

TWO SPECIES OF OCEANIC SQUIDS FROM THE ANDAMAN SEA, INDIAN OCEAN

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ABSTRACT

Male and female of the oceanic squid, *Sthenoteuthis oualaniensis* (Lesson, 1830) are described and illustrated. The morphometrics of two males of *Thysanoteuthis rhombus* Troschel, 1857, are tabulated with reference to previous record from the Andaman Sea. The gladius and habitus are illustrated. The material is deposited in the PMBC Reference Collection.

INTRODUCTION

Nine species of oceanic cephalopods have been recorded in the Andaman Sea, Thailand (Nateewathana & Hylleberg 1989; Sawata & Phongsuwan 1994; Nateewathana 1995). In addition to those described species, a number of oceanic cephalopods have subsequently been collected in the Andaman Sea, and the Indian Ocean. In order to complete the taxonomic descriptions of cephalopods in the Andaman Sea, additional material is described in the present paper.

MATERIALS AND METHODS

The oceanic squids were collected from the Andaman Sea, Thai waters and from the open Indian Ocean. The squids were fixed in 10 % neutralized formalin in the field and transferred to 75 % ethyl alcohol for permanent storage. Taxonomic descriptions, measurements, counts and indices are based on Roper & Voss (1983) and shown in Tab. 1 and Fig. 1. The specimens are deposited in the Reference Collection of Phuket Marine Biological Center, P.O. Box 60, Phuket 83000, Thailand.

SYSTEMATIC ACCOUNT

Family Ommastrephidae Steenstrup, 1857

Diagnosis: an inverted T-shaped funnel locking cartilage, biserial suckers on arms, tetraserial suckers on the tentacular clubs (except *Illex* which has 8 rows of suckers on

the dactylus), buccal connectives that attach to the dorsal borders of arms IV, photophores in some genera, and a muscular bridge anterior to the funnel locking cartilage which passes from the funnel to the ventral surface of the head (Roper *et al.* 1984).

Sthenoteuthis oualaniensis (Lesson, 1830)
(Figs. 2-5, Tab. 2)

Loligo oualaniensis - Lesson 1830: 240, pl.I, fig. 2.

Ommastrephes oualaniensis - Steenstrup 1880: 76.

Symplectoteuthis oualaniensis - Pfeffer 1900: 180; -Pfeffer 1912: 502, pl. 40-41, 42, figs.1-4; - Sasaki 1929: 296, pl.xxx, fig. 8, textfigs. 176-178; - Adam 1954: 157; - Voss 1963:134, fig. 29; - Voss & Williamson 1971: 74, pl.23, figs. 20,27,30; - Roper *et al.* 1984: 180.

Sthenoteuthis oualaniensis - Zuev *et al.* 1975: 1475.

MATERIAL EXAMINED: PMBC no. 11789. 7 specimens. 1 male, 145 mm ML, 6 females, 170-236 mm ML. Indian Ocean. Lat. 5°30' S, Long. 65°00' E R/V Chulabhorn. Handline. Coll. W. Pokapunt and C. Tantivala. 11 February 1994. PMBC no. 11790. 2 specimens. 1 male, 133 mm ML, 1 female, 136 mm ML. Indian Ocean. Lat. 13°27'27" N, Long. 87°34'58" E. R/V Fishery Research no. 2. Handline from surface water over a depth of 3000 m. Coll. W. Pokapunt. 14 March 1989. PMBC no. 11791. 1 female specimen, 102.7 mm ML. Andaman Sea. Lat. 06°45'7" N, Long. 97°57'2" E. M/V Paknam. Trawled. Depth 342 m. Coll. A. Nateewathana. 20 March 1989. PMBC no. 11792. 1 female specimen, 145 mm ML. Andaman Sea. Lat.

Table 1. Definition of counts, measurements and indices.

ML	Mantle Length	Dorsal mantle length measured from the anteriormost point of the mantle to the posterior tip.
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.
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.
CISI	Club Sucker Index	Diameter of largest sucker on (right) club as a percentage of mantle length.
TtLI	Tentacle Length Index	Total length of tentacular stalk and club as a percentage of mantle length.
C1LI	Club Length Index	Length of club as a percentage of mantle length.
GLI	Gladius Length Index	Length of gladius as a percentage of mantle length.
GWI	Gladius Width Index	Greatest width of gladius as a percentage of gladius length.
RLI	Rachis Length Index	Length of free rachis measured from anterior end of gladius to point where anterior edge of vane joins rachis, as a percentage of gladius length.
RWI	Rachis Width Index	Width of rachis measured at point where anterior edge of vane meets rachis, as a percentage of gladius length.
HcAI	Hectocotylized Arm Index	Length of hectocotylized arm measured from proximal most armature 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.

06°23'3" N, Long. 98°05'33" E. R/V Fishery Research no. 2. Handline from surface water over a depth of 200 m. Coll. W. Pokapunt. 1 May 1989. 6 female specimens, 77.0-105.8 mm ML. Andaman Sea. Lat. 07°34'4" N, Long. 97°44'4" E. M/V Paknam. Trawled. Depth 400 m. Coll. A. Nateewathana. 19 March 1989. PMBC no. 11794. 6 female specimens, 139- 200 mm ML. Andaman Sea. R/V Fishery Research no. 4. Handline from surface water over a depth of 220 m. Coll. W. Pokapunt. 10 February 1992. PMBC no. 11795. 1 female specimen, 323 mm ML. Indian Ocean. Lat. 2°00' S, Long. 90° 00' E. M/V SEAFDEC. Handline from surface water over a depth of 2000 m. Coll. A. Munprasit. 8 December 1994.

