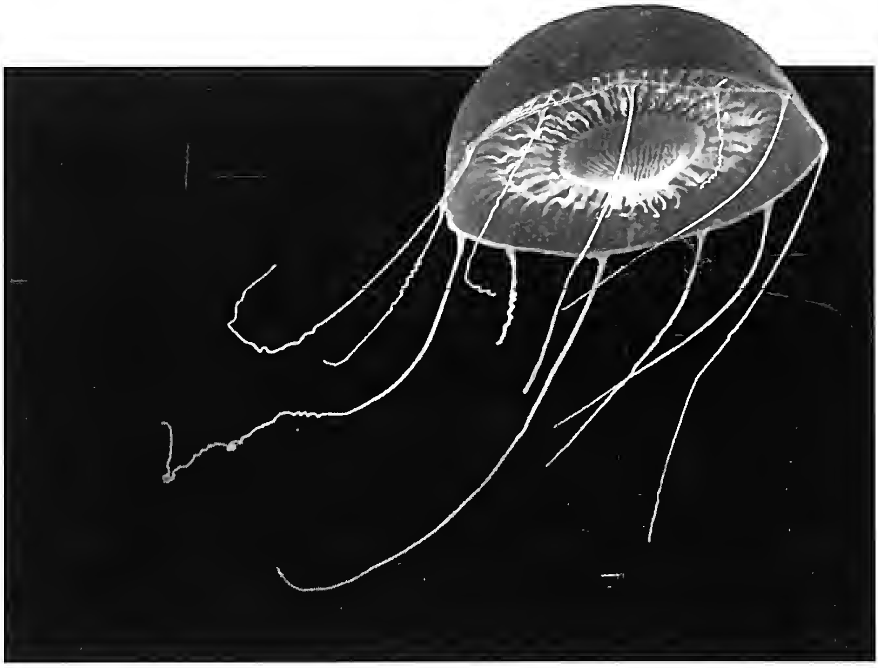
The Beagle

Records of the Museums and Art Galleries of the Northern Territory

Volume 22 **December 2006**



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ISSN 1833-7511

Printed by the Government Printing Office of the Northern Territory

MUSEUM AND ART GALLERY
OF THE NORTHERN TERRITORY

Northern Territory Government
Department of Natural Resources, Environment and the Arts

Front cover: 'Alderslade's medusa' – a new genus and species of hydromedusa, *Aldersladia magnificus,* is common in Darwin Harbour.

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RECORDS OF THE MUSEUMS AND ART GALLERIES
OF THE NORTHERN TERRITORY

Volume 22, December 2006

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Solanum sejunctum (Solanaceae), a new functionally dioecious species from Kakadu National Park, Northern Territory, Australia

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ABSTRACT

A new species of functionally dioecious *Solanum*, *S. sejunctum*, is described from Kakadu National Park, Northern Territory, Australia. It is compared to *S. asymmetriphyllum* Specht, a similar species from the same region. Updated identification keys are provided for *Solanum* in the northern Northern Territory and Kakadu National Park.

Keywords: Solanaceae, *Solanum*, new species, Kakadu National Park, Northern Territory, Australia, dioecy.

INTRODUCTION

This new species was first collected by L.A. Craven in 1973, at which time it was identified as *Solanum asymmetriphyllum* Specht. It was first recognised as a separate taxon by Brennan (1990) on the basis of its anomalous indumentum characteristics and was subsequently segregated in the Northern Territory Herbarium (DNA) by I. Cowie in the latter half of the 1990s, first as *Solanum* A55445 Mt Brockman (Cowie and Albrecht 2001) then as *Solanum* sp. Mt Brockman (L.A. Craven 2371) (Cowie and Albrecht 2004, 2005).

The new taxon belongs to a group of nine recognised species from northern and north-western Australia (two in Arnhem Land, Northern Territory, and seven in the Kimberley region of Western Australia), that are functionally dioecious (*S. asymmetriphyllum*, *S. cardiiforme*, *S. cataphractum*, *S. cunninghamii*, *S. dioicum*, *S. leopoldensis*, *S. petraeum*, *S. tudununggae* and *S. vansittartensis*), although strictly, in terms of gross floral morphology, they could also be described as androdioecious (Symon 1979). The male plants have cymes of numerous smaller flowers while the fruit-bearing plants have single, larger hermaphroditic flowers. However, within this group the pollen produced by the anthers of hermaphroditic flowers has been found to be mostly nongerminable and inaperturate, and does not contribute to fertilisation, thus making the flowers (plants) functionally female and the overall sex form functional dioecy (Anderson and Symon 1989). Pollen produced by the hermaphroditic flowers is believed to serve mainly as a reward for pollinators in the same way that other species provide nectar (Anderson and Symon 1989). Treatments prior to this laboratory study were understandably inconsistent in assigning a sex form to members of the group, leading to some confusion. Symon (1970, 1971, 1981) and Purdie *et al.* (1982) described them as dioecious, whereas Symon (1979) rejected the notion of truly dioecious *Solanum* and revised them as androdioecious. Most of the species in this group are confined to broken sandstone terrain in the monsoon tropics, though some extend to adjacent sand plains in Western Australia.

Results of recent analyses using molecular phylogenetic methods (Martine 2006; Martine *et al.* 2006) and which support the hypothesis that *S. asymmetriphyllum* and *S. sejunctum* sp. nov. are a closely related pair of distinct taxa are presented below, as are brief remarks as to their relationship with other Australian species previously placed in section *Melongena* by Symon (1981).

Institutional acronyms used are: AD (State Herbarium of South Australia, Plant Biodiversity Centre, Adelaide, SA, Australia); CANB (Australian National Herbarium, Centre for Plant Biodiversity Research, Canberra, ACT, Australia); CONN (George Safford Torrey Herbarium, University of Connecticut, Connecticut, USA); and DNA (Northern Territory Herbarium, Palmerston, NT, Australia).

SYSTEMATICS

Solanum sejunctum K. Brennan, C. Martine and D. Symon sp. nov.

(Fig. 1)

Solanum asymmetriphyllum auct. non. Specht 1958: 295.

Solanum sp. Brennan, 1990.

Solanum A55445 Mt Brockman Cowie, I.D. and Albrecht, D.A. 2001.

Solanum sp. Mt Brockman (L.A. Craven 2371) Cowie, I.D and Albrecht, D.A. 2004 and 2005.

Latin diagnosis. Suffruticosa ad 1m alta. Caules densim pubescentes, sparsim aculeati aut inermes. Folia lata et lanceolata, basi inaequali, 11–13 cm longa, 4.5–5.5 cm lata, margine integro, apice acuto, densim pubescentia pilis sessilibus aut stipitatis supra et infra. Plantae dioeciae; flores feminei solitarii per photo; calyx aculeis brevibus et conicis, baccum includens. Bacca 2 cm diam., viridis. Cymae masculinae ad 11 cm longae, ferentes usque as 40 flores sequentiter exutas, late stellatus. Antherae poricidales.

TYPUS: Australia, Northern Territory, north facing wall in central part of Mt Brockman. 12° 44' S, 132° 54' E, 23 February 1973, *L.A. Craven 2371* [fruiting plant] (holotype: DNA; isotype CANB *n.v.*).

Other specimens examined. NORTHERN TERRITORY; Alligator Rivers Region: Mt Brockman, 12° 44' S, 132° 54' E, 23 February 1973, L.A. Craven 2375 [male plant] (CANB, DNA); Radon Gorge ca. 12 km south of Jabiru, 12° 45' S, 132° 54' E, 10 June 1978, P.K. Latz 7690B [fruiting plant] (DNA); Radon Gorge ca. 15 km south of Jabiru, 12° 45' S, 132° 55' E, 11 June 1978, P.K. Latz 7707 [fruiting plant] (DNA); Nourlangie Rock, 12° 51' S, 134° 49' E, 17 June 1984, K. Brennan, 431 [fruiting plant] (DNA); Mt Brockman outlier, 15 km south east of Jabiru along Baroalba Creek, 12° 47' S, 132° 56' E, 20 April 1989, R.W. Johnson, 4690 [male plant] (DNA); Mt Brockman, 12° 47' S, 132° 56' E, 20 April 1989, J. Russell-Smith, 8043 and D. Lucas [fruiting plant, 2 sheets] (DNA); Kakadu National Park, Magela Creek catchment, 12° 49' S, 133° E., 11 April 1995, J. Russell-Smith, 10367 and D. Lucas [fruiting plant] (DNA); Magela Creek catchment, 12° 49' S, 133° E, 12 April 1995, I. Cowie 5656 and K. Brennan [fruiting plant] (DNA); E Koongarra Saddle, 12° 50.8 S, 132° 51.7 E, 19 May 2004, D. Symon 17105 and K. Brennan [male plant] (AD); on Nourlangie side of Koongarra Saddle, 12° 49' S, 132° 53' E, 19 May 2004, C.T. Martine 730, K. Brennan, D. Symon and H. Toelken [male plant] (AD, CONN), Fig. 2; Koongarra Saddle, on east bank of Baroalba Creek, 12° 49.565' S, 132° 53.213' E, 19 May 2004, C.T. Martine 735, K. Brennan, D. Symon and H. Toelken (AD, CONN).

Description. A clonal shrub with erect stems to 1 m, branching above. Branches unarmed or with a few small prickles to 1 mm long, densely pubescent with sessile and stipitate stellate hairs. Petiole 1.25–2.5 cm long, unarmed or with a few conical prickles to 2 mm long. Leaves somewhat variable in size, lower and earlier leaves 11–13 cm long, 4.5–5.5 cm wide, upper and later leaves 5–8.5 cm long, 2.5–3 cm wide; lamina ovate-lanceolate. Leaf base oblique with up to 6–7 mm between insertion of margins; apex acute, margin entire. Upper leaf surface unarmed, pubescent with sessile and stipitate stellate hairs, lamina sometimes visible, grey-green to dull khaki-green; lower leaf surface densely pubescent, lamina obscured, paler grey-green. Bisexual flowers (from photograph only – no precise scale) solitary, corolla relatively large broadly stellate, acumens present, anthers closely erect, poricidal, style and stigma exceeding the anther column, stigma conspicuous. Male flowers: cyme unarmed, to 11 cm long, simple or shortly branched above, bearing up to 40 flowers shed from base in succession, flowers only 1 or 2 open at a time, more or less paired along rachis; pedicel c. 6 mm long; calyx lobes usually 5, rarely 3 or 4, lanceolate, 6 mm long, equal or unequal unarmed, acumen 1 mm, corolla broadly stellate to pentagonal, deep mauve, lobes 1 cm long with 1–1.5 mm inflexed acumens, filaments c. 0.5 mm long (i.e. anthers nearly sessile), anthers 5 mm long, lanceolate, poricidal; ovary and style vestigial, 1.5 mm long. Fruit a berry, almost wholly enclosed in calyx; fruiting pedicel c. 7 mm long, fruiting calyx c. 3 cm diameter, 2.5 cm long, densely minutely pubescent and with conical prickles 1.1–3 mm long; calyx lobes flattened, 10 mm long, 2 mm wide, scarcely leaf-like, of firm texture. Fresh berry not seen, dried specimens with berries to c. 2 cm diameter, drying near black. Seeds, numerous, immature, c. 2.5 mm long, ovate, reticulate.

Distribution and ecology. *Solanum sejunctum* is known primarily from the Mt Brockman outlier in Kakadu National Park and a small area immediately to the east, on the western edge of the Arnhem Land escarpment (Fig. 2). All collections have been from areas of dissected sandstone with plants often reported growing in fissures on the tops of sandstone boulders in, or near, forest dominated by *Allosyncarpia ternata* (Myrtaceae). Some other *Solanum* species in the area (*S. clarkiae* and *S. echinatum*) are known to proliferate after fire and are often regarded locally as 'fire weeds' but this does not appear to be the case for *S. sejunctum*. It has never been reported as common, which is highly significant given that the Mt Brockman outlier is both periodically burnt and visited frequently by botanists. Flowering and fruiting material has been collected during the early part of the dry season from April to June.

Solanum sejunctum occurs in the same general region of Kakadu National Park and occupies much the same habitat as *S. asymmetriphyllum* but the two species have not been recorded growing together. *Solanum asymmetripyllum* has two distinct centres of distribution; one to the north of Mt Brockman around the East Alligator River and another to the south near Deaf Adder Gorge (Fig. 2). We also note

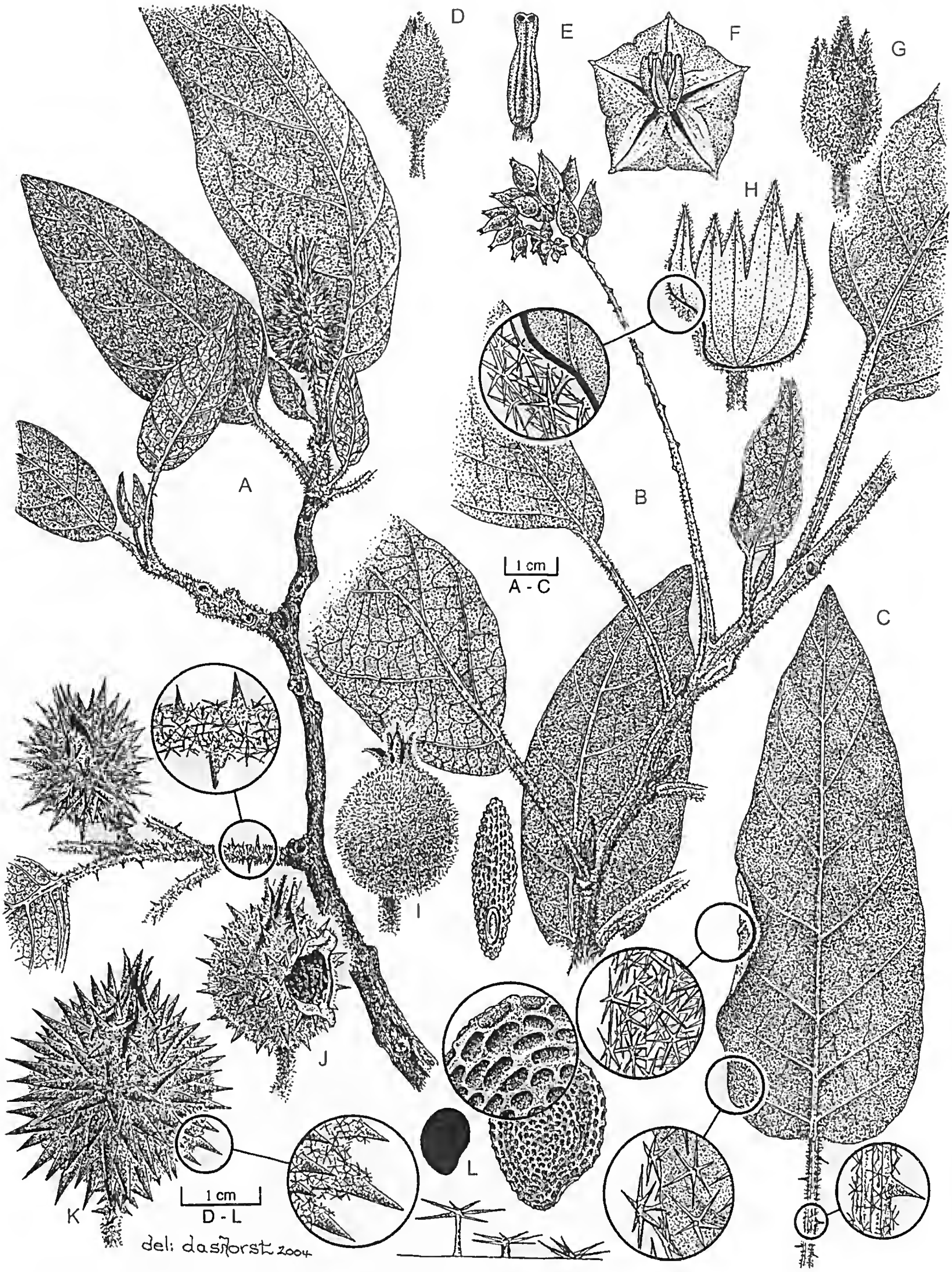

Fig. 1. *Solanum sejunctum* sp. nov. **A**, twig of fruiting plant illustrating leaves, pubescence, prickles, bud and fruiting calyces; **B**, twig of male plant illustrating leaves, pubescence, prickles, cyme, calyx and corolla; **C**, leaf showing details of pubescence and prickles; **D**, male flower bud; **E**, anther; **F**, male flower; **G**, enlarged male calyx; **H**, calyx of male flower; **I, J, K**, variation in mature fruit; **L**, seed. Fruiting plant based on *Craven 2371*. Male plant based on *Craven 2375*. Seed based on *Latz 7707*.

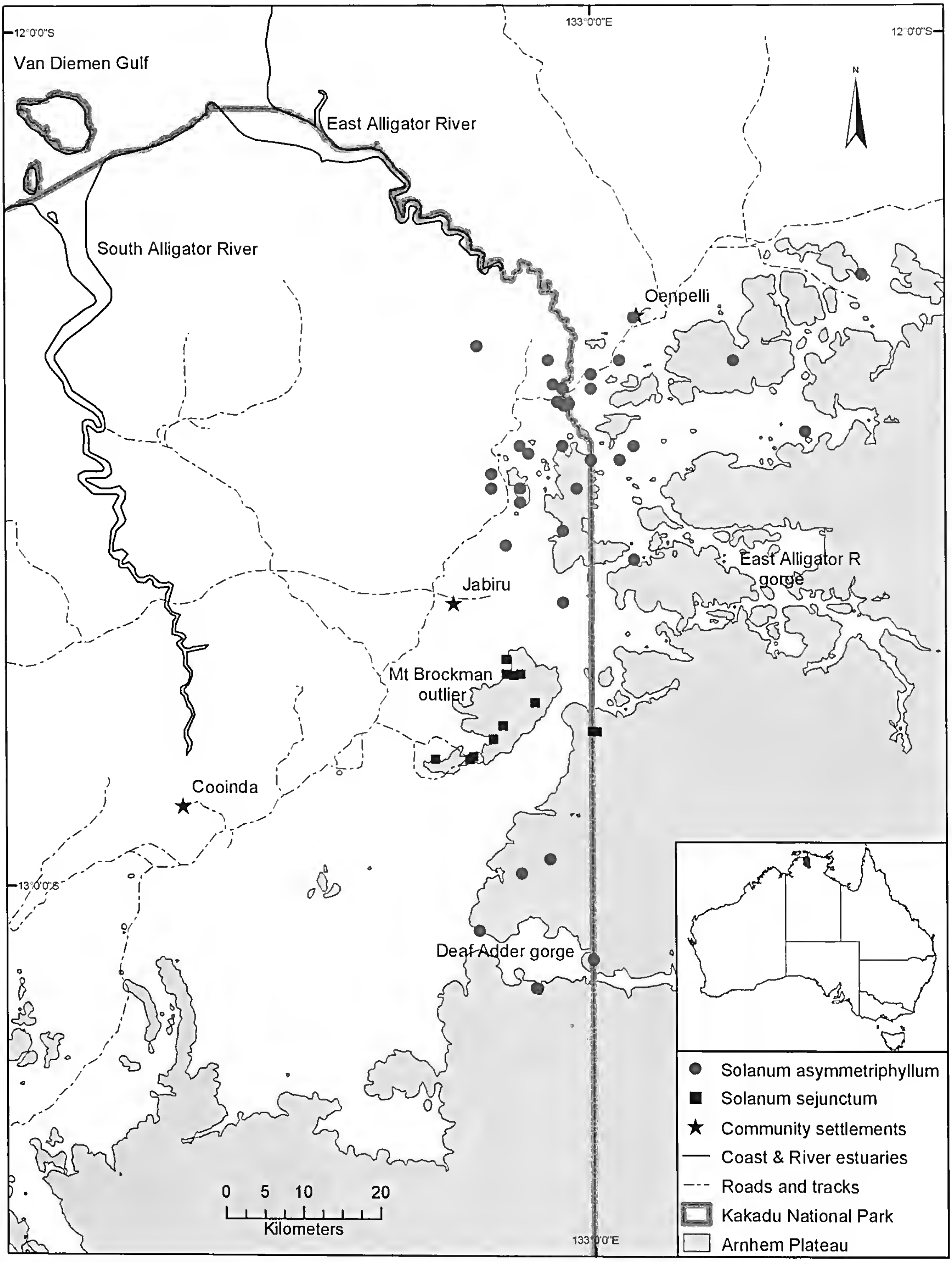

Fig. 2. Distribution of *Solanum sejunctum* and *S. asymmetriphyllum*.

that the leaves on collections of *S. asymmetriphyllum* from the south, around Deaf Adder Gorge, are typically lobed with prickles on the upper surface, whereas the leaves of those from northern populations are usually unlobed and unarmed.

Remarks. *Solanum sejunctum* is similar to *S. asymmetriphyllum*, which occurs in the same region, but the two species may be readily distinguished by reference to a range of vegetative and other characters. The older stems of *S. asymmetriphyllum* become woody with corky bark whereas corky bark has not been observed on *S. sejunctum*. The leaves of each species are highly distinctive; the upper leaf surface of *S. asymmetriphyllum* is almost glabrous apart from some minute stellate hairs on the veins and the leaves dry and markedly discolorous, dark green above and pale below. By contrast, the upper leaf surface of *S. sejunctum* is uniformly, densely pubescent above and the leaves dry and almost concolourous, pale above and below. On inflorescences of male plants the prickles on the calyx of *S. asymmetriphyllum* are thin and slender and up to 10 mm long, whereas those on the calyx of *S. sejunctum* are short and conical and only 2–3 mm long. The male inflorescence of *S. asymmetriphyllum* is simple or compound while that of *S. sejunctum* is simple or only very short branched.

Molecular phylogenetic analyses using ITS (nuclear ribosomal RNA) (Martine *et al.* 2006) and *trnK-matK* (chloroplast DNA) (Martine 2006) sequence data show strong support for the sister relationship of *S. sejunctum* and *S. asymmetriphyllum*, as well as the recognition of *S. sejunctum* as a separate species (Fig. 3). These analyses have also demonstrated that the relationship between the '*sejunctum-asymmetriphyllum*' clade to the rest of the Australian *Solanum* section *Melongena sensu* Symon is unclear. However, phylogenetic analyses using both molecular and morphological data provide some support for a larger dioecious clade in which the two Kakadu species are a sister group to the seven non-Kakadu species (Fig. 3) (Martine 2006). In contrast, the placement of the andromonoecious species also included in Australian *Melongena sensu* Symon (1981) is problematic, and they may not be as closely related to the dioecious species as previously thought. Based on current work in the *Solanum* subgenus *Leptostemonum* (Levin *et al.* 2006) in which a recent radiation of Old World 'spiny solanums' is apparent, it is clear that the evolutionary relationships among most Australian, Asian, and African eggplant relatives will remain difficult to elucidate without a comprehensive sampling of taxa and the utilisation of more informative gene regions.

Conservation status. *Solanum sejunctum* is confined to rugged sandstone terrain in Kakadu National Park and remote parts of western Arnhem Land immediately adjacent to the park. Therefore, it is not threatened by impacts arising from current or prospective industrial or pastoral development. However, the species has a limited distribution (around 150 km^2) and is generally noted as being sparse within its range, so the total population is probably small. There is currently no knowledge about whether the species is self-sustaining or in decline, or to what extent it is affected

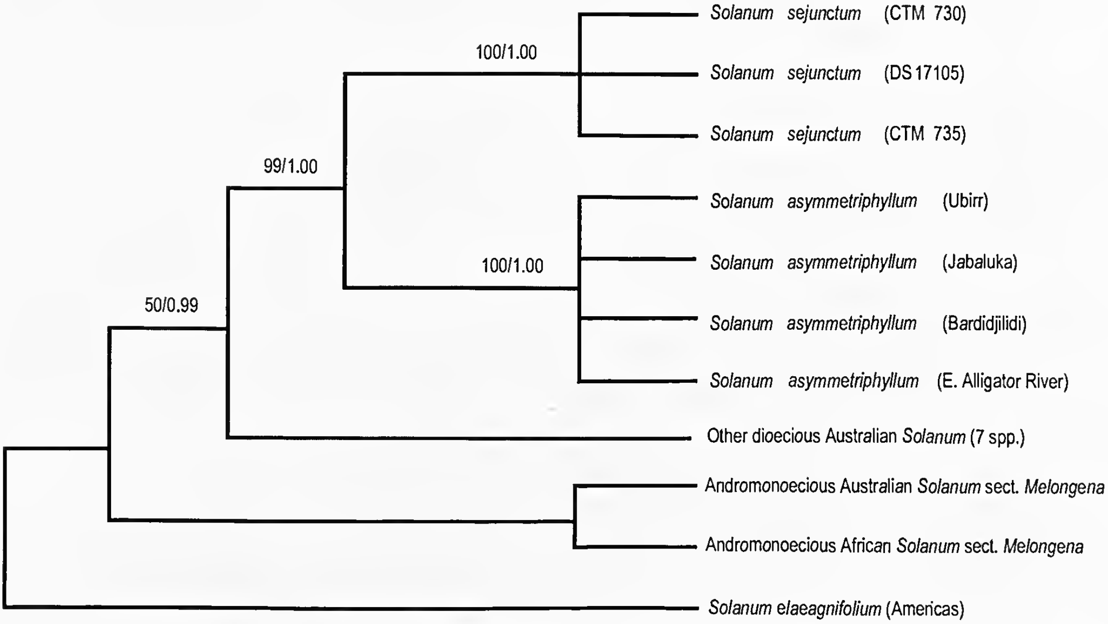

Fig. 3. Representative cladogram based on Martine (2006) showing the phylogenetic position of *Solanum sejunctum* as indicated by analysis of combined molecular (ITS, *trnK-matK*) datasets. First numbers are parsimony bootstrap values; second numbers are Bayesian posterior probabilities.

by contemporary management activities such as prescribed burning. We therefore refrain from assigning a threat rating under IUCN criteria. This should be determined later by reference to additional targeted field searches and a population monitoring program.

Etymology. The specific epithet *sejunctum*, separated or isolated, is used in a double sense in that the species has a distribution mostly confined to a single, isolated sandstone outlier and that it also occurs primarily as widely separated plants.

Revised key to *Solanum* in Kakadu National Park and adjacent western Arnhem Land

1a. Sprawling, mostly prostrate subshrub; leaves usually < 6 cm long .... *S. echinatum*

1b. Erect or spreading shrub or subshrub; leaves mostly > 6 cm long 2

2a. Annual or biennial subshrubs to 1 m high, not clonal; stems densely prickly; calyx lobes in fruit finally reflexed, berry exposed .... *S. clarkiae*

2b. Perennial shrubs to 2 m high, clonal; prickles on stems scattered or absent; calyx lobes in fruit not reflexed, berry almost wholly enclosed 3

3a. Leaves dark green and more or less glabrous above, usually much paler and pubescent below; calyx prickles thin and slender, to 10 mm long .... *S. asymmetriphyllum*

3b. Leaves grey-green, densely pubescent above and below; calyx prickles conical, to 3 mm long .... *S. sejunctum*

Revised key to *Solanum* in the Northern Territory north of 15° S

1a. Herbs or short-lived perennials, unarmed; hairs simple; flowers white; fruits purple-black 2

1b. Not as above 3

2a. Inflorescence a short cyme; berries usually dull; seeds mostly < 40 per berry .... *S. nigrum*

2b. Inflorescence umbellate, berries usually shiny; seeds mostly > 50 per berry .... *S. americanum*

3a. Plant glabrous or nearly so, dull green; prickles prominent straight, straw-coloured; berry dull green or flushed purple; seeds paper-thin .... *S. pugiunculiferum*

3b. Not as above 4

4a. Large shrub or small tree; inflorescence erect compound; flowers white; fruits usually yellowish; weedy species 5

4b. Not as above 6

5a. Unarmed small tree; leaves entire; ripe berry succulent, pubescent .... *S. erianthum*

5b. Strongly armed small tree; leaves lobed; ripe berry firm, mucilaginous, glabrous .... *S. torvum*

6a. Erect or spreading subshrubs; flowers white; fruits red, not enclosed in calyx 7

6b. Not as above 8

7a. Fruiting pedicels erect or nearly so; berry < 1 cm diameter .... *S. tetrandrum*

7b. Fruiting pedicels pendant; berry > 1 cm diameter. .... *S. yirrkalense*

8a. Plants sprawling, more or less prostrate 9

8b. Plants erect or spreading 11

9a. Slender plants; leaves mostly < 6 cm long; fruits usually 1 or 2 per cyme .... *S. echinatum*

9b. Stout, vigorous plants; leaves mostly > 6 cm long; fruits several per cyme 10

10a. Leaves grey-green, slightly discolorous, densely pubescent; fruits 2 or 3 per cyme [eastern Top End and Gulf of Carpentaria] .... *S. seitheae*

10b. Leaves often dark green or purple-green above, discolorous, finely pubescent; fruits up to 10 per cyme [western Top End and Bonaparte Gulf] .... *S. lucani*

11a. Male and fruiting plants separate; male flowers numerous on erect cymes; bisexual flowers solitary; fruits enclosed by calyx 12

11b. Male and bisexual flowers on the same plant; bisexual flowers usually solitary at base of male flowers; fruit visible between calyx lobes 14

12a. Leaf upper surface glabrous or with just a few stellate hairs along veins.................. *S. asymmetriphyllum*

12b. Leaf upper surface densely stellate hairy all over 13

13a. Outer stems with abundant, long, slender prickles.. .... *S. dioicum*

13b. Outer stems without prickles or with just a few short, conical prickles .... *S. sejunctum*

14a. Plant sparsely armed; flowers white or nearly so; few (3 or 4) male flowers per infloresence; fruit usually >50 mm long, mostly shiny purple-black .... *S. melongena*

14b. Plants usually well armed; flowers purple, numerous (>6) male flowers per inflorescence, berry < 35 mm diameter, mostly pale yellow or whitish 15

15a. Mature calyx not reflexed .... *S. chippendalei*

15b. Mature calyx strongly reflexed 16

16a. Perennial shrub; tomentum rusty; calyx lobes of bisexual flowers 5–7 mm long [south-eastern Top End and Gulf of Carpentaria]... *S. melanospermum*

16b. Annual or biennial subshrub; tomentum yellow-green; calyx lobes of bisexual flowers 10–13 mm long [Arnhem Land]............................. *S. clarkiae*

ACKNOWLEDGMENTS

We thank Michael Moody, Don Les, Dan Vanderpool, and Nic Tippery (University of Connecticut) for assistance with the phylogenetic analysis. Mary Marlow (AD) provided the Latin description and Felicity Watt (Biodiversity Conservation Unit) prepared the distribution map (Fig. 2). Figure 1 was drawn by Gilbert Dashorst (AD). Two anonymous reviewers provided valuable comments that greatly improved an earlier draft of the manuscript. This project was funded in part by the National Geographic Committee for Research and Exploration (Grant 7268-4), the Elizabeth DeViney Foundation and the Ronald Bamford Endowment to the Department of Ecology and Evolutionary Biology, University of Connecticut.

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Accepted 20 September 2006

The Beagle, Records of the Museums and Art Galleries of the Northern Territory, 2006 **22**: 9–13

Aldersladia magnificus: a new genus and species of hydromedusa (Cnidaria: Hydrozoa: Leptomedusae: Aequoreidae) from tropical and subtropical Australia

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ABSTRACT

A new genus and species of aequoreid hydromedusa is reported from the Northern Territory, Queensland, and Western Australia. It differs from other genera in the family in having one or more conspicuous, solid, gelatinous papillae underlying the radial canals and gonads.

KEYWORDS: *Aldersladia magnificus,* taxonomy, new genus, new species, Aequoreidae, Hydrozoa, Cnidaria, Northern Territory, Queensland, Western Australia.

INTRODUCTION

The biodiversity of Australian medusae has been previously unappreciated, especially with regard to the smaller, less conspicuous hydromedusae. Historically, relatively few species have been studied, and most were so vaguely described that they remain unrecognisable. Most of the medusae described by Péron and Lesueur (1810) from northern Australian waters have proven unrecognisable, including several new species of Aequoreidae. Haeckel (1879) treated several species of Australian aequoreids, but many of his conclusions were disregarded by later workers for being unsuccessful, 'except from an artistic point of view' (see Browne 1916). Mayer (1915), while sampling through the Great Barrier Reef region and southern Papua, observed that north-eastern Australia was particularly notable for its lack of medusan diversity. Kramp (1953) found a considerable diversity of tropical eastern Australian hydromedusae in general, but treated only four species of Aequoreidae. It seems that most of the workers who have treated tropical Australian medusae have observed relatively high biodiversity in general (i.e., many dozens of species), including numerous different aequoreid species, but have not necessarily appreciated the uniqueness of the regional aequoreid fauna. In studying the Australian medusozoan fauna over the last eight years, I have come to the conclusion that the biodiversity has been grossly underestimated, particularly with respect to the Aequoreidae. A revision of the Australian Aequoreidae is underway (Gershwin in prep.), with this species, *Aldersladia magnificus* gen. and sp. nov., being one of the most abundant and conspicuous.

Kramp (1961a) and Stiasny (unpublished museum identifications) both had the opportunity to study the species described herein, but neither regarded it as unique. The species is most closely similar to *Aequorea pensilis* (Eschscholtz), which also occurs in Australian waters. However, *Aldersladia magnificus* gen. and sp. nov. has several structural characters which separate it from *A. pensilis*, most conspicuously the subumbrellar papillae; even in badly damaged specimens lacking all epithelial tissue, the stiff gelatinous papillae are intact. This character of having the papillae underlying the radial canals, by definition, precludes this species from being in the genus *Aequorea.*

MATERIALS AND METHODS

The collections of Aequoreidae held in various Australian museums were examined. Additional material was collected by hand using plastic bags or glass jars while snorkeling, or by hand-trawling with a 500 μm mesh, 0.5 m wide plankton net.

Live material was relaxed in magnesium chloride (added dropwise) prior to examination and photography, then fixed in 5–10% formalin. Measurements were made with Max-Cal digital calipers to the nearest 0.01 mm. Every effort was made to obtain true dimensions across the widest points; however, some specimens were too brittle to be spread out, in which case absolute measurements were taken across the two farthest available points. Bell diameter (BD) and stomach diameter (SD) were measured with the specimen lying exumbrella-down, and bell height (BH) was measured with the specimen lying on its side. Nematocysts were examined and measured with a Leica DMLB compound microscope and Leica IM-50 Image Manager v. 1.20 for Windows; all observations and photographs were made through a 40x objective, unless otherwise specified. Nematocysts were identified following the keys of Mariscal (1971), Calder (1974), and Williamson *et al.* (1996).

Abbreviations used: Australian states are abbreviated as follows: South Australia (SA), Western Australia (WA), Northern Territory (NT), Queensland (QLD). The Great Barrier Reef is abbreviated 'GBR'. Institutional abbreviations used: Australian Museum, Sydney, NSW (AM); Museum and Art Gallery of the Northern Territory, Darwin, NT (NTM); South Australian Museum, Adelaide, SA (SAM); and Western Australian Museum, Perth, WA (WAM). Other abbreviations: specimen numbers prefixed with an 'A' are from the collection of the late Ronald V. Southcott (RVS), now housed at the SAM.

SYSTEMATICS

Order Leptomedusae Haeckel, 1879

Family Aequoreidae Eschscholtz, 1829

Aldersladia gen. nov.

Type species. Here designated, *Aldersladia magnificus* n. sp.

Diagnosis. Aequoreidae with subumbrellar gelatinous papillae underlying radial canals.

Remarks. According to Kramp (1961b) and Mayer (1910), the chief designation of the genus *Aequorea* from the others in the Aequoreidae is that *Aequorea* lacks subumbrellar papillae. In contrast, *Zygocanna vagans* Bigelow and *Rhacostoma atlanticum* Agassiz, possess subumbrellar papillae in rows between the radial canals, and *Gangliostoma guangdongensis* Xu, has papillae at the base of the manubrium. Thus, it appears of generic importance to have the papillae underlying the radial canals.

Description. As for type species, *Aldersladia magnificus.*

Etymology. Named to honour Dr Philip Alderslade, whose interest in jellyfishes has revealed many new species. In addition, Phil's kindness and generosity enabled me to accomplish much interesting science. Gender masculine, but taking the '-ia' ending following Article 30.2.2 (ICZN 1999) and medusozoan taxonomic tradition for honorific names.

Aldersladia magnificus sp. nov.

(Figs 1–5; Table 1)

Aequorea pensilis. – Kramp 1953: 295 (N. QLD); Kramp 1961a: 202 (Cairns, QLD); ?Kramp 1965: 94 (Brisbane). Not *Aequorea pensilis* (Eschscholtz).

Material examined. HOLOTYPE – NTM C12563, 20 August 1998, Fort Hill Wharf, Darwin, NT, at surface; with parasitic hyperiid amphipod, *Lestrigonus bengalensis* Giles, 1887, on lateral surface of exumbrella. PARATYPES – NTM C5375, 20 March 1986, Vestey's Beach, Darwin; NTM C12226, 11 September 1994, off mouth of Nayarnpi Creek, Roper River, NT, depth 1 m, over hard sand bottom; NTM C11997, 29 March 1993, Casuarina Beach, Darwin, NT; NTM C12565, Casuarina Beach, Darwin, NT, 29 March 1993; SAM H913 (=RVS A796), 20 April 1964, Darwin Harbour, 1 m over 2 m depth sandy bottom, with commensal amphipods; SAM H914 (=RVS A793), Darwin Harbour, 20 April 1964, 1 m over 2 m depth, sandy bottom; SAM H915 (=RVS A369), Cairns Esplanade, N. QLD, 5 February 1959 (erroneously identified as *Aequorea pensilis* by Kramp 1961a); SAM #H916 (=RVS A84), Cairns Dist., N. QLD, January 1957, poor condition; SAM H1042, Fannie Bay Beach, Darwin Harbour, Darwin, NT, 4 January 1999; SAM H1036-H1041, same data as H1042, coll. 5 January 1999; AM G13098, Port Denison, QLD, 1924, 2 specs, fragmented (erroneously identified as *A. pensilis* by Stiasny, unpublished); AM G13091, 3 poor specs, Port Denison QLD, 1924; AM G13100, 3 specs, Bowen Beach, Port Denison, QLD, washed up, 1924; SAM H936, Fremantle Channel, WA, in drift line, 15 March 1999; female; SAM H987, data as for SAM H936, damaged; WAM Z2925, data as for SAM H936, damaged margin; AM G13098, Bowen Harbour, Port Denison, QLD, 20° 11'S 148° 15'E, 1924; AM G13091, same data as AM G13098; AM G13100, same data as AM G13098; QM G304073, Reef Point, Redcliffe, QLD, 2 July 1950.

Description. Bell hemispherical or higher (Fig. 1), to 92 mm diameter, more often about 40–60 mm, with jelly of a tough and rubbery consistency. Subumbrella (Fig. 2) with distinctive gelatinous papillae, singly to several in a row beneath radial canals; shape of papillae typically conical, compressed on both sides (Fig. 3).

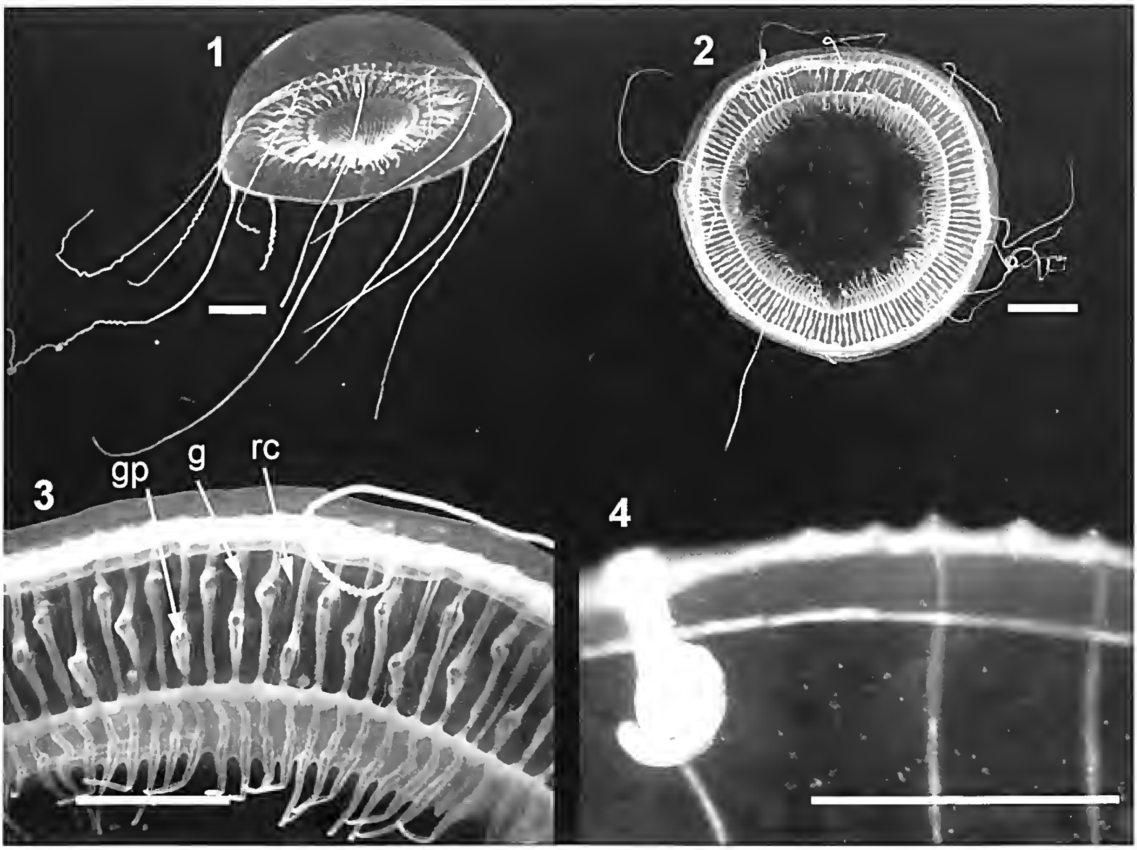
Radial canals approximately 150, generally increasing with body diameter (Table 1); mostly simple, a few forked near margin in some specimens. Gonads bilamellar, along nearly entire length of radial canals, reaching stomach but stopping short of margin.

Tentacles 12–16, hollow, coiled (Table 1); approximately 1–2 times as long as bell diameter when relaxed. Tentacle bulbs broadly triangular to rectangular, with rounded or blunt lateral extensions. Rudimentary tentacle bulbs 6–13, typically about 10, between adjacent tentacles; conical. Statocysts typically three between adjacent tentacles and rudiments, each with two concretions; apparently easily lost. Excretory papillae conspicuous beneath most tentacles and marginal papillae (Fig. 4).

Stomach large, approximately 60% of bell diameter, with gaping mouth over large, shallowly convex, gelatinous mass. Solid external ribs on the stomach wall numbering the same as, and continuous with, lips and radial canals. Lips long and pointed, with shallow furrow down centre on inside.

Colour transparent, from faintly whitish to greenish blue along radial canals and tentacles, with colourless mesoglea.

Tentacular nematocysts of two types (Fig. 5, from holotype): firstly, broad egg-shaped isorhizas, 20.56–29.23 μm long by 15.81–19.46 μm wide (n = 24), and



Figs 1–4. *Aldersladia magnificus* gen. and sp. nov. **1**, whole medusa, subumbrellar-lateral view, in life; **2**, holotype, subumbrellar view, preserved; **3**, holotype, close-up of the gelatinous papillae (gp) underlying the radial canals (rc) and gonads (g); **4**, close-up of the margin; note the numerous marginal warts with excretory papillae. In Figures 1 and 2, scale bar = 1 cm; in Figures 3 and 4, scale bar = 0.5 cm.

secondly, narrow, tongue-shaped, unidentified, of similar length but half as wide (in a few cases, the second type was seen to have a single loop of an extremely fine thread, but no shaft or other identifying features were observed).

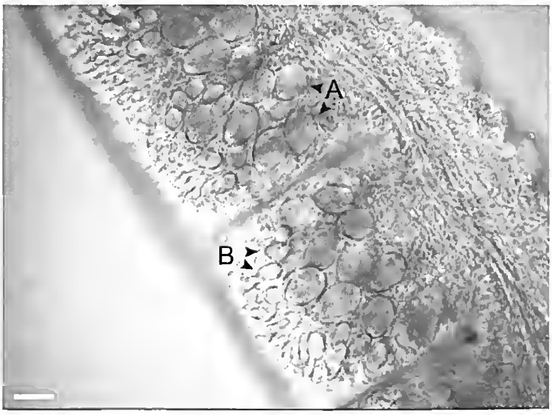


Fig. 5. *Aldersladia magnificus* gen. and sp. nov. holotype, nematocysts: A = primary nematocysts (isorhizas); B = unidentified nematocysts. Scale bar = 25 µm.

Intraspecific variation. In most specimens, the papillae occur under nearly every canal, with papillae lying in approximately two whorls, most often three distal to every one proximal. In a minority of specimens, the papillae occur beneath alternating radial canals, with the papillated canals being thicker and heavier than those lacking papillations. A few specimens have multiple papillae per canal. In some specimens, part of the body contains alternating papillated canals, whilst the other half contains adjacent papillated canals. In the holotype, most canals contain papillae, which alternate proximal-distally along the canals. It is interesting to note that the three WA specimens differ slightly from all the others, in having undulating radial canals and apparently only 5–10 tentacles (estimate based on widely-spaced tentacles in areas of intact margin). All three specimens are damaged – thus I do not know the reliability of these characters.

It is conceivable that this variation in expression of the papillae represents multiple species. However, there did not appear to be reliable geographical difference in expression, nor were there other obvious morphological differences which might be regarded as species-diagnostic. Thus, I am taking a conservative approach in regarding

Table 1. Measurements of *Aldersladia magnificus* gen. and sp. nov. specimens, arranged in ascending order of bell diameter to show corresponding increase in tentacle and radial canal number. Those with missing data lacked margins or were worn and could not be evaluated.

Specimen no.	Total diam. (mm)	Stomach diam. (mm)	Tentacles, no.	Radial canals, no.
H916	27	15	12+	68+
G13098b	28	18	–	117
C12565	31	19	–	128
C12226	32	14	12	59
H1041	34	20	2++	144
H1038	35	19	4++	118
H915	35	20	19	80
H1040	37	26	13	146
H1039	38	26	0++	155
G304073	38	21	11	83
C5375	39	27	11	150
C12563 (holotype)	41	29	12	131
H1036	42	28	4++	156
H1042	44	26	15	125
H987	44	32	–	–
H913	45	31	13	153
H1037	52	32	16	144
H914	57	39	16	166
H936	62	40	5+	136
C11997	62	40	–	139
G13098a	63	42	16	153
Z2925	66	38	–	140
G13091a	74	50	–	–
G13091b	84	47	–	–
G13091c	87	52	–	–
G13100a	87	46	–	–
G13100b	90	45	–	–
G13100c	92	55	–	–

the number and arrangement of papillae to be variable in this one species, while hoping that this question stimulates further research interest.

Associations. This species is often found with evidence of exumbrellar parasitisation; the hyperiid amphipod symbionts on the holotype were identified as females and young of *Lestrigonus bengalensis* (W. Zeidler pers. comm., September 1998).

Etymology. I have chosen the specific name *magnificus*, because the medusa is truly a magnificent one to behold. In life, it is crystal-clear, with faintly blue-tinted canals and few coiled tentacles, giving the medusa a delicate and elegant appearance.

Type locality. Fort Hill Wharf, Darwin Harbour, Darwin, NT.

Distribution. Currently known from Moreton Bay, S.E. Queensland, to Fremantle, Western Australia. Common in Darwin Harbour.

Systematic remarks. *Aldersladia magnificus* has previously been misidentified as *Aequorea pensilis* (Stiasny unpublished; Kramp 1961a). It is unclear why both appeared to ignore the conspicuous subumbrellar papillae (specimens AM G10398 and SAM H915, respectively). In addition, specimens possibly referable to this species have been identified as belonging to *A. pensilis* (Kramp 1953, 1965), though material is unavailable for study.

It is a mistake to confuse *A. pensilis* with *Aldersladia magnificus*. In all figures and written descriptions of *A. pensilis*, the subumbrellar papillae are entirely absent (see especially photographs in Bigelow (1919) and in Russell (1953)), though they are immediately conspicuous in the present collection. Even in damaged specimens lacking all traces of tentacles, gonads, and stomach, these papillae are prominent. Thus, it is apparent that *A. pensilis* lacks the subumbrellar papillae, whereas *Aldersladia magnificus* possesses them, and both species are valid. In addition, the excretory papillae are prominent in *A. magnificus* but absent in *Aequorea pensilis*. Furthermore, Kramp (1961a) describes *Aequorea pensilis* as having "statocysts very numerous," yet they number only about three between adjacent tentacles and rudiments in *Aldersladia magnificus*. I have seen only two Australian specimens that I believe are true *Aequorea pensilis*, both from far northern Queensland, whereas *Aldersladia magnificus* is common along the tropical coasts of Australia.

Péron and Lesueur (1810) described two species with subumbrellar papillae from northern Australia, namely *Aequorea bunogaster* and *A. phosperiphora*. It is possible that *A. magnificus* can be attributed to one or both of these species; however, the descriptions are too vague for confirmation, no material exists for study, and both have been considered unrecognisable for nearly 200 years. Rather than resurrecting one or both of these obsolete names and the uncertainty inherent in doing so, it seems more conservative to start fresh with ample material and a certain identity.

The only other aequoreid that *A. magnificus* could possibly be confused with is *Aequorea papillata* Huang and Xu; however, this would be confused in name only, as the description and figures provide no evidence of subumbrellar papillae, being instead on the manubrium (Huang and Xu 1994). *Aequorea papillata* is said to have spherical-shaped lateral extensions on the tentacle bulbs, and spherical marginal warts; both characters are similar to *A. parva* Browne, but differ in possessing excretory papillae.

The function of the papillae is unknown. This was questioned in review and thought to perhaps be from parasitism. They appear too symmetrical on each specimen and too prevalent throughout the species to be a direct result of parasitism, and I believe that a hypothesis of some sort of allergic reaction to parasitism would be far-fetched and unsubstantiated. I believe them to be fully structural, as are, presumably, those of *Rhacostoma atlanticum*.

