

Two new cuttlefishes (Cephalopoda: Sepiidae) from the North West Shelf, and a redescription of *Sepia sulcata* Hoyle, 1885

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Abstract – Two new cuttlefishes (Cephalopoda : Sepiidae), *Sepia plana* sp. nov. and *Sepia senta* sp. nov., are described, and a third species, *Sepia sulcata* Hoyle, 1885, is redescribed from the type and new Australian material. The three species are found in the Indian Ocean off northwestern Australia at depths between 505–150 m. *Sepia plana* is found in the deeper end of this range, between 505–396 m. *Sepia senta* and *Sepia sulcata* have been collected at 426–256 m, and 404–150 m respectively. *Sepia sulcata* Hoyle was known previously from a single male collected off the Ki Islands in the Arafura Sea.

INTRODUCTION

The genus *Sepia* includes approximately 100 species (Khromov *et al.* in press), and is the largest of three genera within the family Sepiidae. In the genus *Sepia*, 26 species are found in Australian waters, and 21 are endemic to this country (Lu in press, a).

As part of a broader study to revise the cuttlefish fauna of Australia, two new species from the North West Shelf, *Sepia plana* sp. nov., and *Sepia senta* sp. nov. are described in this paper. In addition, *Sepia sulcata* Hoyle, 1885 is redescribed based on new material from the North West Shelf. The latter species was known previously only from a single male specimen collected off the Ki Islands in the Arafura Sea in 1874, and described later by Hoyle (1885). Khromov *et al.* (in press) has described its status as “probably valid, but insufficiently described”. Conspecificity of the Australian animals with *S. sulcata* was confirmed by comparison with the type specimen. While the type, an immature male, differs from the more mature Australian males in the degree of modification of the hectocotylus, most other traits agree between the North West Shelf specimens and *S. sulcata*.

This finding confirms the status of *S. sulcata* as valid and extends the distribution of the species to include northwestern Australia. The redescription of this species from the type and additional material provides information which previously was not known on females and mature males of this species.

MATERIALS AND METHODS

This study is based on specimens held in various

museums. All material studied is listed in the *Material Examined* sections given with each species description. Institutional acronyms used throughout the paper are: BMNH – The Natural History Museum, London, United Kingdom; CSIRO – Commonwealth Scientific and Industrial Research Organisation, Australia; MV – Museum of Victoria, Melbourne, Australia and WAM – Western Australian Museum, Perth, Australia. Other abbreviations: coll. – collected, E – east, fms – fathoms, F – female, FV – Fisheries Vessel, Is. – Island, J – juvenile, m – metres, M – male, mm – millimetres, N – north, NW – northwest, NNW – north northwest, RV – research vessel, S – south, W – west, WNW – west northwest.

Measurements and indices used throughout this paper are primarily those given in Roper and Voss (1983), using dorsal mantle length (ML) as a size standard. Some additional measurements are used, and these with the definitions listed by Roper and Voss (1983) are given in Table 1. Parts of the club and arm sucker rims are described using the terminology of Nixon and Dilly (1977), and nomenclature for radulae follows Nixon (1995). Beaks were described following Clarke (1986). Diagrammatic illustrations of measurements and terminology used for particular structures are shown in Figure 1. With respect to the arrangement of arm and club suckers, the term ‘row’ refers to suckers positioned perpendicular to the longitudinal axis of the arm or club. ‘Series’ refer to those positioned parallel to the longitudinal axis of the arm or club.

Measurements were made either using dial callipers, or an eyepiece micrometer attached to a stereo microscope and (where possible) are given for 10 preserved specimens of each sex for each

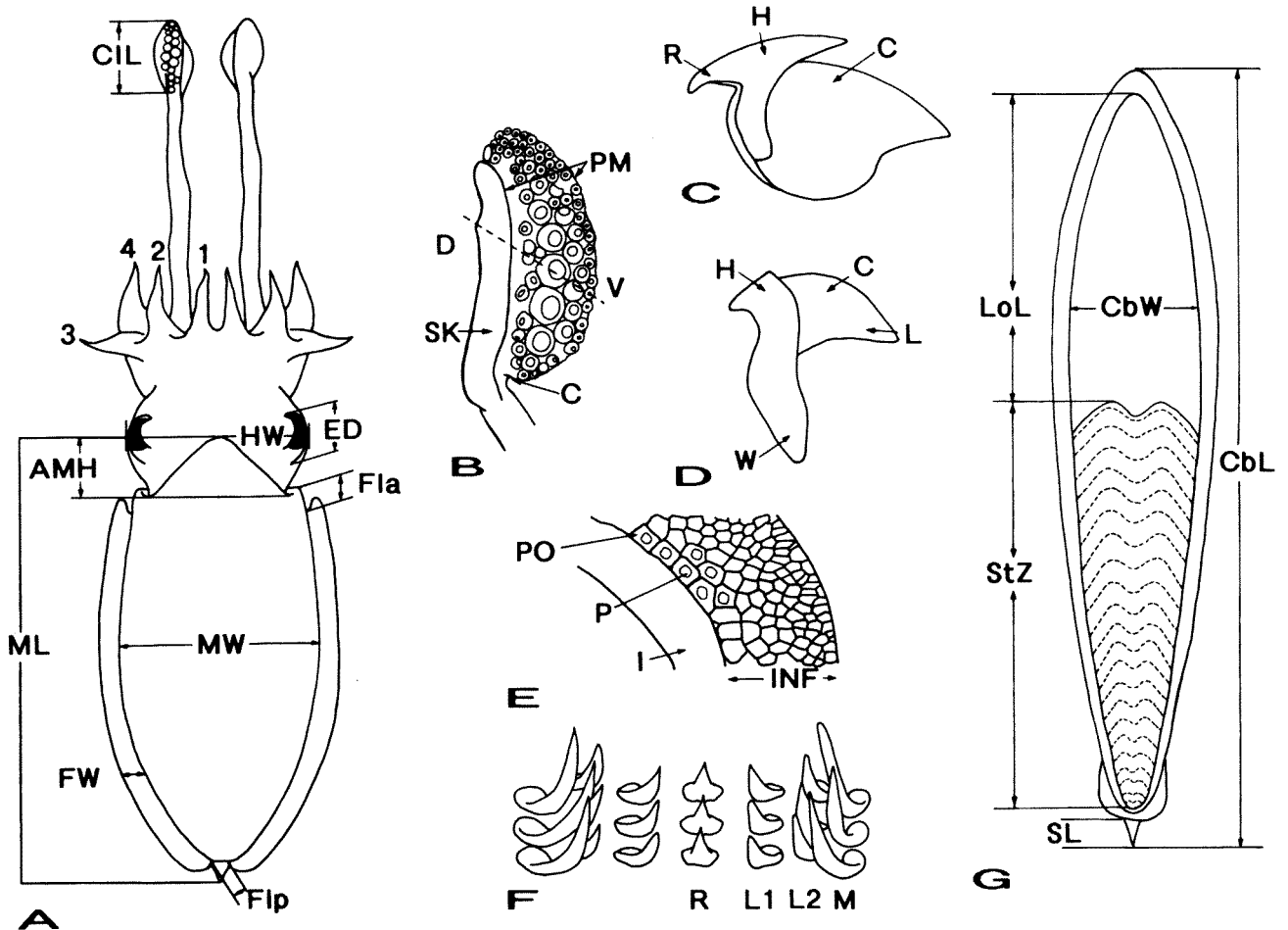


Figure 1 A–F, Measurements and Terminology; A, whole animal dorsal view (for abbreviations and definitions see Table 1); B, tentacular club (C – carpus, D – dorsal, PM – protective membranes, SK – swimming keel, V – ventral). The number of suckers intersected in an oblique transverse line across the club, shown as a hatched line on this figure, is the Club Row Count (CIRC). In the example illustrated CIRC = 4.; C, upper beak (C – crest, H – hood, R – rostrum); D, lower beak (C – crest, H – hood, L – lateral wall, W – wing); E, arm sucker rim (I – inner ring, INF – infundibulum, PO – polygonal process, P – peg); F, radula (R – rhachidian teeth, L1 – first lateral teeth, L2 – second lateral teeth, M – marginal teeth); G, cuttlebone, ventral view (for abbreviations and definitions, see Table 1). [A and G modified from Roper and Voss (1983) Figure 1].

species. All measurements are expressed in millimetres (mm). Measurements and counts for individual specimens are shown in tables accompanying descriptions. Ranges of arm length indices, arm sucker diameter indices, and arm sucker counts are also presented in tables accompanying descriptions, ranges for all other characters appear in the text. In species descriptions and tables, the range of values for each character are expressed as: minimum – mean – maximum (standard deviation (SD)). Ranges refer only to mature animals, and values for each sex are given separately. Numbers shown in bold with the range of measurements for mantle length indicate the upper size limit for each sex (numbers appear after the upper limit of the range when the largest specimens were not necessarily among the 10 specimens selected for detailed examination and measurement for all characters).

Measurements for structures which were clearly distorted or broken were not attempted, and these, in addition to missing values, appear as a dash (–) in the tables. Ranges for specific character traits given with each species description do not, therefore, always refer to the total number of specimens examined for each species.

For scanning electron microscopy, arm and club suckers were removed from the middle of designated arms and the tentacular club, and dehydrated in an ethanol series through to 100% ethanol then air dried. Radulae and beaks were dissected from the buccal mass, and soaked for approximately half hour in a warm, saturated potassium hydroxide solution, then radulae were cleaned using forceps and a fine brush. In all cases, the new, unused portion of the radula was examined. All prepared material was mounted, gold coated and examined in a JSM 6400 (Japan

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 dividing each measure by mantle length or, for cuttlebone characters, cuttlebone length (unless otherwise specified) and are expressed as percentages.

Arm Length – AL : 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) [ALI].	Fin Insertion anterior * – Fia : anterior origin of fin measured from mantle margin to anterior-most junction of fin and mantle [Fia].
Anterior Mantle to Head length * – AMH : dorsal length of mantle measured from anterior-most point of mantle to intersection of transverse line joining dorso-lateral mantle margin [AMHI].	Fin Insertion posterior* – Fip : measured between posterior junctions of fins with mantle [Fip].
Arm Sucker Count * – ASC : total number of suckers on each designated arm (e.g. ASC2).	Funnel Length – FuL : the length of the funnel from the anterior funnel opening to the posterior margin measured along the ventral midline [FuLI].
Arm Sucker diameter – AS : diameter of largest sucker on each designated (i.e. 1, 2 etc.) arm [ASIn]. Suckers on left ventral hectocotyliised arms are differentiated as follows:	Fin Width – FW : greatest width of single fin [FWI].
Arm Sucker left 4 * – ASl4 : diameter of largest sucker on left ventral arm of male [ASInl4].	Gill Lamellae Count – GiLC : number of lamellae on outer demibranch including the terminal lamella.
Arm Sucker left 4 minimum * – ASl4m : diameter of smallest arm sucker on hectocotyliised portion of left ventral arm of male [ASInl4m].	Gill Length * – GiL : length of right gill [GiLI].
Cuttlebone Length – CbL : dorsal length of cuttlebone along midline, including spine (if present).	Head Length – HL : dorsal length of head measured from point of fusion of dorsal arms to anterior tip of nuchal cartilage [HLI].
Cuttlebone Width – CbW : greatest width of cuttlebone [CbWI].	Head Width – HW : greatest width of head at level of eyes [HWI].
Club Length – CIL : length of tentacular club measured from proximal-most basal suckers (carpus) to distal tip of club [CILI].	Loculus Length * – LoL : length of the last loculus (ventral anterior smooth zone of the cuttlebone) [LoLI].
Club Row Count – CIRC : number of suckers in transverse rows on tentacular club.	Mantle Length – ML : dorsal mantle length. Measured from anterior-most point of mantle to posterior apex of mantle.
Club Sucker diameter – CIS : diameter of largest sucker on tentacular club [CISI].	Mantle Width – MW : greatest straight-line ventral width of mantle [MWI].
Club Sucker dorsal * – CISd : diameter of largest tentacular club sucker in dorsal-most (closest to swimming keel) longitudinal row [CISId].	Spine Length * – SL : length of spine [SLI].
Club Sucker ventral * – CISv : diameter of largest tentacular club sucker in ventral-most (opposite swimming keel) longitudinal row [CISIV].	Spermatophore Length – SpL : length of spermatophore [SpLI].
Eye Diameter – ED : diameter of eye [EDI].	Spermatophore Width – SpW : greatest width of spermatophore. Spermatophore width index is expressed as a percentage of spermatophore length [SpWI].
Egg Diameter * – EgD : diameter of egg [EgDI].	Striated Zone length – StZ : length of striated zone of cuttlebone [StZI].
Free Funnel length – Ffu : the length of the funnel from the anterior funnel opening to the point of its dorsal attachment to the head [FFuI].	Transverse Row Count – TrRC : number of suckers in longitudinal series on tentacular club (counted from proximal-most basal suckers (carpus) to distal tip of club).
	Ventral Mantle Length – VML : length of ventral mantle measured from anterior mantle margin at ventral midline, to posterior apex of mantle [VMLI].

Electron Optics Ltd. Japan) scanning electron microscope operated at 15 KV.

Species descriptions were generated by the DELTA (Description Language for Taxonomy) system (Dallwitz 1980; Dallwitz *et al.* 1993; Partridge *et al.* 1993).

SYSTEMATICS

Sepia plana sp. nov.

Figures 2–9; Tables 2,3 and 10

Holotype

Australia: Western Australia, North West Shelf –

M (99.3 mm ML), 14°15'S 121°59'E, 460–430 m, 25 Jan 1990, coll. RV "Courageous", (MV F77206).

Paratypes

Australia: Western Australia, North West Shelf – 1F (63 mm ML), 12°04'S 122°51'E, 420 m, 22 Jan 1990, coll. RV "Courageous", (MV F80339); 1F (100 mm ML), 12°12'S 122°48'E, 485 m, 22 Jan 1990, coll. RV "Courageous", (MV F77205); 1F (148.7 mm ML), North West Shelf, 16°54'S 120°25'E, 396 m, 12 Apr 1989, coll. FV "Striker", (MV F58848); 1F (151.2 mm ML), North West Shelf, 16°59'S 120°14'E, 405 m, 7 Apr 1989, coll. FV "Striker", (MV F77204); 2F (84.4, 127.1 mm ML), 17°55.5'S 118°16.0'E, 505 m, 2 Feb 1992, coll. FV "Surefire", (MV F67700).

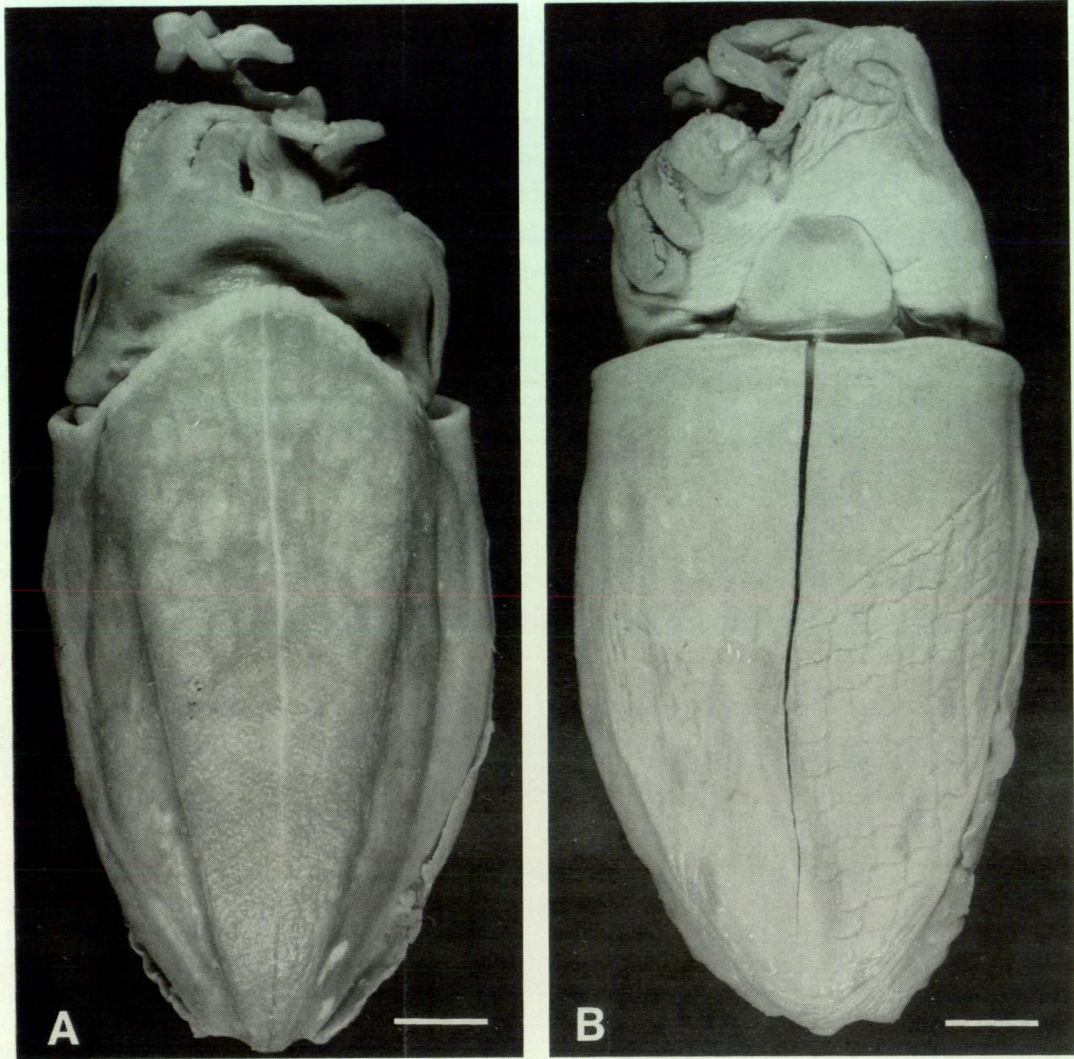


Figure 2 A-B, *Sepia plana* sp. nov.; A, dorsal view, female paratype MV F67700, 127.1 mm ML, ventral view same specimen. Scale bars 15 mm.

Additional material

Australia: Queensland – cuttlebone (broken), Lizard Island, 14°40'S 145°28'E, Nov 1989, coll. M. Norman, (MV 77203).

Diagnosis

Cuttlebone strongly angular, flat medially and laterally; dorsal surface slightly granulose; dorsal median rib indistinct; spine very short; striated zone and last loculus flat; anterior striae broad inverted U-shape; limbs of inner cone narrow, broaden only slightly posteriorly. Tentacular club with 8–10 similar-sized small suckers in transverse rows; swimming keel extends beyond carpus; dorsal and ventral protective membranes not fused at base of club, joined to stalk. Left ventral arm of males hectocotylised: proximal 8 rows of suckers reduced, suckers in dorsal marginal series slightly smaller than remaining suckers. Arm suckers all tetraserial. Large robust species, maximum size to approximately 150 mm ML.

Description

Counts and indices for individual specimens are given in Table 2; ranges for arm length indices, arm sucker diameter indices and arm sucker counts are shown in Table 3.

Large, robust species; ML male 99.3 mm, females 84.4–122.3–151.2 mm (SD, 29.5). Mantle broad, oval, MWI male 57.4, females 54.8–57.7–63.3 (SD, 3.4); dorsal anterior margin rounded (Figure 2A); extending anteriorly beyond eyes; AMHI male 16.8, females 12.2–14.8–17.3 (SD, 2.4). Ventral mantle margin slightly emarginate, without distinct lateral angle (Figure 2B); VMLI male 90.8, females 78.4–86.9–94.4 (SD, 7.3). Fins widest in posterior third; FWI male 13.8, females 7.4–9.1–10.9 (SD, 1.4); anterior origin posterior to mantle margin, set well back from margin; FIIa male 14.4, females 8.9–12.7–16.4 (SD, 3.5); rounded posteriorly; wide gap between fins, FIIp male 9.3, females 9.9–11.9–14.4 (SD, 2.1). Funnel short; FuLI male 38.3, females 28.6–31.9–35.7 (SD, 3.2), robust, very broad; extends to anterior rim of eye. Funnel free portion

Table 2 *Sepia plana* sp. nov.; measurements (mm), counts and indices of 1 male (M) and 6 females (F).

