in females; in males the dorsal fin and pelvics mottled with dark spots with second dorsal streaked distally.

SEXUAL DIMORPHISM: Males are usually larger than females (fig. 7). The anal papilla is also longer in males. The greatest amount of sexual dimorphism appears in the median caudal filaments (fig. 8) in this species with lesser amounts occurring in the length of the last dorsal and anal rays (figs. 9, 10). Little sexual dimorphism appears in the rest of the dorsal spines or rays (figs. 11, 12). Colour differences were discussed above.

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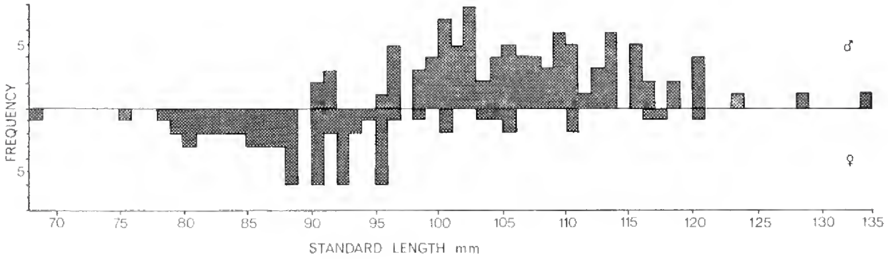
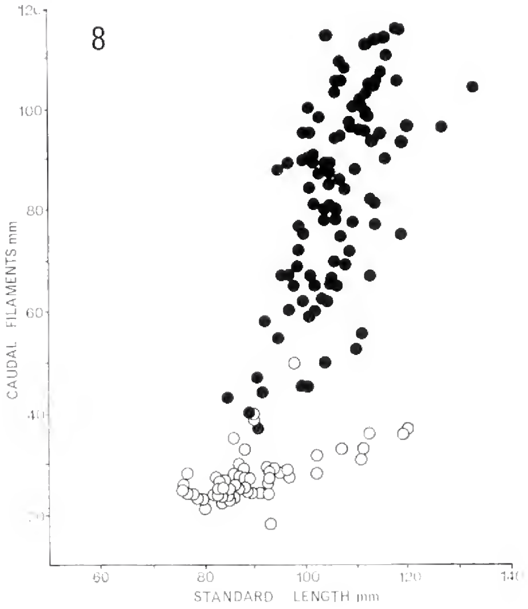
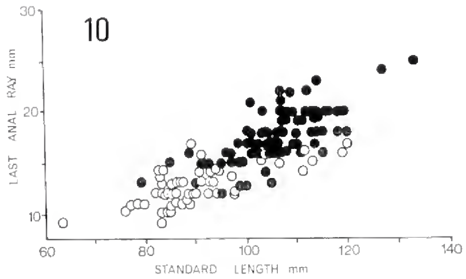
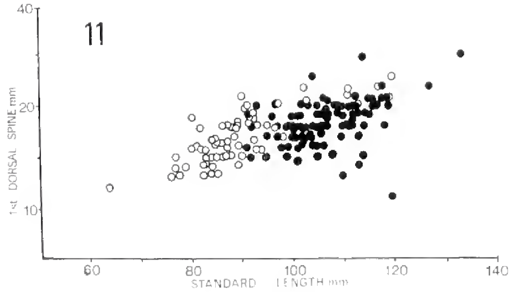
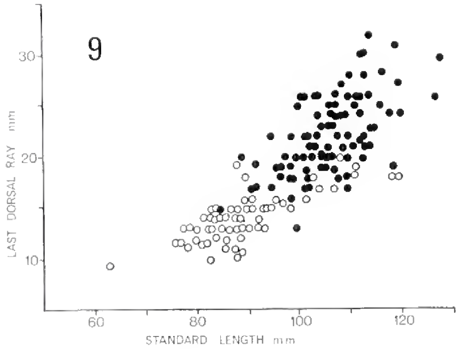


FIG. 7: Length-frequency of *Callionymus calauropomus* (males, n=97; females, n=67).









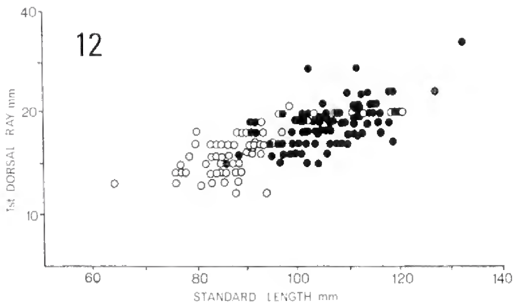


FIG. 8: Sexual dimorphism of the caudal filaments in *C. calauropomus*. Dark circles males (n=100), open circles females (n=69).

FIG. 9: Sexual dimorphism of the last dorsal ray in *C. calauropomus*. Dark circles males (n=100), open circles females (n=69).

FIG. 10: Sexual dimorphism of the last anal ray in *C. calauropomus*. Dark circles males (n=100), open circles females (n=69).

FIG. 11: Sexual dimorphism of the first dorsal spine in *C. calauropomus*. Dark circles males (n=100), open circles females (n=69).

FIG. 12: Sexual dimorphism of the first dorsal ray in *C. calauropomus*. Dark circles males (n=100), open circles females (n=69).

REMARKS: Many attempts have been made to subdivide the genus *Callionymus*, the most recent being that of Schultz *et al.* (1960) in which he placed this species under the genus *Synchiropus*. Mees (1963) attacked the validity of the genus *Synchiropus* avidly and I concur with his arguments. The genus *Synchiropus* is based on too few characters e.g. branched or simple dorsal rays (except in young) and the presence or absence of a basal antrorse spine on the preopercular spine. Schultz placed *C. rameus* in the genus *Callionymus* without comment even though it has branched dorsal rays and an antrorse spine (i.e. his generic limits break down with *C. rameus*). I have to agree with Mees (1963) that *S. calauropomus* should be restored to the genus *Callionymus*. Type material of the genus *Synchiropus* must be reexamined to determine the validity of this genus. I do not wish to comment on *Synchoripus microps* Günther or *S. splendidus* Herre, which can also be found in Australian waters, at this time.

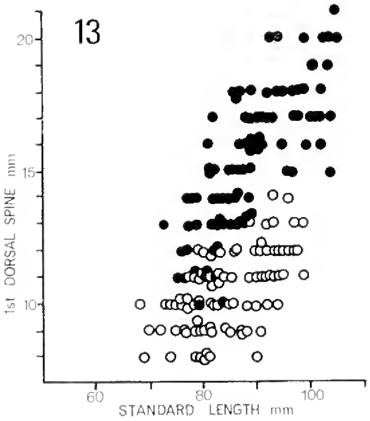
DISTRIBUTION: From coastal southern Queensland (De Vis, 1883; Macleay, 1884; McCulloch and Whitley, 1925; McCulloch, 1929; Whitley, 1931; Mees, 1963). Known from New South Wales: Port Jackson (Macleay, 1881a; McCulloch, 1922, 1923, 1927; McCulloch, 1934); Eden (Mees, 1963); New South Wales (Tenison-Woods, 1883; Waite, 1904; McCulloch, 1923, 1929; T. D. Scott, 1962; Mees, 1963). From Victoria: Bass Straits, 38 fm (Günther, 1880); E. of Flinders I., Bass Strait (McCulloch, 1926); Port Phillip (Macleay, 1881a); Victoria coast (McCulloch, 1923, 1929; T. D. Scott, 1962; Mees, 1963). From South Australia: off Marsden Point, Kangaroo I. (McCulloch, 1926); South Australia coastline (McCulloch and Waite, 1918; Waite, 1921, 1923; McCulloch, 1923, 1929; T. D. Scott, 1962; Mees, 1963). From Western Australia: Michaelmas I., King George Sound; off Limestone I., King George Sound; off Bald I., between Albany and the Archipelago of the Recherche (Mees, 1963); Doubtful Island Bay, Southwestern Australia (McCulloch, 1926); coastal western Australia (Günther, 1861; Macleay, 1881a; Woodward in Fraser, 1903; Glauert, 1921; McCulloch, 1923, 1929; Whitley, 1948a; T. D. Scott, 1962). From Tasmania: Bridgport (Mees, 1963); Tamar River, at Launceston (E. O. G. Scott, 1953); coastal Tasmania (McCulloch, 1929; T. D. Scott, 1962; Mees, 1963). Also known from New Ireland, New Guinea Region (McCulloch, 1929).

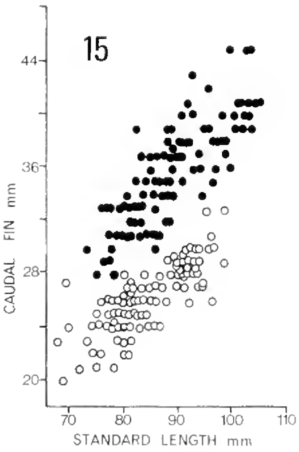
Callionymus belcheri Richardson

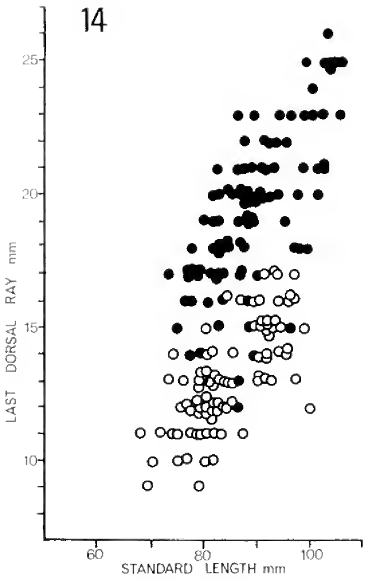
(Figs. 13–17)

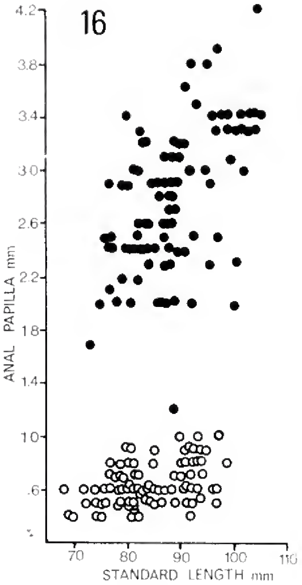
Callionymus belcheri Richardson, 1844, p. 62, pl. 37, figs. 1–2. [Not *C. belcheri* Bleeker, 1879]. McCulloch, 1926, p. 199; 1929, p. 339. Schultz, 1960, p. 403.

MATERIAL EXAMINED: 520 specimens, 34–107 mm SL, from North Queensland (Dunk I., 13 fm; off Townsville, 11 fm; off Cairns, 12 fm), coastal south Queensland (E. of Caloundra, 15 fm), and Moreton Bay (2 miles E. of Redcliffe, 2 fm; 6 miles E. of Scarborough, 7–8 fm; 1.5–2 miles E. of Bishop I., 2 5 fm; E. of Mud I., 3–7.5 fm; E. of St Helena I., 4–7 fm; 7.5 miles W. of Tangalooma, Moreton I., 5 fm; 3 miles SW. of Tangalooma, 15 fm; 4 miles N. of Shark Spit, Moreton I., 14–17 fm; 5 miles SW. of Shark Spit, 11–16 fm; W. of Shark Spit, 11–16 fm; W. of Sand Hills, Moreton I., 12–13.5 fm; Lucinda Bay, Moreton I., 6–18 fm; Brisbane River mouth, 2 fm). Three specimens, Kinikini B., New Guinea, FO969; 1 specimen, Sepik area, New Guinea, FO1386. Three specimens, Gulf of Carpentaria, 16°44′S, 139°33′E, AM I15557-220









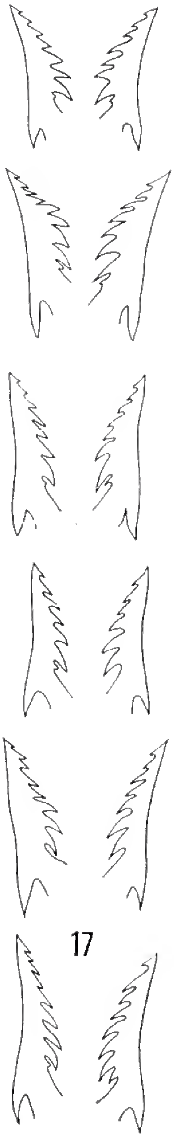


FIG. 13: Sexual dimorphism of the first dorsal spine in *C. belcheri*. Dark circles males (n=100), open circles females (n=100).

FIG. 14: Sexual dimorphism of the last dorsal ray in *C. belcheri*. Dark circles males (n=100), open circles females (n=100).

FIG. 15: Sexual dimorphism of the caudal fin in *C. belcheri*. Dark circles males (n=100), open circles females (n=100).

FIG. 16: Sexual dimorphism of the anal papilla in *C. belcheri*. Dark circles males (n=100), open circles females (n=100).

FIG. 17: Some examples of variation in right and left preopercular spines of *C. belcheri*.

DESCRIPTION: Dorsal IV, 9½; anal 9½; pectoral i14iii (mostly), i15ii, i15iii, i16ii or i16iii; ventral I,5; caudal i7ii; preopercular spine very large, with nearly straight tips directed slightly outwards, 6–7 large spines which increase in size anteriorly; head large, depressed and heart shaped; snout pointed; no membrane behind the 4th spine in spinous dorsal.

Head length 3.26 to 3.73; head width 3.04 to 3.28; length of pectoral fin 3.76 to 4.25; body depth 10.63 to 12.18; all in standard length. Eye 3.42 to 3.71; snout 2.71 to 3.25; pectoral fin length 1.13 to 1.20; all in head length. Eye 1.07 to 1.31 in snout.

COLOUR IN ALCOHOL: Yellowish brown above; chin and ventral yellowish white to white; two characteristic oval dark brown spots, one present on each side immediately below the lateral line, the first spot under tip of pectoral, the second above the 4th or 5th anal ray; first dorsal with a network of grey lines in males, dusky to black in females; 7–8 longitudinal grey lines on soft dorsal in males, these lines faint or non-existent in females; anal in male with a black submarginal stripe, anal white in female; oblique grey lines on membrane of upper caudal rays in males (faint in females) and irregular dots below, obscure brown bars on caudal rays in both sexes; pectorals and ventrals with grey to brownish dots. In prolonged preservation this species becomes very pale with few definite markings apparent; even the two characteristic spots on the sides disappear.

SEXUAL DIMORPHISM: A great deal of sexual dimorphism is apparent in this species. Both the spines and last ray of the dorsal fins are considerably larger in males (figs. 13, 14). The caudal fin is greatly lengthened in the male (fig. 15) as is the anal papilla (fig. 16). In contrast only slight sexual dimorphism occurs in the anal rays and this is most apparent in the last anal ray. Differences in colour between the sexes are discussed above.

REMARKS: McCulloch (1926) mentioned that *C. belcheri* was regarded as the young of *C. longicaudatus* Temminck and Schlegel (= *C. j. japonicus* Houttuyn) but he failed to mention that this was *C. belcheri* Bleeker 1879, a different species entirely to *C. belcheri* Richardson 1844. McCulloch did recognize that *C. belcheri* Richardson was not synonymous to *C. j. japonicus* or *C. longicaudatus*. Considerable variation is evident in the preopercular spines (fig. 17).