ACKNOWLEDGMENTS

I am deeply grateful to the following people and institutions for specimens, information, and hospitality that have collectively made this work possible (in alphabetical order): Phil and Ann Alderslade, the late Peter Arnold, the family of the late Jack Barnes, Penny Berents and her family, Gavin Dally, Peter Fenner, Wally Gibb, James Cook University, Jane Fromont, Steven Gregg, Sue Horner, Thierry Laperousaz, Museum of Tropical Queensland, Northern Territory Museum, Barry Russell, Scoresby and Anna Shepherd, South Australian Museum, South Australian Research and Development Institution, Surf Life Saving Queensland, University of Western Australia, Western Australian Museum, and Wolfgang and Lyn Zeidler. I sincerely thank Dale Calder and George Matsumoto for helpful comments on an earlier draft.

I also gratefully acknowledge the various institutions that have provided funding for this study: Australian Biological Resources Study (grant no. 20045), CRC Reef Research Centre, CSIRO Centre for Research on Introduced Marine Pests, Fulbright Foundation, James Cook University, Surf Life Saving Australia, Surf Life Saving Queensland, Thyne-Reid Foundation, University of California Berkeley, and the University of California Museum of Paleontology.

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Accepted 9 October 2005

The Beagle, Records of the Museums and Art Galleries of the Northern Territory, 2006 **22**: 15–21

Chiropsella bart n. sp., a new box jellyfish (Cnidaria: Cubozoa: Chirodropida) from the Northern Territory, Australia

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ABSTRACT

A new species of multi-tentacled box jellyfish from eastern Arnhem Land along the Gulf of Carpentaria, renowned locally for occurring only in the so-called 'safe season' (i.e., the dry season), is described. *Chiropsella bart* n. sp., differs from other chiropsalmids in maturing at a much smaller size, in its mature tentacle number, in having coalesced gastric saccules in the form of a kidney-bean-shaped knob, and in having very long pedalia with the branches and tentacles clustered near the distal end.

Keywords: taxonomy, Cnidaria, Coelenterata, Chiropsalmidae, Chirodropidae, *Chiropsalmus*, stinger season, Gulf of Carpentaria.

INTRODUCTION

Box jellyfishes in Australia have long been a concern, with at least 70 deaths attributed to *Chironex fleckeri* Southcott (Currie and Jacups 2005). The Chirodropida (i.e., the multi-tentacled box jellyfishes) of Australia have been grouped into only two species, *Chironex fleckeri* and *Chiropsalmus quadrigatus* Haeckel (Cleland and Southcott 1965; Barnes 1965, 1966; Keen 1971; Freeman and Turner 1972; Brown 1973; Fenner 1986; Sutherland 2001). Recent authors have separated the Australian species of *Chiropsalmus* from the true Burmese *Chiropsalmus quadrigatus*, but have still not commented on morphological diversity in the genus around Australia, implying that the regional forms are all the same species (Edmonds 1975; Williamson *et al.* 1996; Carrette *et al.* 2002; Gordon *et al.* 2004), similar to the assumptions made for *Chironex* (Williamson *et al.* 1996; Carrette *et al.* 2002; Currie *et al.* 2002). In fact, recent morphological and molecular analyses of Australian Chirodropida (Gershwin 2005) have indicated considerable diversity in the group, with at least five species comprising what is currently known as *Chironex fleckeri* and at least two species recognised interchangeably as *Chiropsalmus* sp. or *Chiropsalmus quadrigatus*.

The common '*Chiropsalmus*' from northern Queensland was recently described as a new genus and species, *Chiropsella bronzie* (Gershwin 2006a). *Chiropsella* differs from *Chiropsalmus* in having sessile, solid gastric saccules and lacking exumbrellar nematocysts.

A peculiar chiropsalmid from the Gove Peninsula in eastern Arnhem Land was reported by Currie *et al.* (2002). This medusa matures at a much smaller size than is typical for most species of Chirodropida, and normally occurs only during the local dry season, in contrast to all other known species in the Chirodropida, which are predominantly wet season or summertime species. This 'Gove chirodropid', as it is commonly known, is similar to, but distinct from, the Queensland *Chiropsella bronzie*. The purpose of this paper is to describe this new species of chiropsalmid from Arnhem Land. This species is not known to be harmful to humans, aside from a localised painful sting.

MATERIALS AND METHODS

All specimens except the holotype were caught during routine netting operations off the Gove Peninsula Surf Life Saving Club, and forwarded to the Museum and Art Gallery of the Northern Territory (NTM) for identification; the holotype was caught independently and donated by R. Hartwick. All measurements and character assessments were thus made on preserved material. Measurements were made with Max-Cal digital calipers to the nearest 0.01 mm. Bell height (BH) was measured from the apex of the bell to the velarial turnover. Diagonal bell width (DBW) was measured across diagonal pedalia on a flattened specimen, at the height where the pedalium joins the exumbrella of the bell. Interrhopalial width (IRW) was measured between adjacent rhopalia, with the specimen flattened. Tentacle base width (TBW) was measured at the uppermost part of the tentacle, immediately below the pedalium; if the tentacle was flattened, width was measured across the widest points. Sex was determined, when possible, by biopsy. Female gonads have obvious ova; male gonads have a conspicuous 'finger-print' appearance of many fine more-or-less parallel lines. Nematocysts were examined and measured with a Leica DMLB compound microscope and Leica IM-50 Image Manager v. 1.20 for Windows; all observations and photographs were made through a 40x objective (i.e., 400x magnification). Nematocysts were identified following the keys of Calder (1974), Mariscal (1971), and Williamson *et al.* (1996), as elucidated in Gershwin (2006b).

SYSTEMATIC RESULTS

Class Cubozoa Werner, 1973
Order Chirodropida Werner, 1984
Family Chiropsalmidae Thiel, 1936
(*sensu* Gershwin 2006a)
Genus *Chiropsella* Gershwin, 2006
Chiropsella bart n. sp.

(Figs 1–4)

Chiropsalmus sp. Currie, 1992: 1–2.

Gove chirodropid Currie *et al.*, 2002: 649; Currie and Jacups 2005: 631–636.

Chiropsalmus n. sp. B Gershwin, 2005: 125–126, pl. 4.9C, and throughout; Gershwin 2006b: 12; pl. 28; cnidome.

Chiropsella n. sp. Gershwin, 2006a: 25, 36; Table 1; comparison with *C. bronzie*.

Material examined. HOLOTYPE – NTM C15252, Town Beach, Nhulunbuy, Gove Peninsula, NT, coll. P. Schelle and R. Hartwick, 17 May 1986; BH 47.89, DBW 62.03, IRW 30.34, TBW 1.42, 5-tentacle stage on all 4 pedalia, male.

Other material. PARATYPES – NTM C14603, Nhulunbuy, Gove Peninsula, N.T., coll. Surf Life Savers, 6 October 2002, BH 44.81, DBW 62.91, IRW 33.98, TBW 1.76, 5-tentacle stage on all 4 pedalia, mature male; NTM C14601, Nhulunbuy, Gove Peninsula, N.T., coll. Surf Life Savers, 27 April 2002, BH 51.05, DBW 76.08, IRW 37.28, TBW 1.37, 5-tentacle stage, sprouting the 6th on the one intact pedalium, gravid female; NTM C14602, same loc. data as NTM C14601, BH 43.92, DBW 68.54, IRW 34.77, TBW 1.44, 5-tentacle stage on all 4 pedalia, gravid female; NTM C14604, same loc. data as C14603, BH 33.05, DBW 46.40, IRW 24.11, TBW 1.00, 5-tentacle stage on all 4 pedalia, gravid female; NTM C14605, same loc. data as C14603, BH 16.39, DBW 27.03, IRW 12.16, TBW 0.73, 4-tentacle stage, sprouting a 5th on one pedalium, immature; NTM C11046, Nhulunbuy Town Beach, Gove Peninsula, N.T., coll. Surf Life Savers, 2 June 1991, 3 specimens BH 45-50.

Diagnosis. *Chiropsella* species reaching about 5 cm BH with up to about 5 tentacles per pedalium; with long scalpel-like pedalia with main tentacles forming a more or less terminal cluster; with volcano-shaped diverticulum on pedalial canal near pedalial base; with coalesced solid, knob-like gastric saccules, appearing as single kidney-bean-shaped structure.

Description. Body small, with mature gonads at about 3 cm, reaching known maximum of about 5 cm BH, strongly cuboid (Fig. 1). Body mesoglea thick and relatively solid, with thickened and stiff apical dome and interradial pillars; with shallow sub-apical coronal furrow and well-defined interradial and adradial furrows. Adradial furrows extend laterally at level of stomach, forming a well-defined rectangular perradial region. Exumbrellar surface smooth, lacking nematocyst warts or freckles.

Pedalia (Fig. 2A) long, scalpel-shaped, with pronounced adaxial keel reminiscent of structure of carybdeids; abaxial tentacle issuing distally well past halfway point; remaining fingers and tentacles arranged close together more or less terminally, but opposite rather than alternate. Pedalial canal flattened in cross section, with volcano-shaped upward-pointing diverticulum near base. Sub-terminally, pedalial canal bifurcated, each leg giving rise to branches on its own side only (Fig. 2B). Pedalial canals straight at tentacle insertion.

Tentacles up to 5 per pedalium in present collection, with one specimen having a 6th nub; round and very fine in cross section; straight at base. Banding pattern could

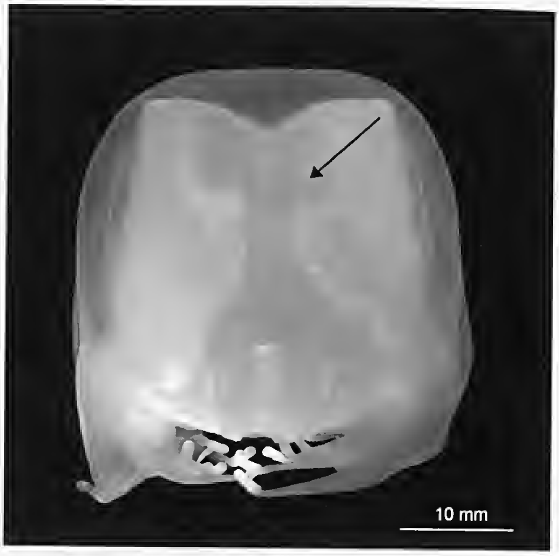

Fig. 1. *Chiropsalmus bart* n. sp. holotype; note coalesced gastric saccules (arrow).

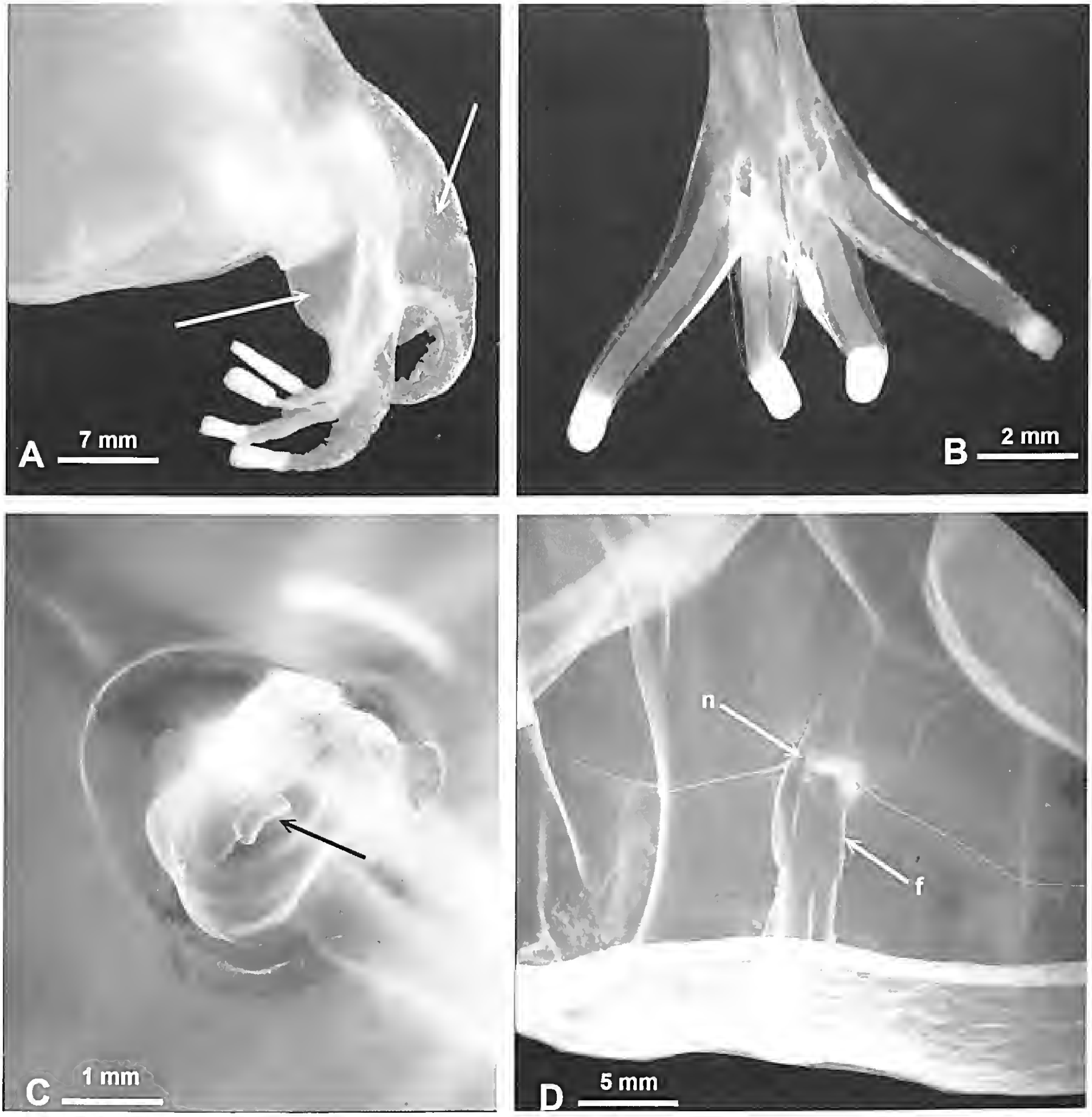

Fig. 2. *Chiropsalmus bart* n. sp. **A**, pedalium, side view; note abaxial and adaxial keels (arrows); **B**, pedalium, adaxial view; **C**, rhopaliar niche ostium, exumbrellar view; note flap (arrow); **D**, rhopaliar niche (n), subumbrellar view, and thickened gelatinous frenulum (f).

not be definitively determined due to loss of tentacles on all specimens.

Rhopalial niche substantially raised from exumbrellar surface. Ostium dome-shaped, with well-developed upper covering scale and no lower scale; upper scale with horizontal, cigar-shaped or banana-shaped flap hanging down in middle to shield rhopalium (Fig. 2C). Niche with single low rounded extension in each of the two upper corners, giving niche a tall, rectangular appearance. Rhopalium with 6 eyes, 2 median ones with lenses; and 2 pairs of lateral eye spots. Statolith located below main eye, rather than behind it; statolith shape could not be determined due to loss in preserved material. Rhopalial window flat on subumbrellar wall, overgrown by top of frenulum (Fig. 2D).

Velarial canals originating from two main canal roots in each octant, but branching so profusely as to be impossible to count. Perradial lappets not substantially raised, but very broad, with many canals emanating from lateral and distal edges (Fig. 3A). Frenulum a solid, gelatinous structure, extending about 3/4 distance toward velarial margin (Fig. 2D).

Gastric saccules forming a coalesced, kidney-bean-shaped structure (Fig. 3B), solid and knob-like, projecting into subumbrellar cavity but not pendant. Gonads leaf-like, attached along entire bell height of interradii, wider

Table 1. Comparison of characters of species in the family Chiropsalmidae.

	Gastric saccules	Pedalial branching	Pedalial canal	Tentacle no; cross section	Bell texture	Distribution
Chiropsalmus quadrumanus (Müller)	Simple, solid, half as long as the bell	In both directions; all along pedalium	Undivided, branching in both directions; without thorn	Up to 7–9; round and fine	With nematocyst warts	Type from southern Brazil; reported to South Carolina, USA
Chiropsalmus zygonema Haeckel	Oval, very small	Two asymmetrical tentacles	(Unknown)	2; unknown shape	(Unknown)	Argentina; found only once
Chiropsalmus alipes Gershwin	Simple, small, with one edge wavy	In both directions; terminal	Divided; with 90° corner at bend	Up to 3–4; round and thick	With nematocyst warts	W. coast of southern Mexico
Chiropsella bronzie Gershwin	Simple, solid, sessile, separate	In both directions; all along pedalium	Divided, each branching in only 1 direction; with 'knee'-like bend	Up to 9; round and fine	Smooth, lacking nematocysts	N. QLD from Cooktown to Townsville
Chiropsella bart n. sp.	Simple, solid, sessile, coalesced	In both directions; nearly terminal	Divided, each branching in only 1 direction; with 'volcano' at bend	Up to 5–6; round and fine	Smooth, lacking nematocysts	Gove Peninsula, Arnhem Land, NT
Chiropsoides buitendijki (Horst)	Simple, hollow, as long as the bell, separate	In one direction only; all along pedalium	Undivided, branching in only 1 direction; with 'thorn' at bend	Up to 5–6; flat and ribbon-like	Smooth, lacking nematocysts	Type from Java Sea; reported from Sri Lanka and southern India
Chiropsoides quadrigatus (Haeckel)	Too young for determination	In one direction only; all along pedalium	Undivided, branching in only 1 direction; with 'thorn' at bend	4; flat and ribbon-like	Smooth, lacking nematocysts	Type from Rangoon; all other records doubtful

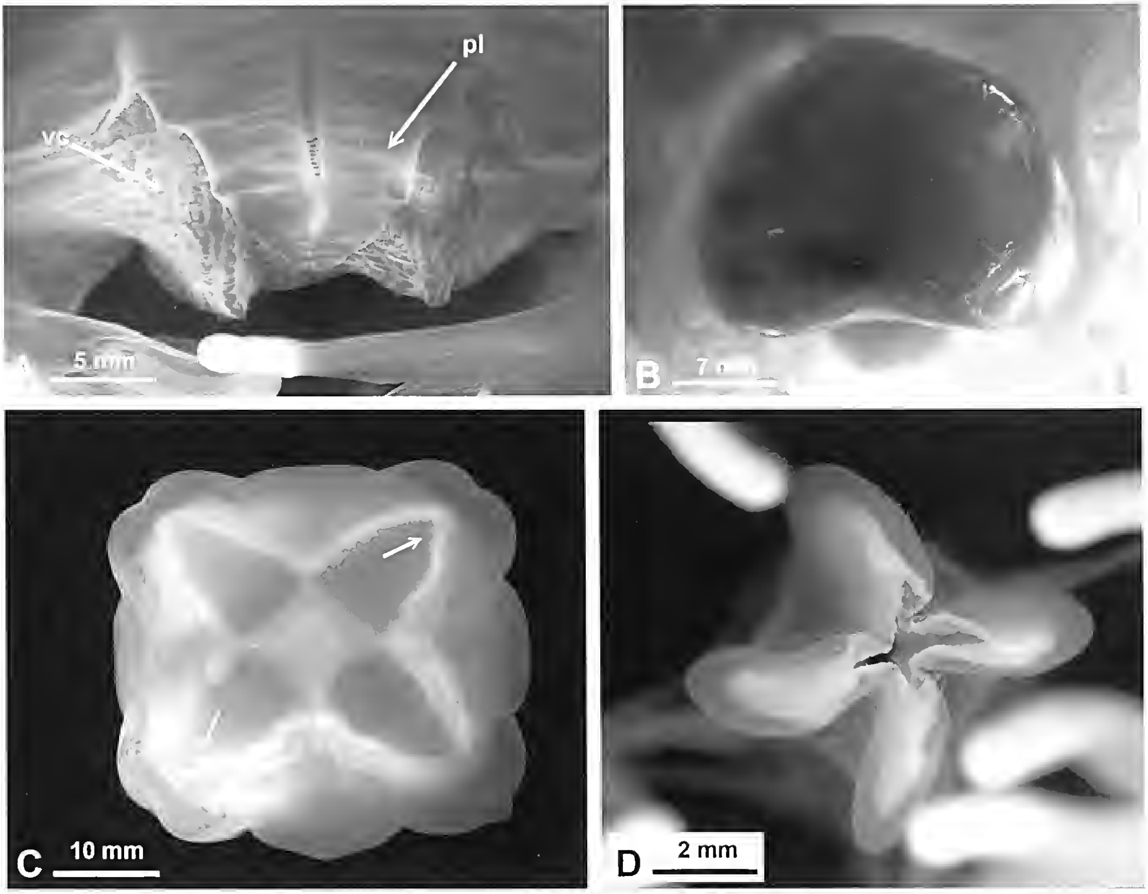

Fig. 3. *Chiropsalmus bart* n. sp. **A**, perradial lappets (pl) and velarial canals (vc) from one quadrant of velarium, exumbrellar view; **B**, gastric saccules, one coalesced pair; **C**, gastric phacellae (arrows), apical view; **D**, mouth, subumbrellar view.

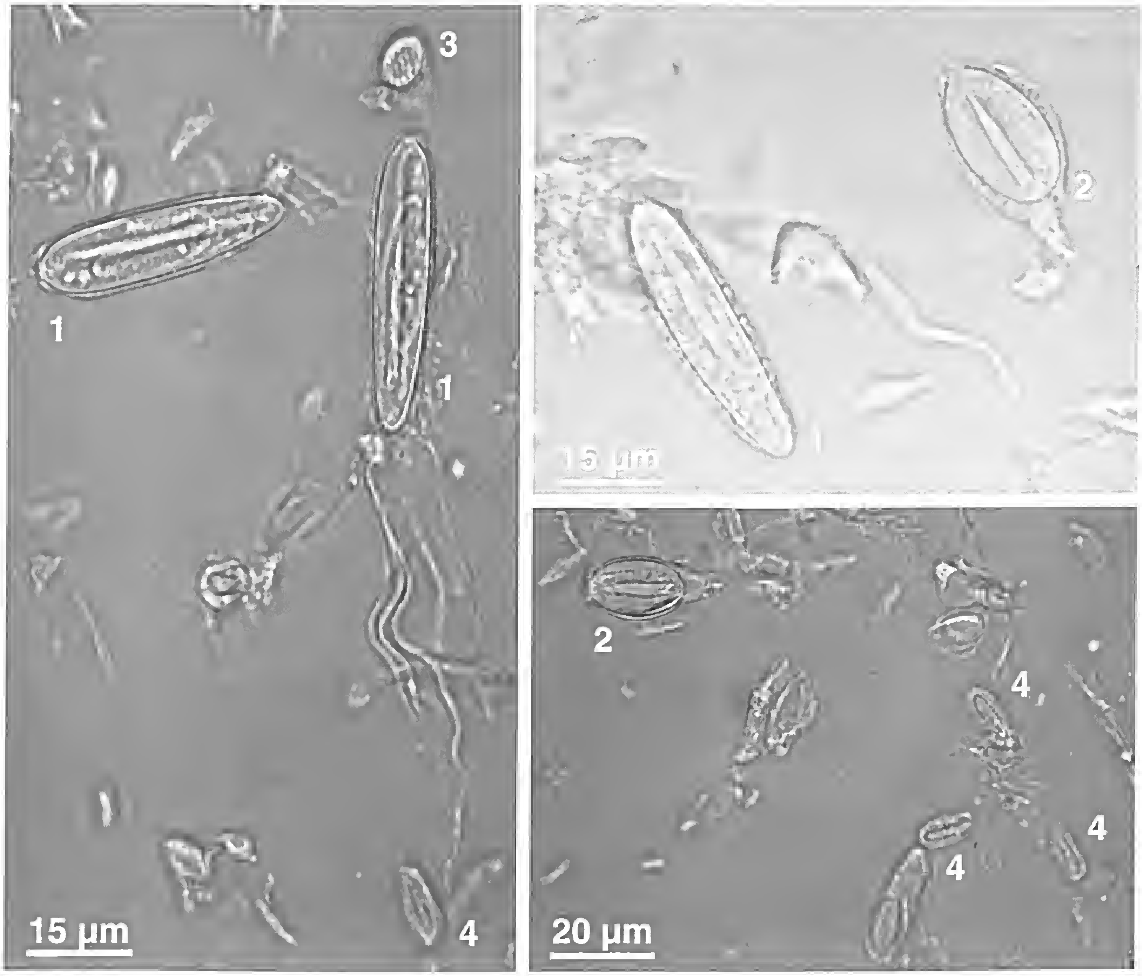

Fig. 4. *Chiropsalmus bart* n. sp. cnidome. Cigar-shaped microbasic *p*-mastigophores (1); large football-shaped microbasic *p*-mastigophores (2); small oval 'beehive' isorhizas (3); small rod-shaped isorhizas (4).

in middle than at top or bottom (Fig. 1). Interradial septa not observed. Stomach shallow and flat, with very short mesenteries reaching only about as far as edge of phacellae. Phacellae continuous, shaped like 4-pointed star (Fig. 3C). Mouth cruciform, with short, smooth lips (Fig. 3D), hanging to about 1/3 bell height.

Cnidome (Fig. 4). Four types of nematocysts found in squash preparation from tentacle of holotype: 1) Cigar-shaped microbasic *p*-mastigophores, 39.28–44.84 µm x 8.79–10.92 µm, n=12; 2) Large football-shaped *p*-rhopaloids, 21.27–26.29 µm x 12.73–14.37 µm, n=10; 3) Small oval 'beehive' isorhizas, 9.04–9.94 µm x 6.88–7.71 µm, n=5; 4) Small rod-shaped isorhizas, 13.21–14.20 µm x 6.54–7.27 µm, n=3.

Etymology. Named to honour Prof. Bart Currie, of the Menzies School of Health Research, Darwin, Northern Territory. Bart's meticulous studies and observations have led to many important contributions in the medical aspects of cubozoology, and he kindly brought this species to our attention. Noun in apposition.

Systematic remarks. *Chiropsella bart* is characterised by a curious morphology. Like *Chiropsella bronzie* Gershwin, from North Queensland – previously erroneously called *C. quadrigatus*, e.g., Barnes (1965, 1966); Cleland and Southcott (1965); Keen (1971); Freeman and Turner (1972); Brown (1973); Fenner (1986) – the gastric saccules are sessile, solid gelatinous knobs. However, in *C. bart* the saccules are coalesced, whereas in *C. bronzie* they are divided. No other chirodropid possess sessile, solid saccules such as these. The tentacles are also round in cross section and very fine in both species, although the pedalia are quite different, being long and scalpel-shaped in *C. bart* but more claw-like in *C. bronzie*. Finally, in fully mature *C. bart*, the tentacles are typically five per pedalium, with one specimen sprouting a sixth on one pedalium; in contrast, fully mature *C. bronzie* have up to about nine tentacles.

DISCUSSION

Chiropsella bart is a most remarkable medusa, being primarily present during the Northern Territory dry season (Currie *et al.* 2002), contrasting with all other known tropical species of cubozoans which reach their peak abundances during their local wet season. Very little is currently known about this species, except that it is common in the early dry season on the sandy beaches of Nhulunbuy, where it sometimes swarms in the hundreds or thousands (unpublished GPSLSC netting records).

The sting of *Chiropsella bart* produces only mild pain and itching, usually persisting less than two hours (Currie *et al.* 2002). It is perhaps the mildest sting known in the Chirodropida.

Chiropsella bart is one of the numerous new species of Australian Chirodropida, a group where the species richness has not been previously appreciated. Others include a small chiropsalmid from northern New South Wales, which is the first known member of the Chirodropida from temperate waters; new species of *Chironex* from each of the Gulf of Carpentaria, the Darwin region, and the Broome region; and a very unusual new species with black tentacles, found in the far northern Kimberley region. In addition to the recently described *Chiropsella bronzie* from North Queensland (Gershwin 2006a), the most peculiar *Chirodectes maculatus* with a spotted exumbrella, subumbrellar muscle bands, filamentous gonads, and no gastric saccules, was recently described by Cornelius *et al.* (2005). For most of these species, their formal description will be only the tip of the iceberg, so to speak, with the remaining features of their biology, ecology, and toxinology yet to be elucidated.

ACKNOWLEDGMENTS

We are indebted to Bernie Whelan, the volunteers of the Gove Peninsula Surf Life Saving Club, and the staff of the Gove District Hospital for collecting the specimens used in the type series and information to help us understand the species. We thank Bart Currie and Susan Jacups for providing us with specimens, collection records, and nematocyst information. LG gratefully acknowledges funding from Australian Biological Resources Study (ABRS grant No. 20045 to LG and W. Zeidler), Great Barrier Reef Research Foundation, CRC Reef, James Cook University, Fulbright Foundation, Lions Foundation, Robert W. King Memorial Scholarship, Surf Life Saving, and a Merit Research Grant (to M. Kingsford).

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Accepted 17 October 2006

The Beagle, Records of the Museums and Art Galleries of the Northern Territory, 2006 **22**: 23–29

Periclimenes jackhintoni sp. nov. (Crustacea: Decapoda: Palaemonidae), a new pontoniine shrimp and crinoid associate from Tonga

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ABSTRACT

A new species of pontoniine shrimp, *Periclimenes jackhintoni* sp. nov., from Tonga is described and illustrated. The new species is most closely related to *P. ceratophthalmus* Borradaile (Palaemonidae). It is readily distinguished from *P. ceratophthalmus,* and all other species of *Periclimenes,* by its unusual sickle-shaped rostrum. The unique specimen was found in association with an unidentified crinoid host.

Keywords: *Periclimenes,* new species, systematics, commensal, Crustacea, Decapoda, Pontoniinae, Tonga, south-west Pacific.

INTRODUCTION

During the course of the Project Raleigh 1986 trans-Pacific cruise, samples of commensal shrimps were collected from a variety of coral reefs between San Francisco and Darwin by Dr Matt Richmond. These were presented to the Museum and Art Gallery of the Northern Territory. Amongst the specimens collected, a single specimen of a new species of pontoniine shrimp was identified from Tonga. This specimen is here described and illustrated.

Some of the earliest pontoniine shrimps to be described from the Indo-west Pacific region were reported from the islands of the Tongan archipelago. Dana (1852) reported *Harpilius lutescens* and *Coralliocaris graminea* (as *Oedipus gramineus*). Since that time the shallow water pontoniine fauna has received little attention and only three species have been added the Tongan fauna list: *Periclimenes ceratophthalmus* Borradaile, from the Vava'u Islands (Borradaile 1915); *Periclimenes tonga* Bruce, from Nuapapu Island, Vava'u Islands (Bruce 1989); and most recently *Odontonia katoi* (Kubo) from Tonga (Fransen 2006). Of the five, *P. tonga* is known only from the holotype from Tonga. The discovery of a further new pontoniine shrimp is therefore of interest and suggests that the Tongan reefs would be worthy of more detailed study. Of the six pontoniine species now known from Tonga, two have not been reported from elsewhere and Tonga is now the type locality for four species.

The holotype specimen is deposited in the collections of the Museum and Art Gallery of the Northern Territory, Darwin.

Abbreviation used, NTM, Museum and Art Gallery of the Northern Territory; CL, postorbital carapace length.

SYSTEMATICS

Family Palaemonidae Rafinesque
Subfamily Pontoniinae Kingsley
Genus *Periclimenes* Costa
Periclimenes jackhintoni sp. nov.

(Figs 1–5)

Material examined. HOLOTYPE – male, Project Raleigh, stn 65a, Nukualofa, Tongatapu , Tonga, 1.5 m, 17 August 1986, coll. M. Richmond, NTM Cr. 004258.

Diagnosis. A *Periclimenes* with a slender decurved sickle-shaped rostrum, feebly dentate distally, without ventral teeth, well-developed supraorbital teeth, inferior orbital angle without ventromedial flange, small marginal antennal spine, small fixed hepatic spine, proximal segment of antennule distolaterally bidentate, cornea with long terminal papilla, small acute epistomal horns present, fourth thoracic sternite without median process, incisor process distally expanded, multidentate, first pereiopod with slender chela with simple fingers with entire cutting edges, second pereiopods unknown, ambulatory dactyls biunguiculate, abdominal pleura rounded, male first pleopod without medial accessory lobe, telson with 2 pairs of small dorsal spines.

Description. A small slenderly built pontoniine shrimp, body subcylindrical, smooth, glabrous (Fig. 1).

Rostrum (Fig. 2B) well developed, about 0.68 of CL, reaching to middle of intermediate segment of antennular peduncle, slender, compressed, decurved, dorsal carina distinct, extending on to anterior carapace, dorsal margin convex, mainly unarmed, with 2 very small denticles on terminal tenth (Fig. 5A), tip slightly up-turned, ventral

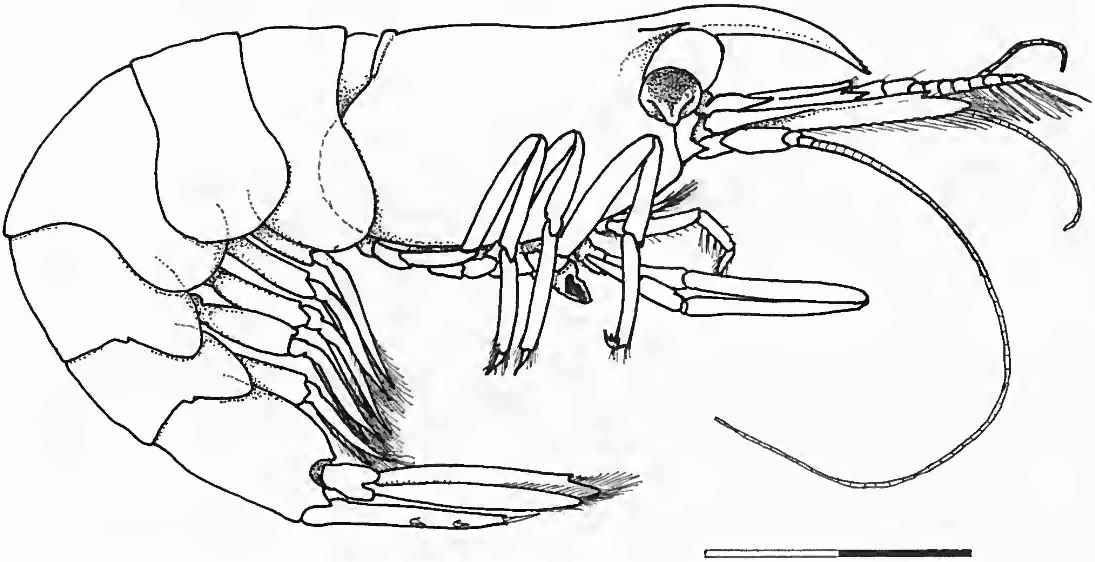

Fig. 1. *Periclimenes jackhintoni* sp. nov., holotype, Tonga, NTM Cr.004258. Scale bar in millimetres.

margin concave, non-setose, unarmed, lateral carinae obsolescent on rostrum proper, expanded laterally over orbit, with small acute lateral tooth.

Carapace with orbit feebly developed (Fig. 2A), inferior orbital angle produced (Fig. 2C) rounded, incurved, without ventral flange, antennal spine slender, marginal, close below inferior orbital angle, hepatic spine similar to antennal, fixed, slightly lower than antennal spine, slightly posterior, anterolateral branchiostegite bluntly rounded.

Abdomen without special features, sixth segment about 0.6 of CL, 1.5 times longer than deep, 1.7 times longer than fifth segment, posterolateral angle acute, posteroventral angle blunt, pleura broadly rounded, margins non-setose.

Telson (Fig. 2I) about 1.3 times sixth segment length, 0.7 of CL, 2.2 times longer than proximal width, expanded proximally, tapering distally, with 2 pairs of small submarginal dorsal spines, about 0.05 of telson length, at 0.5 and 0.75 of telson length, posterior margin about 0.27 of proximal width, angular, slightly produced centrally with small acute median process, lateral spines small, slightly longer than dorsal spines, intermediate spines long, slender, about 0.25 of telson length, 3.0 times lateral spine length, submedial spines slender setulose, about 2.0 times lateral spine length (Fig. 2J).

Antennule (Fig. 2D) with proximal segment of peduncle about 1.8 times longer than wide, medial margin straight, non-setose, with ventromedial tooth at about half length, lateral margin strongly produced distally, with acute inner lobe reaching to distal margin of intermediate segment, with smaller acute distolateral tooth laterally (Fig. 5B); intermediate and distal segments short, subequal, combined length about half of proximal segment length, upper flagellum biramous, short, proximal 3 segments fused, short free ramus with 3 segments, longer ramus filiform, with 3 segments, with about 12 groups of aesthetascs, each darkly pigmented near base, lower flagellum filiform, with 18 segments.

Antenna (Fig. 2E) with basicerite with well-developed acute lateral tooth, distomedial angle with small blunt subcylindrical process, carpocerite short, robust, about twice as long as broad, reaching to about 0.33 of scaphocerite length, flagellum short, scaphocerite well developed, about 3.0 times longer than broad, wider proximally, tapering slightly distally, distal margin bluntly angular, lateral margin straight, with short acute distolateral tooth at about 0.8 of scaphocerite length.

Ophthalmic somite with small accessory pigment spot, without *béc ocellaire*.

Eye (Fig. 2F, G) well developed, cornea oblique, well pigmented, globular, with small dorsal accessory pigment spot, with large distal papilla, proximally broad and compressed, becoming cylindrical and tapering strongly distally, maximal length of cornea subequal to stalk length, stalk sub-cylindrical, tapering slightly distally, about 1.8 times longer than proximal width.

Epistome (Fig. 2H) with small acute horns laterally.

Mandible (Fig. 3A) corpus robust, without palp; incisor process (Fig. 5D) distally moderately expanded, obliquely truncate, with 8 small acute teeth, lateral tooth enlarged, medial tooth reduced, intermediate teeth subequal, molar process stout, obliquely excavate, with blunt marginal teeth and setose tubercles (Fig. 5C).

Maxillula (Fig. 3B) with feebly bilobed palp (Fig. 5E), lower lobe with ventral tubercle with minute simple seta;

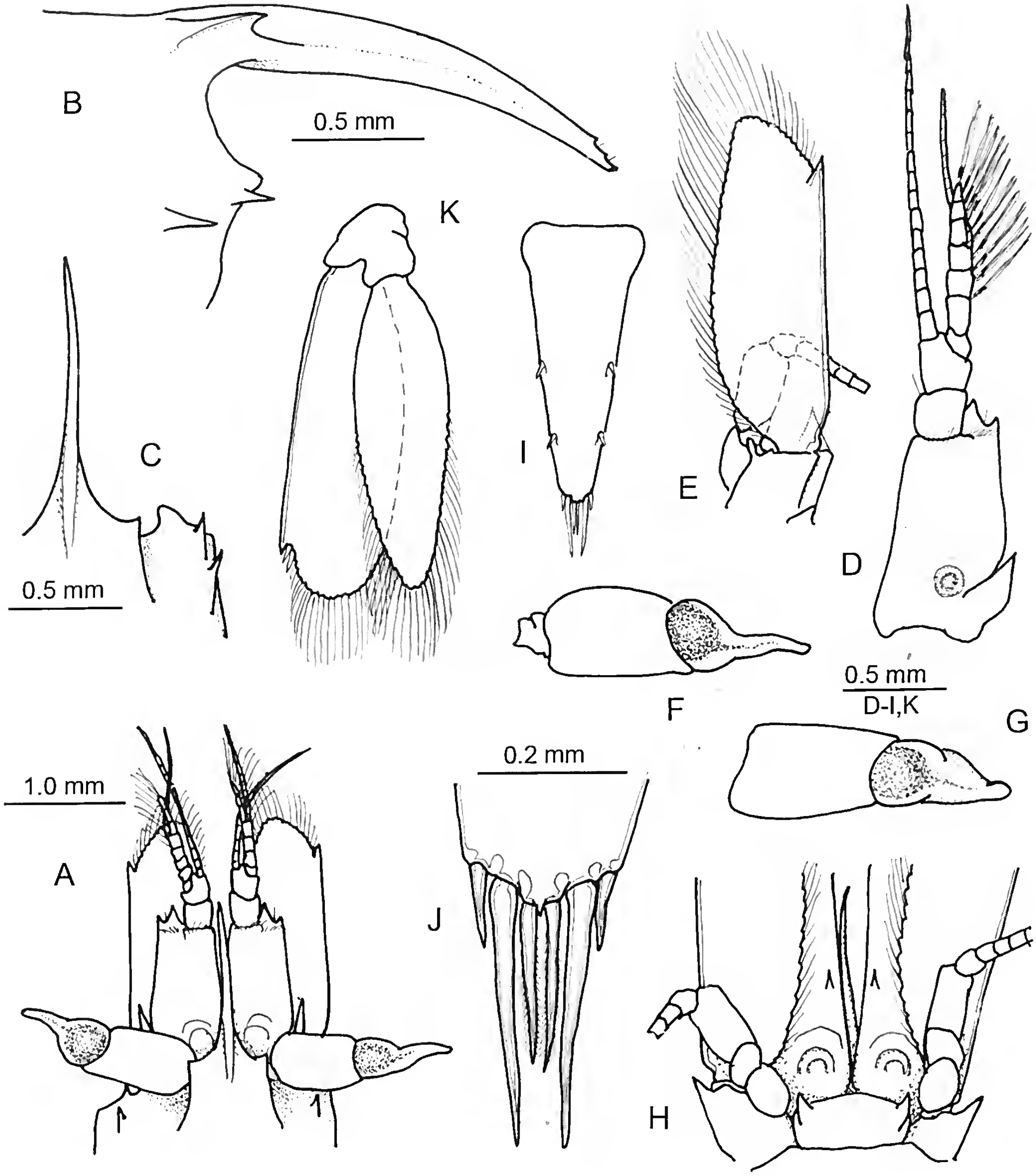

Fig. 2. *Periclimenes jackhintoni* sp. nov., holotype, Tonga, NTM Cr.004258. **A**, anterior carapace and appendages, dorsal; **B**, rostrum and orbital region lateral; **C**, rostrum and right orbital, dorsal; **D**, antennule. **E**, antenna; **F**, eye, lateral; **G**, same, dorsal; **H**, epistomal region, ventral; **I**, telson; **J**, same, posterior spines, (dorsal spine inset); **K**, uropod.

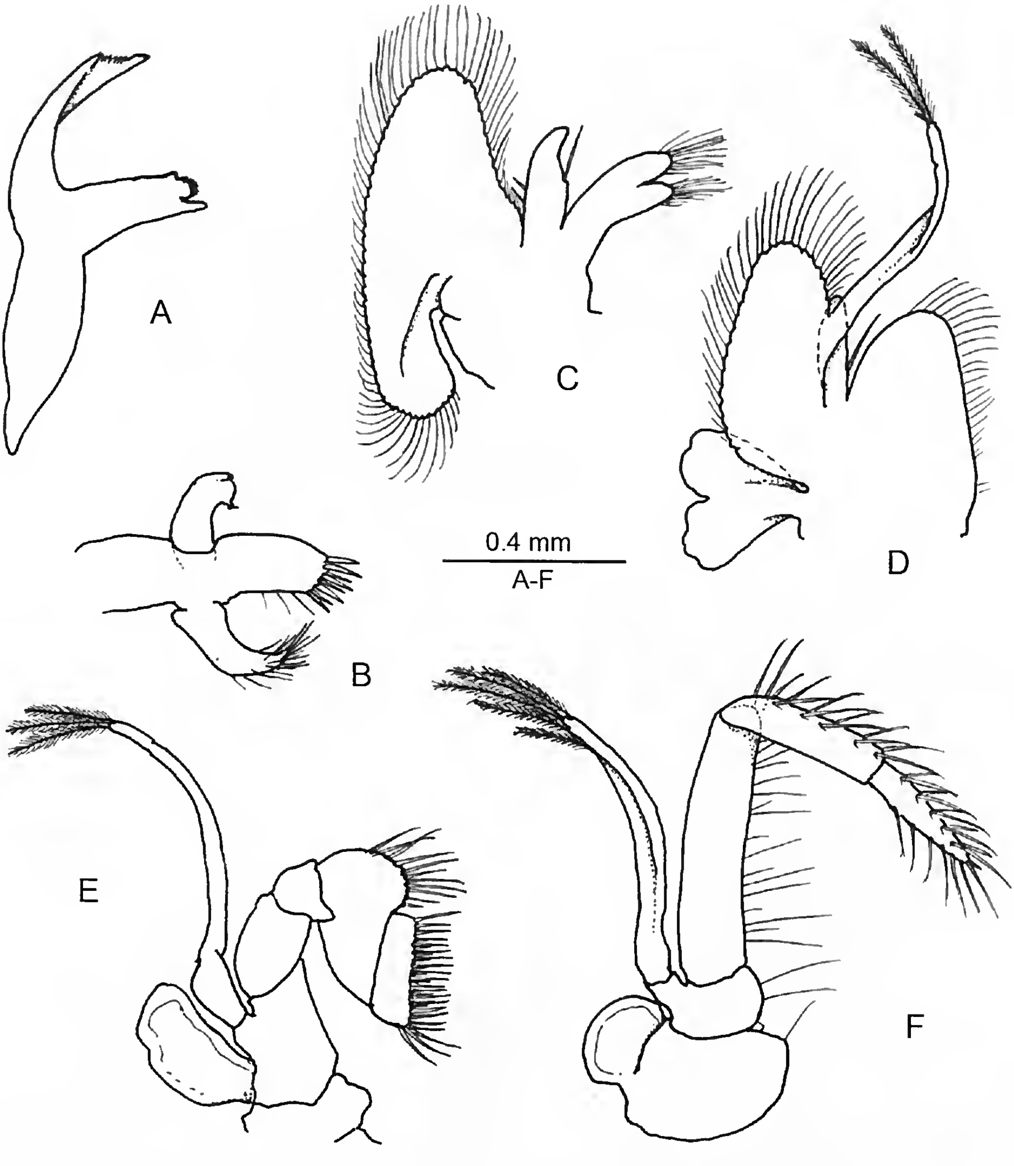

Fig. 3. *Periclimenes jackhintoni* sp. nov., holotype, Tonga, NTM Cr.004258. Mouthparts, left side. **A**, mandible; **B**, maxillula; **C**, maxilla; **D**, first maxilliped; **E**, second maxilliped; **F**, third maxilliped.

upper lacinia bluntly truncate distally with 8 stout simple spines (Fig. 5F), with sparse simple setae, lower lacinia tapering distally with numerous spiniform setae.

Maxilla (Fig. 3C) with simple tapering palp, with slender simple seta at half medial margin length, 2 small plumose setae proximolaterally, basal endite bilobed, lobes short, stout, distally rounded with 10–11 slender simple setae distally, coxal endite obsolete, margin rounded, scaphognathite broad, 2.2 times longer than wide, posterior lobe about 1.5 times longer than basal width, 0.8 of anterior lobe length, anterior lobe about as wide as long, medial margin slightly emarginate.

First maxilliped (Fig. 3D) with short subcylindrical endopod with single simple seta at 0.3 of medial margin, basal endite broad, distally rounded, medial margin straight, sparsely setose, with simple setae, coxal endite obsolete, exopod with well developed flagellum with 2 plumose terminal setae, caridean lobe large, broad, epipod smaller, triangular, bilobed.

Second maxilliped (Fig. 3E) of normal form, dactylar segment about 3.0 times longer than broad,

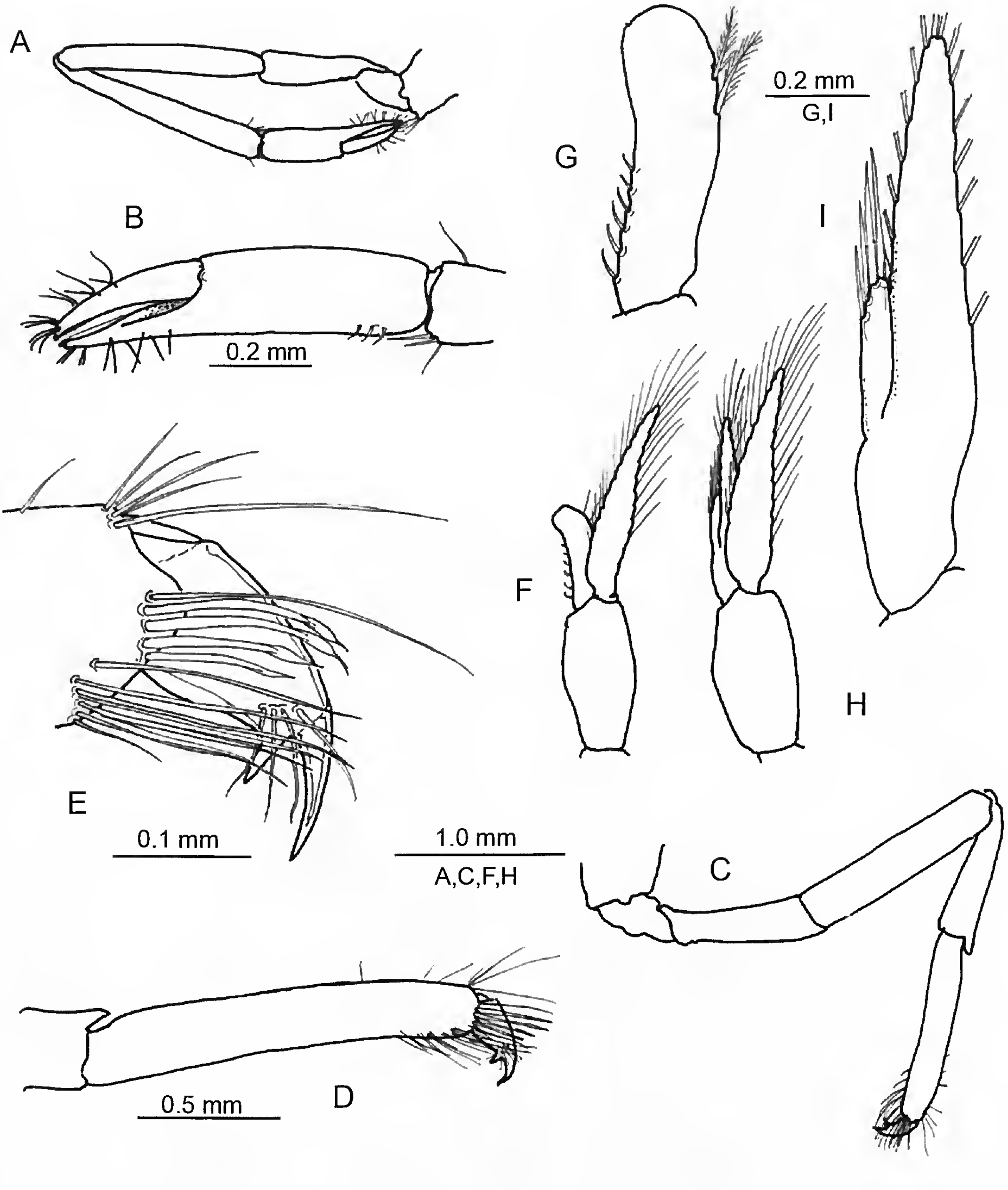

Fig. 4. *Periclimenes jackhintoni* sp. nov., holotype, Tonga, NTM Cr.004258. **A**, first pereiopod; **B**, same, chela; **C**, third pereiopod; **D**, same, propod and dactyl; **E**, same, distal propod and dactyl; **F**, first pleopod; **G**, same, endopod; **H**, second pleopod; **I**, same, endopod.

with numerous denticulate spines along medial margin, propodal segment anteromedially rounded with about 9 long marginal spines, merus and ischiobasis without special features, exopod with well developed flagellum with 3 plumose terminal setae, coxa with medial margin angular, non-setose, with subrectangular epipod laterally, without podobranch.