Museum Reg. No.	MV F77206 (Holotype)	MV F80339 (Paratype)	MV F67700 (Paratype)	MV F77205 (Paratype)	MV F67700 (Paratype)	MV F58848 (Paratype)	MV F77204 (Paratype)
Sex	M	F	F	F	F	F	F
Maturity	mature	immature	mature	mature	mature	mature	mature
ML	99.3	63.0	84.4	100.0	127.1	148.7	151.2
MWI	57.4	61.6	63.3	57.4	55.1	57.9	54.8
AMHI	16.8	14.4	17.2	17.3	14.3	12.8	12.2
VMLI	90.8	82.2	78.4	80.6	87.6	94.4	93.6
FWI	13.8	12.2	—	10.9	7.4	8.9	9.3
FIla	14.4	15.6	—	8.9	16.4	10.7	14.9
FIlp	9.3	10.0	—	9.9	13.0	10.5	14.4
FuLI	38.3	35.1	35.7	32.0	28.7	28.6	34.4
FFuI	16.1	14.3	14.8	13.0	11.4	17.8	15.5
HLI	26.3	40.5	—	23.2	—	27.6	—
HWI	48.8	50.8	—	46.3	48.4	44.4	39.6
EDI	12.1	17.3	—	16.1	12.4	12.4	—
ALI1	48.8	44.4	—	35.5	33.8	38.0	28.8
ALI2	40.8	41.3	—	44.5	—	44.0	36.4
ALI3	41.3	41.3	—	37.5	39.7	40.3	36.4
ALI4	45.8	41.3	—	39.5	41.3	40.0	38.4
ASIn1	1.61	1.27	—	1.07	1.08	1.26	0.89
ASIn2	1.88	1.27	—	1.12	0.98	1.31	0.99
ASIn3	1.51	1.35	—	1.00	0.90	1.21	1.04
ASIn4	1.33	1.27	—	1.00	0.79	1.26	0.96
ASC1	94	102	—	128	102	—	116
ASC2	90	110	—	136	—	—	146
ASC3	112	130	—	145	150	—	142
ASC4	118	146	—	160	172	—	145
ASIn4	1.26	—	—	—	—	—	—
ASIn4m	0.76	—	—	—	—	—	—
CILI	19.1	15.7	—	15.5	18.5	15.5	—
CIRC	8	10	—	8	—	8	—
TrRC	36	34	—	36	45	36	—
CISI	0.22	0.40	—	0.27	0.29	0.34	—
CISId	0.22	0.40	—	0.25	0.31	0.27	—
CISlv	0.22	0.32	—	0.27	0.29	0.27	—
GiLC	29	25	—	30	28	28	—
GiLI	—	34.9	31.1	37.9	42.0	37.0	—
SpLI	8.6	—	—	—	—	—	—
SpWI	4.7	—	—	—	—	—	—
EgDI	—	—	—	4.0	—	8.5	10.0
CbL	—	—	84.3	98.2	126.9	—	—
CbWI	—	—	45.4	45.8	42.9	—	—
SLI	—	—	0.6	1.4	0.4	—	—
StZI	—	—	50.9	57.0	50.7	—	—
LoLI	—	—	45.8	42.9	48.5	—	—
LoL/StZ (%)	—	—	90.0	75.2	95.6	—	—

approximately half funnel length; FFuI male 16.1, females 11.4–14.5–17.8 (SD, 2.5). Funnel organ dorsal elements thick, inverted V-shape; ventral elements oval (Figure 3A). Mantle-locking cartilage curved, with semicircular ridge; funnel-locking cartilage with depression which corresponds to ridge (Figure 3B). Head short; HLI male 26.3, females 23.2–25.4–27.6 (SD, 3.1); broad, narrower than mantle; HWI male 48.8, females 39.6–44.7–48.4 (SD, 3.7). Eyes large; EDI male 12.1, females 12.4–13.7–16.1 (SD, 2.1); ventral eyelids present (Figure 2A).

Male and female arms subequal in length (Table 3). Arm length index of longest arms in male 48.8, females 36.4–41.6–44.5 (SD, 4.6). Protective membranes (both sexes) narrow; normal, not thickened. Distal arm tips (both sexes) strongly attenuate, suckers enclosed by protective membranes. Arm suckers tetraserial in both sexes. Suckers in males normal in size (not greatly enlarged); larger than female arm suckers (Table 3). Inner ring of chitinous sucker rims with blunt projections; infundibulum with 12–14 rows of ovoid-hexagonal processes without pegs,

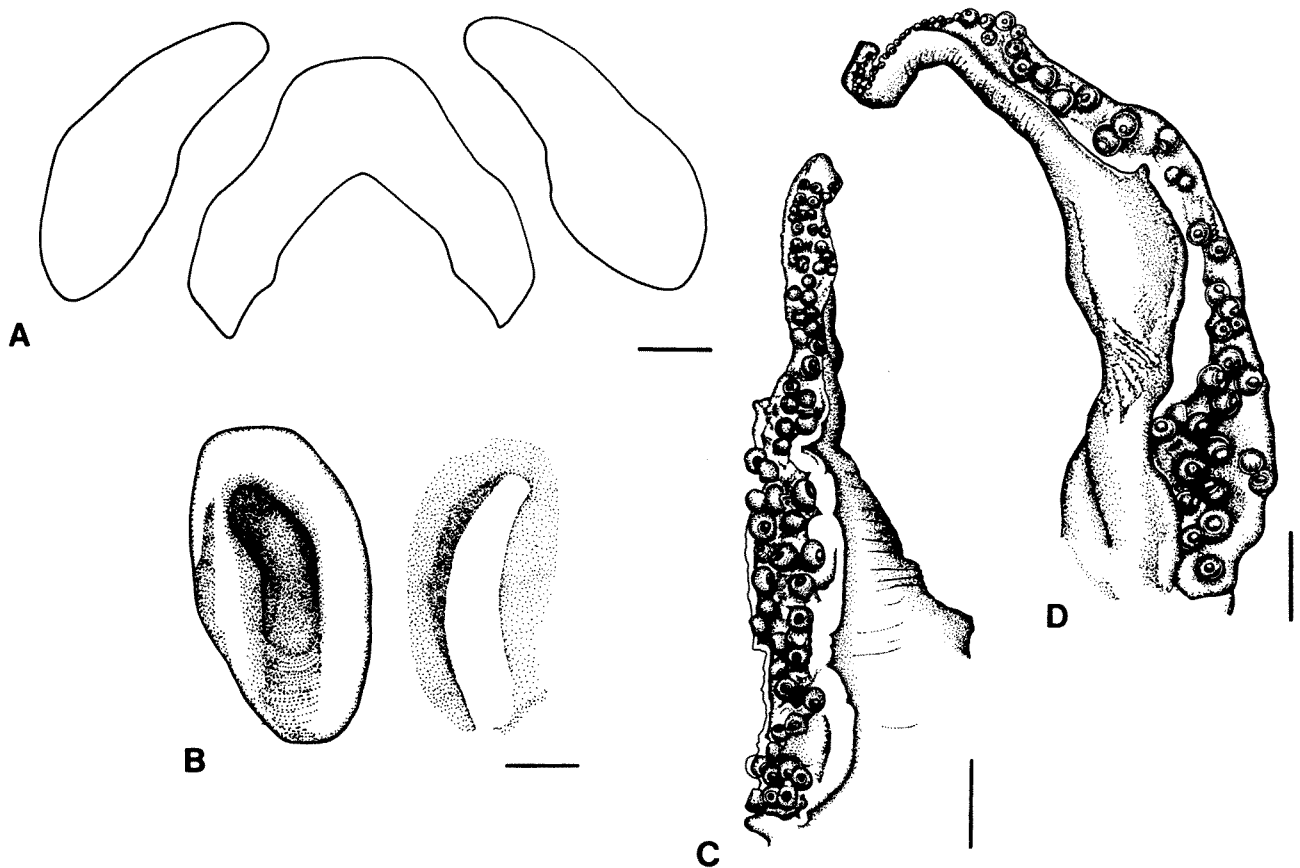


Figure 3 A–D, *Sepia plana* sp. nov.; A, funnel organ, scale bar 3 mm; B, funnel-locking cartilage (left), and mantle-locking cartilage (right), scale bar 1 mm; C, hectocotylied left ventral arm, scale bar 3 mm; D, right ventral arm, scale bar 3 mm. (A–D male holotype MV F77206, 99.3 mm ML).

innermost row large, rectangular-hexagonal; peripheral sucker rim processes radially arranged, slightly more elongate (Figure 4A). Sucker counts range from 90–172; females with higher average counts than male (Table 3).

Table 3 *Sepia plana* sp. nov.; arm length indices (ALI), arm sucker diameter indices (ASIn) and arm sucker counts (ASC) of 1 mature male and ranges of these measures and counts for 5 mature females. min. = minimum, max. = maximum, SD = standard deviation.

	Male	Females			
		min.	mean	max.	SD
ALI1	48.8	28.8	<u>34.0</u>	38.0	3.9
ALI2	40.8	36.4	<u>41.6</u>	44.5	4.6
ALI3	41.3	36.4	<u>38.5</u>	40.3	1.9
ALI4	45.8	38.4	<u>39.8</u>	41.3	1.2
ASIn1	1.61	0.89	<u>1.07</u>	1.26	0.15
ASIn2	1.88	0.98	<u>1.10</u>	1.31	0.15
ASIn3	1.51	0.90	<u>1.04</u>	1.21	0.13
ASIn4	1.33	0.79	<u>1.00</u>	1.26	0.19
ASC1	94	102	<u>115</u>	128	13
ASC2	90	136	<u>141</u>	146	7
ASC3	112	142	<u>146</u>	150	4
ASC4	118	145	<u>159</u>	172	14

Left ventral arm of male hectocotylied: suckers slightly reduced in size (Figure 3C,D), maximum and minimum sucker diameters: ASIn14 1.26, ASIn14m 0.76 (compare with non-hectocotylied arms Table 3); proximal 8 rows (approximately) of suckers reduced; suckers in dorsal marginal series slightly smaller than remaining suckers. Oral surface of modified region wide, fleshy, with transversely grooved ridges; without distinct median furrow. Hectocotylied arm not markedly attenuate distally.

Tentacular club longer in male than in females; CILI male 19.1, females 15.5–~~16.5~~–18.5 (SD, 1.7). Club crescent-shaped; sucker-bearing face flattened. Club with 8–10 suckers in transverse rows, CIRC male 8, females 8–~~9~~–10 (SD, 1); 36–45 suckers in longitudinal series, TrRC male 36, females 36–~~39~~–45 (SD, 5). Suckers all similar size, small (Figure 5A), CISI male 0.22, females 0.27–~~0.30~~–0.34 (SD, 0.03); dorsal and ventral-marginal longitudinal series of suckers similar size; CISId males 0.22, females 0.25–~~0.28~~–0.31 (SD, 0.03); CISIv male 0.22, females 0.27–~~0.28~~–0.29 (SD, 0.01). Sucker dentition: inner ring with blunt projections; infundibulum with 8–9 rows of ovate polygonal processes without pegs; innermost row processes

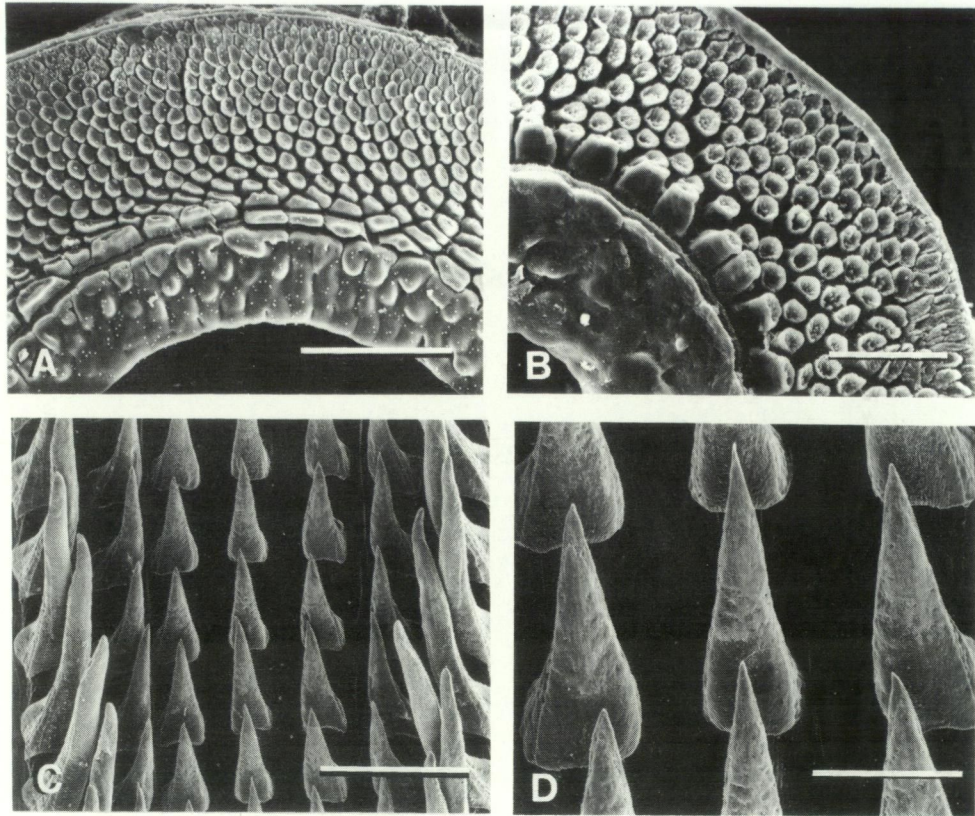


Figure 4 A–D, *Sepia plana* sp. nov.; A, arm 2 sucker rim, female paratype MV F77205, 100 mm ML, scale bar 100 µm; B, club sucker rim, female paratype MV F67700, 127.1 mm ML, scale bar 40 µm; C, radula, female paratype MV F77205, 100.0 mm ML, scale bar 500 µm; D, enlargement of 1st laterals and rhachidian (centre) teeth, same specimen, scale bar 200 µm.

elongate, rectangular; at periphery processes smaller, sub-rectangular (Figure 4B). Swimming keel of club extends well beyond carpus (Figure 5A). Dorsal and ventral protective membranes not fused at base of club; joined to stalk; dorsal and ventral membranes same length, extend beyond carpus along stalk; approximately equal width; dorsal membrane forms shallow cleft at junction with stalk.

Gills with 28–30 lamellae per demibranch; GiLC male 29, females 28–29–30 (SD, 1). Gill length: GiLI females 31.1–37.0–42.0 (SD, 4.5).

Buccal membrane without suckers. Upper beak (Figure 5B) rostrum bluntly pointed, length greater than width; cutting edge slightly curved; hood high above crest posteriorly; lateral wall shallowly indented posteriorly; wings and hood narrow, and short; jaw angle approximately 90°; hood dark brown, lighter on posterior edge, crest darkly pigmented. Lower beak (Figure 5C,D) rostrum bluntly pointed, protrudes only slightly; cutting edge curved; hood low on crest; crest straight, no indentation on lateral wall edge; hood and wings, width narrow; hood notch deep, broad (Figure 5D); wings widely spaced; crest wide with deep notch; rostrum pigmented dark brown, fading gradually on wing, crest pigmented, darkest medially fades on lateral walls. Radula with 7 teeth per row;

homodont; rhachidian teeth narrow, not broad based, slender, triangular, sides straight (Figure 4C,D); first lateral teeth same length as rhachidian teeth, asymmetrical with mesocone displaced toward centre of radula, heel narrow (Figure 4C,D); second laterals longer than first, mesocone displaced towards centre, heel broad; marginal teeth elongate, tapered, curved, rounded proximally and strongly indented (Figure 4C). Digestive tract (Figure 5E): paired salivary glands approximately one-third length of buccal mass; paired digestive glands large, located close together, with sub-triangular lobes posteriorly, ducts connect digestive glands near midline with caecum (not shown in figure), ducts with branched attached pancreatic tissue; oesophagus runs dorsally along median junction of digestive glands, joins sac-like stomach immediately posterior to digestive glands; caecum disc-like, grooved in blunt V-shape anteriorly, surface lining finely pleated; intestine undifferentiated; ink sac and anal flaps well developed.

Male reproductive tract: testis on left posterior side of visceropericardial coelom; at distal end, convoluted vas deferens opens into broad cone-shaped mucilaginous gland, then narrower, curved spermatophoric gland (Figure 6A). Close to junction with lobe-shaped accessory gland and

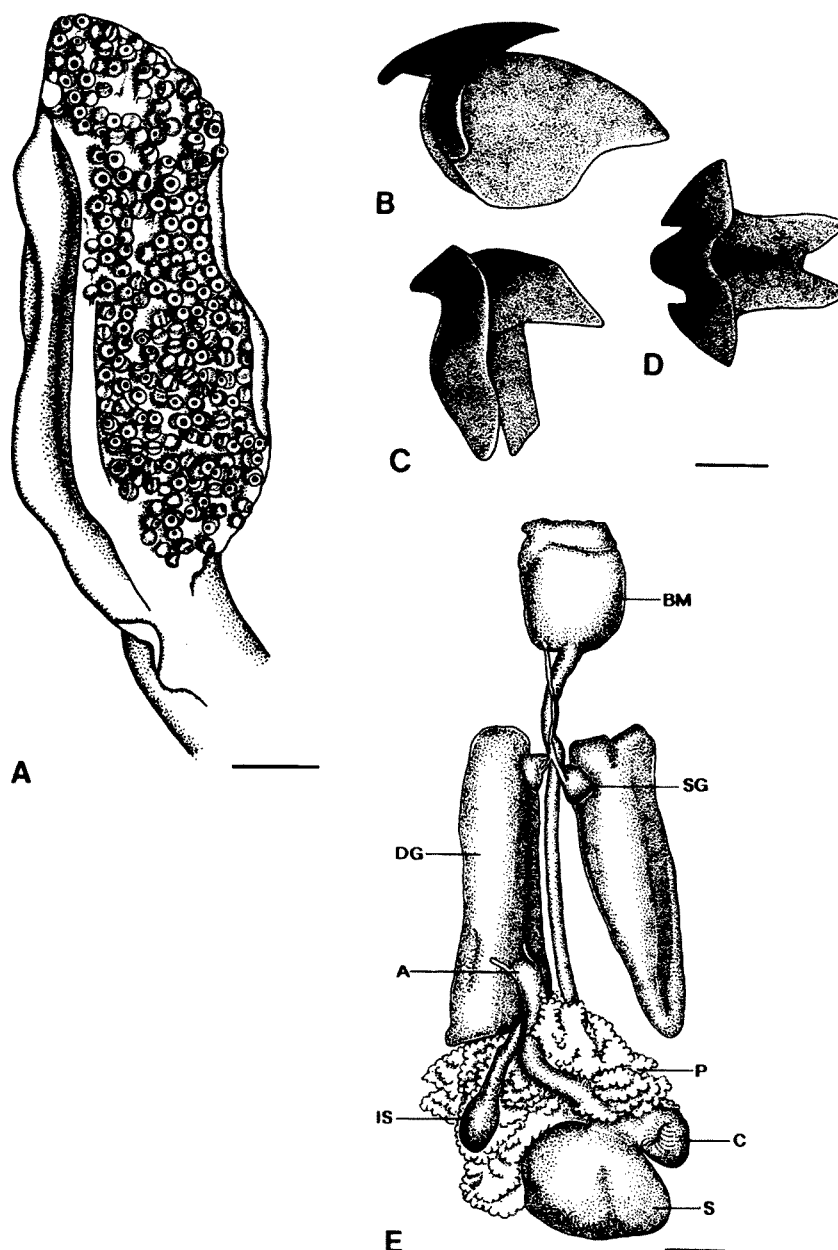


Figure 5 A–E, *Sepia plana* sp. nov.; A, tentacular club, female paratype MV F77205, 100.0 mm ML, scale bar 2 mm; B, upper beak, lateral view; C, lower beak, lateral view; D, lower beak, ventral view (B–D, male holotype MV F77206, 99.3 mm ML, scale bar 3 mm); E, digestive tract, female paratype (MV F80339), 63.0 mm ML, scale bar 6 mm, (A – anus; BM – buccal mass; C – caecum; DG – digestive gland; IS – ink sac; P – pancreas; S – stomach; SG – salivary gland).

gland appendix, delicate ciliated canal joins spermatophoric gland; distal deferent canal connects appendix of accessory gland to spermatophore storage sac; genital orifice opens dorsal to left gill in anterior end of mantle cavity. Spermatophores: cement body bipartite (Figures 6B, 7); aboral end elongate, cylindrical, connects to sperm reservoir via narrow duct which extends from tip of cement body; oral end of cement body approximately half length of aboral end, similar width; connects to aboral end via narrow neck; middle tunic commences along aboral part of cement body; ejaculatory apparatus coiled, extends

into oral dilation of spermatophore. Spermatophores 8.5 mm long, 0.4 mm wide; SpLI 8.6; SpWI 4.7.

Female reproductive tract: ovary hangs from dorsal wall of posterior viscero-pericardial coelom. Oviduct thin-walled, continuous with body cavity; distally with thickened, glandular walls (oviducal glands). Nidamental glands in mature animals occupy large portion of ventral side of mantle cavity. Accessory nidamental glands anterior to nidamental glands (Figure 6C). Eggs spherical, 4.0–7.5–10.0 mm diameter (SD, 3.1); EgDI 4.0–5.4–6.6 (SD, 1.3).