DISTRIBUTION: From north and south coastal Queensland, Gulf of Carpentaria, New Guinea and Pacific Ocean.

Callionymus macdonaldi Ogilby

(Fig. 18)

Callionymus macdonaldi Ogilby, 1911, p. 56. McCulloch, 1923, p. 9; 1926, p. 205; 1929, p. 338. McCulloch and Whitley, 1925, p. 175. Schultz, 1960, p. 403. Marshall, 1965, p. 382.

Material Examined: 8 specimens, 59–71 mm SL, from coastal Queensland (Townsville on beach; mouth of Moon Creek, on beach, Fraser I., 2–3 ft; Cribb I., Moreton Bay, seined 3 ft; E. of St Helena I. and Mud I., Moreton Bay, 4 ft). Twelve specimens from Queensland Museum: Townsville, on beach, I9928; Moreton Bay (holotype) I2473; Woody Pt, I8392–402. One specimen, USNM 177164.

Description: Dorsal IV, 8½ (1 specimen), 9½ (17 spec.), 10½ (2 spec.); anal 8½ (2 spec.), 9½ (16 spec.), 10½ (2 spec.); pectoral i2i13ii (1 spec.). i15ii, i16i or i17ii (usually); ventral I,5; caudal i6iii or i7ii (usually).

Measurements (mm) of holotype (96.8 mm in SL) are as follows: Head length 25.3, greatest body depth 11.4, least depth of caudal peduncle 4.5, snout 7.1, bony interorbital 1.0, eye 6.7, postorbital length of head 9.8, length of cuadal peduncle 12.9, snout tip to origin of first dorsal 32.6, snout tip to anal origin 55.3, length of first dorsal spine 9.3, longest soft dorsal ray 14.7, longest pectoral ray 22.8, longest pelvic ray 24.4, longest caudal fin ray 26.7, tip of snout to rear edge of maxillary 8.2, length of preopercular spine 7.6. Additional measurements are given in table 2.

TABLE 2

Measurements in Percent of Standard Length (SL) or Head Length (*) of the Holotype and other Specimens Of *C. macdonaldi* Ogilby

Sex Cat. No.	♀ QM I2473 (holotype)	♂ QM I8402	♀ QM I8400	♀ QM I8401	♀ QM I8399	♂ QM I8393	♂ personal collection not registered	♀	♀
SL (mm)	96.8	62.7	66.6	59.4	63.9	54.6	71.7	71.1	69.5
Head length	26.2	31.0	28.2	29.8	28.9	25.9	28.8	29.0	29.9
Greatest body depth ..	11.8	12.0	11.9	12.9	13.7	10.8	13.4	13.8	13.4
Least depth of caudal peduncle	4.7	6.2	5.1	5.4	5.6	5.0	5.2	5.8	5.8
Snout*	28.1	31.4	25.7	28.8	28.0	24.1	24.3	23.3	26.0
Bony interorbital*	3.9	3.9	4.3	4.5	3.3	4.3	4.4	4.9	3.8
Eye*	26.4	24.2	25.2	26.6	22.0	31.1	27.2	29.1	25.0
Postorbital length of head ..	10.1	13.1	11.6	12.5	12.4	11.0	11.6	11.8	12.2
Length of caudal peduncle ..	13.4	14.4	14.6	12.5	14.1	12.8	14.5	14.2	13.8
Snout tip to origin of first dorsal	33.6	36.5	35.2	39.8	38.6	34.4	35.4	37.8	37.2
Snout tip to anal origin ..	57.2	58.4	51.1	57.4	57.8	53.4	55.8	57.8	56.6
Length of first dorsal spine*	36.8	41.2	34.2	20.9	28.0	37.6	34.5	31.6	26.4
Longest soft dorsal ray ..	15.2	18.5	14.9	13.3	15.9	18.3	16.5	14.2	14.7
Longest pectoral ray ..	23.6	24.6	26.0	26.1	24.5	24.2	24.1	26.6	25.6
Longest pelvic ray	25.2	26.2	25.4	24.4	20.7	25.3	24.3	23.9	23.5
Longest caudal fin ray ..	27.6	25.6	25.8	24.4	26.7	22.9	27.5	26.1	27.3
Tip of snout to rear edge of maxillary*	32.4	27.8	28.9	22.6	27.5	25.5	26.7	23.3	27.9
Length of preopercular spine*	30.1	28.9	28.9	31.6	28.6	36.9	30.1	31.5	28.4

Body depressed, greatest depth near origin of first dorsal; broader than deep, tapering posteriorly. Head large, depressed, greatest depth slightly less than width at base of preopercular spine; eyes close together, directed upward, interorbital space narrow, 5.9 to 7.4 in eye. Snout rounded, mouth small, jaws unequal, maxillary reaching back to below nostril; dentition villiform, in wide bands with approximately 8 to 12 rows of teeth in both jaws. Head rugose dorsally, bony ridges radiating from raised crests; shallow pits, mostly circular, profuse along bony crests the longest of which are on each side of the occiput. Gill openings on upper surface, midway between origin of spinous dorsal and posterior edge of orbits; space between gill openings less than space between outer margin of orbits. Preopercular spine with recurved tip slightly curved upward distally, with 5 large teeth (2nd and 3rd largest) along the inner margin ending in a recurved tip and with a basal antrorse spine.

Width of caudal peduncle greater than its depth at midlength; lateral line curved downward from head over pectoral fin, raised slightly at end of pectoral and extending posteriad slightly above midline of body to caudal base. Anal papilla present and shows sexual dimorphism. Ogilby (1911) and McCulloch (1926) both stated that the anal papilla was absent in this species; one is present, although small, on the holotype.

Spinous dorsal inserted approximately midway between 2nd dorsal insertion and posterior margin of orbit, short, not reaching second dorsal when depressed, 3rd spine slightly longer than rest. Last ray of second dorsal produced reaching hypural joint; all rays of dorsal simple except last which is branched at base. Anal lower than soft dorsal, all rays simple except last which is branched at base; last anal ray produced, reaching hypural; anal origin on vertical line between 3rd and 4th soft dorsal rays. First pectoral ray simple; upper margin of pectoral incised, median rays longest reaching to about the 4th soft dorsal ray. Ventral rays coarsely branched with 5th longest, reaching vent; broad membrane connects 5th ventral ray to base of pectoral; caudal rounded in both sexes.

COLOUR IN ALCOHOL: Background colouration highly variable, specimens collected from beach sands almost colourless to light grey to greyish white; from muddy environments darker in colour, grey to light brown; dorsal surface closely covered with white, irregularly

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FIG. 18: Some examples of variation in right and left preopercular spines of *C. macdonaldi*.

shaped spots surrounded by an intricate pattern of fine brown lines; a few larger light to dark brown spots present; ventral surface white to yellowish; first dorsal of male grey, dark distally, white basally, in female black with anterior spines white to grey; second dorsal white to grey interspersed with dark spots, dusky posteriad; anal in males with rays white and membrane dusky, in females entire anal white; ventral fins irregularly spotted with a few faint to distinct brown bands present depending upon habitat occupied by specimen (e.g. sand, faint; mud, distinct bands); caudal white to grey with 4–6 irregularly dusky vertical bars.

SEXUAL DIMORPHISM: In addition to colour differences, the only marked sexual dimorphism is that of the anal papilla length. Anal papilla length measured in males 41 to 71 mm ranged from 0.76 to 2.32 mm (mean 1.36 mm) (n = 9) while in females from 38 to 96 mm this ranged from 0.24 to 0.84 mm (mean 0.50) (n = 9). Slight sexual dimorphism may occur in the length of the first dorsal spine and that of the longest soft dorsal, but not enough specimens have been available for examination to accurately determine this.

REMARKS: This species has been redescribed here to correct omissions and incorrect information given in the original description.

McCulloch (1926) stated that this species was closest to *C. calcaratus*. In my estimation *C. macdonaldi* is closest to *C. marleyi* Regan from which it differs in caudal ray counts and colouration (but colouration can be highly variable in both of these species). Specimens of *C. marleyi* examined by Smith (1963) appeared to show less variation in dorsal and anal counts than does *C. macdonaldi*, *C. marleyi* has 8½ anal rays while *C. macdonaldi* can have from 8½ to 10½ (usually 9½). Most specimens of *C. marleyi* have soft dorsal counts of 9½, but one specimen from Mozambique had 10½ (Smith, 1963). The preopercular spines are very similar in both species; *C. macdonaldi* has 3 to 5 teeth along the inner margin depending upon the size of the fish and counts can vary on two sides (fig. 18) while *C. marleyi* can have 3 to 6 teeth and only 6 in large adults (the recurved tip has been counted along with the teeth on the inner margin in Smith's description) and the counts can vary on both sides. I have not counted the recurved tip in my description, but if I did *C. macdonaldi* would also have 6 teeth in large adults.

DISTRIBUTION: From coastal Queensland and New South Wales (McCulloch, 1929; Marshall, 1965).

Callionymus calcaratus Macleay

(Figs. 19–22)

Callionymus calcaratus Macleay, 1881a, p. 628; 1881b, p. 263; Tenison-Woods, 1883, p. 19. Ogilby, 1885, p. 121. McCulloch, 1922, p. 103; 1923, p. 10, pl. 3, fig. 2; 1926, p. 204; 1927, p. 77; 1929, p. 338; 1934, p. 77. T. D. Scott, 1962, p. 168. Mees, 1963, p. 96. Schultz, 1960, p. 403. Marshall, 1965, p. 381.

Callionymus ocelligena McCulloch, 1926, p. 207; 1929, p. 339. Schultz, 1960, p. 403. Johnson, 1969, p. 208.

Callionymus curvicornis: Ogilby, 1886, p. 37. Stead, 1901, p. 476. Waite, 1904, p. 51. Stead, 1906, p. 208.

Callionymus reevesi: Ramsay and Ogilby, 1886, (1887?), p. 942. Waite, 1904, p. 51.

Repomucenus calcaratus: Whitley, 1931, p. 323; 1948a, p. 27; 1948b, p. 275.

Repomucenus sp. nov.: Whitley, 1945, p. 42.

MATERIAL EXAMINED: 561 specimens, 104–165 mm SL, from coastal Queensland (S. of Double Island Point, 22–8 fm; 6–10 miles N. of Noosa, 20 fm; 10 miles N. of Noosa, 21–2 fm; E. of Mooloolaba, 19–19.5 fm; SE. of Mooloolaba, 19–23 fm; Mooloolaba to Caloundra, 19–22.5 fm; E. of Caloundra, 18 fm; 8 miles N. of Cape Moreton, Moreton I., 40 fm; E. of Cape Moreton, 55–9 fm; off Lucinda Bay, Moreton I., 18 fm; 6 miles E. of Scarborough, 8–9 fm) New South Wales (Tweed Heads (CSIRO collection, Cronulla); Wallis Lake; Princess Royal Harbour (Aust. Mus. records); Twofold Bay (Cronulla collection)). Six specimens, Queensland Museum, I4739 (Wide Bay), I4740 (Port Jackson), I2129 (Moreton Bay), I2140 (Moreton Bay), I3427 (southern Queensland), I9263 (Gneering Shoal). Four specimens, Australian Museum IB.358, IA.7858, I7239 (2 spec.), IA.4189.

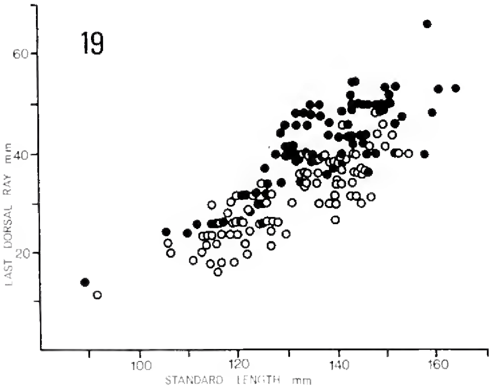
DESCRIPTION: Dorsal IV, 9½; anal 9½; pectoral ii16ii, i17i, i17ii, i17iii, i18i or i18ii (usually i17ii or i17iii); ventral I,5; caudal ii7ii or ii7iii; preopercular spine broad with 3 or 4 teeth besides recurved tip and basal antrorse spine; only last dorsal ray divided; first dorsal origin well behind gill openings; usually only first pectoral ray simple, sometimes first two are simple in juveniles; first dorsal short, with a large, incomplete dark ring between 3rd and 4th spine (not always present) in males and a black blotch against a white background in females; conspicuous grey ocelli with yellow margins between mouth and preopercular spine, preorbital region and operculum in males.

Head 3.44 to 3.78; head width 3.88 to 4.74; length of pectoral fin 4.04 to 4.56; body depth 8.34 to 11.19; all in standard length. Eye 3.64 to 4.12; snout 3.14 to 4.34; pectoral fin length 1.07 to 1.30; all in head length. Eye 0.92 to 1.24 in snout.

COLOUR IN ALCOHOL: Will be discussed under the remarks section.

SEXUAL DIMORPHISM: Generally males are slightly larger than females but this is not nearly as marked in such species as *C. sublaevis* or *C. calauropomus*. The second dorsal fin shows marked sexual dimorphism with the rays being longer in males (fig. 19). The first dorsal spine (fig. 20), the caudal rays (fig. 21), and the last anal ray are longer in males. The anal papilla is much longer in males than in females. Marked differences occur in the colour markings between sexes and will be discussed in the following section.

REMARKS: In my examination of the species of dragonets from Queensland it became apparent that *C. calcaratus* Macleay and *C. ocelligena* McCulloch were strikingly similar in counts, measurements and appearance except for colour markings. *C. ocelligena* was described from a single male specimen in which the collection data had been lost (McCulloch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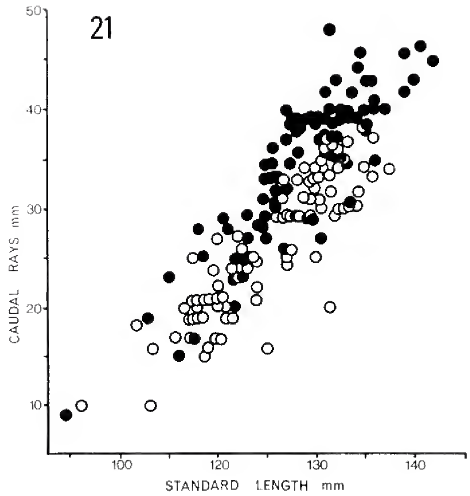
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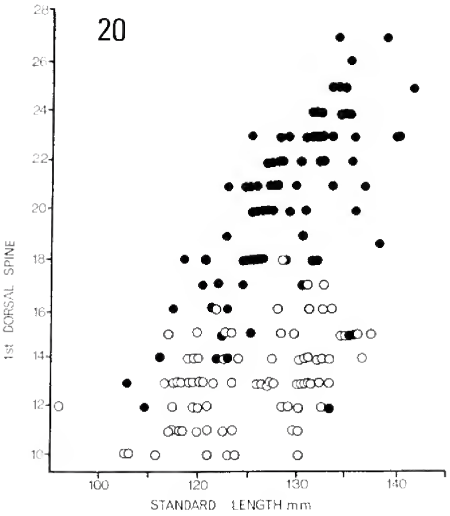
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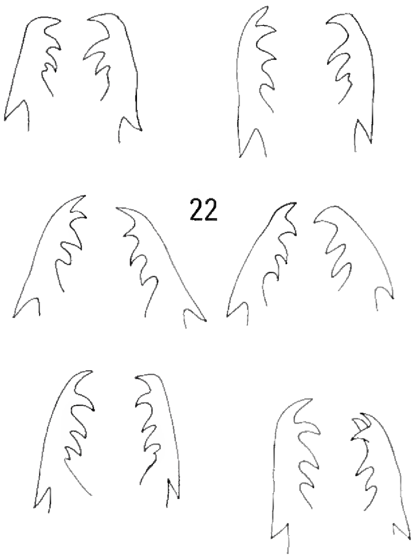
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FIG. 19: Sexual dimorphism of the last dorsal ray in *C. calcaratus*. Dark circles males (n=90), open circles females (n=95).

