

THE SEPIOLIDAE (CEPHALOPODA) OF THE ANDAMAN SEA, THAILAND,
WITH DESCRIPTION OF *EUPRYMNA HYLLEBERGI* SP. NOV.

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ABSTRACT

Iniotheuthis maculosa Goodrich, 1896 and a new species of sepiolid squid, *Euprymna hyllebergi* are reported from the Andaman Sea, Thailand. Descriptions and illustrations are provided. *Euprymna hyllebergi* sp. nov. is close to *E. hoylei* Adam, 1986, but it differs in the arrangement of suckers on the hectocotylized arm, the size and distribution of enlarged suckers on arms II-IV. The suckers on arm II-IV of *E. hyllebergi* sp. nov. do not have any significantly or abruptly enlarged suckers. This state is found in males and females. *E. hyllebergi* sp. nov. differs from *E. hoylei* in the high number of stout papillae with slitlike aperture in the distal half of the hectocotylus. The papillae are crowded in rows of 4-6 suckers in the middle part, and reduced to two rows at the tip of the hectocotylus.

INTRODUCTION

Apart from a series of papers on the taxonomy of cephalopods (Nateewathana & Hylleberg 1989; Hylleberg & Nateewathana 1991 a & b; Nateewathana 1992, 1995, 1996, 1997 a & b), only little research has been carried out on cephalopod species in the Andaman Sea, Thailand (Sithigornkul 1974; Chotiyaputta *et al.* 1992; Sawata & Phongsuwan 1994). This paper deals with the small squids of the family Sepiolidae, the last taxon to be described from the cephalopod material deposited in the PMBC Reference Collection.

MATERIALS AND METHODS

The squids were collected from fishing boats and research vessels, including fish markets and fish landings along the Andaman Sea coast of Thailand, as described by Nateewathana (1992). All samples were fixed in 10 % neutralised formalin and subsequently preserved in 75 % ethyl alcohol. The procedure for preservation and curation follows Roper & Sweeney (1983). Taxonomic descriptions of the present cephalopod studies are based on Roper & Voss (1983). Definitions of counts, measurements (in mm) and indices are summarised in Tab. 1 and are diagrammed in Fig. 1. Most of the indices are expressed as percentage of dorsal man-

tle length and are denoted by the final initial I, *e.g.*, HWI = HW/ML x 100.

Complete specimens have been deposited in the Reference Collection of Phuket Marine Biological Center, P.O. Box 60, Phuket 83000, Thailand.

SYSTEMATIC ACCOUNT

Family Sepiolidae Leach, 1817

Diagnosis: Mantle short, broad, sac-like; fins large, round, separated. Eyes covered with corneal membranes. Shell reduced to chitinous gladius or absent. One or both dorsal arms, or one dorsolateral arm, hectocotylized; no protective membranes on arms. Mantle-funnel locking-cartilage simple, straight.

Subfamily Sepiolinae Appellöf, 1898

Diagnosis: Dorsal mantle fused with head. Left dorsal arm hectocotylized. Gladius rudimentary to absent.

Genus *Euprymna* Steenstrup, 1887

Diagnosis: Left arm I of male hectocotylized with suckers normal on proximal half including 1-2 prominent, nipple-like papillae in ventral sucker row; the distal half of the arm with closely-packed, palisaded papillae. Arms with 2-8 oblique sucker rows. Tentacu-

Table 1. Definition of counts, measurements and indices.

ML	Mantle Length	dorsal mantle length measured from the anterior-most point of mantle to posterior tip, along dorsal mid-line.
MWI	Mantle Width Index	greatest straight-line (dorsal) width of mantle as a percentage of mantle length.
FLI	Fin Length Index	greatest length of fins as a percentage of mantle length.
FWI	Fin Width Index	greatest width (dorsally) across both fins as a percentage of mantle length. Remark: Dr C. C. Lu (pers. comm.) finds that for sepiolids, greatest width of a single fin is more useful to express the size of the fins.
FBI	Fin Base Index	length of fin base as a percentage of mantle length.
HLI	Head Length Index	dorsal length of head measured from point of fusion of dorsal arms to anterior tip of nuchal locking cartilage as a percentage of mantle length.
HWI	Head Width Index	greatest width of head at level of eyes as a percentage of mantle length.
ALI	Arm Length Index	length of arm measured from first basal (proximal-most) sucker to tip of arm as a percentage of mantle length.
ASI	Arm Sucker Index	diameter of largest normal arm sucker on each designated arm as a percentage of mantle length.
TtLI	Tentacle Length Index	total length of tentacular stalk and club as a percentage of mantle length.
CLI	Club Length Index	length of club as a percentage of mantle length.
HcAI	Hectocotylized Arm Index	length of hectocotylized arm measured from proximal-most sucker to tip as a percentage of mantle length.
HcLI	Hectocotylized Length Index	length of modified portion of arm measured from proximal-most modified sucker to tip of arm as a percentage of total length of hectocotylized arm.
SpLI	Spermatophore Length Index	length of spermatophore as a percentage of mantle length.
SpWI	Spermatophore Width Index	greatest width of spermatophore as a percentage of spermatophore length.
EDI	Eye Diameter Index	diameter of eye across bulbus as a percentage of mantle length.
LnDI	Lens Diameter Index	diameter of eye lens as a percentage of mantle length.

lar club with more than 16 sucker rows. A saddle-shaped luminous organ on ink sac. Gladius absent.

Euprymna hyllebergi sp. nov.
(Figs. 2-5, Tab. 2)

HOLOTYPE: PMBC no. 11728. 1 male, 31.6 mm ML, Kantang Fish Landing, Trang province. Coll. A. Nateewathana. 15 December 1994.

PARATYPES: PMBC no. 11731. 1 female, 24.4 mm ML, Tha Lane, Phang-nga Bay. Push net. Coll. S. Utsaha. 23 July 1989. PMBC no. 11737. 1 male, 23.3

mm ML, Kantang Fish Landing, Trang province. Coll. A. Nateewathana. 5 June 1992. PMBC no. 11739. 3 males, 24.0-28.8 mm ML, Southwest of Koh Lanta, Krabi. Trawled. R/V Pramong 10. 15 September 1990. **MATERIAL EXAMINED:** A total of 366 specimens, 181 males and 185 females, were collected and examined. A set of specimens which were preserved in a good condition was selected for registration (Appendix 1). The description is based on the material examined.

DESCRIPTION: Colour in alcohol yellowish; numerous large and conspicuous purplish-brown chromatophores cover the mantle,

head and arms, more dense on dorsal than ventral side; fins devoid of chromatophores except for a small portion on bases; series of large rectangular to oval chromatophores present on aboral surfaces of arms; an oval blotch also occurs on the pedicel of each sucker of the two outer arms; in some specimens, a row of large oval chromatophores present transversely on the aboral surface of tentacular stalk and club. **Mantle** (Fig. 2a-b) dome-shaped, thick, broad anteriorly and rounded posteriorly, slightly longer than wide; antero-dorsal margin fused with head (Fig. 2a); antero-lateral margin slightly projects forward; antero-ventral margin well developed. Large portion of the tubular funnel visible (Fig. 2b, cf. Fig. 2c) median ventral margin slightly concave (Fig. 2b). **Fins** rounded, almost circular in outline, separate and attached at middle of mantle; anterior

margin pronounced and strongly auriculate, posterior margin nearly straight, non-auriculate attachment. **Head** broad, dorsoventrally flattened and compact, width slightly less than mantle width; eyes large, oval with almost rounded pupil. **Funnel** long, tubular, free for most of its length, reaching to gap between ventral arms (Fig. 2b-c). Funnel valve (Fig. 2d) triangular to rounded flap-like. Funnel organs (Fig. 2d) with a roughly triangular dorsal pad and two oval ventral pads. Anterior end of dorsal pad with a low crest projected in midline (dorsal pad free in specimens in a damaged condition). Funnel locking cartilage ovate, rounded at both ends with deep groove (Fig. 2c); mantle cartilage straight, ridge-like, two times longer than funnel cartilage. **Arms** long, subequal, rounded in cross section, tapering distally; arm formula II. III. IV. I.; occasionally II. III.

