

A REVISION OF THE AUSTRALIAN FROGFISHES (BATRACHOIDIDAE)

J.B. HUTCHINS*

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ABSTRACT

Two genera of batrachoidid fishes, *Halophryne* Gill and *Batrachomoeus* Ogilby, are recognized from Australia. The main generic characters for *Halophryne* are the absence of a pore in the pectoral axilla, mandible and palate with bands of small cardiform teeth, gill slit present on the upper half to two-thirds of the pectoral base and ten precaudal vertebrae. The features which distinguish *Batrachomoeus* include a pectoral axillary pore, mandible and palate usually with one series of strong conical teeth, gill slit encompassing the entire pectoral base and nine precaudal vertebrae. Three species of *Halophryne* are recognized: *ocellatus* Hutchins, *diemensis* (Lesueur) and *queenslandiae* (De Vis). Five species of *Batrachomoeus* are recognized: *dubius* (Shaw), *trispinosus* (Günther), *dahli* (Rendahl), *occidentalis* n. sp. and *rubricephalus* n. sp. Two species of *Halophryne* and four of *Batrachomoeus* are considered to be endemic to Australia. The type locality of *Halophryne diemensis* is apparently the north-western corner of the Northern Territory, near Darwin, rather than Tasmania as previously thought. Shaw is recognized as the author of *Batrachomoeus dubius* and the distribution of this species is considerably reduced. *Batrachomoeus broadbenti* Ogilby is placed in the synonymy of *B. trispinosus* and *B. striatus* (Castelnau) is provisionally included with *B. dubius*.

INTRODUCTION

The family Batrachoididae is made up of eighteen genera and approximately forty-six species (Norman, 1966: 583; Smith, 1952: 314; Collette, 1966: 848). The distribution generally is along the coasts of most continents and nearby islands in areas of warm water, from the shoreline to the vicinity of the continental shelf.

In Australia, the family is represented by two genera, *Halophryne* and *Batrachomoeus*. Previously only Ogilby (1908), De Beaufort (1962) and Taylor (1964) reviewed the Australian genera. Ogilby's work was the most

*Assistant Curator, Dept. of Fishes, Western Australian Museum.

comprehensive, but only dealt with four Queensland species. The other two works each involved two species from northern Australia. Whitley (1957) discussed generally five species from Australia, which he also listed in a later paper (1964: 54). In this review, three species of *Halophryne* and five species of *Batrachomoeus* are recognized; two members of the latter genus are herein described as new.

Australian batrachoidids represent a diverse group found at depths exceeding 180 metres, on coral reefs, and in estuaries. They are bottom dwellers and usually shelter under rocks, in caves or bury themselves in sand or mud. They are possibly nocturnal. At least one species, *Batrachomoeus occidentalis*, may migrate from deep water to shallower areas, possibly for reproductive purposes. The spines of the gill covers and dorsal fin are solid and non-venomous. Although the dentition of the two genera differs considerably, their diet is similar consisting of crustaceans (crabs and prawns), molluscs (bivalves, gastropods, chitons and octopuses), echinoderms (sand dollars) and fishes. Food is generally ingested whole. The stomach is capable of great expansion and can occupy the whole abdominal cavity.

Methods

The following abbreviations are used in the text to denote the institutions where the specimens examined are deposited: AM — Australian Museum, Sydney; BM(NH) — British Museum (Natural History), London; KFRS — Kanudi Fisheries Research Station, Papua New Guinea; QM — Queensland Museum, Brisbane; WAM — Western Australian Museum, Perth.

Type specimens have been lodged at AM, BM(NH) and WAM.

Specimens were measured with needle-point dial calipers to the nearest mm (to the nearest tenth of a mm for measurements less than 10 mm). The range for proportional measurements which appears in the species accounts is based on specimens in excess of 40 mm standard length (SL). The peculiar morphology of batrachoidid fishes necessitates the following definitions: Head length — from the anteriormost point of the upper jaw to the midpoint on the nape in line with both upper ends of the gill openings. Head depth — vertical distance from the midpoint between the ventral fin bases to the midline of the nape. Head width — greatest horizontal distance between the preopercular borders of each side. Eye — horizontal diameter of bony orbit. Interorbital — least width of bony interorbital. Snout length — from the anteriormost point of the upper jaw to the midpoint of a line joining the front borders of the eyes. Length of soft dorsal and anal fin bases — from the anterior base of the first ray to the point where the fin membrane meets the caudal peduncle. Lateral line count — this is expressed as the number of bifid tentacles in the upper series on the body, from the mucous pore above the base of the uppermost opercular spine to below the rear edge of the dorsal fin (only those tentacles with their bases arranged vertically, as opposed to

horizontally, are counted). Mucous pore size — the diameter of the largest pore in the preoperculo-mandibular series, usually second or third from tip of lower jaw (see Fig 1). Skin ridge — a raised, narrow fold of skin. When the last two rays of the soft dorsal and anal fins are joined at their bases, they are counted as a single ray (this condition occurs only rarely in *Batrachomoeus*).

Several skeletons of each species except *Halophryne queenslandiae* were studied, thus facilitating a comparison of skull and vertebral features. Where possible, the grooves in the transverse processes of the frontal bone were examined.

Morphology

The general shape of preserved specimens of the same species varies greatly, especially in the genus *Batrachomoeus*. Expanded gill cavities, arched napes, reduced tentacles and looseness of the skin are primarily responsible for this variability. Dentition is also variable due to the nature of the diet; many teeth may be lost, damaged or irregularly arranged, particularly on the vomer.

The sex in *Batrachomoeus* and *Halophryne* can be determined in most cases by examining the first two rays of the anal fin. In females, these rays are considerably differentiated from the rays following them, generally being prominent and the integument unpigmented (see Figs 7 and 12). In males, these rays are identical to those following, hidden by the integument of the fin (see Fig 13).

A slender, flexible spine is present in the angle made by the upper subopercular spine and the ventral limb of the opercular bone. This spine extends in the skin of the gill cover to a point just posterior to the uppermost spine. It possibly has a support function similar to that of the branchiostegal rays. This spine is relatively prominent in *Batrachomoeus* but may be difficult to detect in *Halophryne*. A bony swelling may form at the base of this spine in large specimens, giving the appearance of a further strong spine on the suboperculum.

The pores of these two genera fall into two categories:

Mucous pores — generally open round holes found only on the head, which may have a slender tentacle on the rim. Beneath the pores is a canal which runs along a groove in the underlying bone. There are five pairs of these canals and a single transverse one, supplying 30 or 32 pores. Fig. 1a-b shows the position of these pores in *Halophryne*. There is a series of nine pores along the lower surface of each half of the mandible continued along the preopercular border (preoperculo-mandibular pores). Two canals supply these pores, one in each bone. Three pores are located above the upper lip on each side of the snout, served by a canal in the supramaxilla. Two canals run along the interorbital space and join posteriorly a transverse canal at its midpoint

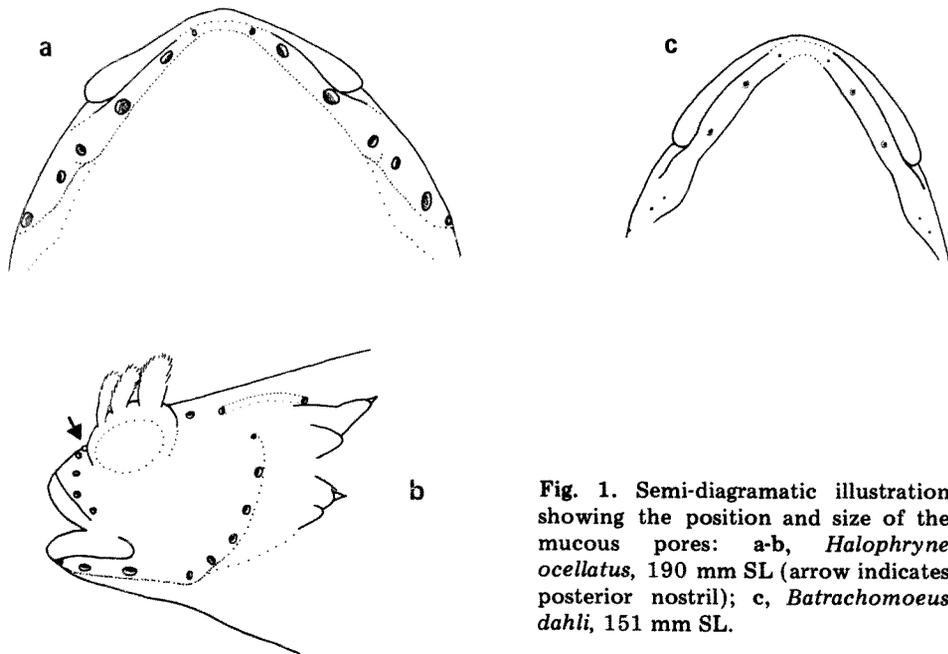


Fig. 1. Semi-diagrammatic illustration showing the position and size of the mucous pores: a-b, *Halophryne ocellatus*, 190 mm SL (arrow indicates posterior nostril); c, *Batrachomoeus dahli*, 151 mm SL.

(see grooves in frontal bone, Fig. 14). This canal system serves four pores, two on each side of the head. The anterior pore is located just anterior to the posterior nostril and the posterior one is found immediately behind the eye on the nape. The last pair of canals do not run in a bony groove but are contained in the skin of the nape. Each canal supplies two pores, one at each end, the anterior pore being located just posterior to the above mentioned pore behind the eye, and the posterior one is found above the base of the upper opercular spine (this canal can usually be seen in the skin). This arrangement is the same for *Batrachomoeus*, except that there is one less pore on the preopercular border. These pores vary in size considerably among the species of the two genera (see Figs. 1 and 2, Table 1).

Sensory pores — these are much smaller than the mucous pores and always surrounded by a bifid tentacle, generally occurring in series on the head and body. There is a single series below each eye, four series along the nape to the dorsal fin, and more or less scattered pores on the lower surface of the mandible, above the upper lip and on the gill covers. The sensory pores of the body are in three series with some scattered ones below the spinous dorsal. The first series commences above the upper opercular spine base and runs below the soft dorsal base to the upper caudal peduncle. The second series branches down from the first row, passes beneath the pectoral fin and continues intermittently along the middle of the side to the caudal peduncle. The last series commences either above the ventral fin base or below the pectoral base and extends along the anal base to the lower caudal peduncle

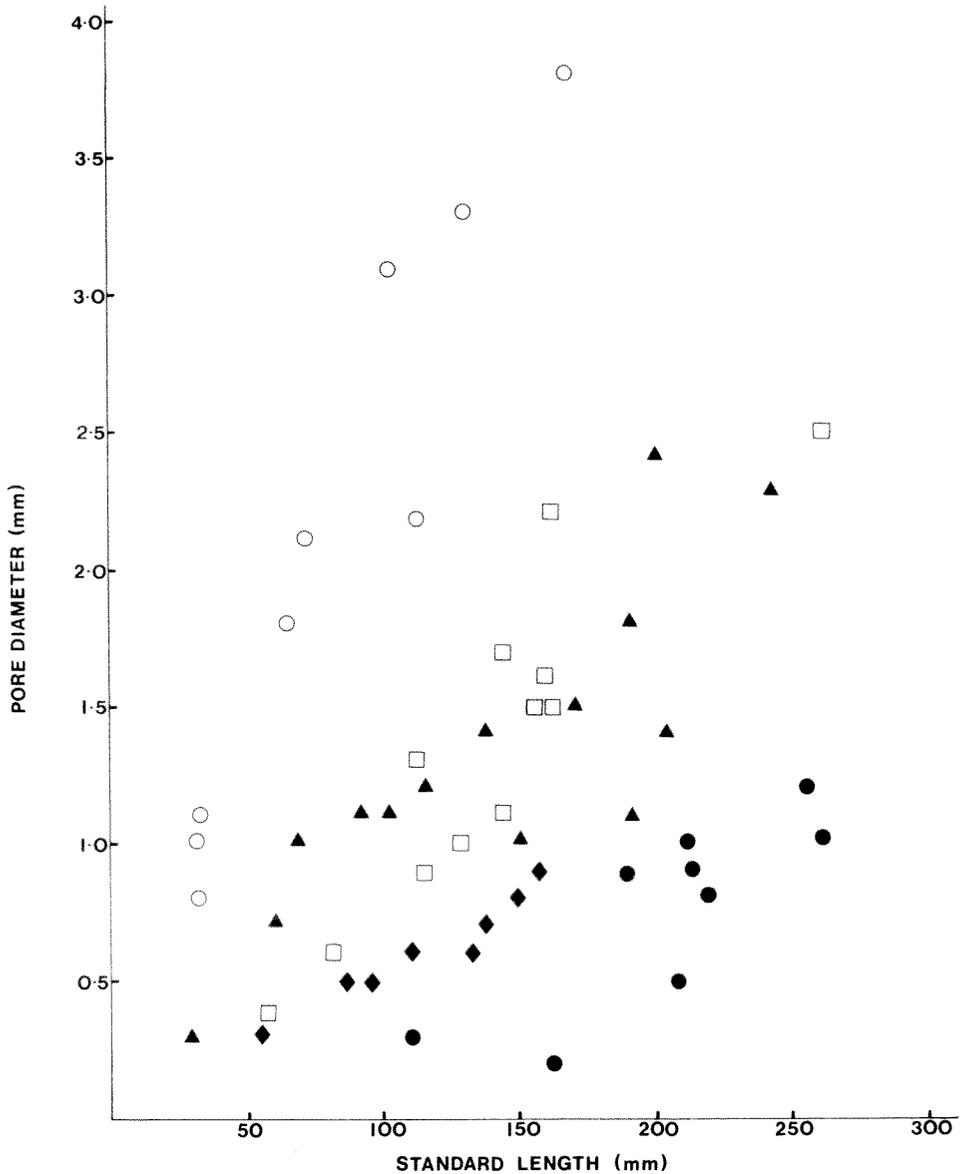


Fig. 2. Mucous pore diameters in *Batrachomoeus occidentalis* (empty circles), *B. dubius* (solid triangles), *B. rubricephalus* (solid circles), *B. trispinosus* (empty squares) and *B. dahli* (solid diamonds).