FIG. 20: Sexual dimorphism of the first dorsal spine in *C. calcaratus*. Dark circles males (n=90), open circles females (n=95).

FIG. 21: Sexual dimorphism of the caudal rays in *C. calcaratus*. Dark circles males (n=90), open circles females (n=95).

FIG. 22: Examples of variation in right and left preopercular spines of *C. calcaratus*.

1926). The type specimen was deposited in the Australian Museum (McCulloch, 1929) but has since disappeared. McCulloch (1926) stated that *C. calcaratus* had the closest affinity to *C. ocelligena* and that *C. ocelligena* was readily distinguishable from *C. calcaratus* by its colour markings (large brown ocelli between mouth and preopercular spine, preorbital region and operculum; large black, white-edged spot on the operculum beneath the preopercular spine), longer caudal fin and having the first dorsal spine longer than the second. All these features are ones that can be affected by sexual dimorphism in this group.

So far over 500 specimens of *C. calcaratus* and *C. ocelligena* have been collected and examined along the Queensland coast. In all cases these two species were found to co-occur and all the *C. calcaratus* collected have been females while all the *C. ocelligena* collected have been males. The brain pattern is identical in both whereas great variability occurs at the interspecific level within the genus *Callionymus* thus examined (Johnson, 1971). Gonadal development and other aspects of their biology coincide. Material from the Queensland Museum showed all *C. calcaratus* to be females and *C. ocelligena* (only one specimen) to be male. Fin ray counts for 16 females (*C. calcaratus*) were D IV, 9½; anal 9½; pectoral ii16ii, i17i, i17ii, i17iii, i18i or i18ii; ventral I,5; caudal ii7ii or ii7iii. Counts for 17 males (*C. ocelligena*) were identical except for less variation in pectoral counts (i17ii, i17iii or i18ii).

From all the material at hand it appears that *C. ocelligena* and *C. calcaratus* are synonymous and that *C. ocelligena* is the male and *C. calcaratus* is the female of the same species, the name of which should be *C. calcaratus*.

The colour of the female *C. calcaratus* fits that described by McCulloch (1923). The colour of the male *C. calcaratus* (*C. ocelligena*) preserved in alcohol from Queensland is as follows: Background colouration yellowish brown, dorsal surface covered with indistinct small grey and orange spots with dark margins; ventral surface white; conspicuous grey ocelli with yellow margins between mouth and preopercular spine, preorbital region and operculum; along the sides of the body are dark blotches below the lateral line (not present in some specimens); bluish grey to black, white-edged spot on operculum beneath preopercular spine; first dorsal with a large, incomplete dark ring between 3rd and 4th spine (not present in some specimens), but instead fin mottled with dark brown and yellow spots similar to those on back; second dorsal mottled with dark brown and yellow spots with yellow margins; anal fin bluish grey to grey; caudal fin with irregular yellow and dark brown dots with yellow margins, with or without a grey stripe on lower rays.

The preopercular spine is highly variable in this species (fig. 22). The counts may vary on two sides and the number of spines appears to be a function of growth. A 20 mm specimen, doubtfully referred to this species, had 3 teeth with the third just forming, and one 33 mm specimen had only 2 teeth along the inner margin. This 33 mm specimen also had some interesting variation in fin counts with the dorsal IV, 8½, and anal 7½. Not much variation is encountered in the counts on adults.

DISTRIBUTION: Known from coastal Queensland (mouth of Wide Bay (McCulloch, 1926); Port Douglas, near mouth of Mary River; South Head, Mary River; Tangalooma Point, Moreton Bay; off Point Lookout, Stradbroke I. (Australian Museum records, from Mees, 1963)), New South Wales (northern New South Wales (McCulloch, 1926); apparently not uncommon at Port Jackson (type locality) (Stead, 1906)), South Australia (Port Lincoln and off York Peninsula (Mees, 1963)), and Western Australia (Cape Jaubert; Wallal, 5 miles offshore, 5 fm; Hampton Harbour; Dampier Archipelago; Exmouth Gulf; Houtman's Abrolhos; Fremantle; Useless Inlet and off Kok's I., Shark Bay (Mees, 1963; Whitley, 1948a; McCulloch, 1926)).

Callionymus limiceps Ogilby

Callionymus limiceps Ogilby, 1908, p. 35. McCulloch, 1923, p. 9; 1926, p. 203; 1929, p. 340. McCulloch and Whitley, 1925, p. 173. Whitley, 1929, p. 115, figs. 3, 4. Schultz, 1960, p. 403. Mees, 1963, p. 98 (*C. limiceps* mentioned; but only *C. l. sublaevis* (*C. sublaevis*) known in Western Australia). Marshall, 1965, p. 380–1.

Callionymus limiceps var. *typica* McCulloch, 1926, pp. 195, 203.

Velesionymus limiceps: Whitley, 1934, suppl. no. 418a.

MATERIAL EXAMINED: 162 specimens, 86–159 mm SL, coastal Queensland (10 miles N. of Noosa, 21–2 fm; E. of Mooloolaba, 19–22.5 fm; between Caloundra and Mooloolaba, 19–19.5 fm; E. of Caloundra, 18 fm), Moreton Bay (3 miles SW. of Tangalooma, Moreton I., 14.5–18 fm; off Shark Spit, Moreton I., 15 fm; W. of Sand Hills, Moreton I., 10–13 fm; W. of Lucinda Bay, Moreton I., 16–18 fm; 1 mile N. of Cowan Cowan, Moreton I., 2 fm; off Mud I., 5 fm; 1 mile E. of SE. corner of St Helena I., 5 fm). Fifteen specimens, Queensland Museum (I4038; I487, 3 spec.; I9492–9; I3340–1; I3360).

DESCRIPTION: Dorsal IV, $9\frac{1}{2}$; anal $9\frac{1}{2}$; pectoral i16i, i16ii, i16iii, i17i or i17ii; ventral I,5; caudal i7ii or ii7ii; preopercular spine with a recurved tip and one antrorse tooth on inner margin and an antrorse spine near the base; only first pectoral ray simple; males with elongated first dorsal rays and a small black spot covering almost the entire fin; occiput and supraorbital ridges rugose.

Head length 3.87 to 4.19; pectoral fin length 4.71 to 5.60; head width 3.77 to 4.08; body depth 10.44 to 11.30; all in standard length. Eye 3.80 to 4.22; snout 2.24 to 2.82; pectoral fin length 1.19 to 1.41; all in length of head. Eye 1.41 to 1.70 in snout.

COLOUR IN ALCOHOL: Consistent with the descriptions by Ogilby (1908) and McCulloch (1923).

SEXUAL DIMORPHISM: Great sexual dimorphism occurs in the length of the first dorsal spines and anal papilla. Minor size differences between sexes are also apparent. Minor colour differences occur as in the markings on the first dorsal fins and anal rays.

DISTRIBUTION: Coastal Queensland, previously from between Hervey Bay and Port Denison, 13–26 fm (McCulloch, 1923).

Callionymus sublaevis McCulloch

(Figs. 23–6)

Callionymus limiceps var. *sublaevis* McCulloch, 1926, p. 204; 1929, p. 340. Mees, 1963, p. 98. Johnson, 1970, p. 294.

MATERIAL EXAMINED: 1322 specimens, 51–134 mm SL, coastal Queensland (6 miles E. of Mackay, 13 fm; E. of Caloundra, 15 fm) and Moreton Bay (1.5–2 miles E. of Bishop I., 2.5–3 fm; W. of Green Island, 2–6 fm; between St Helena I. and Green I., 4–4.5 fm; ½ to 1 mile E. of St Helena I., 5–6 fm; 2.5 miles E. of Mud I., 5–10 fm; ¼ mile E. of Mud I., 5–7.5 fm; 2 miles E. of Redcliffe, 2 fm; 6 miles E. of Scarborough, 8–9 fm; W. of Sand Hills, Moreton I., 7–17 fm; 3 miles SW. of Tangalooma, Moreton I., 14.5–18 fm; 4 miles N. of Shark Spit, Moreton I., 14–17 fm; 5 miles SW. of Shark Spit, 11–16 fm; W. of Shark Spit, 11–16 fm; W. of Lucinda Bay, Moreton I., 7–18 fm). Six specimens, Australian Museum, I15557-218, Gulf of Carpentaria, 16°37′S, 140°43′E.

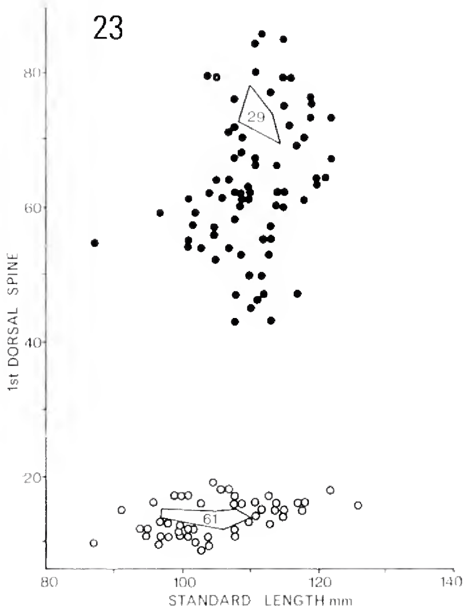
DESCRIPTION: Dorsal IV, 9½; anal 9½; pectoral i16ii, i16iii or i17i (usually i17i); ventral I,5; caudal ii6ii, ii7ii or ii7iii (usually ii7iii); similar to *C. limiceps* in most aspects except in minor colour differences, smaller size and having the occiput and supraorbital ridges almost entirely smooth and covered by skin; preopercular spine with 1 to 2 teeth along inner margin besides recurved tip, basal antrorse spine present.

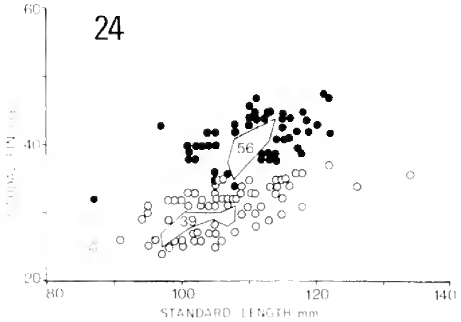
Head 3.60 to 3.92; head width 3.48 to 4.40; length of pectoral fin 4.62 to 4.81; body depth 9.80 to 11.36; all in standard length. Eye 3.66 to 4.14; snout 2.89 to 3.11; pectoral fin 1.19 to 1.32; all in head length. Eye 1.20 to 1.43 in snout.

COLOUR IN ALCOHOL: Brown above, mottled with white spots; first dorsal in male dusky and lacks the black spot between 2nd and 4th spine as in *C. limiceps*; first dorsal in female black; filamentous spines with grey annuli; second dorsal with grey and white streaks; caudal with many white spots between rays; anal fin in male with broad dusky to black margin, narrow in female; ventrals black in male, dusky in females; pectorals pale; 5–6 brown spots along side of body with brown lines vertically in interspaces. In males 74 mm and smaller, the ventral fins and anal fins are similar to female. In a 92 mm male, the ventral fins are partially black and edged with white.

SEXUAL DIMORPHISM: Differences occur in body size with females usually being smaller. The first dorsal spines are greatly elongated in males (fig. 23). Fig. 24 shows the differences in length of the caudal fin rays between sexes. Anal papilla length is greater in males (fig. 25). Colour differences are discussed above.

REMARKS: McCulloch (1926) regarded *C. l. sublaevis* as an exceptional variation of *C. limiceps*. Mees (1963) did not believe *C. limiceps* and *C. l. sublaevis* to be different species or subspecies as they were reported to co-occur along the Queensland coast. I believe them to be distinct at the specific level. Although they do co-occur, it is the exception rather than





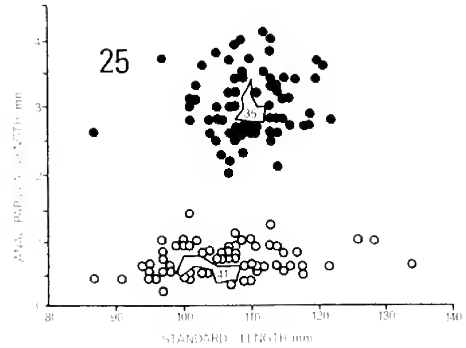


FIG. 23: Sexual dimorphism of the first dorsal spine in *C. sublaevis*. Dark circles males (n=100), open circles females (n=100).

FIG. 24: Sexual dimorphism of the caudal fin in *C. sublaevis*. Dark circles males (n=100), open circles females (n=100).

FIG. 25: Sexual dimorphism of the anal papilla in *C. sublaevis*. Dark circles males (n=100), open circles females (n=100).

FIG. 26: Examples of variation in right and left preopercular spines of *C. sublaevis*

the rule. I have found *C. limiceps* usually outside Moreton Bay at depths from 18 to 22 fm while *C. sublaevis* is most common inside Moreton Bay at depths from 2 to 18 fm. Usually distinct populations exist in either *C. sublaevis* or *C. limiceps*. No more than two *C. limiceps* have ever been encountered in any trawl with *C. sublaevis* in Moreton Bay and no *C. sublaevis* has ever been taken by me with *C. limiceps* in the hundred of trawls made outside the bay. Both are biologically distinct and juveniles can be found in both. The brain patterns are distinctly different in *C. limiceps* and *C. sublaevis* (Johnson, 1971).

Much variation exists in the shape of preopercular spines and counts can vary on two sides (fig. 26).

DISTRIBUTION: 13 miles SE. of Cape Capricorn, 13 fm; 7–10 miles NW. of Hummocky I., near Cape Capricorn, 14–16 fm (holotype) (McCulloch, 1926). Coastal Queensland from off Townsville, 11 fm, south to Moreton Bay (Johnson, 1970). In Western Australia from Dampier Archipelago, Exmouth Gulf and Shark Bay (Mees, 1963).

Callionymus goodladi Whitley

Calliurichthys goodladi Whitley, 1944, p. 270; 1948a, p. 27.

Callionymus goodladi: Mees, 1963, p. 97.

MATERIAL EXAMINED: 7 specimens, 110–160 mm SL, Western Australian Museum (P4369, 4 specimens; P5037; P4540; P5442).