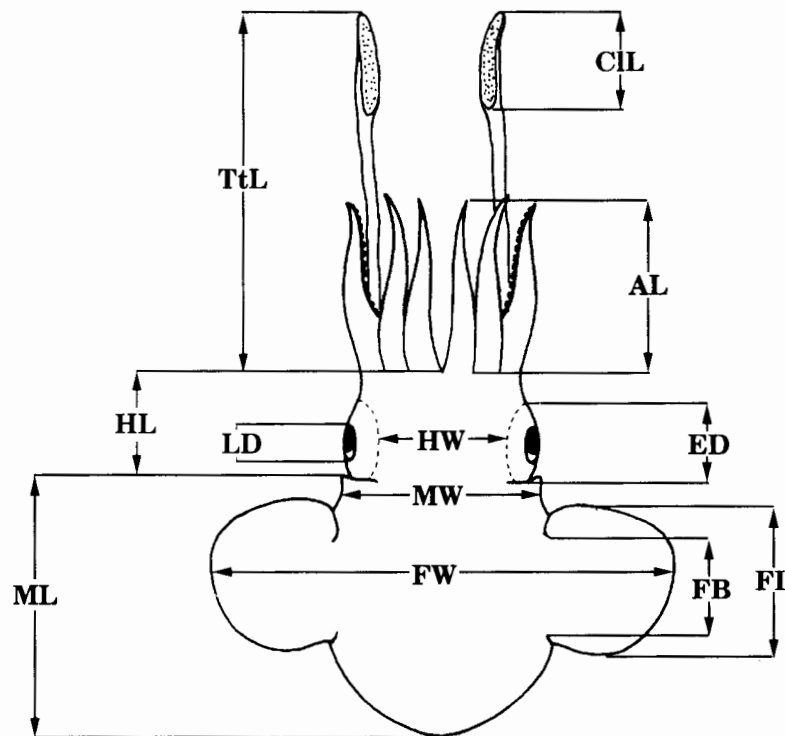


Figure 1. Diagrammatic illustration of measurements in sepiolids. AL = arm length, CIL = club length, ED = eye diameter, FB = fin base, FL = fin length, FW = fin width, HL = head length, HW = head width, LD = lens diameter, ML = mantle length, MW = mantle width, TtL = tentacle length.

= IV. I. Keels on arms vary considerably. Most of specimens without trace of keels. In a few specimens, keels present in all arms, but usually more strongly keeled and prominent on arms I-III. Protective membranes absent. Web between arms III and IV well developed, extends up about one-fourth of arm length. In females (Fig. 3c), arm suckers quadriserial but biserial at both base and distal end. **Suckers** almost equal-sized,

subglobular, with a small, smooth aperture; pedicel thin. In males (Fig. 3a), arm suckers arranged differently, but usually suckers arranged irregularly biserial for about three to four pairs at base and then changed to quadriserial toward distal end; suckers on marginal rows of right arm I almost equal-sized and somewhat larger than suckers of inner rows; sucker arrangement in arm II similar to that of right arm I, suckers on

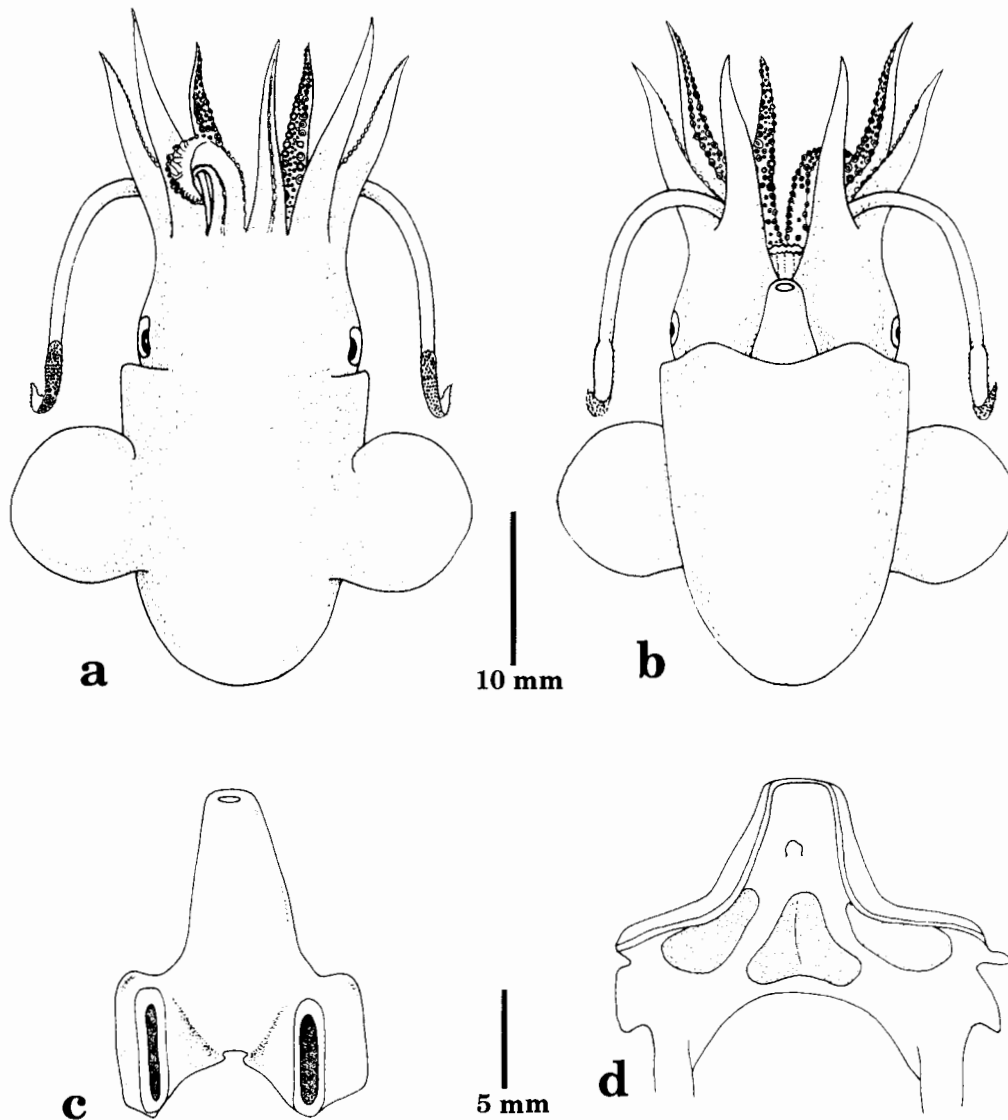


Figure 2. *Euprymna hillebergi* sp. nov. Male, 20 mm ML. (a), dorsal view. (b), ventral view. (c), funnel and funnel locking-cartilages. (d), funnel organs.

marginal rows equal-sized and slightly larger than suckers in inner rows; marginal suckers of arm III somewhat larger than suckers of inner rows, four to five suckers on ventral marginal rows enlarged, about

two to three times larger than smallest suckers; suckers of outer rows of arm IV somewhat larger than the suckers in inner rows, seven to twelve suckers of both outer rows, enlarged, about same size as enlarged suck-

