

**MORPHOLOGY, INTERNAL ANATOMY, AND BIOMETRICS OF
THE CEPHALOPOD *IDIOSEPIUS BISERIALIS* VOSS, 1962.
A NEW RECORD FOR THE ANDAMAN SEA.**

By Jorgen Hylleberg and Anuwat Nateewathana
Phuket Marine Biological Center, P.O.Box 60, Phuket 83000, Thailand

ABSTRACT

In the Andaman Sea, Thailand, *Idiosepius biserialis* Voss, 1962 has been found associated with sea grass. The species is recorded for the first time outside South Africa. Male and female specimens are illustrated with emphasis on the internal anatomy not previously described. The morphology of *I. biserialis* is compared with the closely related *I. pygmaeus* Steenstrup, 1881, living in mangrove biotopes of the Andaman Sea. Hectocotylied arms of males are distinctly different in the two species. In general, the eyes provide a good character for separation of the two species (material fixed in formalin). A thick, wrinkled, and opaque secondary cornea disguises the eyeball in *I. pygmaeus* while *I. biserialis* has a thin, smooth and transparent secondary cornea, allowing the lens and iris to be clearly observed in preserved specimens. A membraneous gladius covers the posterior 2/3 of the dorsum of *I. biserialis* (as in *I. pygmaeus*) suggesting that the genus *Idiosepius* is more closely related to Teuthoidea than to Sepioidea.

INTRODUCTION

In connection with a major survey and description of squid, cuttlefish and octopus in Thai waters carried out by Anuwat Nateewathana of the Reference Collection of the Phuket Marine Biological Center, our attention was drawn to samples of squid of the genus *Idiosepius*. These small squids are found in mangrove channels and sea grass biotopes of the study area. However, in spite of being very common, no previous records have been made from the Andaman Sea.

Our first study (Hylleberg and Nateewathana, 1991) of *Idiosepius pygmaeus* agreed well with the general morphology of the species shown by Steenstrup (1881) but we failed to identify internal characters pointed out by Steenstrup as being unique to the genus *Idiosepius*.

During the study of *I. pygmaeus*, we found that the species possessed a thin but clear gladius covering the posterior 2/3 of the dorsum suggesting that it should be more closely related

to Teuthoidea than to Sepioidea. The latter relationship was originally proposed by Steenstrup (1881; a translation into English, 1962).

The present study on *Idiosepius biserialis* concludes our joint studies on these small squid species.