(see generic descriptions for variations in first and third series). Two series of pores extend a short distance onto the caudal fin.

An axillary pore is found in all species of the genus *Batrachomoeus*. It is located just below the upper termination of the gill opening which curves

back over the top of the pectoral fin base. The internal structure of this organ consists of many invaginated folds which suggests a secretory function. It varies in size among the species of the genus (see Table 1).

TABLE 1. Comparative pore sizes among the species of *Halophryne* and *Batrachomoeus*

| Species | Mucous pore size | Axillary pore size |
|-------------------------|---------------------|---------------------|
| <i>H. ocellatus</i> | Large | — |
| <i>H. diemensis</i> | Small to medium | — |
| <i>H. queenslandiae</i> | Large | — |
| <i>B. occidentalis</i> | Large to very large | Medium |
| <i>B. dubius</i> | Small to large | Medium to large |
| <i>B. rubricephalus</i> | Minute to small | Large to very large |
| <i>B. trispinosus</i> | Medium to large | Small to medium |
| <i>B. dahli</i> | Small | Small |

KEY TO THE AUSTRALIAN GENERA OF BATRACHOIDIDAE

- Gill slit present on upper $\frac{1}{2}$ to $\frac{2}{3}$ of pectoral base; mandible and palate with bands of small cardiform teeth (Fig. 3a); pore absent from pectoral axilla; 3 or 4 (nearly always 4) spines on gill cover; orbital tentacles nearly equal in size, middle one longest; 9 preoperculo-mandibular pores; vertebrae 10 + 18 — 19 *Halophryne*
- Gill slit embraces entire pectoral base, mandible and palate with strong conical teeth, mostly in one series (Fig. 3b); pore present in pectoral axilla; 3 spines on gill cover; orbital tentacles never nearly equal, middle one generally much smaller; 8 preoperculo-mandibular pores; vertebrae 9 + 17 — 21 *Batrachomoeus*

Genus *Halophryne* Gill 1863

Halophryne Gill, 1863: 170 (Type species: *Batrachoides diemensis* Lesueur, 1824, by monotypy).

Coryzichthys Ogilby, 1908: 50 (Type species: *Batrachoides diemensis* Lesueur, 1824, by original designation).

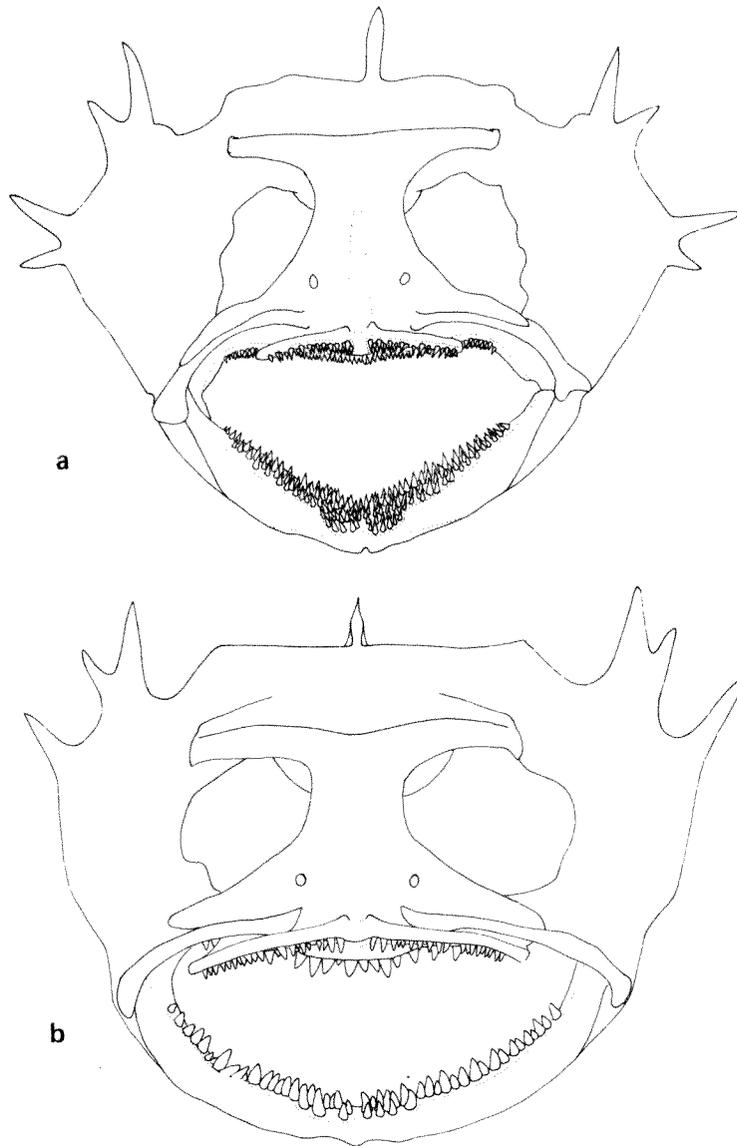


Fig. 3. Semi-diagrammatic illustration showing the dentition of a, *Halophryne ocellatus*, 170 mm SL; and b, *Batrachomoeus occidentalis*, 131 mm SL.

Description

Dorsal rays III, 19-21; anal rays 16-18; pectoral rays 22-24; segmented caudal rays 14-16; pores in lateral line 25-39; vertebrae 10 + 18 - 19.

Body cylindrical, compressed posteriorly; head somewhat depressed; snout short, rather blunt, rounded in profile; jaws equal, gape horizontal,

maxilla reaching to below centre of eye or slightly farther; eyes elevated, interorbital space concave; operculum with 2 divergent spines joined at their bases, upper about equal to eye, $\frac{1}{3}$ longer than lower spine; suboperculum with 1 or 2 spines, similar to above but relatively shorter; gill opening a vertical slit on upper $\frac{1}{2}$ to $\frac{2}{3}$ of pectoral fin base.

Skin smooth or with ridges, scaleless and loosely attached to head, body and fins; 3 tentacles above eye, either simple or multifid, the middle one slightly longer; simple and multifid tentacles on snout, arranged around mouth, along preopercular border and on gill cover; series of bifid tentacles on head and body (see preceding section on morphology); upper series of lateral-line pores commences above opercular spines, approaches spinous dorsal base and continues to upper caudal peduncle; lower series of pores commences just superior and anterior to ventral fin, runs along side of abdomen, above anal base to lower caudal peduncle; open mucous pores on head small to large (see morphology section); 9 preoperculo-mandibular pores; pectoral axillary pore absent; anterior nostril tubular, projecting forwards on each side of snout tip; posterior nostril near inner front border of eye, without an elongate rim.

Jaws, palate and pharyngeals with bands of sharp, cardiform teeth (villi-form in small specimens); premaxilla with 1-3 series of small teeth, widening near symphysis to form 2-4 series; teeth on vomer and palatines larger and in 3-5 series (a few slightly larger teeth may be present posteriorly on palatines); mandibular teeth similar in size to those on palate, in 2-4 series expanding near symphysis forming 2 round or rectangular patches; teeth on lower pharyngeals canine-like, larger than those on palate, in 3-5 series, the bands



Fig. 4. The hyoid and branchial arches structure of left, *Halophryne ocellatus*, 170 mm SL; and right, *Batrachomoeus dahli*, 151 mm SL.

of teeth on each side meeting in the form of a V (Fig. 4); those on upper pharyngeals separated into anterior and posterior bands, the anterior teeth small, villiform, and posterior teeth larger, especially near symphysis and posteriorly; 3-5 knob-like gill rakers on lower limb of each gill arch (those on first arch elongated), terminating in small patches of divergent teeth.

Origin of dorsal fin at or just behind rear border of head; spinous dorsal covered by thick skin, joined to soft dorsal by a low fold of skin; rays of soft dorsal, except last 2-3, about equal in length; rays of anal, except first 2-3 and last 2-3, about equal but shorter than those of soft dorsal; pectoral and caudal rounded, about equal in length; ventral fin consists of one hidden spin and 2 rays, the first much longer and fleshier, equal to pectoral.

KEY TO THE SPECIES OF *HALOPHRYS*

- 1a Body with numerous small ocelli; last 2 body bars not joined medially; skin ridges absent from head and anterior portion of body; preoperculo-mandibular pores always large (Fig. 1a) (Western Australia) *ocellatus*
- 1b Body without ocelli; last 2 body bars joined medially; skin ridges generally present on head and anterior portion of body; preoperculo-mandibular pores small to large (Fig. 1) 2
- 2a Four spines on gill cover; skin ridges always on head, arranged longitudinally; preoperculo-mandibular pores small to medium (Western Australia, Northern Territory and Queensland) *diemensis*
- 2b Three spines on gill cover; skin ridges on head, if present, forming intersecting network; preoperculo-mandibular pores medium to large (Queensland) *queenslandiae*

Halophrys ocellatus Hutchins 1974

Figs. 1a-b, 3a, 4 and 5

Halophrys ocellatus Hutchins, 1974: 115, figs. 1, 2a and 3a. (Type locality: Houtman Abrolhos, Western Australia).

Diagnosis

Dorsal rays III, 20-21; anal rays 17-18; pectoral rays 22-23; segmented caudal rays 14-15; pores in lateral line 26-30.

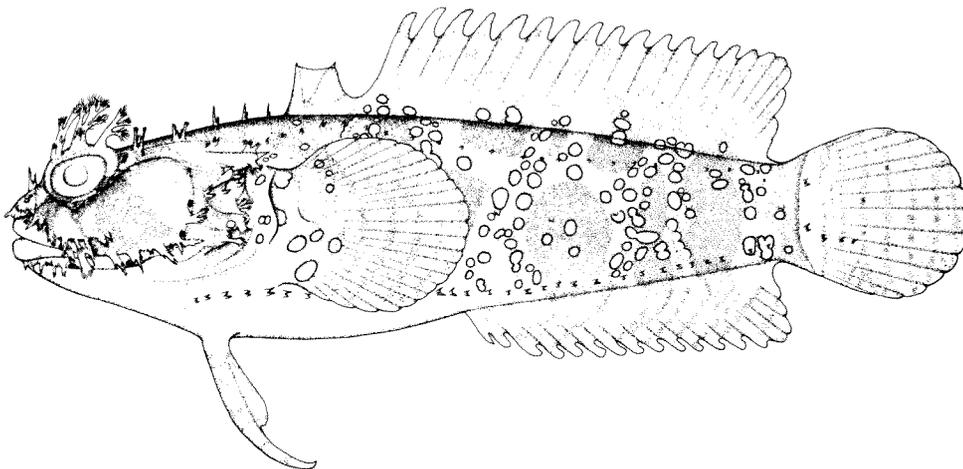


Fig. 5. *Halophryne ocellatus*, WAM P.3364, 138 mm SL.

Head length 2.6-3.1, head depth 3.5-3.8, both in SL; eye 3.0-4.2, snout 4.9-9.0, head depth 1.2-1.5, head width 1.0-1.2, anal base 0.8-0.9, pectoral 1.3-1.5, all in head length; interorbital 1.5-3.6, first dorsal spine 1.0-1.7, both in eye.

Operculum and suboperculum each with 2 prominent spines; preoperculo-mandibular pores large (1.2-3.4 mm in diameter for specimens larger than 100 mm SL); skin ridges absent from head and beneath pectoral fins; orbital tentacles large, about equal to eye, multifid and fringed at extremities; 4 prominent bifid tentacles across occiput immediately behind orbital region nearly in a straight line; grooves in frontal bone of skull wide and deep (see Hutchins, 1974, Fig. 2a); lateral processes of frontal are only slightly directed posteriorly.

Colour in alcohol — Pale brown with dark brown blotches forming 8-9 irregular transverse bars, first across interorbital and last on caudal peduncle, never joined to the preceding bar; sides and head with scattered white ocelli outlined by prominent blackish-brown margins, may be small or great in number and may merge to form blotches; ocelli generally absent or scarce on fins and ventral surface; fins with series of transverse bars, those on soft dorsal and anal forming a continuation of body bars, angled obliquely forward, becoming more numerous and breaking up into small blotches with increasing size (see Hutchins, 1974, fig. 1); the presence of a mucous coating imparts a yellowish-brown colour.

Distribution

H. ocellatus is found only in Western Australia (Fig. 8). Only three specimens have been collected north of Exmouth Gulf and one south of the Houtman Abrolhos. Unlike *H. diemensis*, this species does not appear to

frequent intertidal and shallow water areas. It has been collected by trawl net and craypot in 20-40 metres.