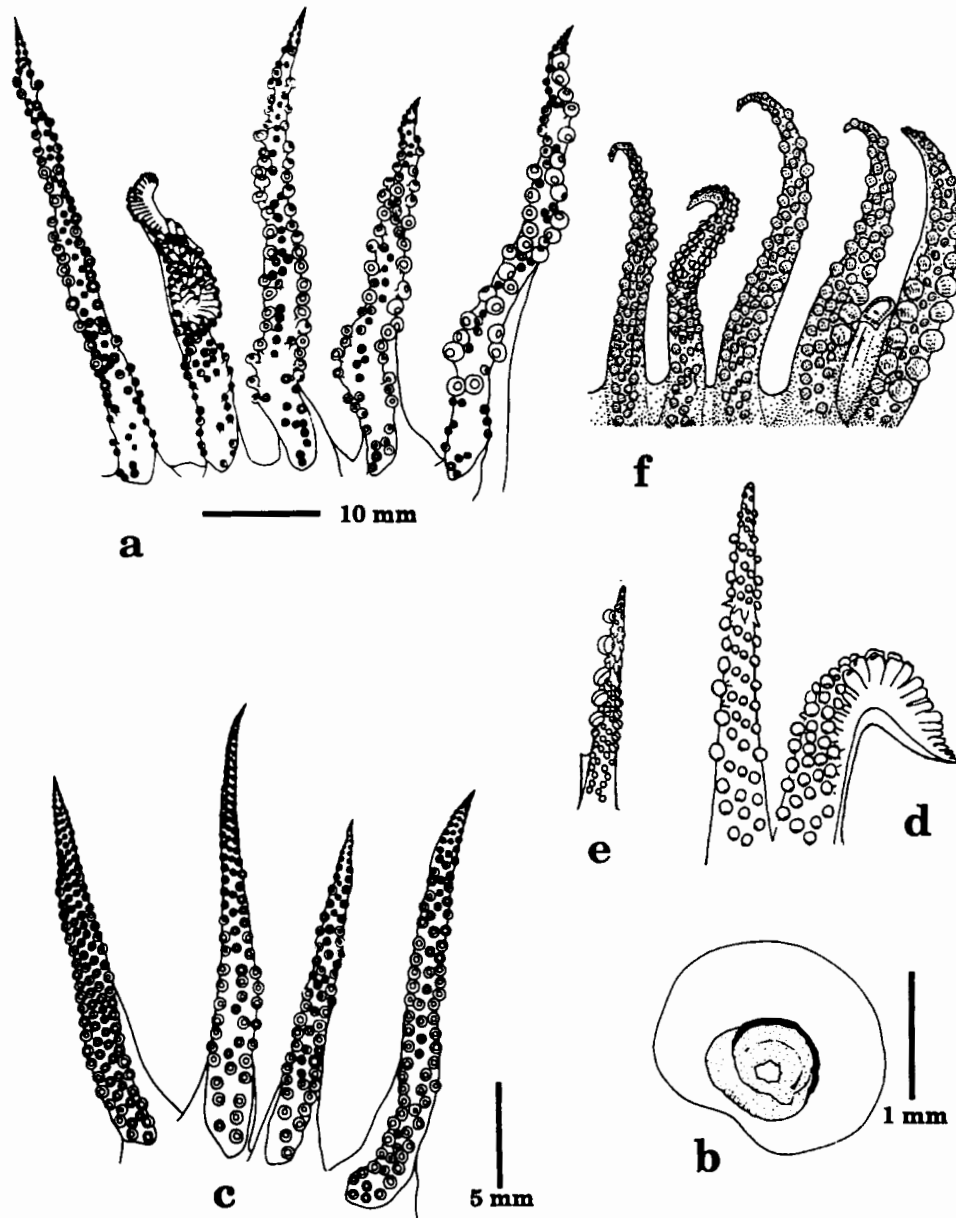


Figure 3. *E. hyllebergi* sp. nov. (a), right arm I, hectocotyized arm and left arms II, III and IV of 20 mm ML of male. (b), enlarged arm sucker. (c), left arms of 19.7 mm ML of female. (d), dorsal arms of male as shown by Hoyle (1904). (e), third right arm from the specimen as shown by Hoyle (1904). (f), arm arrangement (right I, left I, II, III, IV) of the Philippine specimen as shown by Voss (1963).

ers in arm III. Arm suckers globular with smooth horny ring, rounded aperture on normal sucker, but more ovate on enlarged sucker (Fig. 3b). Left arm I of male hectocotylyzed (Fig. 4a-b), stout, shorter than other arms and curved outward; unmodified proximal part with about eight suckers arranged in a row basally in both marginal rows, then changed to four rows, one to two suckerless nipple-like papillae and swollen pedicels present at position of 2nd and 3rd ventral marginal suckers from base; modified distal half of arm basically divided into two parts, a proximal part with 35-60 suckers in 5 rows, about 40 swollen sucker pedicels in 2

rows, comb-like appearance, terminating in a slit-like aperture containing a small sucker (Fig. 4c). The variation of the size of arm suckers on different arms is shown in Fig. 3a. Some specimens bear enlarged suckers on arms III and IV; some with enlarged suckers on dorsal and ventral rows of arm II, but not large as those on arm III and IV (Fig. 3a, enlarged suckers on arm II = 1.2 mm, on arm III = 1.46 mm and on arm IV = 1.54 mm); some with almost the same size of suckers on the three pairs of arms. The variations of these arrangements, however, are within the pattern of the species (see discussion). **Tentacles** (Fig. 4d) round, flattened on oral surface, edges of flat

