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## **Sepioloidea magna sp. nov.: a new bottletail squid (Cephalopoda : Sepiadariidae) from northern Australia**

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**Keywords**

cephalopoda, sepiadariidae, northern, sepioloidea, australia, magna, sp, nov, bottletail, squid

**Disciplines**

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## ***Sepioloidea magna* sp. nov.: a new bottletail squid (Cephalopoda : Sepiadariidae) from northern Australia**

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### ABSTRACT

Examination of specimens of *Sepioloidea* d'Orbigny, 1845, from northern Australia led to the discovery of a new species. It is described here as *Sepioloidea magna* sp. nov. It is distinguished from the other nominal *Sepioloidea* species, *S. lineolata* (Quoy & Gaimard, 1832) and *S. pacifica* (Kirk, 1882), by its size, number of tentacular club suckers, absence of obvious colour pattern and the modification of the hectocotylus.

KEYWORDS: Cephalopoda, Sepiadariidae, *Sepioloidea*, bottletail squid, Australia.

### INTRODUCTION

A new species of sepiadariid (= bottletail) squid was discovered in the collection of the Museum and Art Gallery of the Northern Territory, Darwin, during a visit in 2008. It occurs in relatively deep water (225–300 m) in the Arafura Sea north of Darwin, Australia, and south of the eastern Indonesian island of Kep, Tanimbar Islands. It is assigned here to the genus *Sepioloidea* d'Orbigny, 1845, which presently contains only two species: *S. lineolata* (Quoy and Gaimard, 1832) and *S. pacifica* (Kirk, 1882). This new taxon is unusual among the Sepiadariidae Fischer, 1882 in being quite large, with one mature female examined here measuring 61.9 mm mantle length. In addition, other sepiadariids possess striking fixed colour patterns, a trait not seen in this species, which (in preserved specimens) appears dull in colour and not patterned.

Unfortunately the specimens are in less than perfect condition, typical of animals trawled from depth. Some features, such as the funnel organ, and features of the internal anatomy could not be seen clearly in any of the specimens examined so it cannot be fully described. However, this animal is so distinct from the other two representatives of the genus, that I have no hesitation in describing it as a new species.

### MATERIALS AND METHODS

Terminology, measurements, indices, and abbreviations for anatomical structures follow Roper and Voss (1983), with a few minor differences (Table 1). In the current paper, ASC refers to the total number of suckers on each designated arm. This abbreviation refers to the number of suckers on the basal half of each arm in Roper and Voss (1983), with ASCT used there for the total number of arm suckers. As it is difficult to determine a reliable halfway measure, the

utility of counting the suckers on the basal half of the arm only is dubious and is not used here. All measurements are in millimetres (mm).

Other abbreviations: MV – Museum Victoria, Melbourne; NTM – Museum and Art Gallery Northern Territory (formerly Northern Territory Museum), Darwin.

For scanning electron microscopy, arms and club suckers were removed, mounted, then air dried and examined in a JOEL JEM LA 6490 (Japan Electron Optics Ltd. Japan) scanning electron microscope operated at 15 kV.

### TAXONOMY

#### ***Sepioloidea* d'Orbigny, 1845**

Gender feminine. Type species, by monotypy, *Sepioloidea lineolata* Quoy and Gaimard, 1832. Recent (temperate and tropical) Australia.

**Diagnosis.** Sepiadariid coleoids with body short; fins narrow, located medially on each side of body. Mantle fused with head in occipital area; mantle and funnel locking cartilage with 2 components. Arms joined by a wide web; web forms deep sheath around base of tentacles. Left ventral arm hectocotylised; suckers absent distally, pedicels modified forming series of transverse lamellae. Gladius absent. Light organs absent.

#### ***Sepioloidea magna* sp. nov.**

(Figs 1–7; Tables 1 and 2)

**Material examined.** HOLOTYPE – NTM P.41686, 1♂ (45.7 mm ML, possibly submature), Australia, Northern Territory, Arafura Sea, 82 nm due north of Cape Van Diemen, Melville Island, 9°47'S, 130°26'E, 225 m, coll. D. Evans on FV *Invincible*, 9 December 1990.

PARATYPES – NTM P.41641, 2♀ (60.0 mm ML, mature; 49.5 mm ML, submature), Northern Territory, Arafura Sea, 8°47'S 132°21'E, 274 m, coll. J. Todd on FV *Orion*,

**Table 1.** Description of measurements and counts. Definitions largely follow Roper and Voss (1983). New or modified definitions are indicated by an asterisk (\*). Indices (shown in square brackets) are calculated by expressing each measure as a percentage of mantle length.