Third maxilliped (Fig. 3F) with endopod reaching to proximal carpocerite, ischiomerus distinct from basis, about 4.5 times longer than wide, tapering slightly distally, sparsely provided with simple setae along medial margin, penultimate segment about 0.6 of proximal segment length, 3.7 times longer than width, with sparse spiniform setae, terminal segment about 0.8 of penultimate segment length, 3.6 times longer than proximal width, with sparse groups of spiniform setae, with small short terminal spine, basis medially rounded with 2 simple setae, exopod with well developed flagellum with 5 plumose terminal setae, coxa medially angular, with rounded lateral plate, without arthrobranch.

Thoracic sternites with fourth sternite without median process, posterior sternites unarmed.

First pereiopod (Fig. 4A) slender, exceeding carpocerite by carpus and chela; chela (Fig. 4B) slender, palm subcylindrical, oval in section, about 2.5 times longer than width, with sparse cleaning setae proximoventrally, fingers slender, about 0.75 of palm length, dactyl about 4.0 times longer than proximal width, tapering distally, with small robust hooked terminal spine and smaller accessory tooth, with sparse tufts of setae distally, cutting edge entire over distal third only, fixed finger similar; carpus sub-cylindrical, about 1.6 times chela length, 7.0 times longer than width, tapering slightly proximally; merus about 0.95 of carpus length, ischium 0.55 of carpus length; basis and coxa short, without special features, coxa with small setose distoventral process.

Second pereiopods missing, bases and coxae similar, robust.

Ambulatory pereiopods moderately robust. Third pereiopod (Fig. 4C) reaching almost to end of antennular peduncle, dactyl (Fig. 5G) short, compressed, about 0.22 of propod length, unguis well developed, distinctly demarkated from corpus, curved, about 0.75 of corpus length, 4.0 times longer than basal width, corpus about 1.4 times longer than maximal width, dorsal margin convex, without spinules, ventral margin strongly convex, with strong slightly recurved accessory tooth distally, about 0.5 of unguis length, with 4 well-developed sensory setae

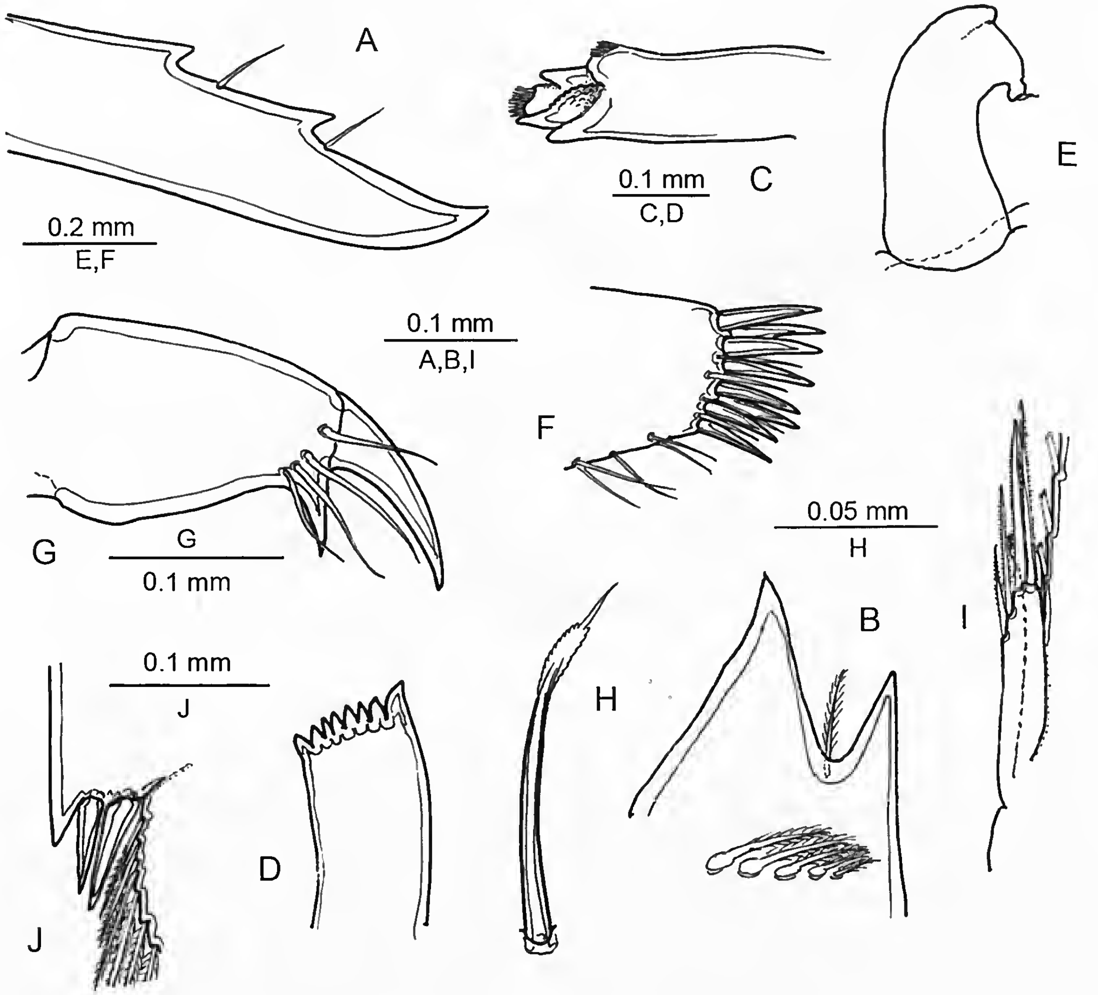

Fig. 5. *Periclimenes jackhintoni* sp. nov., holotype, Tonga, NTM Cr.004258. **A**, tip of rostrum; **B**, right antennule, distolateral angle of proximal segment; **C**, mandible, molar process; **D**, same, incisor process; **E**, maxillula, palp; **F**, same, distal end of dorsal lacinia; **G**, third pereiopod, dactyl; **H**, same, seta from distolateral propod; **I**, second pleopod, appendices masculina and interna; **J**, uropod, distolateral exopod.

distolaterally; propod (Fig. 4D) about 0.4 of CL, about 6.4 times longer than wide, without spines, with numerous long slender simple setae distoventrally, with 4 stout long stout setae distolaterally (Fig. 4E), with preterminal portion expanded, finely denticulate (Fig. 5H); carpus about 0.75 of propod length, 4.0 times longer than distal width, tapering slightly proximally, with well developed distodorsal lobe, unarmed, merus 1.2 times propod length, 4.6 times longer than wide, uniform, unarmed; ischium 0.9 of propod length, 3.0 times longer than distal width, unarmed, basis and coxa without special features, unarmed. Fourth and fifth pereiopods similar to third; fourth propod 1.1 times, fifth subequal to length of third propod.

Male first pereiopod (Fig. 4F), basipodite about twice as long as broad, exopod 1.3 times basipodite length, endopod (Fig. 4G), 0.5 of exopod length, 4.0 times longer than central width, distal third slightly expanded, rounded, lateral margin with 2 short plumose setae, medial margin without accessory lobe, proximal half straight, with 6 short curved simple spines.

Male second pleopod (Fig. 4H) basipodite similar to first pleopod, slightly longer, exopod 1.3 times basipodite length, endopod (Fig. 4I) about 0.8 of exopod length, about 6.5 times longer than central width, with numerous plumose marginal setae, with appendices (Fig. 5I) at 0.3 of medial margin length, appendix masculina about 0.28 of endopod length, subcylindrical, 5.5 times longer than wide, with long stout finely spinulate terminal spine, almost equal to appendix length, with three similar spines of decreasing length proximally along distomedial border, appendix interna exceeding appendix masculina corpus, with few cincinnuli.

Uropod (Fig. 2K) with protopodite bluntly rounded posterolaterally; exopod about 0.8 of CL, 3.0 times longer than broad, lateral margin straight, unarmed, non-setose, with small acute tooth posterolaterally with 2 mobile spines medially on left (Fig. 5J), one on right, diaeresis obsolete; endopod about 0.95 of exopod length, 3.0 times longer than broad.

Host. Unidentified orange crinoid, not preserved.

Colouration. Not recorded.

Etymology. The species is named to honour Dr Colin Jack-Hinton (1933-2006), Foundation Director of the Northern Territory Museum (now Museum and Art Gallery of the Northern Territory), Darwin, in appreciation of his help and encouragement.

Systematic position. *Periclimenes jackhintoni* is most closely related to *P. ceratophthalmus* Borradaile, another crinoid-associated species. *Periclimenes jackhintoni* is readily distinguished from *P. ceratophthalmus* by the long slender decurved sickle-shaped rostrum with two small distal teeth, contrasting with the straight deeper rostrum, slightly up-turned distally, with three to six relatively larger teeth distributed usually over the distal two-thirds of the dorsal border in *P. ceratophthalmus*, as illustrated by Borradaile (1917: pl. XVII, fig. 9a). The corneal papilla is usually short and stout in *P. ceratophthalmus*, about equal to the corneal diameter in length (Bruce 1978: fig. 2A), contrasting with a long slender acutely tapering papilla, about 1.5 times the corneal diameter, in *P. jackhintoni*.

Remarks. *Periclimenes ceratophthalmus* of authors appears to comprise two similar species, both of which are similarly separable from *P. jackhintoni*, lacking its characteristic rostrum. These taxa differ particularly in rostral dentition and telson spinulation. These, together with other closely related species, also found on crinoid hosts, whose systematic status is being revised by J. Okuno and Y. Fujita, are all likely to be removed from the genus *Periclimenes*.

ACKNOWLEDGMENTS

I am most grateful to Dr Matt Richmond for the opportunity to examine this interesting specimen. This study was facilitated by support from the Australian Biological Resources Study.

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Accepted 19 October 2006

The Beagle, Records of the Museums and Art Galleries of the Northern Territory, 2006 **22**: 31–37

Philocheras triangulus, a new crangonid shrimp (Crustacea: Decapoda: Caridea) from the Northern Territory, Australia

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ABSTRACT

A new species of crangonid shrimp, *Philocheras triangulus* sp. nov., is described and illustrated. Two specimens were trawled from a coral sand bottom off West Alligator Head, Kakadu National Park, Northern Territory, Australia, at a depth of 7.3 metres in 2004. The possession of a single lateral tooth on the antennal scale aligns the new species to the seven known species of the genus also having this feature, but the triangular rostrum and the lack of a distinct mid-dorsal carina on the third and fourth pleonal somites immediately distinguish the new species from its congeners. The new species is the ninth *Philocheras* species known from Australia. A key to all nine species is given.

Keywords: Crustacea, Decapoda, Caridea, Crangonidae, *Philocheras*, new species, Northern Territory, Australia.

INTRODUCTION

Of the 22 genera of the family Crangonidae, including about 170 species, the genus *Philocheras* Stebbing, 1900, is remarkably speciose, represented by more than 50 species worldwide. Discovery of new species has been frequent in recent years (Bruce 1994; De Grave 2000; Kim and Hayashi 2000; Komai 2001, 2004). *Philocheras* is characterised by the usual lack of lateral teeth on the rostrum, the transversely oblong stylocerite of the antennule, the first pereiopod without an exopod, and the second pereiopod usually overreaching the extended merus of the first pereiopod. Up to the present time, eight species are known from Australia (Davie 2002; Komai 2004): *P. flindersi* (Fulton and Grant, 1902) from Victoria; *P. intermedius* (Bate, 1863) from Gulf St Vincent, South Australia; *P. lowisi* (Kemp, 1916) from Northern Territory; *P. obliquus* (Fulton and Grant, 1902) from Victoria; *P. pilosus* (Kemp, 1916) from the Northern Territory; *P. planoculminus* Bruce, 1994, from the Timor Sea; *P. victoriensis* (Fulton and Grant, 1902) from Victoria; and *P. brucei* Komai, 2004, from Cairns, Queensland.

Two specimens of a small crangonid shrimp collected during the surveys of inshore waters of the Northern Territory, Australia, were kindly made available for study by Dr Alexander J. Bruce. Close examination revealed that these specimens represent a new species of *Philocheras*, here described as *P. triangulus*. The new species is compared with *P. angustirostris* (De Man, 1918), *P. brucei* Komai, 2004, *P. incisus* (Kemp, 1916), *P. kempi* (De Man, 1918), *P. parasculptus* Burukovsky, 1991, *P. sculptus* (Bell, 1847) and *P. vanderbilti* (Boone, 1935).

The type specimens are deposited in the collections of the Museum and Art Gallery of the Northern Territory (NTM). The abbreviation CL refers to the postorbital carapace length. For detailed observations of the surface structure on the integument, the specimens (including removed appendages) were stained with a solution of methylene blue.

SYSTEMATICS

Family Crangonidae
Genus *Philocheras* Stebbing, 1900
Philocheras triangulus sp. nov.

(Figs 1–4)

Material examined. HOLOTYPE – male (CL 3.6 mm), West Alligator Head, Kakadu National Park, Northern Territory, 12°9.725'S 132°13.959'E, 7.3 m, beam trawl, coll. S.K. Horner, G.M. Dally and party, 21 November 2004, NTM Cr. 14404. PARATYPE – same data as holotype, 1 young male (CL 3.2 mm), NTM Cr. 15264.

Description. Body (Fig. 1) somewhat depressed dorsoventrally, moderately stout; integument ornamented with minute, stone-pavement-like structures (Fig. 2).

Rostrum (Fig. 3A, B) depressed dorsoventrally, directed forward, triangular in dorsal view, reaching distal margin of eyes, terminating in acute tip, about 0.2 of carapace length; dorsal surface shallowly sulcate medially; lateral margins unarmed, with row of short setae extending onto orbital margin, not covering corneal surface; ventral margin carinate medially. Carapace (Figs 1, 3A) about 1.1 times longer than broad, with short setae dorsally and laterally, but without covering of short pubescence; shallow, broad, transverse furrow posterior to rostral base; median carina very low, rather obtuse, smooth on dorsal margin, extending nearly to posterior

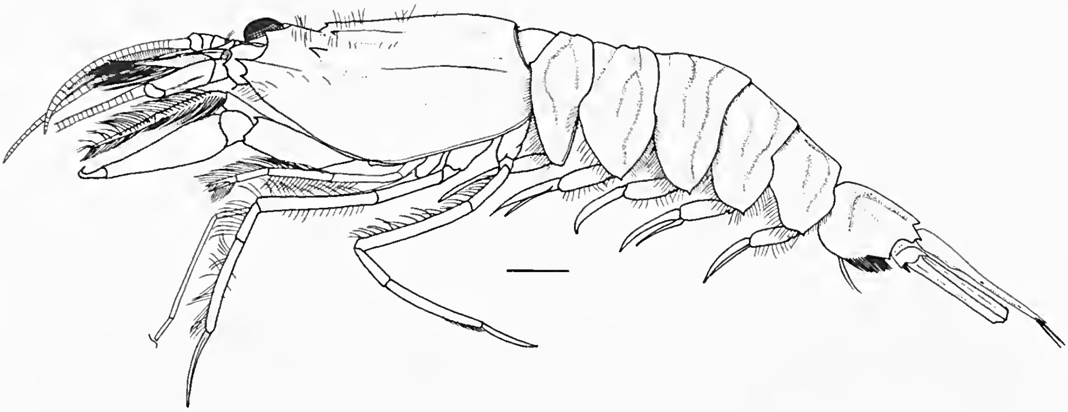

Fig. 1. *Philocheras triangulus* sp. nov. Holotype, male (CL 3.6 mm), NTM Cr. 14404. Habitus, in lateral view. Scale bar: 1 mm.

margin of carapace, terminating in small, sharp epigastric tooth at about 0.15 of carapace length; postorbital carina very low, obsolete, extending to mid-length of carapace, terminating anteriorly in small tooth slightly posterior to level of epigastric tooth; hepatic spine arising slightly anterior to level of epigastric tooth, followed by very low, obsolete ridge; branchial carina very low, but clearly delineated, extending from mid-length of carapace to level of posterodorsal margin of carapace; no other teeth present on lateral surface; orbital margin concave, without cleft; antennal tooth small, acute; branchiostegal tooth moderately long, reaching nearly to dorsodistal margin of antennal basicerite, supported by low, distinct ridge extending to level of hepatic tooth; pterygostomian tooth small.

Thoracic sternum (Fig. 3C) widened posteriorly, with long median spur on anterior margin of fifth sternite far overreaching coxae of second pereopods; each sternite of sixth to eighth thoracomere with sharp median carina terminating anteriorly in acute tooth and blunt transverse ridges; division of sternites indicated by transverse sulci; sternal surface with sparse setae.

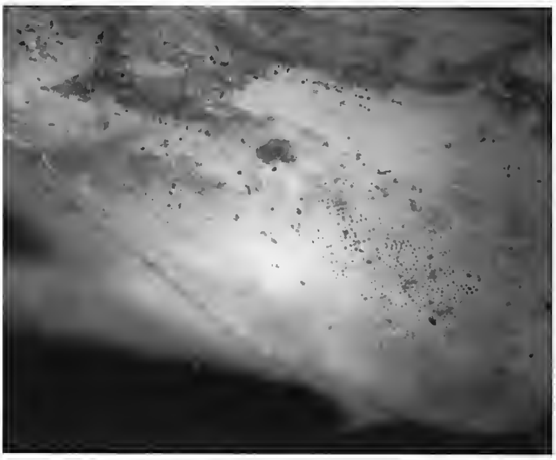

Fig. 2. *Philocheras triangulus* sp. nov. Holotype, male (CL 3.6 mm), NTM Cr. 14404. Light micrograph showing texture on tegumental surface of branchiostegite of carapace.

Third maxilliped with small arthrobranch above; pleurobranch present on each fourth through eighth thoracic somites, ventral apices all directed posteriorly.

Pleon (Figs 1, 3D) weakly sculptured by shallow transverse sulcus; surface nearly naked. Mid-dorsal carina absent on first, second and fourth somites, rudimentary on third somite; fifth somite with faint submedian carinae diverging posteriorly. First somite with 1 transverse sulcus divided in 2 branches laterally on tergum and extending onto pleuron, anterior branch extending to midpoint of pleuron; second somite with 2 transverse sulci, posterior sulcus accompanied by distinct transverse ridge on tergum, divided in 2 branches laterally on tergum and extending to pleuron, posterior branch reaching nearly to ventral margin of pleuron; third somite with 2 transverse sulci, interrupted medially, posterior sulcus longer than anterior sulcus, extending nearly to ventral margin of pleuron; fourth somite with 2 transverse sulci, anterior sulcus short, restricted to lateral surface, posterior sulcus curving toward anterior along midline in dorsal part, extending ventrally to midpoint of pleuron; fifth somite with 2 sulci, anterior sulcus restricted to lateral surface and running about midlength of pleuron, posterior sulcus running from anterior 0.2 of fifth somite along midline and then curving laterally along posterodorsal margin, extending onto pleuron. Posterodorsal margins of second and fifth somites concave, without conspicuous notch; that of third somite weakly convex; that of fourth somite nearly straight, faintly notched medially. Anterior margin of first somite with small, acute tooth laterally. Pleura of first somite slightly angular at posteroventral margin; that of second somite tapering ventrally to tiny, acute tooth; those of third to fifth somite each with small

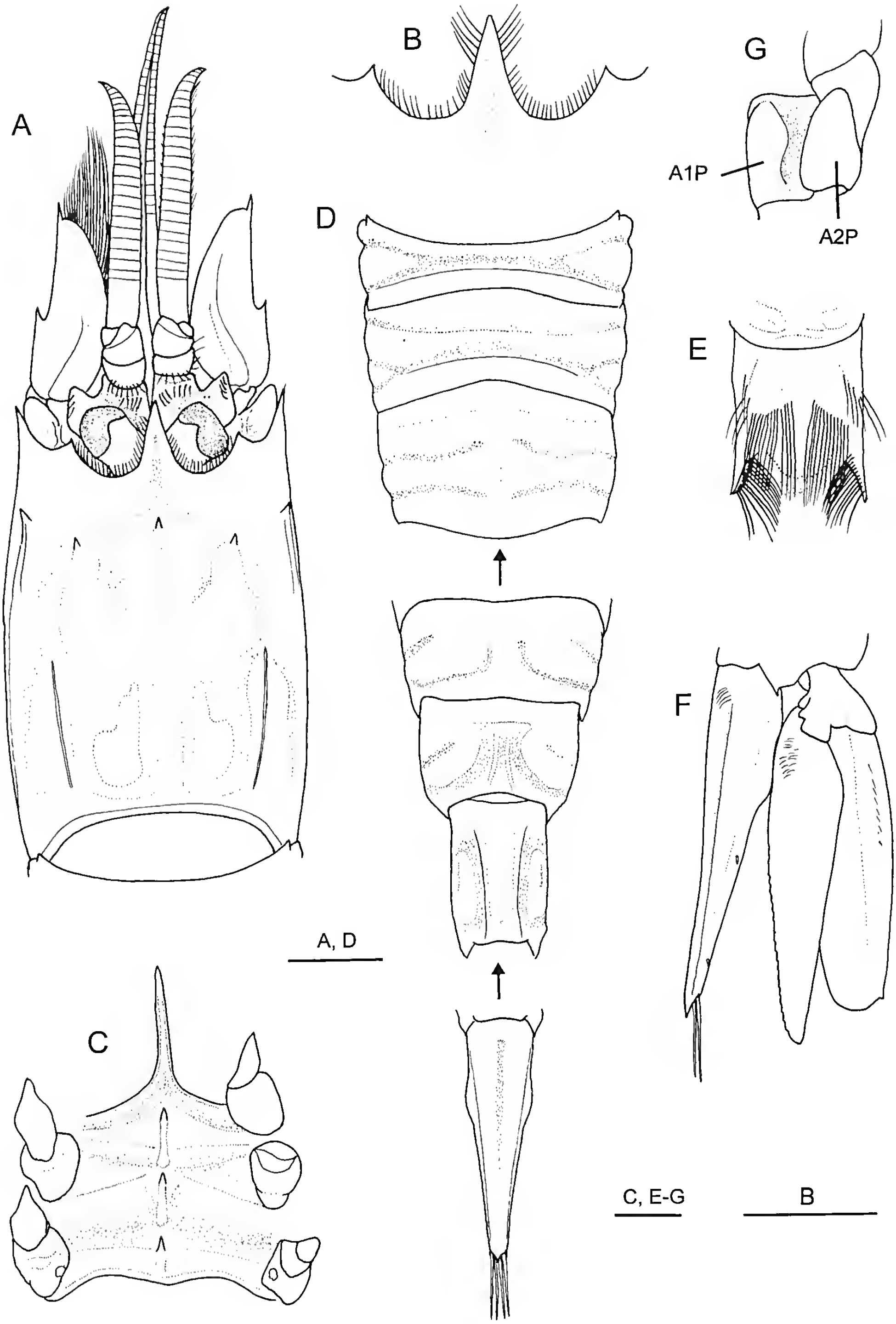

Fig. 3. *Philocheras triangulus* sp. nov. Holotype, male (CL 3.6 mm), NTM Cr. 14404. **A**, carapace and cephalic appendages, dorsal view (setae partially omitted); **B**, rostrum and orbital margins, dorsal view; **C**, thoracic sternum, ventral view; **D**, pleon and telson, dorsal view; **E**, sixth pleonal somite, ventral view; **F**, telson and right uropod, oblique lateral view; **G**, basal part of peduncles of antennae in ventral view, showing ventral concavity on first segment of antennular peduncle (setae omitted); A1P = antennular peduncle; A2P = antennal peduncle. Scales: 1 mm for A, B, D; 0.5 mm for C, E–G.

tooth at posteroventral angle. Sixth somite about 1.4 times longer than fifth somite and 1.3 times longer than high; dorsal surface with low, broad, mid-dorsal carina, without distinct median groove separating mid-dorsal carina; posterodorsal margin weakly 2-lobed; lateral surface with shallow sulcus along mid-dorsal carina curving toward ventral at anterior part; posterolateral process terminating in acute tooth; posteroventral angle acuminate; ventral surface with thick assemblage of long setae on either side of V-shaped median depression; ventral surface convex, with obliquely transverse row of long setae extending to posteroventral margin (Fig. 3E). Telson (Fig. 3D, F) moderately narrow, about 1.6 times longer than sixth somite, tapering posteriorly and terminating in small, triangular tooth; dorsal surface with shallow median sulcus, lateral margin with broad, low convexity subproximally and with 2 pairs of very small spines (anterior spines arising slightly posterior to mid-length of telson, posterior spines at about posterior 0.2 of telson); posteromedian tooth flanked by 1 pair of small spines and 2 pairs of long setulose spiniform setae.

First to fifth pleonal sternites each with blunt median tubercle becoming smaller toward posterior.

Cornea of eye (Fig. 3A) well pigmented and distinctly faceted, slightly wider than eye-stalk; corneal width 0.16 of carapace length; eye-stalk short, without dorsal tubercle.

Antennular peduncle (Fig. 3A) reaching 0.4 length of antennal scale. First segment longer than distal 2 segments combined, dorsal surface strongly excavate to accommodate eye; ventrolateral margin forming sharply delineated, sinuous ridge, lateral part of ventral surface strongly depressed (Fig. 3G); stylocerite subquadrate with anterolateral angle weakly produced and subacutely pointed, posterolateral angle rounded. Second segment wider than long, with slightly produced anterolateral angle. Third segment as wide as second segment. Lateral flagellum broad, overreaching distal margin of antennal scale by half length in male, composed of about 26 articles; mesial flagellum longer than lateral flagellum, composed of more than 20 articles.

Antenna (Figs 1, 3A) with stout basicerite bearing small ventrolateral tooth. Carpocerite stout, overreaching midlength of antennal scale. Antennal scale narrowed distally; dorsal surface naked, with distinct median ridge; lateral margin armed with conspicuous tooth arising at about 0.4 length, margin proximal to lateral tooth slightly sinuous, margin distal to lateral tooth nearly straight; distolateral tooth slender, far overreaching narrow, obliquely rounded distal margin of lamella. Flagellum longer than body.

Mouthparts not dissected. Second maxilliped with endopod composed of 6 segments with basis and ischium fused; epipod subrectangular, podobranch multilamellate. Third maxilliped (Fig. 4A) consisting of 4 segments, flattened dorsoventrally, overreaching distal margin of antennal scale (except for distolateral tooth) by half length of ultimate segment; ultimate segment slightly shorter than carpus (= penultimate segment), moderately narrow (5.4 times longer than basal width), tapering distally, mesial margin with row of long setae; carpus with short to long setae on dorsal surface and lateral margin, mesial surface with numerous transverse tracts of dense, stiff setae; antepenultimate segments (merus, ischium and basis fused segment) somewhat sinuous in dorsal view, setose on margins, setae on dorsolateral distal angle particularly elongate; ventral margin distally with short longitudinal row of 8 spinules; coxa stout, with rounded lateral process and small setose protuberance on mesial surface; exopod reaching beyond midlength of antepenultimate segment, somewhat tapering distally, bearing well-developed flagellum.

First pereopod (Fig. 4B) stout, slightly overreaching distal margin of antennal scale; palm (Fig. 4C) moderately stout, 2.7 times longer than wide, mesial surface with stiff setae or spiniform setae proximally extending to midlength between base of palm and base of pollex; cutting edge strongly oblique, with submarginal row of short setae dorsally and ventrally; pollex basally articulated, straight; dactylus somewhat curved, about half length of palm; carpus short, with small ventrodistal tooth on lateral margin and cluster of stiff setae on mesial surface; merus strongly compressed laterally, with small dorsodistal tooth, distolateral margin unarmed, ventral margin weakly sinuous, unarmed. Second pereopod (Fig. 4D, E) overreaching distal margin of carpus of anteriorly extended first pereiopod, chelate; dactylus about twice length of palm, apparently lacking unguis; chela subequal in length to carpus, with rows of long setae on dorsal and ventral margins; pollex lacking unguis; carpus shorter than merus, with row of long setae on each dorsal and ventral margins; merus and ischium with row of long plumose setae on dorsal and ventral margins; ischium slightly longer than merus. Third pereopod (Fig. 4F) very slender, overreaching distal margin of antennal scale by 0.4 of carpal length; dactylus about 0.7 length of propodus, terminating in acute tip; carpus elongate, longer than distal 2 segments combined or than merus; merus slightly longer than ischium; ischium with row of setae on dorsal and ventral margins; coxa without lateral projection. Fourth pereopod (Fig. 4G) moderately slender for genus, overreaching distal margin of antennal scale by length of dactylus; dactylus about 0.9 length of propodus, slender, weakly curved, weakly flattened dorsoventrally, terminating acutely; ventral surface of dactylus medially ridged on proximal half; propodus with row of setae on dorsal surface; carpus about half length of propodus; merus and ischium with row of setae on dorsal and ventral surfaces (dorsal setae longer than ventral setae), merus about 1.7 times longer than ischium and about 8.0 times longer than high. Fifth pereopod (Fig. 4H) similar to fourth

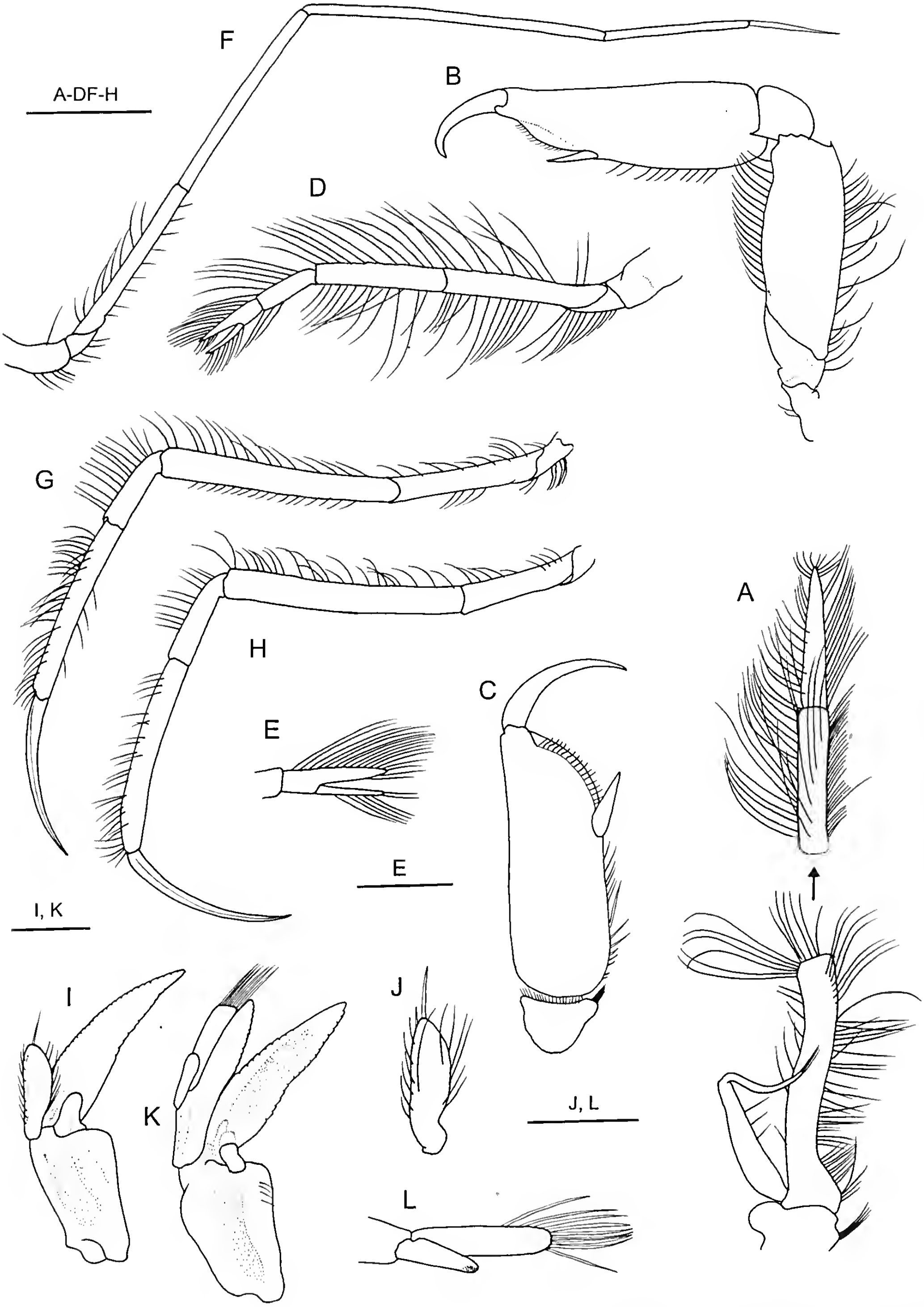

Fig. 4. *Philocheras triangulus* sp. nov. Holotype, male (CL 3.6 mm), NTM Cr. 14404. **A**, left third maxilliped, dorsal view; **B**, left first pereopod, lateral view; **C**, same, chela, dorsal view; **D**, left second pereopod, lateral view; **E**, same, chela, mesial view; **F**, right third pereopod, lateral view; **G**, left fourth pereopod, lateral view; **H**, left fifth pereopod, lateral view; **I**, left first pleopod, ventral view; **J**, same, endopod, ventral view; **K**, left second pleopod, ventral view; **L**, same, appendices interna and masculina, mesial view. Scales: 1 mm for A–D, F–H; 0.5 mm for E, I–L.

pereiopod, but slightly shorter and less setose; dactylus about 0.9 times as long as propodus.

Pleopods (Fig. 1) becoming smaller posteriorly, with stout protopods somewhat widened distally (Fig. 4I, K). Endopod of first pleopod (Fig. 4I, J) about half length of exopod, leaf-like in shape, with 1 long spiniform seta terminally and with sparse row of setae on lateral and mesial margins. Endopod of second pleopod slightly shorter than exopod (Fig. 4K); appendices interna and masculina (Fig. 4K, L) arising at 0.4 length of endopod, appendix masculina stout, about twice length of appendix interna, falling slightly short of tip of endopod, truncate terminally, with about 10 long spiniform setae distally. Endopods of third to fifth pleopods 0.7–0.8 length of exopod, each with stout appendix interna, all provided with cincinnuli.

Protopod of uropod (Fig. 3F) stout, posterolateral projection blunt terminally. Endopod of uropod (Fig. 3F) slightly longer than exopod, overreaching posterior tip of telson, tapering distally; exopod reaching tip of telson, lateral margin slightly convex, terminating in tiny tooth not reaching broadly rounded posterior margin.

Coloration in life. Unknown.

Size. Holotype (male) is adult, 3.6 mm in CL. Female is unknown.

Distribution. So far known only from the Northern Territory, Australia.

Etymology. Derived from the Latin *triangulus* (triangular) referring to the characteristic triangular rostrum of this new species.

Remarks. Only two specimens were available for study. The holotype appears to be mature as the lateral flagellum of the antennule is fully thickened (Fig. 3A), and the appendix masculina of the second pleopod is well developed (Fig. 4L). The paratype, a male (CL 3.2 mm), is immature, because the antennular flagella are slender and the appendix masculina is not fully developed, being distinctly shorter than that of the holotype and provided only with some short setae distally.

Philocheras triangulus has a distinct lateral tooth on the antennal scale, a character shared with the following seven known congeners: *P. angustirostris* (de Man); *P. brucei* Komai; *P. incisus* (Kemp); *P. kempi* (de Man); *P. parasculptus* Burukovsky; *P. sculptus* (Bell); and *P. vanderbilti* (Boone) (de Man 1920; Boone 1935; Burukovsky 1991; Komai 2004). The new species is immediately distinguished from the other seven species by the triangular rostrum terminating in an acuminate point. The rostrum of *P. incisus*, *P. kempi*, *P. parasculptus*, *P. sculptus* and *P. vanderbilti* is distinctly bifid terminally in dorsal view. In *P. angustirostris* and *P. brucei*, the rostrum is distally truncate or slightly concave in dorsal view. Furthermore, the rostrum is very slender in *P. angustirostris* and *P. kempi*. In *P. incisus*, *P. parasculptus*, *P. sculptus* and *P. vanderbilti*, it is broad with the lateral margins being subparallel or concave. The possession of only one mid-dorsal tooth (epigastric tooth) on the carapace distinguishes *P. triangulus* from *P. parasculptus*, *P. sculptus* and *P. vanderbilti*, which have two or three mid-dorsal teeth on the carapace. The absence of a posthepatic tooth separates *P. triangulus* from *P. angustirostris*, *P. incisus*, *P. kempi*, *P. parasculptus* and *P. sculptus*. Sculpture of the pleon is also different among the species under consideration. In *P. triangulus*, the pleonal sculpture is weak; the mid-dorsal carina on the second to fourth somites are absent or faint; the first to fourth somites are provided with shallow transverse sulci. In *P. angustirostris*, *P. brucei*, *P. incisus*, *P. kempi*, *P. parasculptus* and *P. sculptus*, at least the third and fourth somites are provided with a distinct mid-dorsal carina; the first to fourth somites with distinct transverse grooves or sulci bordered by sharp transverse carinae. In *P. vanderbilti*, the third and fourth somites are provided with a weak mid-dorsal carina and all somites are devoid of distinct grooves or sulci.

It is worth mentioning that much of the integument of the body is covered with a minute, stone-pavement-like microsculpture in *P. triangulus*, a feature visible under high magnification (see Fig. 2), although the detailed texture is still unclear. Bruce (1994) reported that much of the cuticle of the body and antennal scales was minutely reticulate in *Philocheras lowisi*, although in the other congenerics the detailed texture of the integument is poorly understood. Detailed observations using SEM will be effective in elucidating the detailed structure of the tegumental surface.

The present new species brings the number of species of the genus known from Australian waters to nine. All the known Australian species are shallow water inhabitants, ranging from intertidal to sublittoral depths, down to 30 m (Davie 2002; Poore 2004). Species of the genus have been recorded also from the bathyal zone (de Man 1920; Chace 1984), and therefore there is little doubt that there are many new species still awaiting discovery in Australian waters, of which the marine fauna is extremely rich.

Key to species of *Philocheras* from Australian waters

1a. Antennal scale with 1 tooth or serration on lateral margin 2
1b. Antennal scale unarmed on lateral margin........... 4

2a. Antennal scale with 1 tooth on lateral margin 3
2b. Antennal scale with serrations on lateral margin... .... *P. lowisi*
[Andaman Islands, Japan Hong Kong and Northern Territory, sublittoral to 30 m]

3a. Rostrum triangular in dorsal view, terminating in acuminate tip; third pleonal somite with trace of mid-dorsal carina .... *P. trigulus*
[Northern Territory, 7.3 m]

3b. Rostrum narrow, but not triangular in dorsal view, terminating in slightly concave or truncate tip; third pleonal somite with distinct mid-dorsal carina .... *P. brucei* [Queensland, 10 m]

4a. Third and fourth abdominal somites with mid-dorsal carina; [carapace with 3 mid-dorsal teeth including epigastric tooth, longitudinal row of 5 teeth posterior to orbit and short row of 4 small teeth posterior to branchiostegal tooth] .... *P. victoriensis* [Victoria, sublittoral]

4b. Third and fourth abdominal somites rounded dorsally 5

5a. Carapace with 3 mid-dorsal teeth including epigastric tooth.. *P. pilosus* [Indian Ocean, New Caledonia and Northern Territory, shallow subtidal]

5b. Carapace with 1 or 2 mid-dorsal teeth including epigastric tooth 6

6a. Carapace with longitudinal row of small teeth posterior to orbit .... *P. intermedius* [Gulf St Vincent, South Australia, sublittoral]

6b. Carapace without longitudinal row of small teeth posterior to orbit.. 7

7a. Carapace with 2 mid-dorsal teeth including epigastric tooth (rostrum broad with concave lateral margins, distal margin truncate in dorsal view).................... .... *P. obliquus* [Victoria, sublittoral]

7b. Carapace with 1 mid-dorsal tooth (epigastric tooth) 8

8a. Rostrum narrow with distal margin convex and lateral margins nearly straight, parallel; carapace with 2 teeth posterior to branchiostegal tooth .... *P. flindersi* [Victoria, sublittoral]

8b. Rostrum broad with distal margin broadly truncate and lateral margins concave; carapace with 1 tooth posterior to branchiostegal tooth .... *P. planoculminus* [Flat Top Bank, Timor Sea, 30 m]

ACKNOWLEDGMENTS

I thank A.J. Bruce of the Queensland Museum for making this interesting material available for study and for reviewing the manuscript.

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Accepted 26 August 2006

The Beagle, Records of the Museums and Art Galleries of the Northern Territory, 2006 **22**: 39–76

Review of the Dinematichthyini (Teleostei, Bythitidae) of the Indo-west Pacific. Part II. *Dermatopsis, Dermatopsoides* and *Dipulus* with description of six new species

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ABSTRACT

An ongoing revision of the dinematichthyine fishes (Ophidiiformes, Bythitidae, Brosmophycinae) of the Indo-west Pacific based on ca. 5000 specimens will be published in several parts. Part II includes 363 identified specimens in the genera *Dermatopsis* Ogilby, 1896 (*D. greenfieldi* n. sp. from Fiji, *D. hoesei* n. sp. from south-eastern Australia, *D. joergennielseni* n. sp. from New Zealand and *D. macrodon* Ogilby, 1896, from south-eastern Australia); *Dermatopsoides* Smith, 1947 (*D. andersoni* n. sp., *D. kasougae* (Smith, 1943) and *D. talboti* Cohen, 1966, from South Africa, and *D. morrisonae* n. sp. from Western Australia), and *Dipulus* Waite, 1905 (*D. caecus* Waite, 1905 and *D. hutchinsi* n. sp. from Western Australia, *D. multiradiatus* (McCulloch and Waite, 1918) from southern Australia, and *D. norfolkanus* Machida, 1993a, from Norfolk Island). *Dermatopsis multiradiatus* McCulloch and Waite, 1918, is reassigned to *Dipulus*. The three genera are distributed along the subtropical shores of South Africa, Australia, northernmost New Zealand and the Norfolk Island and the tropical shores of Fiji. The genera contain mainly fishes adapted to rocky shores as compared to the predominance of other Dinematichthyini found in reef environments. The three genera are indicated to be closely related, sharing characters such as a maxilla not expanded postventrally, the head without scales and lacking an upper preopercular pore. *Dermatopsoides* is further characterized by the lack of an exposed opercular spine (i.e. completely covered by skin), a character unique amongst Indo-west Pacific dinematichthyine genera. The main distinguishing characters of the species contained in these genera are vertebrae and fin ray counts, morphometric characters, head pores and the morphology of otoliths and pseudoclaspers.

Keywords: viviparous brotulas, Indo-west Pacific, Australia, South Africa, New Zealand, Norfolk Islands, Fiji, new species.

CONTENTS

INTRODUCTION

This review of the dinematichthyine fishes, a tribe within the subfamily Brosmophyeinae of the viviparous family Bythitidae, is the fourth part since its inception, dealing first with the American Dinematichthyini (Møller *et al.* 2004a, 2005) and the second on Dinematichthyini from the Indo-west Pacific (Schwarzhans *et al.* 2005). The ongoing review of the Indo-west Pacific Dinematichthyini will result in two more publications before the world-wide review of the group is completed.

Prior to this review, the genera *Dermatopsis* (Ogilby, 1896) and *Dermatopsoides* (Smith, 1947), had been subject to a specific review by Cohen (1966), in which he created the new tribe Dermatopsini for the genera *Dermatopsis*, *Dermatopsoides*, *Gunterichthys* Dawson, 1966 (then undescribed), and possibly *Diancistrus* Ogilby, 1899. Cohen stated that there "is a group of several genera which are more closely related to each other than to the *Dinematichthys-Ogilbia* group". In the diagnosis of his new tribe he listed amongst others "a single pair of hard genital claspers", "scales probably lacking on head" and "posterior end of maxillary not greatly expanded vertically" (see Cohen 1966: fig. 1). He also discussed at length the possible relationship of the then monospecific genus *Dipulus* Waite, 1905, with this group, but concluded that "a proper assessment of its relationships requires further study". In our present concept, Cohen's Dermatopsini are not recognized within the limits of the Dinematichthyini as defined by Cohen and Nielsen (1978). However, the current review supports the close relationship of *Dermatopsis, Dermatopsoides* and *Dipulus* and may well warrant their separation into a distinct systematic unit. *Diancistrus* on the other hand does not have the apomorphic shape of the posterior maxillary shared by the three other genera, and was therefore treated in a separate publication (Schwarzhans *et al.* 2005). The American genus *Gunterichthys* shares the same type of low maxilla, lack of scales on the head and free opercular spine and seems indeed to be closely related to *Dermatopsis, Dermatopsoides* and *Dipulus*. It was revised in a publication dealing with American genera (Møller *et al.* 2004a), and is not included herein. A phylogenetic analysis and possible subdivision of the Dinematichthyini will be subject to a special publication following the completion of the ongoing review.

Dermatopsis and *Dipulus* were discovered more than 100 years ago (Ogilby 1896; Waite 1905) from the east and south Australian shores and have regularly been collected in high numbers since. *Dermatopsoides* on the other hand was first discovered in the middle of the last century (Smith 1943, 1947) and its species have been caught extremely rarely, despite of the introduction of scuba diving and rotenone, which has greatly aided the collection of these cryptic fishes.

The species of the genus *Dipulus* belong to the longest of all Dinematichthyini and may reach up to almost 200 mm in length; those of the genera *Dermatopsis* and *Dermatopsoides* are smaller, often mature at sizes of 30–50 mm. Dinematichthyine fishes live in shallow tropical to subtropical waters, hidden in holes and crevices of coral reefs, algae beds and rocky shores. Different reefal and non-reefal environments can be dominated by different groups of the Dinematichthyini. The species of the three genera reviewed here, however, generally occur in non-reefal environments and are typical for the subtropical rocky shores of South Africa, Australia and northern New Zealand. Only a few species are found in reef-related habitats along the tropical shores of Australia and Fiji. While the geographical distribution of most dinematichthyine species is already very restricted, those of the genera *Dermatopsis, Dermatopsoides* and *Dipulus* exhibit a particularly narrow distribution pattern in some cases, for instance a species endemic to tiny Norfolk Island and a small area at the northern tip of New Zealand or at the south-westernmost area of Western Australia. These narrow distributions might be related to the exceptionally low fecundity in these genera, where no more than four embryos have been found in gravid females.

Dipulus was considered a monotypic genus until Machida (1993a) described a second endemic species from Norfolk Island. *Dermatopsis* was known from two species along the temperate shores of Australia, of which one, *Dermatopsis multiradiatus*, is here assigned to the genus *Dipulus*. With this, a single described species of *Dermatopsis* (*D. macrodon*) remains known from the subtropical shores of south-eastern Australia, chiefly south of the Great Barrier Reef. Now there are three more new species of *Dermatopsis* described herein, one sympatric with *D. macrodon*, a second endemic to northern New Zealand and a third from Fiji. *Dermatopsoides* was previously regarded as geographically restricted to South Africa (two described and one new species), but is now also recorded from the south-western tip of Western Australia with one new species.

The species reviewed here show a higher degree of variation in their general appearance, morphometric measurements and meristic counts than most other dinematichthyines and are mostly slender in body form. Their live coloration, where known, tends to be uniform, the prevailing colours being red, yellow, orange and brown, but there are also species in *Dermatopsis* and *Dermatopsoides* with well-marked dark dorsal and anal fins. Also, head pores and otolith morphology were found to be useful at generic and specific levels. On the other hand, pseudoclaspers, which form a prime character for specific diagnosis in many other groups, for instance the genus *Diancistrus* (see Schwarzhans *et al.* 2005), are morphologically less diversified in this group of genera. Species can be identified reliably without study of pseudoclaspers. Therefore, we have in two cases described new species without males being available, because of sufficient other diagnostic characters.

Information on otoliths of dinematichthyine fishes have also been published on occasions by Nolf (1980) and Schwarzhans (1981). Those assigned to *Dermatopsis* obviously were based on ill-defined specimens probably of the genus *Monothrix*. As a result of this and an even earlier mention by Stinton (1977), fossil otolith-based records had been identified as *Dermatopsis* from areas remote to the restricted recent distribution of the genus, i.e., from Europe, which are clearly invalid (though they may represent some fossil dinematichthyine genera).

Due to the large amount of material with many new taxa we have decided to deal with the dinematichthyine fishes of the Indo-west Pacific in four parts: in the outstanding two parts we will revise the genera *Beaglichthys*, *Brosmolus*, *Monothrix* and include several new genera and finally revise the most common genus *Dinematichthys* sensu lato.

MATERIAL AND METHODS

Examination of ca. 5000 specimens of Indo-west Pacific Dinematichthyini yielded 363 specimens which could be identified to the genera treated herein. Also included are specimens viewed and identified in the collections of AMS, NMNZ and USNM but not borrowed for detailed investigations. These are listed as additional specimens and are not referred to as type specimens for any of the new species.

The material described herein belongs to the following institutions: AMS (Australian Museum, Sydney); CAS (California Academy of Sciences, San Francisco); CSIRO (Commonwealth Scientific and Industrial Research Organisation, Hobart); NMNZ (Museum of New Zealand Te Papa Tongarewa, Wellington); ROM (Royal Ontario Museum, Toronto); SAIAB (South African Institute for Aquatic Biodiversity, formerly RUSI, JLB Smith Institute of Ichthyology, Grahamstown) (both acronyms used here); SAM (South African Museum, Cape Town); SAMA (South Australian Museum, Adelaide); SMNS (Staatliches Museum für Naturkunde, Stuttgart); WAM (Western Australian Museum, Perth); and ZMUC (Zoological Museum, University of Copenhagen).

For methodology used in analysing dinematichthyine fishes, reference is made to Møller *et al.* (2004a) and Schwarzhans *et al.* (2005). Abbreviations used in meristic counts are: D/V = anterior dorsal fin ray above vertebra number; D/A = anterior anal fin ray below dorsal fin ray number; V/A = anterior anal fin ray below vertebrae number.