Material examined

30 specimens, 20-231 mm SL. (Unless otherwise designated, all specimens at WAM). Fremantle — AM I.7029, 120 mm SL. Houtman Abrolhos area — P.3364, 138 mm SL; P.5956, holotype, 190 mm SL; P.24829, 231 mm SL; P.24991, 71 mm SL. Shark Bay — P.5851, 2 specimens, 109-127 mm SL; P.5955, 102 mm SL; P.6149, 136 mm SL; P. 6260, 130 mm SL; P.8169; skeleton, 152 mm SL; P.13767-9, 3 specimens, 75-98 mm SL; P.14653, 101 mm SL; P.14702, 79 mm SL; P.14883, 125 mm SL; P.23604, 99 mm SL; P.24830, 23 mm SL; P.24990, 65 mm SL; P.24993, 2 specimens, 52 mm SL; P.25045-001, 52 mm SL. Exmouth Gulf — P.9393-4, 2 specimens, 43-45 mm SL; P.12073, 38 mm SL; P.16296, 102 mm SL. Onslow — P.24562, 101 mm SL. Dampier Archipelago — P.7148, 47 mm SL. Broome — P.16483, 88 mm SL. Unknown locality — P.25046-001, 20 mm SL; P.25058-001, skeleton, 170 mm SL.

Halophryne diemensis (Lesueur) 1824

Fig. 6

Batrachoides diemensis Lesueur, 1824: 402 (Type locality: Coasts of Van Diemens Land) (apparently near Darwin, Northern Territory — see discussion under Remarks).

Batrachus quadrispinis Valenciennes, 1837: 487 (Type locality: Indian Ocean).

Batrachus diemensis Richardson, 1843: 352; Richardson, 1844-48: 17, pl. 8; Günther, 1861: 170; Günther, 1867: 61; Macleay, 1878: 355; Macleay, 1881: 573; Weber, 1913: 556.

Batrachus mulleri Klunzinger, 1879: 387 (Type locality: Darwin); Macleay, 1884: 29.

Batrachus grunniens (non Linnaeus) Macleay, 1882: 360.

Marcgravia diemensis Jordan & Richardson, 1908: 282.

Coryzichthys diemensis Ogilby, 1908: 51; McCulloch, 1926: 39; Whitley, 1927: 30; Paradice & Whitley, 1927: 94, 96; Fowler, 1928: 447; McCulloch, 1929: 359; Whitley, 1932: 300.

Coryzichthys guttulatus Ogilby, 1910: 42 (Type locality: Aru Islands, south of New Guinea).

Halophryne diemensis Whitley, 1937: 144; Whitley, 1948: 28; De Beaufort, 1962: 189; Taylor, 1964: 299, pl. 67; Marshall, 1964: 508, pl. 63; Munro, 1967: 575, pl. 77; Grant, 1972: 358, pl. 85; Hutchins, 1974: 120, figs. 2b, 3b.

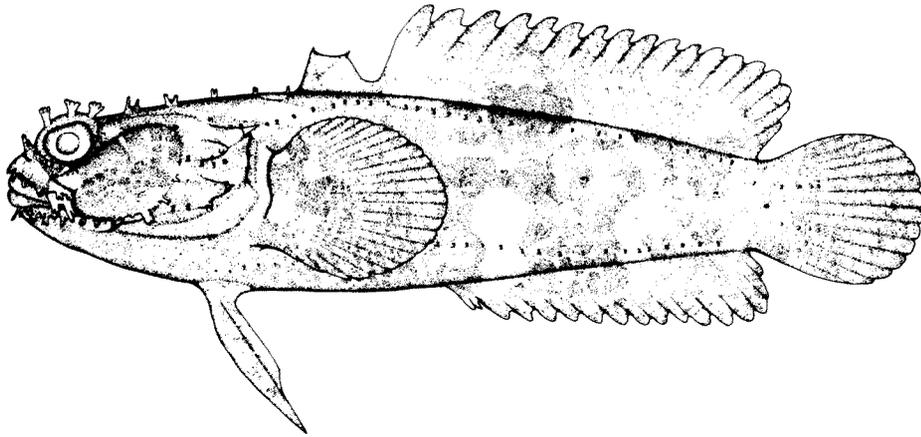


Fig. 6. *Halophryne diemensis*, AM I.15641-002, 111 mm SL.

Diagnosis

Dorsal rays III, 19-21; anal rays 16-18; pectoral rays 22-24; segmented caudal rays 14; pores in lateral line 30-39.

Head length 2.5-2.9, head depth 3.4-4.8, both in SL; eye 3.3-5.1, snout 6.2-8.0, head depth 1.4-1.9, head width 1.0-1.3, anal base 0.8-1.1, pectoral 1.4-2.0, all in head length; interorbital 1.5-5.0, first dorsal spine 1.4-2.0, both in eye.

Operculum and suboperculum each with 2 spines, upper 3 prominent, lowest small to medium but always present; preoperculo-mandibular pores small to medium (0.5-1.8 mm in diameter for specimens larger than 100 mm SL); many longitudinal skin ridges on head becoming thicker and more reticulated beneath pectoral fin; orbital tentacles either small and simple or medium and multifid; 4 prominent bifid tentacles across occiput immediately behind orbital region not in a straight line, central 2 more advanced; grooves in frontal bone generally narrow and shallow (see Hutchins, 1974, fig. 2b); lateral processes of frontal are prominently directed posteriorly.

Colour in alcohol — Australian specimens of *H. diemensis* can be generally divided into three colour varieties: spotted (Western Australia and Northern Territory), non-spotted ornate (Northern Territory and Queensland) and non-spotted plain (Western Australia). These are all variations of a basic colour pattern which consists of about 8 brown to dark brown transverse bars on a pale brown ground. The last 2 body bars are joined medially.

Spotted variety (see Hutchins, 1974, fig. 3b): head and body spotted with black dots and small blotches; fins either pale with narrow dark transverse bars, sloping obliquely forward on soft dorsal and anal, or pale and covered with black spots and blotches (type description was based on a specimen with this colour pattern).

Non-spotted ornate variety (see Fig. 6): brown bars on head and body

generally broken up into a few or many irregular blotches; fins mostly covered with irregular sized blotches in a reticulated pattern and pale narrow transverse bars may be present; a prominent reticulated pattern of brown blotches on lower surface of abdomen, throat and lower jaw, increasing in number with size; a combination of this colour pattern and the above (i.e. spotted ornate) may occur rarely.

Non-spotted plain variety: transverse bars paler, sometimes hard to distinguish from ground colour, especially in large specimens; fins usually immaculate, but bars on median fins sometimes discernible.

Colour in life — Spotted variety (from a colour transparency of an aquarium specimen collected at Point Samson, Western Australia): transverse body bars generally dark brown but those near pectoral fin blackish; 2 black blotches readily discernible, one on spinous dorsal, the other at base of 6th to 9th soft dorsal rays; ground colour pale brown becoming whitish on soft dorsal and anal; bars on these fins honey-brown, greyish-brown on others; spots black with obscure brown margins; all tentacles tipped with white; lips dark brown.

Non-spotted ornate variety (see Grant, 1972: 359, colour-plate 85): background generally yellow, bars dark brown; lips blackish-brown.

Non-spotted plain variety (from observations of an aquarium specimen at Shark Bay, Western Australia): ground colour pale olive-brown, transverse bars darker; tips of tentacles white.

Distribution

The range of *H. diemensis* extends from Shark Bay in Western Australia, across the northern half of Australia to Heron Island, off the southern Queensland coast (Fig. 8). It has been widely recorded throughout the Indo-Malay Archipelago (see De Beaufort, 1962: 190). It is found intertidally as well as trawled in depths up to at least 20 metres. Specimens have been collected from inshore rock pools and caves on the outer reef slope.

Remarks

Lesueur (1824) gave the distribution of *Batrachoides diemensis* as the 'Coasts of Van Diemens Land'. Richardson (1842: 352) interpreted this as Tasmania. In 1908, Ogilby noted that this species had not been found in Tasmania since it was supposedly described from there. McCulloch (1929: 359) recorded the type locality as Shark's Bay, Western Australia, but gave no reason for this.

Lesueur (1824) described *Batrachoides diemensis* from a drawing of a fish collected by Péron during the explorations of Nicholas Baudin in 1800-1804. As well as visiting Tasmania (then known as Van Diemen's Land), the expedition explored along the Western Australian-Northern Territory coast as far north as the area now known as Darwin (see Péron & Freycinet, 1807-16, 2: 287-8). Early Dutch and French maps refer to the north-west

corner of the Northern Territory as Van Diemen's Land, and Arnhem Land is used for the north-east corner (see Skelton, 1970: 221 and Tooley, 1970: 121). Van Diemen's Land of the north, as it was often referred to, was named in 1636 by Pieter Pieterszoon, six years before Tasman discovered Tasmania. It is therefore reasonable to assume that the type locality designation referred to the north-west corner of the Northern Territory rather than Tasmania.

Specimens of *Halophryne diemensis* either have moderate-sized multifid orbital tentacles (Fig. 6) or small simple ones (see Taylor, 1964: 300, pl. 67). Specimens examined from Queensland have moderate orbital tentacles, all but one from the Northern Territory have small tentacles and one-third of those from Western Australia possess small tentacles. Specimens from New Guinea and Christmas Island possess moderate orbital tentacles.

Material examined

62 specimens, 45-233 mm SL. Western Australia (WAM specimens): Shark Bay — P.4346, 233 mm SL; P.5954, 207 mm SL. Exmouth Gulf & North West Cape — P.4344, 138 mm SL; P.23408-9, 2 specimens, 134-160 mm SL; P.23769, 218 mm SL; P.25052-001, 204 mm SL; P.25054-001, 2 specimens, 45-67 mm SL; P.25055-001, 66 mm SL; P.25057-001, 162 mm SL. Onslow — P.15578, 144 mm SL; P.25050-001, 170 mm SL. Barrow Island — P.25047-001, 99 mm SL; P.25053-001, 2 specimens, 106-142 mm SL. Dampier Archipelago — P.4323, 170 mm SL; P.7615, 161 mm SL; P.25051-001, 154 mm SL; P.25056-001, 2 specimens, 99-109 mm SL. Port Hedland — P.3567, skeleton, 204 mm SL; P.3588, 192 mm SL; P.4324, 175 mm SL; P.15289-90, 2 specimens, 140-164 mm SL. Broome — P.13696, skeleton, 136 mm SL; P.13697, 98 mm SL; P.13703, 178 mm SL; P.16489, 94 mm SL; P.25048-001, 77 mm SL; P.25049-001, 159 mm SL. Yampi Sound — P.6156-7, 2 specimens, 99-124 mm SL; P.16485, 61 mm SL. 'North West Coast' — P.577, 2 specimens, 105-108 mm SL. Northern Territory (AM specimens): Darwin — I.10441, 136 mm SL. IA.1715-6, 2 specimens 48-78 mm SL; IA.7749, 155 mm SL. Cape Don — IB.7641, 2 specimens, 113-123 mm SL. Queensland: Thursday Island — QM I.8221, 172 mm SL. Esk Island, Palm Group — QM I.12486, 120 mm SL. Swain Reefs — AM IB.6043, 160 mm SL. Tryon Island, Capricorn Group — AM I.15610-006, 149 mm SL. One Tree Island, Capricorn Group — AM I.15641-002, 111 mm SL; AM I.15680-002, 164 mm SL; AM I.15683-001, 159 mm SL. Heron Island, Capricorn Group — QM I.9547, 170 mm SL; QM I.11417, 203 mm SL; AM IB.5241, 72 mm SL; AM IB.5376, 167 mm SL. New Guinea (unless otherwise designated, all specimens at KFRS): Taurama Beach, Bootless Bay — FO.752, 167 mm SL; FO.786, 2 specimens, 84-110 mm SL. Port Moresby — FO.1250, 166 mm SL. Tuma Island, Louisiade Archipelago — FO.1701, 178 mm SL. Bristow Island, Western Papua — FO.1975, 112 mm SL. 'South coast of New Guinea' — AM I.13402, 180 mm SL. Christmas Island, Indian Ocean: WAM P.21803, 121 mm SL.

Halophryne queenslandiae (De Vis) 1882

Fig. 7

Batrachus dussumieri (non Valenciennes) Klunzinger, 1879: 386.

Porichthys queenslandiae De Vis, 1882: 370 (Type locality: Dunk Island, Queensland).

Coryzichthys diemensis Ogilby, 1908: 51 (in part).