DESCRIPTION: **Colour** in alcohol yellowish brown often with dark purple colouration in the mid-dorsal line of mantle. **Mantle** (Fig. 2,

a) long, slender, cylindrical, muscular, and tapering abruptly from the anterior margin of fins to a sharp pointed end (Fig. 2, b); median antero-dorsal lobe low rounded; ventral mantle margin slightly concave below funnel. **Fins** terminal, rather large, rhombic, occupying about 42-45 % of ML; anterior margins slightly convex; lateral margins pointed; posterior margins straight, continuous to the apex of mantle. **Head** large, as wide as mantle, sharply set off from the neck by a transverse ridge; each side of the head with three nuchal folds connected to the transverse ridge Fig. 3, a). Eyes (encircled by a free eyelid, forming a rounded triangle, truncated posteriorly and with a sharp narrow anterior sinus Fig.

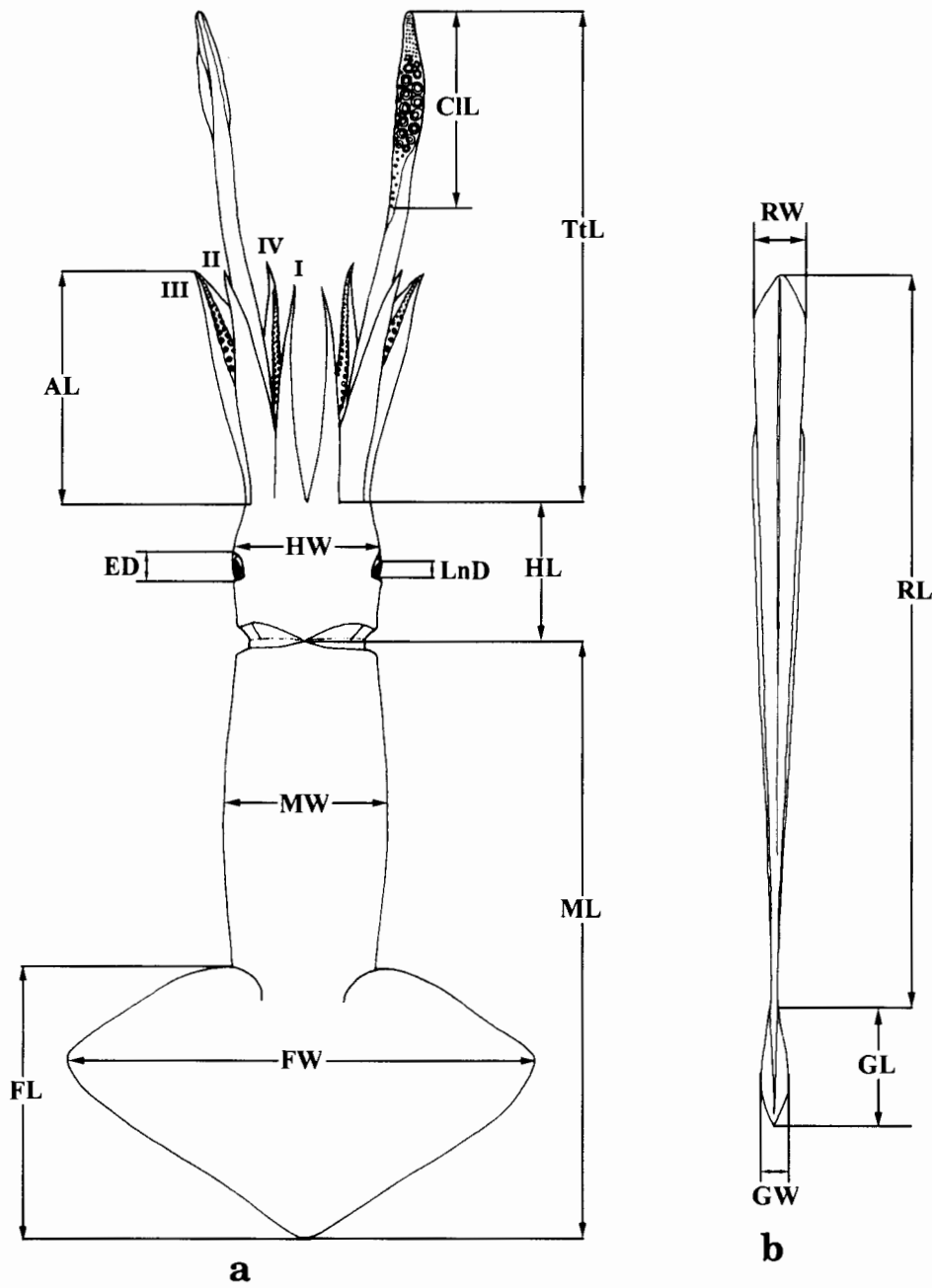


Figure 1. Diagrammatic illustrations of the measurements in oceanic squids: (a) dorsal view and (b) gladius. Dorsal View, AL = Arm Length, CIL = Club Length, ED = Eye Diameter, FL = Fin Length, FW = Fin Width, HL = Head Length, HW = Head Width, LnD = Lens Diameter, ML = Mantle Length, MW = Mantle Width, I = dorsal arm, II = dorso-lateral arm, III = ventro-lateral arm, IV = ventral arm. Gladius, GL = Gladius Length, GW = Gladius Width, RL = Rachis Length, RW = Rachis Width.