The ecology of most of the species is poorly known. From available station data we have gathered some information about habitat and depth range, but we have very little data about behaviour, live coloration and feeding. A number of females were examined for reproductive data, e.g., number and size of embryos.

The distribution maps were created using Microsoft Encarta 2001 digital world atlas.

COMPARATIVE MATERIAL

Indo-West Pacific Dinematichthyini. See Schwarzhans *et al.* (2005).

American Dinematichthyini. See Møller *et al.* (2004a) and Møller *et al.* (2005).

Brosmophycinae and Bythitinae. See Møller *et al.* (2004b).

SYSTEMATICS

Tribe Dinematichthyini Cohen and Nielsen, 1978

(Family Bythitidae Gill, 1861;
subfamily Brosmophycinae Gill, 1862)

Diagnosis. Male copulatory organ with penis and 1–2 (rarely 3) pairs of pseudoclaspers in cavity of ventral body wall covered by fleshy hood. First anal fin pterygiophore slightly to strongly elongate. Head pore system generally unreduced, 6 mandibular, 2–4 preopercular, 5–7 infraorbital and 3–4 supraorbital pores, including supraorbital pore above opercular spine. Posteriormost supraorbital head-pore tubular.

Key to the species of the *Dermatopsis*, *Dermatopsoides* and *Dipulus* (see also Tables 1–3)

1a. Maxilla not vertically expanded postventrally; head without scales; upper preopercular pore absent; 1 pair of (outer) pseudoclaspers; otolith with separate colliculi 2

1b. Maxilla vertically expanded postventrally; head with scales patches, at least on cheek, but commonly also on operculum above and (rarely) below opercular spine; upper preopercular pore present or absent; 2 (rarely 1) pairs of pseudoclaspers; otolith with fused or separate colliculi .... other Indo-west Pacific genera of Dinematichthyini (see Schwarzhans *et al.* 2005)

2a. Opercular spine covered by skin, not exposed; lower lip smooth (except with skin folds in *Dermatopsoides morrisonae* n. sp.) .... (*Dermatopsoides*) 3

2b. Opercular spine free, exposed; lower lip with skin folds 6

3a. Total number of vertebrae 46–47; dorsal fin rays 93–100; anal fin rays 70–71; single pair of pseudoclaspers straight .... *Dermatopsoides kasougae*

3b. Total number of vertebrae 37–44; dorsal fin rays 60–86; anal fin rays 40–59; single pair of pseudoclaspers bent (not known for *Dermatopsoides morrisonae* n. sp.) 4

4a. Lower preopercular pores 3; dorsal and anal fins dark; lower lip with skin folds .... *Dermatopsoides morrisonae* n. sp.

4b. Lower preopercular pores 1 or 2; dorsal and anal fins light, fully translucent; lower lip smooth 5

5a. Precaudal vertebrae 11–12, total number of vertebrae 37–40; dorsal fin rays 60–67; anal fin rays 40–45; lower preopercular pores 2; pectoral fin length 12.3–12.7 % SL .... *Dermatopsoides talboti*

5b. Precaudal vertebrae 13, total number of vertebrae 43–44; dorsal fin rays 80–86; anal fin rays 51–59; lower preopercular pores 1; pectoral fin length 9.5–9.9 % SL .... *Dermatopsoides andersoni* n. sp.

6a. Precaudal vertebrae 11–14; dorsal fin rays 64–85; penis without hook near tip .... (*Dermatopsis*) 7

6b. Precaudal vertebrae 13–25; dorsal fin rays 86–191; penis with hook near tip .... (*Dipulus*) 10

7a. Posterior infraorbital pores 3; pseudoclaspers spiny, half the length of penis, total number of vertebrae 44–46 .... *Dermatopsis joergennielseni* n. sp.

7b. Posterior infraorbital pores 2; pseudoclaspers curved, longer than penis (not known for *Dermatopsis greenfieldi* n. sp.); total number of vertebrae 39–45 8

8a. Scales on body absent; posterior nostril and posterior mandibular pores almost as large as eye; lower preopercular pore not tubular, as large or larger than eye; pseudoclasper broad, expanded, paddle-like; otolith length to height ratio 1.9–2.0 .... *Dermatopsis hoesei* n. sp.

8b. Scales on body present; posterior nostril and posterior mandibular pores 1/3 to 1/4 the size of eye; lower preopercular pore tubular, 1/3 the size of eye; pseudoclasper narrow, with or without fleshy appendix anteriorly (not known for *Dermatopsis greenfieldi* n. sp.); otolith length to height ratio 2.1–2.4 9

9a. Precaudal vertebrae 12–14; dorsal fin rays 69–82; vertical fins with dark pigmentation; supraorbital pore behind eye (in most cases); otolith length to height ratio 2.2–2.4; otolith with sharp postdorsal angle .... *Dermatopsis macrodon*

9b. Precaudal vertebrae 11–12; dorsal fin rays 64–70; vertical fins entirely translucent; no supraorbital pore behind eye; otolith length to height ratio 2.1–2.2; otolith with weak postdorsal angle .... *Dermatopsis greenfieldi* n. sp.

10a. Total vertebrae 79–87; dorsal fin rays 161–191; anal fin rays 109–124; D/A 58–75; V/A 27–28; lower preopercular pores 2; pseudoclaspers with broadly expanded flaps anteriorly and posteriorly, narrow base and pointed, outwardly curved tip .... *Dipulus caecus*

10b. Total vertebrae 45–57; dorsal fin rays 86–112; anal fin rays 56–73; D/A 36–51; V/A 17–26; lower preopercular pores 3; pseudoclaspers bent like a hockey stick, narrow or broadened but without expanded flaps 11

11a. Body without scales; total vertebrae 45–49; dorsal fin rays 86–104; opercular spine straight or bent downward; posterior infraorbital pores 2; pseudoclaspers strongly expanded at curvature; otolith with sharp postdorsal angle .... *Dipulus norfolkanus*

11b. Body scaled, total vertebrae 52–57; dorsal fin rays 97–112; opercular spine bent upwards; posterior infraorbital pores 3; pseudoclaspers not expanded at curvature; otolith with broad or without postdorsal angle 12

12a. Horizontal scales rows above anal fin origin 8–12; precaudal vertebrae 19–22; anal fin rays 57–64; V/A 23–26; 1st and 2nd lower preopercular pores tubular; otolith length to height ratio 2.3–2.4, with wide sulcus and no postdorsal angle .... *Dipulus multiradiatus*

12b. Horizontal scales rows above anal fin origin 6–7; precaudal vertebrae 16–17; anal fin rays 66–73; V/A 19–20; lower preopercular pores not tubular; otolith length to height ratio 2.1–2.2, with narrow sulcus and obtuse, broad postdorsal angle .... *Dipulus hutchinsi* n. sp.

Dermatopsis Ogilby, 1896

(Tables 1–3)

Dermatopsis Ogilby, 1896: 138 (type species *D. macrodon* Ogilby, 1896, by monotypy; see Eschmeyer 1998).

Dermatopsis. – Cohen 1966: 186; Cohen and Nielsen 1978: 56; Paxton *et al.* 1989: 316; Nielsen *et al.* 1999: 126.

Diagnosis. Anterior nostril immediately above upper lip; head without scales; tip of opercular spine free, exposed; maxilla not vertically expanded postventrally, ventral knob well anterior to rear corner; lower lip with skin folds; male copulatory organ with one pair of mostly large, but not very variable pseudoclaspers (probably representing the outer pseudoclasper in terminology of Møller *et al.* 2004a); penis without hook near tip; sulcus of otolith with separated ostium and cauda marked by strong indentation at ventral margin of sulcus, its colliculi separated; anterior anal fin ray pterygiophore elongate; lower preopercular pores 2, often joined in single opening and then counted as 1; upper preopercular pore absent; posterior infraorbital pores 2 or 3; precaudal vertebrae variable between 11 and 14, body size not exceeding 75 mm SL.

Comparison. *Dermatopsis* appears to be closely related to *Dermatopsoides* and *Dipulus*, which are readily distinguished from the other Indo-west Pacific genera so far described by the absence of scales on the head, the maxilla not vertically expanded postventrally and the presence of skin folds on the lower lip (except lip smooth in most species of *Dermatopsoides*, see also key above).

Table 1. Frequency distribution of fin ray counts of the species in the genera *Dermatopsis*, *Dermatopsoides* and *Dipulus*.

	dorsal fin rays																										
	60–64	65–69	70–74	75–79	80–84	85–89	90–94	95–99	100–104	105–109	110–114	115–119	120–124	125–129	130–134	135–139	140–144	145–149	150–154	155–159	160–164	165–169	170–174	175–179	180–184	185–189	190–191
Dermatopsis																											
greenfieldi n. sp.	1	5	1																								
hoesei n. sp		10	39	4																							
joergennielseni n. sp				11	9	1																					
macrodon		2	8	16	2																						
Dermatopsis sp.			1																								
Dermatopsoides																											
andersoni n. sp					2	1																					
kasougae							1	–	1																		
morrisonae n. sp			1	1																							
talboti	3	2																									
Dipulus																											
caecus																					1	2	5	2	1	1	1
hutchinsi n. sp									1	3	1																
multiradiatus								16	32	21	3																
norfolkanus						4	7	3																			

	anal fin rays																
	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89	90–94	95–99	100–104	105–109	110–114	115–119	120–124
Dermatopsis																	
greenfieldi n. sp	2	5															
hoesei n. sp		33	20														
joergennielseni n. sp			7	14													
macrodon		6	18	4													
Dermatopsis sp.		1															
Dermatopsoides																	
andersoni n. sp			2	1													
kasougae							2										
morrisonae n. sp			2														
talboti	3	1															
Dipulus																	
caecus														1	3	4	6
hutchinsi n. sp						4	2										
multiradiatus				22	50												
norfolkanus				8	7												

Within this group of three genera, *Dermatopsis* differs from *Dermatopsoides* in the free opercular spine (vs not exposed, covered by skin) and from *Dipulus* in the number of precaudal vertebrae (11–14 vs 13–25), dorsal fin rays (64–85 vs 86–191) and the penis without a hook near the tip (vs with hook).

Distribution. *Dermatopsis* was recognized as a valid genus by Cohen (1966) and Cohen and Nielsen (1978) as well as by Nielsen *et al.* (1999), containing two species found along the subtropical shores of Australia: *Dermatopsis macrodon* from south-eastern Australia, and *D. multiradiatus* from southern and south-western Australia. The latter is, following our revision, hereinafter placed in the genus *Dipulus*.

Three new species of *Dermatopsis* are being described below, one each from south-eastern Australia (New South Wales), the northern island of New Zealand and Fiji. One specimen is recorded in open nomenclature from the southern part of the Great Barrier Reef, Queensland. South-eastern Australia, south of the Great Barrier Reef, now harbours two sympatric species of the genus. References of *D. macrodon* in past literature therefore are likely to represent both species, particularly since the new species described in the following seems to be generally more common.

Dermatopsis greenfieldi n. sp.

(Figs 1–2, 6; Tables 1–4)

Material examined. (7 specimens, 29–50 mm SL). Holotype – CAS 224403, female, 47 mm SL, Nananui-i-Cake, Fiji, 17°20.006'S, 178°16.374'E, coral reef with dead and living corals, 1–4.5 m, D.W. Greenfield, K. Longenecker, R. Langston and party, 14 March 1982. Paratypes – CAS 224404, female, 42 mm SL, same data as holotype; CAS 224405, 3 females, 28–49 mm SL, Northern division, Fiji, reef about 25 yards off rocky shore, coral and sand, 16°26.701'S, 179°56.261'W, 1–2

Table 2. Frequency distribution of vertebrae counts of the species in the genera *Dermatopsis*, *Dermatopsoides* and *Dipulus*.

	precaudal vertebrae															
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Dermatopsis																
greenfieldi n. sp		2	3													
hoesei n. sp		10	31	12	2											
joergennielseni n. sp				6	15											
macrodon			4	19	5											
Dermatopsis sp.				1												
Dermatopsoides																
andersoni n. sp				3												
kasongae					2											
morrisonae n. sp.				1	1											
talboti		2	4													
Dipulus																
caecus													3	3	7	1
hutchinsi n. sp							3	3								
multiradiatus										37	26	7	1			
norfolkanus					6	6	4									

	total vertebrae										
	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89
Dermatopsis											
greenfieldi n. sp	4	1									
hoesei n. sp		54									
joergennielseni n. sp		7	14								
macrodon		27	1								
Dermatopsis sp.		1									
Dermatopsoides											
andersoni n. sp		3									
kasongae			2								
morrisonae n. sp		2									
talboti	3	3									
Dipulus											
caecus									1	4	8
hutchinsi n. sp				2	4						
multiradiatus				51	21						
norfolkanus			16								

Table 3. Comparison of selected otolith, morphometric and pseudoclasper characters of the species in the genera *Dermatopsis*, *Dermatopsoides* and *Dipulus*.

	pseudoclasper			penis		scales	otolith length to height						ostial colliculum length to caudal colliculum length ratio												
	broadly expanded	paddle-like expanded	long curved stick	short spiny	with hook	without hook	on body	1.9	2.0	2.1	2.2	2.3	2.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7
Dermatopsis																										
greenfieldi n. sp							x			x	x						x	x								
hoesei n. sp		x				x		x	x															x		
joergennielseni n. sp				x		x	x		x															x	x	x
macrodon			x			x	x				x	x	x				x	x	x	x	x					
Dermatopsis sp.							x				x			x												
Dermatopsoides																										
andersoni n. sp				x		x			x									x								
kasongae				x		x	x																			
morrisonae n. sp							x																			
talboti				x		x																				
Dipulus																										
caecus	x				x					x	x	x		x	x											
hutchinsi n. sp			x		x		x			x	x				x	x	x									
multiradiatus			x		x		x					x	x			x	x									
norfolkanus		x			x					x	x								x	x	x					

m, D.W. Greenfield, K. Longenecker, R. Langston and party, 20 May 2003; CAS 222570, female, 44 mm SL, Viti Levu, Carybdis reef, of Rakiraki, Fiji, steep wall, coral pavement and sand, 17°11.566'S, 177°59.195'E, 8–10 m, D.W. Greenfield, K. Longenecker, R. Langston and party, 5 March 2002; ROM 40404, female, 53 mm SL, Cagilai Island, Viti Levu, Fiji, P. Ryan and G. Brodie, 15 Oct. 1982.

Diagnosis. Vertebrae 11–12 + 27–29 = 39–41, dorsal fin rays 64–70, anal fin rays 44–49; scales present on body; eye 1.8–2.6 % SL, sharp spine on ventral maxilla positioned behind rear tip of eye; otolith with pointed posterior tip and weak postdorsal angle, otolith elongate, length to height ratio 2.1–2.2, sulcus with separated colliculi.

Description. The principal meristic and morphometric characters are shown in Table 4. Body slender, up to 50 mm SL. Head without scales. Horizontal diameter of scales on body about 0.8 % SL, in 12 horizontal rows. Maxillary not expanded posteriorly, with sharp ventral spine positioned behind rear tip of eye. Anterior nostril on tip of snout. Posterior nostril, about 1/4 the size of eye.

Head sensory pores (Fig. 2A–B). Supraorbital pores 2. Infraorbital pores 5 (3 anterior and 2 posterior). Mandibular pores 6 (3 anterior and 3 posterior). Preopercular pores 1 lower, no upper. All pores small, about 1/2 the size of posterior nostril, except for lower preopercular pore about size of posterior nostril.

Dentition (of holotype). Premaxilla with 5 rows of small teeth anteriorly, merging into two rows posteriorly. Anteriormost teeth in inner row up to 1/4 diameter of pupil. Vomer horseshoe-shaped, with one row of 14 small teeth up to 1/5 diameter of pupil. Palatine teeth in a single row with 7 small teeth up to 1/5 diameter of pupil. Dentary with 4 outer rows of granular teeth and 1 inner row of larger teeth anteriorly, merging into 1 row of larger teeth posteriorly, up to about 1/3 of pupil diameter.

Otolith (Fig. 2C–D). Elongate, length to height ratio 2.1–2.2 (29–50 mm SL); otolith length to sulcus length

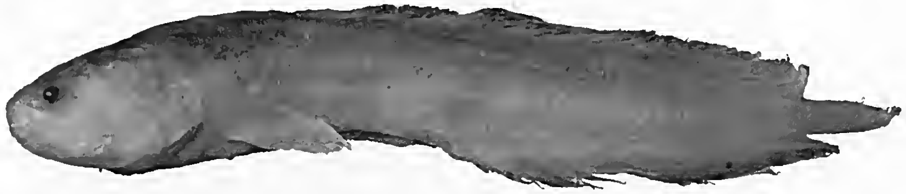

Fig. 1. *Dermatopsis greenfieldi* n. sp., CAS 224403, holotype, female, 47 mm SL.

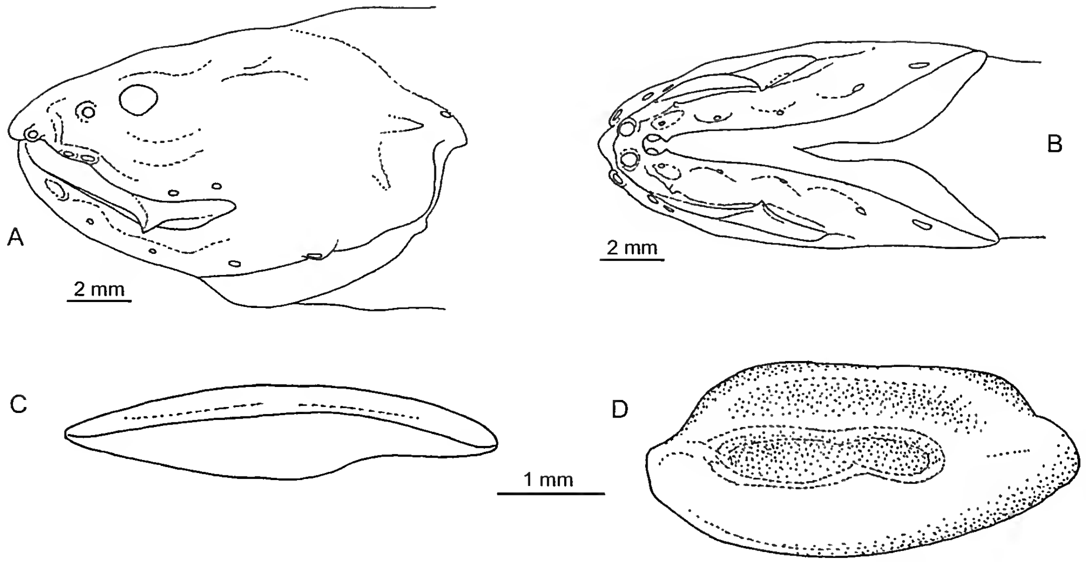

Fig. 2. *Dermatopsis greenfieldi* n. sp. **A**, lateral view of head, CAS 224403, holotype, female, 47 mm SL; **B**, ventral view of head, holotype; **C**, ventral view of right otolith, CAS 222598, paratype, female, 42 mm SL; **D**, median view of right otolith, CAS 222598, paratype, female, 42 mm SL.

Table 4. Meristic and morphometric characters of *Dermatopsis greenfieldi* n. sp.

	Holotype CAS 224403	**Holotype + 6 paratypes**	**n**
		Mean (range)	
Standard length in mm	47	43.1 (29–50)	7
Meristic characters			
Dorsal fin rays	69	67.3 (64–70)	7
Anal fin rays	49	46.1 (44–49)	7
Pectoral fin rays	19	20.3 (19–22)	7
Precaudal vertebrae	11	11.6(11–12)	7
Caudal vertebrae	28	28.0 (27–29)	7
Total vertebrae	39	39.7 (39–41)	7
Rakers on anterior gill arch	17	16.0 (14–19)	6
Pseudobranchial filaments	0	0.7(0–2)	7
D/V	5	6.1 (5–7)	7
D/A	27	24.1 (21–27)	7
V/A	15	15.3 (15–16)	7
Morphometric characters in % of SL			
Head length	24.6	25.2 (23.8–27.5)	7
Head width	11.5	11.9 (11.0–13.1)	7
Head height	16.6	16.3 (14.8–17.4)	7
Snout length	6.0	6.0(5.8–6.2)	6
Upper jaw length	13.7	13.4 (12.1–14.0)	7
Diameter of pigmented eye	1.9	2.1 (1.8–2.6)	7
Diameter of pupil	1.2	1.3(1.1–1.8)	6
Interorbital width	4.9	4.9 (4.4–5.4)	6
Postorbital length	17.7	18.0 (17.2–18.5)	6
Preanal length	51.8	52.2 (50.6–55.4)	7
Predorsal length	30.5	32.1 (30.4–35.9)	7
Body depth at origin of anal fin	13.3	14.0 (12.5–15.9)	7
Pectoral fin length	15.3	15.0 (13.9–15.6)	7
Pectoral fin base height	6.0	6.4(5.9–7.1)	7
Ventral fin length	16.3	17.1 (15.6–18.9)	7
Base ventral fin – anal fin origin	36.2	34.5 (28.2–39.3)	7

ratio 1.8; sulcus divided into ostium and cauda, marked by indention of the ventral sulcus margin, colliculi also divided; length of ostial colliculum to length of caudal colliculum ratio 1.8–1.9; anterior and posterior tips of otolith pointed, each with small concavity dorsally, weak postdorsal angle; inner face with weak ventral furrow close to ventral rim and broad, well defined dorsal depression.

Axial skeleton (of holotype). First neural spine half the length of second. Neural spine of vertebrae 2–4 elongate and 5–8 depressed. Parapophyses present from vertebrae 6 to 10. Pleural ribs on vertebrae 3–8. First anal fin pterygiophore elongate, but not reaching tip of last precaudal parapophysis.

Male copulatory organ. So far only female specimens known.

Coloration. Live colour unknown. Uniformly light brown when preserved.

Comparison. *Dermatopsis greenfieldi* is easily distinguished from *D. macrodon* and *D. joergennielseni* n. sp. by the low number of vertebrae (39–41 vs 40–45 and 44–46), low number of dorsal fin rays (64–70 vs 69–82 and 76–85) and the low number of anal fin rays (44–49 vs 47–56 and 51–58). From *D. joergennielseni* n. sp. it further differs in larger eye (1.8–2.6 vs 1.1–1.7 % SL), the predorsal length (30.4–35.9 vs 25.1–30.0 % SL) and in the otolith length to height ratio (2.1–2.2 vs 2.0); from *D. macrodon* it differs in addition in the absence of a supraorbital pore behind the eye (vs usually present) and translucent vertical fins (vs dark at base). *Dermatopsis greenfieldi* differs from *D. hoesei* n. sp. in the presence of body scales (vs absent), smaller pores, small posterior nostril (1/4 of eye size vs 1/2 of eye size), larger eye (1.8–2.6 vs 1.4–1.9 % of SL) and the otolith length to height ratio (2.1–2.2 vs 1.9–2.0).

Distribution (Fig. 6). *Dermatopsis greenfieldi* is known exclusively from the Fiji Islands.

Ecology. Lives in coral reef habitats in depths from 1 to 10 m.

Etymology. Named in honour of David W. Greenfield, Moss Landing Marine Laboratories, USA, in recognition for his great contributions to coral reef ichthyology.

Dermatopsis hoesei n. sp.

(Figs 3–6; Tables 1–3, 5)

Dermatopsis macrodon (in part). – Whitley 1935: 239, fig. 8; Cohen 1966: fig. 2A.

Material examined. (57 specimens, 25–48 mm SL). Holotype – AMS I.28732–022, male, 35 mm SL, Bitangabee Bay southern headland, New South Wales, 37°13'S, 150°00'E, 0–1.5 m, M. Beshaw, S. Reader, M. Ricketts and J. Leis, 6 April 1989. Paratypes – AMS I.15330-037, 3 males, 31–34 mm SL, 7 females, 29–45 mm SL, Jervis Bay, Chinaman Beach, New South Wales, 35°01'S, 150°46'E, 3 m, M. Cameron, H. and J. Paxton, 3 Jan. 1969; AMS I.15892-022, male, 27 mm SL, female, 38 mm SL, Narrabeen near Sydney, New South Wales, 33°45'S, 151°19'E, 1 m, 25 July 1970; AMS I.15912-046, 6 males, 30–39 mm SL, 5 females, 31–35 mm SL, Jervis Bay, Cabbage Tree Point, New South Wales, 35°01'S, 150°46'E, 0–5 m, 17 Oct. 1970; AMS I.17343-017, male, 44 mm SL, Newcastle area, Seal Rocks, New South Wales, 32°28'S, 152°32'E, 1 m, 11 May 1973; AMS I.20095-049, 1 male, 36 mm SL, 5 females, 27–48 mm SL, and ZMUC P771554-55, male, 38 mm SL, female 41.5 mm SL, Arrawarra Headland, New South Wales, 30°04'S, 153°12'E, 0–1 m, J. Paxton and D. Hoese, 4 May 1977; AMS I.28732-025, 6 males, 27–36 mm SL, 2 females, 34–37 mm SL, same data as for holotype; AMS I.28738-025, 3 males, 27–30 mm SL, 4 females, 30–35 mm SL, Bittangabee Bay, off rocks below camping area, New South Wales, 37°13'S, 150°00'E, 0–4 m, M. McGrouther and party, 8 April 1989; SMNS 14762, male, 34 mm SL, 2 females, 27–43 mm SL, Red Head, 20 km NE of Ulladulla, New South Wales, 35°13'S, 150°32'E, 0–3 m, R. Fricke and T. Trnski, 12 May 1993; WAM P.27112-005, 3 males, 32–40 mm SL, Shelley Point, Summerland Bay, New South Wales, 29°32'S, 153°21'E, J.B. Hutchins, 9 Feb. 1981; WAM P.28844-022, 2 males, 25–29 mm SL, Port Hacking, New South Wales, 34°04'S, 151°07'E, 14 Nov. 1974.

Diagnosis. Vertebrae 11–14 + 27–31 = 40–43, dorsal fin rays 67–77, anal fin rays 46–53; no scales on head and body; posterior nostril large, about half size of eye; lower preopercular pore large, about size of posterior nostril or larger; weak spine on maxilla positioned behind rear tip of eye; single pair of pseudoclaspers curved, expanded and paddle-like, longer than penis, without fleshy appendices; and otolith with pointed posterior tip and concavity above and massive postdorsal angle, otolith length to height ratio 1.9–2.0, sulcus with divided colliculi

Description. The principal meristic and morphometric characters are shown in Table 5. Body slender, up to 48 mm SL, mature at about 30 to 35 mm SL. Head and body without scales. Maxillary not expanded posteriorly, with weak spine positioned behind rear tip of eye. Anterior

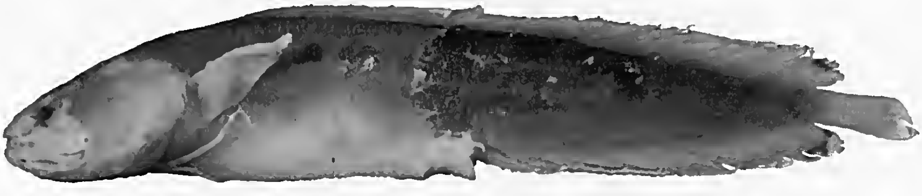

Fig. 3. *Dermatopsis hoesei* n. sp., AMS I.28732-022, holotype, male, 35 mm SL.

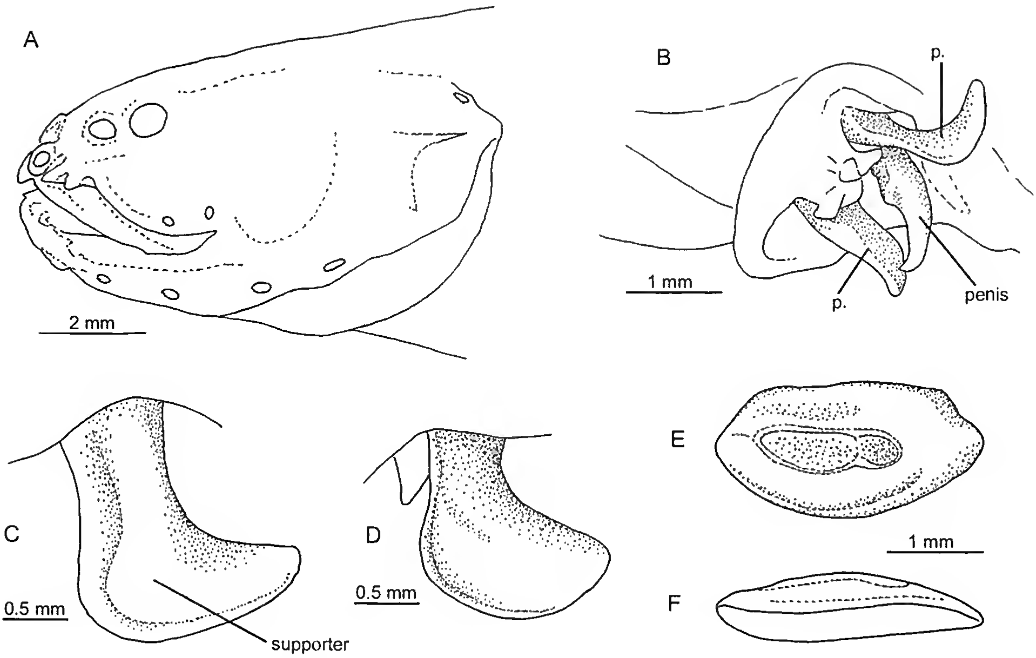

Fig. 4. *Dermatopsis hoesei* n. sp. **A**, lateral view of head, WAM P.27112-005, paratype, male, 40 mm SL; **B**, inclined lateral view of male copulatory organ, WAM P.27112-005, paratype, 40 mm SL; **C**, view of left pseudoclasper from outside, AMS I.28732-002, holotype, 35 mm SL; **D**, view of left pseudoclasper from outside, WAM P.27112-005, paratype, 40 mm SL; **E**, median view of right otolith, SMNS 14762, paratype, female, 43 mm SL; **F**, ventral view of right otolith, SMNS 14762, paratype, female, 43 mm SL.

nostril at tip of snout. Posterior nostril very large, about 1/2 the size of eye.

Head sensory pores (Fig. 4A). Supraorbital pores 2 (rarely 3). Infraorbital pores 5 (3 anterior and 2 posterior). Mandibular pores 6 (3 anterior and 3 posterior). Preopercular pores 1 lower (joined 2 pores), no upper preopercular pore. All pores large, posterior mandibular pores about size of posterior nostril, lower preopercular pore even larger in some specimens.

Dentition (of holotype). Premaxilla with 3 rows of small teeth anteriorly, merging into 2 rows posteriorly. Anteriormost teeth in inner row up to 1/4 diameter of pupil. Vomer horseshoe-shaped, with 1 row of 7 large teeth up to 3/4 diameter of pupil. Palatine teeth in single row with 5 large teeth up to 1/2 diameter of pupil. Dentary with 2 outer rows of granular teeth and 1 inner row of larger teeth anteriorly, merging into 1 row of large teeth posteriorly, up to about size of pupil diameter.

Otolith (Fig. 4E–F). Moderately elongate, length to height ratio 1.9–2.0 (34–43 mm SL); otolith length to sulcus length ratio 1.8; sulcus divided into ostium and cauda, marked by indention of the ventral sulcus margin, colliculi also divided; length of ostial colliculum to length of caudal colliculum ratio 2.5; anterior tip of otolith rounded without concavity dorsally, posterior tip pointed, with concavity dorsally and with massive postdorsal angle; inner face with well marked ventral furrow close to ventral rim and narrow, not well defined dorsal depression.

Axial skeleton (of holotype). First neural spine half the length of second. Neural spine of vertebrae 2–3 elongate and 4–7 depressed. Parapophyses present from vertebrae 6 to 12. Pleural ribs on vertebrae 3–11. First

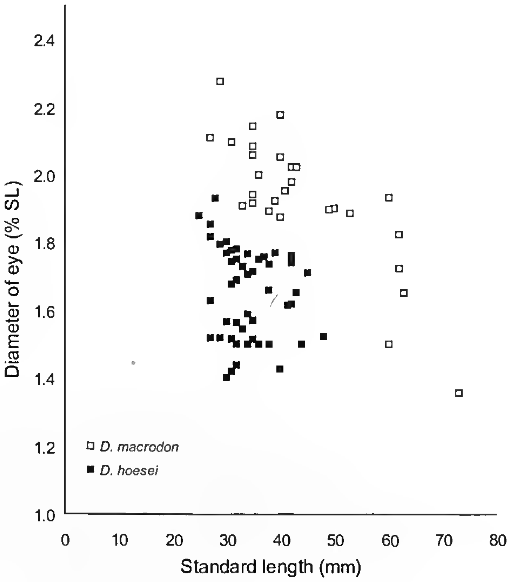

Fig. 5. Eye diameter in relation to standard length in *Dermatopsis hoesei* n. sp. and *Dermatopsis macrodon*.

Table 5. Meristic and morphometric characters of *Dermatopsis hoesei* n. sp.

	Holotype	Holotype + 56 paratypes	n
	AMS I.28732-022	Mean (range)	
Standard length in mm	35	34.0 (25–48)	55*
Meristic characters			
Dorsal fin rays	73	71.6 (67–77)	53
Anal fin rays	50	49.2 (46–53)	53
Pectoral fin rays	19	19.7 (17–22)	32
Precaudal vertebrae	12	12.1(11–14)	55
Caudal vertebrae	29	29.0 (27–31)	54
Total vertebrae	41	41.1 (40–43)	54
Rakers on anterior gill arch	–	8.7 (5–10)	10
Pseudobranchial filaments	–	0.4(0–1)	10
D/V	6	5.9 (5–7)	54
D/A	28	26.9 (23–30)	54
V/A	17	16.7 (15–18)	54
Morphometric characters in % of SL			
Head length	23.2	24.2 (21.9–26.5)	41
Head width	11.2	11.1 (8.8–15.0)	31
Head height	14.2	14.6 (12.8–16.4)	31
Snout length	5.7	5.8 (4.4–6.5)	31
Upper jaw length	11.7	11.6 (10.2–13.3)	34
Diameter of pigmented eye	1.5	1.7 (1.4–1.9)	55
Diameter of pupil	1.3	1.2(0.8–1.6)	38
Interorbital width	4.5	5.1 (4.0–6.0)	30
Postorbital length	16.5	17.1 (15.7–18.7)	30
Preanal length	54.6	52.6 (46.7–55.7)	33
Predorsal length	30.3	30.2 (27.2–33.4)	32
Body depth at origin of anal fin	11.1	13.2 (11.0–16.0)	35
Pectoral fin length	13.9	14.3 (12.7–17.7)	27
Pectoral fin base height	6.2	6.0(4.6–7.1)	28
Ventral fin length	17.5	17.1 (13.3–20.5)	39
Base ventral fin – anal fin origin	37.9	35.5 (29.2–40.1)	32

* Two specimens with broken tail not included.

anal fin pterygiophore elongate, almost reaching tip of last precaudal parapophysis.

Male copulatory organ (Fig. 4B–D). A single pair of pseudoclaspers, expanded paddle-like, underpinned by similarly expanded supporter, longer than penis, without fleshy appendices. Isthmus between pseudoclaspers wide, fleshy. Penis tapering with broad base, curved.

Coloration. Live colour unknown. Uniformly light brown when preserved.

Comparison. *Dermatopsis hoesei* is sympatric with *D. macrodon* and is best recognised by its lack of scales on body (vs present), large pores (vs small), the curved expanded paddle-like pseudoclaspers (vs with narrow supporter and with broad fleshy appendix anteriorly), the usual lack of a supraorbital pore behind the eye (vs present in most), the longer pectoral fin (12.7–17.7 vs 9.8–14.3 % SL), the pale, translucent vertical fins (vs dark at base) and the more compressed otolith (length to height ratio 1.9–2.0 vs 2.2–2.4). Also the eye is larger than in *D. macrodon* (Fig. 5), and the specimens of *D. hoesei* do not seem to grow to the same size (up to 48 mm SL vs up to 73 mm SL) as do *D. macrodon*. The number of vertebrae tends to be lower compared to *D. macrodon* and *D. joergennielseni* n. sp. (40–43 vs 40–45 and 44–46 respectively), likewise the number of dorsal fin rays (67–77 vs 69–82 and 76–85) and anal fin rays (46–53 vs 47–56 and 51–58). With *D. greenfieldi* it shares the low number of vertebrae and fin rays, but is easily distinguished by the weak spine at the ventral maxilla (vs sharp), the otolith proportions (length to height ratio 1.9–2.0 vs 2.1–2.2 and strong postdorsal angle vs weak) and the size of the head pores (Fig. 4A vs Fig. 2A).

Remarks. *Dermatopsis hoesei* has previously been included in *D. macrodon* (see Cohen 1966). For further discussion see *D. macrodon*.

In any event, female specimens, and even more so the juveniles of the two species *D. hoesei* and *D. macrodon* cannot always be reliably distinguished. We have left 37 specimens belonging to one or the other species, all less than 30 mm SL (mostly less than 25 mm SL), in open nomenclature (see *D. macrodon* for more discussion).

Distribution (Fig. 6). *Dermatopsis hoesei* is distributed along the rocky shores of south-eastern Australia, south of the Great Barrier Reef, chiefly along the shores of New South Wales between the latitudes 29°S and 37°S.

Ecology. Lives along rocky shores at shallow depths from 0 to 4 m. A 42 mm SL female (AMS 15330-037), contains 3 embryos, 11–16 mm SL. They are pale except for some weak pigmentation on top of head.

Etymology. Named in honour of Doug Hoese, Sydney, AMS, in recognition of his many great contributions to Australian ichthyology.

Dermatopsis joergennielseni n. sp.

(Figs 6–8; Table 6)

Dermatopsis macrodon. – Cohen 1966 (in part); Ayling and Cox 1982: 153; Paulin *et al.* 1989: 133; Francis 1993: 158; Schwarzhans and Grenfell 2002: 19 (fossil otolith record).

Material examined. (28 specimens, 25–57 mm SL). Holotype – NMNZ P.36610, male, 43 mm SL, North Island, Bay of Plenty, south Whale (Motuhora) Island, New Zealand, 37°51'42"S, 176°58'26"E, 8–12 m, 22 April 1999. Paratypes – NMNZ P.35580, 2 males, 39–44 mm SL, female, 45 mm SL, North Bay, Whale Island, 37°50'03"S, 176°58'34"E, 13–15 m, 3rd East Cape Field Trip, 3 June 1998; NMNZ P.42522, 5 males, 37–51 mm SL, 8 females, 29–54 mm SL, same data as holotype; NMNZ P.36678, 3 males, 31–43 mm SL, 5 females, 35–57 mm SL, juvenile, 25 mm SL, and ZMUC P771549-50, 2 males, 48–52 mm SL, off Homestead Point, White Island, New Zealand North Island, 37°31'46"S, 177°10'41"E, 8–14 m, 23 April 1999.

Additional identified material. All New Zealand: NMNZ P.003154, 61 specimens, 21–50 mm SL, 35°13'00"S, 174°14'00"E; NMNZ P.006103, 13 specimens, 64–63 mm SL, 35°10'00"S, 174°20'00"E; NMNZ P.007997, 2 specimens, 24–32 mm SL, 35°00'00"S, 173°47'00"E; NMNZ P.008003, 20 specimens, 25–34 mm SL, 35°00'00"S, 173°47'00"E; NMNZ P.008004, 1 specimen, 33 mm SL, 35°12'00"S, 174°13'00"E; NMNZ P.014190, 1 specimen, 44 mm SL, 35°13'00"S, 174°14'00"E; NMNZ P.015226, 1 specimen, 52 mm SL, 35°00'30"S, 173°45'30"E; NMNZ P.015264, 4 specimens, 34–55 mm SL, 35°23'24"S, 174°22'12"E; NMNZ P.015275, 1 specimen, 37 mm SL, 35°23'12"S, 174°21'06"E; NMNZ P.015483, 1 specimen, 58 mm SL, 36°58'00"S, 176°05'00"E; NMNZ P.018185, 2 specimens, 47–52 mm SL, 37°17'12"S, 176°16'24"E; NMNZ P.028078, 2 specimens, 32–34 mm SL, 35°34'00"S, 174°30'00"E; NMNZ P.028222, 1 specimen, 25 mm SL, 37°32'36"S, 178°12'54"E; NMNZ P.036629, 1 specimen, 54 mm SL, 37°50'03"S, 176°53'27"E; NMNZ P.029815, 1 specimen, 37 mm SL, 37°36'48"S, 177°54'36"E; NMNZ P.035570, 2 specimens, 38–49 mm SL, 37°49'47"S, 176°52'38"E.

Diagnosis. Vertebrae 13–14 + 30–32 = 44–46, dorsal fin rays 76–85, anal fin rays 51–58; body scaled; posterior infraorbital pores 3; ventral spine on maxilla positioned behind rear of eye; single pair of pseudoclaspers straight, spiny, short, about half the length of penis, without fleshy appendices; otolith with rounded posterior tip and weak postdorsal angle, otolith length to height ratio 2.0, sulcus with nearly fused colliculi.

Description. The principal meristic and morphometric characters are shown in Table 6. Body slender, up to 57 mm SL, mature at about 30 to 35 mm SL. Head without scales, horizontal diameter of scales on body about 0.6 % SL, in about 10 horizontal rows (in holotype). Maxillary not expanded posteriorly, with ventral spine positioned behind rear of eye. Anterior nostril on tip of snout. Posterior nostril large, about 1/3 the size of eye.

Head sensory pores (Fig. 8A). Supraorbital pores 2. Infraorbital pores 6 (3 anterior and 3 posterior). Mandibular

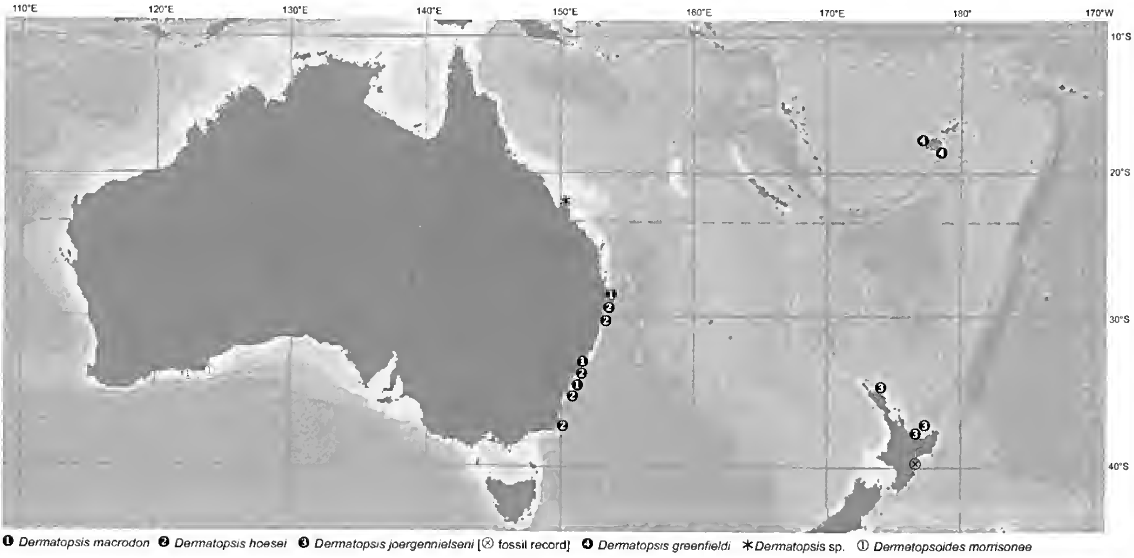

Fig. 6. Sample sites of *Dermatopsis greenfieldi* n. sp., *D. hoesei* n. sp., *D. joergennielseni* n. sp., *D. macrodon*, *Dermatopsis* sp. and *Dermatopsoides morrisonae* n. sp. One symbol may represent several samples.

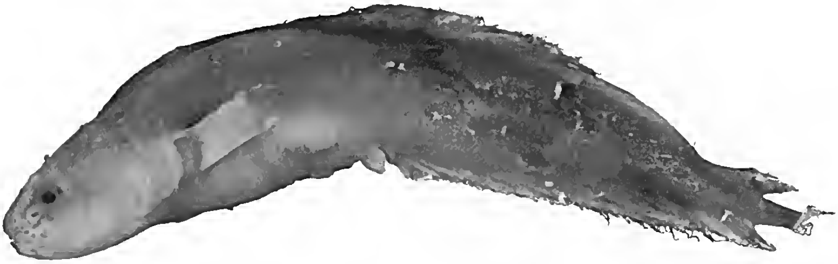

Fig. 7. *Dermatopsis joergennielseni* n. sp., NMNZ P.36610, holotype, male, 43 mm SL.

pores 6 (3 anterior and 3 posterior). Preopercular pores 1 lower, no upper. All pores small, about 1/2 the size of posterior nostril, except for lower preopercular pore about size of posterior nostril.

Dentition (of holotype). Premaxilla with 4 rows of small teeth anteriorly, merging into single row posteriorly. Anteriormost teeth in inner row up to 1/3 diameter of pupil. Vomer horseshoe-shaped, with 1 row of 12 small teeth up to 1/5 diameter of pupil. Palatine teeth in single row with 4 small teeth up to 1/5 diameter of pupil. Dentary with 3 outer rows of granular teeth and 1 inner row of larger teeth anteriorly, merging into 1 row of larger teeth posteriorly, up to about 3/4 of pupil diameter.

Otolith (Fig. 8D–F). Moderately elongate, length to height ratio 2.0 (43–54 mm SL); otolith length to sulcus length ratio 2.0; sulcus divided into ostium and cauda, marked by indention of the ventral sulcus margin, but its colliculi fused; length of ostial colliculum to length of caudal colliculum ratio 2.5–2.7; anterior tip of otolith pointed with small concavity dorsally, posterior tip rounded, with weak or no postdorsal angle; inner face with well marked ventral furrow close to ventral rim bending upwards strongly behind cauda and broad, well defined dorsal depression.

Axial skeleton (of holotype). First neural spine half the length of second. Neural spine of vertebrae 2–4 elongate and 4–9 depressed. Parapophyses present from vertebrae 3 to 12. Pleural ribs on vertebrae 2–12. First anal fin pterygiophore elongate, almost reaching tip of last precaudal parapophysis.

Male copulatory organ (Fig. 8B–C). A single pair of short, spiny straight pseudoclaspers, underpinned by supporter. Isthmus between pseudoclaspers wide. Penis thin, curved, about twice the length of pseudoclaspers.

Coloration. Live colour unknown. Uniformly light to medium brown when preserved.

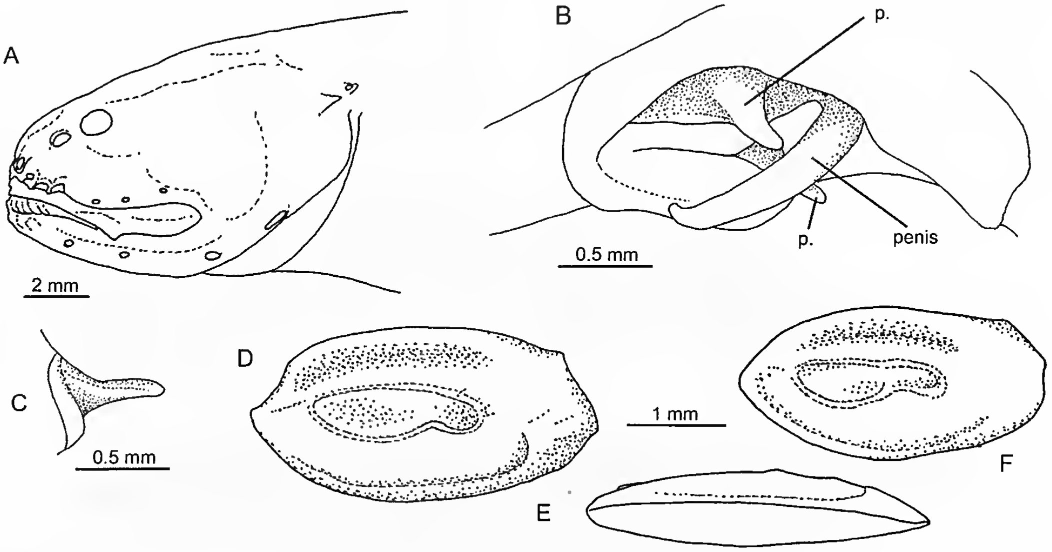

Fig. 8. *Dermatopsis joergennielseni* n. sp. **A**, lateral view of head, NMNZ P.36678, paratype, female, 48 mm SL; **B**, inclined lateral view of male copulatory organ, NMNZ P.36610, holotype, 43 mm SL; **C**, view of left pseudoclasper from inside, NMNZ P.42522, paratype, 40 mm SL; **D**, ventral view of right otolith, NMNZ P. P.42522, paratype, female, 54 mm SL; **E**, median view of right otolith, NMNZ P.42522 paratype, female, 54 mm SL; **F**, median view of right fossil otolith, Nukumuran stage, Late Pliocene, Ashcott Road, Hawkes Bay, New Zealand.

Table 6. Meristic and morphometric characters of *Dermatopsis joergennielseni* n. sp.

	Holotype NMNZ P.36610	Holotype + 27 paratypes Mean (range)	n
Standard length in mm	43	43.5 (25–57)	28
Meristic characters			
Dorsal fin rays	78	79.3 (76–85)	21
Anal fin rays	56	55.0 (51–58)	21
Pectoral fin rays	20	20.2 (19–21)	14
Precaudal vertebrae	14	13.7(13–14)	21
Caudal vertebrae	30	31.2 (30–32)	21
Total vertebrae	44	45.0 (44–46)	21
Rakers on anterior gill arch	13	13.5 (13–14)	5
Pseudobranchial filaments	0	0	5
D/V	7	6.7 (6–7)	21
D/A	26	27.2 (24–31)	21
V/A	17	16.9 (16–18)	21
Morphometric characters in % of SL			
Head length	22.5	22.0 (18.5–25.1)	20
Head width	9.3	10.8 (8.1–15.0)	14
Head height	13.7	13.6 (12.8–15.8)	15
Snout length	5.7	5.9 (5.1–6.7)	17
Upper jaw length	13.0	12.3 (11.8–13.2)	17
Diameter of pigmented eye	1.5	1.5 (1.1–1.7)	21
Diameter of pupil	1.0	1.0(0.7–1.2)	19
Interorbital width	4.0	4.9 (4.0–5.6)	18
Postorbital length	16.8	15.6 (14.4–17.2)	18
Preanal length	47.5	50.6 (47.1–54.1)	17
Predorsal length	30.0	28.4 (25.1–30.0)	18
Body depth at origin of anal fin	12.6	12.3 (10.4–15.6)	9
Pectoral fin length	16.6	14.1 (11.7–16.6)	9
Pectoral fin base height	5.2	5.5(4.9–6.0)	9
Ventral fin length	16.4	15.5 (12.9–18.3)	17
Base ventral fin – anal fin origin	30.9	33.5 (25.0–40.0)	18

Comparison. *Dermatopsis joergennielseni* is distinguished from the other three species of the genus in the high number of vertebrae 44–46 (vs 39–45) and the presence of 3 posterior infraorbital pores (vs 2). *Dermatopsis joergennielseni* differs in addition from *D. hoesei* in the presence of body scales (vs absent), short pseudoclaspers (half the length of the penis vs same length as penis), dorsal fin rays (76–85 vs 67–77), anal fin rays (51–58 vs 46–53) and the postdorsal angle of the otolith (no or weak vs strong); from *D. greenfieldi* in the number of precaudal vertebrae (13–14 vs 11–12), the dorsal fin ray count (76–85 vs 64–70), anal fin rays (51–58 vs 44–49) the eye size (1.1–1.7 vs 1.8–2.6 % SL), the predorsal length (25.1–30.0 vs 30.4–35.9 % SL), and the length to height ratio of the otolith (2.0 vs 2.1–2.2). For further distinction from *Dermatopsis macrodon*, see reference to that species.