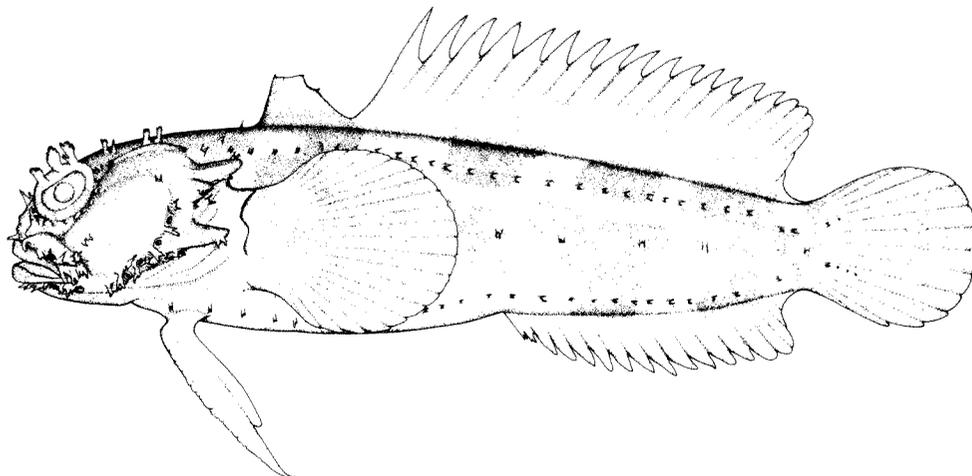


Fig. 7. *Halophryne queenslandiae*, QM I.6628, 212 mm SL.

Diagnosis

Dorsal rays III, 20; anal rays 16-17; pectoral rays 22-23; segmented caudal rays 14; pores in lateral line 25-29.

Head length 2.8-2.9, head depth 4.1-4.4, both in SL; eye 3.6-4.4, snout 6.6-7.4, head depth 1.4-1.5, head width 1.1-1.3, anal base 0.8-0.9, pectoral 1.4-1.7, all in head length; interorbital 1.5-3.7, first dorsal spine 1.2-1.5, both in eye.

Operculum with 2 spines, suboperculum with 1; preoperculo-mandibular pores medium to large (1.1-3.0 mm in diameter for specimens larger than 100 mm SL); skin ridges on head, when present, in the form of intersecting network, not prominently longitudinal, tend to form concentric semi-circles beneath pectoral fin; orbital tentacles medium to large, multifid; grooves in frontal bone moderately wide and deep.

Colour in alcohol — Head and body dark brown with darker ill defined transverse bars, the last 2 body bars joined medially; lower surface of abdomen and breast pale, no prominent small blotches; body bars continued

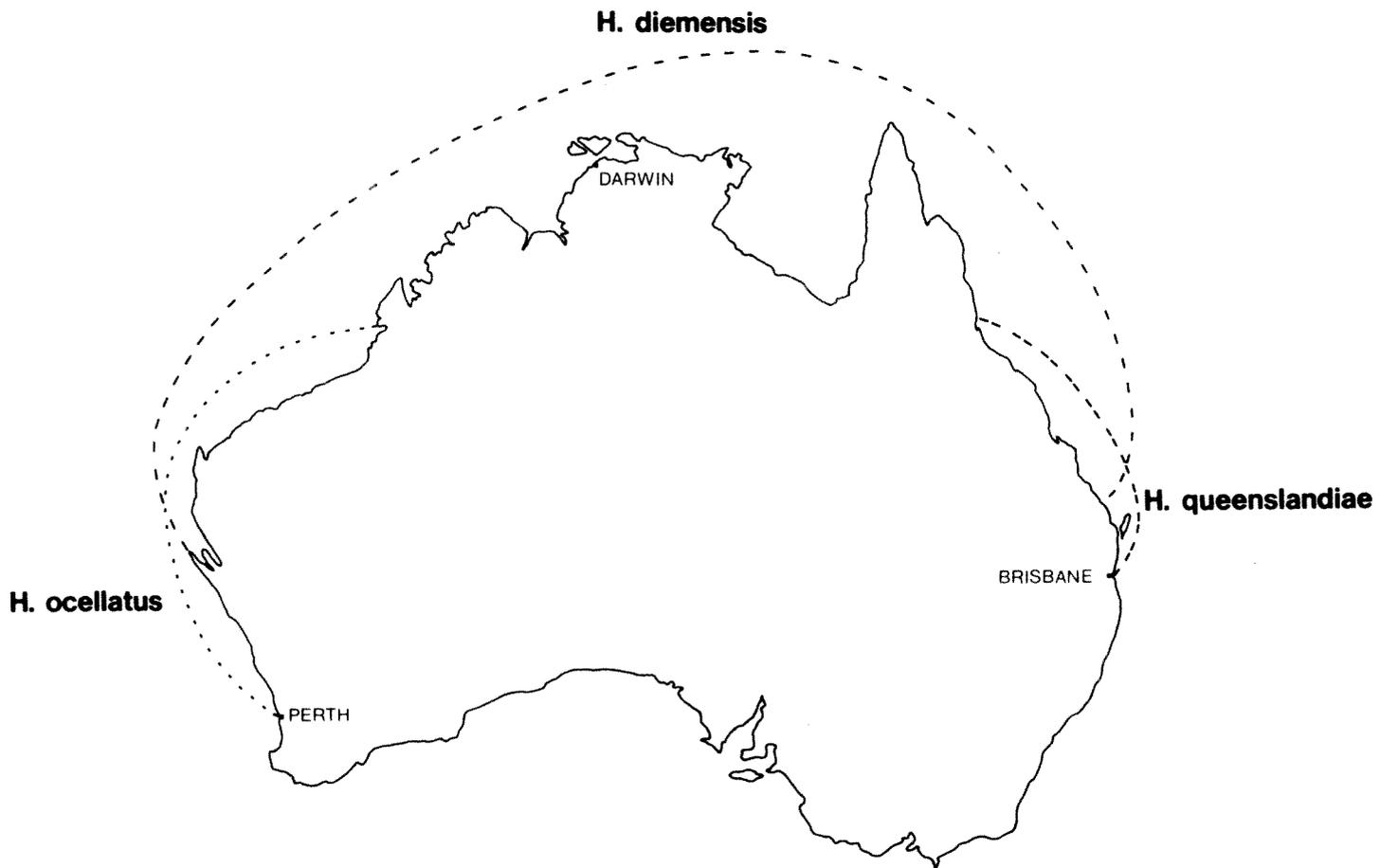


Fig. 8. Map of Australia showing distribution of the species of *Halophryne*.

on soft dorsal and anal, ill defined and angled obliquely forward; caudal and pectoral fins immaculate or with a series of pale transverse bars, thin and irregular (all specimens examined have very poor colour patterns due to long preservation).

Distribution

H. queenslandiae appears to be restricted to Queensland, from the Brisbane River to Dunk Island in the north (Fig. 8). It has been collected from islands close to the coast, and also from the Brisbane River estuary.

Remarks

Previous authors have usually included this species in the synonymy of *H. diemensis* on the assumption that the lower subopercular spine of the latter species may be small and therefore difficult to detect. Ogilby, in his revision of the batrachoidid fishes of Queensland (1908), noted that in twelve specimens of *H. diemensis* he examined, the lower subopercular spine was absent in four, but no other differences were evident; however, he was unable to examine the types of *Porichthys queenslandiae* as, according to him, they were missing. Examination of four specimens lacking the lower subopercular spine by the present author revealed morphological distinctions indicated in the above diagnosis.

De Vis's description is poor, giving little indication as to what genus or species he was describing. He placed his new species in the genus *Porichthys* as he recorded only two spines in the spinous dorsal and small canines on the vomer. Examination of the type (QM I.3735) showed that there are three dorsal spines (the third can be difficult to detect in some specimens of *Halophryne* and *Batrachomoeus*). In addition, enlarged teeth on the palate is a relatively common occurrence in all species of *Halophryne*.

Material examined

4 specimens, 94-212 mm SL. (Unless otherwise designated, all specimens at QM). Dunk Island — I.3735, type, 94 mm SL. Moreton Island — I.6628, 212 mm SL. Brisbane River — AM I.9500, 116 mm SL. South-east Queensland — I.8256, 138 mm SL.

Genus *Batrachomoeus* Ogilby 1908

Pseudobatrachus Castelnau, 1875: 24 (Type species: *Pseudobatrachus striatus* Castelnau, 1875, by monotypy; preoccupied by *Pseudobatrachus* Peters, 1873, an amphibian).

Pelophiletor Ogilby, 1906: 9 (Type species: *Pelophiletor caloundrae* Ogilby, 1906, by monotypy). Nomen nudum, no description given.

Batrachomoeus Ogilby, 1907: 10 (Type species: *Thalassophryne coecus* De Vis, 1884, by original designation). Nomen nudum, no description given.

Batrachomoeus Ogilby, 1908: 45 (Type species: *Batrachomoeus minor* Ogilby, 1908, by subsequent designation of McCulloch, 1929: 358).

Description

Dorsal rays III, 19-24; anal rays 15-20; pectoral rays 21-23; segmented caudal rays 13-16; pores in lateral line 22-38; vertebrae 9 + 17 - 21.

Body cylindrical, compressed posteriorly; head considerably depressed; snout moderate, flat or slightly arched; lower jaw protruding, gape generally horizontal; maxilla reaching to below posterior half of eye or further; eyes large, elevated or only slightly; interorbital space concave to flat, increasing noticeably in width with size; operculum with 2 divergent spines joined at their bases, upper about equal to eye, $\frac{1}{3}$ longer than lower; suboperculum with one spine, either equal to or somewhat shorter than upper opercular one; a flexible spine always present on upper base of subopercular spine, extending to near tip of upper opercular spine (base of this spine may become enlarged and bonelike with age); gill opening moderate, encompassing base of pectoral fin.

Skin smooth and scaleless, loosely attached to head, body and fins; 3-4 tentacles above each eye, posterior one largest, middle smallest, all may be very reduced; small or medium frontonasal tentacle present; simple and multifid tentacles arranged around mouth, along preopercular border and on gill cover; series of bifid tentacles on head and body (see preceding section on morphology); upper series of lateral line pores commences above opercular spines, runs back along upper side, generally rising to near soft dorsal base at middle of fin, and continues to upper caudal peduncle; lower series of pores commences below or just anterior to pectoral fin base, runs along side of abdomen, above anal base to lower caudal peduncle; open mucous pores small to large, 8 in preoperculo-mandibular series (see morphology section); anterior nostril tubular, projecting forwards and upwards from each side of snout tip; posterior nostril near inner front border of eye, without an elongated rim; a small to large pore present in upper portion of pectoral axilla.

Teeth on mandible, vomer and palatines strong and conical, generally in one series except near symphysis of mandible where they are in 2-3 series (teeth on vomer sometimes in several irregular series, which could be due to damage caused by feeding); premaxillary teeth smaller, more acute, in 1-2 series posteriorly, 2-3 series near symphysis; upper and lower pharyngeal teeth cardiform, in 3 series, the posterior row consisting of the largest teeth; lower pharyngeal teeth generally in irregular rows, the bands on each side meeting in the form of a U (Fig. 4); 5-7 low knob-like gill rakers on lower limb of each gill arch, terminating in prominent patches of divergent teeth.

Origin of dorsal fin at or just before rear border of head; spinous dorsal covered by thick skin, joined to soft dorsal by a low fold of skin; soft dorsal rays, except last 2-3, about equal in length; anal rays, except first 2-3 and last 2-3 about equal in length, shorter than those of soft dorsal; pectoral and caudal rounded, about equal in length; ventral fin consists of one hidden spine and 2 rays, first somewhat longer and fleshier, second with 3-4 branches, former equal to or less than length of pectoral.

Remarks

Ogilby introduced his new genus *Pelophiletor* in 1906 to accommodate a single species, *caloundrae*, also new. Both the genus and species were included in a list without an accompanying description. The following year he withdrew both names and replaced them with another new genus and species, *Batrachomoeus minor* (1907: 10 and 13). Besides indicating that a description of *Batrachomoeus minor* had been published earlier that year (misprint?), this name was also listed without description, and he gave no reason for withdrawing *Pelophiletor caloundrae*. It was not until the following year, 1908, that a generic and specific description for *Batrachomoeus minor* was published. Therefore, Ogilby's generic names prior to 1908 are not valid.

De Beaufort (1962), followed by Nagabhushanam & Rama Rao (1970), placed *Batrachomoeus* in the synonymy of *Halophryne*. On the basis of the characters already mentioned in the key to the genera, this is considered incorrect.

KEY TO THE SPECIES OF *BATRACHOMOEUS*

- | | | | |
|----|--|--------|---|
| 1a | Dorsal fin rays III, 19-20; anal fin rays 15-17; colour pattern not marbled, consisting of separate transverse bars on body, with or without blotching; vertebrae 9 + 17 - 18 | | 2 |
| 1b | Dorsal fin rays III, 21-24; anal fin rays 17-20 (rarely 17); colour pattern generally marbled, the transverse body bars either joined medially (Fig. 16) or the last 3 separate (Fig. 13); vertebrae 9 + 19 - 21 | | 3 |
| 2a | Usually 3 sets of double transverse bars on body, posterior to pectoral fin (Fig. 9); small dark blotches on body absent; pectoral and caudal fins pale, with narrow transverse bars; preoperculo-mandibular pores large to very | | |

- large (Fig. 2); head length 2.1-2.4 in SL, greater than length of anal fin base (Western Australia) *occidentalis* n. sp.
- 2b Two wide transverse bars on body, with scattered small dark and pale blotches (Fig.11); pectoral and caudal fins dark, with scattered pale blotches, round and in irregular rows on pectoral, few in number on caudal; preoperculo-mandibular pores small to large (Fig. 2); head length 2.5-3.0 in SL, less than length of anal fin base (New South Wales and Queensland) *dubius*
- 3a Prominent depression on head behind orbital region; maxilla extends to below pupil or slightly farther; pink bars and blotches may be present on head; pectoral and caudal fins dark with large scattered white blotches (Fig. 12); oblique bars on anal fin absent; preoperculo-mandibular pores minute to small (Fig. 2); pore in pectoral axilla large to very large (Western Australia) *rubricephalus* n. sp.
- 3b Depression on nape absent; maxilla extends to below posterior border of eye or further; pectoral and caudal fins with series of dark transverse bars (Figs. 13 and 16); oblique bars on anal fin; preoperculo-mandibular pores small to large; pore in pectoral axilla small to medium 4
- 4a Head length 0.9-1.0 in length of anal fin base; interorbital relatively wide (Fig. 15); preoperculo-mandibular pores medium to large (Fig. 2); dorsal surface of head usually with well contrasted bars and blotches (Western Australia, Northern Territory and Queensland) *trispinosus*
- 4b Head length 0.7-0.8 in length of anal fin base; interorbital relatively narrow (Fig. 15); preoperculo-mandibular pores small (Figs. 1c and 2); dorsal surface of head uniform brown or with poorly contrasting bars and blotches (Western Australia) *dahli*

Batrachomoeus occidentalis n. sp.