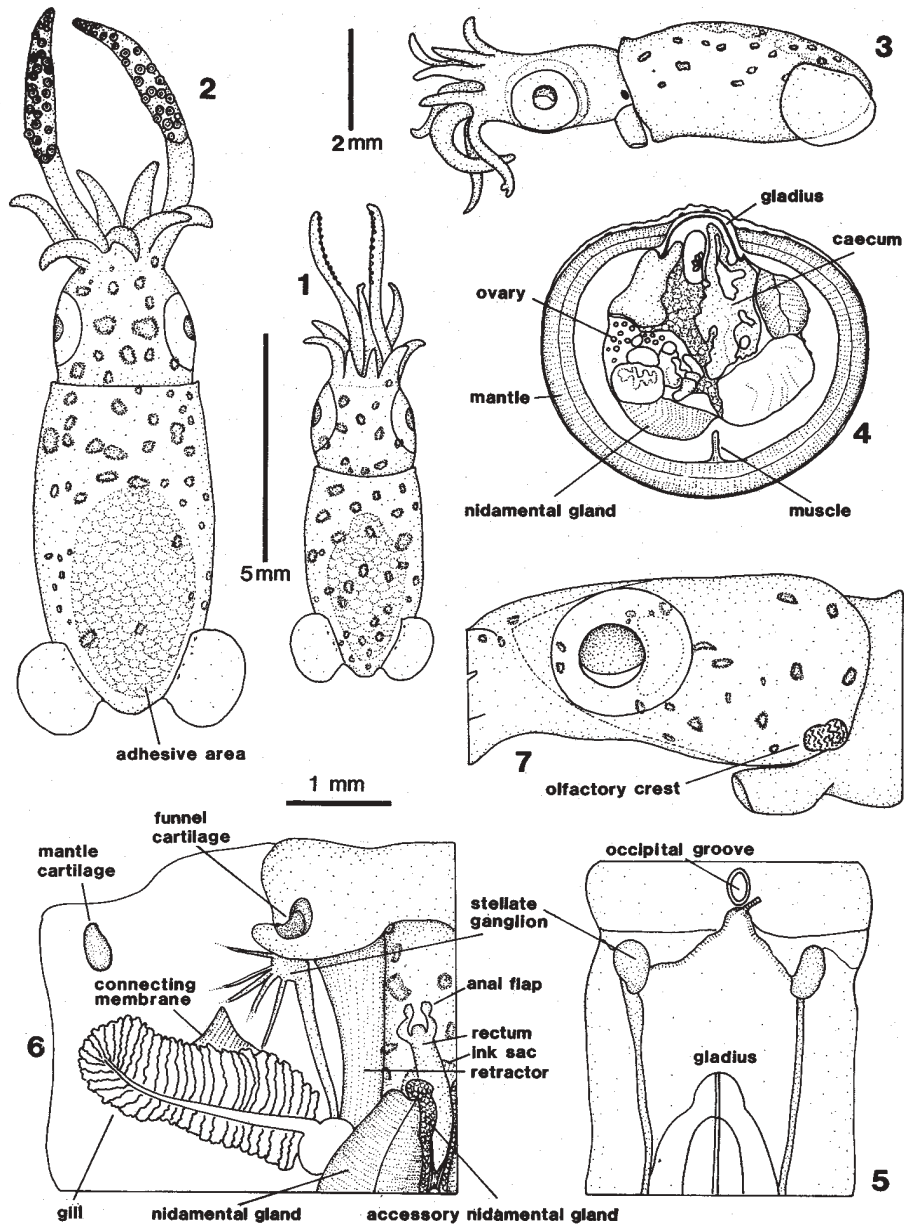
SYSTEMATIC ACCOUNT

Idiosepius biserialis Voss, 1962

Figs. 1-30

Idiosepius biserialis, Voss, 1962, p. 258-259, Figs. 2a-c.; Adam, 1986 p. 152, Fig. 4

MATERIAL EXAMINED: PMBC 7954, 3 males, Ao Phang-Nga, plankton net, coll. V. Janekarn, 26 March 1984. PMBC 7955, 5 females Bang Rong, Phuket Island, Sea grass bed, beam trawl, coll. S. Poovachiranon, 20 March 1991. PMBC 7956, 1 female, Ko Yao Yai, sandy bottom, beam trawl, coll. S. Poovachiranon, 11 January 1989. PMBC 795, 13 females, 1 male, Ko Pratong, Ranong, sea grass



Figs. 1-7. *Idiosepius biserialis*. 1 male, dorsal view. 2 female, dorsal view. 3 male, lateral view. 4 cross section of posterior female body. 5 dorsal part of anterior female body, the mantle removed. 6 dorsal view of dissected anterior body and funnel region, female. 7 head of female, lateral view. Scales: Figs. 1-2: 5 mm; Fig. 3: 2 mm; Figs. 4-7: 1 mm.

bed, beam trawl, coll. S. Poovachiranon, 26 May 1991. PMBC 7958, Bang Rong, Phuket Island, *Enhalus* sea grass bed, 1 m depth, plankton net, coll. S. Poovachiranon, 2 October 1991.

DESCRIPTION

MANTLE: elongate, slightly tapering and rounded at posterior end (Figs. 1-3) Ventrally about 0.3 mm thick; middorsally about 0.1 mm in females (Fig. 4); thinner in the smaller males. The dorsal margin straight. The ventral margin slightly excavated. The posterior 2/3 of the dorsal mantle carries a prominent, rugose area, referred to as the adhesive area (Hylleberg and Nateewathana, 1991). The mantle is free around the neck but united to the funnel complex by complete fusion about 1 mm from the dorsal edge of the mantle (Fig. 5).