Remarks. *Dermatopsis joergennielseni* has previously been described and figured by Cohen (1966) and others (e.g. Paulin *et al.* 1989; Paulin and Roberts 1992) as *D. macrodon*. Cohen noticed certain differences, which he felt not to be significant enough to warrant establishing a separate species. Now with further characters (pseudoclaspers and otoliths) analysed, the distinction of two geographically separated species has become clearly substantiated. It must be remarked that Cohen gave a range of 42 to 45 vertebrae from 16 specimens he investigated from New Zealand while in the 21 specimens x-rayed and counted by us the vertebrae range is between 44 and 46. Cohen's material has not been reviewed, so that this discrepancy remains unanswered at this time. However, the other diagnostic characters, particularly pseudoclaspers, otoliths and pore patterns are stable. Furthermore, part of the lack of differentiation may have been masked by the fact that two sympatric species of *Dermatopsis* are now recognized along the south-eastern Australian coast, which previously were recorded as only one, *D. macrodon* (see species references to *D. macrodon* and *D. hoesei*).

Dermatopsis joergennielseni is the only extant Dinematichthyini so far also known from the fossil record. An otolith, originally described as *D. macrodon*, was recorded from the Nukumuruan (Late Pliocene, 2.4–2.0 Mya) of Hawkes Bay (Fig. 8F), indicating a fairly long presence of the species in New Zealand waters and that it was more widely (more southerly) distributed in the past.

Distribution (Fig. 6). *Dermatopsis joergennielseni* is distributed along the northernmost shores of North Island, New Zealand 35°00'–37°51'S.

Ecology. Lives on rocky shores down to 17 m, most commonly deeper than 5 m.

Etymology. Named in honour of Jorgen Nielsen, Copenhagen, ZMUC, in recognition of his many great contributions to the biology and systematics of the Ophidiiformes.

Dermatopsis macrodon Ogilby, 1896

(Figs 5–6, 9–10; Tables 1–3, 7)

Dermatopsis macrodon Ogilby, 1896: 140 (type locality: Maroubra near Sydney, New South Wales, Australia).

Dermatopsis macrodon (in part). – Ogilby 1897: 86; Whitley 1935: 239, fig. 8; Thinès 1955: 78; Thinès 1969: 157; Cohen 1966: 188; Paxton *et al.* 1989: 316; Kuiter 1993: 61; Gomon *et al.* 1994: 372; Kuiter 2000: 61; Nielsen *et al.* 1999: 126.

Material examined. (28 specimens, 27–73 mm SL). Holotype, AMS I.3505, female, 73 mm SL, Maroubra near Sydney, New South Wales, Australia, 33°57'S, 151°16'E, T. Whitelegge, 1896.

Additional specimens: AMS IA.5928, 4 females, 31–60 mm SL, Port Jackson, New South Wales, 33°51'S, 151°16'E; AMS IB.6836, 2 females, 36–62 mm SL, Minnie Waters, New South Wales, 29°50'S, 153°18'E; AMS I.15892-012, 3 males, 27–42 mm SL, Narrabeen near Sydney, New South Wales, 33°45'S, 151°19'E; AMS I.15912-040, male, 41 mm SL, female, 42 mm SL, Jervis Bay, Cabbage Tree Point, Australian Capital Territory, 35°01'S, 150°46'E; AMS I.16469-016, male, 43 mm SL, female, 62 mm SL, Minnie Waters, New South Wales, 29°50'S, 153°15'E; AMS I.19901-031, male, 49 mm SL, female, 39 mm SL, Neilsen Park, Sydney, New South Wales, 33°51'S, 151°16'E, Bottle and Glass Rocks; AMS I.25380-001, 5 males, 29–38 mm SL, female, 40 mm SL, S end of Pittwater, New South Wales, 33°39'S, 151°18'E; AMS I.25380-002, 1 male, 35 mm SL, 1 female, 33 mm SL, and ZMUC P771552, male 40 mm SL and female 35 mm SL, S end of Pittwater, New South Wales, 33°39'S, 151°18'E; AMS I.40829-032, female, 63 mm SL, Sydney Harbour, Clark Island, New South Wales, 33°51'S, 151°14'E.

Diagnosis. Vertebrae 12–14 + 27–32 = 40–45, dorsal fin rays 69–82, anal fin rays 47–56; body scaled; supraorbital pore behind eye (mostly present); ventral spine on maxilla positioned behind rear of eye; vertical fins dark; single pair of pseudoclaspers, curved, not expanded, often with broad fleshy appendix anteriorly.

Description. The principal meristic and morphometric characters are shown in Table 7. Body slender, up to 73 mm SL, mature at about 35 to 40 mm SL. Head without scales. Horizontal diameter of scales on body about 0.6 % SL, in about 8–10 scattered horizontal rows in the holotype (see Whitley 1935: fig. 8). Maxillary not expanded posteriorly, with ventral spine positioned behind rear of eye. Anterior nostril on tip of snout. Posterior nostril large, about 1/3 the size of eye.

Head sensory pores (Fig. 10 A–B). Supraorbital pores mostly 3 (rarely 2, the female holotype is one of only two specimens lacking the supraorbital pore behind the eye). Infraorbital pores 5 (3 anterior and 2 posterior). Mandibular pores 6 (3 anterior and 3 posterior). Preopercular pores 2 lower with separate or (less common) joined opening, no upper preopercular pore. All pores small, about 1/2 the size of posterior nostril or smaller.

Dentition (in a 43 mm SL male, AMS I.16469-016). Premaxilla with 5 rows of small teeth anteriorly, merging into single row posteriorly. Anteriormost teeth in inner row up to 1/3 diameter of pupil. Vomer horseshoe-shaped, with 1 row of 8 large teeth up to 3/4 diameter of pupil. Palatine teeth in 2 rows with 4+2 small teeth up to 1/3

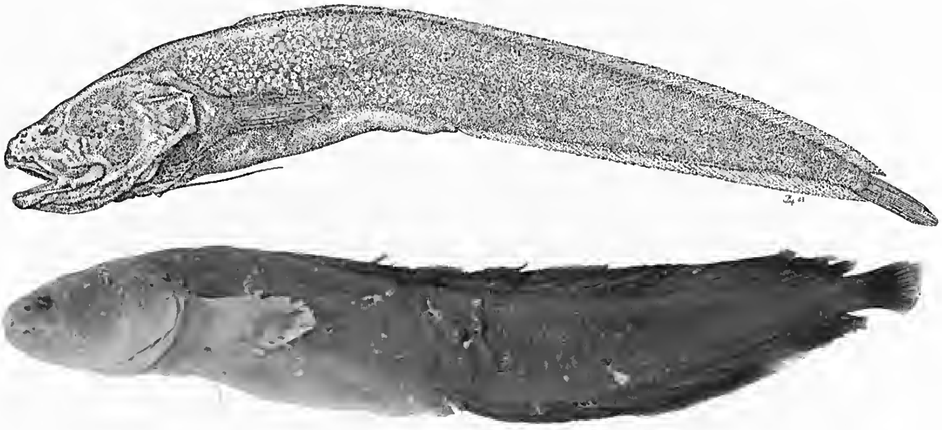

Fig. 9. *Dermatopsis macrodon* Ogilby, 1896. **A**, AMS I.3505, holotype, female, 73 mm SL; **B**, AMS I.15912-040, non-type male, 41 mm SL.

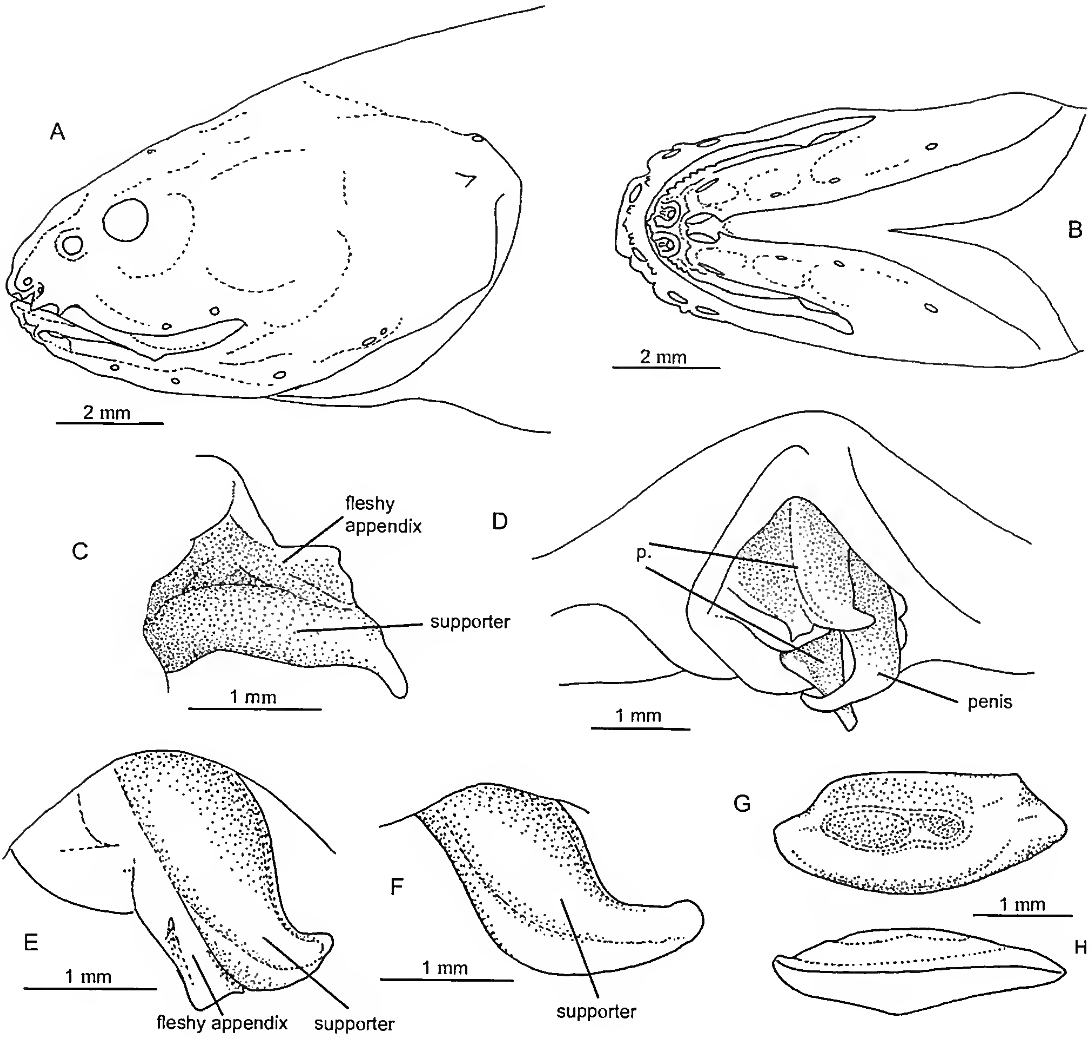

Fig. 10. *Dermatopsis macrodon* Ogilby, 1896. **A**, lateral view of head, AMS I.15912-040, non-type, male, 41 mm SL; **B**, ventral view of head, AMS I.15912-040, non-type, male, 41 mm SL; **C**, view of left pseudoclasper from inside, AMS I.15912-040, non-type, 41 mm SL; **D**, inclined lateral view of male copulatory organ, AMS I.15912-040, non-type, 41 mm SL; **E**, view of left pseudoclasper from outside, AMS I.25380-001, non-type, 38 mm SL; **F**, view of left pseudoclasper from outside, AMS I.25380-001, non-type, 35 mm SL; **G**, median view of right otolith, ZMUC P771553, non-type, male, 40 mm SL; **H**, ventral view of right otolith, ZMUC P771553, non-type, male, 40 mm SL.

diameter of pupil. Dentary with 3 outer rows of granular teeth and 1 inner row of larger teeth anteriorly, merging into 1 row of larger teeth posteriorly, up to about size of pupil diameter.

Otolith (Fig. 10G–H). Elongate, length to height ratio 2.2–2.4 (35–63 mm SL), thick; otolith length to sulcus length ratio 1.9–2.1; sulcus divided into ostium and cauda, marked by indention of ventral sulcus margin, colliculi also divided; length of ostial colliculum to length of caudal colliculum ratio 1.8–2.2; anterior tip of otolith sharply pointed, with small concavity dorsally, posterior tip less sharply pointed, no predorsal angle, sharp postdorsal angle; inner face with weak ventral furrow close to ventral rim and broad, well defined dorsal depression. A mild form of sexual dimorphism was observed in the sense that otoliths from females are slightly less thick than those of males.

Axial skeleton (of holotype). First neural spine half the length of second. Neural spine of vertebrae 2–3 elongate and 4–9 depressed. Parapophyses present from vertebrae 5 to 12. Pleural ribs on vertebrae 2–10. First anal fin pterygiophore slightly elongate, not reaching tip of last precaudal parapophysis.

Table 7. Meristic and morphometric characters of *Dermatopsis macrodon* Ogilby, 1896.

	Holotype AMS I.3505	Holotype + 27 non-types Mean (range)	n
Standard length in mm	73	43.9 (27–73)	28
Meristic characters			
Dorsal fin rays	80	74.5 (69–82)	28
Anal fin rays	55	51.6 (47–56)	28
Pectoral fin rays	20	19.8 (18–22)	21
Precaudal vertebrae	13	13.0(12–14)	28
Caudal vertebrae	31	29.2 (27–32)	28
Total vertebrae	44	42.3 (40–45)	28
Rakers on anterior gill arch	15	10.7 (5–17)	9
Pseudobranchial filaments	0	1.4 (0–2)	10
D/V	7	5.9 (5–7)	28
D/A	29	28.0 (24–31)	28
V/A	17	16.7 (16–18)	28
Morphometric characters in % of SL			
Head length	21.9	23.0 (21.6–24.8)	27
Head width	12.0	11.5 (9.0–14.6)	26
Head height	13.0	13.8 (12.4–15.8)	26
Snout length	5.5	5.6 (5.0–6.5)	26
Upper jaw length	11.4	11.5 (10.4–12.5)	26
Diameter of pigmented eye	1.4	1.9 (1.4–2.3)	28
Diameter of pupil	0.7	1.1(0.7–1.8)	24
Interorbital width	5.0	4.9 (4.2–5.5)	26
Postorbital length	15.9	16.3 (14.9–18.2)	26
Preanal length	50.6	52.1 (47.6–56.2)	25
Predorsal length	30.9	29.1 (26.7–31.3)	25
Body depth at origin of anal fin	11.7	12.6 (10.4–14.4)	26
Pectoral fin length	9.8	12.8 (9.8–14.3)	23
Pectoral fin base height	4.8	5.6(4.8–6.6)	23
Ventral fin length	11.8	14.9 (10.2–20.3)	23
Base ventral fin – anal fin origin	31.5	34.9 (29.8–38.0)	24

Male copulatory organ (Fig. 10C–F). A single pair of large pseudoclaspers, curved, not expanded, underpinned by narrow massive supporter. Pseudoclasper with broad fleshy appendages anteriorly. Isthmus between pseudoclaspers wide. Penis thick, with angularly inclined narrow tip, about the length of pseudoclaspers.

Coloration. Live colour not known. Medium brown when preserved, often darker dorsally and on vertical fins, even after extended preservation.

Comparison. *Dermatopsis macrodon* is distinguished from the three other species of the genus by the broad fleshy appendages anteriorly on the pseudoclasper, which has a narrow supporter, the dark coloration of the vertical fins and the usual presence of a supraorbital pore behind the eye. From *D. joergennielseni* from New Zealand it is distinguished by the long broad pseudoclasper with fleshy anterior appendages (vs short and spiny, of about half the length of the penis) and the number of posterior infraorbital pores (2 vs 3). From *D. greenfieldi* from Fiji it is distinguished by the higher number of vertebrae (40–45 vs 39–41) and dorsal fin rays (69–82 vs 64–70). From the sympatric *D. hoesei* it also differs by having scales on body (vs absent) and smaller eye (Fig. 5).

Remarks. The holotype of *D. macrodon* is a female, which lacks one of the important diagnostic characters for the species (presence of a supraorbital pore behind the eye). Despite these two shortcomings, it is still distinct from the sympatrically occurring *D. hoesei* in the following characters: presence of scales on the body (vs absent), total vertebrae (44 vs 40–42, rarely 43), dorsal fin rays (80 vs 67–77 in *D. hoesei*) and the large size (73 mm SL vs up to 48 mm SL).

In any event, female specimens, and moreso juveniles of the two species *D. hoesei* and *D. macrodon*, can not always be distinguished reliably. We have left 37 juvenile specimens belonging to the one or the other species in open nomenclature.

Dermatopsis macrodon may be less common in its area of distribution than would be suggested from previous records in literature, mainly because a second sympatric new species (*D. hoesei*) was not recognized. Records of *D. macrodon* from New Zealand (e.g. Cohen 1966; Paulin *et al.* 1989) represent a different species (*D. joergennielseni*).

Distribution (Fig. 6). *Dermatopsis macrodon* is distributed along the rocky shores of south-eastern

Australia south of the Great Barrier Reef, chiefly the shores of New South Wales between the latitudes 29°S and 35°S.

Ecology. Lives on rocky shores, often buried in sand, mud or silt below stones or other hard substrate. Specimens in collections often had medium to coarse grained quartz sand trapped in the gill opening. This could point to a more sand-bottom adaptation and explain why *D. macrodon* is so rarely caught together with *D. hoesei*, even though both species live in the same general area of south-eastern Australia between 29°S and 37°S. Depths down to 5 m. A 62 mm SL female (AMS I.16469-016) contains two pale unpigmented embryos, 6–7 mm SL.

Dermatopsis sp.

(Figs 6, 11; Tables 1–3)

Material examined. (1 specimen, 50 mm SL). AMS I.34306-001, NW corner of Bay Island, Shoalwater Bay, Queensland, 22°19'S, 150°18'E, 0–0.3 m, AMS party, 15 Sept. 1993.

Remarks. This single large female specimen is the only one known from the Great Barrier Reef, i.e. considerably north of the occurrence of both *D. hoesei* and *D. macrodon*. With the latter it shares the small mandibular pores, the presence of scales on the body, a supraorbital pore behind the eye and the relatively large size. It differs in its pale colour and the low meristic counts (41 vertebrae, 72 dorsal rays, 49 anal rays), characters, in which it more resembles *D. hoesei*. The otoliths are elongate, as in *D. macrodon* (vs compressed in *D. hoesei*), but with a prominent predorsal projection, which is missing in those of *D. macrodon*. It is possible that this specimen represents another new species, but without males this can not be judged with reasonable certainty.

Dermatopsoides Smith, 1947

(Tables 1–3)

Dermatopsoides Smith, 1947: 361 (type species *Dermatopsis kasougae* Smith, 1943, by monotypy; see Eschmeyer 1998).

Dermatopsoides. – Cohen 1966: 194; Cohen and Nielsen 1978: 57; Smith and Heemstra 1986: 355; Nielsen *et al.* 1999: 127.

Diagnosis. Anterior nostril placed very close above upper lip; head without scales; opercular spine covered by skin, not exposed; maxilla not vertically expanded postventrally, with spine below rear of eye; lower lip smooth (except with skin folds in *D. morrisonae* n. sp.); male copulatory organ with one pair of simple, stick-like pseudoclaspers (probably representing the outer pseudoclasper in the terminology of Moller *et al.* (2004a)); sulcus of otolith with separated ostium and cauda marked by a step-change at ventral margin of sulcus due to cauda being much narrower than ostium, colliculi of ostium and cauda indistinctly separated; anterior anal fin ray pterygiophore short, except long in *D. kasougae*; lower preopercular pores 1, 2 or 3; upper preopercular pore absent; posterior infraorbital pores 2; precaudal vertebrae 11–14.

Comparison. *Dermatopsoides* appears to be closely related to *Dermatopsis* and, more distantly, to *Dipulus*, which are all readily distinguished from the other Indo-west Pacific genera so far described by the absence of scales on the head and the maxilla not vertically expanded postventrally (see also key above).

Within this group of three genera, *Dermatopsoides* is readily recognized by the covered, not exposed opercular spine (vs free). From *Dermatopsis* it differs further in the mostly smooth lower lip (except *D. morrisonae*), and the sulcus outline. *Dipulus* is more elongate with high numbers of precaudal vertebrae (13–25 vs 11–14), and has a hook on the penis (vs absent).

Distribution. *Dermatopsoides* was recognized as a valid genus by Cohen (1966), Cohen and Nielsen (1978) as well as by Nielsen *et al.* (1999), containing two species (*D. kasougae* and *D. talboti*) endemic to the shores of South Africa (Indian Ocean). An additional species is described here from South Africa and another one from Western Australia.

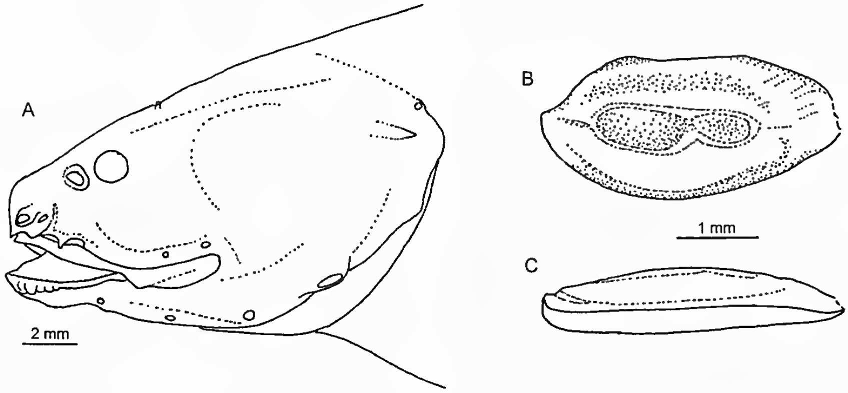

Fig. 11. *Dermatopsis* sp., AMS I.34306-001, non-type, female, 51 mm SL. **A**, lateral view of head; **B**, median view of right otolith; **C**, ventral view of right otolith.

Dermatopsoides andersoni n. sp.

(Figs 12–13, 16; Tables 1–3, 8)

Dermatopsoides talboti. – Cohen 1966 (in part): 199; Anderson 2004: 2, photo.

Material examined. (3 specimens, 39–54 mm SL). Holotype – RUSI 20096, male, 39 mm SL, Algoa Bay, South Africa, 34°S, 25°E, D. Bickell, 17 April 1984. Paratypes – SAM 21493, female, 51 mm SL, Saldanha Bay, Langebaan, South Africa, U.C.T. Ecol. Survey, Sta. L.B. 441A, 3 May 1954; SAIAB 70867, female, 54 mm SL, South Africa, Algoa Bay, NW end of Bird Island, P.C. Heemstra, Nov. 25, 2003.

Diagnosis. Vertebrae 13 + 30–31 = 43–44, dorsal fin rays 80–86, anal fin rays 51–59; snout terminal to slightly inferior; eye small 1.4–1.6 % SL; pectoral fin length 9.5–9.9 % SL; scales absent on head and body; posterior nostril moderately small, more than half the size of eye; lower preopercular pore 1, small; weak ventral spine on maxilla positioned behind rear of eye; single pair of pseudoclaspers dorsally curved at their distal ends, thin, about half the length of penis.

Description. The principal meristic and morphometric characters are shown in Table 8. Body slender, up to 54 mm SL, mature at about 50 mm SL. Head and body without

Fig. 12. *Dermatopsoides andersoni* n. sp. **A**, RUSI 20096, holotype, male, 39 mm SL; **B**, SAIAB 70867, paratype, female, 54 mm SL.

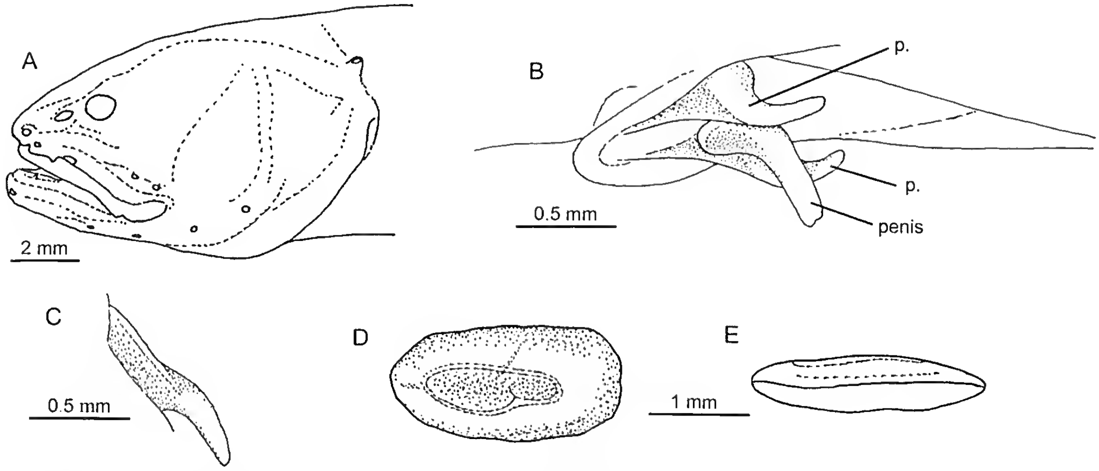

Fig. 13. *Dermatopsoides andersoni* n. sp. **A**, lateral view of head, SAM 21493, paratype, female, 51 mm SL; **B**, inclined lateral view of male copulatory organ, RUSI 20096, holotype, 39 mm SL; **C**, view of left pseudoclasper from inside, holotype, RUSI 20096, 39 mm SL; **D**, median view of right otolith, SAIAB 70867, paratype, female, 54 mm SL; **E**, ventral view of right otolith, SAIAB 70867, paratype, female, 54 mm SL.

Table 8. Meristic and morphometric characters of *Dermatopsoides andersoni* n. sp.

	Holotype RUSI 20096	Holotype + 2 paratypes Mean (range)	n
Standard length in mm	39	48.0 (39–54)	3
Meristic characters			
Dorsal fin rays	86	82.7 (80–86)	3
Anal fin rays	59	54.7 (51–59)	3
Pectoral fin rays	18	17.7 (16–19)	3
Precaudal vertebrae	13	13	3
Caudal vertebrae	31	30.7 (30–31)	3
Total vertebrae	44	43.7 (43–44)	3
Rakers on anterior gill arch	10	12.0(10–14)	2
Pseudobranchial filaments	1	0.3 (0–1)	3
D/V	5	5.7 (5–6)	3
D/A	26	29.7 (26–33)	3
V/A	16	17.3 (16–18)	3
Morphometric characters in % of SL			
Head length	20.2	20.7 (20.2–20.9)	3
Head width	6.8	9.1 (6.8–12.0)	3
Head height	12.4	12.5 (12.4–12.5)	3
Snout length	5.0	5.1 (4.9–5.4)	3
Upper jaw length	9.8	10.4 (9.8–10.8)	3
Diameter of pigmented eye	1.6	1.5 (1.4–1.6)	3
Diameter of pupil	0.8	0.9(0.8–1.1)	3
Interorbital width	3.3	3.9 (3.3–4.4)	3
Postorbital length	14.2	14.8 (14.2–15.5)	3
Preanal length	49.2	52.3 (49.2–54.0)	3
Predorsal length	24.1	25.4 (24.1–26.9)	3
Body depth at origin of anal fin	9.8	10.3 (9.8–11.3)	3
Pectoral fin length	9.5	9.7 (9.5–9.9)	3
Pectoral fin base height	3.5	4.0 (3.5–4.5)	3
Ventral fin length	11.8	11.5 (10.6–12.1)	3
Base ventral fin – anal fin origin	33.8	36.7 (33.8–39.7)	3

scales. Maxillary not expanded posteriorly, with weak spine positioned behind rear of eye. Anterior nostril at tip of snout. Posterior nostril moderately small, more than half the size of eye.

Head sensory pores (Fig. 13A). Supraorbital pores 2. Infraorbital pores 4–5 (3 anterior and 1–2 posterior). Mandibular pores 6 (3 anterior and 3 posterior). Preopercular pores 1 lower, no upper preopercular pore. All pores small, about half the size of posterior nostril.

Dentition. (of holotype). Premaxilla with 4 rows of small teeth anteriorly, merging into single row posteriorly. Anteriormost 2 teeth in inner rows fang-like, up to 3/4 diameter of pupil. Vomer horseshoe-shaped, with 2 irregular rows of 6 large teeth in total, up to 3/4 diameter of pupil. Palatine teeth in 2 irregular rows with 10 large teeth in total, size equal to diameter of pupil. Dentary with 3 outer rows of granular teeth and 1 inner row of larger teeth anteriorly, merging into 1 row of larger teeth posteriorly, up to about size of pupil diameter.

Otolith (Fig. 13D–E). Moderately elongate, length to height ratio 2.0 (54 mm SL); otolith length to sulcus length ratio 1.7; sulcus of otolith deepened, with separated ostium and cauda marked by step-change at ventral margin of sulcus due to cauda being much narrower than ostium, colliculi of ostium and cauda indistinctly separated; length of ostial colliculum to length of caudal colliculum ratio 1.9; anterior tip of otolith rounded without concavity dorsally, posterior tip abrupt, directly behind broad postdorsal angle; inner face with weak ventral furrow close to ventral rim and shallow dorsal depression.

Axial skeleton (RUSI 20096, holotype). First neural spine half the length of second. Neural spine of vertebrae 2–3 elongate and 4–10 depressed. Parapophyses present from vertebrae 6 to 13. Pleural ribs on vertebrae 2–11. First anal fin pterygiophore slightly elongate, not reaching tip of last precaudal parapophysis.

Male copulatory organ (Fig. 13B–C). A single pair of pseudoclaspers, dorsally curved at their distal ends, thin, about half the length of penis, probably underpinned by broad supporter. Isthmus between pseudoclaspers moderately wide. Penis tapering, curved, with broad base.

Coloration. Live colour red (Fig. 12B). Preserved colour uniformly light brown (Fig. 12A).

Comparison. *Dermatopsoides andersoni* is intermediate in vertebrae and finray counts to the two other species of the genus known from South Africa (see respective discussions). Further, it differs from all other species of the genus in the short pectoral fin length (< 10 % vs 11.8–16.2 of SL).

Remarks. Cohen (1966) noted the considerable meristic variation among specimens of his newly described *D. talboti*, with one specimen from the west coast of Saldanha Bay being the "geographically farthest from the type-locality of *D. kasongae*", but yet the "closest to it in count". The two additional specimens now available from Francis Bay and Algoa Bay not only confirm the taxonomic separation from *D. talboti,* but also the broadly overlapping sympatric distribution pattern.

Biology. A recently caught female from Bird Island, Algoa Bay (SAIAB 70867) was found to be gravid at 54 mm SL. For some unknown reason, bony calcification is severely reduced in this specimen to the extent that counting of fin rays is almost impossible. Its dorsal fin ray count of 80 and anal fin ray count of 51 are the lowest numbers recorded for the species and lack ultimate accuracy. In any case, all meristic values are well distinct from *D. talboti.*

Distribution (Fig. 16). *Dermatopsoides andersoni* is known from Saldanha Bay on the west coast of South Africa to Algoa Bay near Port Elizabeth, on the south-east coast.

Ecology. A 54 mm SL female contains four 20–23 mm SL, fully developed embryos; their preserved coloration is uniformly light brown, slightly darker than their mother.

Etymology. Named in honour of M. Eric Anderson, Grahamstown, SAIAB, in recognition of his great help to the present revision.

Dermatopsoides kasougae (Smith, 1943)

(Figs 14–16; Tables 1–3, 9)

Dermatopsis kasougae Smith, 1943: 72, fig. 3 (type locality: Kasouga River estuary, west of Port Alfred, South Africa).

Dermatopsoides kasougae. – Smith 1947: 344; Cohen 1966: 198; Smith and Heemstra 1986: 355.

Material examined. (2 specimen, 57 mm SL). Holotype, RUSI 333, 70 mm TL, Kasouga river estuary, west of Port Alfred, South Africa (only x-ray examined). Non-type: RUSI 8547, male, 57 mm SL, Port Alfred to Bushmans River, Eastern Cape, South Africa, no more data.

Table 9. Meristic and morphometric characters of *Dermatopsoides kasougae* (Smith, 1943).

	Holotype RUSI 333*,**	**Non-type** RUSI 8547***
Standard length in mm	63	57
Meristic characters		
Dorsal fin rays	100	93
Anal fin rays	71	70
Pectoral fin rays	22* or 24**	–
Precaudal vertebrae	14	14
Caudal vertebrae	32	33
Total vertebrae	46	47
Rakers on anterior gill arch	12–13*	–
Pseudobranchial filaments	0	–
D/V	6	6
D/A	31	32
V/A	17	17
Morphometric characters in % of SL		
Head length	24.0	–
Head width	–	–
Head height	–	–
Snout length	4.3	–
Upper jaw length	–	–
Diameter of pigmented eye	2.4	–
Diameter of pupil	–	–
Interorbital width	–	–
Postorbital length	13.6	–
Preanal length	49.9	–
Predorsal length	26.2	–
Body depth at origin of anal fin	16.3	–
Pectoral fin length	11.8	–
Pectoral fin base height	–	–
Ventral fin length	18.8	–
Base ventral fin – anal fin origin	–	–

* Data from Smith (1943) included.
** Data from Cohen (1966) included.
*** Specimen dried, so no morphometric data are included.

Remarks. *Dermatopsoides kasougae* is known from two specimens, the holotype, which we have not been able to borrow for study, and a more recently collected specimen from near the type locality, which we borrowed, but which was completely dried up. As a result of this, certain investigations such as head pores and some morphometric measurements unfortunately could not be evaluated.

Fig. 14. *Dermatopsoides kasougae* (Smith, 1943). RUSI 8547, non-type, male, 57 mm SL.

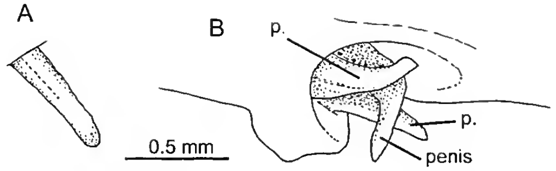

Fig. 15. *Dermatopsoides kasougae* (Smith, 1943). **A**, inclined lateral view of male copulatory organ, RUSI 8547, non-type, 57 mm SL; **B**, view of left pseudoclasper from outside, RUSI 8547, non-type, 57 mm SL.

Fig. 16. Sample sites of *Dermatopsoides kasougae*, *D. talboti* and *D. andersoni* n. sp. One symbol may represent several samples.

Diagnosis. Vertebrae 14 + 32–33 = 46–47, dorsal fin rays 93–100, anal fin rays 70–71; body scaled; pelvic fin extending beyond posterior end of pectoral fin; single pair of pseudoclaspers thin, straight, not quite as long as penis.

Description. Partly based on Smith (1943) and Cohen (1966). The restricted number of meristic and morphometric characters measurable from the only available dry specimen are shown in Table 9. Body slender, up to 57 mm SL. Head without scales. Horizontal diameter of scales on body about 0.8 % SL, covering the whole body (Smith 1943). Maxillary not expanded posteriorly. Anterior nostril on tip of snout. Posterior nostril moderate in size.

Head sensory pores. Cannot be identified on the dried specimen available.

Dentition. (of holotype, from Smith 1943). Premaxilla with 3 rows of small teeth anteriorly, merging into single row posteriorly. Vomer horseshoe-shaped, with 2 irregular rows of total of 10 large teeth. Palatine teeth in 2 irregular rows with 20 teeth in total. Dentary with 3 outer rows anteriorly, merging into 1 row posteriorly, up to about size of pupil diameter.

Otolith. Not known.

Axial skeleton (RUSI 333, holotype). First neural spine half the length of second. Neural spine of vertebrae 2–4 elongate and 4–8 depressed. Parapophyses present from vertebrae 7 to 13. Pleural ribs on vertebrae 2–12. First anal fin pterygiophore slightly elongate, not reaching tip of last precaudal parapophysis.

Male copulatory organ (Fig. 15A–B). A single pair of pseudoclaspers, thin, straight, not quite as long as penis. Isthmus between pseudoclaspers narrow. Penis tapering, curved.

Coloration. Live colour uniformly light salmon-pink, fins light (Smith 1943). Preserved colour light brown.

Comparison. Despite the limited amount of data available, it is obvious that *D. kasougae* can be readily recognized by the high number of vertebrae (46–47), dorsal fin rays (93–100) and anal fin rays (70–71). The values of the other two species of *Dermatopsis* from South Africa are < 45 for vertebrae, < 87 for dorsal fin rays and < 60 for anal fin rays. Also, it has larger eyes (2.4 vs 1.1–2.2 % SL) and is the only one with straight pseudoclaspers (vs inwardly curved, not known for *D. morrisonae*).

Distribution (Fig. 16). *Dermatopsoides kasougae* has in previous literature been cited as being distributed from Algoa Bay to Port Alfred (Smith and Heemstra 1986). However, there are only two confirmed records of the species, both originating from the Port Alfred area (holotype from the Kasouga River estuary near Port Alfred). These geographically extremely restricted records may indicate a specific environmental adaptation of the species.

Dermatopsoides morrisonae n. sp.

(Figs 6, 17–18; Table 1–3, 10)

Material examined. (2 specimens, 26–29 mm SL). Holotype – WAM P.28292-010, female, 26 mm SL, Lucky Bay, Western Australia, 34°00'S, 122°14'E, 7–10 m, J.B. Hutchins, 11 April 1984. Paratype – WAM P.28284-006, female, 29 mm SL, NW side of Six Mile Island, Israelite Bay, Western Australia, 33°37'S, 123°53'E, 5–6 m, N. Sinclair *et al.*, 4 April 1984.

Diagnosis. Vertebrae 13–14 + 28–31 = 42–44, dorsal fin rays 72–76, anal fin rays 52–54; scales present on body; dorsal and anal fins dark; snout terminal; lower lip with skin folds; ventral fin length 15.8–18.5 % SL; posterior nostril moderately small, more than half the size of eye; lower preopercular pores 3, small; weak ventral spine on maxilla positioned behind rear of eye.

Description. The principal meristic and morphometric characters are shown in Table. 10. Head without scales. Horizontal diameter of scales on body of paratype about 0.8 % SL in about 18 horizontal rows. No scales present in juvenile holotype. Maxillary not expanded posteriorly, with weak ventral spine. Lower lip with skin folds. Anterior nostril directly above snout. Posterior nostril moderately small, more than half the size of eye.

Head sensory pores (Fig. 18A–B). Supraorbital pores 2. Infraorbital pores 5 (3 anterior and 2 posterior). Mandibular pores 6 (3 anterior and 3 posterior). Preopercular pores 3 lower, no upper preopercular pore. All pores small, mostly half the size of posterior nostril.

Dentition (of holotype). Premaxilla with 3 rows of small teeth anteriorly, merging into single row posteriorly. Anterior teeth in inner row up to 1/3 diameter of pupil. Vomer horseshoe-shaped, with single row of 6 large teeth up to 3/4 diameter of pupil. Palatine teeth in single row with 5 large teeth up to 1/3 diameter of pupil. Dentary with 2 outer rows of small teeth and 1 inner row of larger teeth anteriorly, merging into 1 row of larger teeth posteriorly, up to about 2/3 of pupil diameter.

Otolith. Not known.

Axial skeleton (of holotype). First neural spine half the length of second. Neural spine of vertebrae 2–4 elongate and 5–9 depressed. Parapophyses present from vertebrae 6 to 13. Pleural ribs on vertebrae 3–10. First anal fin pterygiophore slightly elongate, not reaching tip of last precaudal parapophysis.

Male copulatory organ. So far only female specimens known.

Coloration. WAM P.28292-010 was photographed freshly dead by Barry Hutchins (Fig. 17A). It shows medium brownish body coloration; lighter at the head and shading to reddish over the operculum (gills shining through). The anal fin and most of the dorsal fin are black, the latter except for the anterior part, which is translucent like the pelvic and the caudal fins. The dark coloration of the dorsal and anal fins is still well visible after an extended period of preservation; visible also in the paratype.

Comparison. *Dermatopsoides morrisonae* is readily distinguished from the three South African species by the presence of three lower preopercular pores (vs 1–2), the presence of skin folds on the lower lip (vs smooth lower lip), the dark coloration of the dorsal and anal fins and the large pectoral fin length (>16 vs < 13 % SL). In vertebrae

Table 10. Meristic and morphometric characters of *Dermatopsoides morrisonae* n. sp.

	Holotype WAM P.28292-010	Paratype WAM P.28284-006
Standard length in mm	26	29
Meristic characters		
Dorsal fin rays	72	76
Anal fin rays	52	54
Pectoral fin rays	20	20
Precaudal vertebrae	14	13
Caudal vertebrae	28	31
Total vertebrae	42	44
Rakers on anterior gill arch	11	12
Pseudobranchial filaments	2	2
D/V	5	6
D/A	26	26
V/A	17	17
Morphometric characters in % of SL		
Head length	25.2	25.4
Head width	10.8	12.6
Head height	14.5	14.6
Snout length	6.9	6.3
Upper jaw length	11.8	12.4
Diameter of pigmented eye	2.2	2.1
Diameter of pupil	1.3	1.3
Interorbital width	6.7	4.4
Postorbital length	16.6	17.8
Preanal length	50.1	50.5
Predorsal length	25.9	30.4
Body depth at origin of anal fin	13.5	15.3
Pectoral fin length	16.2	–
Pectoral fin base height	7.4	–
Ventral fin length	15.8	18.5
Base ventral fin – anal fin origin	32.7	31.6

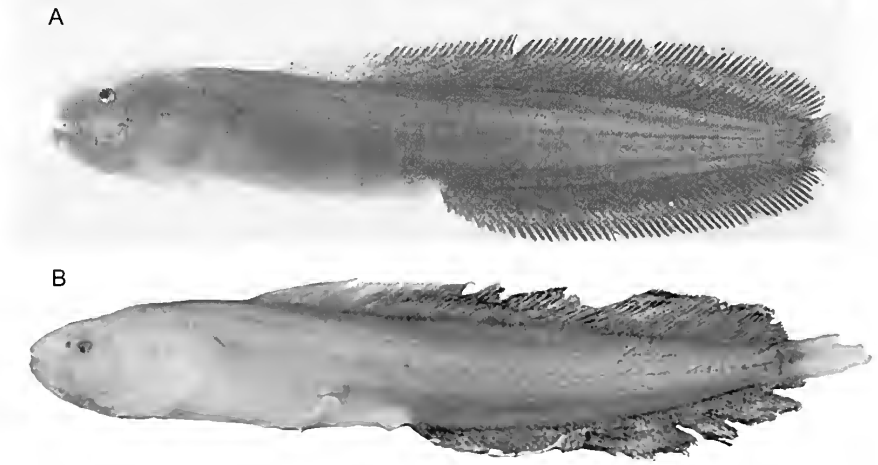

Fig. 17. *Dermatopsoides morrisonae* n. sp., WAM P.28292-010, holotype, female, 26 mm SL. **A**, fresh dead; **B**, after preservation.

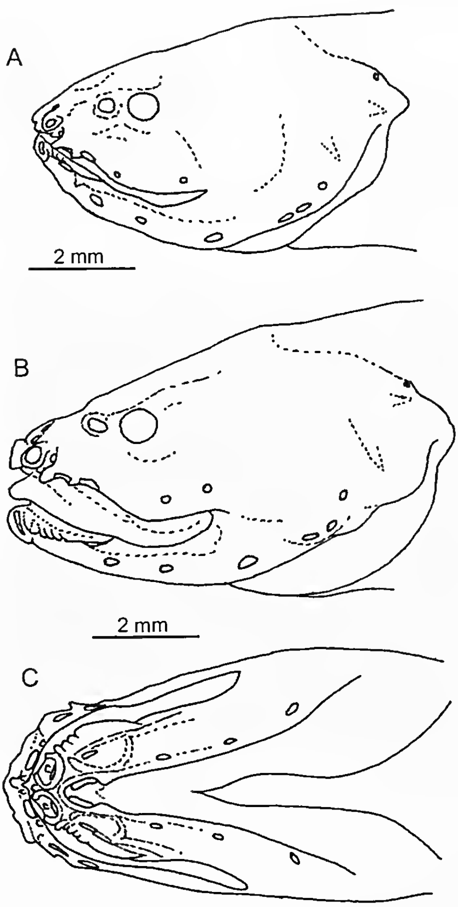

Fig. 18. *Dermatopsoides morrisonae* n. sp. **A**, lateral view of head, , WAM P.28292-010, holotype, female, 26 mm SL; **B**, lateral view of head, WAM P.28284-006, paratype, female, 29 mm SL; **C**, ventral view of head, WAM P.28284-006, paratype, female, 29 mm SL.

and fin ray counts it is intermediate between *D. talboti* and *D. andersoni*.

Dermatopsoides morrisonae is separated from the three species of *Dermatopsoides* in South Africa by nearly 8000 km across the southern Indian Ocean. Despite this long distance, we could not allocate it to a separate genus. In fact the hidden opercular spine is a rare character amongst the Dinematichthyini, which *Dermatopsoides* only shares with one other genus, *Gunterichthys*, from the Atlantic and Pacific shores of tropical America.

Distribution (Fig. 6). *Dermatopsoides morrisonae* is exclusively known from two small specimens caught at the south-westernmost tip of Western Australia near the township of Esperance.

Ecology. Known from depths between 5 and 10 m.

Etymology. Named in honour of Sue M. Morrison, Perth, WAM, in recognition of her great help with our revision of the Dinematichthyini.

Dermatopsoides talboti Cohen, 1966

(Figs 16, 19–20; Tables 1–3, 11)

Dermatopsoides talboti Cohen, 1966: 195, Fig. 5A, 5B (type locality: Bird Island, Algoa Bay, South Africa).

Dermatopsoides talboti. – Smith and Heemstra 1986: 356.

Material examined. (6 specimens, 25–46 mm SL). Holotype, RUSI 340, male, 40 mm SL, Bird Island, Algoa Bay, South Africa, tidepools, J.L.B. and M.M. Smith, 11 May 1964 (only x-ray examined). Paratypes: RUSI 339, sex unknown, data as for holotype (only x-ray examined); SAM 21693, male, 25 mm SL, locality unknown, coll. by Stellenbosch University, 1958; SAM 21800, female, 45 mm SL, Somerset Strand, False Bay, coll. by Stellenbosch University, date unknown. Non-types: RUSI 8546, female, 43 mm SL, Tsitsikama coast, Knysna, Eastern Cape, South Africa, 32°13'S, 26°35'E, R. Liversidge, 19 June 1965; RUSI 17297, female, 46 mm SL, Bird Island, Algoa Bay, South Africa, 33°59'S, 25°40'E, 12 September 1982.

Diagnosis. Vertebrae 11–12 + 26–28 = 37–40, dorsal fin rays 60–67, anal fin rays 40–45; snout inferior; scales absent; pelvic fin not extending beyond posterior end of pectoral fin; pectoral fin length 12.3–12.7 % SL; posterior nostril small, about half the size of eye; lower preopercular pores 2, small; weak spine on maxilla positioned behind rear tip of eye; single pair of pseudoclaspers dorsally curved at their distal ends, about half the length of penis.

Description. The principal meristic and morphometric characters are shown in Table 11. Body moderately slender, up to 46 mm SL; mature at about 40 to 45 mm SL. Scales absent. Maxillary not expanded posteriorly, with weak spine positioned behind rear of eye. Anterior nostril on tip of snout. Posterior nostril small, about 1/2 the size of eye.

Head sensory pores (Fig. 20). Supraorbital pores 2. Infraorbital pores 5 (3 anterior and 2 posterior). Mandibular pores 6 (3 anterior and 3 posterior). Preopercular pores 2 lower, no upper preopercular pore. All pores small, about the size of posterior nostril or smaller.

Dentition (of paratype, SAM 21800). Premaxilla with 4 rows of small teeth anteriorly, merging into single row posteriorly. Anterior teeth in inner row up to 1/4 diameter of pupil. Vomer horseshoe-shaped, with single row of 7 large teeth up to 3/4 diameter of pupil. Palatine teeth in single row with 6 large teeth up to 3/4 diameter of pupil. Dentary with 3 outer rows of small teeth and 1 inner row of large teeth anteriorly, merging into 1 row of larger teeth posteriorly, up to about size of pupil diameter.

Otolith. Not known.

Axial skeleton (of holotype). First neural spine half the length of second. Neural spine of vertebrae 2–4 elongate and 4–10 depressed. Parapophyses present from vertebrae 3 to 18. Pleural ribs on vertebrae 2–8. First anal

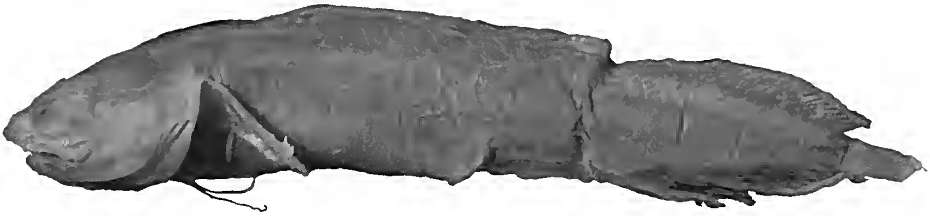

Fig. 19. *Dermatopsoides talboti* Cohen, 1966. WAM P.28284-006, holotype, female, 29 mm SL.

fin pterygiophore elongate, almost reaching tip of last precaudal parapophysis.