DESCRIPTION: Dorsal IV, $8\frac{1}{2}$; anal $7\frac{1}{2}$; pectoral ii15ii, ii15iii or ii16i; ventral I,5; caudal ii7ii or ii7iii; preopercular spine straight with 8 to 12 small serrations along inner margin and a large antrorse spine at base; snout large and prominent; origin of first dorsal nearly on line with gill openings; first and second pectoral rays simple.

Head length 3.07 to 3.54; head width 3.84 to 4.12; length of pectoral fin 4.55 to 5.12; body depth 8.78 to 10.00; all in standard length. Eye 4.42 to 5.71; snout 2.16 to 2.57; pectoral fin length 1.29 to 1.56; all in head length. Eye 1.77 to 2.42 in snout.

COLOUR IN ALCOHOL: As described by Whitley (1944) except that in some specimens the head is brownish grey above and the chin and brachiostegals are white or brown with a bluish tinge.

SEXUAL DIMORPHISM: Pronounced sexual dimorphism is not apparent in this species although some differences in fin length may exist.

DISTRIBUTION: Known only from Western Australia, from Cheyne Beach and near Michaelmas I., King George Sound, Cockburn Sound, Shark Bay (entrance to South Passage, exact locality not known) and Exmouth Gulf (Mees, 1963).

Callionymus calliste Jordan and Fowler

Callionymus calliste Jordan and Fowler, 1903, p. 957. Marshall, 1965, p. 380.

Callionymus hudsoni Fowler, 1941, p. 8.

Callionymus distethommatus Fowler, 1941, p. 18.

MATERIAL EXAMINED: Two specimens, 29 and 31 mm SL, Australian Museum, IA.4463, IA.4630 Low Isles, Queensland.

DESCRIPTION: Dorsal IV, 8½; anal 7½; pectoral i13ii or i13iii; ventral I,5; caudal ii7ii or ii7iii; preopercular spine with 3 hooks along upper margin and a short basal antrorse spine; lateral line simple and not connected by a branch on top of caudal peduncle; gill openings approximately midway between origin of first dorsal fin and posterior edge of eyes.

Head length 3.44 to 3.62; length of pectoral 3.20 to 3.62; head width 3.64 to 4.14; depth of body 6.34 to 7.25; all in standard length. Eye 2.67 to 2.90; pectoral length 0.93 to 1.00; snout 3.81 to 4.10; all in length of head. Eye 0.70 to 0.71 in snout.

COLOUR IN ALCOHOL: Follows the description of Schultz *et al.* (1960).

DISTRIBUTION: Within Australia, known only from Low Isles, Queensland.

Callionymus rameus McCulloch

Callionymus, Calliurichthys rameus [*sic*] McCulloch, 1926, p. 201.

Callionymus rameus: McCulloch, 1929, p. 339. Schultz, 1960, p. 403. Mees, 1963, p. 99, Marshall, 1965, p. 381.

Orbonymus rameus: Whitley, 1947, p. 150.

Callionymus (*Calliurichthys*) *rameus*: Mees, 1959, p. 9; Palmer, 1962, p. 548.

MATERIAL EXAMINED: 30 specimens, 84–135 mm SL, southern Queensland (20 miles SE. of Double Island Point, 32–3 fm; 10 miles N. of Noosa, 21–2 fm; 6–10 miles N. of Noosa, 20 fm; off Caloundra, 19–19.5 fm; E. of Noosa, 41–46.5 fm. Two specimens, Queensland Museum, I4012 (paratype, SE. of Cape Capricorn, I3339 (S. coast of Queensland). One specimen, Australian Museum, I15557-286 (Gulf of Carpentaria 16°30′S, 140°43′E).

DESCRIPTION: Dorsal IV, 8½; anal 7½; pectoral i15ii, i16ii, i16iii, i17ii, or i17iii; ventral I,5; caudal i7ii or ii7ii; all dorsal rays divided, first ray sometimes simple; preopercular spine with 6 to 11 serrations along inner margin, antrorse spine on base; snout slightly shorter than eye; origin of first dorsal on a line with gill openings.

Head length 4.04 to 5.10; length of pectoral fin 3.38 to 4.21; head width 4.09 to 4.62; depth of body 5.79 to 7.00; all in standard length. Eye 2.24 to 3.34; pectoral length 0.84 to 1.00; snout 3.06 to 4.28; all in head length. Eye 0.59 to 0.94 in snout.

COLOUR IN ALCOHOL: Slight variations were noted from the description by McCulloch (1926); the 5 to 6 crossbands on the dorsal surface are quite distinct in some specimens, the irregular bars and spots on ventral rays are absent or very faint, and the darker part of the anal fin has a number of darker spots and bars in most specimens.

LIFE COLOURATION: The life colouration of this species is described for the first time, based upon fresh specimens from the Mackay area.

In males the background colouration is light grey dorsally, white ventrally with red blotches and streaks along sides; yellow reticulated pattern edged in red on chin and branchiostegals; head with red blotch between eye and maxillary, 2 faint red bars on operculum, 2 red blotches on lower jaw, upper jaw pink; dorsal surface with 5 to 6 dark brown to grey bars edged with red and mottled with small blue spots; membranes of first dorsal fin dark yellow or grey with vertical yellow bars with white spots and streaks edged with black, spots basal, streaks distal; second dorsal light grey with horizontal yellow and white streaks on posterior half, a few white spots along basal edge of fin and brown to grey blotches dispersed throughout fin. Caudal fin with 2 wide, vertical, dark grey bars, distinct dorsally, faint ventrally, merging into a black blotch on basal 3 rays, several blue streaks on black blotch, caudal membrane with yellow between horizontal white streaks, rays pink becoming more distinct anteriorly; anal fin black distally, yellowish grey basally with blue horizontal broken streaks edged with black; pectoral fin with membrane clear, rays with minute white and red spots; ventral fin light grey with 2 darker grey wide patches distally and basally across rays, irregular white spots or yellow background basally, red blotches on rays.

In females the background is lighter, ventral surface with a wide indistinct pink patch beginning at 2nd anal ray extending to 6th anal ray; head as in males, reticulated pattern on chin and branchiostegals red instead of yellow; first dorsal fin darker with less yellow, bars with white spots, no streaks; second dorsal with white streaks posteriorly, no yellow streaks; caudal fin whitish yellow, vertical black bars more distinct and fuse into basal black blotch with several blue spots, white horizontal broken streaks present, fin pinker basally; anal fin with blue spots instead of streaks; pectoral and ventral fins as in males.

SEXUAL DIMORPHISM: Besides the colour differences discussed above, the first dorsal fin, caudal fin and anal papilla are longer in males.

DISTRIBUTION: Previously from Queensland (Gulf of Carpentaria (Australian Museum record); 6 miles E. of Mackay, 13 fm; SE. of Cape Capricorn, 13 fm (type locality); 25 miles SE. of Double Island Point, 33 fm; 4–20 miles NE. of Gloucester Head, 19–35 fm (McCulloch, 1926)), Western Australia (Shark Bay (exact location not known); 40 miles S. of Carnarvon (Mees, 1963), and off the Monte Bello Islands (Palmer, 1962)).

Callionymus papilio Günther

Callionymus papilio Günther, 1864, p. 197. Lucas, 1890, p. 29. Waite, 1904, p. 51. McCulloch, 1922, p. 103; 1923, p. 13; 1927, p. 77; 1929, p. 338; 1934, p. 77. Lord, 1923, p. 69; 1927, p. 87. Lord and H. H. Scott, 1924, pp. 12, 78. E. O. G. Scott, 1953, p. 157. T. D. Scott, 1962, p. 168. Mees, 1963, p. 98.

Callionymus ocellifer Castelnau, 1873, p. 49.

Callionymus lateralis Macleay, 1881a, p. 628; 1881b, p. 263. Johnston, 1891, p. 33.

Callionymus macleayi Ogilby, 1886, p. 37—*nomen novum* for *Callionymus lateralis* Macleay, *nec Callionymus lateralis* Richardson.

Callionymus Papilio: Macleay, 1881a, p. 627; 1881b, p. 262.

Callionymus latealis: Tenison-Woods, 1883, p. 19.

Foetorepus papilio: Whitley, 1931, p. 323; 1945, p. 42; 1948a, p. 27.

MATERIAL EXAMINED: 2 specimens, South Australian Museum, F3129, Cape Elizabeth, York Peninsula, South Australia. Four specimens, Australian Museum, I15731-007, B9753, I5004, Point Peron, 30 miles S. of Perth, 32°16′S, 115°40′E.

DESCRIPTION: Dorsal IV, 7½; anal 6½; pectoral i12iiii, i13ii, i15iii or i15iiii; ventral I,5; caudal i7ii, i7iii or ii7ii; all dorsal rays divided at tips except first; preopercular spine resembles that described for *C. calauropomus* with one single curved hook besides tip which is curved upward and no basal antrorse spine present; a small species.

Head length 3.41 to 4.00; length of pectoral fin 4.10 to 4.66; head width 3.66 to 4.31; body depth 5.70 to 7.00; all in standard length. Eye 3.00 to 3.86; pectoral length 1.20 to 1.31; snout 3.08 to 4.24. Eye 0.91 to 1.08 in snout.

COLOUR IN ALCOHOL: Background colouration light brown to dark grey with lighter blotches dorsally, these blotches arranged symmetrically and similar in males and females; ventral surface silvery anteriorly becoming brownish posteriorly with silvery white spots on branchiostegals and chin; head same as body with a distinct white patch below eye in both sexes; males with thin white vertical lines and a few faint white spots on sides of body below lateral line, thin vertical lines absent in females and replaced by numerous white spots below lateral line; first dorsal with black spot on distal portion of membrane between 1st and 2nd spine (also present in juveniles), spines black at tips in adults, 3 irregular horizontal bands of thin white stripes, markings not as distinct in females. Second dorsal in males with 3 horizontal bands of thin white stripes, edged in black on a brown background, in females, membranes clear and mottled with faint white and brown blotches (juveniles lack the black edges of horizontal white bands); pectoral fin clear in both sexes; anal fin in males brown with distal black stripe, clear in females; caudal fin with upper rays clear and lower rays with white and brown spots on membranes, caudal rays in females entirely mottled with white and brown and membranes clear; ventral fin mottled with brown and white blotches, clear in juveniles.

SEXUAL DIMORPHISM: Besides the colour differences noted above, the only difference apparent is that males have slightly longer dorsal spines.

REMARKS: According to McCulloch (1923) this species can have 8½ dorsal rays, but all the material I examined had 7½.

DISTRIBUTION: Known from Port Jackson, New South Wales, southward to Victoria (McCulloch, 1923); from Tasmania (Lord, 1923; McCulloch, 1923, 1929; E. O. G. Scott, 1953; T. D. Scott, 1962).

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Mem. Qd Mus. (1971) **16**(1): 141–143, pl. 4.

NEW RECORDS OF TUBE-NOSED BIRDS (ORDER PROCELLARIIFORMES) FROM QUEENSLAND

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Queensland Museum

The number of species of the order Procellariiformes recorded from Queensland is small compared to the number known from other States. For Queensland Lavery (1969) has listed 25 species whereas McGill (1960) records 36 species from New South Wales and Wheeler (1967) 33 species from Victoria. Additional records have been since added to the lists from New South Wales and Victoria and this contribution now documents several new occurrences of Procellariiformes from Queensland.

In view of the wide-ranging nature of many of the Procellariiformes and the proximity of Queensland to the Central Pacific and Tasman regions, the small number of species recorded is probably a reflection of the number of interested bird workers. Undoubtedly many species are yet to be detected in Queensland waters.

SPECIES ACCOUNTS

Pterodroma rostrata rostrata (Peale) (Pl. 4) TAHITI PETREL

A specimen in good condition was picked up dead by David H. Barry on the Eastern Beach of Fraser Island, Qld, on 12 May 1969. The skin prepared by Mr Barry has been lodged in the Queensland Museum [Q.M. O11165]. Measurements in millimetres are: exposed culmen 38.7, tarsus 48.2, wing 309.0, and tail 124.0.

Two subspecies of *Pterodroma rostrata* are known. One, *P. r. becki*, is known only from the region of the Solomons Islands and Bismarck Archipelago. The specimen under discussion is referable to the larger, nominate subspecies which breeds on islands in the

New Caledonia area, Society and Marquesa Groups during the winter months and ranges the equatorial Pacific. *P. rostrata* has not been previously recorded from Australia, however a live specimen was captured off Port Moresby, Papua, recently (W. Filewood, pers. comm.).

Pterodroma melanopus (Gmelin) BROWN-HEADED PETREL

A specimen in poor condition was found at Eastern Beach, Fraser Island, by Miss M. Hawken on 8 May 1967. The head has been made up as a study specimen [Q.M. O11004]. The determination was made on the basis of bill-shape and facial markings. The exposed culmen of the specimen measured 34.5 mm.

Pterodroma melanopus breeds on Lord Howe Island during the winter months. It formerly bred on Norfolk Island. Odd beach-washed birds have been reported from New South Wales and New Zealand. During the summer months the species apparently ranges widely into the North Pacific.

Pterodroma macroptera gouldi (Hutton) GREY-FACED PETREL

A male specimen in good condition was found dead at Caloundra, Qld, by R. Elks on 3 February 1967. The specimen was prepared into a study skin [Q.M. O11005]. Measurements in millimetres are: exposed culmen 36.4, tarsus 40.7, wing 302.0, tail 132.0. The specimen was determined to race on the basis of measurements and face colouration.

P. m. gouldi breeds on islands and headlands in the New Zealand region during the summer months and ranges widely throughout the Pacific. It is not surprising that the Queensland specimen is of the New Zealand breeding form, this subspecies being recorded occasionally along the New South Wales coast (Hindwood, 1957). *P. m. albani* breeds on the islands off the southwest coast of Western Australia, and has been recorded on a few occasions from Victoria. The nominate subspecies breeds in the sub-antarctic islands and ranges through the Atlantic.

Pelagodroma marina dulciae Mathews WHITE-FACED STORM PETREL

A live specimen found at Eagle Farm, Brisbane, was presented to the Queensland Museum by R. Shortis on 8 August 1967. The specimen, an adult female, died shortly afterwards and was prepared as a study skin [Q.M. O11172]. Measurements in millimetres are: exposed culmen 16.7, tarsus 41.8, wing 145.0, and tail 74.0.

Not unexpectedly, it is an example of the Australian breeding race which breeds as close to Queensland as the Broughton Islands. The specimen was determined to race using the characters given by Oliver (1955). This specimen would appear to be the first recorded from Queensland.

Pachyptila salvini salvini (Mathews) MEDIUM-BILLED PRION

A male specimen in good condition was found at Oxley, Brisbane, on 15 July 1954, and presented to the Queensland Museum by the Royal Queensland Society for the Prevention of Cruelty. This specimen was mounted but has since been relaxed to a cabinet skin [Q.M. O5412]. Measurements in millimetres are: exposed culmen length 29.4, width 15.4, tarsus 32.5, wing 188.0 and tail 96.0.

Two races have been suggested, the larger *P. s. salvini* breeding on Marion Island in the southwest Indian Ocean, and the smaller *P. s. crozeti*, breeding on the Crozet Islands which are approximately 1000 miles to the east. Falla (1940) records both subspecies for New Zealand seas, with *P. s. salvini* in greater numbers. The generally larger measurements of Q.M. O5412 indicate it is probably of the nominate race.