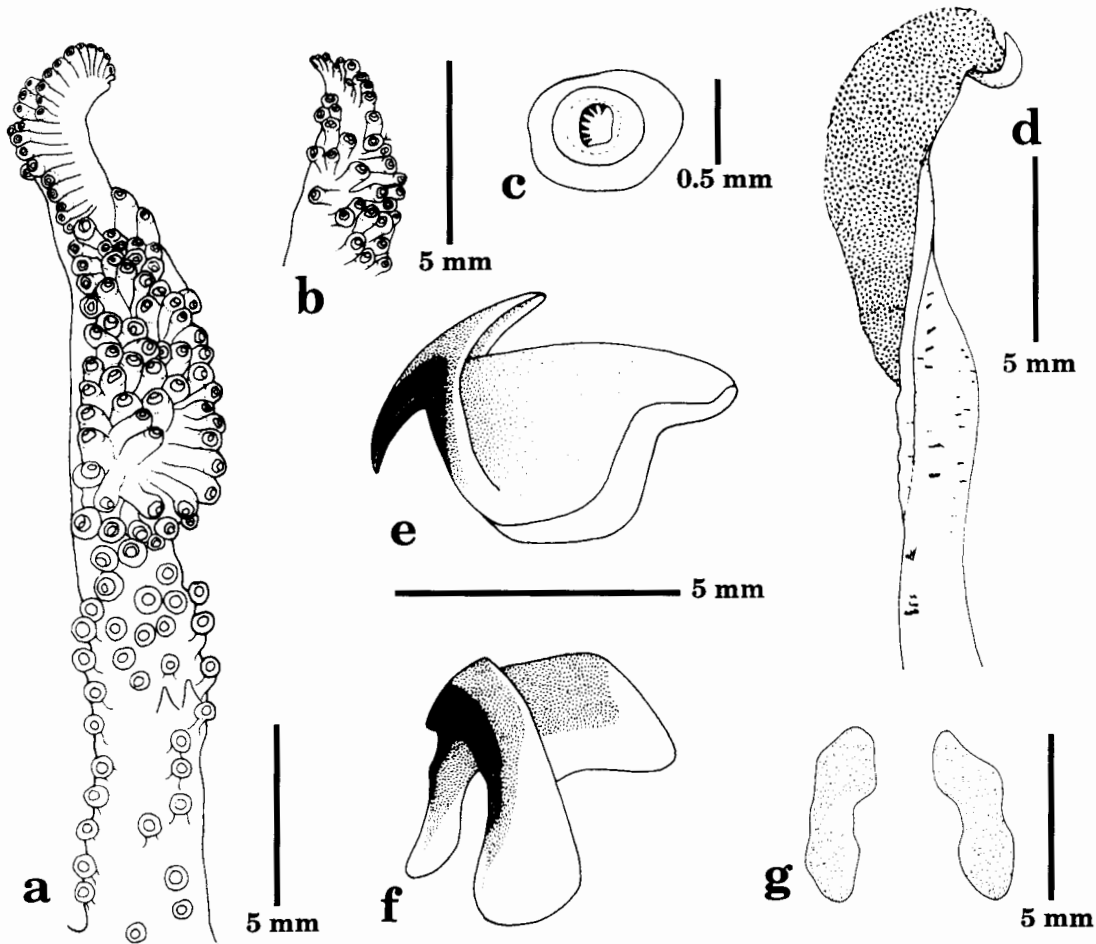


Figure 4. *E. hyllebergi* sp. nov. (a), hectocotylyzed arm of 20 mm ML of male. (b), tip of hectocotylyzed arm. (c), sucker of hectocotylyzed arm. (d), tentacle and club. (e), upper beak. (f), lower beak. (g), luminous organ.

area angled, dorsal margin elevated into a low keel towards club. **Club** short, curled, and rounded with numerous rows of very small suckers. Gladius absent. Buccal membrane smooth without suckers. **Beak**: upper beak (Fig. 4e) with long, strong, black, curved rostrum, hood curved, crest curved and brownish, lateral wall translucent; lower beak (Fig. 4f) with small black rostrum, irregular

crenulated edge and large, thin, hyaline lateral wall. **Radula** with seven transverse rows of teeth; rachidian, laterals and marginal teeth with one simple cusp (Fig. 5a). **Ink sac** present, with a prominent saddle-shaped luminous organ on ventral surface (Fig. 4g). **Spermatophores** measured 6-11 mm in length (n=20) and 0.5 mm in width (Fig. 5b-d). Sperm cord tight and somewhat coiling

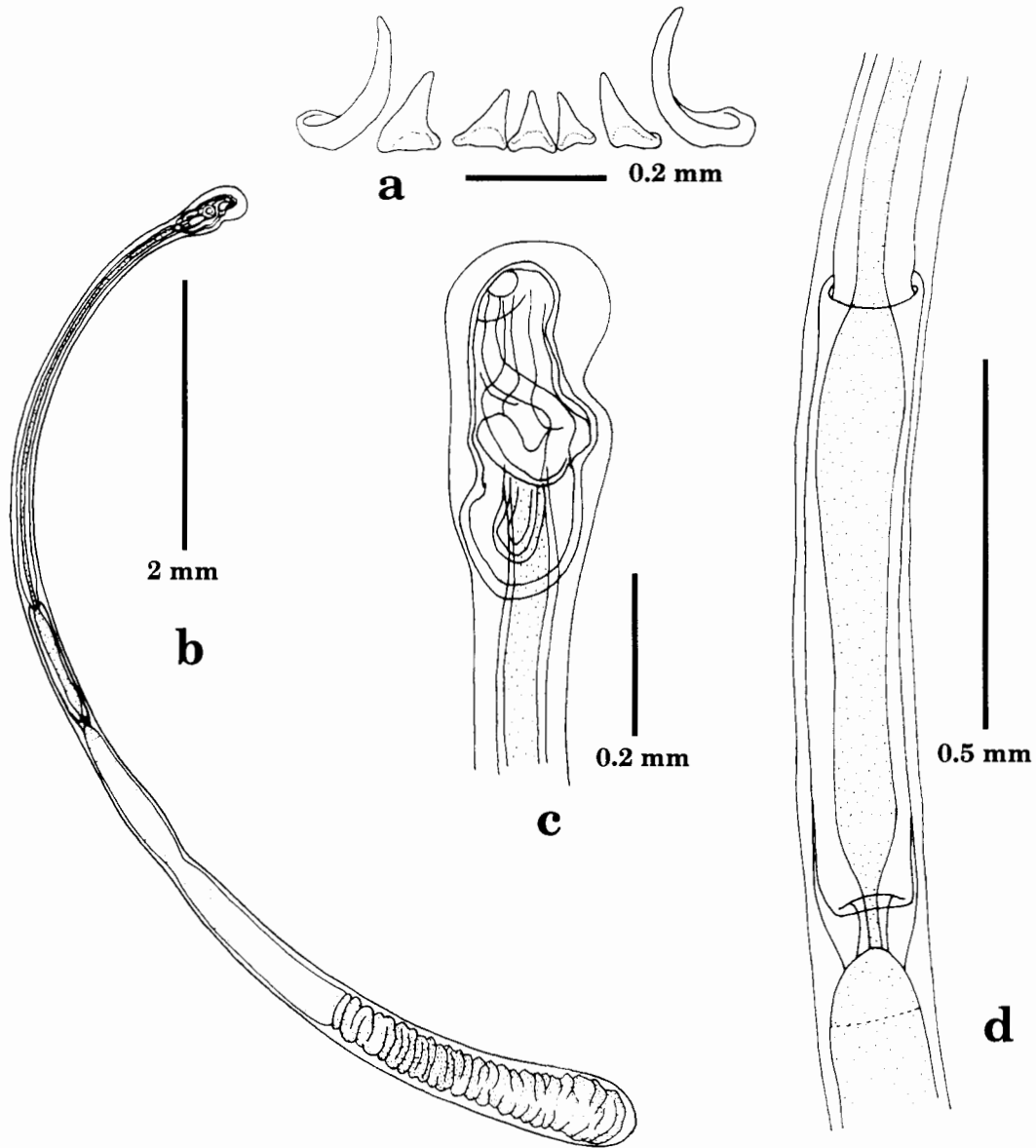


Figure 5. *E. hyllebergi* sp. nov. (a), radula. (b), spermatophore. (c), enlargement of oral cap. (d), enlargement of cement body.

upon itself, occupying about 1/4 of length of spermatophore. Cement body and ejaculatory apparatus long, occupying greater part of spermatophore, divided into four parts by constrictions.

TYPE LOCALITY: the Andaman Sea of Thailand.

ETYMOLOGY: The species is named after Dr Jorgen Hylleberg, Aarhus University, Denmark in appreciation of his contribution to malacological research in Thailand (establishment of the Tropical Marine Mollusc Programme, TMMP).

DISTRIBUTION: only known from the Andaman Sea of Thailand.