Arm Length – <b>AL</b>	length of each designated (i.e. 1, 2 etc.) arm measured from first basal (proximal-most) sucker to distal tip of arm (Arm 1, dorsal; 2, dorso-lateral; 3, ventro-lateral; 4, ventral) [ <b>ALI</b> ].
Arm Sucker Count * – <b>ASC</b>	total number of suckers on each designated arm (e.g. ASC2).
Arm Sucker diameter – <b>AS</b>	diameter of largest normal sucker on each designated (i.e. 1, 2 etc.) arm [ <b>ASIn</b> ].
Club Length – <b>CIL</b>	length of tentacular club measured from proximal-most basal suckers (carpus) to distal tip of club [ <b>CILI</b> ].
Club Row Count – <b>CIRC</b>	number of suckers in transverse rows on tentacular club.
Club Sucker diameter – <b>CIS</b>	diameter of largest sucker on tentacular club [ <b>CISI</b> ].
Egg Diameter – <b>EgD</b>	diameter of largest egg present in the ovary or oviduct [ <b>EgDI</b> ].
Eye Diameter – <b>ED</b>	diameter of eye [ <b>EDI</b> ].
Fin Insertion – <b>FI</b>	length of fin as joined to mantle [ <b>FII</b> ].
Fin Insertion anterior * – <b>FIIa</b>	anterior origin of fin measured from mantle margin to anterior-most junction of fin and mantle [ <b>FIIa</b> ].
Fin Width – <b>FW</b>	greatest width of single fin [ <b>FWI</b> ].
Free Funnel length – <b>FFu</b>	the length of the funnel from the anterior funnel opening to the point of its dorsal attachment to the head [ <b>FFuI</b> ].
Funnel Length – <b>FuL</b>	the length of the funnel from the anterior funnel opening to the posterior margin measured along the ventral midline [ <b>FuLI</b> ].
Head Length – <b>HL</b>	dorsal length of head measured from point of fusion of dorsal arms to anterior tip of nuchal cartilage [ <b>HLI</b> ].
Head Width – <b>HW</b>	greatest width of head at level of eyes [ <b>HWI</b> ].
Mantle Length – <b>ML</b>	dorsal mantle length. Measured from anterior-most point of mantle to posterior apex of mantle.
Mantle Width – <b>MW</b>	greatest straight-line ventral width of mantle [ <b>MWI</b> ].

4 June 1999; P.1387, 1 ♀ (55.9 mm ML, mature), Arafura Sea, north of Melville Island, 9°46'S, 130°14'E, 270–300 m, coll. Northern Territory Fisheries, 15 September 1987; NTM P. 41687, 5 ♀ (53.0, 58.7, 61.9 mm ML, mature; 35.5, 39.5 mm ML, submature), Arafura Sea, 82 nm due north of Cape Van Diemen, Melville, Island, 9°47'S, 130°26'E, 255 m, coll. D. Evans on FV *Invincible*, 9 December 1990.

**Diagnosis.** Mantle length in mature females up to approx. 60 mm. Colouration in preserved specimens bland, pale purplish grey, with tiny chromatophores (no stripes or spots). Hectocotylus structure: basal half of left ventral arm normal, distal half devoid of suckers, with approximately 22 rows of flap-like lappets that are bilobed dorsally, swollen in proximal 12 rows (approximately); ventral lappets consist of thin flaps joined distally to dorsal lappets. Tentacular club with approx. 40 transverse rows of minute suckers.