According to McGill (1960) good numbers of *P. salvini* have been found during the winter months strewn on beaches near Sydney and to the south. This is the first record of this species for Queensland.

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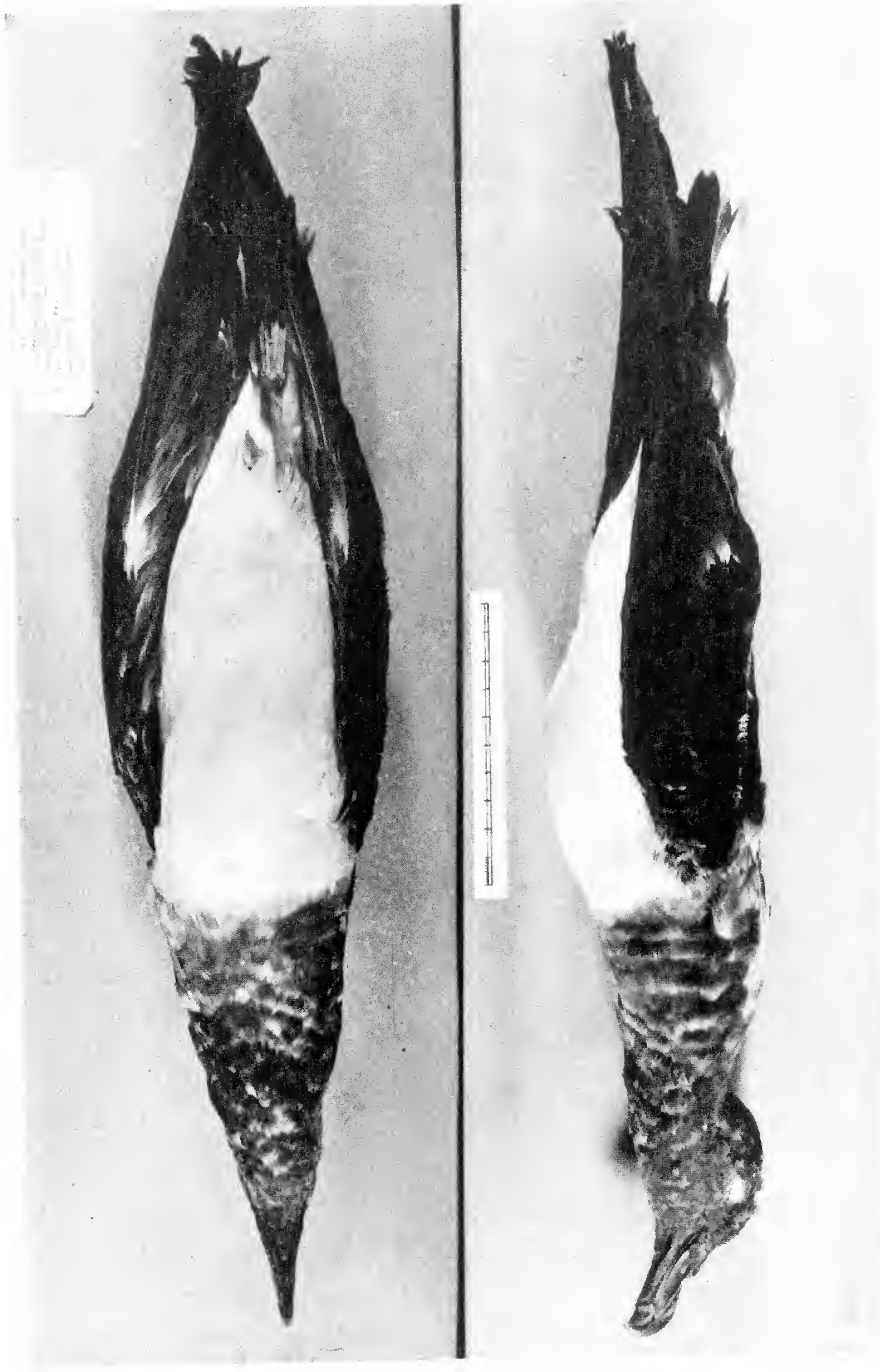
PLATE 4

Pterodroma rostrata rostrata, lateral and ventral views, Q.M. O11165.
Scale divisions in millimetres and centimetres.

PLATE 4



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Mem. Qd Mus. (1971) **16**(1): 145–151

SOME UPPER TRIASSIC HEMIPTERA FROM MOUNT CROSBY, QUEENSLAND

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Recent search in Upper Triassic fossil insect-bearing strata situated at Mount Crosby, Queensland, has yielded a considerable number of wings. In this article a report is furnished on those belonging to the sub-order Homoptera collected by Mr E. C. Dahms, Curator of Insects at the Queensland Museum; on an interesting wing of uncertain relationship found by Mr Dahms and on the wing of a Heteropteron discovered in the same strata by Mr B. V. Timms. The location where Mr Dahms's specimens were found is as follows: Upper bed, M. R. 910805–911805, Ipswich 1 mile military map.

HOMOPTERA

AUCHENORRHYNCHA

FULGOROIDEA

Tricrosbia gen. nov.

Small Upper Triassic Homoptera with a two-branched Rs which diverges from R slightly proximally to its centre. M1+2 is a single vein. M3 and M4 are apically separate and a third vein arises from their common stem. An enclosed cell, situated proximally to the initial branching of M, is bounded laterally by a pair of cross-veins m-cua. CuA, which terminates proximally at the base of the claval suture, has no association with the base of M. In the clavus the anal veins are apically fused into a single vein.

Type-species: *Tricrosbia minuta* sp.nov.

Tricrosbia minuta sp.nov.

(Fig. 1)

Holotype: tegmen, Mt Crosby, upper bed, M.R. 910805-911805, Ipswich 1 mile military map, coll. E. Dahms, Q.M. F6520. Length of tegmen, 3.2 mm; greatest width, 1.3 mm. Surface of tegmen smooth.

Description: The features distinguishing the species are, for the present, those given in the generic description.

Tricrosbia minuta is assigned to the Fulgoroidea, rather than to the Cicadelloidea for the following reasons: although an enclosed cell is a common feature of the tegmina of Mesozoic cicadelloids, it invariably lies within the arms of M, and not, as occurs in *T. minuta* outside them. Then, while certain extinct and extant cicadelloids have a Y-vein in the clavus and others have accessory veins associated with both Rs and M, the combination, in a single wing, of these three particular characteristics is unknown in this superfamily. In the Fulgoroidea, on the other hand, a Y-vein in the clavus is of universal occurrence and branches of other veins, in excess of the basic Homopterous number, are usually developed.

CERCOPOIDEA

MATERIAL: Queensland Museum: F6493, *Dysmorphoptiloides elongata* (fig. 2); F6504, fragment of tegmen of *Trifidella perfecta* Evans, 1956; F6498 (fig. 4A); F6542 (fig. 4B); F6507, small fragment, similar to part of tegmen illustrated in fig. 4A.

Five tegmina, or fragments of tegmina, are attributed to the Cercopoidea. Three of these are illustrated.

The most complete specimen is a tegmen of *Dysmorphoptiloides elongata* Evans, 1956, made notable by the retention of the previously unknown clavus (fig. 2). The two others illustrated (fig. 4A, B) do not seem to belong to described Triassic cercopoids, but are too fragmentary to merit description and naming. As well as on venational grounds, they are considered as belonging to the Cercopoidea because of their rugosity. The fragment illustrated in fig. 4A is 7 mm in length; the one in fig. 4B, 8 mm.

STERNORRHYNCHA

APHIDOIDEA

Crosaphis gen. nov.

Small Homoptera with broad wings in which M is basally incorporated in the same vein as Rs and in such a way that M1+2 and M3+4 diverge separately from their common

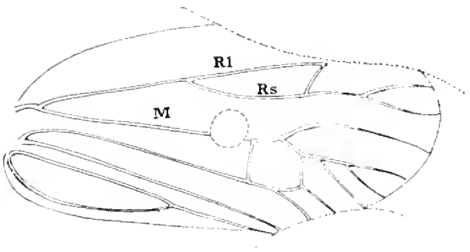

FIG. 1: *Tricrosbia minuta*, tegmen.

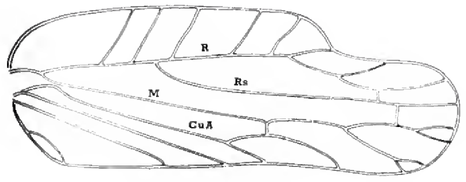

FIG. 2: *Dysmorphoptiloides elongata*, tegmen.

stem with Rs. CuA, which has two branches, meets R proximally at an acute angle. A clavus is absent and anal veins are lacking.

TYPE-SPECIES: *Crosaphis anomala* sp. nov.

Crosaphis anomala sp. nov.

(Fig. 3A)

HOLOTYPE: wing, Mt Crosby, upper bed, M.R. 910805–911805, Ipswich 1 mile military map, coll. E. Dahms, Q.M. F6508a. Length of wing, 3.5 mm; greatest width, 1.5 mm.

DESCRIPTION: The features distinguishing the species are, for the present, those given in the generic description.

The reason this unusual wing is regarded as that of an aphidoid rather than of a psylloid, is that in the last-named group M is invariably proximally associated with CuA, and never, as in aphidoids, with Rs.

It resembles the forewing of *Triassoaphis cubitus* Evans, 1956, from the Mt Crosby beds, in having a possible Sc; a two-branched M1+2 and a single-branched M3+4 which is proximally incorporated in the same vein as Rs; a two-branched CuA and no clavus. It differs from *T. cubitus* in shape, being considerably broader proximally; in having a less strengthened Rl, which does not extend so near to the apex of the wing; in having the base of M, as far as its initial branching into M1+2 and M3+4, incorporated in Rs; a considerably shorter CuA.

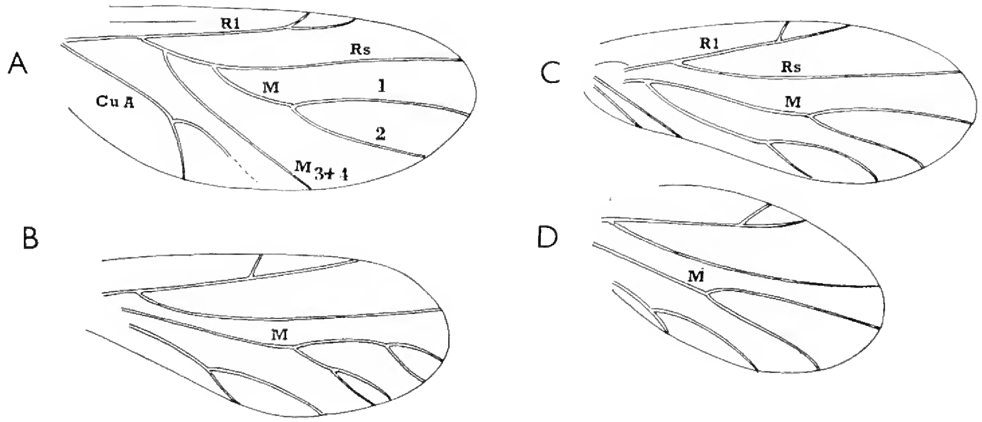

FIG. 3: Wings of A, *Crosaphis anomala*; B–D, *Triassothea analis*.

In shape, though not in venational characteristics, the wing of *C. anomala* resembles the forewing of the more ancient *Kaltanaphis permiensis* Becker-Migdisova (illustrated in Becker Migdisova and Aizenberg, 1962, fig. 566), more closely than it does that of *T. cubitus*.

PSYLLOIDEA

Triassothea analis Evans

(Fig. 3B–D)

Triassothea analis Evans, 1956, p. 236.

In the collection of fossil Homoptera assembled by Mr Dahms there are no less than 53 wings attributable to this species. At the time of its description it was mentioned that it was the sole psylloid represented in Mt Crosby strata, in contrast to the Upper Permian fossil insect beds at Belmont, New South Wales, which have yielded a rich fauna of these insects.

A forewing of *T. analis* (F6523; length, 3 . 8 mm) is illustrated in fig. 3C for comparison with a fragment of a presumed hind wing of the same species (fig. 3D, F6524; length, 2 . 4 mm). Both wings occur on the same rock specimen.

Also illustrated (fig. 3B, F6515; length, 3 mm), is the forewing of a psylloid which is assigned to *T. analis*, though differing from all other known specimens in having a four-branched M. No previously recorded Permian or Triassic Psylloidea have more than a three-branched M, hence it is presumed the condition shown in the figure is an anomalous one.

Fragments and Incertae Sedis

Fragments of five wings are illustrated in fig. 4. Two of these have previously been mentioned and ascribed to the Cercopoidea (4A, B). Of the remainder, one (4C) is a clavus while the two others are supposed to be parts of hind wings.

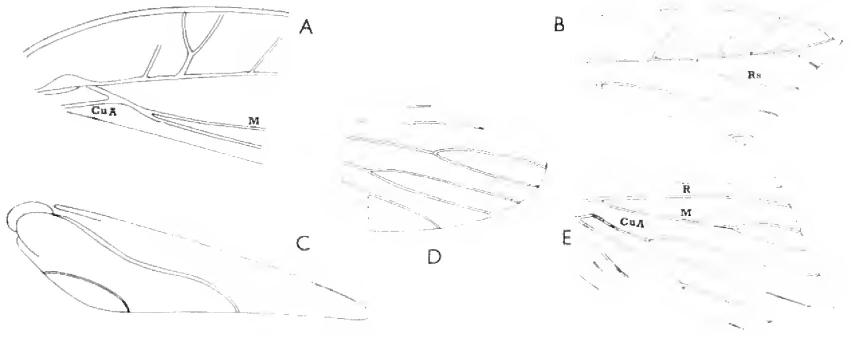

FIG. 4: A–C, fragments of tegmina of Homoptera; D, E, incertae sedis.

The clavus (F6491; length, 7 mm), which is finely punctate, is illustrated because of its excellent state of preservation and the paucity of records of this part of tegmina of Upper Triassic Homoptera.

The fragment (F6540; length, 4 mm) illustrated in fig. 4D is too incomplete to need discussion.

The other (F6483; length, 3.5 mm) (fig. 4E), is of greater interest since as well as being almost complete it presents certain puzzling features. If the veins have been correctly labelled in the figure, then the posterior cubitus is two-branched and such a condition of CuP is unknown in the Homoptera.

A search of the literature discloses that this wing has a certain superficial resemblance, especially in regard to CuP, to the wing of a Miomopteran, *Tychtodelopterum relictum* Martynova, (Martynova, 1962). If a different interpretation of its venation is adopted, then even closer matching can be established with the wing of another Miomopteran, *Delopterum incertum* (Martynov), (Martynova, 1962). Such an alternative would involve the vein labelled M in the figure becoming Rs, and CuA becoming M. The posterior forked vein would then become CuA. The reason the above interpretation of the venation of fig. 4E is not accepted and the wing neither named, nor assigned to the Miomoptera, is because it is thought a single wing fragment provides insufficient evidence for recording a representative of a northern hemisphere Permian insect order from Australian Upper Triassic strata.