On the inner surface of the free part of the mantle is a small, narrow muscular "scar" located middorsally above a corresponding depression on the neck (Fig. 5). The "scar" and the oval depression are readily observed in females but often difficult to see in males of very small size. In *I. pygmaeus*, a similar depression was termed occipital groove by Hylleberg and Nateewathana (1991), and interpreted as a rudimentary nuchal funnel cartilage. Observation of the occipital groove is greatly facilitated by a slight staining with methylene blue in water.

In the posterior half of the mantle cavity, at the level of the gills (Fig. 6), a ventral muscle connects the mantle to the body (Figs. 4, 14, 17). The muscle is attached to the ventral mantle surface for about 2/3 of the mantle length (Fig. 4) We have not observed a ventral septum dividing the mantle cavity into right and left halves.

A pair of stellate ganglia are easily detached from the mantle in preserved specimens (Figs. 5, 6). They are seen as rounded discs together with the mantle connectives on either side of the dorsal mid line after removal of the mantle (Fig. 5).

Purple brown melanophores and yellow chromatophores are present on the body, but

never densely crowded on preserved specimen (Figs. 1, 2). Live animals have not been studied.

FINS: Small, separate fins are attached to the posterior dorsal body at an angle (Fig. 3). Fins are rounded kidney-shaped, distally free, projecting slightly beyond the posterior body. Dorsally, the muscular base of the fins carry only a few, small, black and yellow chromatophores in preserved specimens. The outer fin is hyaline and very thin.

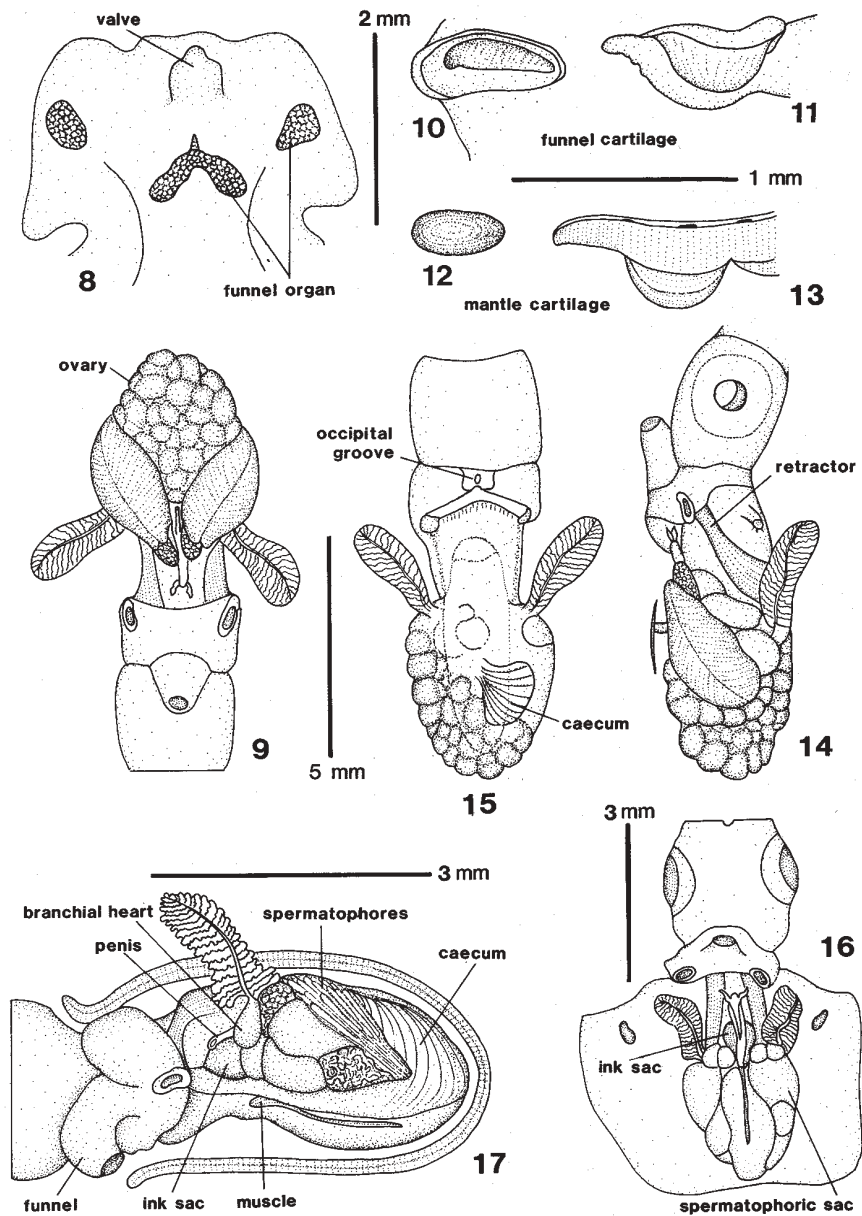
HEAD: The head is small, about 1/3 of the total length, excluding the tentacles. It is compact and the width slightly less than that of the mantle (Figs. 1, 2). The eyes are clearly visible in preserved specimens on account of a smooth, transparent secondary cornea (Fig. 7). The iris is silvery and contractible to an oblong slit. Anterior pores were not observed on the eyes. Posterior to the eyes, at the edge to the mantle, a distinct pair of olfactory crests were observed in larger females. In contrast, the olfactory crests were either very small or even impossible to locate in males (Figs. 3, 7).