REMARKS: The genus *Euprymna* was first erected by Steenstrup (1887). According to Nesis (1987), the genus comprises 7 species, i.e., *E. phenax* Voss, 1962 from the Philippines; *E. tasmanica* (Pfeffer, 1884) from eastern and southern Australia and Tasmania; *E. morsei* (Verrill, 1881) from Japan to China, Philippines, Indonesia, India, and Maldives; *E. stenodactyla* (Grant, 1833) from Indo-West Pacific (Mascarene Islands to Queensland and Polynesia); *E. albatrossae* Voss, 1962 from the Philippines; *E. berryi* Sasaki, 1929 from Japan, China and Gulf of Tonkin; and *E. scolopes* Berry, 1913 from the Hawaiian islands. He also pointed out that *E. berryi* probably is a synonym of *E. morsei*. However, Okutani *et al.* 1987 mentioned that *E. berryi* is a sympatric sibling species of *E. morsei*. The two species are hardly distinguishable, particularly females. But, the males display distinct differences in arm sucker enlargement, morphology of tentacular suckers, and spermatophore. Subsequently it was concluded that they are sympatric species (Okutani & Horita 1987). Finally, Adam (1986) described *E. hoylei*, the eighth species of the genus (see later). To distinguish the species of the genus *Euprymna*, the arrangement of the sessile suckers of the male is the only diagnostic character (see the Key to species in Nesis 1987, p. 126-127). Bursa copulatrix of the female was used by Bello (1995) to distinguish the species. I have not attempted to

elucidate the specific characters of the females as found by Bello (1995). It should be pointed out that the species may be difficult to identify because the suckers on arms easily fall off and are lost in the preserved material. *E. stenodactyla* is characterised by having 7-8 rows of suckers on the arms (confirmed by Dr C.C. Lu, pers. comm.). *E. morsei* has been found (record in a question mark) in the southern part of Thai, Malaysian and Indonesian waters (Roper *et al.* 1984). It has also been recorded in the Indian Ocean (Andamans, Gulf of Mannar and Maldives Archipelago) by Massy (1916). *E. morsei* is characterised by having 10-12 enlarged suckers present in ventral rows of arms II, III and IV in male. In 1987, Jothinayagam reported *E. berryi* from the Madras coast of India. This species has greatly enlarged suckers on dorsal and ventral rows of arms II and IV. *E. berryi* was erected by Sasaki (1929) and he described the arrangement of the arm suckers as follows (Sasaki 1929, p.145) "The suckers of second and fourth arms markedly unequal, several of both the marginal series being twice or even thrice as large as in diameter as the corresponding ones of the central series. Suckers on third arm also unequal, being larger in the marginal series than in the central series, and five or six in the ventral marginal series being by far the largest of all, though decidedly smaller than the aforesaid large suckers of the second and fourth arms." Some of the Andaman specimens are very similar to *E. berryi*, but none possess enlarged suckers on third arms smaller than those in the second arms (Fig. 3a). Adam described *E. hoylei* in 1986, but did not illustrate it. Instead he gave reference to drawings in Hoyle (1904 figs. B, C, D) and Voss (1963 figs. 8 a, b). The latter two authors wanted to illustrate what they believed were *E. stenodactyla* (Grant, 1833), but this species has 7-8 rows of suckers on the arms. Hence *E. stenodactyla* is distinctly different from all other *Euprymna* species described. Therefore, Adam (1986) erected a new species, *E. hoylei*, and *E. stenodactyla* as de-

Table 2. Means, standard deviations and ranges of selected measurements and indices (in percent) of *Euprymna hyllebergi* from the Andaman Sea, Thailand.

Index	MALES				FEMALES			
	n	mean	s.d.(n-1)	Range	n	mean	s.d.(n-1)	Range
ML(mm)	20	27.2	4.2	17.0-31.7	20	24.9	5.5	13.4-32.5
MWI	20	81.2	11.3	57.6-98.9	20	80.7	8.9	66.7-97.8
FLI	20	49.1	7.1	33.8-58.2	20	52.5	7.8	37.5-61.9
FWI	20	131.1	13.8	110.4-160.1	20	142.4	12.8	124.3-164.8
FBI	20	31.5	4.0	22.5-39.8	20	35.8	5.0	27.6-47.1
HLI	20	52.8	8.5	34.3-71.8	20	55.3	6.2	42.0-67.2
HWI	20	65.2	7.1	54.5-82.9	20	67.7	7.9	48.3-81.9
AL _I I	20	103.7	20.0	70.6-137.6	20	85.4	11.4	58.9-101.1
AL _{II} I	20	141.0	15.7	112.6-159.9	20	110.6	12.3	84.3-130.6
AL _{III} I	20	118.2	14.1	83.2-150.5	20	93.2	8.8	73.1-109.3
AL _{IV} I	20	118.6	18.0	80.8-139.5	20	89.7	9.2	71.6-105.3
AS _I I	20	3.5	0.5	2.7-4.4	20	2.7	0.4	2.1-3.3
AS _{II} I	20	4.4	0.6	3.4-5.9	20	2.8	0.5	2.1-3.9
AS _{III} I	20	5.1	0.7	4.0-6.3	20	3.0	0.4	2.4-3.9
AS _{IV} I	20	5.3	0.6	4.3-6.4	20	2.8	0.4	2.1-3.3
TtLI	20	282.8	47.1	203.0-372.5	19	266.2	60.7	169.8-399.1
CILI	20	48.4	7.1	35.3-64.0	19	53.3	10.9	40.5-76.9
HcAI	20	85.6	14.6	56.9-108.2				
HcLI	20	63.4	8.3	51.4-75.4				
SpLI	20	33.3	4.3	26.7-42.3				
SpWI	20	5.7	1.0	3.7-7.8				
EDI	20	23.3	5.6	15.5-37.1	20	23.5	3.8	17.0-31.3
LnDI	20	14.4	2.8	9.9-18.8	20	14.9	2.1	12.0-20.3

scribed by Hoyle (1904) and Voss (1963), became synonyms of this species.

Euprymna hyllebergi sp. nov. is close to *E. hoylei* Adam, 1986, but it differs in the arrangement of suckers on the hectocotylized arm, the size and distribution of enlarged suckers on arms II-IV, and in the length of the tentacles (Fig. 3). However, the length of tentacles may not be a usable character (C. C. Lu, pers. comm.). Hoyle (1904) stated that in *E. stenodactyla* (= *E. hoylei*), the hectocotylized arm (left) is decidedly thicker than the first right arm. In *E. hyllebergi* sp. nov. the two arms do not differ decidedly in thickness (Figs. 3d and 3a). Further Hoyle

(1904) stated that "The suckers are first in two, afterwards in four rows, and extend halfway up the arm where they are succeeded by a number of stout papillae in two or three rows; these thicken towards the tip and do not bear suckers, but each has in its rounded top a slit, much resembling a mouth, closed by two lips, one thicker than the other" (Fig. 3d). This description agrees with *E. stenodactyla* (= *E. hoylei*) in Voss (1963) except that Voss found that "distal to the normal suckers are 35-40 closely palisaded papillae terminating in a slitlike aperture containing a small sucker" (Fig. 3f). Adam (1986) stated that in *E. hoylei*, the

distal part of the hectocotylus has suckers in rows of four followed by 12-14 rows of papillae in two rows.

E. hyllebergi sp. nov. differs from *E. hoylei* in the high number of stout papillae with slitlike aperture in the distal half of the hectocotylus. The papillae are crowded in rows of 4-6 suckers in the middle part, and reduced to two rows at the tip of the hectocotylus (Figs. 3a, 3d, 3f).

E. stenodactyla (= *E. hoylei*) is characterized by enlarged suckers on arms II-IV, particularly on arm III where four or five suckers in the ventral row are much larger than the rest (Figs. 3f, 3e). Also arm IV carries two to three enlarged suckers of the dorsal series and four to five in the ventral (Hoyle 1904, p. 25). The same characteristic feature is stated by Voss (1963, p. 54) and Adam (1986, p. 135). The suckers on arm II-IV of *E. hyllebergi* sp. nov. differ from *E. hoylei* in not having any significantly or abruptly enlarged suckers (Fig. 3a). This state is found in males and females (Figs. 3a, 3c).