3, a). **Funnel** large, compact and set in a deep pit on the ventral side of the head; funnel valve large and well-developed; dorsal funnel organ large and inverted v-shaped; ventral pads elongate, oval shape; foveola (Fig. 3, b) with

7-9 longitudinal folds in the central pocket and 3-5 lateral pockets on either side. Funnel locking apparatus inverted T-shaped and fused in its middle portion with the mantle groove (Fig. 3, c). **Arms** moderately long, stout with

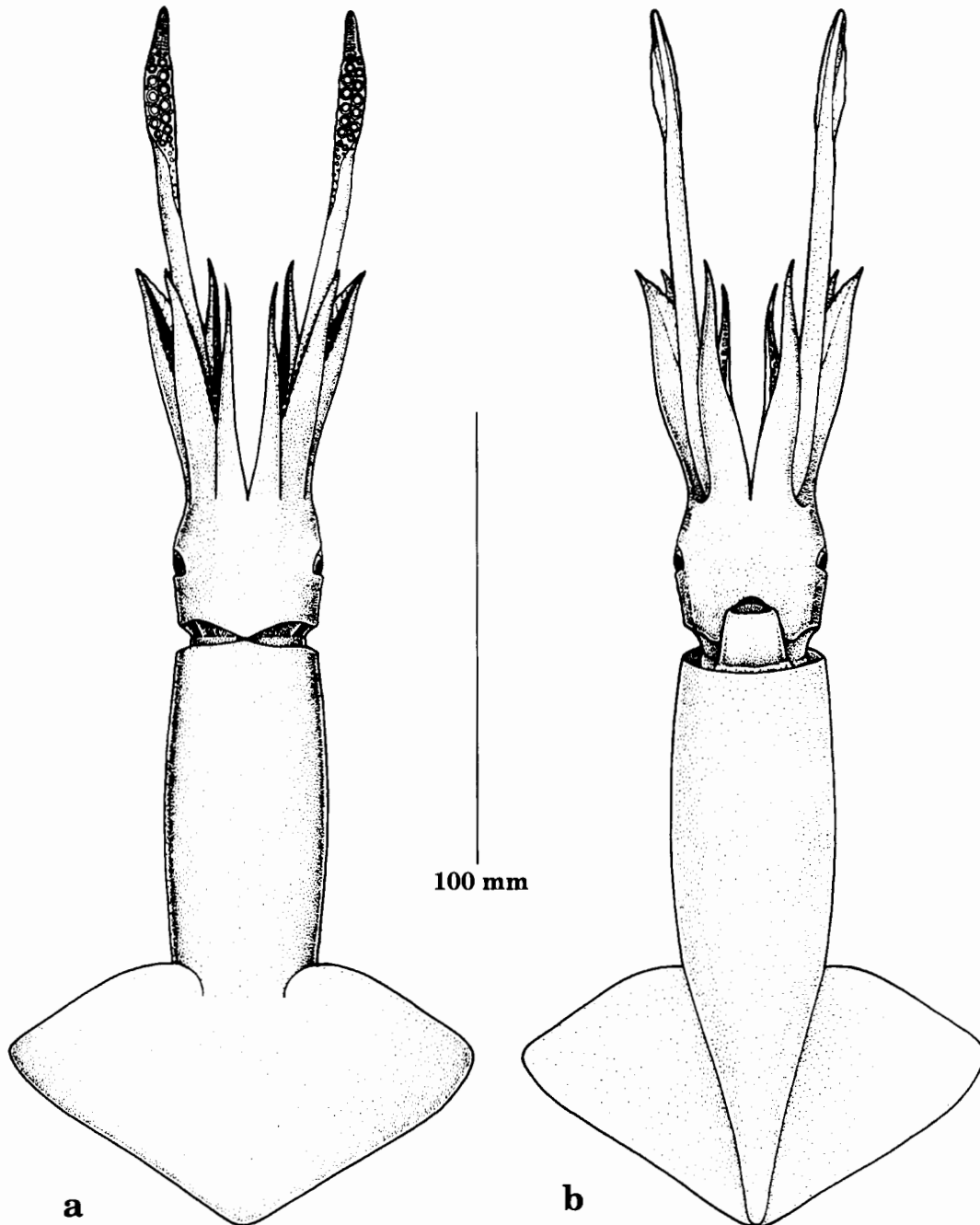


Figure 2. *Sthenoteuthis oualaniensis*. (a), dorsal view and (b), ventral view of 134.6 mm ML of female.

pointed tip, unequal in order of III.II.IV.I. Arms compressed with sharp keel along the edges. Arm III triangular, broad, strongly keeled on the proximal half of arm. Protective membranes well-developed with prominent trabeculae. Biserial suckers present in all arms; arm sucker rounded with about 12 sharp teeth laterally and distally, of which the median is largest (Fig. 3, d). Left arm IV of

males hectocotylized (Fig. 4, a), enlarged and thicker than other arms; proximal half of arm with 12 suckers arranged in two longitudinal rows bordered by heavy flap-like modifications of the supports of the protective membrane; a series of pits in a single row present along the base of protective membrane on each side of the proximal part of arm (Fig. 4, b); distal arm devoid of suckers and papillae.