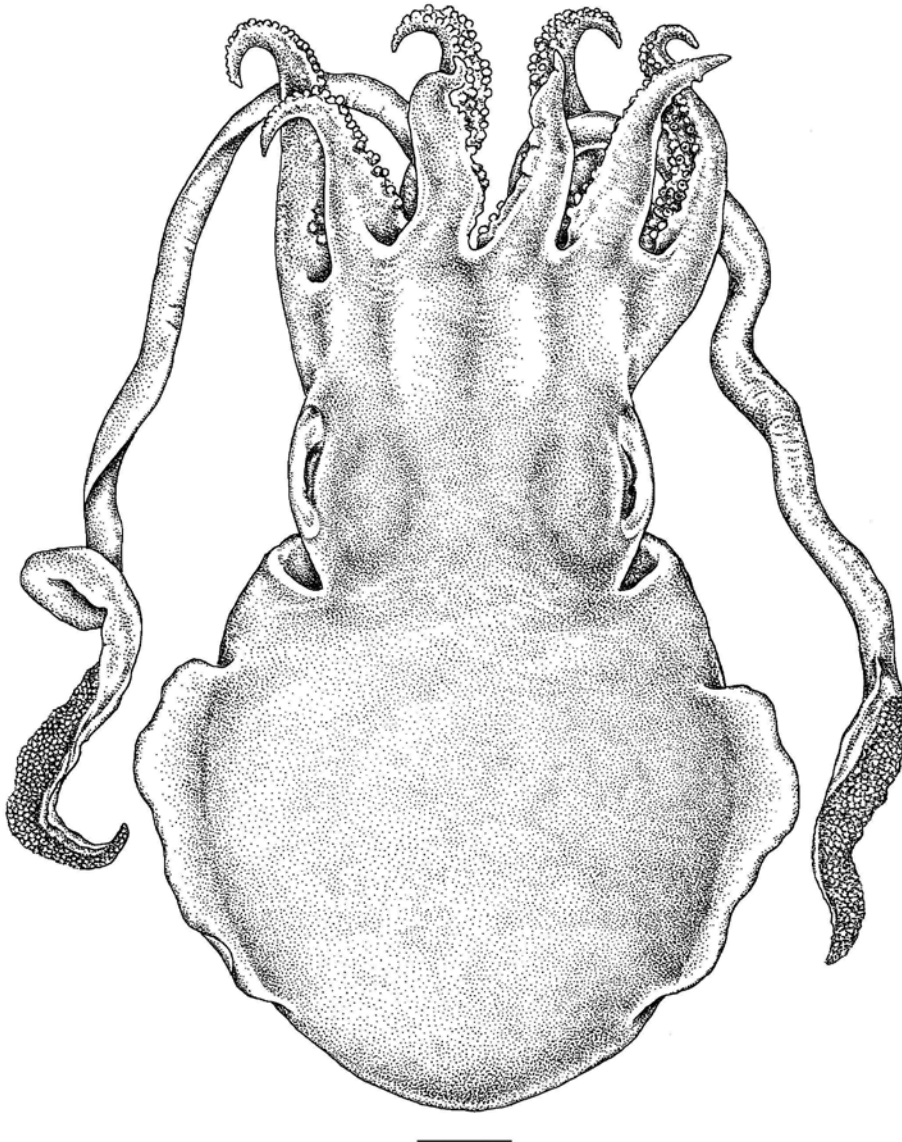
**Description.** Counts and indices for individual specimens are given in Table 2.

Species moderate size: ML male 45.7, females 39.5–54.1–61.9 (*SD*, 7.7; *n* = 7). Mantle short, broad, cylindrical in anterior half to two-thirds, rounded posteriorly; MWI male 81.0, females 75.0–87.5–96.7 (*SD*, 10.2; *n* = 6). Fins rather small, narrow, ear-like; fin length approximately 75% ML, FIIa male 20.6, females 22.5–26.0–29.9 (*SD*, 2.5; *n* = 6); fin width about 20% ML, FWI male 15.5, females 10.5–18.0–25.5 (*SD*, 5.6; *n* = 7), attached laterally between 1st and 4th quarters of mantle; posterior margins curved, tapered; anterior margins convex without well-developed lobes, lateral lobes crescentric. Anterior edges of fins do not project to level of anterior mantle margin (Fig. 1).

Funnel long, conical, base broad, tapered and projects anteriorly slightly beyond anterior margin of eye (Fig. 2A); FuLI male 53.6, females 48.5–61.2–72.7 (*SD*, 8.4; *n* = 7); free for most of its length, FFuI male 32.8, females 25.0–28.4–30.7 (*SD*, 2.6; *n* = 7). Funnel valve small, rounded anteriorly. Dorsal funnel organ structure not able to be determined (damaged in all specimens). Funnel locking cartilage with broad, deep anterior hollow and shallow, longer and narrower posterior groove. Mantle cartilage compliments funnel member with prominent anterior lobe and much smaller posterior lobe (Fig. 2B).

Head broader than long in both sexes, HLI male 70.9, females 55.4–71.2–89.6 (*SD*, 12.6; *n* = 7); HWI male, 72.6, females 56.5–71.0–80.0 (*SD*, 7.9; *n* = 7), narrower than mantle width. Eyes moderate in size, EDI male 17.7, females 13.1–15.8–20.2 (*SD*, 2.6; *n* = 7); ventral eyelids not free, eyes covered by transparent membrane; small olfactory pore present on latero-posterior surface of head, behind eye.