E. stenodactyla (= *E. hoylei*) has tentacles about as long as, or shorter than the arms (Hoyle 1904, p. 25), Voss (1963, fig. 8a). Adams (1986) measured the length of tentacles in the holotype of *E. hoylei*. Total length of the tentacle is 18 mm compared to an arm length of 14 mm, that is 28 % longer than the arms. In comparison *E. hyllebergi* sp. nov. has long tentacles, approximately two times the length of arms. But, as previously mentioned, tentacular length in cephalopods varies greatly depending on how the specimen is fixed and preserved. Live fixed animals have short tentacles because of the contraction, on the other hand, specimens thawed from frozen condition have long tentacles. In order for this character to be of some use, the condition when the specimens are fixed must be the same. Even so, specimens from the same batch may vary greatly (C. C. Lu, pers. comm.)

Genus *Iniotheuthis* Verrill, 1881

Diagnosis: Hectocotylized arm widened in basal half in area of copulatory apparatus,

distal part of arm normal. Tentacular club with 8-10 sucker rows. No luminous organ on ink sac. Gladius absent.

Iniotheuthis maculosa Goodrich, 1896

(Figs. 6-7, Tab. 3)

Iniotheuthis maculosa - Goodrich 1896:2; - Massy 1916:216; - Adam 1954:128 - Voss 1963:59-63, fig. 9; - Oomen 1975:186-187; - Jothinayagam 1987:39-41, fig. 13.

MATERIAL EXAMINED: PMBC no. 11724. 4 specimens, 1 male: 12.7 mm ML, 3 females: 13.4-14.3 mm ML, Laem Tang, Phang-nga Bay. Push net, Coll. S. Utsaha. 22.7.1988.

DESCRIPTION: Colour in alcohol yellowish with numerous minute to large deep purplish brown chromatophores covering mantle, head, and arms; dense dorsally and scattered ventrally; chromatophores banded on arms and aboral distal half of tentacles; fins with chromatophores at base dorsally, and devoid of chromatophores ventrally. **Mantle** (Fig. 6a-b) conical, widest anteriorly, bluntly rounded posteriorly; dorsally united with head; ventral anterior margin rounded and slightly projecting forward; ventral median margin slightly emarginate. **Fins** small, circular in outline, attached laterally, and originate at about midpoint of the mantle; fin base narrow (FBI = 27.2); anterior lobes strongly auriculate (Fig. 6a). **Head** small, dorsoventrally flattened, narrower than mantle. Eyes large with distinct eyelids; a small pore present postero-ventrally to eye. **Funnel** (Fig. 6c) long, stout basally and tubular distally, free for most of its length. Funnel organs (Fig. 6d) in male obscure, could not be observed in the present specimen; females with roughly triangular shaped dorsal pad and two enlarged oval ventral pads. Dorsal pad free at distal end, with a ridge present along the midline. Funnel valve rounded and well-developed. Funnel cartilage oblong, parallel-sided, slightly pointed at both ends, with deep median groove (Fig. 6c); mantle cartilage straight, ridge-like, about 50% longer than funnel cartilage. **Arms** rather long, unequal, arm

order III. II. IV. I or III. II. I. IV. Arms I and II slender with indistinct aboral keel along their length. Arm III stout proximally and slender distally, with aboral keel along

greater part of its length. Arm IV short, stout with well defined aboral keel extending along its length. Low web present between arms III and IV. Arm suckers biserial

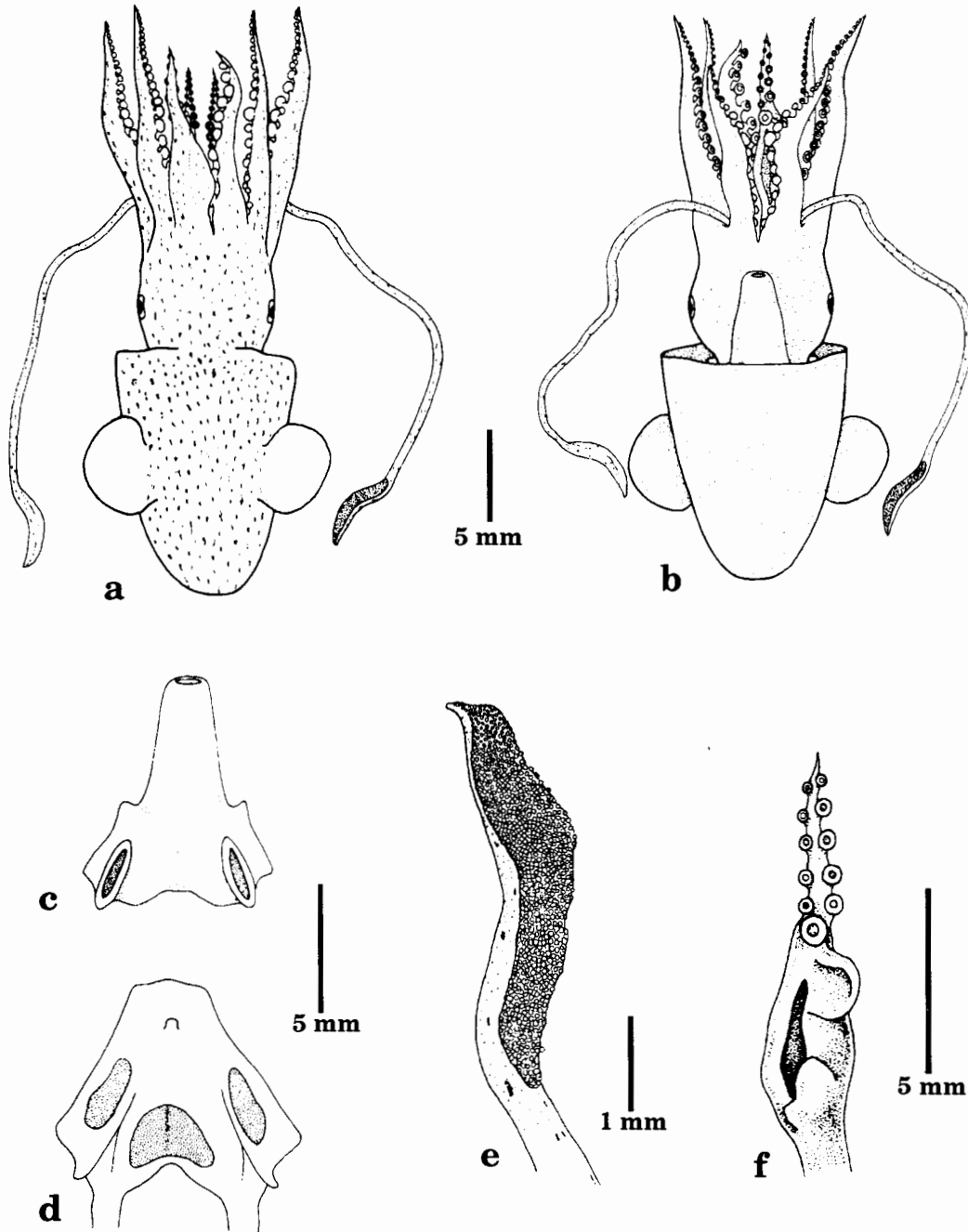


Figure 6. *Inioeteuthis maculosa*. Male, 12.7 mm ML. (a), dorsal view. (b), ventral view. (c), funnel and funnel cartilages. (d), funnel organs. (e), tentacle. (f), hectocotylied arm.