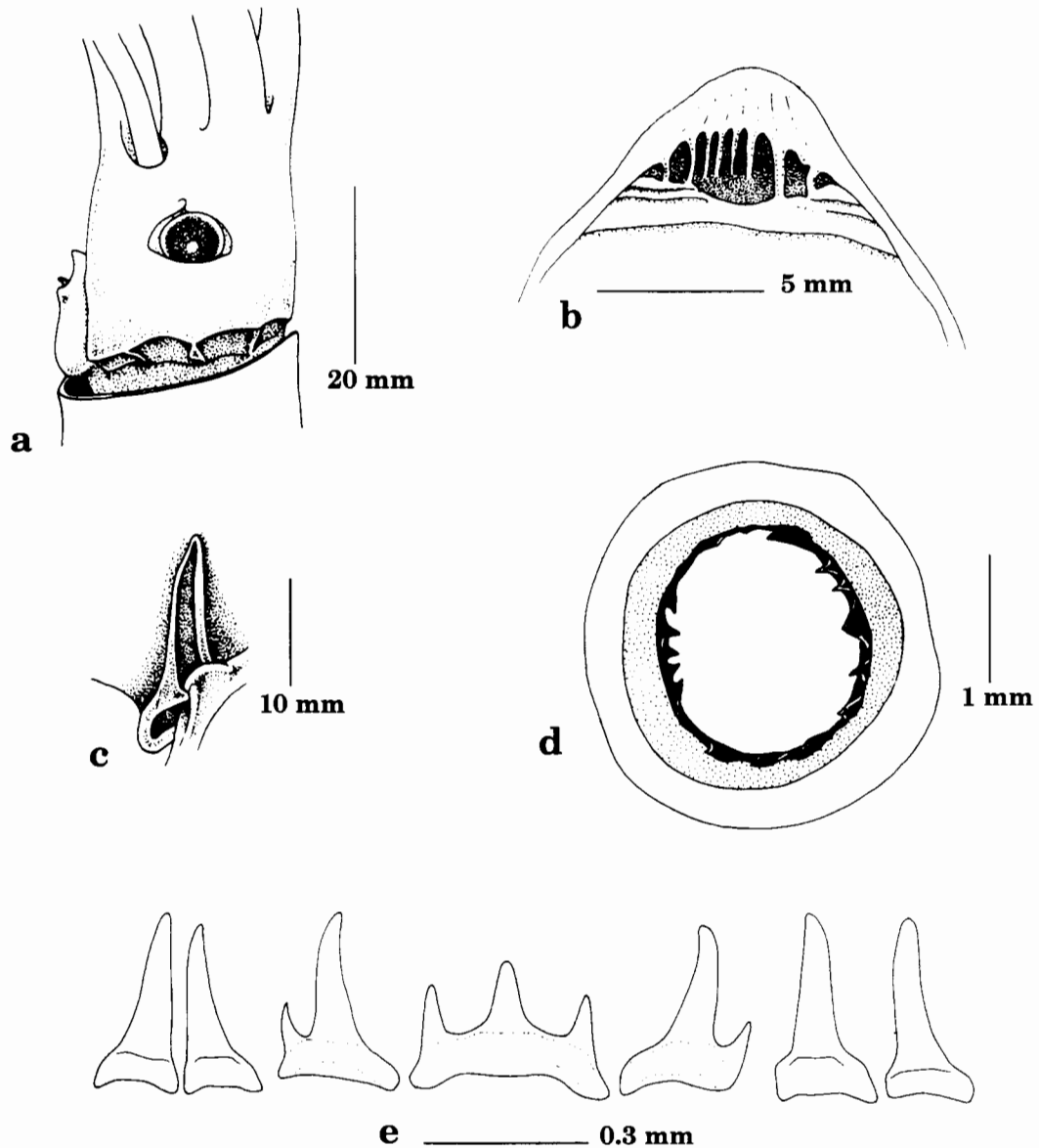


Figure 3. *Sthenoteuthis oualaniensis*. (a), head, lateral view of 141.9 mm ML of male. (b), foveola and side pockets. (c), funnel and mantle locking cartilages. (d), arm sucker. (e), radula.

Tentacles moderately long, stout, laterally compressed, and with elongated club (Fig. 4, c). Protective membranes slightly expanded on manus, trabeculae well-developed. Aboral keel present along the club. Club suckers quadriserial on dactylus and manus; two median rows of suckers 2-3 times larger than the lateral rows; carpal suckers small, arranged in two irregular rows. Enlarged club sucker dentition on dactylus and manus with