FUNNEL: a tapered tube with downwards pointing aperture; the flap-like funnel valve is comparatively larger in the females. The funnel organ is complete: the dorsal member is inverted V-shaped with pointed anterior papilla; two rounded ventrolateral pads (Fig. 8).

MANTLE APERTURE AND LOCKING APPARATUS: Dorsally the neck carries an oblong depression (Fig. 5) interpreted as part of a rudimentary locking apparatus. Nuchal locking cartilage absent.

Two oval, auriculate grooves on each side of the funnel (Figs. 6, 9-11). The corresponding oval tubercles are located on the inner surface of the mantle (Figs. 6, 12-13). A pair of strong postero-lateral adductor muscles connect the funnel from the level of the funnel cartilages to the level of the gills (Figs. 6, 9, 14).

ARMS: The stout arms with blunt tips do not differ much in length in females (Table 1, Fig.



Figs. 8-17. *Idiosepius biserialis*. 8 dissected funnel, ventral view. 9 dorsal view of female body mantle removed. 10 funnel cartilage, bird's-eye view. 11 funnel cartilage, longitudinal section. 12 mantle cartilage, bird's-eye view. 13 mantle cartilage, longitudinal section. 14 lateral view of female body, mantle removed. 15 dorsal view of female body, mantle removed, but not the visceral envelope. 16 ventral view of dissected male. 17 lateral view of dissected male. Scales Figs. 9, 14, 15: 5 mm; Figs. 16-17: 3 mm; Fig. 8: 2 mm; Figs. 10-13: 1 mm.

30). Keels are absent or weakly developed. The web is very low except between the arms III and IV, which partly enclose the two tentacles. The suckers are biserial and of similar size (about 0.25 mm in females). The diameter decreases towards the tip of the arms. Single large suckers are located at the base of each arm, and smaller biserial suckers at the tip of the arms (Fig. 30). There are up to 28 suckers on arms I-IV in females (Table 1).

The arms of the smaller males carry fewer suckers (Table 1, Fig. 18). Arms IV are markedly hectocotylized in males and about one and a half times as long as the arms I-III. Hectocotylized arms carry 3-7 suckers in various combinations at the base of the arms (Table 1). The right arm is slender and pointed. It is bordered by a low membrane on each side (Fig. 19). The left arm is very slender and without lateral membranes. It carries two flaps: one lateral flap near the tip, and one terminal flap (Fig. 20). The suckers on both hectocotylized arms are surrounded by a low protective membrane (Figs. 18-20).

TENTACLES: The two tentacles are sheathed in triangular pockets between arms III and IV. The tentacles can only partly be withdrawn into the pockets. There are up to 45 suckers in females, and 32 suckers in males (Figs. 18, 21). The suckers are generally arranged in two horizontal rows, but (presumably as a result of the preservation), three or four oblique rows can also be found (Fig. 21). An effect of preservation on the number of rows of suckers has previously been observed in males of *Idiosepius pygmaeus* (Hylleberg and Nateewathana, 1991).