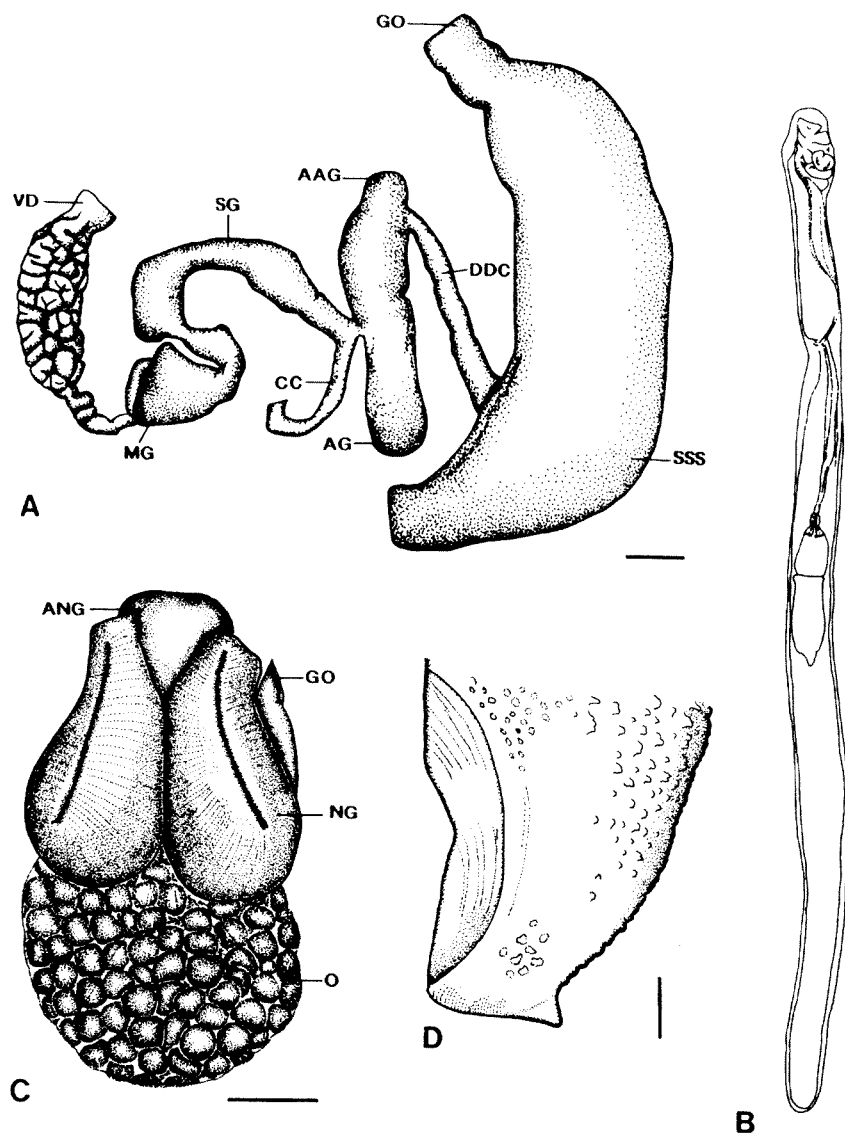


Figure 6 A-D, *Sepia plana* sp. nov.; A, male reproductive tract (testis not shown), holotype MV F77206, 99.3 mm ML, scale bar 1 mm, (AAG - appendix of accessory gland; AG - accessory gland; CC - ciliated canal; DDC - distal deferent canal; GO - genital orifice; MG - mucilaginous gland; SG - spermatophoric gland; SSS - spermatophore storage sac; VD - vas deferens); B, spermatophore, holotype MV F77206, 99.3 mm ML, scale bar 1 mm; C, female reproductive tract, paratype MV F77205, 100 mm ML, scale bar 20 mm, (ANG - accessory nidamental gland; GO - genital orifice; NG - nidamental gland; O - ovary); D, posterior end of cuttlebone, lateral view, female paratype MV F67700, 84.4 mm ML, scale bar 1 mm.

Subdermal cartilaginous layer between cuttlebone and skin absent. Cuttlebone length approximately equal to mantle length; outline oval (Figure 8A,B); CbL females 84.3–103.1–126.9 (SD, 21.7); CbWI females 42.9–44.7–45.8 (SD, 1.6). Cuttlebone bluntly rounded anteriorly; acuminate, acute posteriorly (Figure 8A,B); recurved ventrally (Figure 6D). Dorsal surface creamy white; flat medially, flat laterally (Figure 8A); granulate (Figure 8C). Dorsal median rib present, indistinct, broadens anteriorly; lateral ribs present, distinct. Chitin borders lateral margins of cuttlebone. Spine present, short (Figures 6D, 8A,C); SLI females 0.4–0.8–1.4 (SD, 0.5); curves dorsally (Figure 6D);

keel(s) absent; cuttlebone smooth between spine and outer cone; ventral notch at base of spine absent. Dorso-posterior end of cuttlebone smooth, without median longitudinal ridge anterior to spine. Striated zone flat; StZI females 50.7–52.9–57 (SD, 3.6). Last locus flat; LoLI females 42.9–45.7–48.5 (SD, 2.8); slightly shorter than striated zone, LoL/StZ(%) females 75.2–86.9–95.6 (SD, 10.6). Sulcus absent. Anterior striae broad inverted U-shape (Figure 8B). Limbs of inner cone extend anteriorly to end of striated zone. Inner cone limbs narrow, broaden very slightly posteriorly, not raised to form ledge posteriorly; not thickened posteriorly. Outer cone calcified; narrow

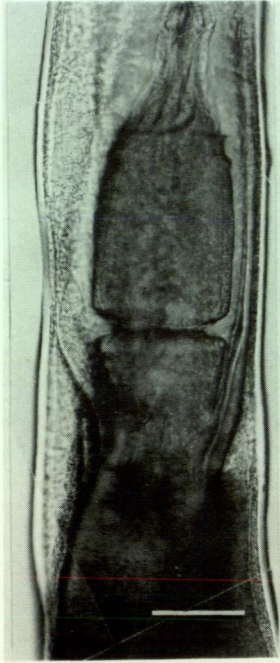


Figure 7 *Sepia plana* sp. nov.; middle portion of ejaculatory apparatus of spermatophore, holotype MV F77206, 99.3 mm ML, scale bar 100 μ m.

anteriorly, broadens posteriorly (Figure 8B); lateral limbs not flared ventro-laterally; limbs continue as broad ledge ventral to spine (Figure 6D).

Body papillae present. Ventral mantle with longitudinal row of up to 5 narrow ridges along each side, close to fins (not visible in all specimens). Head and arm papillae absent. Colour (alcohol preserved specimens): head and arms pale buff pinkish-brown; dorsal mantle pale buff pinkish-brown; paired dorsal eye spots absent. Fins pale; without markings at base. Ventral pigment absent. Ventral longitudinal ridges pale orange.

Type locality

Australia: Western Australia, North West Shelf, 14°15'S 121°59'E; 460–430 m.

TYPE: Holotype, MV F77206, male, 99.3 mm ML.

Distribution

Australia: Western Australia, North West Shelf, 12°04'S 122°51'E – 17°55.5'S 118°16.0'E (Figure 9); depth range 505–396 m. May also occur off eastern Australia (see Remarks).

Etymology

The specific name, *plana*, is derived from the Latin *planus* meaning "level" or "flat", and refers to the flattened dorsal and lateral sides of the cuttlebone in this species. Gender feminine.

Remarks

A single sepiion was collected on Lizard Is., off

Queensland, 14°40'S 145°28'E in November 1989. This suggests that this species may also occur off the northeastern Australian coast, though the possibility that the sepiion was carried by currents from the west cannot be excluded. The elongate appearance of the innermost row of polygonal processes on the club sucker ring infundibulum (Figure 4B) may be due to contraction of the suckers during drying for SEM preparation. The dorsal funnel organ element seems to lack an anterior papilla in this species. However, the funnel organs were damaged in most specimens. The absence of the anterior papilla needs to be confirmed when additional well-preserved material becomes available.

Determination of the relationships of *Sepia plana* sp. nov. to other species is at present difficult owing to the general confusion of relationships within *Sepia*, and the lack of comprehensive descriptions for many of the nominal species within the genus. While some species 'complexes' have been recognised (e.g. Khromov *et al.*, in press; Lu, in press b), these may not be monophyletic. These complexes are not tightly defined, based on few characters, and differ among authors, so assignment of *S. plana* sp. nov., or the other species described in this paper, to a particular complex is of limited value. For these reasons, it is difficult to select those species from among the 100 or so nominal sepiids which are of particular interest for comparison of individual characters with *S. plana* sp. nov. Some characters are shared between *S. plana* sp. nov. and other species, while other characters differ. The structure of the cuttlebone, however, with its distinctive flattened dorsal and lateral margins distinguishes *S. plana* sp. nov. from all other nominal species in the genus.

Sepia senta sp. nov.

Figures 9–16; Tables 4–6 and 10

Holotype

Australia: Western Australia, North West Shelf – M (41.5 mm ML), 14°07'S 122°06'E, 415 m, 25 Jan 1990, coll. V. Wadley on RV "Courageous", (MV F77200).

Paratypes

Australia: Western Australia, North West Shelf – 1F (64.2 mm ML), 13°45'S 122° 39'E, 420 m, 23 Jan 1990, coll. RV "Courageous", (MV F77195); 7M (42.1–61.6 mm ML) 2F (54.6, 54.7 mm ML), NW of Cape Leveque, 14°50.2'S 121°31.4'E – 14°48.6'S 121°33.2'E, 356 m, 12 Feb 1984, coll. S. Slack-Smith on RV "Soela", (WAM 332–86); 3F (62.5–83.2 mm ML), NW of Cape Leveque, 14°51.9'S 121°40.6'E – 14°54.0'S 121°39.1'E, 260–256 m, 16 Feb 1984, coll. S. Slack-Smith on RV "Soela", (WAM 104–96); 1M

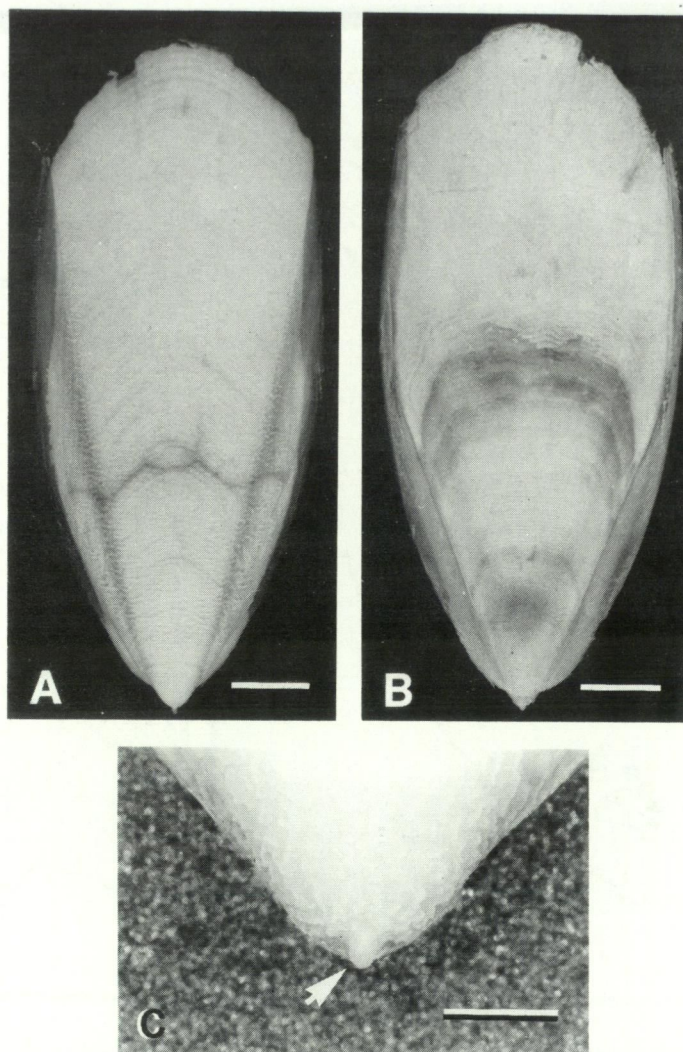


Figure 8 A-C, *Sepia plana* sp. nov.; A, cuttlebone, dorsal view, female paratype MV F77205, 100.0 mm ML, scale bar 10 mm; B, cuttlebone, ventral view, same specimen, scale bar 10 mm; C, posterior end of cuttlebone, dorsal view, female paratype MV F67700, 127.1 mm ML, arrow indicates spine, scale bar 1.5 mm.

(49.8 mm ML) 1F (48.2 mm ML), North West Shelf 18°06'S 118°6'E, 340 m, 28 Feb 1983, coll. RV "Soela", (MV F77197); 1F (43.4 mm ML), North West Shelf, 18°25'S 117°48'E, 375 m, 2 Aug 1988, coll. RV "Soela", (MV F77199).

Additional Material

Australia: Western Australia, North West Shelf - 1F (65.0 mm ML), 12°04'S 122°51'E, 420 m, 22 Jan 1990, coll. RV "Courageous", (MV F80340); 1M 1J (62.0, 16.6 mm ML), NW of Augusta, 14°29.4'S 122°01.4'E - 14°28.4'S 122°03.2'E, 304-296 m, 12 Feb 1984, coll. S. Slack-Smith on RV "Soela", (WAM 334-86); 2M (56.5, 65.0 mm ML) 2F (68.2, 74.5 mm ML), NNW of Cape Leveque, 14°35.8'S 121°49.4'E - 14°37.2'S 121°47.4'E, 304-300 m, 16 Feb 1984, coll. S. Slack-Smith on RV "Soela", (WAM 103-96); 2M (56.2, 61.5 mm ML) 11F (52.9-77.2 mm ML), NW of Cape Leveque, 14°49.0'S 121°36.1'E - 14°50.8'S 121°35.6'E, 302-300 m, 12 Feb 1984, coll. S. Slack-Smith on RV "Soela", (WAM 264-88); 1M (67.5 mm

ML), NW of Cape Leveque, 15°11.1'S 12°26.9'E - 15°12.9'S 121°25.7'E, 260-258 m, 17 Feb 1984, coll. S. Slack-Smith on RV "Soela", (WAM 102-96); 1M (36.5 mm ML) 2F (32.0, 37.3 mm ML), NW of Beagle Bay, 15°13.5'S 121°08.9'E - 15°15.0'S 121°06.5'E, 352 m, 11 Feb 1984, coll. S. Slack-Smith on RV "Soela", (WAM 331-86); 1M (61.9 mm ML) 2F (55.7, 57.1 mm ML), WNW of Lacepede Archipelago, 15°48.0'S 120°41.0'E - 15°50.1'S 120°39.5'E, 400-396 m, 10 Feb 1984, coll. S. Slack-Smith on RV "Soela", (WAM 329-86); 1M (58.7 mm ML), W of Lacepede Archipelago, 16°55.8'S 119°53.9'E - 17°01.8'S 119°51.3'E, 426 m, 19 Feb 1984, coll. S. Slack-Smith on RV "Soela", (WAM 263-88); 1F (75.3 mm ML), North West Shelf, 16°58'S 120°13'E, 413 m, 2 Apr 1989, coll. S. Morris on FV "Striker", (MV F77201); 1F (48.9 mm ML), W of Broome, 17°59'S 118°23'E - 17°54'S 118°29'E, 390-389 m, 24 Feb 1984, coll. S. Slack-Smith on RV "Soela", (WAM 349-86); 1F (31.0 mm ML), W of Roebuck Bay, 18°04'S 118°14'E - 18°00'S 118°19'E,

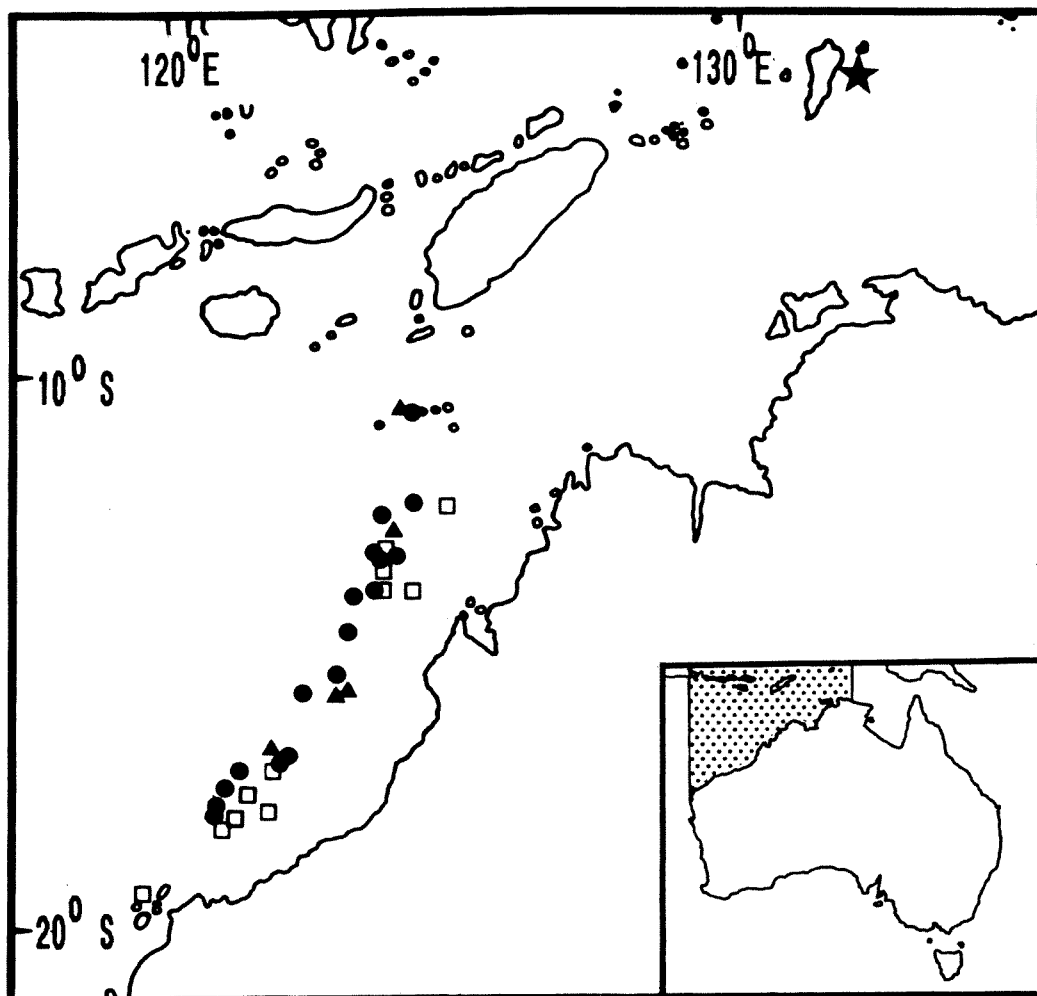


Figure 9 Distributions of *Sepia plana* sp. nov. (triangles), *S. senta* sp. nov. (solid circles), and *S. sulcata* Hoyle (open squares). The type locality of *S. sulcata* is indicated by a star (top right of figure).

400–396 m, 24 Feb 1984, coll. S. Slack-Smith on RV "Soela", (WAM 346–86); 1F (60.7 mm ML), North West Shelf, 18°33'S 117°36'E – 18°33'S 117°38'E, 356–344 m, 17 Aug 1983, coll. RV "Soela", (MV F77198); 1F (58.6 mm ML), North West Shelf, 18°35'S 117°29'E, 404 m, 31 Jan 1984, coll. P. Berry & N. Sinclair on RV "Soela", (MV F77196); 1F (67.3 mm ML), N of Karratha, 18°44'S 116°59'E, 406–404 m, 23 Aug 1983, RV "Courageous", (WAM 4292–83).

Diagnosis

Cuttlebone oval; dorsally rough, with irregular calcified projections; thin chitinous film covers entire dorsal surface; spine absent; sulcus absent, anterior striae slightly convex to straight. Club with 6–8 suckers in transverse rows; suckers small, differ slightly in size; dorsal and ventral protective membranes not fused at base of club; joined to stalk; differ in length, ventral protective membrane terminates at posterior end of carpus, dorsal membrane shorter than carpus; swimming keel extends slightly beyond carpus. Left ventral arm

hectocotylied in males: proximally a single row of normal suckers, followed distally by 8–11 rows of greatly reduced suckers, 2 dorsal series smaller than 2 ventral series; oral surface wide, fleshy; remaining suckers normal. Small to moderate species, maximum size to approximately 80 mm ML. Arm lengths subequal, suckers tetraserial on all arms.

Description

Counts and indices for individual specimens are given in Tables 4–5; ranges for arm length indices, arm sucker diameter indices and arm sucker counts are shown in Table 6.