Figs. 3b, 9 and 10; Table 2

Holotype

WAM P.23702, 169 mm SL, male, collected near Sunday Island, Exmouth Gulf, Western Australia, by prawn trawl in 14-20 metres, R. Rowe, August 1973.

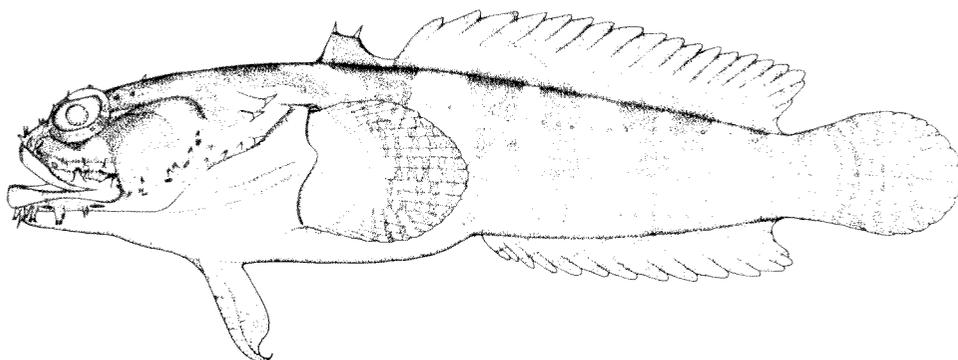


Fig. 9. *Batrachomoeus occidentalis*, n. sp., holotype, WAM P.23702, 169 mm SL.

Paratypes

9 specimens, 32-169 mm SL (unless otherwise designated, all specimens at WAM). P23876-7, 2 specimens, the larger a skeleton, 113-131 mm SL, 11 kilometres W of North West Cape, trawled in 150 metres, R. Rowe, August 1973; P.9343, 32 mm SL, DM1/24/64, HMAS *Diamantina*, 1 February 1964, no other data; AM I.18472-001, 62 mm SL, SW of Dongara, station 214 (29° 49'S, 114° 22'E), 140-144 metres, HMAS *Diamantina*, 11 October 1963; BM(NH). 1975. 10.10.1, 66 mm SL, W of Dongara, station 56 (29° 18'S, 114° 04'E), 170-174 metres, HMAS *Diamantina*, 20 March 1972; P.25091-001, 32 mm SL, NW of Green Head, station 66 (29° 59'S, 114° 25'E), 146 metres, HMAS *Diamantina*, 22 March 1972; P.25092-001, 33 mm SL, W of Rottnest Island, station 78 (32° 00'S, 115° 15'E), 146-150 metres, HMAS *Diamantina*, 23 March 1972; P.25093-001, 2 specimens, 73-104 mm SL, NW Rottnest Island, 160 metres, W. & W. Poole on *Bluefin*, 15 September 1965.

Diagnosis

A species of *Batrachomoeus* characterized by the following combination of characters: low dorsal and anal fin ray counts (D.III, 19-20; A.15-16); large puggish head (2.1-2.4 in SL); large preoperculo-mandibular pores (2.2-3.8 mm in diameter); colour pattern generally consisting of 3 double transverse bars on body behind pectoral fin and transverse bars on pectoral and caudal fins.

TABLE 2. Measurements in mm and fin ray counts of selected type specimens of *Batrachomoeus occidentalis*

| | Holotype WAM P.23702 | WAM P.23877 | WAM P.25093-001 | Paratypes BM(NH) 1975.10.10.1 | WAM P.9343 | WAM P.25091-001 |
|-------------------------|----------------------------|----------------|--------------------|-------------------------------------|---------------|--------------------|
| Total length | 216 | 143 | 128 | 84 | 43 | 42 |
| Standard length | 169 | 113 | 104 | 66 | 32 | 33 |
| Soft dorsal fin base | 93 | 56 | 55 | 34 | 15 | 17 |
| Anal fin base | 66 | 44 | 37 | 25 | 13 | 13 |
| Head length | 72 | 50 | 46 | 29 | 15 | 15 |
| Head depth | 42 | 28 | 28 | 19 | 8.0 | 7.2 |
| Head width | 65 | 41 | 41 | 26 | 13 | 12 |
| Eye diameter | 17 | 11 | 12 | 8.8 | 4.0 | 4.7 |
| Interorbital width | 9.2 | 5.5 | 4.3 | 3.5 | 0.8 | 0.8 |
| Snout length | 10 | 7.0 | 7.3 | 5.0 | 2.6 | 2.4 |
| Pectoral fin length | 38 | 25 | 21 | 14 | 8.0 | 8.0 |
| Ventral fin length | 32 | 22 | 23 | 13 | 9.0 | 8.0 |
| 1st dorsal spine length | 10 | 7.5 | 6.0 | 5.5 | 1.8 | * |
| 2nd dorsal spine length | 11 | 7.7 | 7.0 | * | 2.3 | * |
| Longest dorsal ray | 23 | * | 15 | * | * | * |
| Longest anal ray | 20 | * | 12 | * | * | * |
| Mucous pore diameter | 3.8 | 2.2 | 3.1 | 1.8 | 1.0 | 0.8 |
| Axillary pore diameter | 2.0 | 1.5 | 0.9 | 0.9 | * | 0.6 |
| Soft dorsal ray count | 20 | 20 | 19 | 19 | 19 | 20 |
| Anal ray count | 16 | 16 | 16 | 15 | 15 | 16 |
| Pectoral ray count | 22 | 23 | 21 | 22 | 21 | 22 |
| Caudal ray count | 15 | 15 | 15 | 15 | 14 | * |
| Lateral line count | 30 | 28 | 22 | 24 | 24 | * |
| Sex | Male | Female | Male | Male | Juvenile | Juvenile |

* Some measurements and counts were not taken due to distortion and small size.

Description

Measurements and counts of the holotype and selected paratypes are presented in Table 2. Counts and proportions are given below for the holotype, followed by the range for the paratypes in parentheses.

Dorsal rays III, 20 (III, 19-20); anal rays 16 (15-16); pectoral rays 22 (21-23); segmented caudal rays 15 (13-15); pores in lateral line 30 (22-30); vertebrae (9 + 17 - 18).

Head length 2.3 (2.1-2.4), head depth 4.0 (3.5-4.0), pectoral 4.4 (4.0-5.0), all in SL; eye 4.2 (3.0-4.5), snout 7.2 (5.4-7.2), anal base, 1.1 (1.1-1.3), head depth 1.7 (1.5-1.9), head width 1.1 (1.1-1.2), all in head length; interorbital 1.7 (1.7-5.0), first dorsal spine 1.7 (1.6-2.3), both in eye.

In addition to the characters given for the genus, the following features are distinctive: eyes large, elevated; mouth wide, giving the head a distinctive pug-like appearance (Fig. 10); maxilla extends to below posterior border of eye or slightly farther; orbital tentacles usually flaps of skin with a fringed margin, considerably reduced in specimens over 100 mm SL; small fronto-nasal tentacle; upper series of lateral line pores generally do not rise noticeably below middle of soft dorsal fin base; mucous pores on head large to very large, preoperculo-mandibular series 2.2-3.8 mm in diameter for specimens over 100 mm SL (Fig. 2); premaxillary teeth in 1-2 series posteriorly, 2 series near symphysis; grooves in frontal bone relatively wide and deep; pore in pectoral axilla medium (0.9-2.0 mm in diameter for specimens over 100 mm SL).

Colour of holotype in 70% ethanol: head and body pale brown with 9-10 dark brown irregular transverse bars, those occurring behind pectoral fin tending to form 3 pairs; first bar joins anterior portion of eyes across interorbital, passes through eye and divides into 2 sections, one bar anteriorly to maxilla and the other sloping posteriorly across cheek to preopercular border; second bar always separated dorsally along its midline (Fig. 10); fins pale with series of dark transverse bars, those on soft dorsal and anal forming continuation of body bars, angled obliquely forward; bars on pectoral and caudal narrow with darker margins, increasing in number with size; occasionally bars on pectoral in a somewhat reticulated pattern.

Colour when fresh (frozen specimen): ground colour pale yellowish-green, paler on ventral surface of abdomen, breast and throat; bars on head and body dark brownish-green, those on fins lighter with dark brown margins; iris yellow.

Comparisons

B. occidentalis is easily distinguished from its closest relative *B. dubius* by the combination of characters indicated in the diagnosis. The most conspicuous of these are the large puggish head and colour pattern. Furthermore, *B. occidentalis* differs from *B. dubius* by having more prominent bars

on the dorsal surface of the head (Fig. 10), the second bar separated medially rather than being continuous, less prominent tentacles on head and body, orbital tentacles which are conspicuously fringed rather than smooth edged, larger mucous pores, enlarged elongated rims on the anterior nostrils, and by having grooves in the frontal which are relatively wider and deeper.

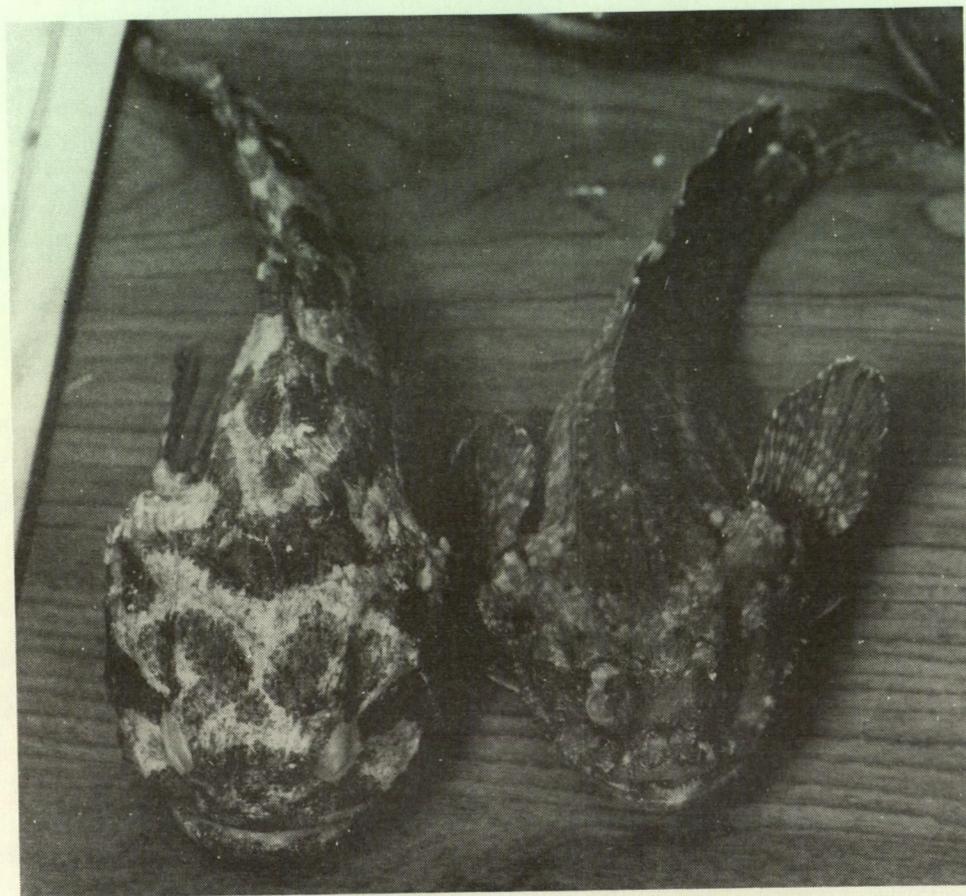


Fig. 10. Dorsal colour patterns of left, *Batrachomoeus occidentalis*, holotype, WAM P.23702, 169 mm SL; and right, *Batrachomoeus dubius*, WAM P.25087-001, 152 mm SL.

Distribution

B. occidentalis has been found only in Western Australia, from off Rottnest Island north to Exmouth Gulf (Fig. 17). Except for one specimen taken in 14-20 metres, it has only been collected by deepwater trawling and dredging in 140-174 metres.

Remarks

Named *occidentalis* with reference to the geographical distribution.