It has been suggested that the Miomoptera lie close to the base of the Hemipteroid stem (Riek, 1970). Accordingly, it might be expected that some fossil wings might have venational features with characteristics of both orders. A study of Miomoptera remains illustrated by Martynova (1962), lends no support to this suggestion for not only did insects belonging to this order have a very different pattern of venation from the Hemiptera, but they possessed cerci. Accordingly, if the two orders had a common origin their divergence must have taken place before the time the Hemiptera acquired their very special characteristics. This being so, there seems no good reason why the Miomoptera, any more than several other insect orders, should be regarded as one of the 'Hemipteroid orders'.

HETEROPTERA

Heterochterus gen. nov.

Upper Triassic Heteroptera from Mt Crosby, Queensland, with a well defined costal fracture in the forewing situated at approximately one-third of its length from its base. R multi-branched, terminating near the point of commencement of the apical appendix. M, which diverges from its common stem with R at the angle of the costal fracture, with two equal branches. M and CuA linked by three cross-veins. Marginal vein meeting the claval suture at an acute angle. Clavus unknown.

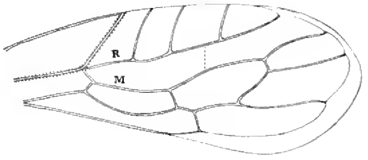

FIG. 5: *Heterochterus timmsii*, forewing.

Resembling *Heterojassus* Evans, 1961, from the same horizon, in general facies: differing in having an additional cross-vein m-cua, a more extensive appendix, and in being broader apically.

TYPE-SPECIES: *Heterochterus timmsii* sp. nov.

Heterochterus timmsii sp. nov.

(Fig. 5)

HOLOTYPE: wing, Mt Crosby, coll. B. V. Timms, presented by Department of Entomology, University of Queensland, Q.M. F6473. Length, 4.3 mm; greatest width, 1.6 mm.

DESCRIPTION: The features distinguishing the species are, for the present, those given in the generic description.

The above wing is regarded as that of an insect belonging to the sub-order Heteroptera because of the presence of a costal fracture; the lack of Rs; and the abrupt termination of the marginal vein at the apex of the claval suture. The 'costal fracture', which is a characteristic of certain Heteroptera, but unknown in the Homoptera, is a transverse line of weakness which extends from the costal margin of the hemelytron as far as vein R+M (Evans, 1950, p. 246).

In the paper referred to above the forewing of a recent ochterid is illustrated (*Ochterus marginatus* Latreille; fig. 8) which, as well as closely resembling that of *H. timmsii* in general appearance, has all the features listed above as being peculiarly Heteropterous in nature. In the Ochteridae the clavus is reduced and anal veins are lacking, but in certain other Recent Heteroptera, such as the Dipsocoridae, the marginal vein is the trans-claval continuation of the apically fused anal veins.

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SUGGESTIONS FOR THE RE-EVALUATION OF SOME AUSTRALIAN SCRAPER TYPES

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ABSTRACT

A simple attribute analysis was applied to all stone tools in a surface collection from southeast Queensland. The results were then compared with McCarthy's types (McCarthy, 1967). It is suggested that the more sophisticated scrapers usually described by archaeologists may have less formalized counterparts among the so-called miscellaneous scrapers.

The implements discussed in this paper were collected during a field survey in 1966 at Arubial, Horseshoe and Nangram Lagoons on the Condamine River, and at Eurombah and Hornetbank Lagoons near the Dawson River (fig. 1). As the collecting was relatively unsystematic and restricted to surface finds little archaeological importance attaches to them. However, the analysis of the 285 implements revealed that only 15 could not be wholly counted as scrapers. Most of the 'scrapers' belonged to that ubiquitous group 'miscellaneous scrapers'. In an effort to objectify some characteristics of this group the following experiment was carried out.

The comparison of attribute analysis results with standard type descriptions was adopted in response to a situation in which over 90 per cent of implements in a collection would normally be classed as *ad hoc* scrapers. Although evolved independently of J. P. White's analysis of New Guinea highlands flake tools (White, 1967), the attribute analysis employed here places similar emphasis on utilized edges rather than on implement morphology.

The assumption is that 'scraper' may be used as an omnibus term describing a large-scale functional grouping of tools. It is probable that tools capable of satisfying generalized cutting, graving, planing, scraping or even sawing functions have been classified under the headings miscellaneous or generalized scrapers. At the other end of the scale some highly

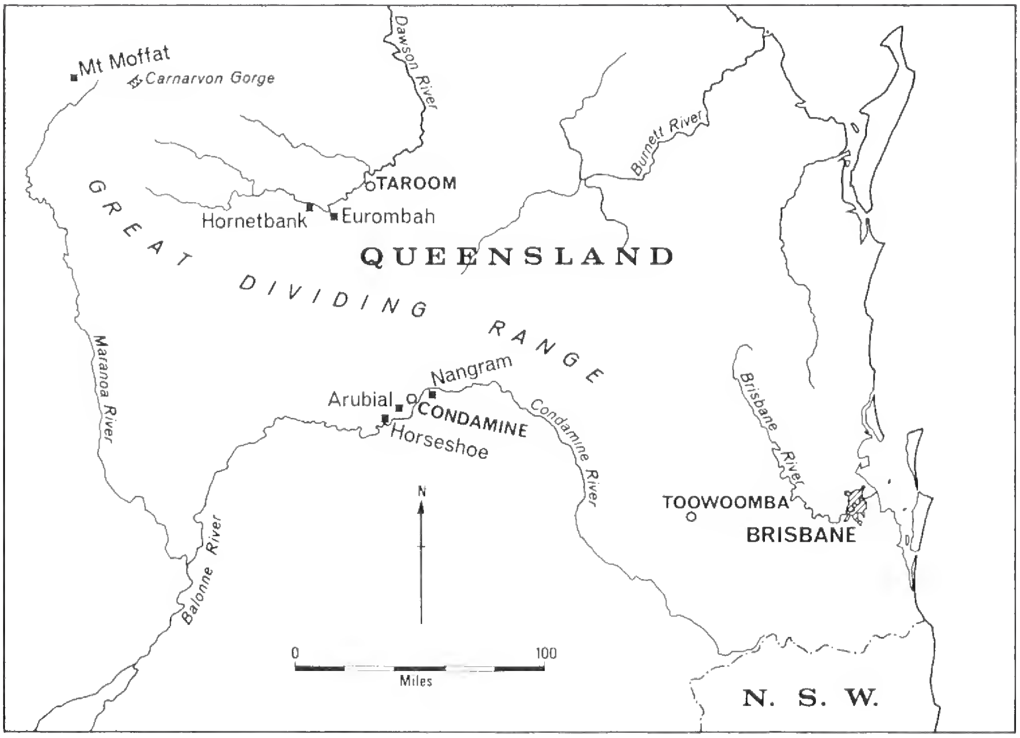

FIG. 1: Map of southeast Queensland.

sophisticated types of scraper have been identified. For Australia, Mitchell (1949, pp. 10–14, 29–34) records the use of any suitable edge of a stone for general cutting operations, but some obviously carefully shaped scrapers are known to exist, for example horsehoof cores, and the various so-called adzes. For this study it is further assumed that by comparing working on unformalized tools with that on more formal ones usage which depends on the existence of a suitably sized and shaped edge may be isolated. Such edges may or may not need to be trimmed to these suitable sizes, shapes, and probably angles. Therefore, if types of scrapers are to be distinguished on this basis, any type may range from completely retouched tools to ones with no retouching at all, provided the characteristics of its use-fractured edges are consistent. By extension, then, the extent to which a tool is retouched, and the form of this retouch are not criteria for distinguishing a functional scraper type, though they may well distinguish varieties within a major group.

It should be noted that an analysis in the terms described below does not distinguish scrapers from types such as chopping tools, pebble tools, *elouera*, points, and other more formalized groupings which are recognized by visual inspection. In other words an attribute analysis will not provide the structure of a typology but if applied to all tools will allow comparison between retouch and use patterns on formalized and unformalized tools and may therefore permit approximation of the two.

Besides allowing the grouping of relatively unformalized with relatively more formalized tools which seem to belong to the same 'types', the analysis does permit recognition of instances where more than one form of usage is present. In this collection 8 percent of the edges appear to belong to groups other than those into which the artefact they occur on is classed (table 4c).

ANALYSIS

In this paper the term 'utilized' is employed to indicate any edge modified by human intent. Utilized edges, therefore, include use-fractured, retouched, ground and friction polished edges. Retouched edges may often have superimposed use-fracturing. The mor-

TABLE 1

A CODE FOR DESCRIBING STONE TOOLS

- 1 Morphology:
  - 1a Flake retaining striking platform
  - 1b Broken flake
  - 1c Core
  - 1d Pebble
  - 1e Lump

- 2 Shape of utilized edge:
  - 2a Straight
  - 2b Convex
  - 2c Concave
  - 2d Nosed
  - 2e Pointed

- 3 Angle of utilized edge:
  - Accurate measurement of steepest part

- 4 Form of retouch:
  - 4a Scalar retouch—flakes up to 3mm high removed
  - 4b Scalar retouch—flakes up to 6mm high removed
  - 4c Scalar retouch—flakes greater than 6mm removed
  - 4d Step retouch
  - 4e Edge ground

- 5 Percentage of edge retouched:
  - 5a less than 10%
  - 5b 10–19%
  - 5c 20–29%
  - 5d 30–39%
  - 5e 40–49%
  - 5f 50–59%
  - 5g 60–69%
  - 5h 70–79%
  - 5i 80–89%
  - 5j 90–99%
  - 5k 100%

- 6 Degree of use-fracture:
  - 6aa Very slight, chips less than 1mm removed
  - 6a Edge still sharp, chips up to 2mm removed
  - 6b Edge blunted, chips up to 4mm removed
  - 6c Edge very blunt, chips up to 6mm removed
  - 6d Edge rounded by battering, bruising extends up to 1cm from working edge

- 7 Percentage of edge with use-fracture:
  - Same groupings as in 5

phological classification is simple and self-explanatory, the term lump being reserved for bits of stone apparently shattered by natural agencies such as fire. Among this collection 41 percent are flakes which retain their striking platforms, 30 percent are broken flakes, 20 percent are lumps, 5 percent are cores, and 4 percent are pebbles. The most common material is quartzite, of which 77 percent of the implements are made. Chalcedonic silica, silicified wood, quartz, basalt, siliceous mudstone, and conglomerate make up the rest.

Table 1 lists the attributes used in this analysis, dividing the material into seven categories. Some of the results of the application of this code are given in tables 2 and 3, and figures 2 to 4. These are briefly discussed below.

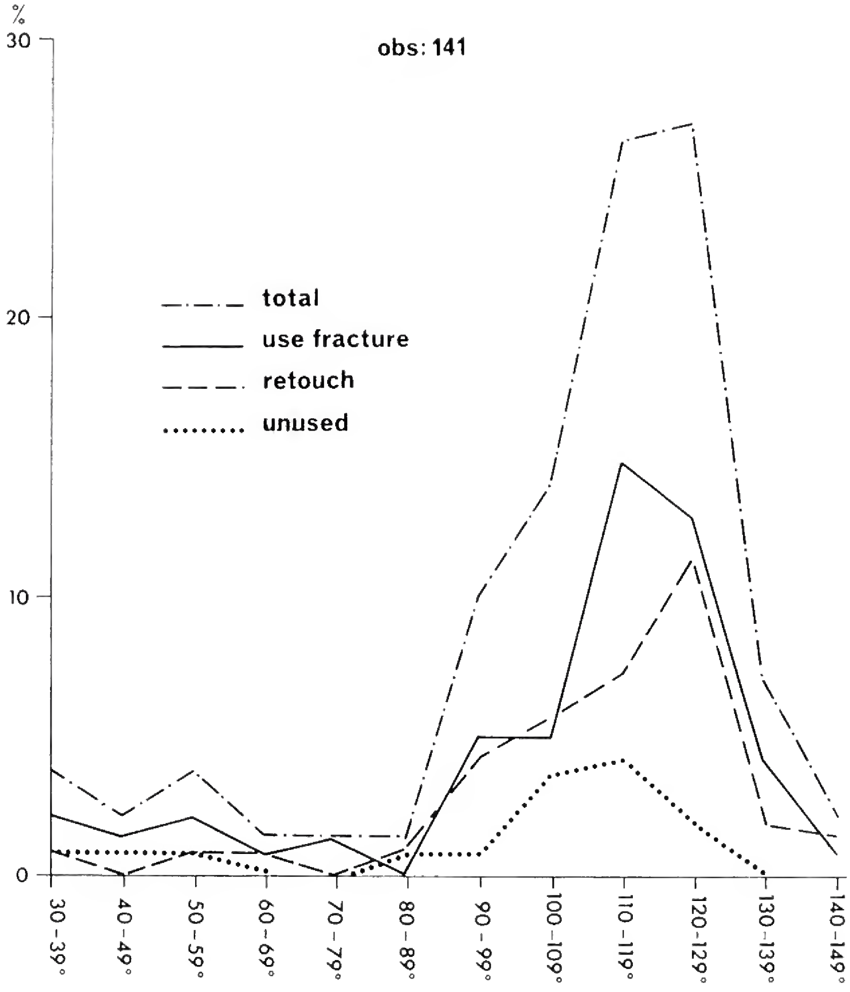

FIG. 2: Striking platform angles.

TABLE 2

OCCURRENCE OF FORMS OF RETOUCH AND USE-FRACTURE AND THEIR COMBINATIONS

Form of retouch or use-fracture	No.	%
Small scalar retouch	60	31
Medium scalar retouch	22	12
Large scalar retouch	68	35
Step retouch	40	22
Very slight use-fracturing	9	2
Slight use-fracturing	266	53
Medium use-fracturing	130	25
Rough use-fracturing	100	20
Use-fracture only	326	63.3
Scalar retouch only	8	1.5
Use-fracture and scalar retouch	142	27.3
Step retouch only	3	0.6
Use-fracture and step retouch	37	7.3

TABLE 3

COMPARISON OF SHAPES AND USAGE ON UTILIZED EDGES

Shape	Use-Fracture		Scalar Retouch		Step Retouch		Total	
	No.	%	No.	%	No.	%	No.	%
Straight	161	49.4	48	32.0	18	45.0	227	44.0
Convex	88	27.0	33	22.0	9	22.5	130	25.0
Concave	59	18.1	52	34.6	9	22.5	120	23.2
Concave/convex	13	4.0	13	8.7	3	7.5	29	5.6
Nosed			2	1.3			2	0.4
Pointed	1	0.3	1	0.7	1	2.5	3	0.6
Straight/convex	1	0.3					1	0.2
Straight/concave	3	0.9					3	0.6
Straight/nosed			1	0.7			1	0.2
Total	326	100	150	100	40	100	516	100

All flakes retaining their striking platforms were examined for evidence of post-detachment trimming of the platform and two were rejected as unmeasurable because of this. Otherwise all striking platform angles were measured using a template former. The range recorded (fig. 2) extends on both sides of that reported for Kenniff Cave (Mulvaney and Joyce, 1965, p. 180), and the inclusion of the unused flakes in the collection made no difference to the range recorded. Although retouched flakes tend to have higher striking platform angles the angle of the striking platform appears to have very little effect on the usability of the flake. Some low angle flakes may have been struck from the side of a core. Prepared or facetted striking platforms are so rare that, as at Kenniff Cave, they may, 'be considered as fortuitous' (Mulvaney and Joyce, 1965, p. 175).