Small to moderate species, ML males 41.5–~~53.9~~–61.6 83.2 mm (SD, 6.5), females 43.4–~~61.6~~–75.3 83.2 mm (SD, 9.8). Mantle broad, oval (Figure 10A,B); MWI males 49.3–~~60.4~~–69.2 (SD, 7.5), females 55.5–~~62.6~~–69.9 (SD, 4.9); dorsal anterior margin triangular, obtuse; extending to anterior margin of eyes; AMHI males 14.3–~~18.9~~–25.1 (SD, 3.5), females 14.4–~~20.7~~–26.8 (SD, 4.6). Ventral mantle margin emarginate, without distinct lateral angle; VMLI

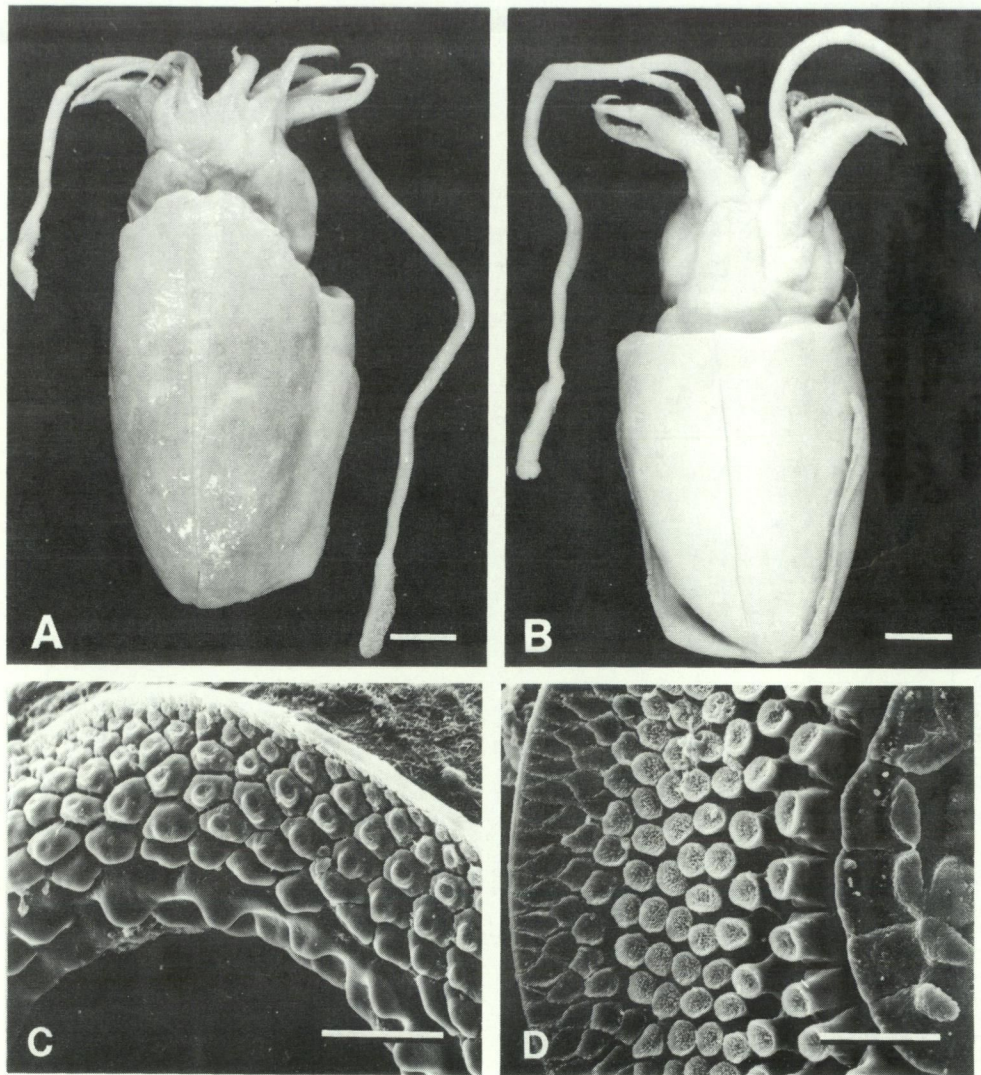


Figure 10 A–D, *Sepia senta* sp. nov.; A, dorsal view, female paratype MV F77195, 64.2 mm ML, scale bar 10 mm; B, ventral view same specimen, scale bar 10 mm; C, sucker rim, hectocotylyzed arm 4, male paratype MV F77197, 49.8 mm ML, scale bar 30 μ m; D, club sucker rim, female paratype MV F77197, 48.2 mm ML, scale bar 10 mm.

males 77.9–87.0–92.6 (SD, 5.1), females 68.1–81.1–89.8 (SD, 7.3). Fins widest in posterior third; FWI males 6.5–9.7–12.0 (SD, 2.1), females 9.7–12.5–16.2 (SD, 2.4); anterior origin posterior to mantle margin (Figure 10A,B); FIIa males 10.4–12.8–15.1 (SD, 1.8), females 11.4–14.3–19.3 (SD, 2.4); rounded posteriorly; narrow gap between fins; FIIP males 5.8–8.2–10.2 (SD, 1.5), females 3.5–8.6–11.9 (SD, 3.0). Funnel long, FuLI males 28.0–34.8–39.1 (SD, 3.5), females 30.0–35.0–39.6 (SD, 2.9); broad-based; extends to anterior rim of eye. Funnel free portion approximately one-third funnel length (slightly greater in females); FFuI males 9.6–12.9–16.9 (SD, 2.3), females 11.3–14.8–18.7 (SD, 2.5). Funnel organ dorsal elements inverted V-shape with small papilla in front; ventral elements oval (Figure 11A). Mantle-locking cartilage curved, with semicircular ridge; funnel-locking cartilage with depression which corresponds to ridge (Figure 11B). Head

short (Figure 10A,B), HLI males 23.7–33.8–44.6 (SD, 6.3), females 21.9–31.4–35.2 (SD, 3.8); broad, narrower than mantle, HWI males 41.2–47.9–54.5 (SD, 4.3), females 43.8–47.8–51.3 (SD, 2.8). Eyes large, EDI males 11.9–13.9–16.6 (SD, 1.5), females 10.8–12.6–15.0 (SD, 1.6); ventral eyelids present.

Male and female arms subequal in length (Table 6); ALI of longest arms in males 39.8–47.8–61.4 (SD, 5.9), females 36.9–45.3–54.9 (SD, 5.0). Protective membranes (both sexes) narrow; normal, not thickened. Distal arm tips (both sexes) not markedly attenuate. Arm suckers tetraserial in both sexes. Suckers in males normal in size (not greatly enlarged), larger than female arm suckers (Table 6). Chitinous rims of all arm suckers with smooth, or only slightly crenulated inner ring; infundibulum with 7–11 rows of hexagonal processes with blunt pegs (Figure 10C); peripheral sucker rim processes radially arranged, elongate,

Table 4 *Sepia senta* sp. nov.; measurements (mm), counts and indices of 10 mature males from Australia, and a single mature male (species not determined) from the Philippines (see remarks).

Museum Reg. No.	MV F77200 (Holotype)	WAM 332-86 (Paratype)	MV F77197 (Paratype)	WAM 332-86 (Paratype)	WAM 332-86 (Paratype)	WAM 264-88	WAM 332-86 (Paratype)	WAM 263-88	WAM 264-88	MV 332-86 (Paratype)	MV F77982 (Philippines)
ML	41.5	47.3	49.8	51.5	54.0	56.2	57.3	58.7	61.5	61.6	45.4
MWI	69.2	62.4	66.3	49.3	57.6	67.8	49.7	68.5	57.9	55.2	59.5
AMHI	22.2	14.8	25.1	22.3	18.9	16.7	16.6	18.9	14.3	19.5	17.2
VMLI	79.8	92.6	77.9	82.5	91.3	89.3	90.2	88.9	89.8	87.5	83.5
FWI	12.0	10.8	-	10.1	6.5	-	8.9	8.0	-	11.9	9.0
FIIa	14.7	14.6	12.0	14.6	10.4	11.9	10.5	11.9	12.5	15.1	16.5
FIIp	8.4	8.9	10.2	7.2	7.0	9.6	9.4	-	7.0	5.8	11.7
FuLI	28.0	35.9	31.9	37.9	34.4	39.1	34.0	35.8	39.0	32.1	37.2
FFuI	16.9	13.7	12.0	14.6	14.8	11.6	9.6	10.2	11.4	14.6	15.4
HLI	44.6	38.3	36.1	35.3	30.4	38.6	32.3	23.7	33.5	25.0	31.7
HWI	54.5	51.0	50.6	47.6	47.4	45.9	41.2	52.6	46.7	41.9	55.5
EDI	16.6	14.2	14.5	13.2	13.9	13.3	12.9	16.2	11.9	12.3	13.7
ALI1	50.6	49.7	43.2	42.7	50.9	49.8	50.6	39.2	41.5	42.2	34.1
ALI2	54.2	46.5	39.2	40.8	51.9	42.7	51.5	42.6	39.0	42.2	33.0
ALI3	61.4	48.6	45.2	46.6	50.9	49.8	48.9	44.3	42.3	39.8	33.0
ALI4	51.8	48.6	53.2	41.7	39.8	55.2	42.8	42.6	48.0	43.0	43.0
ASIn1	2.41	2.64	2.51	2.68	2.76	2.67	2.62	2.33	2.31	2.44	1.65
ASIn2	2.41	2.64	2.51	2.62	2.87	2.33	2.18	2.33	2.44	2.44	1.65
ASIn3	2.89	2.43	2.51	2.62	2.41	2.58	2.27	2.04	2.44	2.44	1.65
ASIn4	2.41	2.11	2.15	2.45	2.19	2.22	2.18	1.91	1.82	2.03	1.59
ASC1	74	84	68	78	75	78	62	64	68	80	72
ASC2	78	76	64	85	96	80	82	82	66	78	84
ASC3	80	98	89	94	109	96	87	82	70	107	96
ASC4	116	134	120	140	119	144	164	120	140	138	114
ASIn4	0.89	0.95	1.10	0.76	1.19	0.89	1.05	-	0.81	0.73	1.32
ASIn4m	0.60	0.85	0.74	0.58	0.74	0.48	0.87	-	0.36	0.49	-
CILI	33.7	27.5	30.1	30.1	29.6	33.8	24.4	20.4	26.0	24.4	22.0
CIRC	7	8	7	8	6	7	7	7	7	8	9
TrRC	25	28	31	25	30	32	24	22	28	26	33
CISI	0.84	1.27	1.00	1.17	0.89	1.01	1.08	0.77	1.06	0.97	0.37
CISId	0.89	0.85	0.70	1.05	0.81	0.80	0.87	0.72	0.93	0.88	0.26
CISiv	0.65	0.76	0.50	0.58	0.81	0.75	0.65	0.72	0.60	0.63	0.33
GiLC	20	22	22	20	22	-	22	-	-	22	25
GiLI	28.2	41.2	33.5	29.7	25.7	38.8	21.8	39.0	36.1	30.7	33.0
SpLI	13.3	11.2	12.0	9.3	10.2	11.6	9.2	10.2	8.9	9.7	-
SpWI	2.73	3.79	3.33	4.17	3.64	3.85	3.77	3.33	3.64	3.67	-
CbL	-	47.0	50.1	50.5	53.3	54.2	55.3	57.6	59.4	58.3	42.1
CbWI	-	49.1	48.9	45.7	48.6	46.1	44.5	44.1	42.4	45.5	55.1
StZI	-	56.2	55.5	55.6	56.3	58.5	60.6	50.3	55.9	59.5	54.4
LoLI	-	41.1	42.1	43.8	40.3	36.2	39.2	40.8	37.9	40.3	33.7
LoL/StZ(%)	-	73.1	75.9	78.6	71.7	61.8	64.8	81.0	67.8	67.7	62.0

Table 5 *Sepia senta* sp. nov.; measurements (mm), counts and indices of 10 mature females.

Museum Reg. No.	MV F77199 (Paratype)	MV F77197 (Paratype)	MV F77196	MV F77198	WAM 264-88	MV F77195 (Paratype)	WAM 264-88	WAM 264-88	WAM 264-88	MV F77201
ML	43.4	48.2	58.6	60.7	60.9	64.2	65.6	67.8	71	75.3
MWI	57.6	69.9	58.4	60.8	67.3	55.5	65.5	65.9	59.0	65.7
AMHI	25.1	26.8	25.1	22.7	16.4	22.4	15.7	16.1	14.4	22.6
VMLI	82.9	72.0	79.2	78.9	86.2	77.1	89.8	87.8	88.7	68.1
FWI	9.7	-	14.7	13.2	11.5	11.5	15.2	16.2	9.7	10.8
FIIa	15.0	11.4	11.4	14.7	13.5	16.0	13.1	19.3	14.1	-
FIIp	3.5	7.5	7.7	5.9	7.4	-	11.9	11.9	11.8	9.8
FuLI	37.6	36.3	30.0	33.8	36.1	34.3	39.6	37.3	33.8	31.3
FFuI	18.4	18.7	14.5	12.4	14.8	15.6	16.8	13.3	12.7	11.3
HLI	31.3	33.0	-	32.5	32.0	31.2	32.2	33.3	35.2	21.9
HWI	43.8	49.6	47.6	45.0	50.6	43.9	50.0	48.8	47.2	51.3
EDI	14.7	10.8	15.0	13.3	10.8	11.7	11.3	12.5	14.1	12.1
ALI1	35.7	40.5	45.2	44.5	37.8	34.3	43.4	44.2	42.3	38.5
ALI2	38.0	39.4	46.1	49.4	40.2	45.2	51.1	47.2	48.6	39.8
ALI3	36.9	41.5	45.2	47.8	44.3	42.8	54.9	47.2	50.0	42.5
ALI4	39.2	45.6	39.2	46.1	46.8	45.2	48.8	47.9	46.5	47.8
ASIn1	1.73	1.80	2.00	2.06	1.74	1.71	1.83	1.55	1.79	1.79
ASIn2	2.00	1.87	1.91	2.06	2.15	1.56	1.75	1.58	1.76	1.79
ASIn3	1.61	1.66	2.13	2.01	1.84	1.79	1.60	1.65	1.58	1.42
ASIn4	1.84	1.80	1.91	1.68	1.76	1.71	1.71	1.84	1.41	1.33
ASC1	80	88	102	96	100	107	92	90	86	100
ASC2	98	112	100	115	90	116	112	116	116	114
ASC3	114	120	118	130	118	132	120	130	130	128
ASC4	122	140	128	140	136	150	156	150	153	140
CILI	-	28.0	34.1	32.1	34.5	28.0	34.3	28.0	26.8	31.9
CIRC	-	7	7	7	7	7	7	7	7	7
TrRC	-	27	37	26	27	32	29	24	25	32
CISI	-	1.04	1.23	1.15	1.10	1.28	0.99	0.96	0.70	1.00
CISId	-	0.73	0.80	0.66	0.94	0.78	0.69	0.91	0.63	0.66
CISlv	-	0.52	0.55	0.61	0.82	0.58	0.69	0.69	0.49	0.66
GiLC	23	-	23	25	-	25	23	-	-	-
GiLI	33.6	40.7	26.1	34.1	37.9	31.5	40.9	33.5	34.1	36.5
EgDI	-	-	-	-	-	-	5.5	8.3	5.9	6.6
CbL	43.3	47.6	55.4	59.7	62.0	63.2	63.7	67.1	69.4	75.4
CbWI	50.8	46.4	48.7	45.7	50.2	47.9	46.3	43.2	43.1	43.0
StZI	54.5	52.7	-	52.6	47.9	51.4	45.5	47.7	55.9	52.1
LoLI	42.7	47.7	47.3	46.9	49.2	50.8	46.8	45.0	40.5	48.4
LoL/StZ (%)	78.4	90.4	-	89.2	102.7	98.8	102.8	94.4	72.4	92.9

with or without pegs. Sucker counts range from 62-164; females with higher average counts than males (Table 6).

Left ventral arm of male hectocotylied: sucker size normal proximally, reduced distally, then normal to arm tip (Figure 11C, compare with Figure 11D); from proximal to distal end of arm, 1 row of normal suckers (slightly larger than rest), 8-11 rows of reduced suckers; suckers in 2 dorsal series smaller than rest in series (dorsal-marginal series slightly larger than dorso-medial series); reduction marked, maximum and minimum sucker diameters hectocotylied arm, ASIn4 0.73-0.93-1.19 (SD, 0.16), ASIn4m 0.36-0.63-0.87 (SD, 0.18) (compare with non-hectocotylied arms Table 6); 2 dorsal and 2 ventral series of suckers widely spaced. Oral surface wide, fleshy, with transversely grooved ridges (Figure 11C); without distinct

median furrow. Right ventral arm slightly thickened, fleshy, with slightly reduced suckers. Hectocotylied arm not markedly attenuate distally.

Tentacular club similar length in males and females; CILI males 20.4-28.0-33.8 (SD, 4.3), females 26.8-30.9-34.5 (SD, 3.1). Club crescent-shaped; sucker-bearing face flattened. Club with 6-8 suckers in transverse rows, CIRC males 6-8-8 (SD, 1), females 7; 22-37 suckers in longitudinal series, TrRC males 22-27-32 (SD, 3), females 24-29-37 (SD, 4.2). Suckers small differ slightly in size; (Figure 12A); CISI males 0.77-1.01-1.27 (SD, 0.15), females 0.70-1.05-1.28 (SD, 0.17); dorsal-marginal series of suckers slightly larger than those in ventral-marginal series row; CISId males 0.70-0.85-1.05 (SD, 0.10), females 0.63-0.76-0.94 (SD, 0.11); CISlv males 0.50-0.67-0.81 (SD, 0.09), females

Table 6 *Sepia senta* sp. nov.; ranges of arm length indices (ALI), arm sucker diameter indices (ASIn) and arm sucker counts (ASC) of 10 mature males and 10 mature females. min. = minimum, max. = maximum, SD = standard deviation.

	Males				Females			
	min.	mean	max.	SD	min.	mean	max.	SD
ALI1	39.2	<u>46.0</u>	50.9	4.7	34.3	<u>40.6</u>	45.2	3.9
ALI2	39.0	<u>45.1</u>	54.2	5.6	38.0	<u>44.5</u>	51.1	4.7
ALI3	39.8	<u>47.8</u>	61.4	5.9	36.9	<u>45.3</u>	54.9	5.0
ALI4	39.8	<u>46.7</u>	55.2	5.4	39.2	<u>45.3</u>	48.8	3.4
ASIn1	2.31	<u>2.54</u>	2.76	0.16	1.55	<u>1.80</u>	2.06	0.14
ASIn2	2.18	<u>2.48</u>	2.87	0.19	1.56	<u>1.84</u>	2.15	0.19
ASIn3	2.04	<u>2.46</u>	2.89	0.22	1.42	<u>1.73</u>	2.13	0.22
ASIn4	1.82	<u>2.15</u>	2.45	0.20	1.33	<u>1.70</u>	1.91	0.19
ASC1	62	<u>73</u>	84	7	80	<u>94</u>	107	8
ASC2	64	<u>79</u>	96	9	90	<u>109</u>	116	9
ASC3	70	<u>91</u>	109	12	114	<u>124</u>	132	6.6
ASC4	116	<u>134</u>	164	15	122	<u>141</u>	156	11

0.49–0.62–0.82 (SD, 0.10). Sucker dentition: half inner ring circumference with 6–7 blunt projections, half circumference with 6–7 pointed teeth (Figure 12B); infundibulum with 8–9 rings of round-ovate processes without pegs; at periphery processes smaller, flattened, hexagonal, or quadrilateral (Figure 10D). Swimming keel of club extends slightly beyond carpus (Figure 12A). Dorsal and ventral protective membranes not

fused at base of club; joined to stalk; differ in length, ventral protective membrane terminates at posterior end of carpus, dorsal membrane shorter than carpus (Figure 12A); approximately equal width; dorsal protective membrane forms shallow cleft at junction with stalk.

Gills with 20–25 lamellae per demibranch; females with greater number than males; GiLC males 20–21–22 (SD, 1), females 23–24–25 (SD, 1).

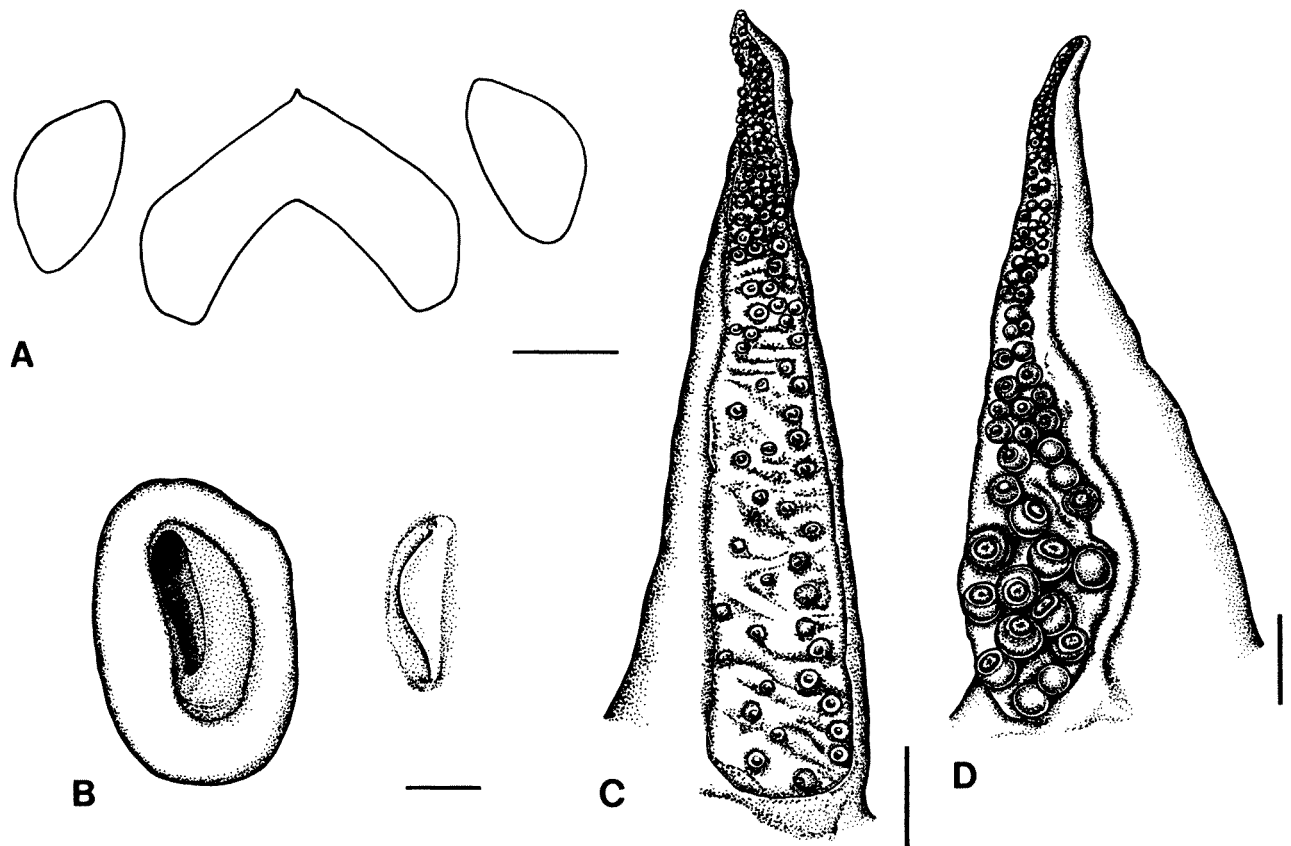


Figure 11 *Sepia senta* sp. nov.; A, funnel organ, male holotype MV F77200, 41.5 mm ML; B, funnel-locking cartilage (left), and mantle-locking cartilage (right), male holotype MV F77200, 41.5 mm ML; C, hectocotylied left ventral arm, male paratype WAM 332–86, 57.3 mm ML; D, right ventral arm, male paratype WAM 332–86, 57.3 mm ML. Scale bars 2 mm.