Arms robust, broad basally, tapered distally; order variable, arms 1 typically slightly shorter than other arm pairs (Table 2). Arm length index of longest arm in male (ALI3) 101.3, females (ALI3) 76.7–87.1–101.3 (*SD*, 9.0; *n* = 7). All arms similar in shape, semicircular to subtriangular in section; indistinct keels present on median aboral sides of arms. Sucker pedicels short, each with curved bilobed lappets on posterior margin. Arms suckers biserial proximally for about 10 rows, tetraserial distally; spherical throughout. Suckers on distal half of right ventral arm 4 of males, widely spaced, two rows on each side, arm fleshy medially. Largest arm suckers on each arm all of similar size. Suckers largest basally; smaller and crowded on distal arm



**Fig. 1.** *Sepioloidea magna* sp. nov.: dorsal view, female paratype, NTM P.41687, 53.0 mm ML, scale bar 10 mm.

tips. In male, basal 2–3 rows of suckers enlarged on arms 2 and 3 and to lesser extent on arm 4. Largest suckers on arms 4 smaller than those on arms 1. Suckers similar sized on all arms of females. Sucker counts range from 100–166 on each arm, mean sucker counts on arms 1–4 in females 119, 128, 143 and 141, respectively. All arms connected by relatively deep web, and bordered by shallow scalloped protective membranes.

Chitinous rims of all arm suckers with crenulated inner ring. Infundibulum with 7–10 rows of hexagonal processes with blunt pegs (Fig. 3A).

Left ventral arm of males hectocotylosed. Suckers normal in size and shape; biserial arrangement basally for 12 rows, tetraserial for next 4–5 rows. Arm modified distally for approximately half its length; suckers absent, with 22 rows of flap-like bilobed lappets on dorsal side of arm. Dorsal lappets quite swollen for proximal 12 rows (approximately). Ventral lappets not bilobed, thin flaps joined distally to dorsal lappets. Deep furrow between dorsal and ventral lappets (Fig. 4A).

Tentacles long, slender, stalks naked, semicircular in section; oral surface convex. Club long (Fig. 4B), exceeds half mantle length CILI male 54.7, females 58.2–66.0–75.1 (*SD*, 6.9; *n* = 6), not expanded, diameter uniform through most of length, tip tapers to blunt end distally. Suckers 0.15–0.20 mm diameter in centre of club; arranged in 39–42 oblique rows. Narrow swimming keel on aboral side of carpus extends posteriorly to slightly beyond carpus. Keel forms slight groove on oral side. Proximal third of keel widest.

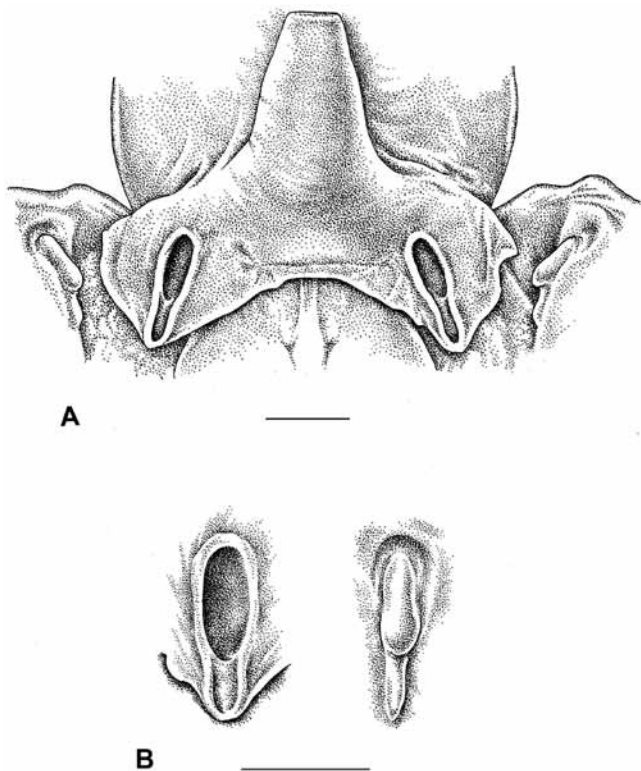
Gills in all specimens in poor or damaged condition, hence number of lamellae per demibranch could not be determined.

Dentition of club suckers (Fig. 3B): inner ring with blunt teeth; teeth well defined on half of rim, rest indistinct. Infundibulum with round-ovate polygonal processes without pegs. At periphery, polygonal processes smaller, subrectangular.