Male copulatory organ. Description based on Cohen (1966). A single pair of pseudoclaspers, dorsally curved at their distal ends, thin, about half the length of penis, probably underpinned by broad supporter. Isthmus between pseudoclaspers wide, fleshy. Penis tapering, curved.

Coloration. Live colour unknown. Preserved specimens light brown.

Comparison. *Dermatopsoides talboti* is the least slender of the three species of the genus occurring in South Africa and also the one with the lowest vertebrae count (37–40 vs > 42), dorsal fin ray count (60–67 vs > 79) and anal fin ray count (40–45 vs > 50). Another typical character for *D. talboti* seems to be the usually distinctly

Table 11. Meristic and morphometric characters of *Dermatopsoides talboti* Cohen, 1966.

	Holotype RUSI 340	Holotype + 5 paratypes Mean (range)	n
Standard length in mm	40*	39.8 (25–46)	6
Meristic characters			
Dorsal fin rays	67	63.0 (60–67)	5
Anal fin rays	43	42.3 (40–45)	4
Pectoral fin rays	–	17.5 (17–18)	2
Precaudal vertebrae	12	11.7(11–12)	6
Caudal vertebrae	27	27.3 (26–28)	6
Total vertebrae	39	39.0 (37–40)	6
Rakers on anterior gill arch	–	17	1
Pseudobranchial filaments	–	0	1
D/V	6	6.5 (6–7)	6
D/A	28	25.0 (22–28)	6
V/A	17	16.5 (16–17)	6
Morphometric characters in % of SL			
Head length	22.2	24.6 (22.2–27.3)	4
Head width	–	11.1 (10.2–12.1)	2
Head height	16.7	14.5 (13.9–16.7)	3
Snout length	5.6	5.4 (5.1–5.7)	3
Upper jaw length	10.8	11.4 (10.8–11.8)	3
Diameter of pigmented eye	1.6	1.3 (1.1–1.6)	5
Diameter of pupil	–	0.6	1
Interorbital width	–	3.5 (2.9–4.1)	2
Postorbital length	14.6	16.7 (14.6–17.4)	3
Preanal length	59.0	56.2 (54.4–59.0)	3
Predorsal length	33.0	32.1 (31.3–33.0)	3
Body depth at origin of anal fin	11.8	13.0 (11.8–13.3)	3
Pectoral fin length	12.5	12.5 (12.3–12.7)	3
Pectoral fin base height	6.3	5.6 (5.5–6.3)	3
Ventral fin length	15.3	11.1–15.3	2
Base ventral fin – anal fin origin	41.0	37.2 (33.2–41.2)	3

* Data from Cohen (1966) included, including measurements of Fig. 5.

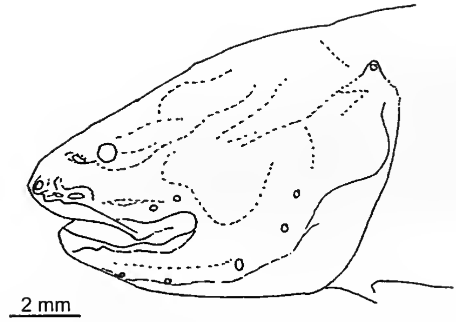

Fig. 20. *Dermatopsoides talboti* Cohen, 1966. Lateral view of head, SAM 21800, paratype, female, 45 mm SL.

inferior snout. It differs from *D. andersoni* also in the longer pectoral fin (>12 vs <10 % of SL). From *D. kasougae* it is further distinguished by the small eye size (1.1–1.6 vs 2.4 % SL).

Remarks. Cohen (1966) included a single specimen as paratype of *D. talboti*, with much higher meristic counts, that now with two more available specimens, it is recognized as a separate species (*D. andersoni*).

Distribution (Fig.16). *Dermatopsoides talboti* is known from False Bay, near Cape Town, to Algoa Bay, near Port Elizabeth in South Africa.

Ecology. Appears to live in shallow waters including tide pools.

Dipulus Waite, 1905

(Tables 1–3)

Dipulus Waite, 1905: 361 (type species *D. caecus* Waite, 1905 by monotypy; see Eschmeyer 1998).

Dipulus. – Cohen and Nielsen 1978: 59; Smith and Heemstra 1986: 355; Machida 1993a: 43; Nielsen *et al.* 1999: 128.

Diagnosis. Body long to eel-like; anterior nostril placed very close above upper lip; head without scales; opercular spine free, exposed; maxilla not vertically expanded postventrally, with spine or broad angle below rear of eye; lower lip with skin folds; male copulatory organ with one pair of large to very large pseudoclaspers, much longer than penis, hockey stick-shaped or expanded; penis with hook at tip; sulcus of otolith with separated ostium and cauda, each with separate colliculi, ventral sulcus margin with indention at ostium-cauda joint; anterior anal fin ray pterygiophore long; lower preopercular pores 2 or 3; upper preopercular pore absent; posterior infraorbital pores 2 or 3; precaudal vertebrae variable between 13 and 25; dorsal fin rays 86–191; anal fin rays 56–124.

Comparison. *Dipulus* contains some of the most elongate, almost eel-like fishes within the Dinematichthyini. It contains species with extremely high vertebrae and fin ray counts. The most "compressed" species of the four now recognized in *Dipulus, D. norfolkanus,* still has meristic counts similar to the most elongate species of the two other genera, with which it is related, i.e. *Dermatopsis kasougae.* A unique autapomorphous character found in all *Dipulus* species is the hooked tip of the penis.

Distribution. *Dipulus* is chiefly known from Australian shores, containing three species along the subtropical southern shores and one along the Western Australian coast. A fourth species of *Dipulus* is endemic to small Norfolk Island, located in an isolated position between New Caledonia and New Zealand and is one of the few species in this group found associated with reefs.

Dipulus caecus Waite, 1905

(Figs 21–23; Tables 1–3, 12)

Dipulus caecus Waite, 1905: 140, fig. 2 (type locality: Fremantle, Western Australia).

Dipulus caecus. – Hubbs 1938: 289; Mees 1962 (part): 27; Thinès 1969: 159; Paxton *et al.* 1989: 317; Machida 1993a: 43; Gomon *et al.* 1994: 370; Nielsen *et al.* 1999: 131.

Material examined. (15 specimens, 38–197 mm SL). Holotype, WAM P.13261-001, male, 146 mm SL, Fremantle, Western Australia (only a photo investigated). Non-types: AMS I.14247, Swan River, Western Australia, 32°01'S, 115°48'E, 9 m, A. Abjornssen, 21 August 1917; AMS I.20229-022, 3 males, 146–197 mm SL, 3 females, 145–162 mm SL, Cockburn Sound, Carnac Island, Western Australia, 32°10'S, 115°40'E, 6–8 m, B.C. Russell, 26 March 1978; AMS I.20229-023, female, 63 mm SL, Cockburn Sound, Carnac Island, Western Australia, 32°10'S, 115°40'E, 6–8 m, B.C. Russell, 26 March 1978; AMS I.20245-011, male, 129 mm SL, Rottnest Island, Horse Shoe Reefs, Western Australia, 32°00'S, 115°28'E, 12–15 m, B.C. Russell, 12 April 1978; WAM P.29884-012, subadult male, 51 mm SL, Abrolhos Islands, Western Australia, 28°53'S, 113°59'E, G.R. Allen, 4 March 1988; WAM P.29886-007, juvenile, 38 mm SL, Abrolhos Islands, Western Australia, 28°55'S, 114°02'E, G.R. Allen, 6 March 1988; ZMUC P77485, female, 130 mm SL, Point Peron, near Fremantle, Western Australia, R.J. McKay, 8 Dec. 1961; ZMUC P77486-87, 147 mm SL, male, 98 mm SL,

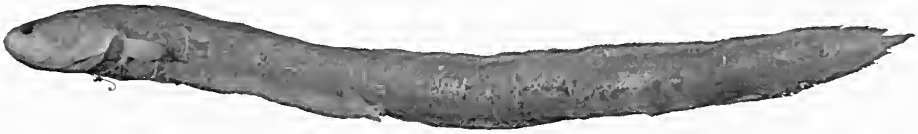

Fig. 21. *Dipulus caecus* Waite, 1905. AMS I.20229-022, non-type, male, 147 mm SL.

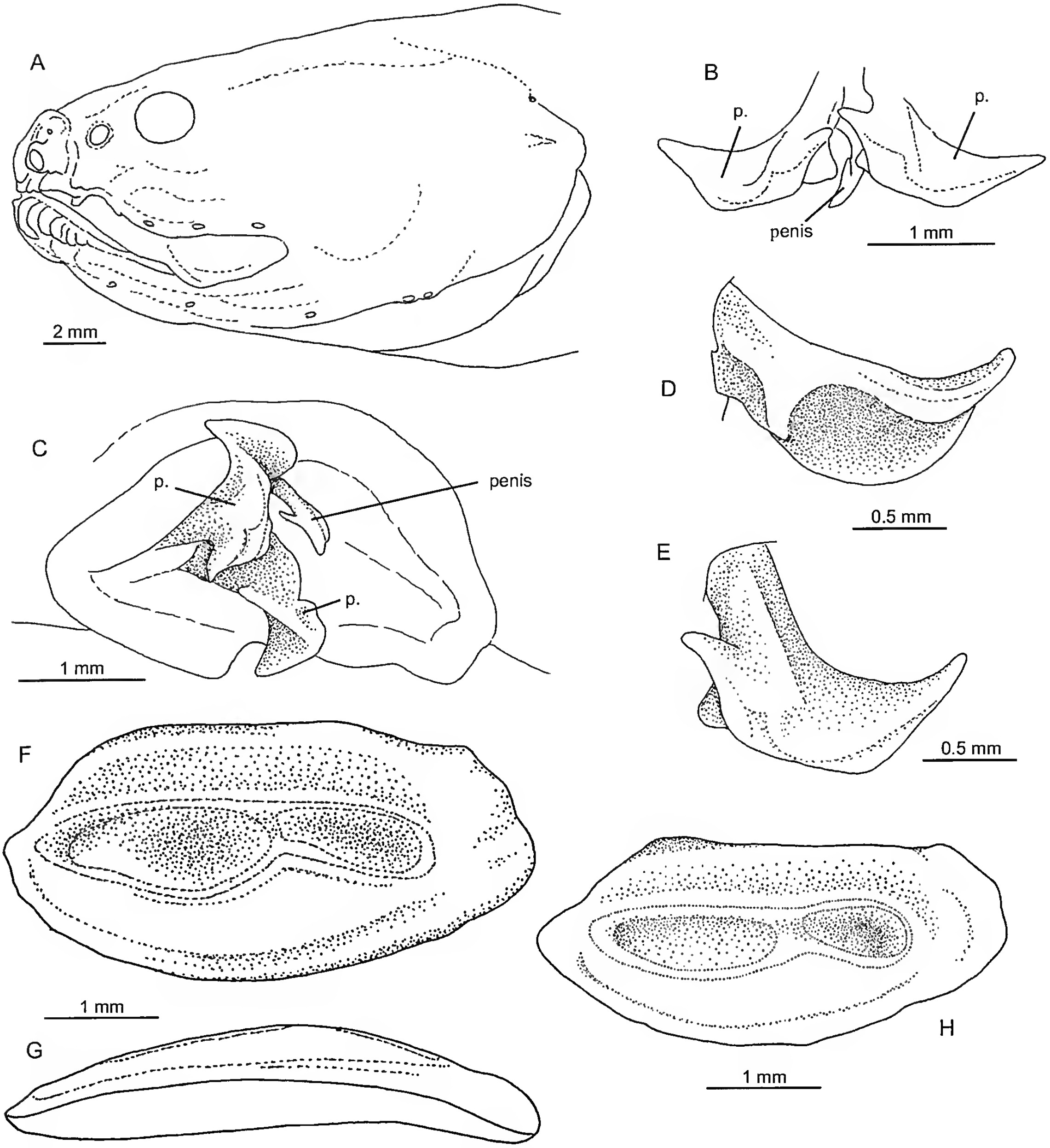

Fig. 22. *Dipulus caecus* Waite, 1905. **A**, lateral view of head, ZMUC P77486, non-type, male, 148 mm SL; **B**. ventral view of male copulatory organ, ZMUC P77486, non-type, 148 mm SL; **C**, inclined lateral view of male copulatory organ, ZMUC P77486, non-type, 148 mm SL; **D**, view of left pseudoclasper from inside, ZMUC P77486, non-type, 148 mm SL; **E**, view of left pseudoclasper from ventral, ZMUC P77486, non-type, 148 mm SL; **F**, median view of right otolith, AMS I.20229-022, non-type, male, 192 mm SL; **G**, ventral view of right otolith, AMS I.20229-022, non-type, male, 192 mm SL; **H**, median view of right otolith, AMS I.20229-022, non-type, male, 192 mm SL.

female, W end of Nancy Cove, Rottnest Island, Western Australia, R.J. McKay, 21 Jan. 1954.

Diagnosis. Body very elongate, almost eel-like, attaining sizes up to 197 mm SL; vertebrae 22–25 + 57–65 = 79–87, dorsal fin rays 161–191, anal fin rays 109–124, D/A 58–75, V/A 27–28; scales absent; no supraorbital pore behind eye; lower preopercular pores 2; posterior infraorbital pores 3; broad angle on ventral maxilla positioned behind rear of eye; exposed opercular spine small, short, straight; lower lip with prominent skin folds;

Table 12. Meristic and morphometric characters of *Dipulus caecus* Waite, 1905.

	Holotype WAM P.13261 -001*	Holotype + 14 non-types Mean (range)	n
Standard length in mm	146	128.4 (38–197)	15
Meristic characters **			
Dorsal fin rays	–	175.6 (161–191)	14
Anal fin rays	–	117.2 (109–124)	14
Pectoral fin rays	–	18.5 (17–21)	13
Precaudal vertebrae	–	23.4(22–25)	14
Caudal vertebrae	–	61.2 (57–65)	14
Total vertebrae	–	84.6 (79–87)	14
Rakers on anterior gill arch	–	9.0(8–10)	7
Pseudobranchial filaments	–	0.8(0–1)	6
D/V	–	6.1 (6–7)	14
D/A	–	64.7 (58–75)	14
V/A	–	27.6 (27–28)	14
Morphometric characters in % of SL			
Head length	13.0	13.0 (10.9–17.4)	15
Head width	–	6.4 (5.0–7.9)	12
Head height	7.2	7.2 (6.5–9.4)	15
Snout length	2.7	2.9 (2.0–4.2)	15
Upper jaw length	5.5	6.3 (5.2–8.6)	15
Diameter of pigmented eye	–	1.3 (1.0–1.7)	14
Diameter of pupil	–	0.8 (0.6–1.2)	14
Interorbital width	–	2.4 (1.9–3.6)	13
Postorbital length	10.3	9.4 (7.7–12.2)	14
Preanal length	41.1	43.2 (39.2–47.6)	15
Predorsal length	16.4	15.6 (13.2–20.2)	14
Body depth at origin of anal fin	7.5	6.0 (4.0–8.3)	15
Pectoral fin length	4.8	5.8 (4.6–8.3)	13
Pectoral fin base height	2.7	2.5 (1.9–3.6)	15
Ventral fin length	–	7.9(5.9–12.1)	11
Base ventral fin – anal fin origin	31.5	34.6 (27.7–43.9)	15

* Data from Waite, 1905 included, incl. measurement from Fig. 2.

** The holotype is so poorly ossified, that vertebrae and fin ray counts could not be seen on x-rays (B. Hutchins, per. comm., Aug. 2006).

single pair of pseudoclaspers curved outwards, with narrow base and pointed tip, with broadly expanded fleshy flaps anteriorly and posteriorly; penis small, less than half the length of pseudoclaspers, with hook at tip; otoliths pointed anteriorly, rounded posteriorly, their predorsal angle more pronounced than postdorsal angle.

Description. The principal meristic and morphometric characters are shown in Table 12. Body elongate, eel-like, attaining sizes up to almost 200 mm SL. Head and body without scales. Maxillary not expanded posteriorly, but with broad angle ventrally just behind rear of eye. Anterior nostril on tip of snout. Posterior nostril about 1/3 the size of eye.

Head sensory pores (Fig. 22A). Supraorbital pores 2. Infraorbital pores 6 (3 anterior and 3 posterior). Mandibular pores 6 (3 anterior and 3 posterior). Preopercular pores 2 lower, no upper preopercular pore. All pores small, about 1/2 the size of posterior nostril or smaller.

Dentition (of 197 mm SL male, AMS I.20229-022). Premaxilla with 4 rows of small teeth anteriorly, merging into single row posteriorly. Anterior teeth in inner row up to 1/5 diameter of pupil. Vomer horseshoe-shaped, with 3 irregular row of totally 10 small teeth, up to 1/4 diameter of pupil. Palatine teeth in 3 rows with 14+4+10 small teeth up to 1/4 diameter of pupil. Dentary with 4 rows of small teeth anteriorly, merging into 2 rows posteriorly, up to about 1/3 of pupil diameter.

Otolith (Fig. 22F–H). Elongate, length to height ratio 2.1–2.3 (51–197 mm SL); otolith length to sulcus length ratio 1.3–1.5; sulcus deepened, divided into ostium and cauda, marked by indention of ventral sulcus margin, colliculi also divided and rather small inside ostium and cauda; length of ostial colliculum to length of caudal colliculum ratio 1.5–1.6; anterior tip of otolith moderately pointed, posterior tip rounded, predorsal angle developed, sometimes slightly projecting, postdorsal angle indistinct;

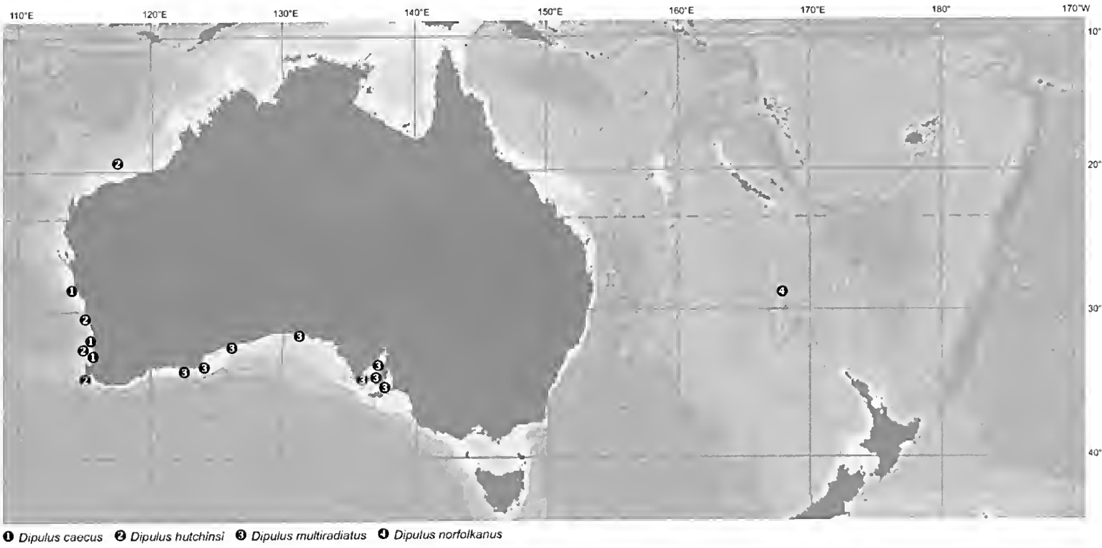

Fig. 23. Sample sites of *Dipulus caecus*, *D. hutchinsi* n. sp., *D. multiradiatus* and *D. norfolkanus*. One symbol may represent several samples.

inner face with marked ventral furrow close to ventral rim and large, well defined dorsal depression.

Axial skeleton (of non-type, ZMUC P77486, 148 mm SL, male). First neural spine half the length of second. Neural spine of vertebrae 2–3 elongate and 3–8 depressed. Parapophyses present from vertebrae 6 to 22. Pleural ribs on vertebrae 3–10. First anal fin pterygiophore elongate, but not reaching tip of last precaudal parapophysis.

Male copulatory organ (Fig. 22B–E). A single pair of large pseudoclaspers, curved outwards, with pointed tip and narrow, stem-like base, underpinned by massive supporter. Pseudoclasper with broad fleshy appendices anteriorly and posteriorly, each ending in pointed tip about 1/4 above the base of the pseudoclasper. Isthmus between pseudoclaspers narrow. Penis thin, short, about half the length of pseudoclaspers, with distinct hook near tip.

Coloration. Live colour reported as red, orange or yellow, but it is uncertain if all colour morphs belong to this species. Uniformly light brown when preserved.

Comparison. *Dipulus caecus* is probably the most unmistakable dinematichthyine fish and is easily recognized by the very elongate body shape, the extremely high meristic counts and the distinctive pseudoclasper morphology.

Distribution (Fig. 23). *Dipulus caecus* is distributed along the shores of Western Australia from about 34°S (near Perth) north to about 25°S (Carnarvon, Shark Bay).

Ecology. Caught at 6 to 15 m depth.

Dipulus hutchinsi n. sp.

(Figs 23–25; Tables 1–3, 13)

Dermatopsis multiradiatus (in part). – Mees 1962: 27; Cohen 1966: 191.

Material examined. (8 specimens, 66–118 mm SL). Holotype – WAM P.4677-001, male, 102 mm SL, Rottnest Island, west end of Nancy Cove, Western Australia, Zool. Dept. W.A. University, 20 January 1954. Paratypes – CSIRO H4651-01, female, 118 mm SL, NW of Port Hedland, Western Australia, 19°37'S, 117°48'E, 58–60 m, 23 August 1997; AMS I.20245-013, female, 74 mm SL, Rottnest Island, Horse Shoe Reefs, 32°00'S, 115°28'E, 12–15 m, B.C. Russell, 12 April 1978; WAM P.4677-002, 2 males, 69–75 mm SL, and ZMUC P771551, male, 70 mm SL, same data as for holotype; WAM P.27953-006, female, 66 mm SL, Jurien Bay, Western Australia, 30°18'S, 115°00'E, 10–14 m, J.B. Hutchins *et al.*, 11 April 1983; WAM P.28522-005, male, 95 mm SL, NW corner of Flinders Island, Western Australia, 34°23'S, 115°11'E, 12–13 m, J.B. Hutchins, 18 April 1985.

Diagnosis. Body very elongate, attaining sizes of more than 100 mm SL; vertebrae 16–17 + 36–40 = 53–56,

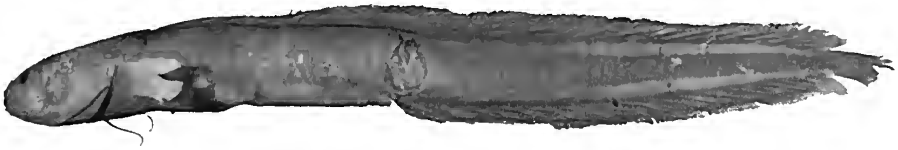

Fig. 24. *Dipulus hutchinsi* n. sp. WAM P.4677-001, holotype, male, 102 mm SL.

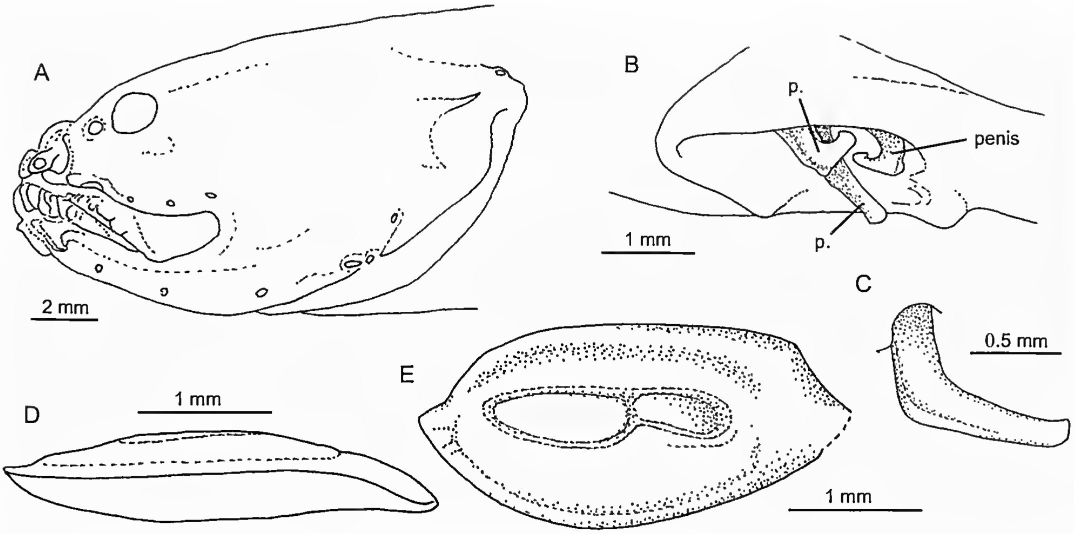

Fig. 25. *Dipulus hutchinsi* n. sp. **A**, lateral view of head, WAM P.4677-001, holotype, male, 102 mm SL; **B**, inclined lateral view of male copulatory organ, WAM P.4677-001, holotype, 102 mm SL; **C**, view of left pseudoclasper from outside, WAM P.4677-001, holotype, 102 mm SL; **D**, ventral view of right otolith, WAM P.28522-005, paratype, male, 95 mm SL; **E**, median view of right otolith, WAM P.28522-005, male, 95 mm SL.

dorsal fin rays 104–110, anal fin rays 66–73, D/A 41–43, V/A 19–20; scales present on body; no supraorbital pore behind eye; lower preopercular pores 3, non-tubular; posterior infraorbital pores 3; broad angle on ventral maxilla positioned behind rear of eye; exposed opercular spine bent upwards; lower lip with skin folds; single pair of pseudoclaspers curved, hockey stick-like, thin; penis slightly shorter than pseudoclaspers, with hook at tip; otoliths pointed anteriorly and posteriorly, their predorsal and postdorsal angles similar in expression, otolith length to height ratio 2.1–2.2, sulcus narrow.

Description. The principal meristic and morphometric characters are shown in Table 13. Body elongate; fishes attaining up to 118 mm SL. Head without scales. Horizontal diameter of scales on body about 0.6 % SL in 6–7 irregular horizontal rows. Maxillary not expanded posteriorly, but with broad angle just behind rear of eye. Anterior nostril on tip of snout. Posterior nostril small, about 1/4 the size of eye.

Head sensory pores (Fig. 25A). Supraorbital pores 2. Infraorbital pores 6 (3 anterior and 3 posterior). Mandibular pores 6 (3 anterior and 3 posterior). Preopercular pores 3 lower, not tubular, no upper preopercular pore. All pores small, about 1/2 the size of posterior nostril or smaller.

Dentition (of holotype). Premaxilla with 4 rows of small teeth anteriorly, merging into single row posteriorly. Anterior teeth in inner row up to 1/3 diameter of pupil. Vomer horseshoe-shaped, with 2 irregular rows of totally 9 small teeth, up to 1/4 diameter of pupil. Palatine teeth in 2 rows with 5+5 small teeth up to 1/4 diameter of pupil. Dentary with 3 outer rows of granular teeth and 1 inner row of larger teeth anteriorly, merging into 1 row of larger teeth posteriorly, up to about 1/3 of pupil diameter.

Otolith (Fig. 25D–E). Elongate, length to height ratio 2.1–2.2 (66–95 mm SL); otolith length to sulcus length ratio 1.7–1.8; sulcus not deepened, narrow, divided into ostium and cauda, marked by indention of ventral sulcus margin, colliculi also divided; length of ostial colliculum to length of caudal colliculum ratio 1.6–1.8; anterior and posterior tips of otolith pointed, each with small concavity above, predorsal and postdorsal angles similarly developed; inner face with weak ventral furrow close to ventral rim and narrow dorsal depression.

Axial skeleton (of holotype). First neural 2/3 the length of second. Neural spine of vertebrae 2–3 elongate and 3–8 depressed. Parapophyses present from vertebrae 6 to 16. Pleural ribs on vertebrae 3–14. First anal fin pterygiophore slightly elongate, not reaching tip of last precaudal parapophysis.

Male copulatory organ (Fig. 25B–C). A single pair of moderately large pseudoclaspers, curved like a hockey stick, thin, underpinned by supporter. Isthmus between pseudoclaspers narrow. Penis thin, slightly shorter than pseudoclaspers, with hook near tip.

Coloration. Live colour bright uniformly yellow, light brown when preserved.

Comparison. *Dipulus hutchinsi* closely resembles *D. multiradiatus*, with which it has been confused in the past (see remarks to *D. multiradiatus*).

Distribution (Fig. 23). *Dipulus hutchinsi* is distributed along the shores of south-westernmost Western Australia from 30°S–115°E to 34°S–115°E, including Rottnest

Table 13. Meristic and morphometric characters of *Dipulus hutchinsi* n. sp.

	Holotype WAM P.4677-001	**Holotype + 6 paratypes Mean (range)**	**n**
Standard length in mm	102	78.7 (66–118)	8
Meristic characters			
Dorsal fin rays	110	106.8 (104–110)	6
Anal fin rays	73	69.3 (66–73)	6
Pectoral fin rays	22	20.7 (20–22)	6
Precaudal vertebrae	16	16.5 (16–17)	6
Caudal vertebrae	40	38.0 (36–40)	6
Total vertebrae	56	54.5(53–56)	6
Rakers on anterior gill arch	12	9.6(8–12)	5
Pseudobranchial filaments	–	0.5(0–1)	4
D/V	6	5.7 (5–6)	6
D/A	42	42.0 (41–43)	5
V/A	20	19.8 (19–20)	6
Morphometric characters in % of SL			
Head length	14.5	16.9 (14.5–18.2)	8
Head width	7.8	8.5 (7.4–9.3)	8
Head height	8.0	9.3 (8.0–10.6)	8
Snout length	3.4	4.0 (3.4–4.5)	8
Upper jaw length	6.7	7.4 (6.6–8.1)	8
Diameter of pigmented eye	1.1	1.3 (1.1–1.5)	8
Diameter of pupil	0.7	0.9 (0.7–1.1)	8
Interorbital width	3.2	3.4 (3.2–3.7)	8
Postorbital length	10.4	12.2 (10.4–14.0)	8
Preanal length	46.0	48.1 (46.0–50.2)	7
Predorsal length	19.1	21.4 (19.1–23.4)	8
Body depth at origin of anal fin	7.6	8.8 (7.3–10.7)	8
Pectoral fin length	8.5	9.2 (8.5–10.5)	8
Pectoral fin base height	4.1	4.4 (4.1–4.7)	8
Ventral fin length	8.1	10.2(8.1–12.1)	8
Base ventral fin – anal fin origin	34.0	35.4 (34.0–38.5)	8

Island. A single record from 19°S, 117°E, indicates a wider distribution.

Ecology. Depth range 10–60 m.

Etymology. Named in honour of J. Barry Hutchins, Perth, WAM, in recognition of his many great contributions to Australian ichthyology.

Dipulus multiradiatus (McCulloch and Waite, 1918)

(Figs 23, 26–27; Tables 1–3, 14)

Dermatopsis multiradiatus McCulloch and Waite, 1918: 63, pl. 5, fig. 4 (type locality: Kangaroo Island, South Australia).

Dermatopsis multiradiatus. – Scott 1962: 172; Cohen 1966: 191; Glover 1976: 172; Paxton *et al.* 1989: 316; Gomon *et al.* 1994: 371; Nielsen *et al.* 1999: 127.

Dipulus caecus (in part). – Mees 1962: 27.

Material examined. (95 specimens, 22–103 mm SL). Holotype, SAMA F480, male, 83 mm SL, Kangaroo Island, South Australia, 35°50'S, 138°30'E, depth and precise location unknown, Waite 1917 (only drawing examined). Paratypes: AMS I.14614, male, 74 mm SL, female, 69 mm SL, same data as for holotype.

Additional specimens. AMS I.17613-009, 3 males, 69–70 mm SL, 4 females, 65–82 mm SL, Port Victoria, Spencer Gulf, South Australia, 34°30'S, 137°29'E; AMS I.17613-013, male, 57 mm SL, Port Victoria, Spencer Gulf, South Australia, 34°30'S, 137°29'E; AMS I.17614-016, 16 males, 55–81 mm SL, 34 females, 54–97 mm SL, 11 juveniles, 22–27 mm SL, and ZMUC P771556-57, male 86 mm SL, female 80 mm SL, Tickera, Spencer Gulf, South Australia, 33°49'S, 137°40'E; AMS I.20180-008, 6 females, 34–103 mm SL, Kangaroo Island, South Australia, 35°44'S, 137°58'E; WAM P.27140-001, subadult male, 41 mm SL, female, 63 mm SL, Boston Island, South Australia, 34°42'S, 135°55'E; WAM P.28290-001, 2 males, 75–76 mm SL, 3 females, 70–86 mm SL, Twilight Cove, Western Australia, 32°16'S, 126°02'E; WAM P.28292-009, subadult male, 49 mm SL, 2 females, 49–84 mm SL, Lucky Bay, Western Australia, 34°00'S, 122°14'E; WAM P.28293-012, 3 males, 78–83 mm SL, juvenile, 40 mm SL, Lucky Bay, Western Australia, 34°00'S, 122°14'E; WAM P.28513-005, female, 70 mm SL, John Island, Duke of Orleans Bay, Western Australia, 33°54'S, 122°37'E.

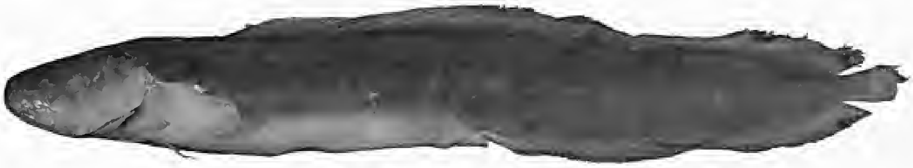

Fig. 26. *Dipulus multiradiatus* (McCulloch and Waite, 1918). ZMUC P771556, non-type, male, 86 mm SL.

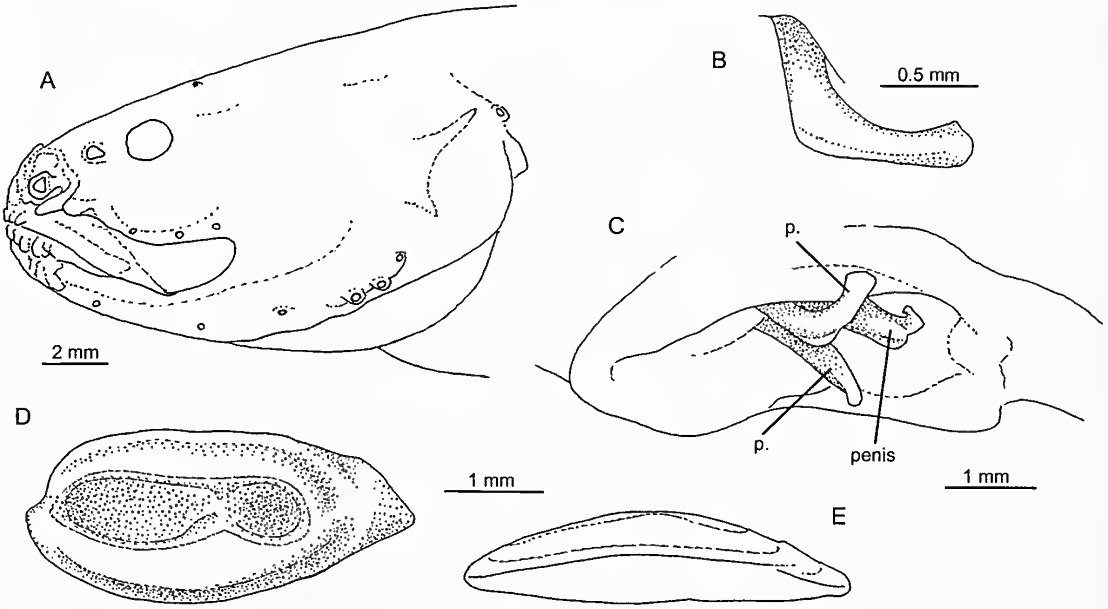

Fig. 27. *Dipulus multiradiatus* (McCulloch and Waite, 1918), WAM P.28293-012, non-type, male, 83 mm SL. **A**, lateral view of head; **B**, view of left pseudoclasper from outside; **C**, inclined lateral view of male copulatory organ; **D**, median view of right otolith; **E**, ventral view of right otolith.

Diagnosis. Body very elongate, attaining sizes of more than 100 mm SL; vertebrae 19–22 + 33–36 = 52–57, dorsal fin rays 97–112, anal fin rays 57–64, D/A 42–51, V/A 23–26; body scaled; supraorbital pore behind eye present; lower preopercular pores 3, the 2 first tubular; posterior infraorbital pores 3; broad angle on ventral maxilla positioned behind rear of eye; exposed opercular spine bent upwards; lower lip with skin folds; single pair of pseudoclaspers curved, hockey stick-like, thin; penis slightly shorter than pseudoclaspers, with hook at tip; otoliths rounded anteriorly and expanded posteriorly, without postdorsal angle, otolith length to height ratio 2.3–2.4, sulcus wide.

Description. The principal meristic and morphometric characters are shown in Table 14. Body elongate; attaining more than 100 mm SL. Head without scales. Horizontal diameter of scales on body about 1.0 % SL (in a 81 mm SL male, AMS I.17614-016), in 8–12 irregular horizontal rows. Maxillary not expanded posteriorly, but with broad ventral angle just behind rear of eye. Anterior nostril on tip of snout. Posterior nostril small, about 1/4 the size of eye.

Head sensory pores (Fig. 27A). Supraorbital pores 3. Infraorbital pores 6 (3 anterior and 3 posterior). Mandibular pores 6 (3 anterior and 3 posterior). Preopercular pores 3 lower, the first two tubular, no upper preopercular pore. All pores small, about 1/2 the size of posterior nostril or smaller.

Dentition (of a non-type, 81 mm SL male, AMS I.17614-016). Premaxilla with 3 rows of small teeth anteriorly, merging into single row posteriorly. Anterior teeth in inner row up to 1/2 diameter of pupil. Vomer horseshoe-shaped, with 3 irregular rows of totally 17 small teeth, up to 1/4 diameter of pupil. Palatine teeth in 3 rows with 11+3+7 small teeth up to 1/3 diameter of pupil, larger in inner row. Dentary with 3 outer rows of granular teeth and 1 inner row of larger teeth anteriorly, merging into 1 row of larger teeth posteriorly, up to about 2/3 of pupil diameter.

Otolith (Fig. 27D–E). Very elongate, length to height ratio 2.3–2.4 (63–84 mm SL); otolith length to sulcus length ratio 1.5–1.7; sulcus deepened, wide, divided into ostium and cauda, marked by indention of ventral sulcus margin, colliculi also divided; length of ostial colliculum

Table 14. Meristic and morphometric characters of *Dipulus multiradiatus* (McCulloch and Waite, 1918).

	Holotype SAMA F480*	**Holotype, 2 paratypes + 92 non-types Mean (range)**	**n**
Standard length in mm	83	67.3 (22–103)	95
Meristic characters			
Dorsal fin rays	–	102.9 (97–112)	72
Anal fin rays	–	60.5 (57–64)	72
Pectoral fin rays	–	19.1 (17–21)	26
Precaudal vertebrae	–	19.6 (19–22)	71
Caudal vertebrae	–	34.4 (33–36)	72
Total vertebrae	–	54.1(52–57)	72
Rakers on anterior gill arch	–	6.1(5–7)	9
Pseudobranchial filaments	–	0.7(0–1)	9
D/V	–	6.4 (5–7)	72
D/A	–	46.1 (42–51)	72
V/A	–	23.7 (23–26)	72
Morphometric characters in % of SL			
Head length	17.2	19.7 (17.0–22.3)	24
Head width	–	9.2 (8.3–11.4)	20
Head height	11.2	11.0 (9.1–12.0)	21
Snout length	4.3	4.7 (4.0–6.0)	23
Upper jaw length	9.1	9.4 (8.5–10.1)	24
Diameter of pigmented eye	1.3	1.7 (1.3–2.1)	31
Diameter of pupil	–	1.0 (0.8–1.3)	29
Interorbital width	–	3.7 (2.9–5.6)	23
Postorbital length	12.1	13.9 (12.0–15.8)	23
Preanal length	57.8	55.8 (51.8–60.3)	23
Predorsal length	25.9	24.4 (21.5–27.3)	24
Body depth at origin of anal fin	12.9	11.0 (8.9–13.2)	24
Pectoral fin length	11.2	10.2 (8.6–12.4)	24
Pectoral fin base height	4.3	4.5 (3.8–5.8)	24
Ventral fin length	11.2	10.9(7.6–16.3)	34
Base ventral fin – anal fin origin	43.1	42.3 (35.4–54.9)	24

* Data from McCulloch and Waite, 1918, included, incl. measurement from Plate V, Fig. 4.

to length of caudal colliculum ratio 1.7–1.8; anterior tip rounded, posterior tip pointed, strongly expanded, predorsal rim broadly rounded, no postdorsal angle; inner face with marked ventral furrow close to ventral rim and narrow dorsal depression.

Axial skeleton (of non-type, WAM P.28293-012, 83 mm SL, male). First neural spine half the length of second. Neural spine of vertebrae 2–3 elongate and 5–10 depressed. Parapophyses present from vertebrae 4 to 12. Pleural ribs on vertebrae 6–10. First anal fin pterygiophore slightly elongate, not reaching tip of last precaudal parapophysis.

Male copulatory organ (Fig. 27B–C). A single pair of moderately large pseudoclaspers, curved like a hockey stick, thin, underpinned by supporter. Isthmus between pseudoclaspers narrow. Penis thin, slightly shorter than pseudoclaspers, with hook near tip.

Coloration. Live colour bright uniformly yellow, light brown when preserved.

Comparison. *Dipulus multiradiatus* is intermediate in vertebrae and fin rays counts between *D. caecus* and *D. norfolkanus*, but its vertebra count of 52 to 57 is higher than that found in other dinematichthyine genera except for *Brosmolus* Machida, 1993b, which has scales on the cheeks (vs naked head) and an otolith with an undivided sulcus and fused colliculi (vs both separated). It differs from the two other species of *Dipulus* in the more slender and smaller pseudoclaspers and details of the otolith morphology (Fig. 27 vs Figs 22 and 29). From *D. caecus* it differs further in having three lower preopercular pores (vs 2) and from *D. norfolkanus* in having three posterior infraorbital pores (vs 2).

The most similar species is *D. hutchinsi*, with which it has commonly been confused in the past. With this species, *D. multiradiatus* shares the head pore system (although lower preopercular pores are non-tubular (vs tubular), total vertebrae and dorsal fin ray counts and the pseudoclasper morphology. It differs from *D. hutchinsi* in the higher number of precaudal vertebrae (19–22 vs 16–17), lower number of caudal vertebrae (33–36 vs 36–40), the lower number of anal fin rays (57–64 vs 66–73), D/A (42–51 vs 41–43), V/A (23–26 vs 19–20) and the morphology of the otolith with a length to height ratio of 2.3–2.4 (vs 2.1–2.2), the absence of an obtuse postdorsal angle (vs present) and the wide sulcus (vs narrow).

Remarks. In all previous records, *D. multiradiatus* had been allocated to *Dermatopsis* rather than *Dipulus*, following its original assignment. Meristic measurements, elongate body shape and the presence of a hook at the tip of the penis clearly assigns it to *Dipulus*. In fact, the most similar of all *Dipulus* species to *Dermatopsis* in terms of meristic counts is *D. norfolkanus*.

Mees (1962) and Cohen (1966) discussed differences between the South Australian and the Western Australian specimens of *D. multiradiatus*. The three differences listed by Mees were degree of squamation, relative body depth and colour, all of which Cohen could not substantiate from his investigations. We agree with Cohen's assessment, however, as mentioned above, as there are other stable characters pointing to two species (precaudal and caudal vertebrae relations, anal fin ray counts, otolith morphology). Both species indeed seem to not overlap in geographic distribution; *D. multiradiatus* occurs chiefly east of 122°E and *D. hutchinsi* west of 116°E.

Distribution (Fig. 23). *Dipulus multiradiatus* is distributed along the shores of South and Western Australia from about 34°S, 122°E (Recherche Archipelago) to 36°S, 137°E (Kangaroo Island).

Ecology. Depth range 0–10 m. A 77 mm TL female was reported by McCulloch and Waite (1918) to contain three fully developed embryos, 28 mm in total length. Coloration is reported to include dark pigmentation dorsally. Specimens of *D. multiradiatus* are commonly found with copepod remains in the stomach (seen from x-rays).

Dipulus norfolkanus Machida, 1993a

(Figs 23, 28–29; Tables 1–3, 15)

Dipulus norfolkanus Machida, 1993a: 43, fig. 1–2 (type locality: Cascade Rocks, 29°15'S–167°58'E, Norfolk Island).

Dermatopsis macrodon. – Francis 1993: 158.

Dipulus norfolkanus. – Nielsen *et al.* 1999: 131, fig. 126.

Material examined. (114 specimens, 17–73 mm SL, all from Norfolk Island). Holotype, NTM S. 11422-00, male, 45 mm SL, Cascade rocks, 29°15'S, 167°58'E, 0–0.5 m, H. and J. Larson, 17 April 1984 (not investigated, data taken from Machida 1993a). Paratypes: AMS I.20256-010, 1 male and 5 females, Cooks Landing, 29°00'S, 167°56'E, 0–1 m, H. Larson and G. Anderson, 8 September 1975; AMS I.20257-017, 1 male and 4 females; Cooks Landing, 0–5 m, D. Hoese, 8 September 1975; AMS I.20260-014, 1 male; Nepean Island, 29°04'S, 167°57'E, 15–20 m, G. Anderson *et al.*, 9 September 1975; AMS I.20264-004, 1 male, Sydney Bay, 29°04'S, 167°57'E, 1–2 m, D. Hoese and H. Larson, 11 September 1975; AMS I.20268-021, 4 males and 9 females, Point Hunter, 29°04'S, 167°57'E, 0–1 m, D. Hoese *et al.*, 1975.

Additional specimens (all from Norfolk Island). AMS I.20271-020, 78 specimens, 17–68 mm SL, Bumbora beach tidepools, 29°04'S, 167°56'E; NMNZ P.11706, female, 63 mm SL, 29°05'S, 168°00'E; NMNZ P.11742, female, 73 mm SL, 29°05'S, 168°00'E; NMNZ P.27162, male, 43 mm SL, 2 females, 40–42 mm SL, Crystal Pool, 29°03'S, 167°55'E; NMNZ P.27166, 2 males, 44–47 mm SL, 2 females, 19–52 mm SL, "Swiss Cheese" ca. 1 km S of Kingston Wharf, 29°03'S, 167°56'E.

Diagnosis. Body elongate, attaining sizes of up to 73 mm SL; vertebrae 13–16 + 31–35 = 45–49, dorsal fin rays 86–104, anal fin rays 56–65, D/A 36–42, V/A 17–19; scales absent; no supraorbital pore behind eye; lower preopercular pores 3, non-tubular; posterior infraorbital pores 2; spine on maxilla positioned behind rear tip of eye; exposed opercular spine straight; lower lip with skin folds; single pair of pseudoclaspers large, curved, broad club-shaped; penis about half the length of pseudoclaspers, with hook at tip; otoliths pointed anteriorly and rounded posteriorly, postdorsal angle sharp, pronounced.

Description. The principal meristic and morphometric characters are shown in Table 15. Body elongate; fishes attaining up to 73 mm SL. Head and body without scales. Maxillary not expanded posteriorly, but with distinct ventral spine just behind rear tip of eye. Anterior nostril directly above snout. Posterior nostril about 1/3 the size of eye.

Head sensory pores (Fig. 29A). Supraorbital pores 2. Infraorbital pores 5 (3 anterior and 2 posterior). Mandibular pores 6 (3 anterior and 3 posterior). Preopercular pores 3 lower, not tubular, no upper preopercular pore. All pores small, about 1/2 the size of posterior nostril or smaller.

Dentition (of a 73 mm SL female, NMNZ P.11742). Premaxilla with 4 outer rows of small teeth and 1 inner

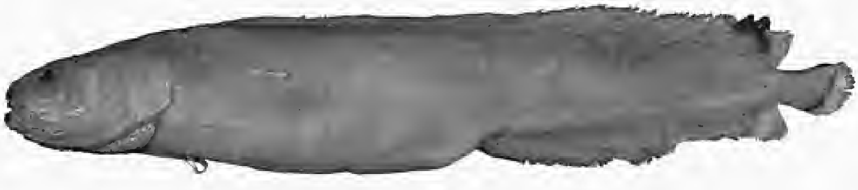

Fig. 28. *Dipulus norfolkanus* Machida, 1993a. AMS I.20271-020, non-type, female, 61 mm SL.