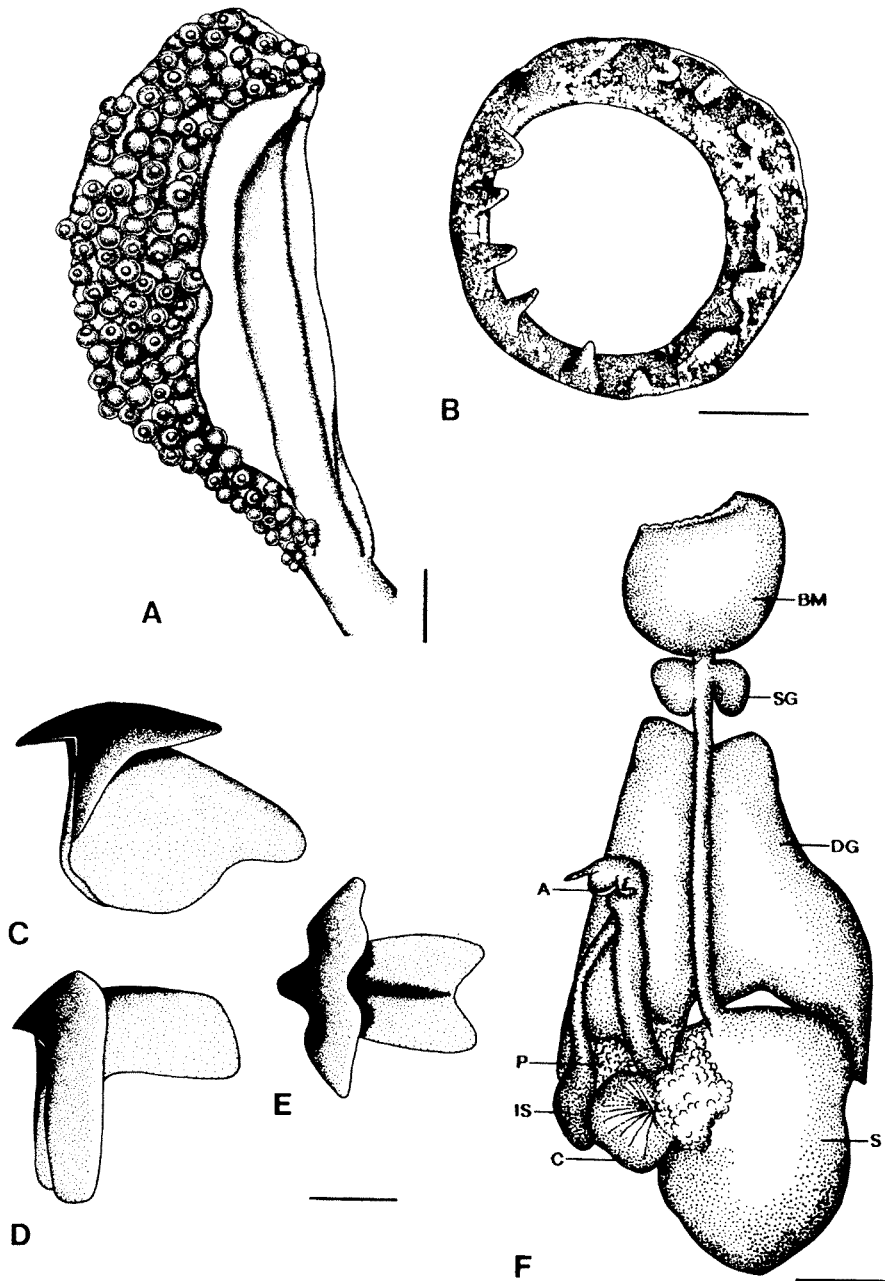


Figure 12 *Sepia senta* sp. nov.; A, tentacular club, female MV F77201, 75.3 mm ML, scale bar 2 mm; B, club sucker infundibulum, female paratype MV F77197, 48.2 mm ML, scale bar 50 µm; C, upper beak, lateral view; D, lower beak, lateral view; E, lower beak, ventral view (C-E, female paratype MV F77195, 64.2 mm ML, scale bar 2 mm); F, digestive tract, dorsal view, female MV F77196, 58.6 mm ML, scale bar 5 mm, abbreviations as in Figure 5E.

Gill length: GiLI males 21.8–32.5–41.2 (SD, 6.3), females 26.1–34.9–40.9 (SD, 4.4).

Buccal membrane without suckers. Upper beak (Figure 12C) rostrum sharply pointed, long, length greater than width, cutting edge straight; hood high above crest posteriorly; crest curved, lateral wall shallowly indented posteriorly; wings and hood narrow and short; jaw angle approximately 90°, slightly acute; hood dark brown, lighter on ventral margin, crest only slightly pigmented. Lower beak (Figure 12D,E) rostrum protrudes only slightly; cutting edge slightly curved; hood low on

crest; crest straight, no indentation on lateral wall edge; hood and wings, width narrow; hood notch deep, broad (Figure 12E); wings widely spaced; crest wide; rostrum pigmented dark brown, wings pigmented along margin, pigmentation on hood fades posteriorly, crest pigmented medially in narrow band. Radula with 7 teeth per row; homodont; rhachidian teeth with narrow, truncate bases, slender, triangular, sides straight to slightly concave (Figure 13A,B); first lateral teeth similar length to rhachidian teeth, slightly broader with wide heels, asymmetrical with mesocone displaced

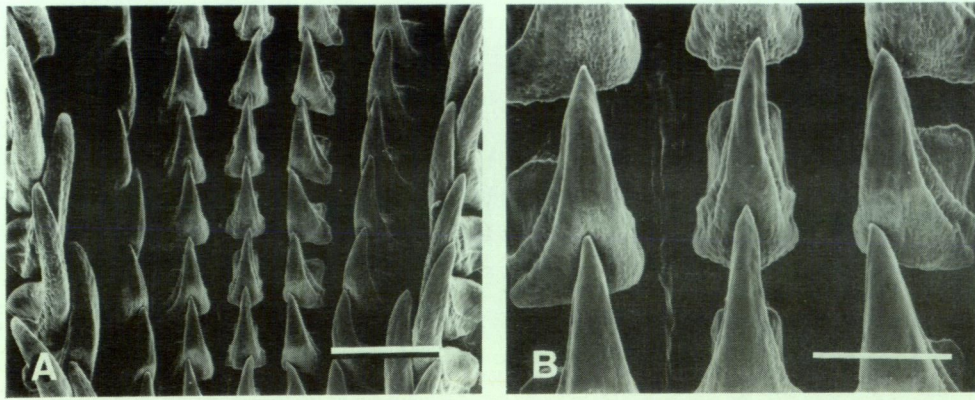


Figure 13 A–B, *Sepia senta* sp. nov.; A, radula, male holotype MV F77200, 41.5 mm ML, scale bar 200 µm; B, 1st lateral and rhachidian (centre) teeth, same specimen, scale bar 100 µm.

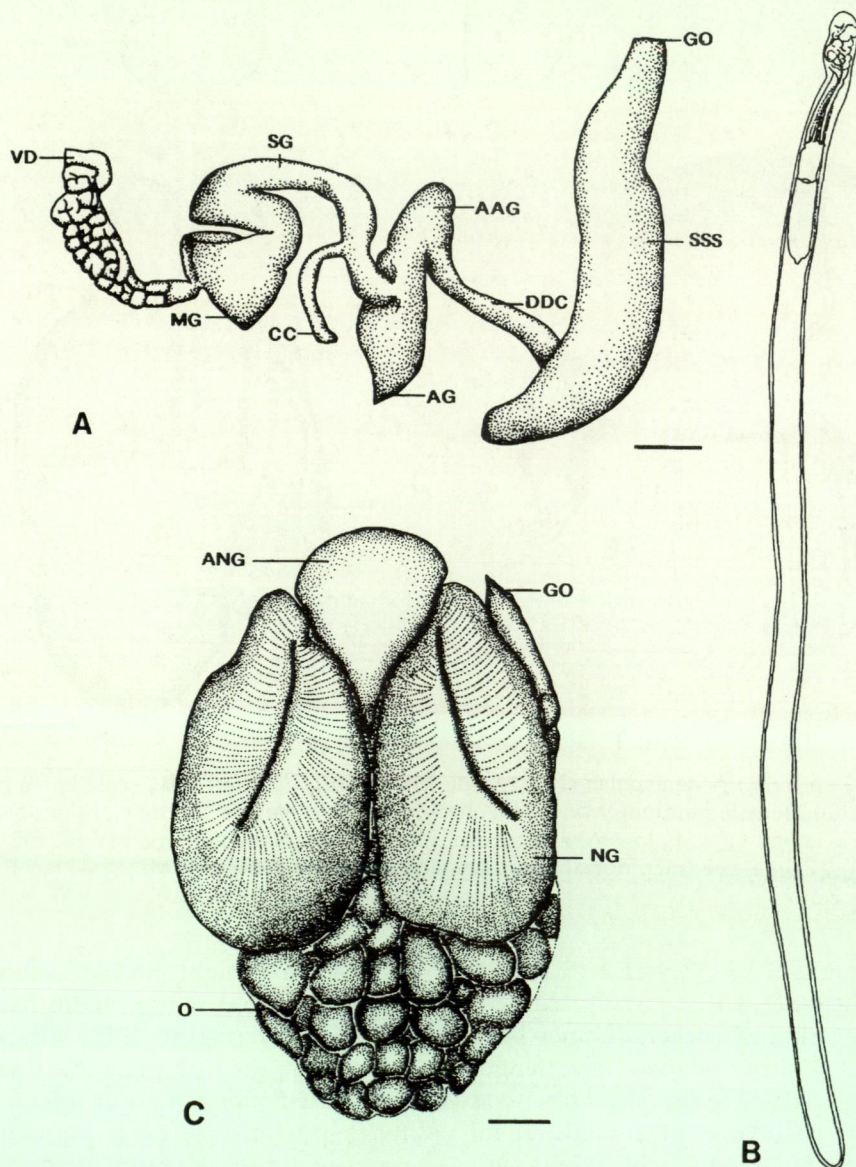


Figure 14 *Sepia senta* sp. nov.; A, male reproductive tract (testis not shown), paratype MV F77197, 49.8 mm ML, scale bar 2 mm, abbreviations as in figure 6A; B, spermatophore, male paratype MV F77197, 49.8 mm ML, scale bar 1 mm; C, female reproductive tract, paratype WAM 104–96, 83.2 mm ML, scale bar 5 mm, abbreviations as in Figure 6C.

toward centre of radula (Figure 13A,B); second laterals longer than first, distinctly curved, with broad heels; marginal teeth elongate with long tapered and curved mesocone (Figure 13A). Digestive tract (Figure 12F): paired salivary glands approximately one-third length of buccal mass; paired digestive glands large, located close together, with sub-triangular lobes posteriorly, ducts (not shown in figure) connect digestive glands near midline with caecum, ducts with branched attached pancreatic tissue; oesophagus runs dorsally along median junction of digestive glands, joins sac-like stomach immediately posterior to digestive gland; caecum disc-like, grooved in blunt V-shape anteriorly, surface lining finely pleated; intestine undifferentiated; ink sac and anal flaps well developed.

Male reproductive tract: testis on left posterior side of visceropericardial coelom; at distal end, convoluted vas deferens opens into broad, cone-shaped mucilaginous gland, then narrower, curved, spermatophoric gland (Figure 14A). Close to junction with lobe-shaped accessory gland and gland appendix, delicate ciliated canal joins spermatophoric gland; distal deferent canal connects appendix of accessory gland to spermatophore storage sac; genital orifice opens dorsal to left gill in anterior end of mantle cavity. Spermatophores: cement body bipartite (Figures 14B, 15A,B); aboral end elongate, cylindrical, connects to sperm reservoir via narrow duct which extends from nipple-like tip of cement body; oral end of cement body approximately half length of, and slightly narrower than aboral end; connects to aboral end via narrow neck, tapers toward oral extremity of cement body; middle tunic commences along aboral part of cement body; ejaculatory apparatus coiled, extends into oral dilation of spermatophore. Spermatophores 4.8–5.6–6.5 mm long (SD, 0.5), 0.15–0.20–0.30 mm wide (SD, 0.04); SpLI 8.9–10.6–13.3 (SD, 1.4); SpWI 2.73–3.59–4.17 (SD, 0.39).

Female reproductive tract: ovary hangs from dorsal wall of posterior visceropericardial coelom. Oviduct thin-walled, continuous with body cavity; distally with thickened, glandular walls (oviducal glands). Nidamental glands, in mature animals occupy large portion of ventral side of mantle cavity. Accessory nidamental glands anterior to nidamental glands (Figure 14C). Eggs spherical 3.6–4.6–5.6 mm diameter (SD, 0.9); EgDI 5.5–6.6–8.3 (SD, 1.2).

Subdermal cartilaginous layer between cuttlebone and skin absent. Cuttlebone length approximately equal to mantle length; outline oval; CbL males 47.0–54.0–59.4 (SD, 4.2), females 43.3–60.7–75.4 (SD, 9.7); CbWI males 42.4–46.1–49.1 (SD, 2.3), females 43.0–46.5–50.8 (SD, 2.9); triangular, obtuse anteriorly; bluntly rounded posteriorly

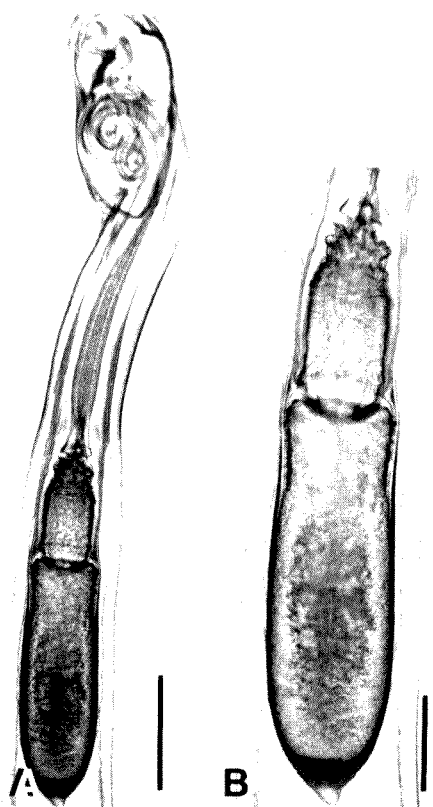


Figure 15 A–B, *Sepia senta* sp. nov.; A, oral end of spermatophore, paratype MV F77197, 49.8 mm ML, scale bar 400 μ m; B, enlargement of middle portion of ejaculatory apparatus, same specimen, scale bar 200 μ m.

(Figure 16A,B). Dorsal surface yellowish; flat medially, curved, convex laterally; texture rough, with irregular calcified projections (particularly pronounced towards distal tip of sepion) (Figure 16C–E). Dorsal median rib present, indistinct, broadens anteriorly; lateral ribs present, indistinct. Dorso-posterior end of cuttlebone without median longitudinal ridge. Chitin present as a thin film over entire dorsal surface of cuttlebone. Spine absent (Figure 16D). Striated zone flat; StZI males 50.3–56.5–60.6 (SD, 3.0), females 45.5–51.2–55.9 (SD, 3.4). Last loculus convex; LoLI males 36.2–40.2–43.8 (SD, 2.2), females 40.5–46.5–50.8 (SD, 3.1). Last loculus slightly shorter than striated zone, LoL/StZ(%) males 61.8–71.4–81 (SD, 6.4), females 72.4–91.3–102.8 (SD, 10.4). Sulcus absent. Anterior striae slightly convex to straight (Figure 16B). Limbs of inner cone extend anteriorly to end of striated zone. Inner cone limbs uniform width, narrow, not raised to form ledge; not thickened posteriorly (Figure 16B,E). Outer cone calcified; broadens slightly posteriorly (Figure 16B); lateral limbs not flared, slightly recurved posteriorly (Figure 16E).

Body papillae absent. Head and arm papillae absent. Colour (alcohol preserved specimens): head

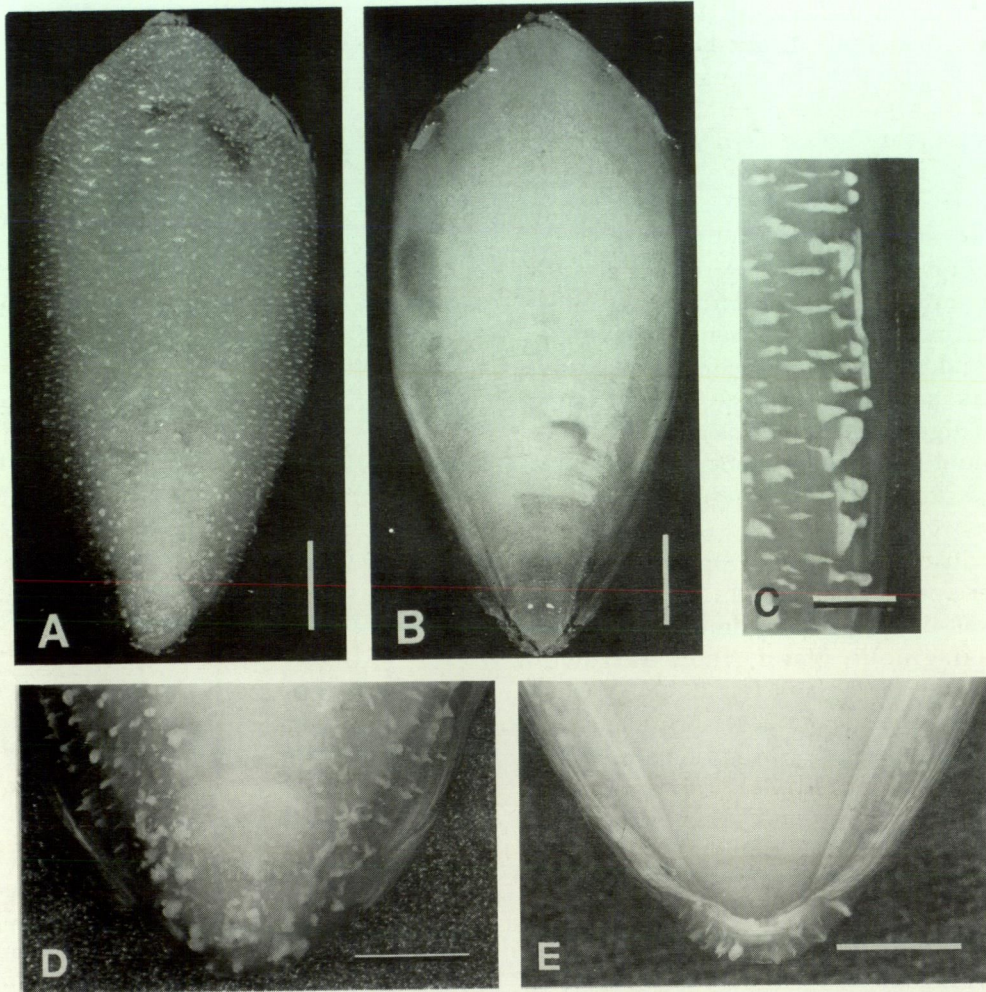


Figure 16 A–E, *Sepia senta* sp. nov.; A, cuttlebone, dorsal view, female paratype MV F77197, 48.2 mm ML, scale bar 7 mm; B, cuttlebone ventral view, same specimen, scale bar 7 mm; C, lateral margin of cuttlebone, dorsal view, male paratype MV F77197, 49.8 mm ML, scale bar 1 mm; D, posterior end of cuttlebone, dorsal view, female MV F77198, 60.7 mm ML, scale bar 4 mm; E, posterior end of cuttlebone, ventral view, male paratype MV F77197, 49.8 mm ML, scale bar 5 mm.

and arms pale, without colour pattern; dorsal mantle pale brownish, without markings (Figure 10A); paired dorsal eye spots absent. Fins pale; without markings at base. Arms without markings. Ventral pigment absent (Figure 10B).

Type locality

Australia: Western Australia, North West Shelf, 14°07'S 122°06'E; 415 m.

TYPE: Holotype, MV F77200, male 41.5 mm ML.

Distribution

Australia: Western Australia, North West Shelf, 12°04'S 122°51'E – 18°44'S 116°59'E (Figure 9); depth range 426–256 m. Habitat soft, muddy substrate.

Etymology

The specific name, *senta*, is derived from the Latin, *sentus*, meaning “thorny or rough”. It refers

to the calcareous protuberances on the dorsal side of the cuttlebone in this species. Gender feminine.