The forms of retouch and the degrees of use-fracture have been arbitrarily divided in an attempt to make more nearly objective recognition of the obvious differences. Deliberate retouch was recorded when more than one chip of about the same size had been taken from one edge. When in serious doubt it was preferred to place an edge in the heavily used, rather than in a retouch category. Utilized edges may occupy from 3 to 100 percent of the margins of a tool and each tool may have more than one utilized edge, distinguished by an unused area or an abrupt angular bend. Altogether 516 utilized edges were recorded on 285 implements. Tables 2 and 3 list the sorts of usage and the shapes of edges, while the graphs in figure 3 show the edge angles of the four commonest edge shapes and the pattern for the whole collection.

Slightly more than one third of the edges are retouched, and of these 22 percent have step retouching, which in this collection occurs only on a form of scraper as a presumed working edge. No evidence of preparation of the core to permit standardized flakes to be removed was found, although the group distinguished as peaked scrapers may have been formed in this way. Table 3 and figure 3 indicate a high proportion of concave retouched edges with high edge angles, an observation also made by McCarthy (1967, p. 29). However, a high proportion of step retouched edges are straight. This contrasts with observations that such edges on the Kenniff Cave material had semi-discoidal and frequently concave-nosed working edges (Mulvaney and Joyce, 1965, p. 176).

Edge angles for retouched and use-fractured edges have almost the same range but, as would be expected, more of the thin edges are merely use-fractured, and more of the thick edges retouched. Figure 3 demonstrates this clearly.

As an approximate guide to the percentage of the margins of the tool a used edge occupies, the centre of the artefact was placed over a point having radiating arms 36° (10%) apart. On many edges use-fracturing exceeds the length of retouch and the greatest length of utilization was recorded. Figure 4 shows the amount of usage on each implement. In this graph the retouch category includes all implements with one or more edges and any use-fractured edges. Implements with retouching tend to have a greater length of their margins utilized. Flakes which retain their striking platforms are never 100 percent used.

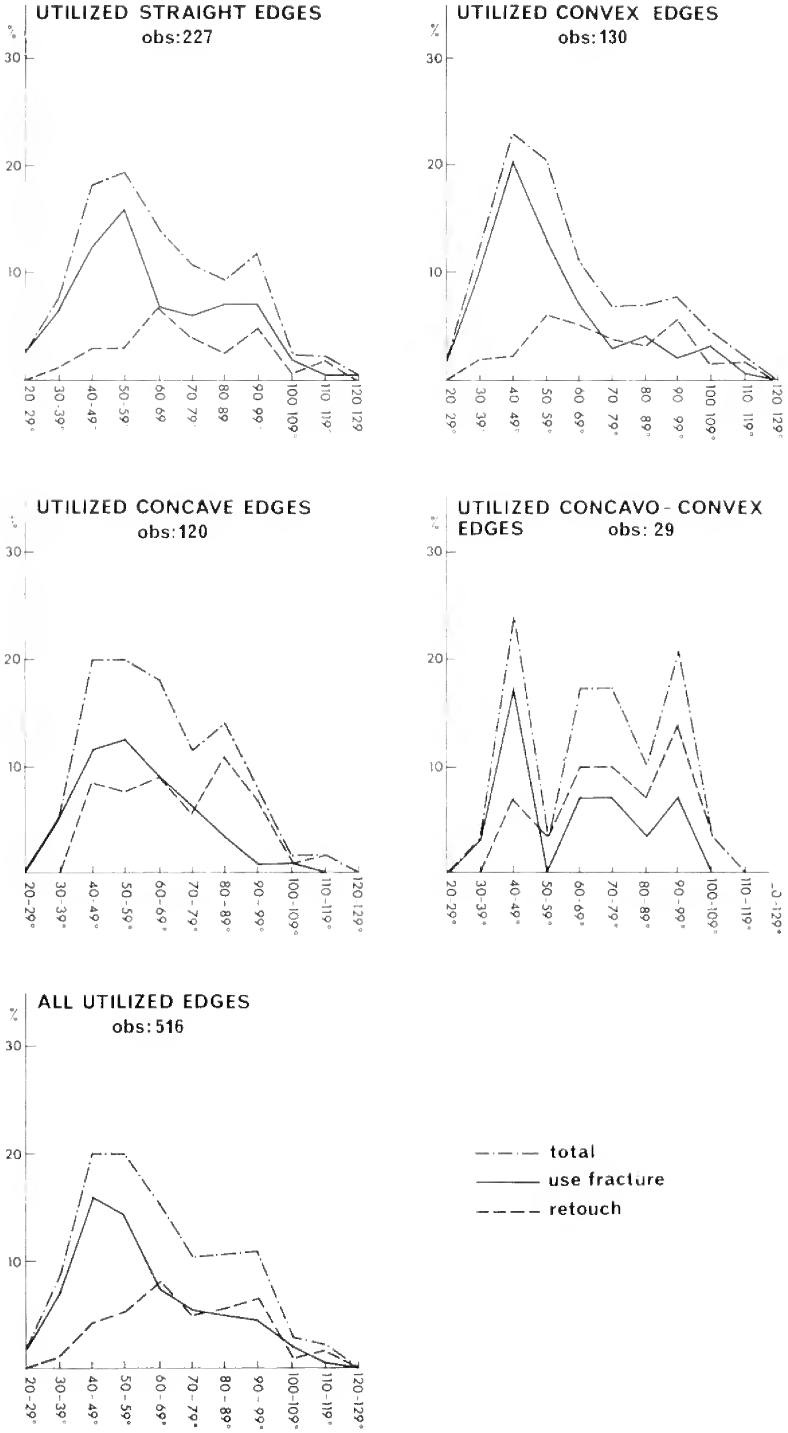

FIG. 3: Edge angles of four commonest edge shapes.

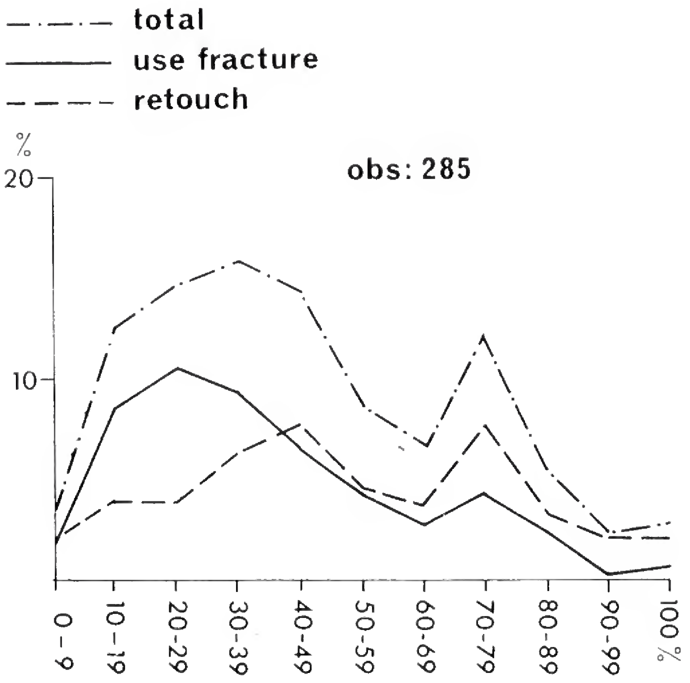

FIG. 4: Percentage of implement margins utilized.

The figures and tables include all edges, not just 'scraper edges'. To facilitate discussion the following points about the non-scraper component may be made. Fifteen implements have edges not classed as scraper edges, that is 6 edges on four pebble tools, 2 on two chopping tools, 2 on one *leilira*, 5 on four *elouera*, 2 on two points, one adze flake edge, and one axe edge. These nineteen edges are 3.7 percent of the edges recorded but 68 percent of them are convex, or concavo-convex, over twice the proportion in the rest of the collection. The angles on the edges fall within the general range, but whereas the general range shows a drop between 70° and 90°, these edges fall most often between 70° and 99°. Six of the implements have more than 70 percent of their margins utilized, the others (two pebble tools, both chopping tools, the *elouera*, and the axe) fall within the less used categories.

CLASSIFICATION

The content of tool types which are highly formalized, such as ground axe-heads or the *leilira* knife, is not necessarily altered by the procedure outlined above for it is easy to define boundaries for them. However, where a tool to satisfy a particular need or use may have edges of any form from fortuitously 'correct' to those which must be trimmed to appropriate sizes, shapes and angles, as in the case of many scrapers, then a study such as this is helpful in sorting out the simpler or less extensively trimmed tools which essentially correspond to types isolated by other means.

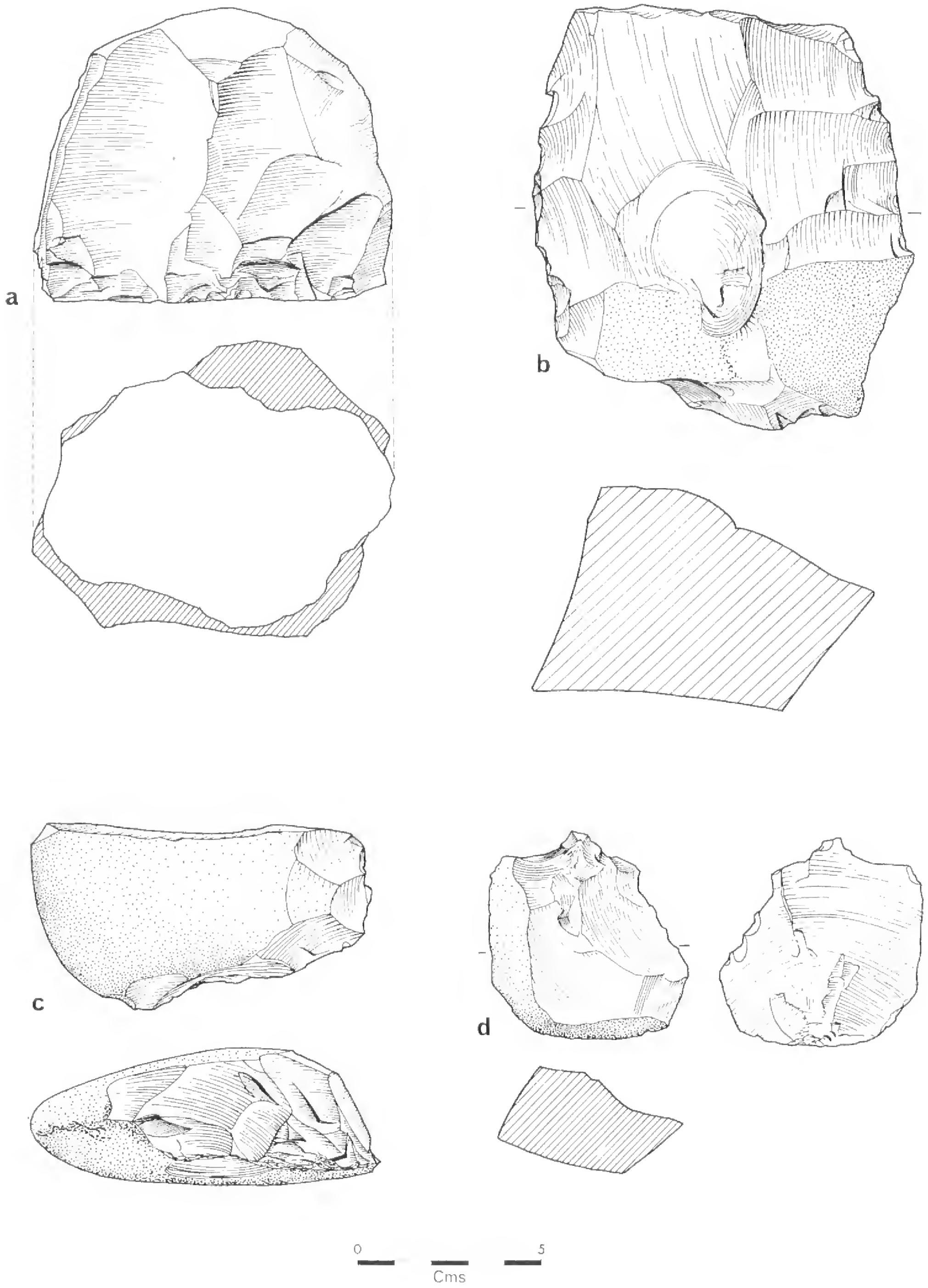

FIG. 5: 'Cliffed' Scrapers: a, Nangram Lagoon; c, Eurombah Lagoon; b, d, Hornetbank Lagoon.

In the generalized sense used in this paper, scrapers account for 93 percent of the implements identified in this collection, and have between them 96.3 percent of the utilized edges. For none of the forms of scraper isolated by this study is any typological validity claimed. However, it should be noted that two of the groups—'cliffed' and 'peaked' scrapers—form isolates which appear to be justifiable empirical groups.

CLIFFED SCRAPERS: *Horsehoof* implements (McCarthy, 1967, p. 18) may be taken as the 'textbook' type (fig. 5a, 6a). They were separated visually from the other tools and to them were added a group of implements similar in many respects but which lacked step-retouch on the edges. The group now corresponded to Mulvaney's *core scrapers* (Mulvaney and Joyce, 1965, p. 176).

Utilized edges on these tools range from 69° to 129° a result obtained by using a template former to make an edge profile, making it possible to measure the actual working edge without obstruction from projecting faces. This is important because a major characteristic of edges on these implements is that acute as well as obtuse angled edges become overhanging above the working edge. This is especially the case with step-retouched edges. It is interesting to note that many obtuse angled edges were not retouched. This overhanging of the edge is coupled with a considerable height—always at least as high as the width of the base and often up to twice this distance. Since all *horsehoofs* and *core scrapers* will balance on this base the face above the working edge might appropriately be described as 'cliffed'.

Working edges on cliffed scrapers have some other characteristics. Use-fracturing is unifacial or mainly unifacial directed from the base or platform up the overhanging face. Scalar and step retouch is always unifacial and is similarly directed, tending to increase the cliffed appearance. Amongst the scrapers step-retouching is confined to cliffed scrapers. Step retouch directed up the face of the tool is clearly different from the facetting on prepared platform cores, and from that on some *tula* adze flakes on which the step retouch runs from the face of the flake across the striking platform.

Thirteen other implements with similar edges and relationship of base to height (fig. 5b, c, d) but of which only one could be described as a core were then added to the original group of *core scrapers* and *horsehoofs*.

The other implements in this group have the appropriate used and overhanging edges. Four of them have such narrow bases that they will not balance (fig. 6b), the other 18 appear to be either accidental removals or tool rejuvenation flakes (fig. 6c, d, e).