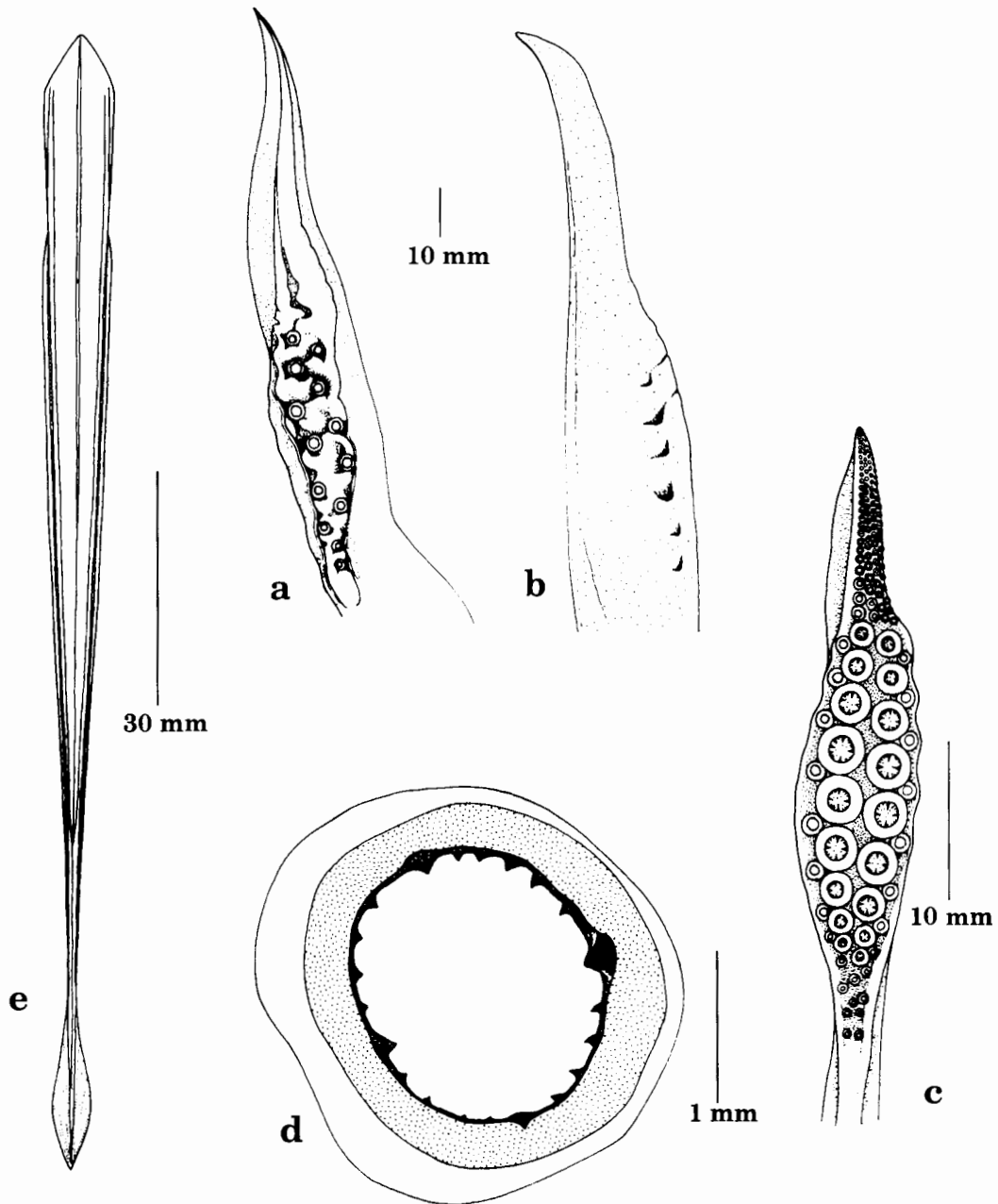


Figure 4. *Sthenoteuthis oualaniensis*. (a), hectocotylized arm of 146.8 mm ML of male. (b), lateral view of hectocotylized arm showing a series of pits. (c), tentacular club of 141.9 mm ML of male. (d), club sucker. (e), gladius.

about 20 sharp teeth and one in each quadrant enlarged (Fig. 4, d); carpal suckers with smooth horny rings; one to four distinct tubercles or knobs present on the carpus. **Gladius** (Fig. 4, e) thin and very slender; rachis stout anteriorly, uniformly narrowing to the posterior tip, and with median rib and two

marginal ribs along the edges; posterior end with a small vane about one-seventh of the total gladius length. **Buccal membrane** with seven buccal lappets, and with strong ribs projecting beyond the margin in sharp points; two pores present under arm I and between arm III, continuous with each other below