Remarks

A single male animal (MV F77982) from off Cebu in the Philippines (14°41.07'N 123°24.12'E – 14°42.42'N – 123°21.42'E) closely resembles this species. The specimen differs, however, in a number of morphometric characters, notably in having relatively shorter arms, smaller arm and club suckers and a greater number of gill lamellae and rows of club suckers than the Australian animals. Measurements, counts and indices for this specimen are shown in Table 4 for comparison. The left ventral arm of the Philippines specimen shows no modification, but as it additionally has no mature spermatophores in the spermatophore storage sac, the animal may be immature. The body pigmentation is much darker, a deep rust brown in the Philippines animal, in contrast to the pale brownish skin coloration of the Australian

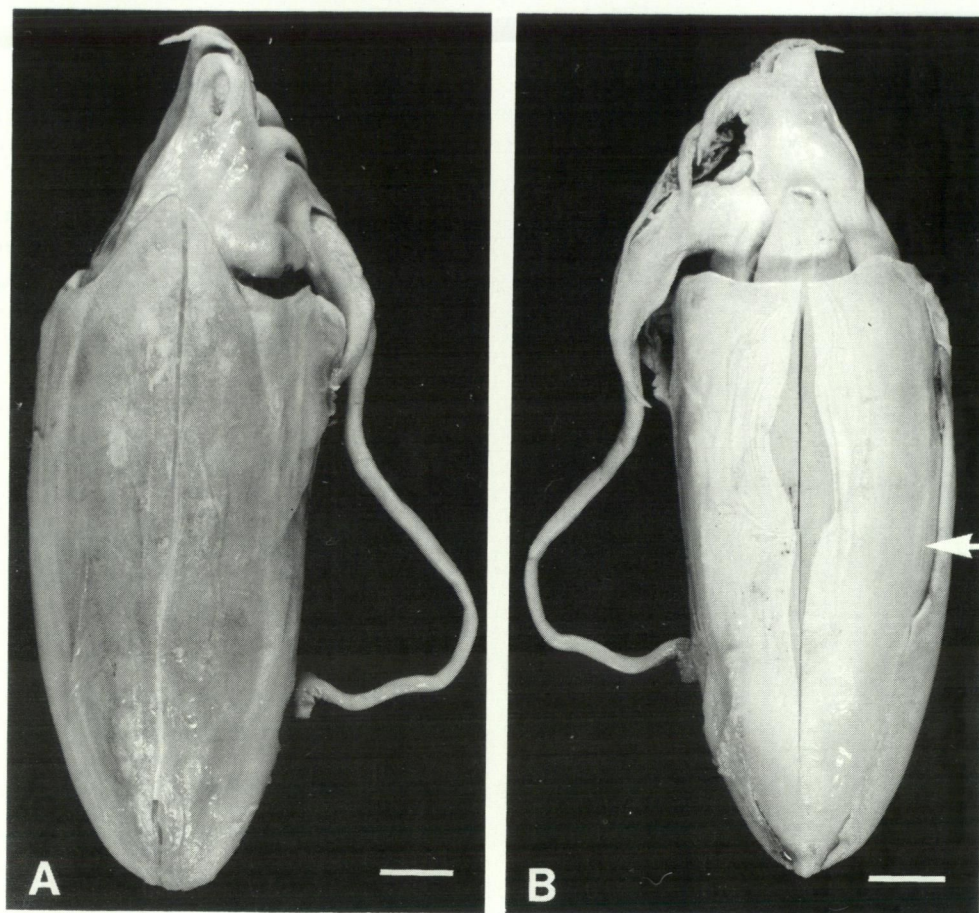


Figure 17 A–B, *Sepia sulcata* Hoyle; A, dorsal view female MV F56919, 96.2 mm ML; B, ventral view, same specimen, arrow indicates the position of a ventrolateral ridge. Scale bars 10 mm.

animals. The dorsal surface of the sepiion is roughened with calcified projections, but these projections are more regular in arrangement and shape in the Philippines animal than in the Australian species. The Philippines animal was collected at 30 m depth, in contrast to the Australian specimens found between 426–256 m. Until additional specimens become available, conspecificity of the Philippines form with *S. senta* sp. nov. remains uncertain.

Sepia senta sp. nov. differs from all other sepiids in the structure of the dorsal side of the cuttlebone, with its irregular calcareous projections. Other characters are either shared or differ among other members of the genus. As discussed in the remarks section of *S. plana* above, until relationships among the sepiids are established there is little value in comparing differences in individual characters between *S. senta* sp. nov and all other nominal species.

Sepia sulcata Hoyle, 1885

Figures 9, 17–25; Tables 7–10

Holotype

Indonesia: Arafura Sea, off Ki Is. – 1M (53.2 mm

ML), 5°49'15"S 132°14'15"E, 140 fms (255 m), 26 Sep 1874, coll. W.E. Hoyle on HMS "Challenger", (BMNH 89.4.24.77).

Additional material

Australia: Western Australia, North West Shelf – 2F (28.1, 38.1 mm ML), NW of Augustus Is., 13°51.4'S 123°01.8'E – 13°52.8'S 122°59.0'E, 308–306 m, 14 Feb 1984, coll. S. Slack-Smith on RV "Soela", (WAM 337–86); 1F (42.8 mm ML), NW of Collier Bay, 14°16.5'S 122°34.4'E – 14°13.6'S 122°38.3'E, 302 m, 14 Feb 1984, coll. S. Slack-Smith on RV "Soela", (WAM 336–86); 3F (57.0–64.1 mm ML), NW of Augustus Is., 14°29.4'S 122°01.4'E – 14°28.4'S 122°03.2'E, 304–296 m, 12 Feb 1984, coll. S. Slack-Smith on RV "Soela", (WAM 335–86); 7M (37.8–50.6 mm ML) 13F (37.1–65.3 mm ML), 14°35.8'S 121°49.4'E – 14°37.2'S 121°47.4'E, 304–300 m, 16 Feb 1984, coll. S. Slack-Smith on RV "Soela", (WAM 343–86); 6M (42.9–60.0 mm ML) 4F (55.6–66.1 mm ML), NW of Cape Leveque, 14°49.0'S 121°31.1'E – 14°50.8'S 121°35.6'E, 302–300 m, 12 Feb 1984, coll. S. Slack-Smith on RV "Soela", (WAM 333–86); 4M (46.0–52.7 mm ML) 2F (42.8, 60.9 mm ML), NW of Cape Leveque, 14°51.9'S 121°40.6'E, 260–256 m, 16 Feb 1984, coll. S. Slack-Smith on RV "Soela",

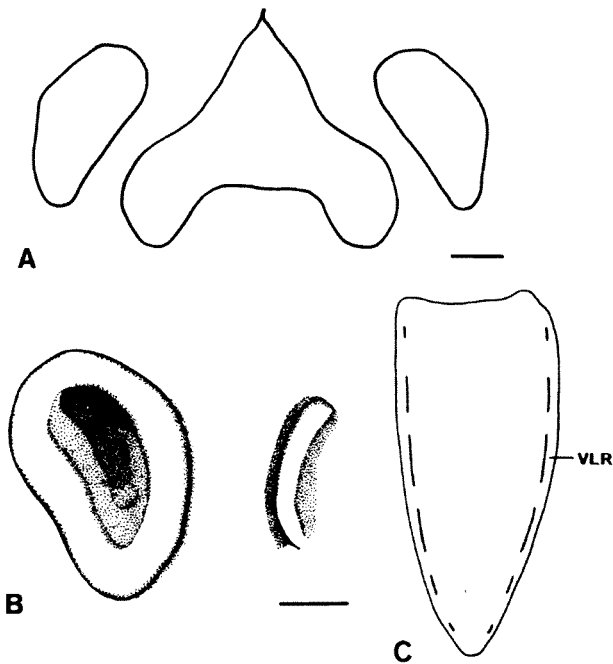


Figure 18 A–B, *Sepia sulcata* Hoyle; A, funnel organ, female MV F56919, 96.2 mm ML, scale bar 2 mm; B, funnel-locking cartilage (left), and mantle-locking cartilage (right), male MV F56919, 65.9 mm ML, scale bar 2 mm; C, diagram of mantle, ventral view showing position of ventrolateral ridges (VLR).

(WAM 339–86); 1M (45.7 mm ML) 5F (45.1–61.3 mm ML), NW of Cape Leveque, 15°11.1'S 121°26.9'E – 15°12.9'S 121°25.7'E, 260–258 m, 17 Feb 1984, coll. S. Slack-Smith on RV "Soela", (WAM 341–86); 5F (35.9–56.9 mm ML), North West Shelf, 18°10'S 118°18'E – 18°10'S 118°23'E, 300–298 m, 10 May 1982, coll. RV "Courageous", (MV F65584); 2M (65.9, 67.6 mm ML) 2F (86.6, 96.2 mm ML), North West Shelf, 18°49'S 117°41'E, 168–166 m, 6 May 1983, coll. RV "Soela", (MV F56919); 1F (90.6 mm ML), North West Shelf, 18°36'S 118°2'E, 184–182 m, 6 Jun 1983, coll. RV "Soela", (MV F56918); 1M (38.5 mm ML) 2F (54.5, 64.1 mm ML), off Port Headland, 18°41'S 117°54'E – 18°41'S 117°52.6'E, 404 m, 2 Apr 1982, coll. L. Marsh on RV "Soela", (WAM 3103–83); 1M (62.8 mm ML) 2F (61.5, 67.2 mm ML), off Port Headland, 18°54'S 117°02'E – 18°55.5'S 117°00'E, 306–300 m, 13 Apr 1982, L. Marsh on RV "Soela", (WAM 3102–83); 1F (85.7 mm ML), N of Monte Bello Is., 19°58'S 115°13'E, 180–150 m, 10 May 1978, coll. RV "Courageous", (WAM 3100–83).

Diagnosis

Sucker rows on arms 1–3 in males biserial proximally (approximately 8–11 rows biserial suckers arms 1, 6–8 rows biserial suckers arms 2 and 3), tetraserial distally; suckers arms 4 biserial proximally (approximately 2 rows), tetraserial

distally. Sucker rows on arms 1–3 in females biserial proximally for 6–7 rows, tetraserial distally, suckers on arms 4 biserial proximally for 2–3 rows, rest tetraserial. Distal arm tips strongly attenuate. A thick, cartilaginous sub-dermal layer adheres closely to dorsal side of cuttlebone. Cuttlebone oblong, strongly acuminate, acute anteriorly and posteriorly. Dorsal median and lateral ribs present, distinct. Sulcus shallow, narrow, flanked by prominent rounded ribs bordered laterally by shallow grooves. Inner cone limbs form narrow, raised ledge posteriorly. Left ventral arm hectocotylied: proximally 14 rows (approximately) of greatly reduced suckers; 2 dorsal and 2 ventral series widely spaced; in mature males, oral surface wide, fleshy with deep longitudinal furrow between swollen protective membranes. Tentacular clubs with 5–7 small, subequal suckers in transverse rows; dorsal and ventral protective membranes not fused at base of club. Dorsal mantle with up to 10 short, longitudinal, orange-pink ridges along each side close to fins; ventral mantle with 6 (3 long and 3 short) longitudinal ridges along each side close to fins. Small to moderate sized species, maximum size up to approximately 100 mm ML.

Description

Counts and indices for individual specimens are given in Table 7–8; ranges for arm length indices, arm sucker diameter indices and arm sucker counts are shown in Table 9.

Small to moderate sized species; ML males 42.9–55.7–67.6 mm (SD, 8.1), females 61.3–74.6–96.2 mm (SD, 13.5). Mantle very slender, obovate; MWI males 40.4–45.3–51.7 (SD, 2.9), females 39.3–45.0–51.6 (SD, 4.2); markedly attenuate posteriorly, tapers to point (Figure 17A,B); dorsal anterior margin triangular, acute (Figure 17A); projects anteriorly beyond eyes; AMHI males 12.8–14.6–16.6 (SD, 1.1), females 12.5–14.7–16.2 (SD, 1.2). Ventral mantle margin emarginate, without distinct lateral angle; VMLI males 81.2–86.9–95.8 (SD, 4.4), females 69.8–83.5–88.7 (SD, 5.7). Fins widest in posterior third; FWI males 5.8–8.6–11.2 (SD, 1.7), females 5.0–8.6–11.1 (SD, 2.1); anterior origin posterior to mantle margin; FIIa males 5.1–6.8–8.9 (SD, 1.2), females 2.5–5.6–8.7 (SD, 2.0); rounded posteriorly; narrow gap between fins; FIIp males 6.8–8.2–9.8 (SD, 1.0), females 4.1–6.8–9.2 (SD, 1.7). Funnel long, broad-based; extends to anterior rim of eye; FuLI males 23.9–29.4–32.6 (SD, 3.2), females 26.4–29.9–31.8 (SD, 1.9). Funnel free portion approximately half funnel length, FFuI males 8.8–12.2–18.8 (SD, 2.7), females 26.4–29.9–31.8 (SD, 1.9). Funnel organ dorsal elements inverted V-shape with small papilla in front; ventral elements oval (Figure 18A). Mantle-locking cartilage curved, with semicircular ridge; funnel-locking cartilage with

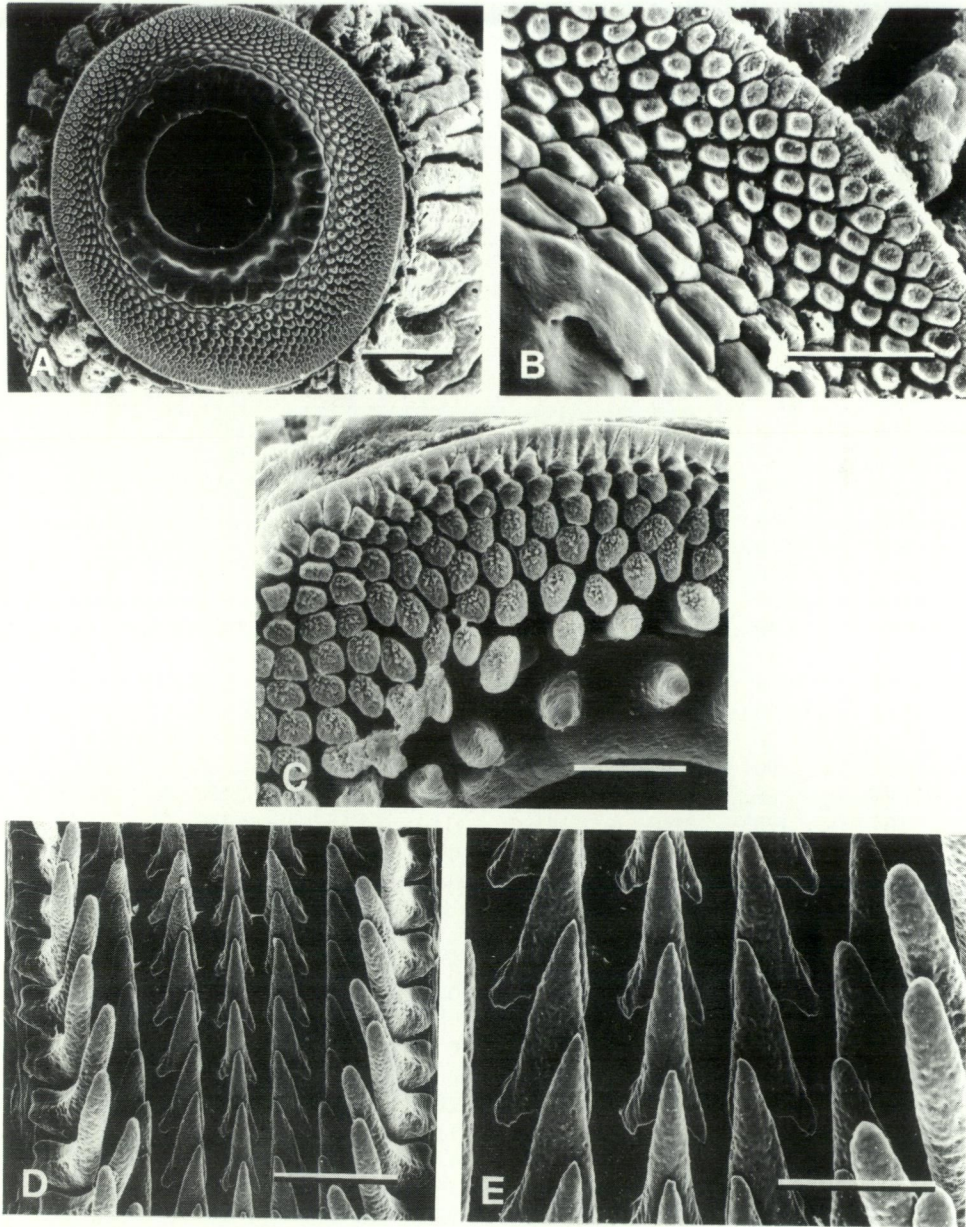


Figure 19 A–E, *Sepia sulcata* Hoyle; A, sucker rim, arm 2, male MV F56919, 65.9 mm ML, scale bar 100 µm; B, sucker rim, arm 2, female MV F56919, 96.2 mm ML, scale bar 30 µm; C, club sucker rim, female MV F56919, 96.2 mm ML, scale bar 30 µm; D; radula, female MV F56919, 96.2 mm ML, scale bar 200 µm; E; radula, from left to right 1st laterals, rhachidian, 1st and 2nd lateral teeth, marginal teeth (distal tips) same specimen, scale bar 200 µm.

depression which corresponds to ridge (Figure 18B). Head slender; HLI males 20.6–25.6–29.6 (SD, 2.8), females 16.1–23.2–31.9 (SD, 4.5); narrower than mantle; HWI males 29.0–35.3–41.7 (SD, 3.8), females 28.9–35.6–40.9 (SD, 4.2). Eyes moderate size, EDI males 11.2–12.5–14.9 (SD, 1.2), females 8.6–11.2–14.1 (SD, 1.5); ventral eyelids present.

Male and female arms subequal in length (Table 9). ALI of longest arms in male 30.4–36.4–42.5 (SD, 4.0), females 32.7–35.3–39.1 (SD, 2.2). Protective membranes (both sexes) wide, well developed; normal, not thickened. Distal arm tips (both sexes) strongly attenuate, suckers enclosed by protective membranes. Arrangement of arm sucker rows

differs between sexes. In males, sucker rows on arms 1–3 biserial proximally (approximately 8–11 rows biserial suckers arms 1, 6–8 rows biserial suckers arms 2 and 3), tetraserial distally; arms 4 suckers biserial at base (approximately 2 rows), suckers tetraserial distally. In females, sucker rows on arms 1–3 biserial proximally for 6–7 rows, tetraserial distally; suckers on arms 4 biserial proximally for 2–3 rows, rest tetraserial. Suckers in males normal in size (not greatly enlarged); larger than female arm suckers (Table 9). Chitinous rims of arm suckers smooth, or with blunt processes on inner ring; infundibulum with 9–13 rows of ovoid-hexagonal processes with blunt pegs, inner row

Table 7 *Sepia sulcata* Hoyle; measurements (mm), counts and indices of 10 mature males.

Museum Reg. No.	BMNH 89.4.24.77 (Holotype)	WAM 333-86	WAM 343-86	WAM 343-86	WAM 339-86	WAM 333-86	WAM 333-86	WAM 3102-83	MV F56919	MV F56919
ML	53.2	42.9	47.8	50.6	52.7	53.9	60.0	62.8	65.9	67.6
MWI	46.4	51.7	46.2	44.7	46.3	45.5	45.2	40.4	43.4	43.6
AMHI	14.1	16.1	13.8	12.8	15.0	14.3	14.5	16.6	14.6	14.5
VMLI	86.8	95.8	86.2	93.1	84.3	86.1	87.0	81.2	85.1	83.9
FWI	9.4	9.8	9.8	8.9	7.6	7.6	5.8	6.5	9.3	11.2
FIIa	5.1	8.2	7.7	7.3	8.9	6.9	6.0	6.4	5.3	6.1
FIIp	8.5	8.2	9.8	8.3	7.6	7.8	8.3	7.2	6.8	9.6
FuLI	32.5	32.6	32.4	23.9	24.7	29.7	28.3	28.7	32.6	28.7
FFuI	18.8	11.7	13.6	9.9	11.4	12.1	11.7	8.8	11.4	12.6
HLI	27.8	29.6	26.6	28.1	23.3	20.6	25.5	23.4	-	25.9
HWI	41.7	35.2	41.0	33.2	33.2	35.6	34.7	33.0	36.4	29.0
EDI	12.0	12.4	14.9	11.3	11.2	11.7	13.7	12.6	11.7	13.6
ALI1	30.1	33.8	31.4	33.6	31.3	39.0	33.3	34.2	37.2	38.5
ALI2	30.1	32.6	33.5	31.6	36.1	30.6	29.2	28.7	33.4	35.5
ALI3	28.2	32.6	31.4	32.6	30.4	33.4	33.3	30.3	33.4	36.2
ALI4	32.0	42.0	35.6	38.5	30.4	36.0	38.3	33.4	42.5	35.5
ASIn1	1.07	1.40	1.26	1.48	1.35	1.11	1.25	1.27	1.32	1.33
ASIn2	1.17	1.17	1.26	1.48	1.35	1.11	1.33	1.19	1.32	1.36
ASIn3	0.94	1.52	1.26	1.58	1.40	1.11	1.42	1.35	1.52	1.48
ASIn4	1.17	1.63	1.36	1.68	1.54	1.48	1.50	1.53	1.78	1.66
ASC1	-	76	88	110	94	106	86	94	102	106
ASC2	92	90	106	104	-	114	80	104	124	127
ASC3	94	88	108	102	104	96	106	96	113	126
ASC4	104	120	140	146	150	152	140	-	140	120
ASIn14	0.70	0.93	0.63	0.79	0.66	0.93	0.75	0.83	1.02	0.96
ASIn14m	0.51	0.58	0.52	0.59	0.38	0.56	0.33	0.51	0.38	0.40
CILI	11.3	14.0	13.0	-	10.6	9.8	9.3	14.3	10.2	10.4
CIRC	7	5	5	-	6	5	5	5	5	5
TrRC	19	21	21	-	24	18	18	22	23	22
CISI	0.51	0.58	0.46	-	0.57	0.46	0.52	0.57	0.56	0.70
CISId	0.47	0.47	0.42	-	0.42	0.41	0.47	0.51	0.46	0.44
CISiv	0.41	0.42	0.36	-	0.42	0.41	0.43	0.45	0.38	0.37
GiLC	29	27	27	27	26	27	26	27	29	29
GiLI	36.1	33.1	33.5	30.8	29.8	28.4	28.2	30.4	26.6	21.3
SpLI	-	11.7	8.4	9.5	11.4	9.8	9.3	10.7	12.4	12.6
SpWI	-	5.00	6.25	6.25	4.50	9.43	4.46	4.78	3.66	3.18
CbL	-	-	47	49	50.3	5.3	-	60.9	65	65.6
CbWI	-	-	34.0	34.1	33.0	32.3	-	31.2	29.4	31.3
SLI	-	-	-	-	-	4.4	-	2.5	3.1	3.2
StZI	-	-	63.4	63.1	60.2	60.0	-	64.2	65.7	67.8
LoLI	-	-	35.1	36.9	38.2	40.3	-	33.7	28.9	31.7
LoL/StZ (%)	-	-	55.4	58.6	63.4	67.2	-	52.4	44.0	46.7

processes larger than rest, rectangular; peripheral sucker rim processes radially arranged, elongate, without pegs (Figure 19A,B). Sucker counts range from 76-152; females with higher average counts than males (Table 9).