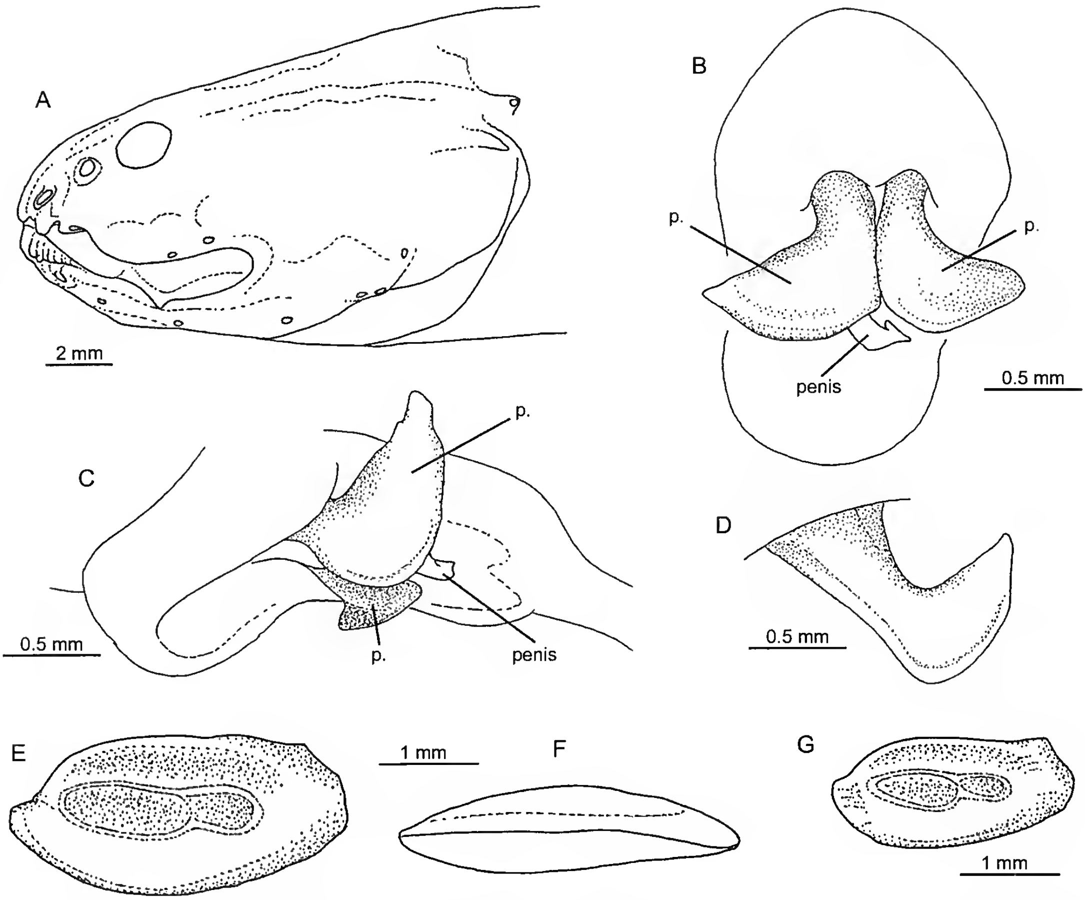

Fig. 29. *Dipulus norfolkanus* Machida, 1993a. **A**, lateral view of head, NMNZ P.11742, non-type, female, 73 mm SL; **B**, ventral view of male copulatory organ, NMNZ P.27166, non-type, 47 mm SL; **C**, inclined lateral view of male copulatory organ, NMNZ P.27166, non-type, 47 mm SL; **D**, view of left pseudoclasper from outside, NMNZ P.27162, non-type, 43 mm SL; **E**, median view of right otolith, NMNZ P.27166, non-type, female, 52 mm SL; **F**, ventral view of right otolith, NMNZ P.27166, non-type, female, 52 mm SL; **G**, median view of right otolith, NMNZ P.27162, non-type, female, 42 mm SL.

row of larger teeth anteriorly, merging into 2 rows posteriorly. Anterior teeth in inner row up to 1/3 diameter of pupil. Vomer horseshoe-shaped, with 2 irregular rows of totally 13 small teeth, up to 1/4 diameter of pupil. Palatine teeth in 2 rows with 6+19 small teeth up to 1/4 diameter of pupil. Dentary with 3 outer rows of granular teeth and 1 inner row of larger teeth anteriorly, merging into 1 row of larger teeth posteriorly, up to about 1/2 of pupil diameter.

Otolith (Fig. 29E–G). Elongate, length to height ratio 2.1–2.2 (42–52 mm SL); otolith length to sulcus length ratio 1.7; sulcus slightly deepened, divided into ostium and cauda, marked by indention of ventral sulcus margin, colliculi also divided; length of ostial colliculum to length of caudal colliculum ratio 2.0–2.2; anterior tip of otolith pointed, with small concavity above, posterior tip rounded; predorsal angle indistinct, postdorsal angles sharp, pronounced; inner face with weak ventral furrow very close to ventral rim and large, well defined dorsal depression.

Axial skeleton (of non-type NMNZ 27166, 47 mm SL, male). First neural spine 4/5 the length of second. Neural spine of vertebrae 3–6 depressed. Parapophyses present from vertebrae 5 to 14. Pleural ribs on vertebrae 2–6. First anal fin pterygiophore slightly elongated, not reaching tip of last precaudal parapophysis.

Male copulatory organ (Fig. 29B–D). A single pair of pseudoclaspers; large, curved, almost rectangular, sticking out from below hood, broad club-shaped, underpinned by massive supporter. Isthmus between pseudoclaspers narrow. Penis about half the length of pseudoclaspers, with hook at tip.

Coloration. Live colour not known, medium brown when preserved.

Table 15. Meristic and morphometric characters of *Dipulus norfolkanus* Machida, 1993a.

	Holotype* NTM S. 11422	**Holotype, 26 paratypes* + 23 non-types** **Mean (range)**	n
Standard length in mm	45	(17–73)	50
Meristic characters			
Dorsal fin rays	99	(86–104)	42
Anal fin rays	62	(56–65)	42
Pectoral fin rays	20	(19–22)	28
Precaudal vertebrae	16	(13–16)	43
Caudal vertebrae	33	(31–35)	43
Total vertebrae	49	(45–49)	43
Rakers on anterior gill arch	–	7.0(6–9)	5
Pseudobranchial filaments	–	0	7
D/V	–	5.5 (5–6)	15
D/A	–	38.7 (36–42)	15
V/A	–	18.4 (17–19)	15
Morphometric characters in % of SL			
Head length	19.3	(19.2–23.3)	28
Head width	–	9.4(8.4–11.6)	7
Head height	–	11.6(9.2–14.2)	12
Snout length	4.7	5.2(4.6–6.3)	12
Upper jaw length	9.3	10.7(9.3–12.4)	12
Diameter of pigmented eye	2.4	1.8(1.5–2.4)	12
Diameter of pupil	–	1.1(0.9–1.4)	12
Interorbital width	3.3	3.2(2.4–4.0)	12
Postorbital length	–	15.1(13.7–16.7)	12
Preanal length	55.6	(52.6–58.8)	28
Predorsal length	25.3	(24.4–29.4)	28
Body depth at origin of anal fin	15.1**	10.7(8.1–12.3)	9
Pectoral fin length	13.3	(8.3–14.5)	28
Pectoral fin base height	–	4.9(3.9–6.0)	9
Ventral fin length	17.1	(14.5–18.2)	28
Base ventral fin – anal fin origin	–	36.8(32.3–42.0)	12

* Data from Machida (1993a) included.
** Measured as maximum body depth.

Comparison. *Dipulus norfolkanus* is the species of the genus *Dipulus* with the lowest vertebrae and fin ray counts. Also characteristic are the pseudoclasper and otolith morphology, the ventral spine at the maxilla positioned behind the eye and two posterior infraorbital pores (vs three). From *D. caecus* it differs further in the presence of three lower preopercular pores (vs two).

The low meristic counts resemble species of *Dermatopsis*. Dorsal fin ray counts still are higher than in any *Dermatopsis* species (86–97 vs <86). The hook at the tip of the penis is also regarded as a synapomorphic character of all species of the genus *Dipulus*.

Distribution (Fig. 23). *Dipulus norfolkanus* is restricted to Norfolk Island, located in the south-west Pacific between New Caledonia and New Zealand.

Ecology. Depth range 0–15 m.

GEOGRAPHIC DISTRIBUTION

The three related genera *Dermatopsis, Dermatopsoides* and *Dipulus* are distributed south of the main reef belt of the Indo-west Pacific species, a pattern that they share with very few other Dinematichthyini, chiefly the monotypic genus *Monothrix* (southern and south-eastern Australia). The only exception is *Dermatopsis greenfieldi* from Fiji and a single record of a *Dermatopsis* sp. from the southern Great Barrier Reef. Occasional fossil otolith-based records of *Dipulus* or *Dermatopsis* from the northern hemisphere are thus very unlikely, since they would have had to be a result of crossing of the broad tropical belt. So far, there is no evidence in the recent or fossil record of an antitropical distribution pattern in the Dinematichthyini, as was described for other groups of Indo-West-Pacific fishes by Randall (1981).

The three genera in question are also remarkable for their very narrowly distributed endemic species. *Dermatopsis* is restricted with two species to the subtropical shores of south-eastern Australia, one species to northern New Zealand (with fossil evidence dating back to about 2.0 to 2.4 mya) and an out of range occurrence around Fiji. *Dipulus* is restricted with three species in southern and south-western Australia, thereof two in Western Australia from the Abrolhos Islands to the Flinders Bay, including Perth and the Rottnest Island. This seems to be a particularly rich area in dinematichthyine endemisms. A fourth species of *Dipulus* – *D. norfolkanus* – occurs 'out of range', endemic as the only representative of the Dinematichthyini around Norfolk Island, and therewith constituting one of the most narrow distribution patterns in the group. It is also the least elongate species of this genus, probably indicating a plesiomorphic character status. *Dermatopsoides* was finally understood as endemic to southern Africa. All three South African species are restricted to the southernmost tip of the continent, chiefly south of 33°S, more common on the Indian Ocean side, but present on the Atlantic side as well. One of them – *D. kasougae* – is known from only two specimens from the Kasouga river estuary near Port Alfred, and therefore possibly adapted to a very specific environment. Again, there is a (new) out of area find – *D. morrisonae* – from the south-western tip of Western Australia, 8000 km across open ocean from the South African species. Also, *D. morrisonae* appears to be the most plesiomorphic of the group with three lower preopercular pores and skin folds on the lower lip.

Southern Australia is the only area where all three genera are represented. From this it could be concluded that it represents the core area of evolution for this small sub-group of the Dinematichthyini, but that will have to be tested further with phylogentic and biogeographic analyses. The present paper provides an update of the known diversity of the group.

Several species, however, are known from very few specimens, indicating that much more field work is needed before we truly know the ranges of these fishes. They appear to be rare, but are probably just rarely caught. Even for the most abundant species, the biology is almost unstudied.

ACKNOWLEDGMENTS

We wish to thank the following persons for helping us with material and information: Gerald R. Allen (WAM), M. Eric Anderson (SAIAB), Dianne J. Bray (NMV), David Catania (CAS), Daniel M. Cohen (CAS), Gavin Dally (NTM), Guy Duhamel (MNHN), Jon Fong (CAS), Ronald Fricke (SMNS), Alistair Graham (CSIRO), Phil Heemstra (SAIAB), Mysi Hoang (CAS), Peter A. Hulley (SAM), J. Barry Hutchins (WAM), Tomio Iwamoto (CAS), Susan Jewett (USNM), Jeffrey Johnson (QM), Helen K. Larson (NTM), Jeff Leis (AMS), James Maclaine (NHM formerly BMNH), John E. McCosker (CAS), Mark McGrouther (AMS), Sue Morrison (WAM), Vusi Mthombeni (SAIAB), John R. Paxton (AMS), John E. Randall (BPBM), Sandra Raredon (USNM), Sally Reader (AMS), Clive Roberts (NMNZ), Andrew Stewart (NMNZ), Carl Struthers (NMNZ), Tom Trnski (AMS) and Richard Winterbottom (ROM).

Also thanks are due to the following colleagues at ZMUC: Brigitte Rubæk for making the specimen drawing, Geert Brovad for producing the photos and Tammes Menne for help with X-raying and packing. The project

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the NZ Foundation for Research Science and Technology through the Te Papa Biosystematics of NZ EEZ Fishes subcontract within NIWA's Marine Biodiversity and Biosecurity OBI programme (contract C01X0502)

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Accepted 9 November 2006

The Beagle, Records of the Museums and Art Galleries of the Northern Territory, 2006 **22**: 77–90

A revision of the marine eel-tailed catfish genus *Euristhmus* (Teleostei: Siluriformes: Plotosidae)

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ABSTRACT

The Indo-west Pacific plotosid catfish genus *Euristhmus* Ogilby is revised and found to include five species: *E. lepturus* (Günther) occurs along the eastern and northern parts of Australia, from Sydney to the Gulf of Carpentaria; *E. microceps* (Richardson) is reported from Shark Bay, Western Australia to Goulburn Islands, Northern Territory; and *E. nudiceps* (Günther), the most widely distributed species, extends along the northern margin of Australia, from Exmouth Bay, Western Australia to Moreton Bay, Queensland. Two new species are described herein: *E. microphthalmus*, from coastal regions of the Northern Territory, Australia and West Papua, Indonesia; and *E. sandrae* from the vicinity of Rowley Shoals and Exmouth Gulf, Western Australia. *Exilichthys* Whitley is a junior synonym of *Euristhmus*; *Cnidoglanis microcephalus* Günther is an unnecessary replacement name for *E. microceps*; and *Plotosus elongatus* Castelnau is a junior subjective synonym of *E. lepturus*. A lectotype is designated for *Cnidoglanis lepturus* Günther.

Keywords: eel-tailed catfishes, Plotosidae, *Euristhmus*, Indo-Wwest Pacific, taxonomy, new species.

INTRODUCTION

Eel-tailed catfishes (Siluriformes: Plotosidae) comprise a group of Indo-west Pacific freshwater and marine catfishes with elongate bodies that taper posteriorly and a continuous median fin that is supported by rays of the anal and caudal fins, and procurrent caudal-fin rays (Ferraris 2001). Marine eel-tailed catfishes possess a dendritic organ protruding from behind the anus that apparently functions as a salt regulatory organ (Burgess 1989) and the fin spines are sharp-pointed and supported by venom-producing epidermal tissue that causes extremely painful wounds to careless handlers of these fishes. Four genera of marine plotosids are currently recognised (i.e., *Cnidoglanis*, *Euristhmus*, *Paraplotosus*, and *Plotosus*), however, no comprehensive systematic treatment of marine plotosids is available. Species of the marine plotosid genus *Plotosus* are widely distributed in the Indo-west Pacific region, while the other three genera are restricted to the Australia-New Guinea region and parts of the Malay Peninsula.

Recent authors have treated the taxonomy of marine Plotosidae in various ways. Burgess (1989) summarised the taxonomy of the marine and freshwater species and included a key to the genera. Paxton *et al.* (1989) listed valid genera and species, with their synonyms, of all Australian plotosids. Ferraris (2001) provided a key to genera and species of marine plotosids found in the tropical western Pacific.

Euristhmus is possibly the most poorly understood of the marine plotosid genera. *Euristhmus* was erected by Ogilby (1899) for *Plotosus elongatus* (Castelnau, 1878) and *Cnidoglanis lepturus* (Günther, 1864). Although he provided a description of *Euristhmus*, Ogilby (1899) did not distinguish his new genus from either *Cnidoglanis* or *Plotosus*, so it is unclear why *Euristhmus* was erected or delimited except by inference from the derivation of the genus name (Greek for 'wide isthmus'). A wide, versus narrow, isthmus was the only character McCulloch (1921) used to separate *Euristhmus* from *Plotosus* and *Cnidoglanis*. In his key to the family Plotosidae, McCulloch (1921) stated that the gill membranes were narrowly united with the isthmus in *Cnidoglanis* and *Plotosus*, whereas in *Euristhmus* the gill membranes were separated by a wide isthmus.

The use of *Euristhmus* as a valid genus has been sporadic and has only gained wide acceptance recently. In most earlier publications, the species that Paxton *et al.* (1989) placed in *Euristhmus* were all considered as part of *Cnidoglanis*. Neither Weber and De Beaufort (1913) nor Taylor (1964) recognised *Euristhmus*. Grant (1978) was one of the few workers to recognise *Euristhmus* subsequent to McCulloch (1921). That author provided a colour photograph, a drawing, and a descriptive account of the morphology and ecology of *E. lepturus*. Gloerfelt-Tarp and Kailola (1984) provided colour photographs and short descriptions of *E. lepturus* (Günther) and *E. nudiceps* (Günther). Burgess (1989) and Paxton *et al.* (1989) recognised three species of *Euristhmus* – *E. lepturus, E. nudiceps* and *E. microceps* (Richardson) – and synonymised *Plotosus elongatus* Castelnau with *Euristhmus lepturus*. Burgess (1989) also provided a key to the species of Plotosidae.

Whitley (1933) erected the new genus *Exilichthys* for *Cnidoglanis nudiceps* Günther. In describing his new genus, Whitley stated: "Occipital region osseous, not covered with loose skin. Head small, depressed, with gill membranes not united across isthmus." *Exilichthys* was listed as a synonym of *Cnidoglanis* by Burgess (1989), but was not mentioned in either Taylor (1964) or Paxton *et al.* (1989). We recognise *Cnidoglanis nudiceps* as a valid species of *Euristhmus* and must, therefore, treat *Exilichthys* as a junior synonym of *Euristhmus*.

The objectives of this paper are to: elucidate characters that distinguish the genus *Euristhmus* from other marine plotosid genera; provide a key to species of *Euristhmus* and a description of each, including two species not previously recognised; and present information about the distribution of the species of *Euristhmus*.

METHODS AND MATERIAL

Measurements were made point-to-point with dial calipers and recorded to 0.1 mm. Head length (HL) was measured from the tip of the snout to the posteriormost extremity of the fleshy opercular flap; head width (HW) was the greatest width of the head; as both the pectoral- and pelvic-fins have a thick, fleshy covering with the fin-rays not visible, the length of each of these fins was the greatest straight-line distance from where the fin joined the body to the distal tip; preanal length (PL) was measured from the snout tip to the anterior basis of the anal fin; snout to first dorsal-fin origin was the length from the snout tip to the anterior basis of the first dorsal fin; interorbital width was the least distance between the orbits; opercle height was the straight-line vertical distance at the posterior edge of the opercle; nape height was the greatest straight-line vertical distance anterior to the first dorsal-fin origin; eye length was the greatest horizontal distance anterior to posterior; and vertebral counts, which are given as preanal (with open haemal arches) plus anal (with closed haemal arches) vertebrae. The number of specimens observed to have a particular count is given in parentheses immediately following that count. The count in the holotype or lectotype is underlined.

Counts of vertebrae and unpaired fin rays were made from radiographs. Counts of paired fins were made on both the right and left sides. The dorsal procurrent caudal-fin rays extend anteriorly to a point near the terminus of the first dorsal fin. The elongate rays in this fin are unbranched and are not associated with pterygiophores, but in outward appearance this fin looks like a second dorsal fin. For purposes of convenience, we are calling this the second dorsal fin. Based on radiographic images, it was evident that many of our specimens had sustained damage to, or lost, a portion of their caudal region, probably due to predation. In most of these specimens, the caudal region had regenerated or was in the process of regeneration and was often externally indistinguishable from that in an intact specimen. Because this situation was evident in more than just a few specimens, we did not attach any significance to counts of anal vertebrae or fin rays of median fins. For the same reason, proportional body measurements were not compared against standard length but were, instead, compared to preanal length (PL). When the range of a particular proportional body measurement is provided in the diagnosis of a species, the mean is also provided and represented by the Greek letter *mu* (μ). Specimen length is reported as total length (TL), in mm, throughout the paper.

Eschmeyer (1998) is followed for institutional codes.

TAXONOMY

Euristhmus Ogilby, 1899

Euristhmus Ogilby, 1899: 154. Type species: *Plotosus elongatus* Castelnau, 1878. Type by original designation. Gender: Masculine.

Exilichthys Whitley, 1933: 65. Type species: *Cnidoglanis nudiceps* Günther, 1880. Type by original designation. Gender: Masculine.

Description. *Euristhmus* comprises a group of eel-tailed catfishes with a broad, slightly depressed head and a long, tapering, compressed body. The second-dorsal and anal fins are confluent with the caudal fin, which is pointed at its terminus. The body has a complete lateral line that extends to the caudal fin.

The profile of the head from the snout to the first dorsal-fin origin is a smooth, posterodorsal slope. The head depth is greatest at a vertical with the posteriormost edge of the operculum. The snout margin is gently rounded from dorsal view. The lips are very fleshy; lower lip is continuous with the chin. The eye is dorsolateral in position and not visible from ventral view; eye small to moderate, its length is 0.10–0.27 of head length (Table 1). The interorbital width is greater than the eye length (interorbital width 0.21–0.35 of head length).

Four pairs of barbels are located in the mouth region: nasal, maxillary, and 2 pairs of mandibular barbels. The nasal barbels are positioned almost medially and are about one eye length dorsal to the anterior naris. The nasal barbels are separated from each other by a distance approximately equal to the eye length. The nasal barbel extends posteriorly at least as far as the posterior margin of the orbit and sometimes onto the nape. The maxillary barbel extends posteriorly almost to, or beyond, the base of the pectoral-fin spine. The 2 pairs of mandibular barbels are in a transverse line just posterior to the lip of the lower jaw. The mandibular barbels extend posteriorly to about the posterior edge of the gill cover.

The anterior naris is located dorsal to the papillate portion of the upper lip; its opening is anteriorly-directed. The posterior naris is an elongate slit at the posterolateral base of the nasal barbel.

The branchiostegal membrane is supported by 6 or 7 rays on the anterior ceratohyal and 1 on the posterior ceratohyal. The branchiostegal membranes are cutaneously attached along ventral midline and narrowly attached to the isthmus. The gill opening is wide.

The mouth is subterminal with the upper jaw extending anteriorly slightly beyond the margin of the lower jaw. Upper jaw teeth are distributed in 2 ovoid tooth patches, 1 on each side of the symphysis. Five to 10 teeth occur in each tooth patch; teeth are conical and stout, with the medial teeth larger than the more laterally positioned teeth. Vomerine teeth are present in a medial crescentic or triangular patch; teeth are short, blunt, and stout, with the largest teeth along the midline. The teeth in the lower jaw are bluntly rounded, arranged in 2 or 3 rows medially and taper to 1 row laterally; teeth in the outer row are the largest on the jaw.

The first dorsal fin originates on a vertical line through, or just posterior to, the pectoral-fin base. The first dorsal fin consists of a spinelet or first spine, a second spine and 3–5 segmented rays. The spinelet is very short and closely applied to the base of the second spine (and thus easily overlooked). The second spine is tall and pungent with serrae on the anterior and posterior margins. The penultimate and ultimate soft rays are closely applied.

The second dorsal fin, which was described in Materials and Methods, has 72–136 fin rays (Table 2). The second dorsal-fin origin is anterior to, or on, a vertical line through the pelvic-fin origin.

The caudal fin tapers to a point, however, the tail region frequently exhibits signs of damage and subsequent regeneration. Caudal-fin rays are not easily distinguished from the confluent second dorsal- and anal-fin rays. The caudal fin has 5–19 rays on the hypural plate with numbers greater than 5 present on specimens that appear to have regenerated caudal regions. There are no ventral procurrent fin rays.

The anal-fin origin is located at about the anterior one-third of TL. The anal-fin base is shorter than that of the second dorsal fin, but rays of both fins are approximately the same height. Anal-fin rays are segmented and range in number from 67–117.

The distal margin of the pelvic fin is broadly convex with the middle rays longest. The pelvic-fin rays are segmented and all but the first ray are branched. The tip of the adpressed pelvic fin extends slightly past the anal-fin origin. The pelvic fin has 10–13 rays.

The pectoral-fin spine is well developed. The anterior surface of the pectoral-fin spine has distinct serrae; serrae are sometimes also present on the posterior surface. The anteriormost pectoral-fin rays are longest, and the posterior margin of the fin is convex. The pectoral fin has 8–11 branched rays. The axillary pore is single, large and horizontally elongate. In some mature males, the axillary area has a patch of rugose epidermis (Fig. 1) of unknown function that may obscure the axillary pore.

The vertebral column has 17–20 preanal and 52–108 anal vertebrae. The wide range in number of anal vertebrae (as well as anal and second dorsal-fin rays) is likely to be attributable to loss, probably due to predation, and subsequent regeneration of the tail region.

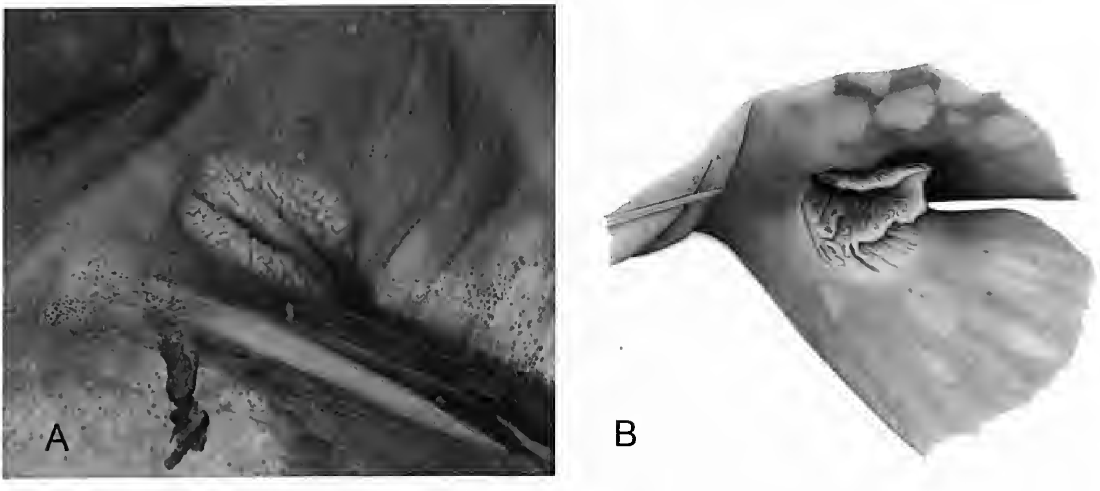

Fig. 1. **A**, lateral view of axillary region of the left pectoral fin in *Euristhmus microphthalmus* n. sp. (WAM P.29974-047). Image by Sandra J. Raredon; **B**, dorsolateral view of the axillary region of the left pectoral fin in *Euristhmus microceps*. Drawing by Janet R. Gomon, specimen not indicated.

Comparison with other marine plotosids. Amongst the four marine genera of the Plotosidae (*Cnidoglanis, Euristhmus, Paraplotosus* and *Plotosus*), *Cnidoglanis* and *Euristhmus* are the most elongate with the body depth at first dorsal-fin origin less than 12% of total length (vs. body deeper, body depth at the first dorsal-fin origin typically greater than 15% of total length in *Paraplotosus* and *Plotosus*).

Paraplotosus further differs from *Euristhmus* in having the following combination of characters: the anterior naris is situated within the folds of the upper lip and opens directly ventrally; the second dorsal-fin origin is immediately posterior to the posterior terminus of the first dorsal fin; and the gill membranes are joined broadly across the isthmus and attach to the isthmus anteriorly.

Plotosus further differs from *Euristhmus* in having the following combination of characters: the second dorsal-fin origin is posterior to a vertical line extending from the pelvic-fin origin; and the premaxillary tooth patch is elongate and extends laterally for most of the width of the mouth.

In the literature, *Euristhmus* has most commonly been confused with *Cnidoglanis*, but actually character differences between *Cnidoglanis* and *Euristhmus* are numerous: *Cnidoglanis* has a prominent lower lip fringe (*Euristhmus* has none); *Cnidoglanis* has a tapering head shape, more narrow anteriorly than posteriorly (*Euristhmus* is less tapered anteriorly); *Cnidoglanis* has a more horizontally-elongate eye (the eye of *Euristhmus* is more circular); *Euristhmus* has two prominent tooth patches with five to ten teeth each anteriorly in upper jaw (*Cnidoglanis* has two small tooth patches with fewer than five teeth); and *Euristhmus* has the mandibular barbels positioned along a straight line (in *Cnidoglanis* the more lateral barbels are posterior to the medial barbels).

Key to species of *Euristhmus*

1a. Rays of first dorsal fin elongate, with longest rays equal to, or greater than, head length; tip of adpressed first dorsal fin reaching almost to, or beyond, vertical line through anal-fin origin 2

1b. Rays of first dorsal fin not elongate, with longest rays less than head length; tip of adpressed first dorsal-fin terminating far short of vertical line through anal-fin origin 3

2a. Body coloration mottled; large dusky brown blotch located near lateral line ventral to base of first dorsal fin; head width 32% or greater of preanal length; branched pectoral-fin rays 9–11 .... *Euristhmus microceps*

2b. Body coloration solid brown, gray, tan, or whitish; no large dusky brown blotch near lateral line ventral to base of first dorsal fin; head width 28% or less of preanal length; branched pectoral-fin rays 8 .... *Euristhmus sandrae* n. sp.

3a. Abdomen speckled with tiny brown spots; dorsoposterior portion of cranium visible through skin; vomerine tooth patch broadly curved posteriorly and thin, only 2 to 3 teeth deep at midline .... *Euristhmus nudiceps*

3b. Abdomen not speckled with tiny brown spots; dorsoposterior portion of cranium not visible through skin; vomerine tooth patch slightly curved or almost straight posteriorly, 4 or more teeth deep at midline... 4

4a. Eye length 14–20% of head length (Fig 2A); eye length 6–10% of preanal length .... *Euristhmus lepturus*

4b. Eye length 10–12% of head length (Fig. 2C); eye length 5–6% of preanal length............................... ....*Euristhmus microphthalmus* n. sp.

Euristhmus lepturus (Günther, 1864)

(Figs 2A, 3, 4A; Tables 1–2)

Cnidoglanis lepturus Günther, 1864: 28. Type locality: Sydney, New South Wales, Australia.

Plotosus elongatus Castelnau, 1878a: 237. Type locality: Brisbane River, Queensland, Australia.

Euristhmus lepturus. – Ogilby 1899: 155 (new combination).

Material examined. 52 specimens, 40–388 mm TL. AUSTRALIA, NEW SOUTH WALES: Sydney, BMNH 1864.1.17.33 (1, 333), lectotype of *Cnidoglanis lepturus*, designated herein, no stated locality, AMS I.31441-002 (1, 357), AMS IB.5511-5512 (2, 270–310); Rose Bay, 33°52'S, 151°16'E, AMS I.7579 (1, 388); Port Jackson, Sydney Harbour, AMS IB.641-643 (3, 142–235); Port Jackson, SU 20975 (1, 130); Bobbin Head, Kuringai Chase National Park, 33°39'S, 151°09'E, AMS I.30177-002 (1, 330), AMS I.30335-001 (1, 190), AMS I.30336-001 (1, 230) and AMS I.30353-001 (1, 255); Tea Gardens, 32°40'S, 152°10'E, AMS IB.4539, 4554 (2, 199–295); Clarence River, AMS I.19341-004 (3, 54–96); Parramatta River, 33°50'S, 151°05'E, AMS I.13033-13035 (3, 160–270); Hawkesbury River, AMS I.27073-001 (2, 160–250); Hawkesbury River, Gentleman's Halt, 33°28'S, 151°11'E, AMS I.19951-016 (1, 220); *ibid.*, ANSP 135468 (2, 92–119); *ibid.*, LACM 37501-2 (1, cleared and stained, 124); *ibid.*, USNM 219608 (4, 127–300); Hawkesbury River Bridge, 33°30'S, 151°10'E, AMS I.14628 (1, 330); Hunter River, Newcastle, 33°30'S, 151°47'E, AMS I.15886-002 (2, 251–252); Raleigh, Bellinger River, 30°27'S, 153°01'E, AMS IB.2314 (1, 365). QUEENSLAND: Moreton Bay, ANSP 122289 (1, 120); Moreton Bay, 27°15'S, 15°315'E, WAM P.28777-024 (8, 87–208); Serpentine Creek, Moreton Bay, AMS I.19574-007 (4, 89–105); Brisbane River, SU 20551 (1, 338); Norman, Karumba Point Beach, AMS I.22083-007

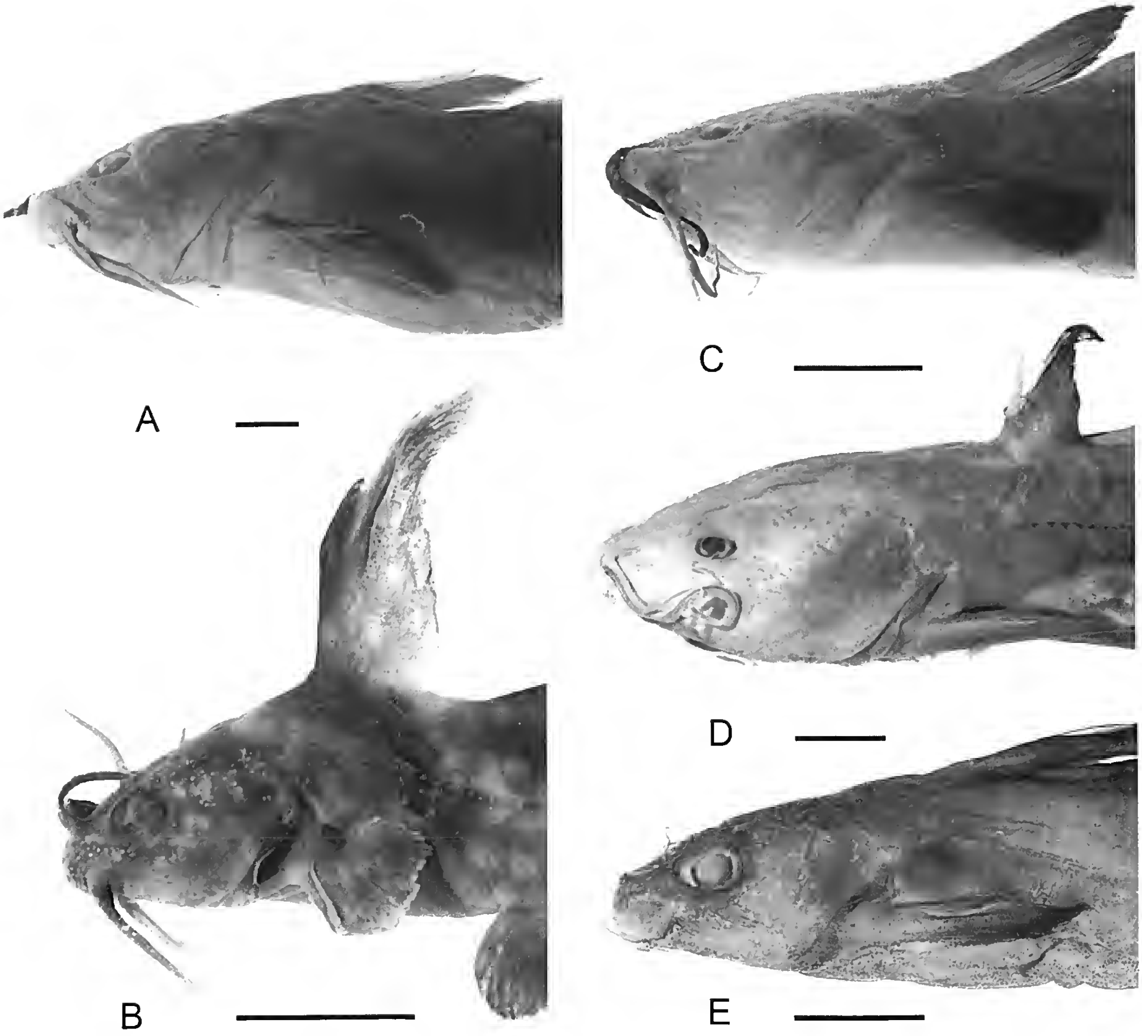

Fig. 2. Lateral view of head of *Euristhmus* species: **A**, *Euristhmus lepturus* (USNM 219608); **B**, *Euristhmus microceps* (WAM P.30081-001); **C**, *Euristhmus microphthalmus* n. sp. (AMS I.24689-012); **D**, *Euristhmus nudiceps* (AMS I.20771-081); **E**, *Euristhmus sandrae* n. sp. (WAM P.32730-001). Scale bar on each figure equals 1 cm. Images by Sandra J. Raredon.

(2, 40–42); Karumba, 17°29'S, 140°50'E, AMS I.26859-016 (1, 173).

Diagnosis. *Euristhmus lepturus* is distinguished from its congeners in having: the nasal barbel extending posteriorly as far as the nape; vomerine tooth patch slightly curved or almost straight posteriorly, 4 or more teeth deep at midline; eye length 14% of head length or greater (14–20%); and maxillary barbel extending posteriorly to pectoral-fin base. Among proportional measurements within the genus (Table 1), *E. lepturus* has the least ratio between body depth and head length (0.460–0.615, μ = 0.537), the greatest ratio between pectoral-fin length and preanal length (0.206–0.387, μ = 0.327), and the greatest ratio between head length and preanal length (0.446–0.537, μ = 0.496).

Description. As for genus except as indicated below.

First dorsal-fin rays: II,3(1), II,4(6), II,5(6). Second dorsal-fin rays: 95(1), 110(1), 111(1), 112(1), 113(1), 114(3), 116(1), 117(2), 118(1), 127(1). Anal-fin rays: 85(1), 97(1), 98(1), 100(1), 101(1), 102(2), 103(1), 105(2), 106(1), 109(2). Pectoral-fin rays: I,9(7), I,10(8), I,11(3). Pelvic-fin rays: 10(2), 11(5), 12(10). Preanal vertebrae: 18(3), 19(6), 20(4). Anal vertebrae: 58(1), 74(2), 75(2), 76(1), 77(4), 78(3).

Adpressed first dorsal fin reaches or slightly overlaps second dorsal fin, but in large specimens (>300 mm) adpressed first dorsal fin typically does not reach second

Fig. 3. *Euristhmus lepturus* from New South Wales, Australia (USNM 219608, 300 mm TL). Image by Sandra J. Raredon.

dorsal fin. Vomerine tooth patch large and deep, more than four teeth deep at midline. Second dorsal fin slightly taller than anal fin.

Coloration of preserved material. Head and body dusky brown to light brown. Nasal barbel dusky to black, more dusky or black than other barbels. Distal portions of first-dorsal, pectoral and pelvic fins black; second-dorsal and anal fins black distally; and anal fin darker than second dorsal fin.

Distribution. East coast and northern Australia, from Sydney, New South Wales to Karumba in the Gulf of Carpentaria (Fig. 4).

Remarks. Günther's (1864) original description of *Cnidoglanis lepturus* indicated that he examined two specimens: a 14 inch-long specimen from Sydney and a 13 inch-long stuffed specimen that was stated to have originated only from Australia. Günther's description was based primarily on the Sydney specimen (BMNH 1864.1.17.33); hence we designate this specimen as the lectotype.

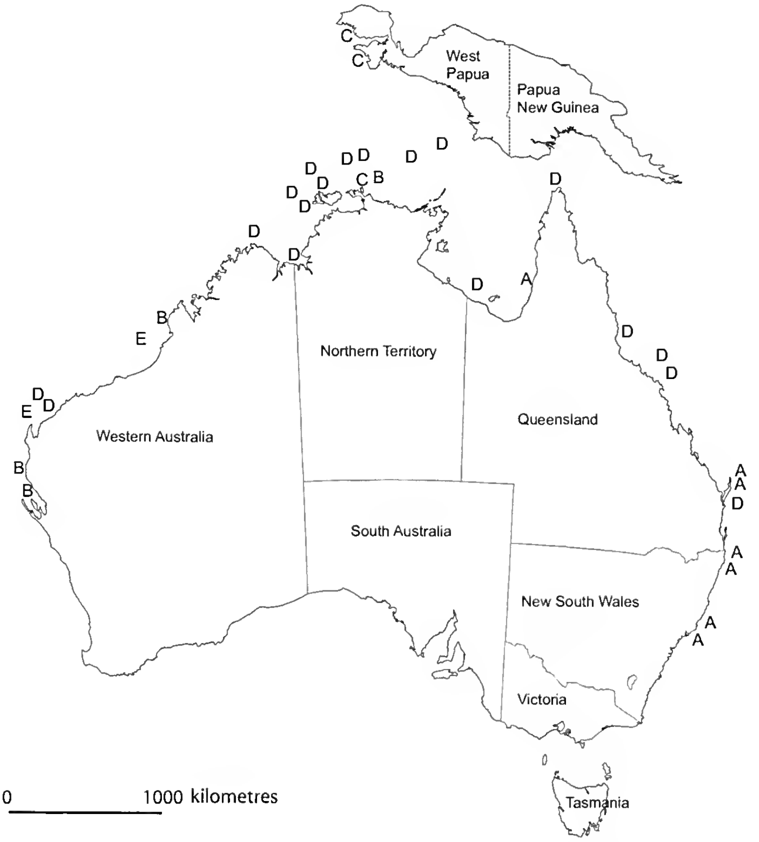

Fig. 4. Distribution map for species of *Euristhmus*: *E. lepturus* (A), *E. microceps* (B), *E. microphthalmus* n. sp. (C), *E. nudiceps* (D), and *E. sandrae* n. sp. (E). Symbols are only approximate locations and may represent more than one specimen.

Euristhmus microceps (Richardson, 1845)

(Figs 1B, 2B, 4–6; Tables 1–2)

Plotosus microceps Richardson, 1845: 31, pl. 21, figs 4–7 (north-west coast of Australia).

Cnidoglanis microcephalus Günther, 1864: 28 (unnecessary replacement name for *Plotosus microceps* Richardson, 1845).

Cnidoglanis microceps. – Taylor 1964: 86 (new combination).

Euristhmus microceps. – Paxton *et al.* 1989: 223 (new combination).

Material examined. 12 specimens, 96–243 mm TL. AUSTRALIA, north-west coast, BMNH 1846.3.3.2 (1, 226), holotype of *Plotosus microceps* and *Cnidoglanis microcephalus*. WESTERN AUSTRALIA: Broome, AMS IA.5112 (1, 185); north side of Cloughs Bar, Shark Bay, 25°25'S, 113°35'E, WAM P.30258-003 (1, 166); Shark Bay, 25°21'S, 113°44'E, WAM P.14779-001 (1, 209); Shark Bay, 25°21'S, 113°44'E, WAM P.8504-001 (1, 148); Shark Bay, 25°21'S, 113°44'E, 38.3 m, WAM P.9094-001 (1, cleared and stained); Shark Bay, Cape Peron North, 6.23 km east of cape, 25°30.484'S, 113°33.688'E

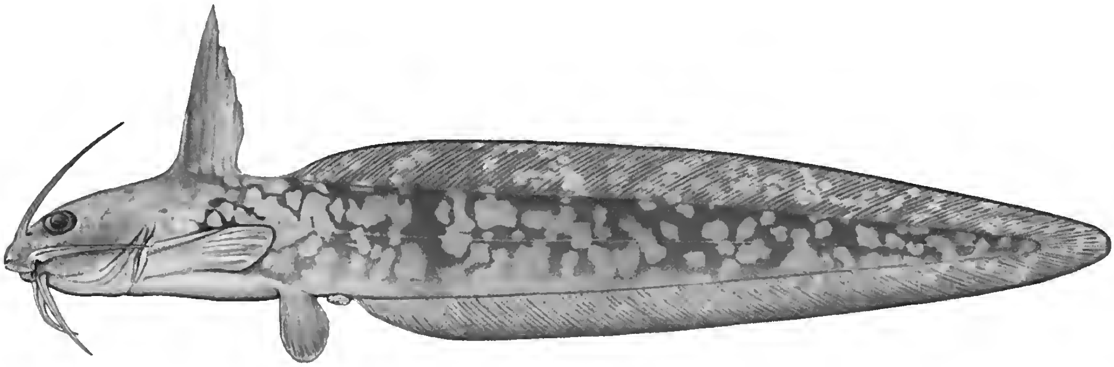

Fig. 5. *Euristhmus microceps*. Drawing by Janet R. Gomon, specimen not indicated.

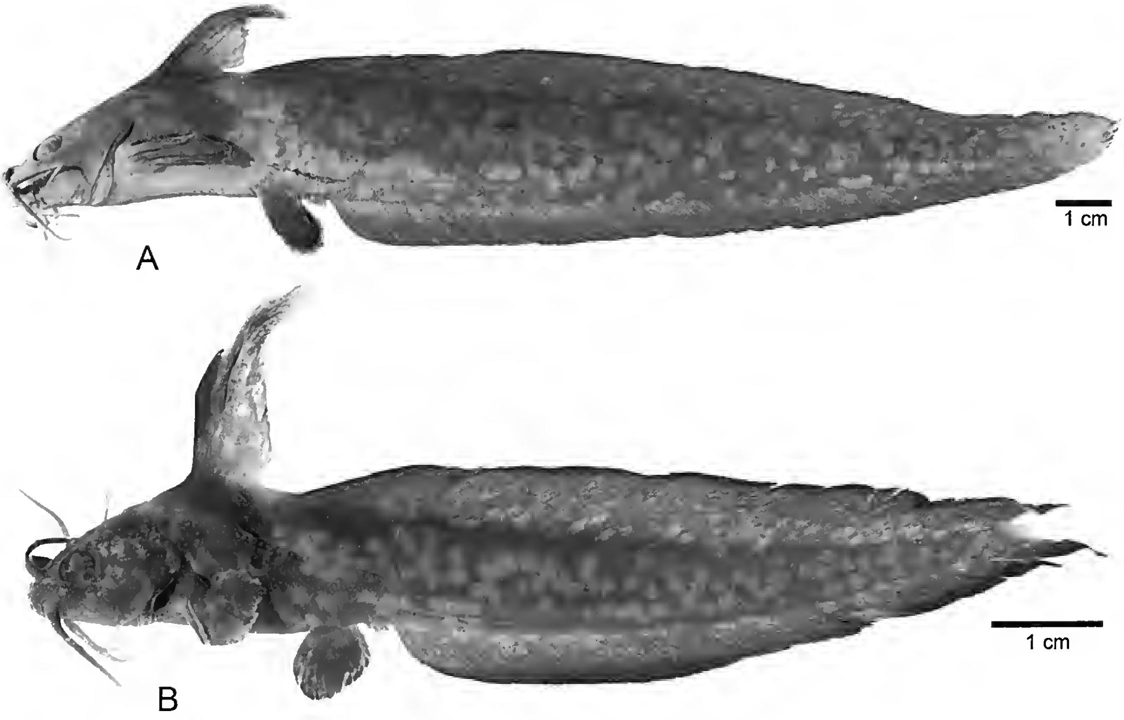

Fig. 6. A, *Euristhmus microceps* from Shark Bay, Western Australia, Australia (WAM P.30166-017, 209 mm TL); **B,** *Euristhmus microceps* from Shark Bay, Western Australia, Australia (WAM P.30081-001, 96 mm TL). Images by Sandra J. Raredon.

to 25°31.030'S, 113°32.6245'E, WAM P.32381-001 (1, 243); Shark Bay, Cape Peron North, 25°30'S, 113°33'E, 13 m, WAM P.32477-001 (1, 243); Shark Bay, 25°56'S, 113°32'E, 0.5–2.5 m, WAM P.30166-017 (1, 209); Shark Bay, 26°09'S, 113°13'E, 1.0–1.5 m, WAM P.30081-001 (1, 96); Cape Lesueur, 47.62 km west of cape, 25°36.736'S, 113°14.478'E, WAM P.32439-002 (1, 192). NORTHERN TERRITORY: North of Goulburn Islands, 60 m, NTM S.11897-017 (1, 96).

Diagnosis. *Euristhmus microceps* is distinguished from its congeners by the combination of its elongate first dorsal fin that is equal to or greater than head length, and its mottled body coloration. The adpressed first dorsal-fin tip of *E. microceps* reaches almost to a vertical line through the anal-fin origin (vs. adpressed first dorsal-fin tip not approaching a vertical line through the anal-fin origin in all other *Euristhmus* species except for *E. sandrae* n.sp.). The coloration of the body is mottled (vs. body coloration solid brown, gray, tan, or whitish in all congeners). *Euristhmus microceps* is the only species in the genus for which no specimen examined had more than 99 anal-fin rays (67–99 vs.77–117 in congeners) and second-dorsal fin rays not exceeding 107 (72–107 vs.79–136 in congeners). For proportional measurements within the genus (Table 1), *E. microceps* has the greatest ratio between body depth and head length (0.552–0.859, μ = 0.691), the greatest ratio between pelvic-fin length and head length (0.428–0.537, μ = 0.497), and the greatest ratio between pelvic-fin length and preanal length (0.191–0.264, μ = 0.230). First dorsal fin is proportionally longer in juveniles than in adults.

Description. As for genus, except as indicated below.

First dorsal-fin rays: II,3(2), II,4(3), II,5(5). Second dorsal-fin rays: 72(1), 83(1), 96(1), 100(3), 102(1), 103(2), 107(1). Anal-fin rays: 67(1), 79(1), 80(1), 85(1), 86(1), 87(1), 90(1), 93(1), 99(2). Pectoral-fin rays: I,9(3), I,10(5), I,11(5). Pelvic-fin rays: 11(3), 12(7), 13(6). Preanal vertebrae: 18(4), 19(4), 20(1). Anal vertebrae: 52(1), 61(1), 62(1), 65(1), 67(1), 68(2), 78(1), 80(1).

In the holotype and in two other specimens (WAM P.30258-003 and WAM P.32381.001), numerous raised neuromasts are visible on the head. Jaw teeth are larger and more numerous than in congeners. Nasal barbels of the holotype and a second specimen (WAM P.30258-003) are very long, extending to the base of the first dorsal fin.

Coloration of preserved material. Head and body mottled with large white spots. Large dusky brown spot near lateral line ventral to base of first dorsal fin. Anal fin and second dorsal fin with black distal margin. Filamentous first dorsal-fin ray black.

Distribution. Shark Bay, Western Australia, to Goulburn Islands, Northern Territory, in nearshore habitats as deep as 60 m over soft bottoms (Fig. 4).

Remarks. The venter of the holotype has been sutured. This is likely the result of the examination of the gut mentioned in the original description (Richardson 1845).

Euristhmus microphthalmus new species

(Figs 1A, 2C, 4, 7; Tables 1–2)

Type material. HOLOTYPE – AUSTRALIA, NORTHERN TERRITORY: Woods Inlet, Darwin Harbour, 12°30'S, 130°45'E, coll. H. Larson and R. Williams, 16 March 1984, NTM S.11242-001 (1, 367). PARATYPES (15, 81–283) – AUSTRALIA, NORTHERN TERRITORY: Beagle Gulf, mouth of Buffalo Creek, 0–1 m, coll. D. Rennis and R. Williams, 10 August 1983, AMS I.23944-002 (2, 204–235); Beagle Gulf, mouth of Buffalo Creek, coll. S. Reader, D. Beechy and R. Williams, 13 September 1984, AMS I.24689-012 (2, 164–258); mouth of East Alligator River, 0–2 m, 12°05.39'S, 132°32.1'E, coll. H. Larson and party, 2 June 1997, NTM S.14456-010 (5, 81–150); Woods Inlet, Darwin Harbour, same data as holotype, NTM S.11242-040 (2, 252–270). INDONESIA, WEST PAPUA: Bintuni, 0–1 m, coll. G.R.

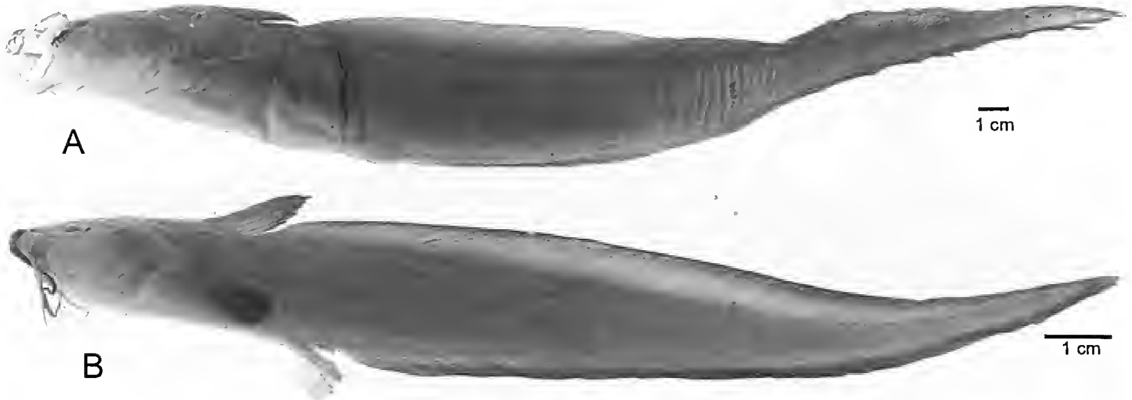

Fig. 7. **A**, *Euristhmus microphthalmus* (holotype) from Northern Territory, Australia (NTM S.11242-001, 367 mm TL); **B**, *Euristhmus microphthalmus* (paratype) from Northern Territory, Australia (AMS I.24689-012, 164 mm TL). Images by Sandra J. Raredon.