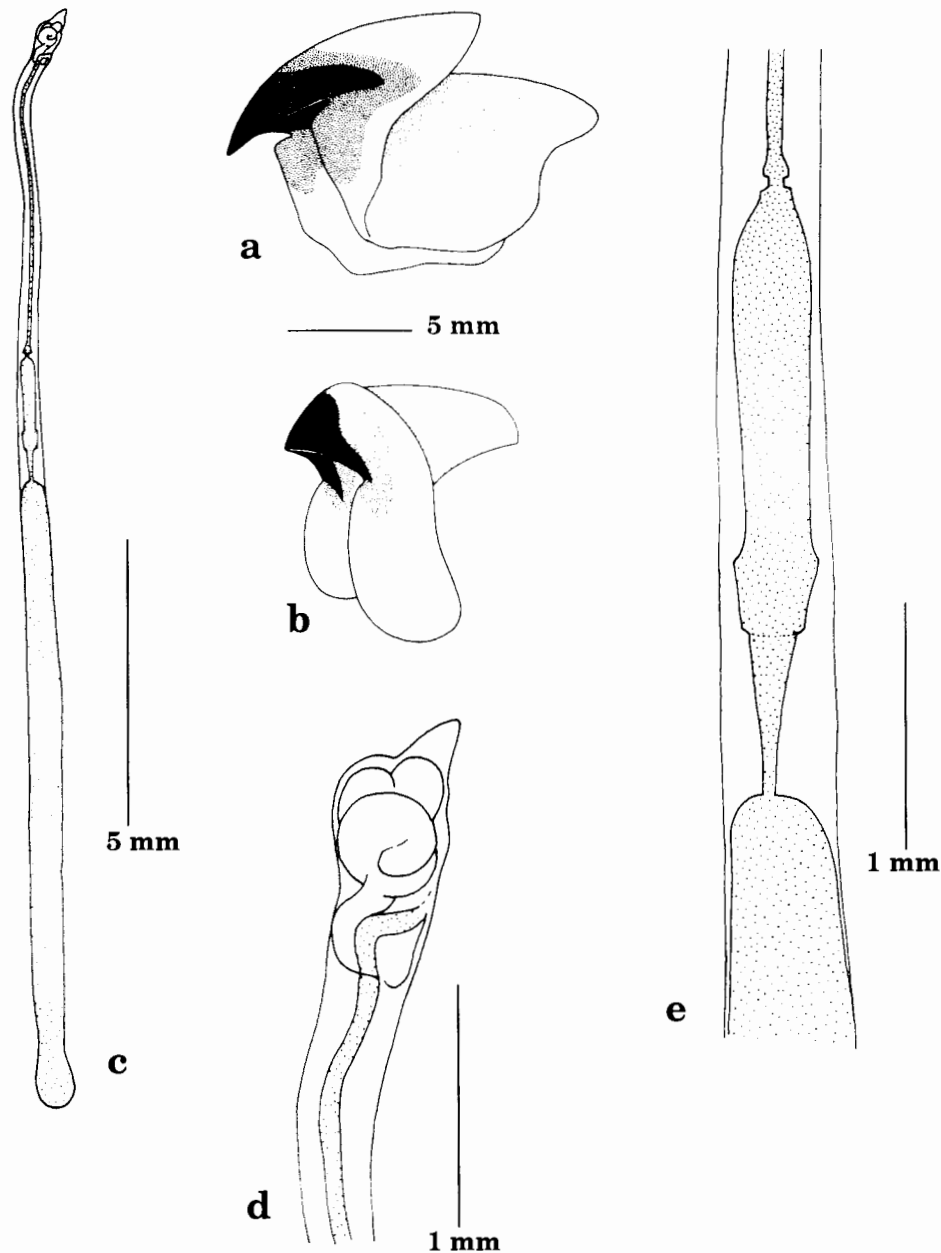


Figure 5. *Sthenoteuthis oualaniensis*. (a), upper beak of 141.9 mm of male. (b), lower beak. (c), spermatophore of 133 mm ML of male. (d), enlargement of oral cap. (e), enlargement of cement body.

Table 2. Means, standard deviations and ranges of selected measurements and indices (in percent) of *Sthenoteuthis oualaniensis*.

Index	MALES				FEMALES			
	n	mean	s.d (n-1)	Range	n	mean	s.d.(n-1)	Range
ML(mm)	3	142.3	8.3	133.0-149.0	5	155.9	42.1	102.7-208
MWI	3	27.1	2.2	24.6-28.4	5	27.1	7.1	20.6-37.2
HLI	3	22.4	1.3	20.9-23.5	5	20.6	2.2	17.0-23.0
HWI	3	17.8	3.9	14.9-22.2	5	19.1	3.4	16.7-25.0
FLI	3	46.1	0.8	45.2-46.8	5	42.8	3.1	38.2-47.0
FWI	3	74.7	7.7	67.1-82.5	5	69.4	13.2	55.2-82.2
AL _I I	3	36.6	0.7	35.9-37.2	5	32.4	6.6	26.4-40.9
AL _{II} I	3	41.6	5.4	35.9-46.6	5	37.3	6.7	31.3-45.6
AL _{III} I	3	43.8	5.6	37.6-48.3	5	36.9	5.2	30.4-42.7
AL _{IV} I	3	41.3	5.2	36.2-46.6	5	41.2	6.4	34.5-48.6
AS _I I	3	1.5	0.1	1.3-1.6	5	1.7	0.2	1.5-1.9
AS _{II} I	3	1.9	0.2	1.6-2.1	5	2.0	0.3	1.7-2.4
AS _{III} I	3	1.7	0.06	1.6-1.7	5	1.8	0.3	1.5-2.2
AS _{IV} I	3	1.2	0.1	1.1-1.2	5	1.5	0.3	1.2-2.0
CISI	3	2.3	0.1	2.2-2.5	5	2.5	0.5	1.9-3.2
TtLI	3	104.6	13.4	90.2-116.8	5	100.0	18.6	75.9-119.3
CILI	3	33.1	3.5	29.2-36.1	5	31.8	8.5	23.3-45.7
GLI	3	99.4	0.1	99.3-99.5	5	99.4	0.1	99.3-99.5
GWI	3	3.8	0.4	3.5-4.2	5	4.0	0.7	3.3-5.1
RLI	3	87.6	1.5	86.1-89.1	5	87.1	1.1	85.9-88.0
RWI	3	5.4	0.3	5.1-5.6	5	4.7	0.7	4.2-5.9
HcAI	3	46.6	7.2	38.6-52.6				
HcLI	3	59.7	3.6	56.8-63.7				
SpLI	2	17.8	1.5	16.7-18.9				
SpWI	2	3.3	0.1	3.2-3.4				
EDI	3	11.3	1.4	10.4-12.9	5	8.9	1.9	6.6-11.7
LnDI	3	4.5	0.8	3.7-5.4	5	4.6	1.1	2.9-5.7

the overhanging dorsal connective membranes; no suckers; numerous small oval seminal receptacles surrounding the mouth of mature females. **Beaks:** Upper beak (Fig. 5, a) with long, sharply pointed, curved rostrum tip; jaw angle deep; hood length almost half of crest; lateral wall large. Lower beak (Fig. 5, b) with short, conical rostrum; hood short; wing large; lateral wall long. **Radula** (Fig. 3, e) with seven transverse rows of teeth; rachidian tooth tricuspid; first lateral

tooth bicuspid, outer cusp small; second and lateral marginal teeth single and slightly curved. **Spermatophore** (Fig. 5, c) long and small (SpLI=17.8, SpWI=3.3), sperm mass comprises 50-60% of total length; cement body oval, slightly constricted at the posterior quarter of the body (Fig. 5, e); ejaculatory apparatus coiled at oral end (Fig. 5, d).