Suckers are stalked and largest on the proximal part of the club, about 0.25 mm in diameter in females, decreasing in size towards the distal end (Fig. 21). About 8 cone-shaped, pointed teeth can clearly be seen on the inner edge of the ring at 50 times magnification. The surface of the ring is provided with numerous smaller, pointed teeth.

GLADIUS: A slipper-shaped, very thin membrane without developed rachis is found in the

position of the gladius (Figs. 4, 5, 15). The rudimentary gladius is best observed in cross sections of the body (Fig. 4). In the middorsal region it is close to the connective tissue containing melanophores. It continues under the muscular layer of the mantle, and is attached to the dorsal margin of the viscera (Fig. 4). The rudimentary gladius can not be dissected out. It is even thinner and more brittle than found in *I. pygmaeus* (Hylleberg and Nateewathana, 1991).

BUCCAL MEMBRANE: The membrane is smooth and without suckers (Fig. 16). Spermatozoa were not observed attached to the buccal membrane of females as reported in *I. pygmaeus*. (Hylleberg and Nateewathana, 1991).

BEAK: Only females were dissected with a view to study the beak. The upper mandible is short. The small black, horny hood has crenated edge. The rostral lamella and insertion plate are thin and hyaline (Fig. 22). The lower mandible with small black rostrum (Fig. 23).

RADULA: Typical rachidian radula with 7 rows. The prominent median members carry strong central teeth and 2 weak lateral teeth (Fig. 24). Inner marginal row of small, pointed teeth. Outer marginals are broad and pointed. Lateral rows with slender, hook-like teeth. Marginal plates absent. Only one female was studied.

MALE REPRODUCTIVE SYSTEM: The left hand side of males is tightly packed with the spermatophoric organ, testis, glands and prostate (Figs. 16, 17). The exact nature of glands and their numbers were not studied. All males contained spermatophores in the spermatophoric sac (Fig. 17) which turned into a short penis attached along most of its length to the ink sac (Fig. 17).

Spermatophores measured about 1.1 mm in length and 0.1 mm in width (Fig. 25). The granular sperm mass occupied half of the length of individual spermatophores. The cement body, supporting cylinder, and ejaculatory apparatus constituted the other half. Ejaculatory apparatus coiled, terminated with a long filament (Fig. 26).

Table 1. MEASUREMENTS AND INDICES of 3 males and 7 females: Means, Standard Deviations, and Ranges of selected measurements and Indices (in percent) of *Idiosepius biserialis* Voss, 1962. Indices abbreviated according to Ropers and Voss (1983).

Measure/ Index	n	MALES			n	FEMALES		
		Mean	S.D. (n-1)	Range		Mean	S.D. (n-1)	Range
TL(mm)	3	6.8	0.9	6.0- 7.7	7	14.3	3.7	11.4-22.3
ML(mm)	3	3.6	0.5	3.0- 4.0	7	6.4	1.7	5.1-10.1
MWI	3	62.5	9.0	52.6-70.0	7	67.2	11.5	44.5-77.6
FLI	3	27.9	8.9	20.0-37.5	7	27.9	6.0	19.0-37.2
FWI	3	68.5	4.9	63.1-72.5	7	72.4	13.0	59.4-98.0
HWI	3	52.2	3.9	50.0-56.7	7	47.3	6.0	34.6-53.4
HLI	3	48.0	7.6	42.5-56.7	7	45.7	10.2	29.7-60.8
AL _I	3	23.9	3.3	21.0-27.5	7	30.3	4.7	23.5-35.6
AL _{II}	3	27.6	4.5	23.7-32.5	7	38.0	4.7	32.8-44.8
AL _{III}	3	25.7	3.8	23.3-30.0	7	33.6	2.4	29.0-36.2
AL _{IV}	-	-	-	-	7	38.9	4.2	32.1-45.1
HcAI-L	3	38.0	8.2	28.9-45.0	-	-	-	-
HcAI-R	3	26.3	1.2	36.7-50.0	-	-	-	-
HcLI-L	3	39.0	15.4	25.0-55.5	-	-	-	-
HcLI-R	3	26.3	1.2	25.0-27.3	-	-	-	-
ASC _I L	3	13	2	12-16	7	21	3	18-26
ASC _I R	3	13	3	11-16	7	20	3	14-23
ASC _{II} L	3	17	2	15-19	7	22	3	18-25
ASC _{II} R	3	16	3	14-19	7	21	2	18-24
ASC _{III} L	3	15	3	13-18	7	21	4	15-25
ASC _{III} R	3	15	3	13-18	7	22	4	17-27
ASC _{IV} L	3	5	2	4-7	7	24	4	18-28
ASC _{IV} R	3	4	1	3-5	7	21	3	17-26
CILI	3	40.1	21.0	21.0-62.5	7	55.0	8.4	44.8-69.6
EDI	3	22.2	3.4	18.4-25.0	7	24.1	6.4	14.8-35.3
LnDI	3	9.3	1.2	7.9-10.0	7	9.8	4.0	4.9-18.0