Left ventral arm hectocotylised. Suckers: reduced proximally in size: 14 rows of suckers reduced (approximately, dorsal and ventral sides of hectocotylus differ, see Figure 20); suckers in dorsal marginal series smaller than remaining suckers (Figure 20 A,B, compare with Figure 20C); reduction marked, maximum and minimum sucker diameters: ASIn14 0.63-0.82-1.02 (SD, 0.14), ASIn14m 0.33-0.48-0.59 (SD, 0.09), (compare with

non-hectocotylised arms Table 9); two dorsal and two ventral series of suckers widely spaced. Oral surface wide, fleshy, with transversely grooved ridges; proximal end with deep furrow between raised fleshy ridge formed from swollen protective membranes; distal to this region, protective membranes thin, wide, form a deep, narrow furrow (Figure 20B). Hectocotylised arm distally attenuate, compressed (as for remaining arms).

Tentacular club approximately same length in males and females; CILI males 9.3-11.4-14.3 (SD, 1.9), females 9.8-11.2-14.9 (SD, 1.6); club crescent-shaped (very short); sucker-bearing face flattened. Club with 5-7 suckers in transverse rows, CIRC

Table 8 *Sepia sulcata* Hoyle; measurements (mm), counts and indices of 10 mature females

Museum Reg. No.	WAM 341-86	WAM 3102-83	WAM 343-86	WAM 343-86	WAM 333-86	WAM 3102-83	WAM 3100-83	MV F56919	MV F56918	MV F56919
ML	61.3	61.5	65.1	65.3	66.1	67.2	85.7	86.6	90.6	96.2
MWI	48.9	44.6	42.2	50.7	43.1	51.6	45.5	41.0	42.7	39.3
AMHI	16.0	14.0	13.8	15.0	13.8	15.6	16.2	15.7	13.9	12.5
VMLI	85.0	82.9	85.4	78.7	88.7	82.6	69.8	88.0	86.6	87.5
FWI	7.7	7.8	8.0	-	10.1	6.4	5.0	11.1	10.5	10.7
FIIa	6.2	6.8	4.8	8.7	6.1	8.2	4.2	4.3	4.2	2.5
FIIp	8.0	7.0	4.6	7.4	7.7	8.0	5.0	6.7	9.2	4.1
FuLI	31.8	28.9	31.2	31.4	31.0	28.3	26.4	27.7	30.9	31.7
FFuI	11.4	8.9	10.0	12.3	11.3	16.4	12.8	13.9	15.5	16.1
HLI	26.3	24.2	-	31.9	20.3	16.1	24.4	19.1	23.1	23.9
HWI	36.5	33.8	-	36.0	38.9	40.9	40.5	30.1	34.8	28.9
EDI	12.2	10.4	-	14.1	11.2	8.6	10.5	11.5	11.9	10.6
ALI1	32.6	32.5	29.2	38.3	34.0	30.5	31.5	34.6	34.8	33.8
ALI2	30.2	30.9	26.1	34.5	31.8	26.0	30.3	30.6	34.8	33.3
ALI3	28.5	30.9	29.2	33.7	31.8	27.5	31.5	31.2	33.1	31.2
ALI4	33.4	34.1	36.9	39.1	34.8	32.7	33.8	33.5	36.4	37.9
ASIn1	0.98	1.38	1.08	1.07	1.21	1.56	1.12	1.15	1.27	1.04
ASIn2	1.04	1.46	1.15	1.07	1.21	1.19	1.12	1.21	1.24	1.16
ASIn3	1.04	1.46	1.15	1.07	1.13	1.34	1.05	1.15	1.24	1.14
ASIn4	0.98	1.63	1.23	1.23	1.21	1.19	1.05	1.15	1.10	1.16
ASC1	95	102	106	112	96	90	120	98	106	100
ASC2	124	102	116	128	104	126	106	114	130	126
ASC3	136	110	136	128	144	132	112	122	120	117
ASC4	152	-	142	152	132	145	130	132	103	144
CILI	10.4	9.8	10.1	11.5	10.6	14.9	11.1	10.3	12.7	10.2
CIRC	5	5	5	5	5	7	5	5	5	5
TrRC	21	22	21	21	21	20	22	22	22	22
CISI	0.46	0.60	0.61	0.61	0.61	0.54	0.64	0.60	0.55	0.52
CISId	0.39	0.50	0.46	0.57	0.48	0.54	0.41	0.46	0.46	0.47
CISlv	0.39	0.41	0.40	0.54	0.53	0.40	0.35	0.46	0.46	0.36
GiLC	27	27	27	27	28	-	-	31	31	-
EgDI	-	-	-	-	-	-	-	4.0	4.3	4.6
GiLI	28.7	29.8	29.0	34.6	29.8	33.8	28.8	26.7	27.0	32.2
CbL	61.3	60.5	63.3	62.7	64.4	65.6	80.1	86.5	-	-
CbWI	33.0	32.1	33.2	31.9	33.7	33.1	30.0	28.7	-	-
SLI	3.3	3.3	3.5	3.3	3.4	-	2.5	1.2	-	-
StZI	60.2	65.3	57.0	63.3	61.3	-	71.3	69.7	-	-
LoLI	39.2	33.6	37.9	36.8	38.0	-	25.0	25.3	-	-
LoL/StZ (%)	65.0	51.4	66.5	58.2	62.0	-	35.0	36.3	-	-

males 5-5-6 (SD, 0), females 5-5-7 (SD, 1); 18-24 suckers in longitudinal series, TrRC males 18-21-24 (SD, 2), females 20-21-22 (SD, 1). Suckers differ slightly in size (Figure 21A); small (those in middle of club slightly larger than rest); CISI males 0.46-0.55-0.7 (SD, 0.07), females 0.46-0.57-0.64 (SD, 0.06); dorsal marginal series of suckers slightly larger than those in ventral marginal series; CISId males 0.41-0.45-0.51 (SD, 0.03), females 0.39-0.47-0.57 (SD, 0.05); CISlv males 0.36-0.40-0.45 (SD, 0.03), females 0.35-0.43-0.54 (SD, 0.06). Sucker dentition: inner ring with approximately 20 elongate projections (Figure 19C) evenly distributed around circumference; infundibulum with 6-8 rows hexagonal-ovate processes without pegs; at periphery, processes smaller, flattened, hexagonal (Figure 19C). Swimming keel of club

extends beyond carpus for about third the length of the club (Figure 21A). Dorsal and ventral protective membranes not fused at base of club; joined to stalk; dorsal and ventral membranes differ in length, dorsal membrane extends beyond carpus along stalk, ventral membrane terminates at posterior end of carpus; dorsal membrane much wider than ventral membrane; dorsal membrane forms deep cleft at junction with stalk.

Gills with 26-31 lamellae per demibranch; GiLC males 26-27-29 (SD, 1), females 27-28-31 (SD, 2). Gill length: GiLI males 21.3-29.8-36.1 (SD, 4.1), females 26.7-30-34.6 (SD, 2.7).

Buccal membrane without suckers. Upper beak with long, pointed, and slightly curved rostrum, width greater than length (Figure 21B); cutting edge straight; hood high above crest posteriorly;

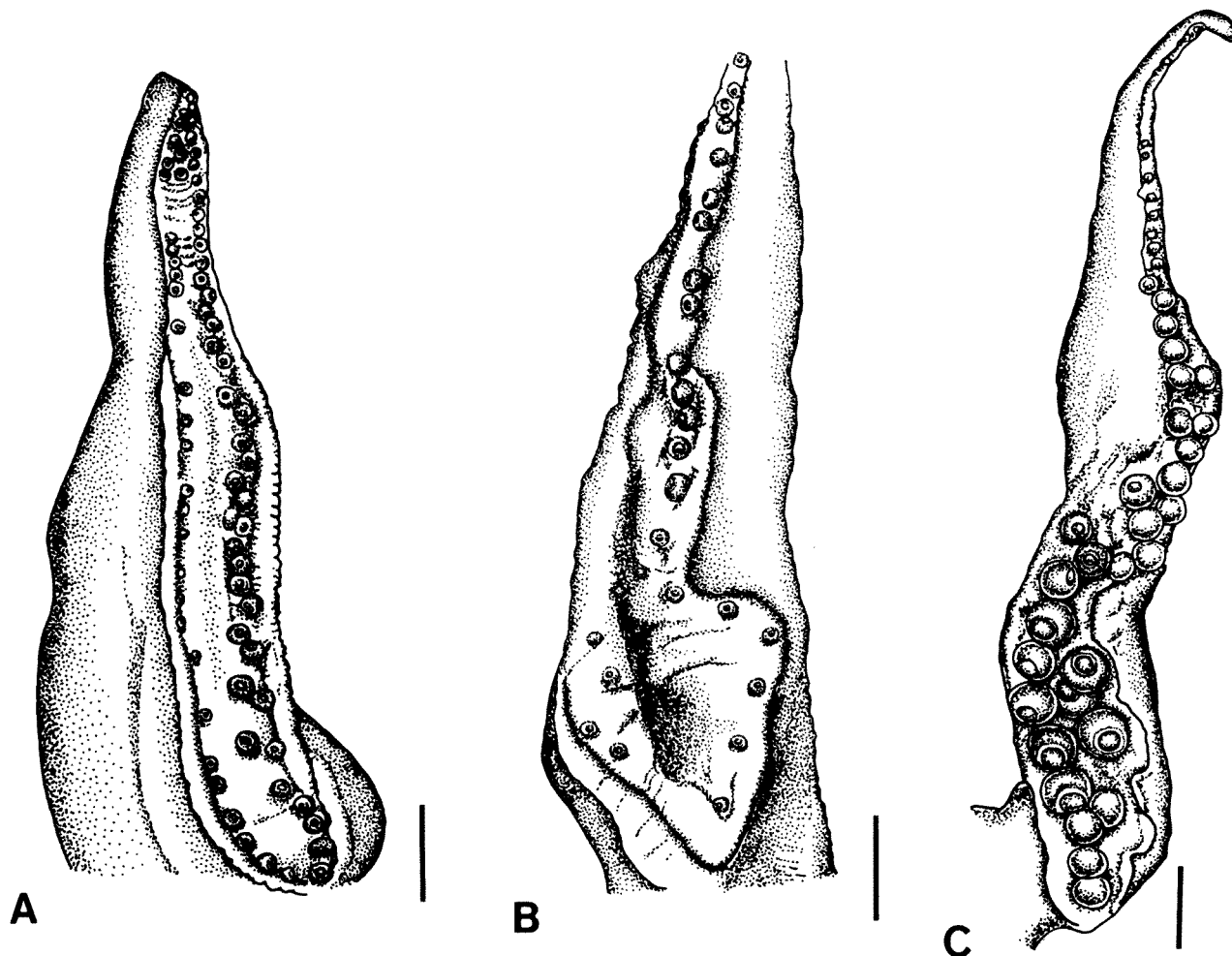


Figure 20 A-C, *Sepia sulcata* Hoyle; A, hectocotylied left ventral arm, holotype BMNH 89.4.24.77, 53.2 mm ML; B, modified portion of hectocotylied left ventral arm, MV F56919, 67.6 mm ML; C, right ventral arm, male MV F56919, 67.6 mm ML. Scale bars 2 mm.

wings and hood narrow and short; lateral wall shallowly indented posteriorly; jaw angle approximately 90° ; hood darkly pigmented, fades toward posterior margin; crest pigmented along midline, lateral walls pale. Lower beak cutting edge straight; hood low on crest (Figure 21C); crest straight; lateral wall edge without indentation; hood and wings, width narrow; hood notch deep (Figure 21D); crest wide; jaw angle obtuse; hood darkly pigmented, fades toward posterior margin; crest pigmented along midline, lateral walls pale. Radula with 7 teeth per row; homodont; rhachidian teeth with broad, strongly indented bases, narrow, tapered, blunt distally (Figure 19D,E); first lateral teeth slightly longer, broader than rhachidian teeth, with wide heels and bases strongly indented, asymmetrical with mesocone displaced toward centre of radula (Figure 19D,E); second laterals similar in shape, slightly longer than first laterals; marginal teeth elongate, curved, bluntly rounded distally, with rounded heel, strongly indented proximally (Figure 19D). Digestive tract (Figure 21E): paired salivary glands approximately one-

third length of buccal mass; paired digestive glands large, located close together, with sub-triangular lobes posteriorly, ducts (not shown in figure) connect digestive glands near midline with caecum, with branched attached pancreatic tissue; oesophagus runs dorsally along median junction of digestive glands, joins sac-like stomach immediately posterior to digestive gland; caecum disc-like, grooved in blunt V-shape anteriorly, surface lining finely pleated; intestine undifferentiated; ink sac and anal flaps well developed.

Male reproductive tract: testis on left posterior side of viscero-pericardial coelom; at distal end, convoluted vas deferens (Figure 22A) opens into broad, cone-shaped mucilaginous gland, then narrower, curved, spermatophoric gland. Close to junction with lobe-shaped accessory gland and gland appendix, delicate ciliated canal joins spermatophoric gland; distal deferent canal connects appendix of accessory gland to spermatophore storage sac; genital orifice opens dorsal to left gill in anterior end of mantle cavity.

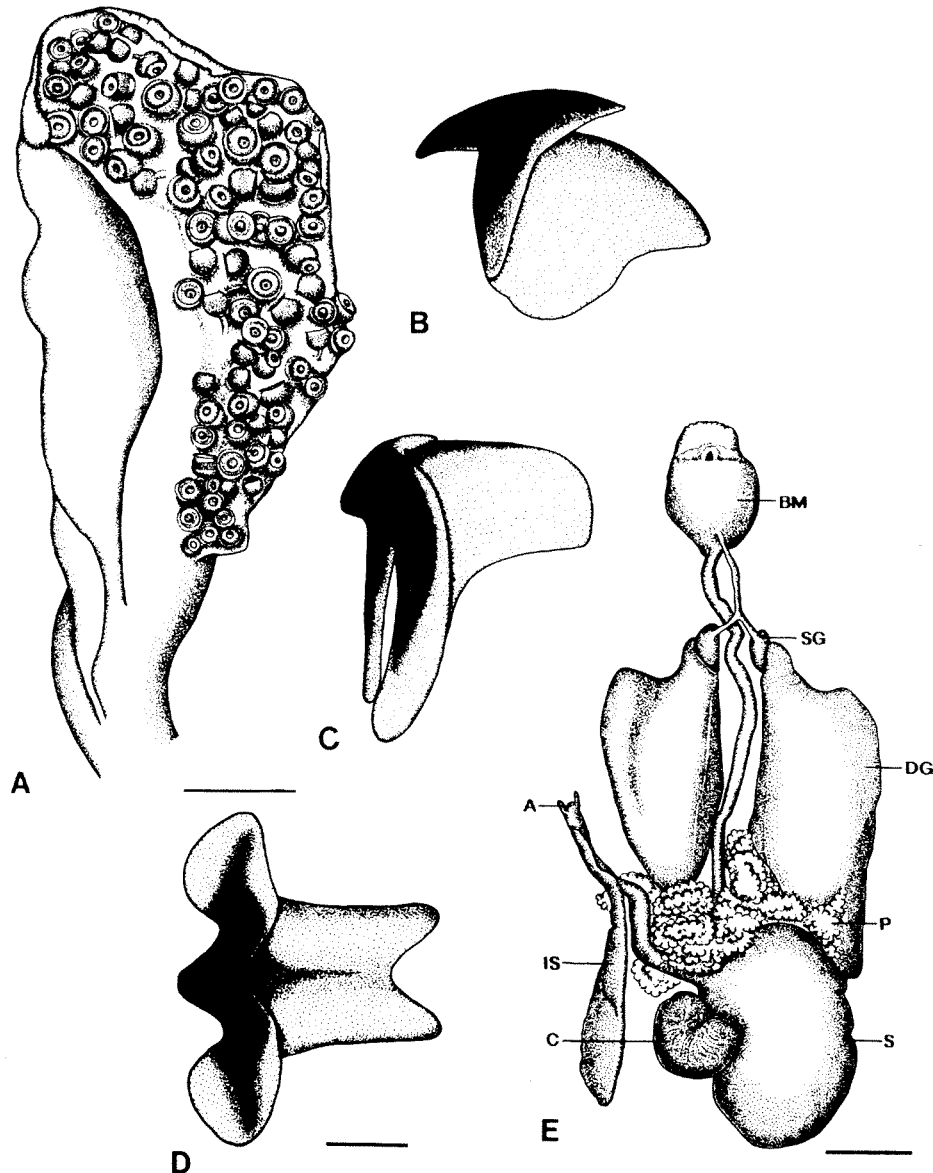


Figure 21 A-E, *Sepia sulcata* Hoyle; A, tentacular club, female WAM 341-86, 63.5 mm ML, scale bar 2 mm; B, upper beak, lateral view; C, lower beak, lateral view; D, lower beak, ventral view (B-D, male MV F56919, 65.9 mm ML, scale bar 2 mm); E, digestive tract, male WAM 333-86, 54.9 mm ML, scale bar 5 mm, abbreviations as in Figure 5E.

Table 9 *Sepia sulcata* Hoyle; ranges of arm length indices (ALI), arm sucker diameter indices (ASIn) and arm sucker counts (ASC) of 10 mature males and 10 mature females. min. = minimum, max. = maximum, SD = standard deviation.

	Males				Females			
	min.	mean	max.	SD	min.	mean	max.	SD
ALI1	30.1	<u>34.2</u>	39.0	3.1	29.2	<u>33.2</u>	38.3	2.5
ALI2	28.7	<u>32.1</u>	36.1	2.5	26.0	<u>30.8</u>	34.8	3.0
ALI3	28.2	<u>32.2</u>	36.2	2.2	27.5	<u>30.9</u>	33.7	1.9
ALI4	30.4	<u>36.4</u>	42.5	4.0	32.7	<u>35.3</u>	39.1	2.2
ASIn1	1.07	<u>1.28</u>	1.48	0.12	0.98	<u>1.19</u>	1.56	0.18
ASIn2	1.11	<u>1.27</u>	1.48	0.11	1.04	<u>1.19</u>	1.46	0.12
ASIn3	0.94	<u>1.36</u>	1.58	0.20	1.04	<u>1.18</u>	1.46	0.13
ASIn4	1.17	<u>1.53</u>	1.78	0.17	0.90	<u>1.19</u>	1.63	0.17
ASC1	76	<u>96</u>	110	11	90	<u>103</u>	120	9
ASC2	80	<u>105</u>	127	16	102	<u>118</u>	130	11
ASC3	88	<u>103</u>	126	11	110	<u>126</u>	144	11
ASC4	104	<u>135</u>	152	16	103	<u>137</u>	152	15

Table 10 Species of *Sepia* found in northwestern Australian waters, distinguishing features and depth ranges (in Australian waters). Primary source of information Lu (in press a,b). + = present, - = absent, F = flattened, C = convex, * = bone very distinctive: lanceolate (*S. cottoni*), flattened dorsally and laterally (*S. plana*), dorsally rough with calcareous projections (*S. senta*); † = one sepion has been collected from Qld., North Stradbroke Island 27°35'S 153°27'E (Adam, 1979); ‡ = possibly also eastern Australia, see remarks, *Sepia plana*.