Buccal membrane with 6 lappets; suckers absent. Females with deep buccal pouch on ventral side, formed from

**Table 2.** *Sepioloidea magna* sp. nov.: measurements (mm), counts and indices.

Museum Reg. no.	NTM P.41686 holotype	NTM P.41687 paratype	NTM P.41641 paratype	NTM P.41687 paratype	NTM P.1387 paratype	NTM P.41687 paratype	NTM P.41641 paratype	NTM P.41687 paratype
Sex	male	female	female	female	female	female	female	female
ML	45.7	39.5	49.5	53.0	55.9	58.7	60.0	61.9
MWI	81.0	95.4	76.4	96.6	84.8	75.0	96.7	–
FWI	15.5	19.0	18.2	25.5	24.3	16.2	10.5	12.6
FIIa	20.6	26.6	26.3	24.5	29.9	22.5	–	26.2
FII	21.9	58.7	–	–	–	54.5	–	53.8
FuLI	53.6	67.1	72.7	60.4	53.1	59.6	66.7	48.5
FFuI	32.8	30.4	26.3	30.2	30.4	25.6	25.0	30.7
HLI	70.9	89.6	55.4	70.4	86.9	63.4	65.0	67.9
HWI	–	80.0	76.0	75.1	68.3	66.6	74.5	48.3
EDI	17.7	13.9	18.2	20.2	15.0	13.1	16.2	13.7
ALI1	65.6	78.5	78.8	75.5	71.6	69.8	80.0	74.3
ALI2	76.6	88.6	70.7	83.0	96.6	–	83.3	67.9
ALI3	78.8	101.3	88.9	96.2	85.9	76.7	80.0	80.8
ALI4	78.8	88.6	82.8	88.7	91.2	71.6	91.7	77.5
ASIn1	4.16	3.54	2.83	2.83	2.86	2.39	2.33	2.26
ASIn2	6.35	3.54	3.03	2.83	2.50	2.56	2.33	2.26
ASIn3	6.35	3.29	3.23	3.21	2.86	2.39	2.67	2.58
ASIn4	3.06	3.29	3.03	2.64	2.15	2.21	2.83	2.26
ASC1	76	116	126	128	134	100	118	112
ASC2	80	114	132	134	134	–	134	120
ASC3	100	140	143	152	152	130	144	138
ASC4	104	140	126	166	152	122	134	144
CILI	54.7	63.3	60.6	73.6	75.1	–	65.0	58.2
CIRC	–	41	42	40	42	39	40	40
CISI	–	0.51	0.40	0.38	0.36	0.34	0.25	0.32
EgDI	–	–	–	16.8	16.1	15.3	20.8	17.6



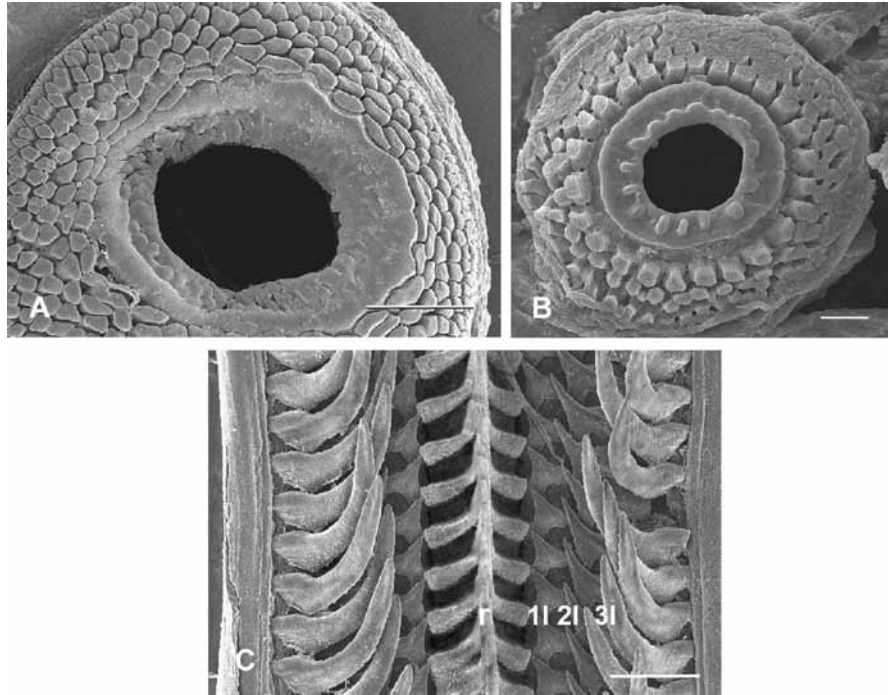
**Fig. 2.** *Sepioloidea magna*, sp. nov. **A**, funnel, female paratype, NTM P.41687, 53.0 mm ML, scale bar 10 mm; **B**, funnel locking cartilage (left) and mantle locking cartilage (right), same specimen, scale bar 10 mm.

expanded buccal membrane. Numerous spermatophores present in buccal pouch of all but smallest two specimens examined. Spermatophores also present attached to buccal mass in several specimens.