TYPE LOCALITY: Oualan (=Kusaie, Caroline Islands).

DISTRIBUTION: Tropical Indo-Pacific; from

the Red Sea to Mozambique Channel and Natal, from southern Japan to southern Queensland and from the south of Baja California to northern Chile.

REMARKS: *S. oualaniensis* is in the family Ommastrephidae. The family is divided into the three subfamilies Ommastrephinae, Todarodinae, and Illicinae. These subfamilies can be distinguished by the following characters:

1. The Ommastrephinae is characterized by having a central pocket (foveola) and several side pockets in the funnel groove, and by the presence of photophores which are often deeply buried in the tissue of the mantle, head, and arms.

2. The Todarodinae has a foveola, but lacks side pockets in the funnel groove, and lacks photophores.

3. The Illicinae lacks both central and side pockets in the funnel groove as well as photophores.

S. oualaniensis belongs to the subfamily Ommastrephinae. The species was first described as *Loligo oualaniensis* by Lesson (1930). Later the species was transferred to genus *Ommastrephes*, and subsequently to genus *Symplectoteuthis* by Pfeffer (1900). Finally, *Symplectoteuthis oualaniensis* (Lesson, 1830) and *Ommastrephes pteropus* Steenstrup, 1855 were united in the genus *Sthenoteuthis* (Zuev *et al.* 1975; Roeleveld 1982). The typical character of the genus is the funnel and mantle cartilages fused at a single point. At present, the genus contains two species; *S. oualaniensis* and *S. pteropus*. The first species is distributed in the Indo-West Pacific, while the latter lives in the Atlantic Ocean (Nesis 1987).

Eventhough *S. oualaniensis* has the unique character of the subfamily, *i.e.*, foveola and side pockets, another character, photophore, may be present or absent. Two forms of the species, both forms are represented by males and females, are known: one small, without dorsal photophore, another larger, with dorsal photophore (Clarke 1965; Roper *et al.* 1984). Besides the presence or absence of the dorsal photophore, they differ by the structure of the

hectocotylus. Most investigators have suggested that the two forms might represent two valid species, but they have not yet been described. Until, recently, Nesis (1993) has considered *S. oualaniensis* as a single species. He recognized three main forms represented by females but only two forms represented by males. The three main forms of the species are:

Form 1. The dwarf, early-maturing equatorial form without dorsal photophore. Modal ML of males 9-10 cm, of females 9-12 cm.

Form 2. The middle-sized, most common and widespread form with dorsal photophore. Modal ML of males 12-15 cm, of females 19-25 cm.

Form 3. The giant, late-maturing form that inhabits the Red and Arabian Seas. Modal ML of females from 30-40 to 50-55 cm. The males of this form are unknown, thus only Form 1 and Form 2 are distinguished by mature males.

The present material contains Form 1 of Nesis (1993). All specimens lack dorsal photophore, but the females are much longer than 12 cm (the biggest specimen, PMBC no.11795, 32.3 cm ML). The distribution of the present material is in accordance with the distribution of Form 1. This form inhabits equatorial waters of the Indian and Pacific Oceans.

Bizikov (1991 cited after Nesis 1993) has considered *S. oualaniensis* as three clearly different groupings of unknown taxonomic status: the equatorial (= dwarf, without photophore), the tropical (middle sized, double lateral axes of the rachis) and the Red Sea-Arabian (single lateral ax of the rachis). Based on the grouping of Bizikov 1991) the present material should constitute the equatorial form but it has both single and double-axes on the rachis. In other words, characters that should distinguish the tropical form from the Red Sea-Arabian form. Therefore, it can be concluded that *S. oualaniensis* of the Andaman Sea and nearby areas in the Indian Ocean constitute only one form, which fits best with equatorial-photophoreless form of both Bizikov (*op.cit.*) and Nesis (*op.cit.*).

The common English name for *S. oualaniensis*

is the purpleback flying squid. The stock in the Pacific is subjected to commercial exploitation along with other species of oceanic squids in Japan and Taiwan (Roper *et al.* 1984). At present the species is not exploited in Thai waters.

Family *Thysanoteuthidae* Keferstein, 1866

Thysanoteuthis rhombus Troschel, 1857
(Fig. 6 a-b, Tab. 3)

Thysanoteuthis rhombus - Nateewathana & Hylleberg 1989:227-233, figs.1-3.

ADDITIONAL MATERIAL: PMBC no. 11725. 1 male. Krabi Fish landing, Purse seine, Coll. A. Nateewathana, 9 December 1991. PMBC no. 11726. 1 male.