Batrachomoeus dubius (Shaw) 1790

Figs. 10 and 11

Lophius dubius Shaw in White, 1790: 265, figure (Type locality: near Sydney, New South Wales).

Batrachus dubius Richardson, 1844-48: 16, pl. 10; Günther, 1861: 169; Günther, 1867: 61; Castelnau, 1879: 353; Macleay, 1881: 572; Ogilby, 1886: 31.

Batrachus trispinosus (non Günther) Kner, 1865: 189.

?*Pseudobatrachus striatus* Castelnau, 1875: 24 (Type locality: Cape York, Queensland).

Thalassophryne coeca De Vis, 1884: 547 (Type locality: Queensland).

Pelophiletor caloundrae Ogilby, 1906: 9. Nomen nudum (see remarks in preceding section on genus).

Batrachomoeus coecus Ogilby, 1907: 10; Ogilby, 1908: 49.

Batrachomoeus minor Ogilby, 1907: 13. Nomen nudum (see remarks in preceding section on genus).

Batrachomoeus minor Ogilby, 1908: 47 (Type locality: Moreton Bay, Queensland).

Pseudobatrachus dubius McCulloch, 1914: 224; McCulloch, 1922: 122, pl. 41; McCulloch, 1929: 358; Whitley, 1937: 144.

Batrachomoeus dubius Whitley, 1957: 139; Marshall, 1964: 507, pl. 63; Grant, 1972: 358.

Diagnosis

Dorsal rays III, 19-20; anal rays 16-17; pectoral rays 22-23; segmented caudal rays 13-15; pores in lateral line 25-32; vertebrae 9 + 17 - 18.

Head length 2.5-3.0, head depth 4.1-6.4, pectoral 3.3-4.6, all in SL; eye 3.1-5.3, snout 5.6-6.8, anal base 0.8-0.9, head depth 1.6-2.3, head width 0.9-1.3, all in head length; interorbital 1.6-6.5, first dorsal spine 1.2-2.6, both in eye.

Preoperculo-mandibular pores small to large, 1.0-2.4 mm in diameter for specimens larger than 100 mm SL (Fig. 2) (see section on comparisons below); maxilla extends to below posterior portion of eye, or to hindborder; pore in pectoral axilla medium to large (1.7-2.8 mm in diameter for specimens greater than 100 mm SL); tentacles on head simple, multifid or flaps of skin; orbital tentacles small to medium flaps of skin, smooth edged or minutely fringed, 3 or 4 above each eye (2 small middle tentacles sometimes present); eyes usually elevated, interorbital space concave or flat; grooves in frontal bone relatively shallow and narrow.

Colour in alcohol — Head greyish-black to uniform black, speckled with obscure small paler blotches, a paler diffuse V-shaped bar across occiput, ventral surface grey; sides of body greyish with 2 darker wide transverse bars, profusely covered with pale blotches, some of which may be larger; small dark blotches scattered between body bars; body bars continued onto soft dorsal fin, angled obliquely forward; anal fin dark grey with scattered pale blotches; pectorals and caudal dark grey, with scattered pale blotches, round and in irregular rows on pectorals, few in number on caudal; tips of all fin rays may be white; long preservation usually imparts a much browner colouration.

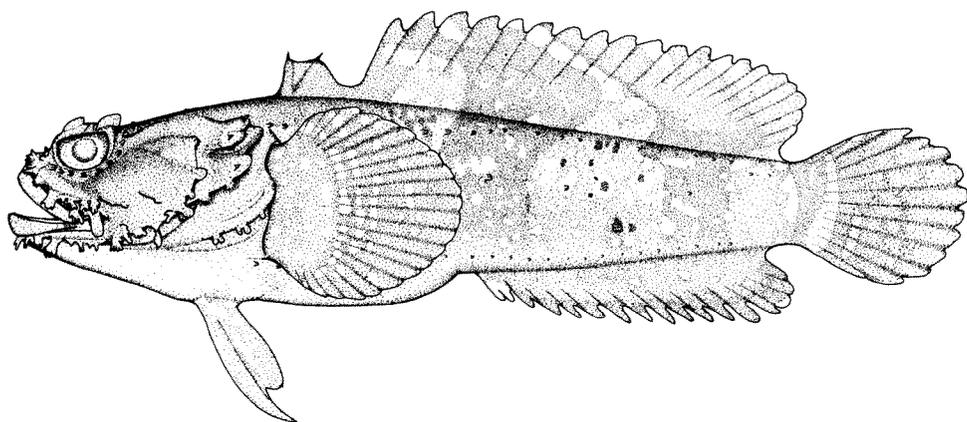


Fig. 11. *Batrachomoeus dubius*, WAM P.25087-001, 152 mm SL.

Comparisons

B. dubius has been confused with *B. trispinosus*, but it is distinguished from this species by fin ray counts and colour pattern, especially the absence of dark transverse bars on the pectoral and caudal fins. For a comparison with the closely related *B. occidentalis* see the discussion under that species.

B. dubius exhibits geographical variation in the mucous pores and orbital tentacles. These are relatively larger in Sydney specimens compared with those from Moreton Bay, Queensland. Also, some specimens from Queensland have many simple tentacles spread over the nape and cheeks, absent on those from Sydney.

Distribution

B. dubius is found from Sydney, New South Wales northwards to Mooloolabar in Queensland (Fig. 17). It frequents estuaries, inshore reefs and has been trawled off the coast in 140 metres.

Remarks

B. dubius was described as *Lophius dubius* in the appendix to White (1790) but the actual author of this description has been in doubt. In a preface to the narrative of this paper, the editor mentions that the naturalists Shaw, Smith and Hunter assisted with the descriptions. Shaw is considered the author of the birds described in the appendix (Cleland, 1950: 553) and Hunter's contribution is introduced as such. There is no information as to the author of the fishes described and most workers have attributed the descriptions to White. McCulloch (1914) considered Shaw as the author of *B. dubius*, apparently attributing the appendix to him, but reverted back to White in his 1929 paper. However, he gave no reason for this change. Shaw, in his 1803 paper, says of *Cottus australis* (= *Centropogon australis*): 'A doubtful species, described by myself in Mr Whites Voyage to Botany Bay.' This description is found on page 266 and the description of *Lophius dubius* occurs on the previous page. Therefore it seems likely that Shaw is the author of the new fishes described in White.

Pseudobatrachus striatus was described by Castelnau from Cape York, Queensland in 1875 and since then has either been placed in the synonymy of *Batrachomoeus dubius* (McCulloch, 1929: 358) or recognized as a valid species (Whitley, 1957: 141 and 1964: 54). However, no additional specimens have been reported since the original description. Castelnau's description indicates that this species belongs to the genus *Batrachomoeus*, but the only member of this genus occurring in the Cape York area is *B. trispinosus* which has much higher fin ray counts (Castelnau's counts of D. II, 17; A.14 could easily be incorrect if his specimens were in poor condition). Castelnau noted that his specimen appeared to resemble Richardson's figure (1844-48, pl. 10) of *Batrachomoeus dubius*, however, the 'strong longitudinal striae' on the head and body are characteristic of *Halophryne diemensis*. Because no recent specimens have been collected and the original description is inadequate, this species is provisionally relegated to the synonymy of *Batrachomoeus dubius*.

Batrachomoeus minor Ogilby, 1908 was described from a specimen collected in Moreton Bay, Queensland. McCulloch (1914) compared this species with specimens of *B. dubius* from Sydney and concluded that they were identical. I concur with this opinion. However, there are slight variations between the Sydney and Moreton Bay populations (see discussion above). The specimen registered as holotype for *B. minor* (QM I.1564) was apparently selected by McCulloch when he designated this species as the type for the genus *Batrachomoeus* (1929: 358). However, this specimen is definitely not one of those that Ogilby used for his description. Examination showed that it has two irregular rows of teeth on the vomer instead of one row (see Ogilby, 1908: 49). This specimen is probably the basis of Ogilby's redescription of *Batrachomoeus coecus* (De Vis) 1884 in his 1908 paper. This

discrepancy is puzzling as McCulloch had earlier (1914) recognized *B. coecus* as the large adult of *B. minor*.

Records of *B. dubius* from north Queensland, Gulf of Carpentaria, New Guinea and Western Australia are in error, being attributable to either *B. trispinosus*, *B. dahli*, *B. rubricephalus* or *Halophryne diemensis*.

Material examined

25 specimens, 30-244 mm SL. New South Wales (unless otherwise designated, all specimens at AM): Sydney Harbour — IB.8254, 206 mm SL; I.15895-016, 2 specimens, 30 mm SL; I.16249-008, 2 specimens, 92-171 mm SL; I.17759-001, 60 mm SL; I.17760-006, 61 mm SL; I.17793-002, 3 specimens, 70-155 mm SL; WAM P.25086-001, 31 mm SL; WAM P.25087-001, 152 mm SL; WAM P.25088-001, skeleton, 138 mm SL. Minnie Waters (south of Grafton) — IB.8248, 2 specimens, 122-146 mm SL. North Solitary Island — IB.8186, 244 mm SL. Queensland (unless otherwise designated, all specimens at QM): Brisbane River — AM I.12547, 171 mm SL. Moreton Bay — I.343, 145 mm SL; I.1564, not type of *Batrachomoeus minor*, 198 mm SL; I.5236, 159 mm SL; I.7943, 192 mm SL; I.7723, 205 mm SL; AM I.9503, 194 mm SL. Moreton Island — I.4941, 152 mm SL. Mooloolabar — I.9734-5, 2 specimens, 110-120 mm SL.

Batrachomoeus rubricephalus n. sp.

Figs. 12 and 14b; Table 3

Pseudobatrachus dubius McCulloch, 1914: 226 (in part); Whitley, 1948: 28.

Holotype

WAM P.25082-001, 211 mm SL, female, collected west of Garden Island, Western Australia, T.K. MacFarlans, 7 August 1960.

Paratypes

14 specimens, 111-262 mm SL (unless otherwise designated, all specimens at WAM). P.159, skeleton, 196 mm SL, Eucla, W.B. Alexander, July 1914; P.1195, 232 mm SL, Point Peron, J.S. Gary, November 1931; P.4003, 262 mm SL, Rottnest Island, V. Glauert, December 1956; P.4292, 203 mm SL, near Perth, W. David, July 1958; P.5792, 191 mm SL, Safety Bay, August 1962; P.6092, 214 mm SL, Cervantes, N. Beissell, 26 January 1963; AM I.18473-001, 219 mm SL, Garden Island, May 1959; P.7120, 256 mm SL, Lancelin, J. Oliver, 10 May 1964; P.7122, 236 mm SL, Shoalwater Bay, R.W. Clifton, 16 April 1964; P.7198, 256 mm SL, Marmion Beach, J. Blakey, 11 May 1964; P.14788, 193 mm SL, Pelsart Group, Houtman Abrolhos, R.J. McKay, 10 May 1963; BM(NH).1975.10.10.2, 162 mm SL, Snag Island, in craypot, J. Bario, June 1972; P.25083-001, skeleton, 222 mm SL, Recherche Archipelago, W. & W. Poole, 1959; P.25123-001, 111 mm SL, Cliffhead, 13 metres in craypot, D. Wright, 13 December 1974.

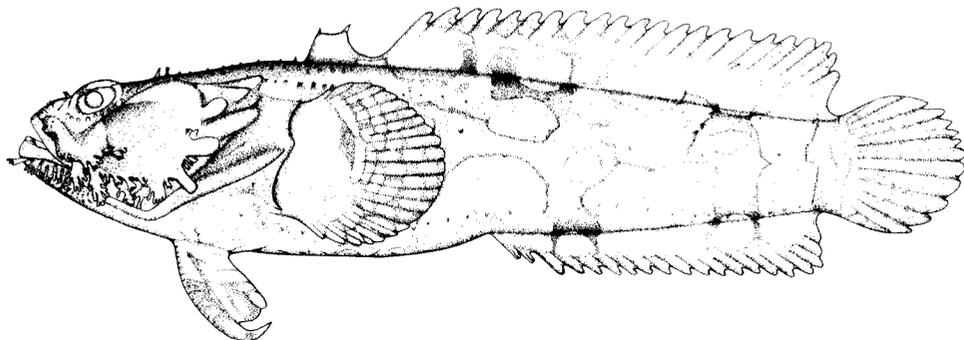


Fig. 12. *Batrachomoeus rubricephalus* n.sp., holotype, WAM P.25082-001, 211 mm SL.

Diagnosis

A species of *Batrachomoeus* characterized by the following combination of characters: higher dorsal and anal fin ray counts (D.III, 21-23; A.18-20); prominent depression on nape; shorter maxilla; large pore in pectoral axilla (2.0-5.0 mm in diameter); minute to small preoperculo-mandibular pores (0.2-1.2 mm in diameter); blotched colour pattern of the pectoral and caudal fins; pink bars and blotches may be present on head.

Description

Measurements and counts of the holotype and selected paratypes are presented in Table 3. Counts and proportions are given below for the holotype, followed by the range for the paratypes in parentheses.

Dorsal rays III, 23 (III, 21-23); anal rays 20 (18-20); pectoral rays 23 (22-23); segmented caudal rays 14 (14-16); pores in lateral line 29 (24-29); vertebrae (9 + 20 - 21).