Allen, 22 March 1989, 02°07'S, 133°31'E, WAM P.29959-003 (1, 270); Bintuni Bay, 02°20'S, 133°25'E, coll. G.R. Allen, 6 April 1989, WAM P.29974-047 (1, 201); Bintuni Bay, coll. S. Viada, 5 February 2001, UF 11756 (1, 169); Bintuni Bay, 25–35 m, coll. S. Viada, 5 February 2001, UF 11762 (1, 283).

Non-type material. 9 specimens, 127–365 mm TL. AUSTRALIA, NORTHERN TERRITORY: South of Cape Shield, north of Groote Eylandt, 13°24'S, 136°20'E, NTM S.10943-009 (1, 355); mangrove creek at mouth of Towns River, 14°54.89'S, 135°25.82'E, NTM S.14042-030 (1, 290); east side of East Alligator River mouth, 12°05.68'S, 132°38.29'E, NTM S.14656-011 (1, 128); south of Orontes Reef, Cobourg Peninsula, 11°06'S, 132°04'E, NTM S.12445-035 (1, 305); east end Pocock's Beach, West Alligator Head, 12°11.33'S, 132°13.30'E, NTM S.14424-008 (1, 345); seaward off Buffalo Creek, Shoal Bay, 12°21'S, 130°55'E, NTM S.12488-001 (1, 127); Micket Creek, 0–1 m, 12°21'S, 130°57'E, AMS I.23941-028 (1, 139); Woods Inlet, Darwin Harbour, 12°30'S, 130°45'E, NTM S.13019-001 (1, 177); Joseph Bonaparte Gulf, 14°12.79'S, 128°41.27'E, NTM S.14355-023 (1, 365).

Diagnosis. *Euristhmus microphthalmus* is distinguished from its congeners in having a small eye, whose length is less than 13% of head length (0.095–0.124, $\mu = 0.113$). For other proportional measurements within the genus (Table 1), *E. microphthalmus* has the greatest ratio between head width and head length (0.706–0.868, $\mu = 0.771$) and the least ratio between eye length and preanal length (0.046–0.063, $\mu = 0.053$).

Description. As for genus, except as indicated below.

First dorsal-fin rays: I1,4($\underline{6}$), I1,5(4). Second dorsal-fin rays: 79(1), 93(1), 95(1), 112(1), 114(1), 117(1), 123(1), 127(2), 129($\underline{1}$), 136(1). Anal-fin rays: 83(1), 85(1), 93(1), 101(1), 102(1), 103(1), 106(1), 108(1), 112(1), 116(1), 117($\underline{1}$). Pectoral-fin rays: I,9(5), I,10($\underline{5}$), I,11(2). Pelvic-fin rays: 10(1), 11(5), 12($\underline{10}$). Preanal vertebrae: 17(1), 18(3), 19($\underline{7}$). Anal vertebrae: 37(1), 49(1), 61(1), 64(1), 65(1), 70(1), 71(1), 78($\underline{2}$), 80(1), 108(1).

Vomerine tooth patch large and deep, 4–6 teeth deep at midline. Nasal barbel long, reaching to nape and sometimes beyond first dorsal-fin origin. Leading edge of pectoral fin gently curved. Second dorsal-fin origin not contiguous with base of first dorsal fin; adpressed first dorsal fin sometimes not reaching second dorsal fin. Distance from pectoral-fin terminus to pelvic-fin origin sometimes as great as pelvic-fin length. Axillary area very fleshy and whitish in males.

Coloration of preserved material. Nasal barbel more blackish than other mouth barbels. Head and body dusky grey, dusky brown, or tan. Venter whitish. Pectoral fin dusky or blackish. Pelvic fin less darkly pigmented than pectoral fin. Median fins dusky to blackish, more dusky or blackish posteriorly and distally.

Distribution. Northern Territory, Australia and West Papua, in nearshore habitats over soft bottoms (Fig. 4).

Etymology. The name, *microphthalmus*, is from the Greek *micro*, small, and *ophthalmus*, eye, in reference to the small eye of this species in comparison to its congeners.

Remarks. Hardenberg (1941) reported *Cnidoglanis nudiceps* from Merauke, West Papua, Indonesia, and mentioned that his specimens had a "much smaller eye" than the type specimen. Although we did not examine Hardenberg's specimens or any specimens from Merauke, we speculate that Hardenberg's specimens were conspecific with the new species described here, based on the reported small size of the eye and the distribution of the species.

Euristhmus nudiceps (Günther, 1880)

(Figs 2D, 4, 8, 9; Tables 1–2)

Cnidoglanis nudiceps Günther, 1880: 49 (Arafura Sea).

Exilichthys nudiceps. – Whitley 1933: 65 (new combination).

Euristhmus nudiceps. – Gloerfelt-Tarp and Kailola 1984: 69 (new combination).

Material examined. 92 specimens, 102–340 mm TL. AUSTRALIA, QUEENSLAND: Gulf of Carpentaria, 16°48'S, 139°30'E, AMS I.15557-039 (2, 172–183); near Torres Strait, Cape York, 11°37'S, 142°56'E, 16–18 m, AMS I.20771-081 (8, 184–309); Lindeman Island, 20°27'S, 149°03'E, AMS IA.6731-2 (3, 261–280); 6 km E of North East Point, Port Clinton entrance, 22°28.17'S, 150°48.44'E, AMS I.34364-008 (3, 170–265); Townsville, ANSP 122318 (1, 221). NORTHERN TERRITORY: Arafura Sea, BMNH 1879.5.14.590 (1, 232), holotype of *Cnidoglanis nudiceps;* north of Cape Wessel, Arafura Sea, 09°56'S, 136°55'E, NTM S.12069-003 (1, 248); north of Arnhem Land, Arafura Sea, 84 m, 10°02'S, 133°58'E, AMS I.21847-008 (4, 218–338); north-east of Goulburn Islands, Arafura Sea, 10°21'S, 134°23'E, NTM S.12263-002 (1, 280); north

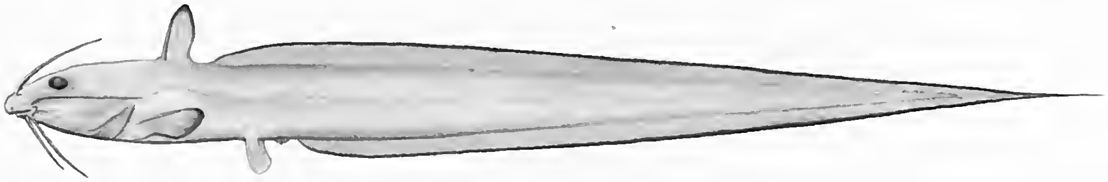

Fig. 8. *Euristhmus nudiceps*. Drawing by Janet R. Gomon, specimen not indicated.

Fig. 9. *Euristhmus nudiceps* from Western Australia, Australia (AMS I.20771-081, 309 mm TL). Image by Sandra J. Raredon.

of Goulburn Islands, Arafura Sea, 10°17'S, 133°35'E, NTM S.12268-006 (2, 153–270); Melville Island, 10°51'S, 130°43'E, NTM S.331-001 (1, 248); *ibid.*, NTM S.332-001 (1, 250); *ibid.*, NTM S.333-001 (1, 265); *ibid.*, NTM S.334-001 (1, 248); *ibid.*, NTM S.335-001 (1, 267); *ibid.*, NTM S.432-001 (1, 210); *ibid.*, NTM S.433-001 (1, 177); ibid., NTM S.434-001 (1, 248); *ibid.*, NTM S.435-001 (1, 245); *ibid.*, NTM S.436-001 (1, 225); *ibid.*, NTM S.437-001 (1, 194); *ibid.*, NTM S.438-001 (1, 255); 6 km north of Jones Shoal, Cobourg Peninsula, 10°53'S, 132°17'E, NTM S.614-001 (1, 226); *ibid.*, NTM S.616-001 (1, 210); *ibid.*, NTM S.618-001 (1, 270); *ibid.*, NTM S.588-001 (1, 230); *ibid.*, NTM S.589-001 (1, 140); *ibid.*, NTM S.590-001 (1, 265); *ibid.*, NTM S.591-001 (1, 271); *ibid.*, NTM S.446-001 (1, 235); north of Smith Point, Cobourg Peninsula, 10°58'S, 132°10'E, NTM S.10031-039 (8, 102–340); north of Arnhem Land, Arafura Sea, 11°01'S, 132°03'E, 32–33 m, AMS I.21830-018 (1, 303); west of Orontes Reef, Cobourg Peninsula, 11°04'S, 132°06'E, NTM S.12434-038 (1, 136); *ibid.*, NTM S.12536-033 (4, 200–275); *ibid*, NTM S.12445-034 (1, 255); NE of Point Charles, Beagle Gulf, 12°14.64'S, 130°41.46'E, NTM S.13283-019 (1, 181); Shoal Bay, 12°18'S, 130°58'E, NTM S.12490-001 (1, 147); off Lee Point, Shoal Bay, 12°19'S, 130°54'E, NTM S.12487-001 (2, 182–182); north of Bowra Shoals, Fog Bay, 12°42'S, 130°11'E, NTM S.13001-003 (1, 185); Joseph Bonaparte Gulf, Timor Sea, 14°05'S, 129°05'E, NTM S.13378-013 (5, 150–220). WESTERN AUSTRALIA: Joseph Bonaparte Gulf, 13°43'S, 128°38'E, WAM P.25712-001 (7, 137–225); Joseph Bonaparte Gulf, 14°31.51'S, 128°52.13'E, NTM S.14353-009 (3, 118–191); Bonaparte Archipelago, Admiralty Gulf, 14°00'S, 124°25'E, 60 m, AMS I.20402-039 (1, 317); York Sound, NTM S.26-001 (1, 192); (?) Hampton Harbour, AMS IB.3093 (1, damaged); Exmouth Gulf, 22°S, 114°E, AMS IB.3004 (1, 156); Exmouth Gulf, 22°05'S, 114°15'E, AMS I.33311-001 (4, 183–247); Exmouth Gulf, Badjirrajirra Creek, 22°07'S, 114°12'E, WAM P.32621.008 (3, 181–213).

Diagnosis. *Euristhmus nudiceps* is distinguished from its congeners in having the dorsoposterior portion of the cranium visible through the skin, and the vomerine tooth patch broadly curved posteriorly and thin being only 2 or 3 teeth deep in the midline. In addition, the abdomen is speckled with tiny brown spots. For proportional measurements within the genus (Table 1), *E. nudiceps* has the least ratio between pelvic-fin length and head length (0.225–0.393, μ = 0.321), the least ratio between nape height and head length (0.529–0.641, μ = 0.592), the least ratio between pectoral-fin length and head length (0.442–0.669, μ = 0.548), the least ratio between pectoral-fin length and preanal length (0.210–0.333, μ = 0.268) and the least ratio between pelvic-fin length and preanal length (0.109–0.196, μ = 0.156).

Description. As for genus, except as indicated below.

First dorsal-fin rays: II,3(2), II,4(8). Second dorsal-fin rays: 89(1), 95(1), 97(1), 99(1), 112(1), 115(1), 116(1), 117(1), 119(2). Anal-fin rays: 77(1), 87(2), 88(1), 92(1), 99(1), 103(1), 106(1), 109(1), 111(1). Pectoral-fin rays: I,8(1), I,9(3), I,10(3), I,11(2). Pelvic-fin rays: 10(1), 11(2), 12(5). Preanal vertebrae: 18(4), 19(5), 20(1). Anal vertebrae: 43(1), 53(1), 55(1), 56(1), 66(1), 75(1), 77(2), 79(1), 81(1).

Distance from terminus of pectoral fin to pelvic-fin origin greater than pelvic-fin length. Second dorsal-fin origin not contiguous with posterior base of first dorsal fin. Adpressed first dorsal-fin margin does not reach, or just barely overlaps second dorsal fin. Nasal barbels typically shorter than in congeners, barbels extend posteriorly only to nape.

Coloration of preserved material. Head and body tannish to light brown. Second-dorsal, anal, and caudal fins distally black for their entire length. First-dorsal and pectoral fins distally blackened. Abdomen speckled with microscopic brown dots.

Distribution. Exmouth Bay, Western Australia, to Moreton Bay, Queensland, Australia, in nearshore habitats as deep as 84 m over soft bottoms (Fig. 4).

Remarks. Paxton *et al.* (1989) list BMNH 1879.5.14.590 as the holotype for *Cnidoglanis nudiceps*. The Natural History Museum in London lists a second specimen (BMNH 1890.2.26.165) taken during the *Challenger* expedition from the Arafura Sea that may also have been examined by Günther, although there is no evidence in the original description that more than one specimen was examined.

Table 1. Ranges and means of selected morphometric measures of *Euristhmus*. Head length and preanal length are abbreviated as HL and PL, respectively.

Morphometric measure	*E. lepturus*			*E. microceps*			*E. microphthalmus* n. sp.			*E. nudiceps*			*E. sandrae* n. sp.		
	n	mean	range	n	mean	range	n	mean	range	n	mean	range	n	mean	range
Pelvic–fin length/HL	10	0.402	0.325–0.482	9	0.497	0.428–0.537	12	0.463	0.382–0.558	10	0.321	0.225–0.393	2	0.453	0.406–0.500
Pectoral–fin length/HL	20	0.655	0.461–0.807	17	0.671	0.553–0.829	22	0.658	0.542–0.762	17	0.548	0.442–0.669	4	0.699	0.605–0.832
Preanal length/HL	10	1.951	1.862–2.240	9	2.177	1.974–2.425	12	2.163	1.920–2.440	10	2.058	1.933–2.211	2	2.461	2.341–2.580
Head width/HL	10	0.705	0.642–0.756	9	0.754	0.686–0.799	12	0.771	0.706–0.868	10	0.654	0.584–0.739	2	0.666	0.601–0.731
Snout – D1 origin/HL	10	1.123	0.948–1.240	9	1.135	1.110–1.193	12	1.130	0.983–1.190	10	1.129	1.067–1.194	2	1.200	1.150–1.250
Interorbital width/HL	10	0.290	0.244–0.339	9	0.278	0.256–0.292	12	0.264	0.231–0.339	10	0.246	0.214–0.279	2	0.247	0.214–0.279
Nape height/HL	10	0.653	0.560–0.733	9	0.701	0.565–0.795	12	0.657	0.589–0.768	10	0.592	0.529–0.641	2	0.636	0.613–0.659
Body depth/HL	10	0.537	0.460–0.615	9	0.691	0.552–0.859	12	0.638	0.522–0.806	10	0.550	0.482–0.603	2	0.680	0.653–0.707
Opercle height/HL	10	0.583	0.512–0.706	9	0.616	0.540–0.703	12	0.594	0.526–0.677	10	0.552	0.503–0.629	2	0.564	0.546–0.582
Eye length/HL	10	0.162	0.135–0.195	9	0.209	0.191–0.242	12	0.113	0.095–0.124	10	0.157	0.124–0.187	2	0.248	0.226–0.269
Head length/PL	10	0.496	0.446–0.537	9	0.461	0.412–0.507	12	0.465	0.409–0.522	10	0.487	0.452–0.517	2	0.408	0.388–0.427
Pelvic–fin length/PL	10	0.218	0.145–0.392	9	0.230	0.191–0.264	12	0.215	0.175–0.288	10	0.156	0.109–0.196	2	0.186	0.157–0.214
Pectoral–fin length/PL	20	0.327	0.206–0.387	17	0.308	0.252–0.391	22	0.305	0.264–0.363	17	0.268	0.210–0.333	4	0.287	0.235–0.355
Head width/PL	10	0.350	0.303–0.383	9	0.348	0.316–0.390	12	0.358	0.323–0.397	10	0.319	0.272–0.363	2	0.270	0.257–0.283
Snout – D1 length/PL	10	0.557	0.507–0.621	9	0.524	0.459–0.591	12	0.525	0.470–0.586	10	0.550	0.482–0.606	2	0.489	0.486–0.491
Interorbital length/PL	10	0.143	0.128–0.156	9	0.129	0.108–0.146	12	0.123	0.103–0.162	10	0.131	0.108–0.239	2	0.101	0.083–0.119
Nape height/PL	10	0.324	0.250–0.368	9	0.325	0.243–0.396	12	0.304	0.277–0.344	10	0.289	0.268–0.321	2	0.259	0.237–0.281
Body depth/PL	10	0.265	0.246–0.303	9	0.318	0.239–0.389	12	0.295	0.250–0.331	10	0.267	0.236–0.292	2	0.278	0.253–0.302
Opercle height/PL	10	0.289	0.238–0.328	9	0.285	0.234–0.327	12	0.275	0.233–0.310	10	0.269	0.238–0.313	2	0.230	0.212–0.248
Eye length/PL	10	0.081	0.060–0.102	9	0.096	0.084–0.121	12	0.053	0.046–0.063	10	0.076	0.062–0.089	2	0.101	0.097–0.104

Table 2. Selected meristic counts or ranges for species of *Euristhmus*. Count or range in holotype or lectotype is underlined.

	Second dorsal-fin rays												
	72–79	80–84	85–89	90–94	95–99	100–104	105–109	110–114	115–119	120–124	125–129	130–135	136–140
E. lepturus					1			7	4		1		
E. microceps	1	1			1	6	1						
E. microphthalmus n. sp.	1			1	1			2	1	1	3		1
E. nudiceps			1		3			1	5				
E. sandrae n. sp.						1		1					

	Anal-fin rays									First dorsal-fin rays		
	67–79	80–84	85–89	90–94	95–99	100–104	105–109	110–114	115–119	11,3	11,4	11,5
E. lepturus			1		2	5	5			1	6	6
E. microceps	2	1	3	2	2					2	3	5
E. microphthalmus n. sp.		1	1	1		3	2	1	2		6	4
E. nudiceps	1		3	1	1	1	2	1		2	8	
E. sandrae n. sp.						1		1			2	

	Anal vertebrae														
	35–40	41–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89	90–95	96–99	100–104	105–108
E. lepturus					1			2	10						
E. microceps				1		2	4		1	1					
E. microphthalmus n. sp.	1		1			2	1	2	2	1					1
E. nudiceps		1		1	2		1		4	1					
E. sandrae n. sp.									2						

	Preanal vertebrae				Pectoral-fin rays				Pelvic-fin rays			
	17	18	19	20	1,8	1,9	1,10	1,11	10	11	12	13
E. lepturus		3	6	4		7	8	3	2	5	10	
E. microceps		4	4	1		3	5	5		3	7	6
E. microphthalmus n. sp.	1	3	7			5	5	2	1	5	10	
E. nudiceps		4	5	1	1	3	3	2	1	2	5	
E. sandrae n. sp.			1	1	2						1	

At the time of our examination of the holotype, the pelvic and pectoral fins were missing and only the base of the first dorsal fin was present.

Euristhmus sandrae new species

(Figs 2E, 4, 10; Tables 1–2)

Type material. HOLOTYPE – AUSTRALIA, WESTERN AUSTRALIA: Exmouth Gulf, 21°42'S, 114°48'E, 9 m, coll. S. M. Morrison, 3 November 2004, WAM P.32730.001 (1, 148). PARATYPE – AUSTRALIA, WESTERN AUSTRALIA: south of Rowley Shoals, Northwest Shelf, 18°12'S, 118°41'E, 76–80 m, coll. B. Russell and Northern Territory Observers team, 1 June 1985, NTM S.11673-030 (1, 217).

Diagnosis. *Euristhmus sandrae* is distinguished from its congeners in having a whitish tan body coloration and an elongate first dorsal fin that is greater than head length and reaches to, or beyond, a vertical line with the anal-fin origin. All fins are violet-black. This species differs from all examined congeners (except for one specimen of *E. nudiceps*) in having only 8 branched pectoral-fin rays. For proportional measurements within the genus (Table 1), *E. sandrae* has the greatest ratio between preanal length and head length 2.34–2.58, $\mu = 2.46$), the greatest ratio between eye length and head length (0.226–0.269, $\mu = 0.248$), and the least ratio between snout to first-dorsal fin origin and preanal length (0.486–0.491, $\mu = 0.489$). [As more specimens of this species are examined and measured, the above ratios may change significantly].

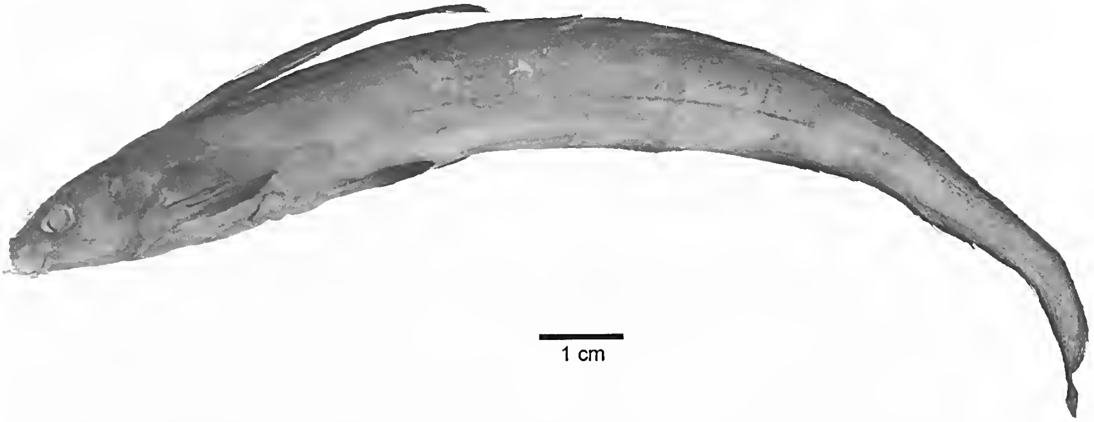

Fig. 10. *Euristhmus sandrae* n. sp. (holotype) from Western Australia, Australia (WAM P.32730-001, 148 mm TL). Image by Sandra J. Raredon.

Description. As for genus, except as indicated below.

First dorsal-fin rays: II,4(2). Second dorsal-fin rays 102(1), 114(1). Anal-fin rays: 100(1), 111(1). Pectoral-fin rays: I,8(2). Pelvic-fin rays: 12(1). Preanal vertebrae: 19(1), 20(1). Anal vertebrae: 76(1), 78(1). [As the pectoral and pelvic-fin rays of the holotype cannot be counted without cutting and damaging the specimen, counts for these fins were not reported].

Vomerine tooth patch crescentic, only two rows of teeth in midline. Nasal barbel reaching almost to nape. Maxillary barbel not reaching opercle in holotype but extending to middle of operculum in paratype.

Coloration of preserved material. Nasal barbel more blackish than other mouth barbels, which are whitish. Head and body whitish tan, without mottling. Dusky area located dorsal to pectoral fin. Tiny, dusky speckles on body. Slightly larger dusky speckles ventrally on body and covering isthmus. All fins violet-black.

Etymology. The name, *sandrae*, honours Sandra J. Raredon of the National Museum of Natural History, Smithsonian Institution, U.S.A., who contributed greatly to this study and others undertaken by the authors.

Distribution. Western Australia, from south of Rowley Shoals and Exmouth Gulf, in waters as deep as 80 m over soft bottoms (Fig. 4).

ACKNOWLEDGMENTS

We appreciate the fine hospitality extended to us by Mark McGrouther when we visited AMS. Similarly, one of us (CJF) received a warm reception from Helen Larson and Barry Russell when he visited NTM. We also wish to thank Mark Sabaj (ANSP), Ralf Britz (BMNH), David Catania (CAS), Mary Anne Rogers (FMNH), Chris Thacker (LACM), and Barry Hutchins and Glenn Moore (WAM) for the loan of specimens from their collections and information about them. Richard Vari (NMNH) generously provided space for us to work on this project and facilitated loans of specimens. Janet R. Gomon allowed us to use the exquisitely-rendered drawings of *Euristhmus microceps* and *E. nudiceps* that she had originally intended for another publication. Peter Unmack provided the basemap. Our special thanks go to Sandra J. Raredon (NMNH) who expertly radiographed specimens used in this study and made digital images of the specimens illustrated herein. This study is part of the All Catfish Species Inventory, a five-year project supported by the US National Science Foundation (NSF DEB-0315963). Any opinion, findings and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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Accepted 11 July 2006

The Beagle, Records of the Museums and Art Galleries of the Northern Territory, 2006 **22**: 91–97

Art, ichthyology, Charles Darwin and the Northern Territory of Australia

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ABSTRACT

This paper reflects on the antiquity and continuation of depictions of fishes dating back 24 000 years as highlighted by some specific illustrations. The earliest Aboriginal depictions of fishes date to about 8000 years ago. An Aboriginal x-ray bark painting of a barramundi, *Lates calcarifer* (Centropomidae), by Jimmy Njiminumna is juxtaposed with a modern scientific illustration of a barramundi skeleton by Christopher May. A recent commissioned x-ray painting of a nurseryfish, *Kurtus gulliveri* (Kurtidae), from the Adelaide River by Joshua Bangarr represents the first known Aboriginal drawing of this species. Some fishes named in honour of Charles Darwin and the Port of Darwin are discussed. A drawing from 1878 of a jawfish, *Opistognathus darwiniensis* (Opisthognathidae), described from Darwin Harbour and a 1911 drawing of the gudgeon, *Mogurnda mogurnda* (Eleotridae), described from Port Essington in 1844, are presented.

Keywords: Aboriginal art, barramundi, Charles Darwin, Port of Darwin, *Lates calcarifer, Kurtus gulliveri, Mogurnda mogurnda, Opistognathus darwiniensis,* prehistoric art, scientific illustration, skeleton.

INTRODUCTION

Symbolic engravings appeared in the archaeological repertoire of anatomically modern *Homo sapiens* in the Middle Stone Age of southern Africa 77 000 years ago (Henshilwood *et al.* 2002). About 40 000 years ago, at the beginning of the Upper Paleolithic in Europe, an explosion of image-making coincided with a major cultural transformation that included musical instruments, new kinds of tools and weapons, fired ceramics, weaving, and long-distance trade (White 2003). Traditionally, the oldest cave paintings in the world were radiocarbon dated from about 32 000 years ago in Chauvet Cave of the Ardèche region of France (Clottes *et al.* 1996, Clottes 2003; Wong 2005). Recent developments in radiocarbon dating methodology indicate that the spectacular menagerie of Ice Age animals drawn in ochre in the galleries of Chauvet Cave can now be said to date from about 36 000 years BP in real terms as compared to about 32 000 years BP in radiocarbon terms (Mellars 2006a). Klingender (1971) comprehensively reviewed animals in art.

People have been depicting fishes for millennia. The oldest known fish representation is a salmon sculpted in the roof of the 'Shelter of the Fish' at Les Eyzies, in the Dordogne River region of France about 24 000 years ago (Ruspoli 1987). A pike is engraved along the back of a horse at Pech-Merle in the Lot River region of France. This site is 20 000 years old (Ruspoli 1987). The Magdalenian culture (18 000–11 000 years ago) of Western and Central Europe represents the apogée of Palaeolithic art and Lascaux Cave (France) is its most notable example (Ruspoli 1987; White 2003). Depictions of salmon, trout, pike, sole and eel, although rare on rock walls, were more commonly etched on small artifacts of reindeer antler and bone (mobiliary art) from Middle-Magdalenian sites about 14 000 years ago (Ruspoli 1987; Moyle and Moyle 1991).

The style and materials used by artists is a reflection of the culture from which the artist comes. This includes an indigenous taxonomy and totemic system used by the people of that culture. Similarly, scientific illustrators are guided by principles and conventions (e.g., Weitzman 2003) and aided by available technology such as camera lucidae, stereoscopic microscopes and computer graphics. Moyle and Moyle (1991) introduced a series of 80 papers detailing many forms of fish imagery in art in *Environmental Biology of Fishes* from 1991–1995. Whitehead (1991) described what he termed "scientific surrealism" which involves the combination of incongruous images as in a dream. This surely reached its peak with the fish art of Ray Troll (2004).

ABORIGINAL ICHTHYOLOGY AND SCIENTIFIC ILLUSTRATION

An emerging consensus points to the arrival of humans in Australia shortly after 60 000 years ago (Roberts and Jones 2001), although some authorities consider this date speculative and contested, and prefer a more conservative estimate of 45 000 BP (Mellars 2006b). The oldest known Aboriginal campsites may date back to an upper limit of 60 000 years ago in Kakadu National Park at the foot of the western escarpment of the Arnhem Land plateau (Roberts *et al.* 1990). Used pieces of haematite and red ochre-impregnated grindstone from the Kakadu area suggest pigment use 50 000 years ago (Chaloupka 1993). Some of the earliest representations of fishes were made by Aboriginal rock artists during the Estuarine Period 8000–1500 years ago (Chaloupka 1993). White (2003) considered the Estuarine Period as 6000–1500 years ago. Mulvaney and Kamminga (1999) discussed alternative schemes for dating and classifying different motifs, but they also noted areas of concordance among the various approaches. Sixteen fish taxa from fresh, brackish, and marine waters have been identified by Chaloupka (1993) in the rock art of the Arnhem Land Plateau (Table 1). A similar list of 11 species is given by Taylor (1987). The greatest concentration of fish images is found in shelters near the lower reaches of the East Alligator River. The most commonly represented species (barramundi, fork-tailed catfish and mullet) were of economic importance to the local people, and they are rendered with substantial accuracy (Taylor 1987; Chaloupka 1993). Commonly illustrated freshwater species from the middle reaches of northern rivers include archerfish, sooty grunter, long tom, saratoga and eel-tailed catfish.

X-ray paintings are so called because they are naturalistic depictions that show skeletal or iconically motivated motifs to represent internal organs such as the spinal column, heart and digestive tract (Taylor 1987; Mulvaney and Kamminga 1999). Taylor (1987), in his analysis of both mundane and esoteric ceremonial encoded meanings in Kunwinjku bark paintings from western Arnhem Land, showed how their x-ray art is basically iconic, that is, it reflects the naturalistic features of particular species. Iconicity is defined as the formal resemblance between the painted form and the object or species represented. The artists say that the depicted organs "look like" the organs they represent as opposed to geometric, cross-hatched or parallel line infill x-ray motifs that symbolise some organs or body regions (Taylor 1987). The organs (or species) are meant to be obvious to other Kunwinjku or even Europeans familiar with the species under discussion.

Figure 1 is a representative x-ray painting of a barramundi from the collection of the Museum and Art Gallery of the Northern Territory (hereafter NTM) (ABART-0660). The natural pigments on bark painting was done by the late Jimmy Njiminjuma of Maningrida in 1979 and is entitled Namarngol the Barramundi. The vertebral column with neural and haemal spines is shown as white dashes and chevron-shaped marks along the length of the middle of the body. The crescent-shaped white structure below the spinal column represents the swim bladder atop the brown stomach. A long wavy intestine leaves the ventral surface of the stomach and exits the body posteriorly. The lateral line is correctly shown extending onto the rounded caudal fin. This feature is characteristic of the family Centropomidae. Sensory pores are also represented on the head. The long spiny dorsal fin joins the rounded soft dorsal fin posteriorly, and the concave head slope is accurately depicted. This indicates a high degree of realism based upon observation and familiarity with the species, and the naturalistic x-ray infill is typical of items restricted to the pragmatic realm of food (Taylor 1987). Other examples of Njiminjuma's art are discussed by Taylor (1987: plates 4.14, 8.20), and a Njiminjuma Rainbow Serpent is reproduced in Isaacs (1980: 63).

Table 1. Fishes depicted in Arnhem Land rock art, updated from Chaloupka (1993), and their corresponding Aboriginal name, widely understood by Western Arnhem Land peoples. Paintings of these fishes are illustrated in Chaloupka's *Journey in Time*. The phylogenetic arrangement of families follows Nelson (1994) and Berra (2001).

Family	Species	Common Name	Aboriginal Name
Carcharhinidae	*Carcharhinus leucas*	Bull shark	
Pristidae	*Pristis microdon*	Freshwater sawfish	
Dasyatidae	*Dasyatis fluviorum*	Estuary stingray	
Osteoglossidae	*Scleropages jardinii*	Gulf saratoga	Guluibirr
Megalopidae	*Megalops cyprinoides*	Oxeye herring	Garlalba
Clupeidae	*Nematolosa erebi*	Bony bream	Nabardebarde
Plotosidae	*Anodontiglanis dahli*	Toothless catfish	Nagurl
Plotosidae	*Neosilurus ater*	Black catfish	Binijdjarrang
Plotosidae	*Neosilurus* sp.	Eel-tailed catfish	Ganbaldjdja
Ariidae	*Ariopsis leptaspis*	Fork-tailed catfish	Almakkawarri
Mugilidae	*Liza alata*	Diamond mullet	Madjabarr
Belonidae	*Strongylura kreffti*	Freshwater longtom	Burrugulung
Centropomidae	*Lates calcarifer*	Barramundi	Namarngorl
Toxotidae	*Toxotes chatareus*	Common archerfish	Njarlgan
Toxotidae	*Toxotes lorentzi*	Primitive archerfish	
Terapontidae	*Hephaestus fuliginosus*	Sooty grunter	Nagenjhmi (male) Galarrk (female)

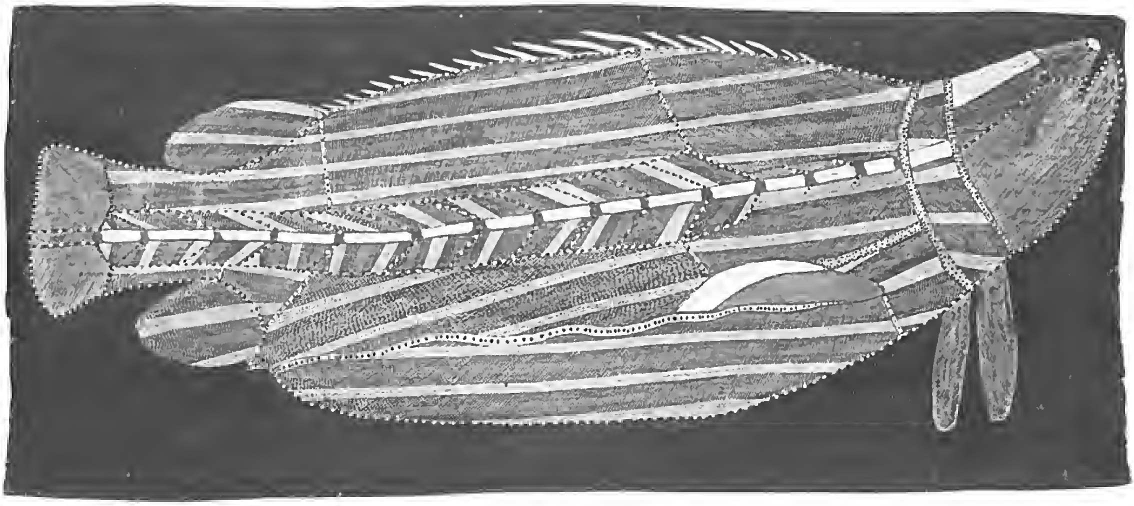

Fig. 1. X-ray painting, natural pigments on bark, Namarngol the Barramundi, by Jimmy Njiminjuma from the collection of the NTM ABART-0660. 124 x 55 cm. © Jimmy Njiminjuma licensed by Viscopy, Australia, 2005. Photo by Gilbert Herrada.

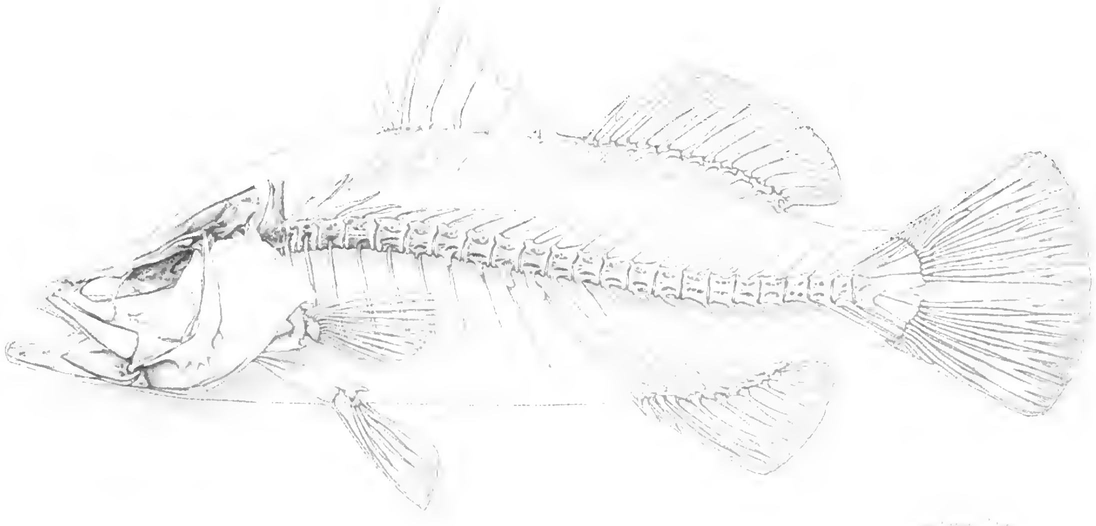

Fig. 2. Barramundi skeleton in colour pencil by Christopher May. The actual total length of the drawing is 538 mm. © Christopher May.

Figure 2 is a recent scientific illustration of the barramundi's skeleton drawn in coloured pencil by Queensland artist, Christopher May. The skeleton was prepared as a display specimen for the NTM in the late 1980s by Ian Archibald and Andrew Cappo. There are no recorded collection data for it, but the specimen's total length is 1080 mm. This illustration shows the exact number of vertebrae (25, Nelson 1994), protruding lower jaw with small teeth, serrated preopercle and the very large mouth typical of barramundi. The first dorsal fin has seven spines. One spine precedes the second dorsal fin and its 11 branched soft rays. Three anal spines precede the eight soft anal rays. Greenwood (1976) reviewed the osteology of centropomids including *Lates*.

The x-ray painting is obviously more stylised than the scientific illustration, but it is nevertheless clearly recognisable as a barramundi. Both representations are aesthetically pleasing and objects of beauty from the cultures they represent. Their appeal is cross-cultural.

The nurseryfish, *Kurtus gulliveri* Castelnau (Perciformes: Kurtidae), is an unusual fish found in fresh and brackish waters of northern Australia and southern New Guinea (Berra 2003). This species has a remarkable method of egg brooding. The male carries the eggs on a hook on his head like a bunch of grapes (Weber 1913; de Beaufort 1914). Until 2001 when I began fieldwork on the Adelaide River, the most recent papers published on this species were the two references cited above. The seven recent papers published on nurseryfish biology to date are referenced by Berra *et al.* (2004). This species is unknown to local people. No representation of nurseryfish is present in the art collection of the NTM. Local Aboriginal artists did not recognise the fish when I showed them photographs or specimens, and they have no word for this species in their language. Barramundi anglers almost never catch nurseryfish. So poorly was this fish known that several people in Darwin called the local radio station to express disbelief that such a fish existed when my research was discussed on the ABC radio in 2001. The only group aware of its existence was the commercial barramundi fishers who caught it in their gill nets, and referred to it as "breakfast fish". Dennis McCarthy of the Didgeridoo Hut and Art Gallery south of Darwin arranged for Joshua Bangarr, a well-known Kunwinjku artist from Arnhem Land, whose work appears in *Images in Ochre* (Parker 1997), to draw a male and female nurseryfish for me from photographs I supplied. This drawing is reproduced as Figure 3. It was done with the fibrous stem of a freshwater reed pared to the thickness required for undertaking the fine line work in the artist's Yirridja moiety group (D. McCarthy, pers. comm.). The four ochre colours are used: yellow, red, white, black. The artist captured the essential sexual dimorphism of the male's supraoccipital hook. The concave snout, long anal fin and deeply forked caudal fin

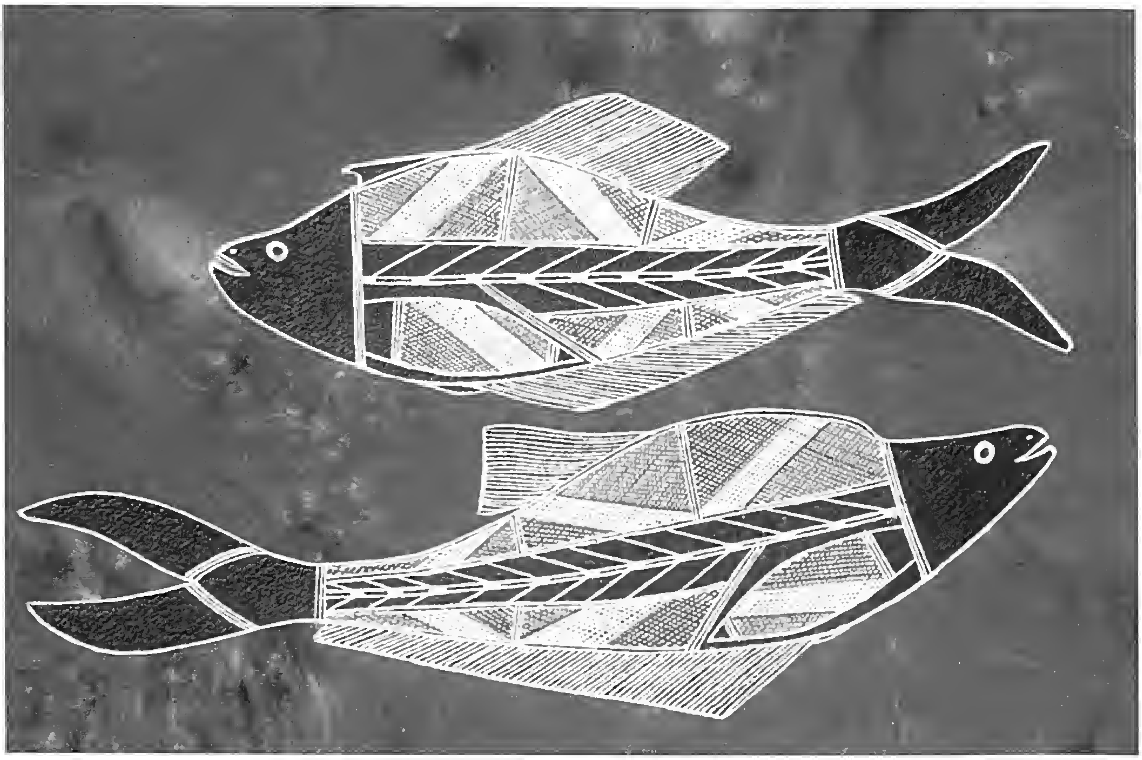

Fig. 3. Male (top) and female nurseryfish, *Kurtus gulliveri*, by Joshua Bangarr from the private collection of the author. X-ray painting on fibreboard (cropped) 58 x 41 cm.

are accurately represented. The painting is also an x-ray image with a naturalistic vertebral column and oval shaped stomach depicted in a geometric type of infill.

CHARLES DARWIN, THE NORTHERN TERRITORY AND NEW FISH SPECIES DESCRIPTIONS

Charles Darwin collected 137 fish species during the voyage of the *Beagle* from 1831–1836. The vast majority of those were described by Jenyns (1840–1842). From the scholarship of Pauly (2004), we know that Darwin commented on 91 species of mostly European fishes in his publications, notebooks and correspondence. Seventeen fish species have been named after Charles Darwin. *Gephyroberyx darwinii,* Darwin's roughy, is an example of such an eponym. This member of the Trachichthyidae was originally described as *Trachichthys darwinii* by Johnson (1866) from deep water off Madeira, but now is known from around the world including western and southern Australia in waters about 270–825 m deep. The Australian name of roughy is due to the large, sharp ventral scutes (Wheeler 1975). This species can reach 46 cm and is remarkably long-lived, up to 149 years (Fenton *et al.* 1991).

A number of fish species were named after the Port of Darwin. Such second order eponyms include *Lates darwiniensis* Macleay (1878), which is a junior synonym of *Lates calcarifer* (Bloch), the barramundi (Paxton *et al.* 1989). The Darwin jawfish, *Opistognathus darwiniensis,* was described by Macleay (1878) from Port Darwin (Fig. 4). This Australian member of the Opistognathidae is known from Ningaloo Reef, Western Australia to the Gulf of Carpentaria. It inhabits shallow reefs in sandy or rubble areas and can reach 50 cm. It is distinguished by the presence of yellow and brown bands on its fins (Allen 2000). Jawfish live in burrows that they construct themselves and enter tail first. Figure 4 resembles a sketch a scientist might make in a field notebook rather than a formal scientific illustration. It does not attempt to represent the individual scale count or pattern. While not possessing the artistic elegance of Figure 5, it does convey the essential scientific information required for a new species description. The bulbous head with large mouth and canine teeth, tapering narrow body, pelvic fins positioned anteriorly to pectoral fins, and lateral line canals embedded in the skin clearly assign this fish to the Opistognathidae (Smith-Vaniz 2000). In this way Figure 4 may also be considered an iconic illustration not unlike Figures 1 and 3. A modern colour painting of *Opistognathus darwiniensis* can be found in Allen (2000).

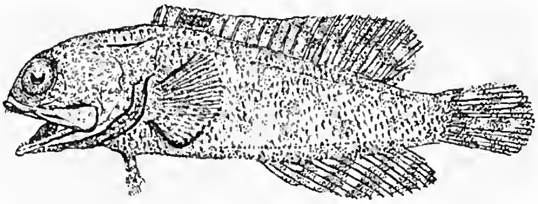

Fig. 4. The Darwin jawfish, *Opistognathus darwiniensis*. The actual total length of the drawing as it appeared in Macleay (1878: pl. 9, fig. 3) was only 50 mm.

Larson and Martin (1990) listed 17 taxa of fishes described as new to science from fresh waters of the Northern Territory. One of these, the purple-spotted gudgeon, *Mogurnda mogurnda* (Richardson), was described from Port Essington. This species is widespread in vegetated streams of the Timor and Gulf of Carpentaria drainages, southern New Guinea and parts of inland Lake Eyre drainage in the Northern Territory. It commonly reaches 10 cm, may grow to 17.5 cm, is colourful, especially the males during courtship, and breeds readily in captivity. Figure 5 is a portrait by J. F. Obbes of *M. mogurnda* from Weber (1911) that shows two to three diagonal dark bands radiating from below the eye across the operculum and the distinctive series of seven to eight

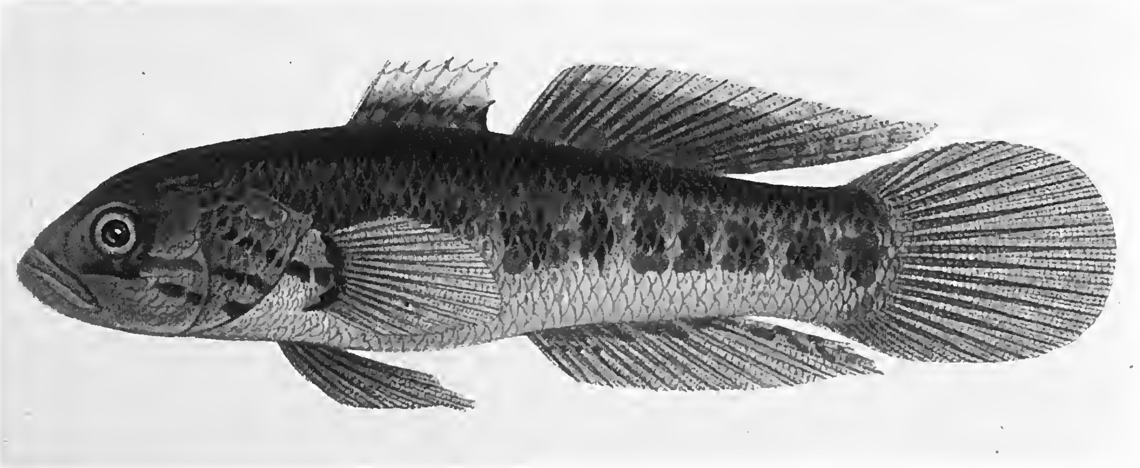

Fig. 5. The purple-spotted gudgeon, *Mogurnda mogurnda*, drawn by J. F. Obbes and reproduced from Weber (1911: pl. 1, fig. 1).

purple and red blotches along the flanks of the body (Larson and Martin 1990; Allen *et al.* 2002). Scales and fin spines and rays are accurately depicted as they should be in a scientific illustration while the overall impression is aesthetically pleasing.

It may be suggested that the portrayal of fishes by artists represents a sliding scale of differences in which certain iconic similarities exist according to the particular requirements and cultural orientations of the illustrator. Aboriginal and indigenous artists of different cultures use fish images that are more symbolic to convey a message or an abstract idea. Scientific illustrators convey a precise essence of the animal itself for a practical application. Fine artists that delve into exact likenesses of fishes and use science to fuel their creative fires, blur the distinctions. An example of the latter include the fish paintings of Tasmanian convict-artist William Buclow Gould, so imaginatively portrayed in the literary masterpiece *Gould's Book of Fish* by Australian novelist Richard Flanagan (2001).

ACKNOWLEDGMENTS

I am grateful to M. West whose suggestions greatly improved the manuscript and for suggesting the barramundi x-ray painting and to G. Herrada for photographing it. The NTM provided permission to reproduce this work (RR5004/359). Christopher May graciously allowed the reproduction of his barramundi skeleton drawing. The nurseryfish painting would not have existed without the talent of J. Bangarr and the thoughtfulness of D. McCarthy. Figure 4 was photographed by J. Smith of Ohio State University Libraries, and S. Hasley arranged the rather obscure interlibrary loans. Ichthyologists T. Pietsch, W. Anderson, B. Burr, P. Moyle and artists R. Troll and J. Thrasher commented on early versions of the manuscript. I appreciate all this assistance.

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Accepted 8 June 2006

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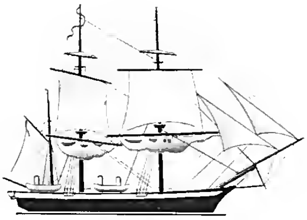

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