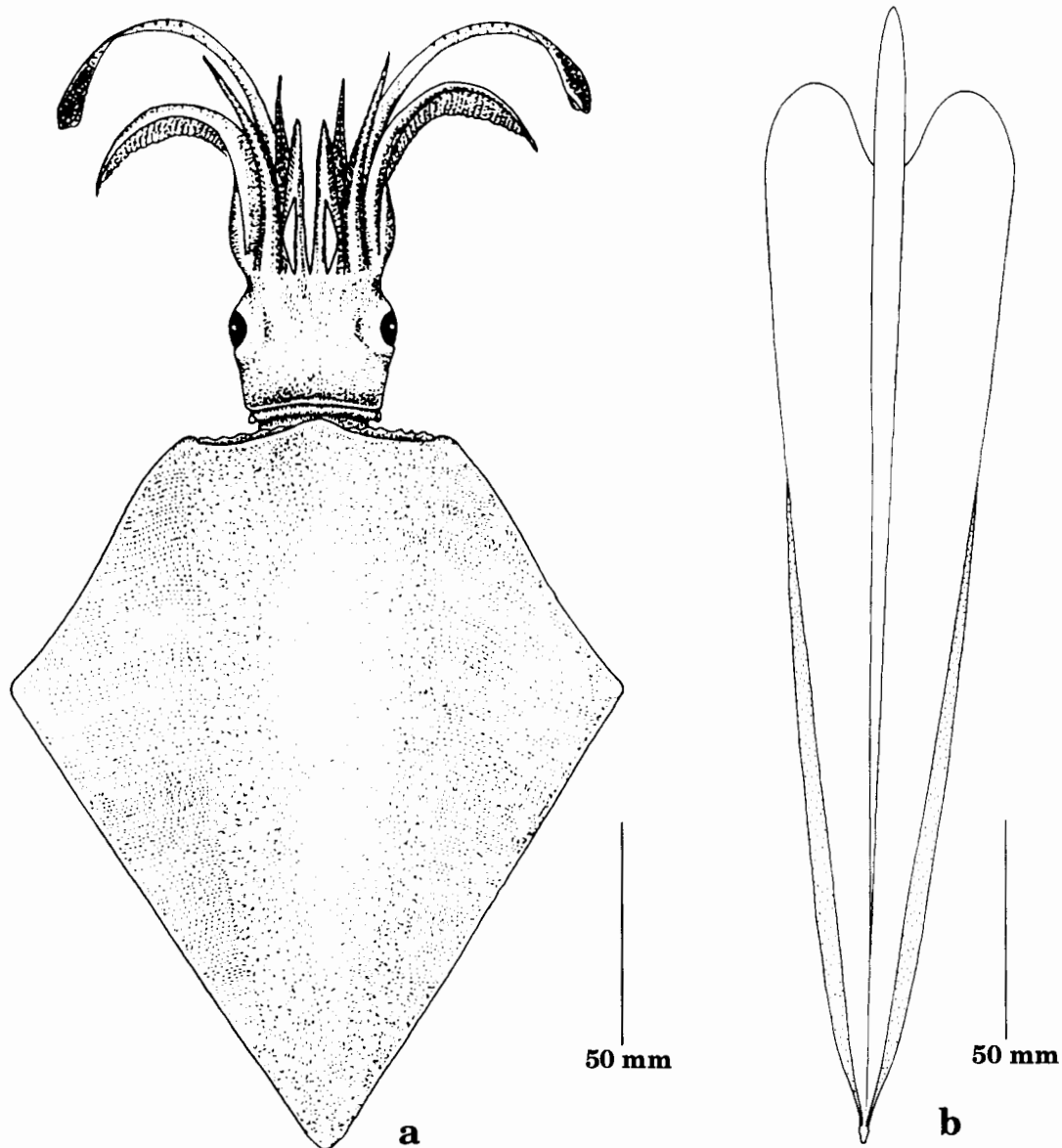


Figure 6. *Thysanoteuthis rhombus*. (a), dorsal view. (b), gladius.

Andaman Sea, Handline, R/V Chulabhorn. W. Pokapunt. 4 December 1994.

Diagnosis: Muscular mantle; rhomboidal fin extending nearly the full length of the mantle (Fig. 6, a); arms short, with 2 rows of suckers and extremely long, cirrate trabeculae; tentacles with 4 rows of suckers; a funnel locking cartilage with a long, narrow longitudinal groove and a short, broad transverse groove; a nuchal-mantle lock with two distinct knobs that fit into opposing pits; buccal connectives that attach to the ventral borders of arms IV; photophores absent; gladius resembles a long spearhead on a short shaft (Fig. 6, b); the left ventral arm hectocotylized.

DISCUSSION

Thysanoteuthis rhombus and *Sthenoteuthis oualaniensis* have been recorded in the Andaman Sea, Thailand by Nateewathana & Hylleberg (1989) and Chotiyaputta *et al.* (1992), respectively. *T. rhombus* is a monotypic species of the family Thysanoteuthidae (Roper *et al.* 1984). The species is well-defined and unique. The present collection is in accordance with the previous descriptions. However, the drawings Fig. 1a and Fig. 2b, in Nateewathana & Hylleberg (1989) did not show the correct habitus (the dorsal side), and the gladius was not in correct shape. The Figures have been redrawn and shown in the present paper.

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Table 3. Measurements and indices of *Thysanoteuthis rhombus*.

Index	PMBC no. 11725	PMBC no. 11726
ML (mm)	292.0	338.0
MWI	34.8	35.1
HLI	20.5	21.0
HWI	23.3	19.7
FLI	90.7	99.4
FWI	81.8	70.7
AL _I	28.1	30.5
AL _{II}	38.6	37.0
AL _{III}	58.9	62.4
AL _{IV}	34.1	34.0
AS _I	1.1	1.4
AS _{II}	1.0	1.7
AS _{III}	1.4	1.8
AS _{IV}	1.1	1.2
TtLI	77.4	64.8
CILI	20.9	24.8
CISI	1.5	1.4
GLI	99.7	99.7
GWI	21.0	24.0
RLI	14.8	15.0
RWI	0.3	0.4
EDI	8.2	12.5
LnDI	5.1	3.8

grateful to Mr Patairat Singdam (PMBC Artist) for drawing the pictures and finally I want to thank Dr Jørgen Hylleberg (Department of Marine Ecology, Aarhus University) for his guidance and comments to the manuscript. Support from the Tropical Marine Mollusc Programme (TMMP) is sincerely acknowledged.

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