Head length 2.8 (2.5-2.8), head depth 4.5 (4.2-4.9), pectoral 5.0 (4.1-5.5), all in SL; eye 4.5 (3.9-5.2), snout 6.4 (5.2-6.9), anal base 0.8 (0.8-0.9), head depth 1.6 (1.6-1.9), head width 1.0 (1.0-1.3), all in head length; interorbital 1.5(1.1-2.1), first dorsal spine, 1.5 (1.3-2.1), both in eye.

In addition to the characters given for the genus, the following features are distinctive: eyes slightly elevated, interorbital space somewhat concave; maxilla extends to below posterior half of eye or, at most, rear border of eye; 3 tentacles above each eye but usually prominently reduced or absent; small fronto-nasal tentacle; tentacles on posterior border of preoperculum large fleshy flaps, occasionally reduced; mucous pores on head minute to small, difficult to detect, preoperculo-mandibular series 0.2-1.2 mm in diameter for specimens over 100 mm SL (Fig. 2), teeth on premaxilla nearly always in one series posteriorly, 2 series near symphysis; grooves in frontal bone relatively narrow (Fig. 14b); interorbital width relatively wide (Fig. 15);

TABLE 3. Measurements in mm and fin ray counts of selected type specimens of *Batrachomoeus rubricephalus*

| | Holotype WAM P.25082-001 | WAM P.7198 | WAM P.4003 | Paratypes AM I.18473-001 | BM(NH) 1975.10.10.2 | WAM P.25123-001 |
|-------------------------|--------------------------------|---------------|---------------|--------------------------------|------------------------|--------------------|
| Total length | 254 | 320 | 310 | 266 | 193 | 137 |
| Standard length | 211 | 256 | 262 | 219 | 162 | 111 |
| Soft dorsal fin base | 122 | 162 | 172 | 121 | 91 | 68 |
| Anal fin base | 92 | 118 | 116 | 98 | 75 | 51 |
| Head length | 76 | 91 | 97 | 83 | 64 | 43 |
| Head depth | 47 | 58 | 56 | 52 | 33 | 23 |
| Head width | 75 | 85 | 79 | 73 | 53 | 33 |
| Eye diameter | 17 | 19 | 18 | 16 | 13 | 11 |
| Interorbital width | 11 | 15 | 16 | 12 | 8.8 | 5.2 |
| Snout length | 12 | 16 | 14 | 16 | 12 | 6.7 |
| Pectoral fin length | 42 | 58 | 57 | 47 | 29 | 27 |
| Ventral fin length | 40 | 50 | 43 | 42 | 28 | 24 |
| Longest dorsal ray | 28 | 41 | 34 | 31 | * | 19 |
| Longest anal ray | 26 | 38 | 29 | 27 | * | 16 |
| 1st dorsal spine length | 11 | 9.6 | 12 | 9.4 | 8.3 | 7.1 |
| 2nd dorsal spine length | 14 | 14 | 14 | 13 | 10 | 7.7 |
| Mucous pore diameter | 1.0 | 1.2 | 1.0 | 0.8 | 0.2 | 0.3 |
| Axillary pore diameter | 4.1 | 5.0 | 2.8 | 2.5 | 3.5 | 2.1 |
| Soft dorsal ray count | 22 | 22 | 22 | 22 | 21 | 22 |
| Anal ray count | 19 | 19 | 18 | 18 | 19 | 19 |
| Pectoral ray count | 23 | 22 | 23 | 23 | * | 22 |
| Caudal ray count | 14 | 14 | 15 | 15 | 16 | 15 |
| Lateral line count | 29 | * | 27 | 26 | 28 | 29 |
| Sex | Female | Male | Female | Male | Female | Male |

*Some measurements and counts were not taken due to damage and distortion.

pore in pectoral axilla large to very large (2.0-5.0 mm in diameter for specimens over 100 mm SL).

Colour of holotype in 70% ethanol: body a pale greenish-grey with irregular dark brown transverse bars and mottlings, bars with darker borders (Fig. 12); numerous round pale blotches on sides, more noticeable ventrally and on abdomen; head greenish-grey with faint brownish blotches on dorsal surface; ventral surface of head greyish with brown mottlings; body bars continued irregularly on soft dorsal and anal fins, sloping obliquely forward on former; outer half of anal fin dark brown; pectoral and caudal fins dark brown with numerous round pale blotches, those on pectoral tending to form transverse series (similar blotches on outer portion of soft dorsal); ventrals dark with several pale blotches.

Paratypes are similar to the holotype except the general coloration of some tends to be brownish rather than greenish, and many have retained pink bars and blotches on the head.

Colour when fresh (frozen specimen, P.25123-001): ground colour pale greenish-brown with white to yellowish-white ventral surface; bars on body dark brown, on head dark brown with reddish-pink margins and tinges, the bar across interorbital a prominent reddish-pink; pectoral and caudal fins prominent dark brown with large green blotches on former and obscure white blotches on latter; ground colour of soft dorsal pale brown, bars dark brown, green blotches on outer portion of fin; anal fin with pale brown basal half, outer half a prominent dark brown; ventral fin yellowish-brown with outer portion dark brown; membrane at base of mandibular teeth yellow; iris pink with reddish-brown radiating bars.

Comparisons

B. rubricephalus differs from its closest relatives *B. trispinosus* and *B. dahli* in having a prominent depression on the nape, the pinkish colouration of the head, the blotched nature of the pectoral and caudal fins rather than barred, the outer portion of the anal being prominently darker, and by having grooves in the frontal which are relatively narrower (Fig. 14b). Furthermore, the relative sizes of the mucous pores and pectoral axillary pores among these species are significant (Table 1, Fig. 2).

Distribution

B. rubricephalus is known only from Western Australia, from Eucla in the south-east to the Houtman Abrolhos on the west coast (Fig. 17). Most specimens have been taken by handline and craypot.

Remarks

Named *rubricephalus* in reference to the pinkish colour of the head when fresh.

Batrachomoeus trispinosus (Günther) 1861

Figs. 13 and 14a

Batrachus trispinosus Günther, 1861: 169 (Type locality: Singapore and Penang, Malaysia); Weber, 1913: 557.

Batrachus dubius (non White) Alleyne and Macleay, 1877: 335; Macleay, 1883: 267.

Batrachomoeus trispinosus Bean & Weed, 1912: 609; Taylor, 1964: 299, pl. 68.

Batrachomoeus broadbenti Ogilby, 1908: 49 (Type locality: Cardwell and Bundaberg, Queensland); McCulloch, 1929: 358; Whitley, 1952: 311 (fig. only); Whitley, 1957: 141; Marshall, 1964: 508; Grant, 1972: 358.

Pseudobatrachus eugeneius Fowler, 1937: 260, fig. 288 (Type locality: Rayong, Thailand).

Batrachomoeus dahli Whitley, 1957: 140, figure.

Batrachonemus trispinus (mis-spelling) Gillis, 1961: 5.

Halophryne trispinosus De Beaufort, 1962: 186.

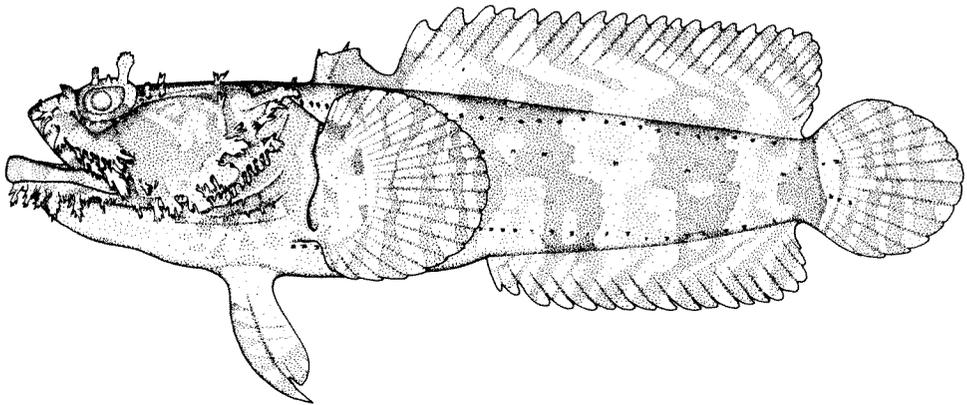


Fig. 13. *Batrachomoeus trispinosus*, AM L15557-280, 163 mm SL.

Diagnosis

Dorsal rays III, 21-23; anal rays 17-20; pectoral rays 22-23; segmented caudal rays 14-16; pores in lateral line 28-38; vertebrae 9 + 19 - 20.

Head length 2.4-2.7, head depth 3.9-5.4, pectoral 4.2-4.7, all in SL; eye 4.0-7.2, snout 5.9-8.4, anal base 0.9-1.0, head depth 1.6-2.0, head width 1.1-1.4, all in head length; interorbital 0.9-2.6, first dorsal spine 1.3-2.1, both in eye.

Preoperculo-mandibular pores medium to large, 0.9-2.5 mm in diameter for specimens above 100 mm SL (Fig. 2); maxilla extends to below hind-border of eye or farther; pore in pectoral axilla small to medium (0.6-2.0 mm in diameter for specimens over 100 mm SL); tentacles on head either medium to large or considerably reduced; head generally large and broad; eyes elevated or not, interorbital space concave or flat; grooves in frontal bone wide and deep (Fig. 14a).

Colour in alcohol — Head and body pale brown with irregular dark brown transverse bars and blotches, those bars on posterior part of body usually well separated (Fig. 13); bars and blotches always with sharply defined borders, well contrasted from ground colour; lower surface of head and abdomen uniform creamy to pale brown or spotted and blotched with darker brown; fins pale brown with series of dark brown irregular transverse bars, those on soft dorsal and anal continuous with body bars, sloping obliquely forward; prominent bars on pectoral and caudal fins.

Comparisons

B. trispinosus is easily confused with *B. dahli* but the combination of characters indicated in the key will distinguish them. Furthermore, *B. trispinosus* has the last three body bars usually well separated rather than joined medially, a relatively longer first dorsal spine (1.3-2.1 in eye versus 2.1-2.9 for *B. dahli*) and wider grooves in the frontal (Fig. 14). The largest *B. dahli* known is 158 mm SL while specimens of *B. trispinosus* in excess of this are frequently taken. For comparison with *B. dubius* see section under that species.

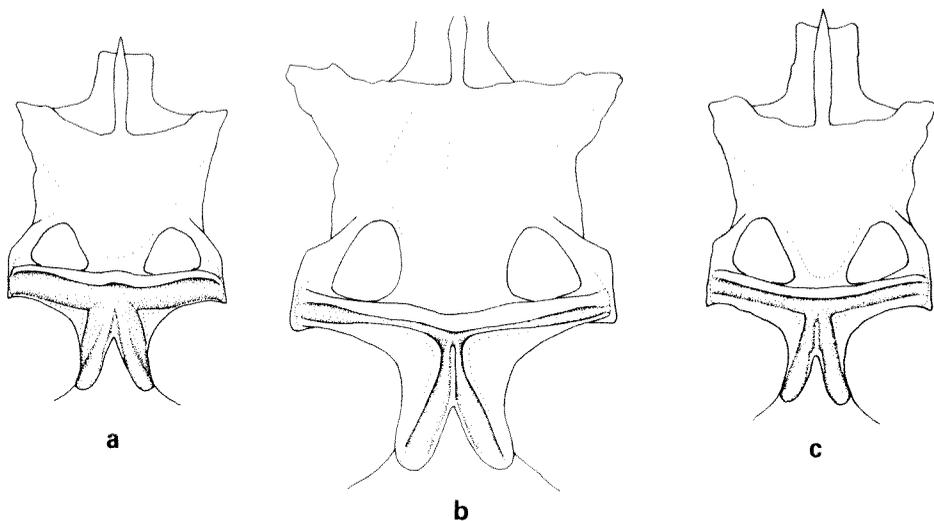


Fig. 14. Semi-diagrammatic illustration showing the frontal grooves (dorsal view) in skulls of a, *Batrachomoeus trispinosus*, 125 mm SL; b, *B. rubricephalus*, 196 mm SL; c, *B. dahli*, 158 mm SL.

Distribution

B. trispinosus is found in northern Australia, from Barrow Island, off Western Australia to Maroochydore in southern Queensland (Fig. 17). It appears to favour more northern waters and is found only rarely below 18° south. It has been trawled in depths to 36 metres, and has been taken intertidally amongst mangroves, on reefs, and in estuaries on the east coast of Queensland.

B. trispinosus is also found in New Guinea and most likely distributed throughout the East Indies to Thailand (see De Beaufort, 1962: 188).

Remarks

Günther described *Batrachus trispinosus* from two specimens, a half grown individual from Singapore and the dried skin of an adult from Penang. The vertebral count that he gave (12 + 17) has caused confusion (Ogilby, 1908: 47), as all Australian species of *Batrachomoeus* only have nine precaudal vertebrae. Günther perhaps copied this count from Valenciennes's description (1837: 472) of *Batrachus grunniens* (Linnaeus) which he believed was identical with *Batrachus trispinosus*. A radiograph of Günther's Singapore specimen (83 mm SL) was kindly sent to me by Mr A. Wheeler of the British Museum (Natural History). This clearly shows nine precaudal and nineteen caudal vertebrae, which proves that Günther's count was incorrect.