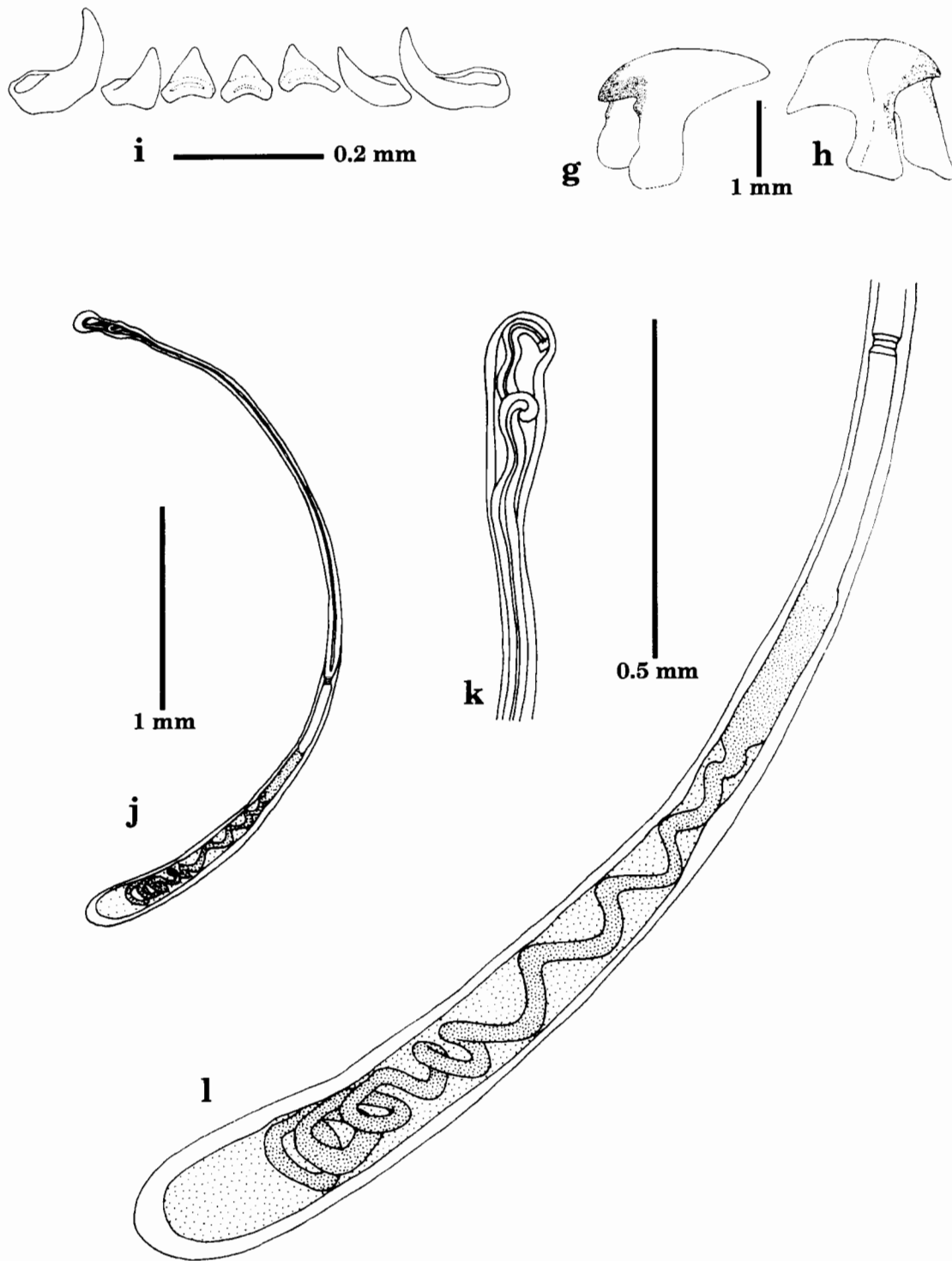


Figure 7. *Inioleuthis maculosa*. (g), upper beak. (h), lower beak. (i), radula. (j), whole spermatophore. (k), enlargement of oral cap. (l), enlargement of sperm reservoir.

throughout; subglobular with rounded aperture and without teeth; pedicels short. In male, arm suckers generally larger than in female; greatly enlarged suckers present on ventral rows of arms I, II and III; on Arm IV suckers somewhat enlarged on ventral rows but not greatly enlarged as on other arms (Figs. 6a-b). Left dorsal arm in male hectocotylized (Fig. 6f), by modification of proximal half of its length. Modified portion with enormously expanded basal part of arm; a deep excavation on oral surface, with sides inrolled along edges, dorsal edge entire, ventral edge with incision; two small tongue-like papillae present in central part. Two to three small suckers on proximal excavation. Unmodified portion with eight pairs of normal suckers in two rows; suckers on ventral row larger than those on dorsal row. Tentacles (Fig. 6e) long, slender, flattened, with somewhat expanded clubs. **Clubs** with low protective membranes ventrally and wide keel dorsally from base to tip. Suckers minute, toothed and in about 8-10 rows. **Gladius** absent. Buccal membrane with seven connectives, no sucker. **Beak:** Upper beak (Fig. 7g) with stout, short curved rostrum; hood short; cutting edge with a notch and a prominent tooth; crest curved; lateral wings enlarged. Lower beak (Fig. 7h) with short, conical rostrum; hood short; cutting edge curved and smooth; lateral wings enlarged; lateral walls long, squarish. **Radula** (Fig. 7i) with seven transverse rows of teeth, all unicuspid. Rachidian and first lateral teeth short and conical, second lateral teeth and marginal teeth slightly curved. **Spermatophore** (Fig. 7j-l) about 6 mm length and 0.5 mm width, aboral part conical and broadest; sperm cord coiled; cement body elongated; ejaculatory apparatus loosely coiled. Ink sac present and no luminous organ.

TYPE LOCALITY: Andaman Islands.

DISTRIBUTION: Andaman Islands, Persian Gulf (Goodrich 1896); Indonesia (Adam 1954); Philippines (Voss 1963); the Arabian Sea (Oomen 1975); Madras coast, India

(Jothinayagam 1987) and the Andaman Sea, Thailand.

REMARKS: The genus *Iniotheuthis* comprises 3 species viz. *I. japonica* Verrill, 1881 which is distributed from Southern Japan to China; *I. maculosa* Goodrich, 1896 from the Northern Indian Ocean, Persian Gulf, Bay of Bengal, Andaman Sea, Indonesia and Philippines; and *I. capensis* Voss, 1962 from South Africa. All species are well-defined. *I. japonica* and *I. maculosa* have the left dorsal arm of male greatly widened in basal half and with deep incision on ventral side, while the left dorsal arm of male *I. capensis* is slightly widened in basal half and without incision on the ventral side (Tab. 4).

DISCUSSION

Sepioids are small squids with a mantle length of about 1-8 (rarely 10) cm (Nesis 1987). They live in all oceans and seas ranging from intertidal to deep-sea benthic and mesopelagic habitats. The family comprises 3 subfamilies (Heteroteuthinae, Sepiolineae and Rossinae), 14 genera, and 51-56 species (Nesis 1987). The family was initially placed in the order Sepioidea but Fioroni (1981) proposed a new order called Sepioliodea, which includes the family Sepiolidae. Clarke (1988) suggested the name Sepiolida for this order (see discussions by Boletzky 1991, 1995 a). The systematic position of the family is uncertain, and the identity of some species is still unclear (Adam 1986; Okutani & Takayama 1991). Volpi *et al.* (1995) mentioned the problems encountered in identification of sepioid species by using ill-defined characters, *e.g.*, the number of sucker rows on the tentacular club or the number of proximal suckers on the hectocotylus in species of *Sepietta*. In order to solve the problems, concerted research efforts have been attempted for the Mediterranean sepioids with good results (Bello 1995; Boletzky 1995 b).