Upper and lower beaks (Fig. 5). Chitin, dark brown to black, darkens gradually from rostrum to hood, crest, and lateral walls. Upper beak with pointed, slightly curved rostral edge, jaw angle obtuse, lateral wall edge with shallow indentation; hood high above crest posteriorly, crest wide. Lower beak with almost curved rostral edge, rostrum slightly protruded, jaw angle obtuse, lateral wall edge without indentation, hood notch absent, wings almost straight, widely spread.

Radula with 7 transverse rows of teeth (Fig. 3C). Rhachidian teeth with very wide, narrow, rectangular bases, taper abruptly to single straight-sided, long, fine cusps. First lateral teeth, with much broader bases, differing markedly in outline to rhachidian teeth, with broad heel basally on outer side, narrower and pointed at base on inner side; teeth with short pointed cusps displaced laterally and directed towards midline of radula. Second and third laterals with elongate bases. Second laterals with narrow, rectangular bases, similar in shape to rhachidian teeth, cusps narrow, pointed, displaced toward midline of radula. Rhachidian, first and second lateral teeth strongly concave basally. Third laterals with sabre-like teeth, longer than second laterals.

Gladius absent.



**Fig. 3.** *Sepioloidea magna*, sp. nov.: **A**, arm sucker rim, male holotype, NTM P.41686, 45.7 mm ML, scale bar 100  $\mu$ m; **B**, tentacular club sucker, female paratype, NTM P.41687, 53.0 mm ML, scale bar 100  $\mu$ m; **C**, radula, female paratype NTM P.1387, 55.9 mm ML, scale bar 200  $\mu$ m. Abbreviations: r, rhachidian tooth; 1l, first lateral tooth; 2l, second lateral tooth; 3l, third lateral tooth.

The male reproductive tract was not removed from the only available male specimen because of its poor condition.

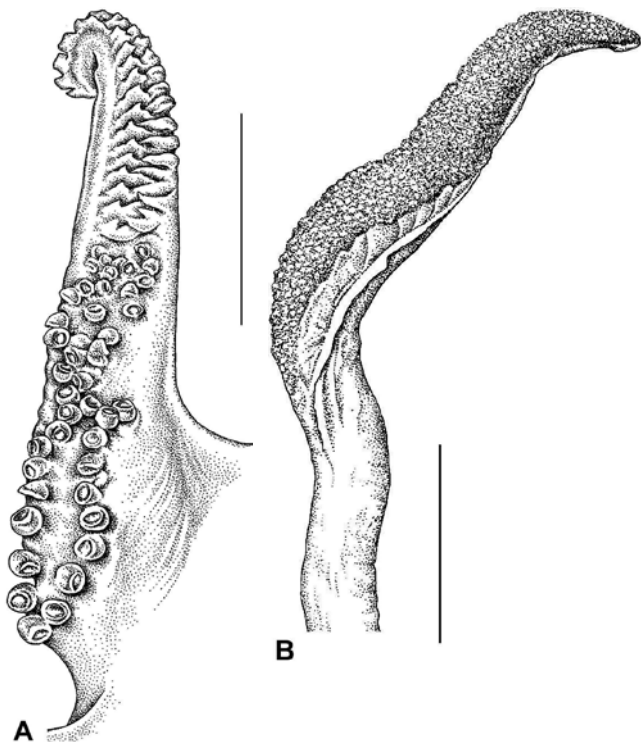
Female reproductive tract. Ovary large, occupies large proportion of posterior end of mantle cavity; displaces other organs when mature. Opens via single thick-walled

oviduct at anterior end on left side. Nidamental glands paired, broad, located ventral to ovary toward anterior end. Inverted, cream coloured, U-shaped accessory nidamental glands located toward distal end of nidamental glands. Eggs spherical, 8.9–10.9 mm diameter; EgDI 15.3–17.3–20.8 (*SD*, 2.1; *n* = 5).

Colour in alcohol cream with tiny purple chromatophores peppered evenly over mantle, fins, head and arms; chromatophores on dorsal surface of mantle, fins and head slightly darker and more concentrated than those on ventral surface.