In their review of the Indian frogfishes, Nagabhushanam & Rama Rao (1970: 340) placed *Batrachomoeus trispinosus* in the synonymy of *Batrachus dussumieri* Valenciennes (1837: 477). As the specimens they examined all had four spines on the gill cover (above radiograph of the type of *Batrachus trispinosus* shows three spines), *Batrachomoeus trispinosus* is retained here.

Batrachomoeus broadbenti was described by Ogilby in his 1908 revision. In the description his mention of a small second subopercular spine on the upper base of the normal long subopercular spine has created some confusion (Taylor, 1964: 299). This spine is actually a bony swelling which forms at the base of the flexible spine which is found in the above position on all species of *Batrachomoeus* (see preceding section on morphology). This swelling can usually only be detected in large specimens.

Material examined

32 specimens, 19-262 mm SL. Western Australia (WAM specimens): Barrow Island — P.24572, 176 mm SL. Admiralty Gulf — P.25070, 2 specimens, the larger a skeleton, 93-125 mm SL. 'North-west coast' — P.577, 120 mm SL. Northern Territory: Darwin area — WAM P.14221, 129 mm SL; WAM P.16482, 145 mm SL; AM IA. 1714, 2 specimens, 31-82 mm SL; AM IA. 7770, 143 mm SL. Melville Island — AM IA. 7858, 30 mm SL. Cobourg Peninsula — AM IA. 7847, 19 mm SL. Queensland: Gulf of Carpentaria — WAM P.25071-001, 116 mm SL; QM I.7929, 151 mm SL; AM IB.6937-8, 2 specimens, 24-73 mm SL; AM I.15557-280, 4 specimens,

57-163 mm SL. Cairns — AM I.16530, 262 mm SL. Cardwell — QM I.874, type of *Batrachomoeus broadbenti*, 198 mm SL. Proserpine — QM I.8303, 157 mm SL. Maroochydore — QM I.8128, 138 mm SL. No locality, unregistered, in jar with QM I.874, 179 mm SL. New Guinea (KFRS specimens): Marshall Lagoon, eastern Papua — FO.341, 142 mm SL. Yule Island — FO.2060, 162 mm SL. Orokolo Bay, Gulf of Papua — FO.2070, 160 mm SL. Bahoture River, western Papua — FO.2984, 2 specimens, 56-65 mm SL; FO.2986, 85 mm SL. Kerema, Gulf of Papua — FO.4121, 121 mm SL.

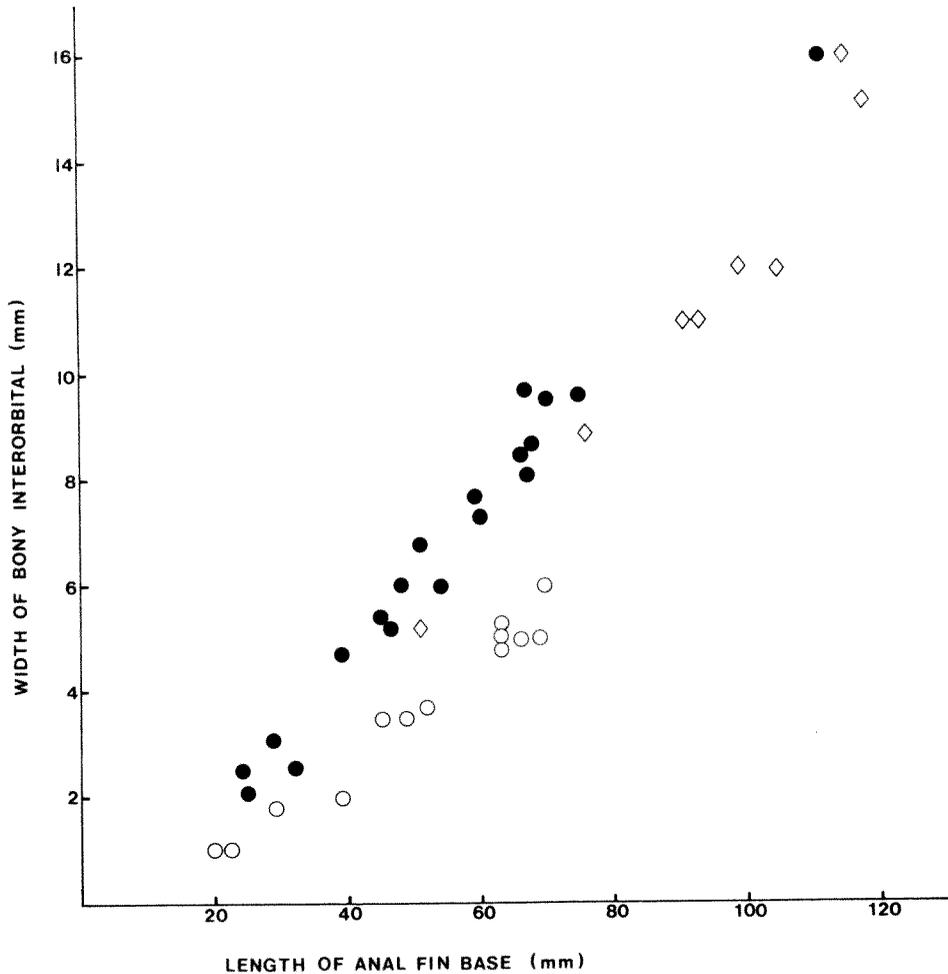


Fig. 15. Bony interorbital widths in *Batrachomoeus trispinosus* (solid circles), *B. dahli* (empty circles) and *B. rubricephalus* (diamonds).

Batrachomoeus dahli (Rendahl) 1922

Figs. 1c, 4b, 14c and 16

Pseudobatrachus dahli Rendahl, 1922: 195 (Type locality: Roebuck Bay, Western Australia); Whitley, 1937: 145; Whitley, 1948: 28.

Batrachomoeus dahli Whitley, 1957: 141; Whitley, 1964: 54.

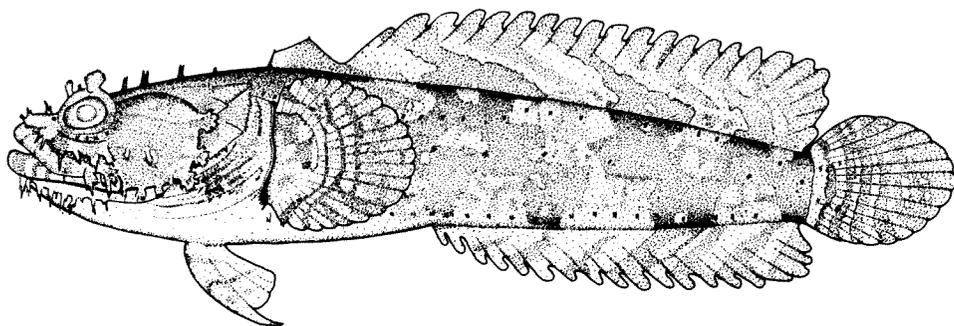


Fig. 16. *Batrachomoeus dahli*, WAM P.13698, 151 mm SL.

Diagnosis

Dorsal rays III, 21-24; anal rays 18-20; pectoral rays 22-23; segmented caudal rays 15-16; pores in lateral line 30-35; vertebrae 9 + 20.

Head length 2.6-3.1, head depth 4.3-5.4, pectoral 4.1-5.2, all in SL; eye 3.3-4.9, snout 5.6-7.0, anal base 0.7-0.8, head depth 1.5-2.0, head width 1.0-1.4, all in head length; interorbital 1.8-3.5, first dorsal spine 2.1-2.9, both in eye.

Preoperculo-mandibular pores small, 0.5-0.8 mm in diameter for specimens over 100 mm SL (Figs. 1c and 2); maxilla extends to below posterior border of eye or slightly farther; pore in pectoral axilla small (0.5-1.0 mm in diameter for specimens over 100 mm SL); tentacles on head never reduced in size; eyes elevated, interorbital space concave, rather narrow; grooves in frontal relatively narrow and shallow (Fig. 14c).

Colour in alcohol — sides of body pale brown with darker blotches tending to form irregular transverse bars, usually joined along midline of side giving a marbled appearance (Fig. 16); head is generally dark brown dorsally or with poorly contrasted bars and blotches, the ventral surface creamy; dark brown bar connects anterior half of each eye; fins pale with series of irregular transverse bars, those on soft dorsal and anal continuous with body bars, sloping obliquely forward; bars on pectoral and caudal may be indistinct or joined in a reticulated pattern.

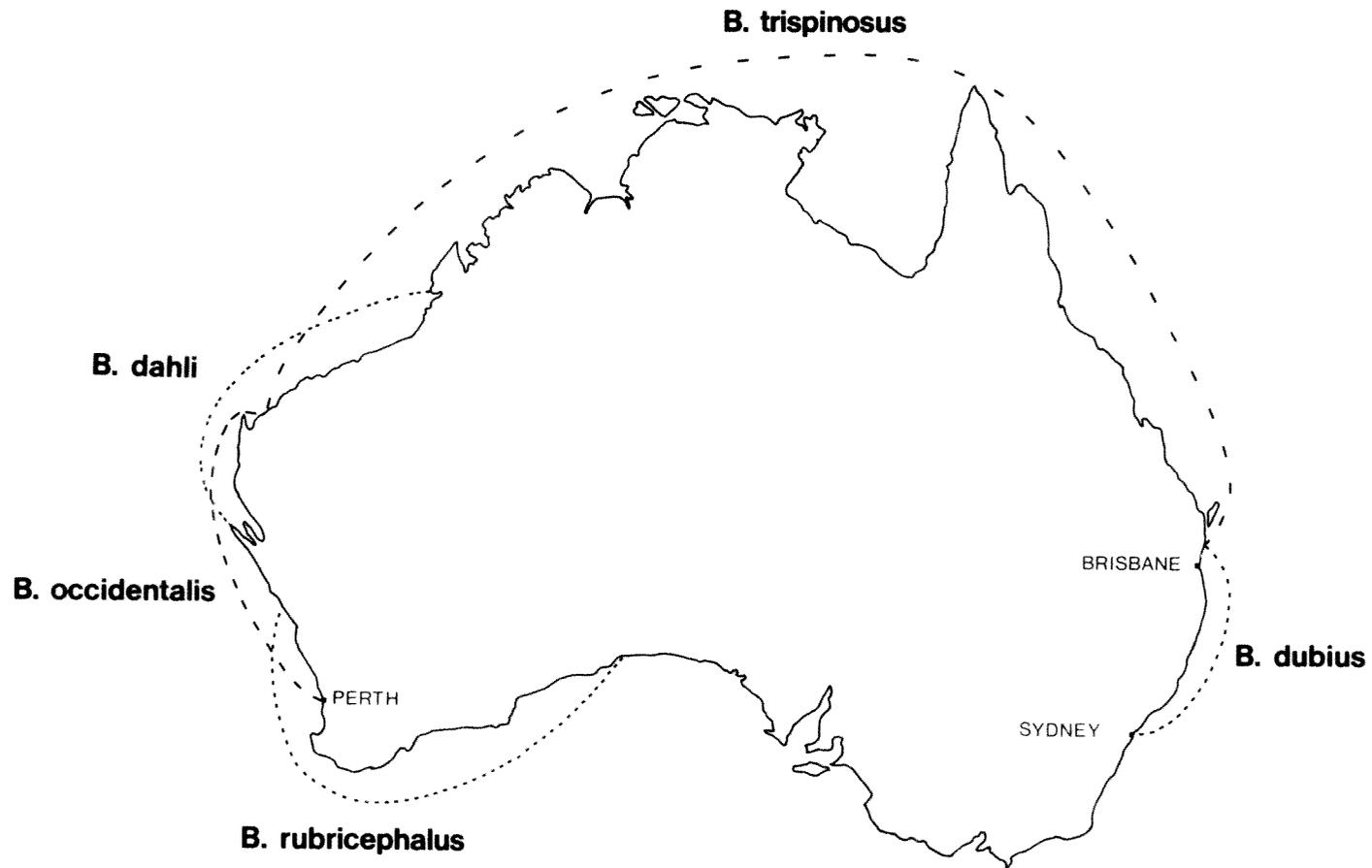


Fig. 17. Map of Australia showing the distribution of the species of *Batrachomoerus*.

Comparisons

For comparisons with *B. trispinosus* and *B. rubricephalus* see the relevant section under each species account.

Distribution

B. dahli is restricted to Western Australia, occurring from Shark Bay northwards to Broome. It has been collected from intertidal areas on offshore islands and trawled in relatively shallow water.

Material examined

24 specimens, 41-158 mm SL. (Unless otherwise designated, all specimens at WAM). Shark Bay — AM I.13282, 48 mm SL; P.14659, 102 mm SL. Barrow Island — P.25066-001, 2 specimens, 106-110 mm SL. Dampier Archipelago — P.20244, 123 mm SL; P.22250, 138 mm SL; P.23975, 57 mm SL; P.25065-001, 41 mm SL. Port Hedland — P.3589, 140 mm SL; P.16484, 155 mm SL. Broome & Roebuck Bay — P.6306, 108 mm SL; P.13690-1, 6 specimens, 82-143 mm SL; P.13698-9, 2 specimens, 111-151 mm SL; P.13700, skeleton, 158 mm SL; P.13701-2, 2 specimens, 87-116 mm SL.

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