These cliffed scrapers and the parts removed from them account for 16 percent of the tools in the collection. Except those corresponding to the *core scrapers* all cliffed scrapers

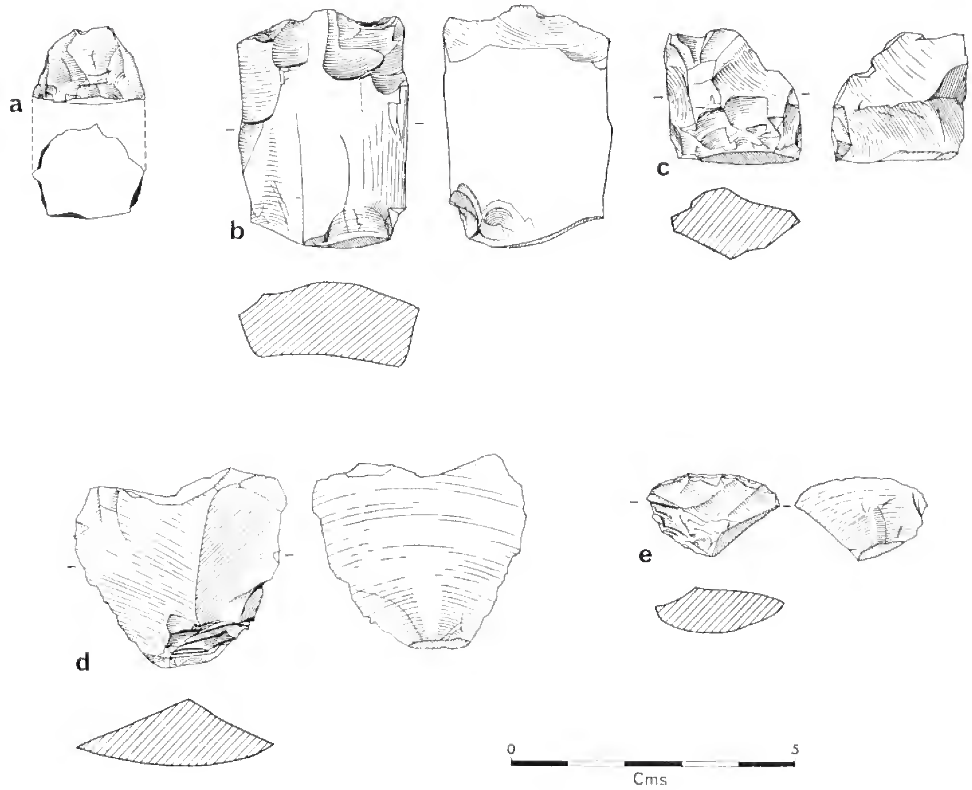

FIG. 6: 'Cliffed' Scrapers: a,c, Horseshoe Lagoon; b,d, Nangram Lagoon; e, Arubial Lagoon.

have other forms of use on them (see table 4), including one which appears to have been turned into an adze (fig. 6e), but in this collection only cliffed scrapers have step retouched edges.

PEAKED SCRAPERS: A second group of scrapers has been called 'peaked' scrapers for want of a better term. It includes 7 percent of the collection. Well made 'peaked' scrapers are almost circular and are characterised by a number of flake scars which meet at a central peak (fig. 7a–d). These flakes appear to have been removed before the implement was detached from its parent nodule. This is also true of less well made items but here the flake scars are less regular and the central peak is often lacking, nor is the circular form so regular (fig. 7e–h). It is noticeable that the less well made group has more retouched edges than the well made group, as if it was necessary to trim the less well made ones more. Two items in each part of the group appear to be unused but have not been checked under a microscope to determine if this is true.

TABLE 4

TYPOLOGICAL CORRELATION

4A: COMPARISON OF CLASSIFICATORY GROUPS WITH MORPHOLOGICAL FORMS

Morphology	Cliffed Scrapers				Plain Scrapers		Peaked Scrapers		Cores		Pebble Tools		Chopping tool	Axe head	Adze flake	Leilira	Elouera?	Point?	Unused	Total
	Core scrapers	Other balancing scrapers	Tool rejuvenation	Non-balancing	Well made	*ad hoc*	Well made	Poorly made	Simple	Biconical	Unifacial	Bifacial								
Flake		1	11	2	12	89	2	3					1		(1)		1	1	20	143
Broken flake . .		1	5		8	59	3	5					1			1	1	1	17	102
Core	12	1							4	1										18
Pebble		6									2	2		1					1	12
Lump		4	2	2	4	26	6	2									2		21	69
Total	12	13	18	4	24	174	11[a]	10[a]	4	1	2	2[b]	2	1	(1)[cd]	1	4	2	59	344

4B: COMPARISON OF CLASSIFICATORY GROUPS WITH DISTRIBUTION BY SITES

Nangram ..	4	3	7	4	16	71	2	7	3	1					(1)		2	1	33	154
Horseshoe ..	5	5	7		3	31	3	1			1	1		1				1	18	77
Arubial	1	1	3		3	33	4	2	1		1						2		3	54
Eurombah ..		2			1	11	2					1	1						2	50
Hornetbank ..	2	2	1		1	28							1			1			3	39

4C: COMPARISON OF CLASSIFICATORY GROUPS WITH EDGE UTILIZATION AND EVIDENCE FOR RE-USE OF IMPLEMENTS

Primary Use																				
Fractured ..	18	10	3			232	14	9			1						2			289
Retouched ..	1	5			45	68	5	10			1	2	2	1	(1)	2	3	2		147
Step retouch ..	11	7	18	4																40
Secondary—																				
Other ad hoc edges			(17)	(2)	(10)	36							(4)					(3)		
Other well made edges			(1)		1															1
Other pebble chopper edges..		(2)									1	1								2
Other retouched edges			(1)												1					1
Total	30	22	21	4	46	336	19	19			3	3	2	1	1	2	5	2		516

Notes: a Both these totals include two apparently unused items
b Two other bifacial pebble tools were recorded among the balancing cliffed scrapers
c The adze flake is primarily classed as a cliffed scraper tool rejuvenation flake
d Items in parentheses are not included in column or row totals.

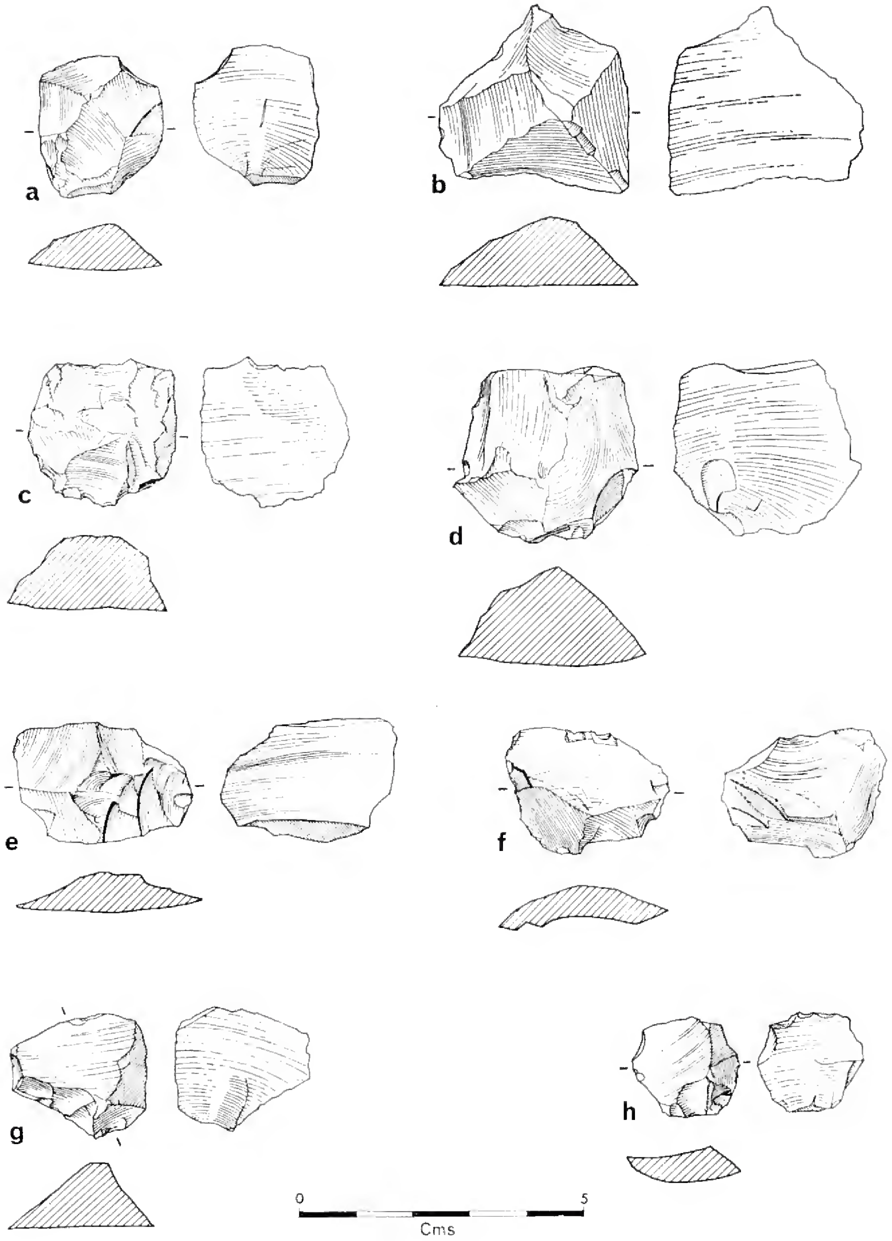

FIG. 7: 'Peaked' Scrapers: a,e,f,g, Nangram Lagoon; h, Arubial Lagoon; c, Horseshoe Lagoon; b,d, Eurombah Lagoon.

FIG. 8: 'Plain' Scrapers: a,e,f,i, Nangram Lagoon; c, Arubial Lagoon; d, Horseshoe Lagoon; b,g,h,j, Hornetbank Lagoon.

PLAIN SCRAPERS: This category includes the implements not referable to any other group. In face of the miscellany of edge shapes and angles and morphological forms few regularities were distinguishable so that the 'waste basket' category of 'plain' scrapers is the most variable and includes 70 percent of the tools in the collection. Even amongst the neatly retouched group a wide variety of edge shapes and sizes occur. One neatly retouched edge on a 'cliffed' scraper (fig. 6d) is referable to the well made 'plain' scrapers.

Amongst the regularities recorded on the neatly retouched edges were eight neatly made concavities (fig. 8a), two well produced noses, one of which was retouched from alternate sides (fig. 8b, c); and two semi-circular scrapers made on broken flakes (fig. 8d). It was noticed that all the well made (i.e. neat and regular) scraper edges are over 70° and that most have edge angles of over 75°. This division of edges at about 75° seems effectively to distinguish the more formal from the less formal tools. The less formal 'plain' scrapers are probably better described as *ad hoc* cutting or scraping tools. Their used edges are even more variable than those recorded for the better made 'plain' scrapers and the retouching is very irregular and haphazard. Once again regularities of form or edge are rare. Amongst those recorded several times are three triangular pieces, thirteen parallel sided pieces, three pieces the shape of a quarter circle, and five large pieces with lunate concavities (fig. 8e–i).

OTHER IMPLEMENTS: Because of the small number of these tools no typological divisions have been attempted and McCarthy's (1967) groupings have been followed. The identification of *elouera* and points in this collection is based on form and these items might in fact belong in scraper groups, their form being fortuitous. Similarly the adze flake might be considered a form of scraper for adze flakes are hafted as chisels and seem to be used as scrapers. In the analysis these fifteen implements with edges not considered to belong to scrapers show different patterns of distribution in edge shape, angle, and length of margins utilized. However, as these are only 3.7 percent of the total edges no conclusions can be drawn. If further investigation showed these differences to be real it might be suggested that scrapers, sophisticated or 'miscellaneous', do have characteristics by which they can be distinguished from other groups of tools, for example projectile points, knives, chopping tools and axes. On the other hand it could be equally true to say that the characteristic quality of some specialized tool types lies not in their whole shape but in the placement and form of their utilization. It might be expected also that such tools would show consistency in the length of margins affected by working, a factor which does not appear to be crucial for many forms of scraper.

DISCUSSION

SITES

At all sites the main scatter of material was on the highest part of the bank and on the slope facing the lagoon between twenty and fifty yards from the line of coolibahs and water gums marking average water level.

A number of comparisons may be drawn between the five lagoons although the samples are so small and selective that no characterization of industries typical of a particular lagoon should be attempted. The Hornetbank and Eurombah Lagoons on the Dawson River have higher banks than the Condamine lagoons. They appear to be built of outcrops of quartzite pebbles and the implements collected were noticeably heavier and larger than those from the Condamine area. At these three sites a wider variety of stone types was present and the implements were usually smaller, especially at Horseshoe Lagoon. None of the Condamine lagoons had any visible billy outcrops, and at Horseshoe, in particular, much of the site seemed to be subject to periodic flooding. Because the greatest variety of formalized tools came from this lagoon it would seem to hold the best prospect for excavation.

The *leilira* blade was picked up away from the brow of the bank of Hornetbank Lagoon in an area where Aborigines were living until the early years of this century. It is possibly a woman's knife (McCarthy, 1967, p. 32). With this exception all tools were found clustered on the slope of the banks as already described.

All the tools in the collection, except possibly the points, seem to be referable to subsistence activities. These appear to have been mainly the preparation of vegetable foods and the manufacture of bark containers. The collections may thus represent with some accuracy patterns of Aboriginal activities around the lagoons, for container trees were recorded at Horseshoe and Arubial while Nangram is known to have been an important source for waterlilly roots, but it must be emphasized that this conclusion is based on surface collections, and while exploitation patterns may have been stable for centuries, the technology discussed here can in no way approximate an archaeological culture.

ATTRIBUTE ANALYSIS

It is now apparent that the code on which the edge analysis was based (table 1) is rather too simple.* For instance, no account was taken of whether the edge was complete, truncated by subsequent use, or broken; the relationship of use-fracturing to retouch was ignored; whether or not some edges may have been contemporary was not determined; neither were the sorts of surface which meet to form a utilized edge. Finally, on some artefacts, not all working was around the margins of the same plane, and this made calculation of the percentage of the edges used more difficult.

In the analysis measurements were divided arbitrarily into 10 degree or 10 percent groupings and no attempt was made to see whether the measurements could be divided into more 'naturally' occurring groups. Similarly the problem of measuring the size—length, breadth and thickness—of each artefact was ignored except in the case of flakes with striking platforms. However all items were weighed. (The results of this analysis showed,

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*The following criticisms partly result from the use of a more detailed descriptive coding, evolved from this and Dr White's (1967) scheme, to analyse a large collection of New Zealand flake tools. The code employed here was established in 1966.

as expected, that unused items occur on both sides of the weight range for used items.) A more detailed analysis should probably include a section for measurements of different thicknesses for each edge not in the same plane as the surface from which artefact thickness is measured.

CONCLUSIONS

The main contribution of this paper is to point out the considerable degree to which less formalized tools may approximate 'text-book' types under some Australian conditions. To achieve this recognition it is necessary to have a typological structure and to apply an attribute analysis to all the tools within the typology not just within certain parts of the typology. Analysis by attributes only is liable to result in a formless picture while inspectional typologies are well known to be selective. This paper has been an attempt to combine both approaches. As a result the original scraper types, isolated according to McCarthy's (1967) scheme, have been considerably altered in content where a large sample was available. It would be interesting to see the approach used on a larger and more varied collection to attempt to determine whether an attribute analysis will distinguish between major groupings of tools, as well as to see whether other tool groups have more and less formalized variants.

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