Species	Arm Sucker Rows		Hectocotylised Arm	Club Sucker-bearing Face	CIRC	Club Suckers relative sizes	Club Dorsal & Ventral Protective Membranes		Cuttlebone Inner Cone Limbs			Depth Range (m)	Distribution (Australian)
	biserial	tetraserial					separate	fused	broaden posteriorly	thickened posteriorly	form a ledge posteriorly		
<i>S. cottoni</i> Adam, 1979	+	+	-	F	5	vary, some large	+		-	+	-*	122 - 114	W.A., Hassall Beach, 34°49'S 118°24'E - Broome, 17°31.5'S 121°27'E †
<i>S. elliptica</i> Hoyle, 1885	-	+	+	F	10 - 12	all similar, minute	+	+	+	-	+	142 - 16	W.A., Exmouth Gulf, 22°23'S 114°06'E - Qld., Capricorn Group, 23°30'S 152°00'E
<i>S. irvingi</i> Meyer, 1909	-	+	-	F	8	vary, some large		+	-	+	-	170 - 130	W.A., Cockburn Sound, 32°11'S 115°43'E - North West Shelf, 18°49'S 118°29'E
<i>S. latimanus</i> Quoy & Gaimard, 1832	-	+	-	F	5 - 6	vary, some large		+	-	+	-	30 - 0	W.A., Shark Bay, 25°25'S 113°35'E to Qld., approx. 23°S
<i>S. opipara</i> (Iredale, 1926)	-	+	+	F	8	vary, some large	+		-	+	-	184 - 83	W.A., Dirk Hartog Is., 25°45'S 113°03'E to Qld., 26°57'S 151°45'E
<i>S. papuensis</i> Hoyle, 1885	+	+	-	F	5 - 6	vary, some large	+	+	+	-	-	155 - 17	W.A., Fremantle, 32°03'S 115°44'E to N.S.W., 36°35'S 150°16'E
<i>S. pharaonis</i> Erenberg, 1831	-	+	+	F	8	vary, some large	+		+	+	-	102 - 25	W.A., Cape Le Grande, 33°55'S 122°30'E to Qld., Townsville, 19°16'S 146°41'E
<i>S. plana</i> sp. nov. this study	-	+	+	F	8 - 10	all similar, small	+		-	-	-*	505 - 396	W.A., North West Shelf, 12°04'S 122°59'E - 17°55.5'S 118°16.0'E ‡
<i>S. senta</i> sp. nov. this study	-	+	+	F	6 - 8	differ slightly, small	+		-	-	-*	426 - 256	W.A., North West Shelf, 14°07'S 122°51'E - 18°44'S 116°59'E
<i>S. smithi</i> Hoyle, 1885	-	+	+	C	20	all similar, minute	+		+	+	+	138 - 33	W.A., Shark Bay, 25°25'S 113°35'E to Qld., Moreton Bay, 27°25'S 153°20'E
<i>S. sulcata</i> sp. nov. Hoyle, 1886	+	+	+	F	5 - 7	differ slightly, small	+		+	-	+	404 - 150	W.A., North West Shelf, 13°51.4'S 123°01.8'E - 19°58'S 115°13'E.

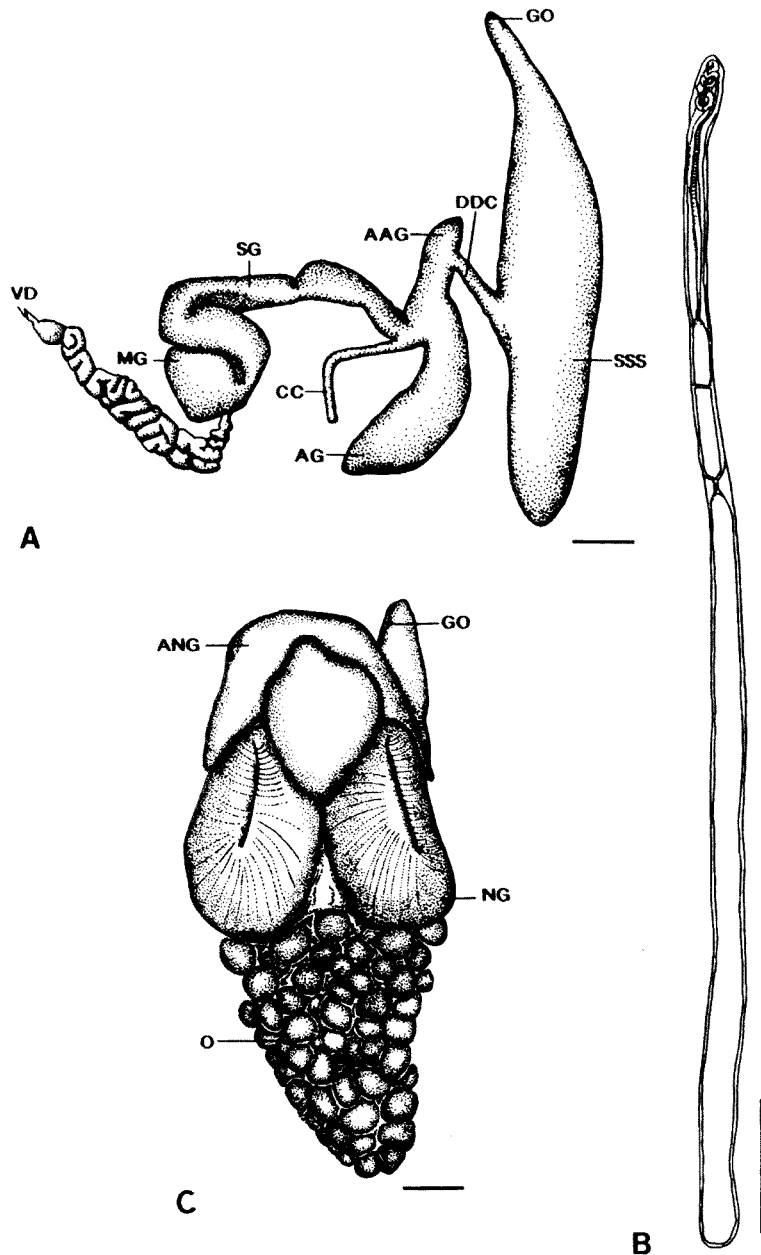


Figure 22 A–B, *Sepia sulcata* Hoyle; A, male reproductive tract (testis not shown), MV F56919, 65.9 mm ML, scale bar 1 mm, abbreviations as in Figure 6A; B, spermatophore, MV F56919, 67.6 mm ML, scale bar 1 mm; C, female reproductive tract, MV F56918, 90.6 mm ML, scale bar 5 mm, abbreviations as in Figure 6C.

Spermatophores: cement body clearly bipartite; aboral end elongate, cylindrical, connects to sperm reservoir via narrow duct which extends from nipple-like tip of cement body, connects to oral end by narrow neck (Figures 22B, 23); oral end shorter than aboral end of cement body, cylindrical, tapers evenly to terminal dilation; middle tunic commences along aboral part of cement body; ejaculatory apparatus coiled, extends into oral dilation of spermatophore. Spermatophores 4.8–6.0–8.5 mm long (SD, 1.5 mm), 0.25–0.30–0.50 mm wide (SD, 0.10); SpLI 8.4–10.6–12.6 (SD, 1.5), SpWI 3.18–5.28–9.43 (SD, 1.86).

Female reproductive tract: ovary hangs from dorsal wall of posterior visceropericardial coelom.

Oviduct thin-walled, continuous with body cavity; distally with thickened, glandular walls (oviducal glands). Nidamental glands, in mature animals, occupy large portion of ventral side of mantle cavity. Accessory nidamental glands anterior to nidamental glands (Figure 22C). Eggs spherical, 3.5–4.0–4.4 mm diameter (SD, 0.5); EgDI 4.0–4.3–4.6 (SD, 0.3).

Dorsal mantle with thick, cartilaginous subdermal layer; cartilaginous layer adheres closely to cuttlebone. Cuttlebone length approximately equal to mantle length; CbL males 47–55.9–65.6 (SD, 7.8), females 60.5–68.1–86.5 (SD, 9.7); outline oblong (Figure 24A,B); CbWI males 29.4–32.2–34.1 (SD, 1.7), females 28.7–31.9–33.7 (SD, 1.8); acuminate,

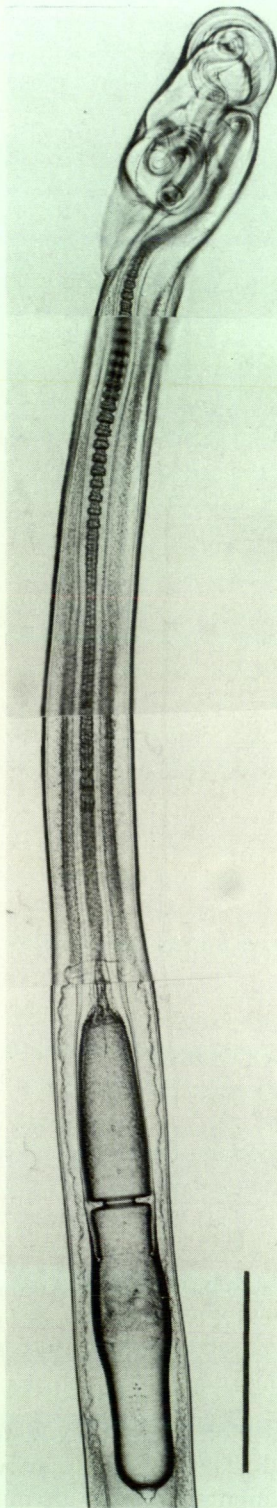


Figure 23 *Sepia sulcata* Hoyle; spermatophore, oral end, MV F56919, 67.6 mm ML, scale bar 1 mm.

acute anteriorly; acuminate, acute posteriorly (pointed). Dorsal surface yellowish; flat medially, curved, convex laterally; texture smooth, not pustulose. Dorsal median rib present; distinct; broadens anteriorly; lateral ribs present, distinct. Chitin present over entire surface of cuttlebone, with thicker band on each side. Spine present; short; SLI males 2.5–3.3–4.4 (SD, 0.8), females 1.2–

2.9–3.5 (SD, 0.8); curves dorsally; keel(s) absent; cuttlebone smooth between spine and outer cone; ventral notch at base of spine absent. Dorso-posterior end of cuttlebone with short, median longitudinal ridge anterior to, and separate from spine (Figure 24A). Striated zone convex (slightly); StZI males 60–63.5–67.8 (SD, 2.8), females 57–64–71.3 (SD, 5.1). Last loculus flat; LoLI males 28.9–35.0–40.3 (SD, 3.9), females 25–33.7–39.2 (SD, 6.1); one-third length of striated zone (approximately); LoL/StZ(%) males 44.0–55.4–67.2 (SD, 8.4), females 35–53.5–66.5 (SD, 13.1). Sulcus extends along entire length of bone; shallow, narrow; flanked by rounded ribs bordered laterally by shallow grooves (distinctive). Anterior striae inverted U-shape (slightly wavy due to ribs). Limbs of inner cone extend anteriorly to end of striated zone. Inner cone limbs broaden posteriorly, raised to form ledge; ledge flat, not thickened (Figures 24B, 25). Outer cone chitinous, not calcified; narrow throughout; lateral limbs not flared ventro-laterally; outer cone strongly recurved ventral to spine, forms cup-like structure.

Body papillae present; dorsal mantle with longitudinal row of up to 10 short longitudinal ridges along each side close to fins (not visible in all specimens examined); ventral mantle with longitudinal row of 6 narrow ridges along each side close to fins; anterior-most pair and posterior 2 pairs shorter than rest (Figure 18C) (short ridges sometimes difficult to detect in small specimens). Head and arm papillae absent. Colour (alcohol preserved specimens): Head pale, without colour pattern. Dorsal mantle pale buff pinkish-brown; paired dorsal eye spots absent. Fins pale; without markings at base. Arms without markings. Ventral pigment absent. Dorsal and ventral longitudinal ridges pinkish-orange.

Original reference

Hoyle, W.E. (1885). Diagnoses of new species of cephalopoda collected during the cruise of H.M.S. "Challenger." Part II. The Decapoda. *Annales and Magazine of Natural History* (5) 110: 181–203.

Type locality

Indonesia: Arafura Sea, off Ki Is., 5°49'15"S 132°14'15"E; 255 m.

TYPE: Holotype, BMNH 89.4.24.77, male, 53.2 mm ML.

Distribution

Indonesia, Arafura Sea, off Ki Is., 5°49'15"S 132°14'15"E to Australia: Western Australia, North West Shelf, 19°58'S 115°13'E; depth range 404–150 m. Habitat mud (holotype blue mud), silt, rock.

Remarks

This species previously was known only from the

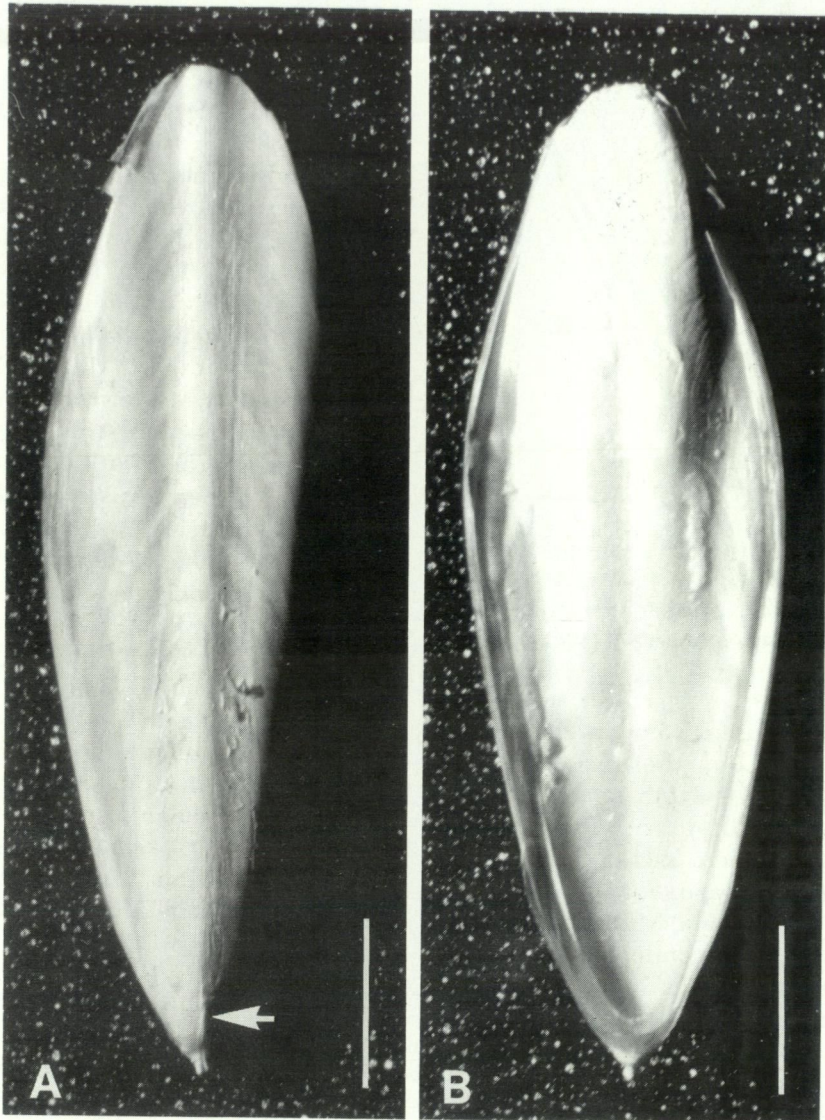


Figure 24 A–B, *Sepia sulcata* Hoyle; A, cuttlebone, dorsal view, female WAM 339–86, 60.9 mm ML, arrow indicates median longitudinal ridge; B, ventral view, same specimen. Scale bars 6 mm.

type specimen. The discovery of new material among collections of the Western Australian Museum and Museum of Victoria has enabled a redescription based on the type and this new material, thus adding information on females (which previously were unknown) and has provided more information on the distribution of the species. In most respects, the Australian material conforms to Hoyle's (1885) original description which was based on the single male type specimen. Some differences, however, were found. The two dorsal arms are described as bearing biserial suckers. We have found that while suckers are biserial for most of the length of these arms, they are arranged in 4 series on the extreme distal tips of both arms in males. The club suckers in the type specimen are arranged in 7 rows, while those of the Australian specimens are usually in 5 rows, rarely 6, or 7. Hoyle (1885) reports the presence of a few minute papillae on the posterior-

dorsal surface of the mantle. Aside from the short bars described above (which may be the same as those that Hoyle (1885) is referring to), no other papillae could be found on the dorsal side of the mantle in the specimens examined in this study. The modification of the hectocotyliised arm in the type specimen is typical of immature males of this species. While the suckers are reduced on the left ventral arms in all males, the degree of development of the median furrow differs depending upon the state of maturity of the animal. In males determined to be immature due to the absence of spermatophores in the spermatophore storage sac, the median furrow on the hectocotylus may be absent (as in the type specimen (Figure 20A)), or only weakly developed as a small pit, or depression at the base of the arm. In mature males, the furrow is deep and pronounced (Figure 20B). Hoyle (1885) describes the suckers on the distal portion of the

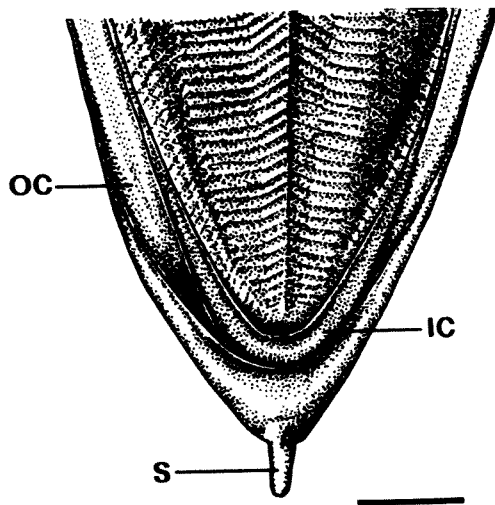


Figure 25 *Sepia sulcata* Hoyle; posterior end of cuttlebone, ventral view, female WAM 343-86, 65.1 mm ML, scale bar 4 mm, (IC - inner cone; OC - outer cone; S - spine).

hectocotylied arm as biserial, but in all material examined in this study, these suckers are tetraserially arranged. The depth range occupied by this species is broad (404-150 m). There is some evidence to suggest that there might be a migration into relatively shallower waters for spawning. The largest males (65.9-67.6 mm ML), and females (85.7-96.2 mm ML) were collected at depths between 184-150 m (MV 56918, MV 56919, WAM 3100-83), and all mature, while those collected at depths in excess of this range are smaller and include immature animals.

This cuttlebone of this species shows some similarities with that of *S. australis* Quoy and Gaimard, 1832 from South Africa. In both species, the cuttlebone is narrow and oblong, distinctly pointed anteriorly, with pronounced dorsal median and lateral ribs and, on the ventral side, the lateral ribs in both species are bordered by grooves. The ventral grooves, and sulcus are much deeper and more pronounced in *S. australis* than in *S. sulcata*. Both species have the short, median ridge on the dorsal side of the cuttlebone, anterior to the spine. The posterior end of the cuttlebone is broader in *S. sulcata*; in *S. australis* outer cone is poorly developed and the inner cone is not raised forming a ledge. *S. australis* is darkly pigmented, unlike *S. sulcata* and has a distinctive unbroken longitudinal ridge at the base of the fins. The arm suckers in *S. australis* are arranged in four series, unlike those seen in this species.

DISCUSSION

With the inclusion of *Sepia plana*, *S. senta* and *S. sulcata*, 29 nominal sepiids are now known to occur in the Australian fishing zone (200 nautical miles

from the coast). In addition to the three species described above, the following sepiids are found off northwestern Australia: *Metasepia pfefferi* (Hoyle, 1885); *Sepia cottoni* Adam, 1979; *S. elliptica* Hoyle, 1885; *S. irvingi* Meyer, 1909; *S. latimanus* Quoy and Gaimard, 1832; *S. opipara* (Iredale, 1926); *S. papuensis* Hoyle 1885; *S. pharaonis* Ehrenberg, 1831; *S. smithi* Hoyle, 1885, and *Sepiella weberi* Adam, 1939. These latter species (with the exception of *S. irvingi*) are widely distributed in the Northern Australian Region, a zoogeographic zone recognised by Wilson and Allen (1987). This zone extends across northern Australia to southern Queensland. Though regions of overlap occur on each side of the continent, the predominantly tropical Northern Australian assemblage largely differs in species composition from the more temperate Southern Australian fauna. Most marine species within this region also occur elsewhere in the Indo-West Pacific, though many Australian endemics are found in the zone. Among the sepiids, *S. cottoni*, *S. irvingi*, *S. opipara*, *S. plana*, *S. smithi*, *S. senta* and *M. pfefferi* are known only from Australia at present. The presence of an animal very similar in appearance to *S. senta* in the Philippines, either a distinct species, or population, suggests that *S. senta* is unlikely to be a true Australian endemic. *Sepia irvingi* is classed by Lu (in press, a) as belonging to the Western Overlap zone. It is included in the list of species above as its distribution extends to the North West Shelf.

Species in the genus *Sepia* are easily distinguished from the two other sepiid genera, *Sepiella* and *Metasepia*. *Sepiella* differ from other sepiids by the presence of a gland, and gland pore at the posterior end of the mantle between the fins, the mantle cartilage has a triangular tubercle, and the sepion has very short limbs. *Metasepia* can readily be recognised by the distinctive rhomboidal sepion which is situated in the anterior 2/3 - 3/4 of the mantle (Khromov *et. al.*, in press). Table 10 lists some characters which can be used distinguish representatives of the genus *Sepia* found off northwestern Australia.

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