Silas (1968) mentioned that 9 species of the family Sepiolidae have been listed in the Indian Ocean. The family comprises the fol-

Table 3. Means, standard deviations and ranges of selected measurements and indices (in percent) of *Iniotheuthis maculosa* from the Andaman Sea, Thailand.

Index	MALE		FEMALE		s.d (n-1)	Range
	n	value	n	mean		
ML(mm)	1	12.7	3	13.8	0.4	0.4-14.3
MWI	1	59.8	3	63.5	16.7	48.9-82.1
FLI	1	31.5	3	41.6	5.3	36.6-47.1
FWI	1	110.2	3	104.1	5.5	99.3-110.1
FBI	1	26.8	3	27.2	3.5	23.1-29.4
HLI	1	48.0	3	34.3	1.2	32.9-35.1
HWI	1	58.3	3	54.7	2.0	52.4-56.0
AL _I	1	84.2	3	55.3	6.8	47.5-59.7
AL _{II}	1	105.5	3	64.5	6.1	58.7-70.9
AL _{III}	1	106.3	3	70.0	5.3	66.4-76.1
AL _{IV}	1	85.8	3	56.3	7.4	49.6-64.2
AS _I	1	7.1	3	2.2	0.06	2.1-2.2
AS _{II}	1	7.1	3	2.4	0.4	2.1-2.9
AS _{III}	1	5.5	3	2.4	0.4	2.1-2.9
AS _{IV}	1	5.5	3	2.2	0.06	2.1-2.2
TtLI	1	350.4	3	199.7	92.7	145.6-306.7
CILI	1	44.9	3	34.9	6.6	28.7-41.8
HcAI	1	83.5				
HcLI	1	50.9				
SpLI	1	47.2				
SpWI	1	8.3				
EDI	1	31.5	3	28.7	1.8	26.6-29.8
LnDI	1	21.3	3	16.4	1.8	14.5-18.2

lowing genera and species: 3 genera, 6 species of the subfamily Sepiolinae: *Sepiola penares* (Gray, 1849), *Euprymna berryi* Sasaki, 1929, *E. morsei* (Verrill, 1881), *E. stenodactyla* (Grant, 1833), *Iniotheuthis japonica* Verrill, 1881, *I. maculosa* Goodrich, 1896; 1 genus and 2 species of the subfamily Rossiinae: *Rossia enigmatica* Robson, 1924, *R. mastigophora* Chun, 1914, and 1 species in the subfamily Heteroteuthinae: *Heteroteuthis hawaiiensis* var. *dagamensis* Robson, 1924. Of these, only *E. stenodactyla*

Table 4. *I. japonica* and *I. maculosa* can be separated by the following characters (*sensu* Nesis 1987).

<i>I. japonica</i>	<i>I. maculosa</i>
1. Left dorsal arm of male much shorter than right arm.	1. Left dorsal arm of male not shortened.
2. Several small suckers present on dorsal side of widened basal part of left dorsal arm.	2. No suckers on dorsal side of widened part of left dorsal arm.
3. A large ear-like lobe free of papillae in central part of arm copulatory apparatus.	3. Two small tongue-like papillae in central part of arm copulatory apparatus.

and *I. maculosa* have type localities in the Indian Ocean. In 1987, Jothinayagam reported *E. berryi*, *I. maculosa* and *I. japonica* from the Madras coast of India. It is a puzzle why the species composition of this family is very low in the Indian Ocean compared with other areas, for instance, in the Mediterranean Sea where the family is represented by 16 species belonging to 7 genera (Bello 1995).

The Mediterranean Sea may provide more opportunities for immigrant species from the Atlantic as well as the Indian Ocean *e.g.*, the butterfly squid *Stoloteuthis leucoptera* has migrated into the Mediterranean Sea (Orsi Relini & Massi 1991). Other explanations could be suggested for the Indian Ocean. The sepiolids are small. Therefore, they are always mixed with other small animals as trash fish during fishing operations. Another reason, could be that many species live from the upper slope to bathyal depth of more than 1,000 m (Villanueva 1995). Only few investigations have been made in these depths in the Indian Ocean, and none in the Andaman Sea. An intensive investigation might increase the number of species of sepiolid squids in these areas.

Only 4 species of sepiolids have been recorded in Thai waters. *E. stenodactyla* was first recorded in the Gulf of Thailand by Sithigornkul (1974) and 4 species by

Chotiyaputta *et al.* (1992), *i.e.*, *Sepiola trollostrata* Voss, 1962 from the Gulf of Thailand, and *I. maculosa*, *E. berryi*, *E. stenodactyla* from both the Gulf of Thailand and the Andaman Sea. However, the records of *E. stenodactyla* need to be confirmed (C.C. Lu, pers. comm.).

Even though the sepiolids are small in sizes, a large amount, taken as bycatch in bottom trawls along the coasts, has resulted in a high commercial value. Recently, Supongpan (1995) mentioned that frozen *E. stenodactyla* have been exported from Thailand.

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Appendix 1. *Euprymna hyllebergi* : selected material deposited in the PMBC Reference Collection.

PMBC no.	No. ind.	Sex	ML(mm)	Locality	Date	Gear/depth	Collector
1607	3	M	20.1-24.1	Phuket	March 6th 1972		C.F.E., Roper
	2	F	18.9-20.2				
11727	1	F	25.6	Krabi Fishmarket	April 7th 1991		Author
11728	1	M	31.6	Kantang Fish Landing, Trang	Dec. 15th 1994		Author
11729	2	M	23.6-34.4	Kantang Fish Landing	March 4th 1989		Author
	4	F	23.7-35.4				
11730	9	M	14.7-35.1	Kapur Ranong	Jan. 4th 1995	Push net	V. Janekarn
	11	F	16.6-17.6				
11731	1	F	24.4	Tha lane Phang-nga Bay	July 23rd 1989	Push net	S. Utsaha
11732	1	F	23.7	07°01'N; 98°58'E	March 15th 1989	Trawl/64-74 m	M/V Paknam
11733	3	M	22.0-29.2	Krabi Fish market	March 4th 1994		Author
	3	F	25.2-33.5				
11734	1	M	19.8	Chong Pra Phang-nga Bay	June 18th 1988	Push net	S. Utsaha
	4	F	21.6-33.1				
11735	1	M	28.8	Ko Raya Ring	May 23rd 1987	Push net	S. Utsaha
	1	F	18.6				
11736	2	M	18.0-19.6	Tha Lane Phang-nga Bay	June 23rd 1987	Push net	S. Utsaha
	4	F	12.0-23.8				
11737	1	M	23.3	Kantang Fish Landing	June 5th 1992		Author
11738	5	F	13.5-28.6	08°02.45'N; 98°30.17'E	May 15th 1989	Trawl/25 m	R/V Pramong 10
11739	3	M	24.0-28.8	Krabi, SW of Ko Lanta	Sept. 15th 1990	Trawl	R/V Pramong 10
11740	4	F	16.2-29.7	Laem Tang	June 23rd 1988	Push net	S. Utsaha
11741	1	M	16.0	Phang-nga Bay	May 22nd 1987	Push net	S. Utsaha
	4	F	11.4-31.1				
11742	15	F	22.0-32.0	Kantang Fish Landing	Feb. 14th 1996		Author
11782	2	M	13.1-32.35	07°04.4'N; 98°53.5'E	March 15th 1989	Trawl/70 m	Author