**Type locality.** Arafura Sea, due north of Cape Van Diemen, between northern Australia and Kep, Tanimbar (Indonesia), 9°47'S, 130°26'E, 225 m.

**Distribution.** Arafura Sea, from approx. 8°47'S, 132°21'E to 9°47'S, 130°26'E. Depth range 225–300 m (Fig. 6). (It is likely that MV specimens (identified as *Sepioloidea* and occurring at similar depths to those described above) from the Northwest Shelf, Scott Reef,



**Fig. 4.** *Sepioloidea magna*, sp. nov.: **A**, hectocotylus, male holotype, NTM P.41686, 45.7 mm ML, scale bar 10 mm; **B**, tentacular club, female paratype, NTM P.41687, 53.0 mm ML, scale bar 10 mm.



**Fig. 5.** *Sepioloidea magna*, sp. nov.: upper beak (left) and lower beak (right), female paratype NTM P.1387, 55.9 mm ML, scale bar 2 mm.

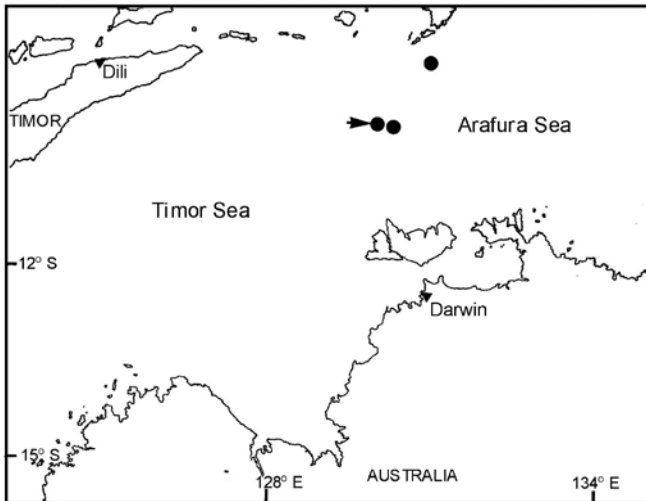


Fig. 6. *Sepioloidea magna* sp. nov. distribution. Arrow indicates the type locality.

and the Timor Sea: MV F.68177, 9°46'S, 130°17'E; MV F.68178, 18°48'S, 117°06'E; MV F.68179, 14°51'S, 121°35'E; MV F.68181, 18°29'S, 117°42'E, and MV F.68182, 18°25'S, 117°48'E, also belong to this species. However, I was not able to borrow this material. If these specimens are conspecific with this new species, its range actually extends westwards to the Timor Sea off Western Australia, to north of Dampier.)

**Etymology.** The species name, *magna*, is derived from the Latin, *magnus*, meaning large, or great and refers to the large size of this species compared to others in the genus. This specific name is adjectival in form.

## DISCUSSION

The family Sepiadariidae was erected by Fisher (1882) to include two genera, *Sepiadarium* and *Sepioloidea*. *Sepioloidea lineolata* from Jervis Bay in NSW was described by Quoy and Gaimard in 1832 and later transferred to the genus *Sepioloidea* by d'Orbigny (1845). The history of the definition of the family and its genera was reviewed in detail by Berry (1921). Over the years there have been many generic-level reclassifications and uncertainties, many of which remain.

*Sepioloidea lineolata* is widespread in Australian waters, occurring in shallow water around the southern Australian coastline. The distinct patterning of this small 'Striped Pyjama Squid' (Norman and Reid 2000) has meant that any specimens of this taxon that are collected are typically identified as *S. lineolata*. However, they need to be critically re-examined to determine whether all representatives do, in fact, belong to a single species.

*Sepioloidea pacifica* was described by Kirk in 1882 (again initially placed in the genus *Sepioloidea*) based on a specimen collected in Wellington Harbour. The original description is very brief and the type specimen has been lost. Dell (1952: 87) comprehensively redescribed the supposed species, but qualified his description by saying: "There is

no complete certainty that the species here described is conspecific with Kirk's *Sepioloidea pacifica*, but the writer has seen no other Cephalopod from New Zealand which approaches this species". The specimens Dell examined (56 males, and one female) were from Lyttelton Harbour and not the type locality, hence, he did not establish a neotype in that publication. Following the collection of additional specimens from the type locality, he did so a few years later (Dell 1959: 2).

*Sepioloidea pacifica* is now known to be widespread in New Zealand waters and has been collected from depths ranging from approx. 15–550 m from the following additional locations: *North Island*, off Tryphena, Great Barrier Island, Cape Colville, Hauraki Gulf, Hawkes Bay, Lowry Bay and Cook Strait and the *South Island*, off Cape Campbell, Middle Bank, Kaikoura, Dunedin Harbour, Mernoo Bank, the Chatham Rise, Chatham Islands and Waitangi (Powell 1979). It has also been reported from the Nazca and Sala y Gómez submarine ridges in the eastern Pacific Ocean (Parin *et al.* 1997), although these locality records in the eastern Pacific require additional verification.

*Sepioloidea lineolata* differs from *S. pacifica* based on the presence of: a fringed dorsal anterior margin (lateral to the junction of mantle and head); numerous cuticular pores on the sides and ventral surface of the head and mantle, and in the presence of longitudinal stripes on the dorsal side of the body, head and arms. In *S. pacifica* the mantle is not fringed, and the body pigment consists of numerous, small, dark chromatophores.

*Sepioloidea magna* differs from its congeners in a number of traits. *Sepioloidea lineolata* is very distinctive in having a fringed anterior mantle margin adjacent to the junction of the dorsal mantle and the head. In addition, the sides and ventral surface of the head and mantle are covered with numerous tubercles (openings of cuticular pores), from which copious quantities of slime are released when these animals are attacked or disturbed (Norman 2000). The dorsal side of the body, head and arms is banded with brownish stripes – the dramatic patterning perhaps indicative of toxicity. The club of *S. lineolata* has suckers arranged in 20 rows, while in *S. magna* the suckers are minute and arranged in approximately 40 rows.

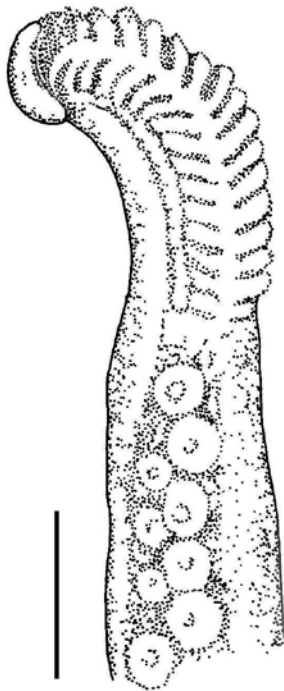
*Sepioloidea pacifica* is similar to *S. magna* in that it does not have a fringed mantle margin. It has a smooth body surface without tubercles. However, the body in *S. pacifica* is covered with numerous, small, dark chromatophores and is dark purplish to black in colour, unlike that of *S. magna*. The arms suckers are biserial in *S. pacifica* rather than tetraserial over a portion of the arms as in *S. magna*. The club of *S. pacifica* has suckers arranged in four rows. The modification of the hectocotylus also appears to differ. As described by Dell (1952: 82): "Paired furrows set somewhat obliquely render this portion of the arm rather feather-like. A deep longitudinal groove runs along the left margin". No such groove can be seen on the modified portion of the



arm in *S. magna* and the modification of the lappets is quite different as can be seen by comparing Fig. 4A and Fig. 7 (redrawn from Dell (1952)).

*Sepioloidea magna* is the largest of the three nominal species of the genus that are now known. The holotype (45.7 mm ML) did not contain spermatophores, but it is difficult to determine whether the animal is mature or may have spent the spermatophores prior to capture. The smallest mature female (i.e., containing well developed ovarian eggs) was 53.0 mm ML (Table 2).

It remains to be seen whether the Sepiadariidae represents a monophyletic group. Phylogenetic analysis of the cephalopods in general and members of the Sepioidea in particular is limited in its scope and most analyses include only a limited number of taxa. A comprehensive revision of all genera within the Sepioidea is long overdue.



**Fig. 7.** *Sepioloidea pacifica* hectocotylus (redrawn from Dell 1952, Pl. 34, fig. 4), scale bar 2 mm.

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I would like to thank Geoff Hirst, who first took me to Darwin. This trip led to a second visit to the NTM and the discovery of this species among the museum collection. I would also like to thank Richard Willan for organising my visit to the NTM in July 2008 and for being a fabulous host and support while I was there. Thanks also to Steven Gregg for preparing the loan of the NTM specimens for my examination and to Nick Mackie from the EM Unit at the University of Wollongong for help with scanning electron microscopy. I would also like to thank Kathie Hollis for producing the superb illustrations of this species, and Eric Hochberg and Takashi Okutani for their review of the manuscript and provision of many very helpful comments.

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