Legend: TL=Total Length, ML=Mantle Length, MWI=Mantle Width Index, FLI=Fin Length Index, FWI=Fin Width Index, HWI=Head Width Index, HLI=Head Length Index, AL_I=First Arm Length Index, AL_{II}=Second Arm Length Index, AL_{III}=Third Arm Length Index, AL_{IV}=Fourth Arm Length Index, HcAI_L=Left Hectocotylized Arm Index, HcAI_R=Right Hectocotylized Arm Index, HcLI_L=Left Hectocotylized Length Index, HcLI_R=Right Hectocotylized Length Index, ASC_IL=First-Left Arm Sucker Count, ASC_IR=First-Right Arm Sucker Count, ASC_{II}L=Second-Left Arm Sucker Count, ASC_{II}R=Second-Right Arm Sucker Count, ASC_{III}L=Third-Left Arm Sucker Count, ASC_{III}R=Third-Right Arm Sucker Count, ASC_{IV}L=Fourth-Left Arm Sucker Count, ASC_{IV}R=Fourth-Right Arm Sucker Count, CILI=Club Length Index, EDI=Eye Diameter Index, LnDI=Lens Diameter Index.

Apart from smaller size the spermatophores do not differ from those of *I. pygmaeus* (Hylleberg and Nateewathana, 1991).

FEMALE REPRODUCTIVE SYSTEM: A large ovary occupies most of the posterior body (Figs. 9, 14-15). We have only been able to observe the left hand oviduct (Fig. 27). The oviduct is packed with eggs, which (when dissected out) were about 0.9 mm long (Fig. 28). The oviducal gland is egg-shaped, joined with the oviduct at one end, and projecting as a short, slender lip at the other end (Fig. 27). Two large nidamental glands dominate the ventral body (Fig. 9). The glands are elongated oval with short vertical lips at anterior ends (Fig. 29). The accessory nidamental glands project anterior to the nidamental glands (Figs. 9, 27).

INK SAC: The pyriform ink sac is a compact organ with a silvery outer layer. It is usually hidden under the nidamental glands in females (Fig. 9) but in one female specimen with reduced glands, the ink sac was exposed. In males, the ink sac is always prominent on the ventral side of the intestine in front of the branchial hearts (Figs. 16, 17).

DIGESTIVE SYSTEM: The anterior part of the digestive system has not been investigated in detail, but it resembles the system in *I. pygmaeus* (Hylleberg and Nateewathana, 1991). The prominent spiral part of the caecum covers the posterior right hand half of the dorsal body of both sexes (Figs. 15, 17).

The intestine continues from the stomach to the ventral surface of the hepato-pancreatic gland, and terminates with the anus provided with 2 lanceolate flaps (Figs. 6, 9, 16).

INNER CARTILAGENOUS SKELETON: It is a rounded capsule with three sections: one dorsal part housing the brain, and two ventrolateral statocysts. It is located at the transition between head and body above the funnel. The statocysts have well developed maculae. Calcified statoliths not present. At low magnification (x50), the structure of the inner cartilagenous

skeleton can not be distinguished from what we observed in *I. pygmaeus* (Hylleberg and Nateewathana, 1991, Figs. 4-5).

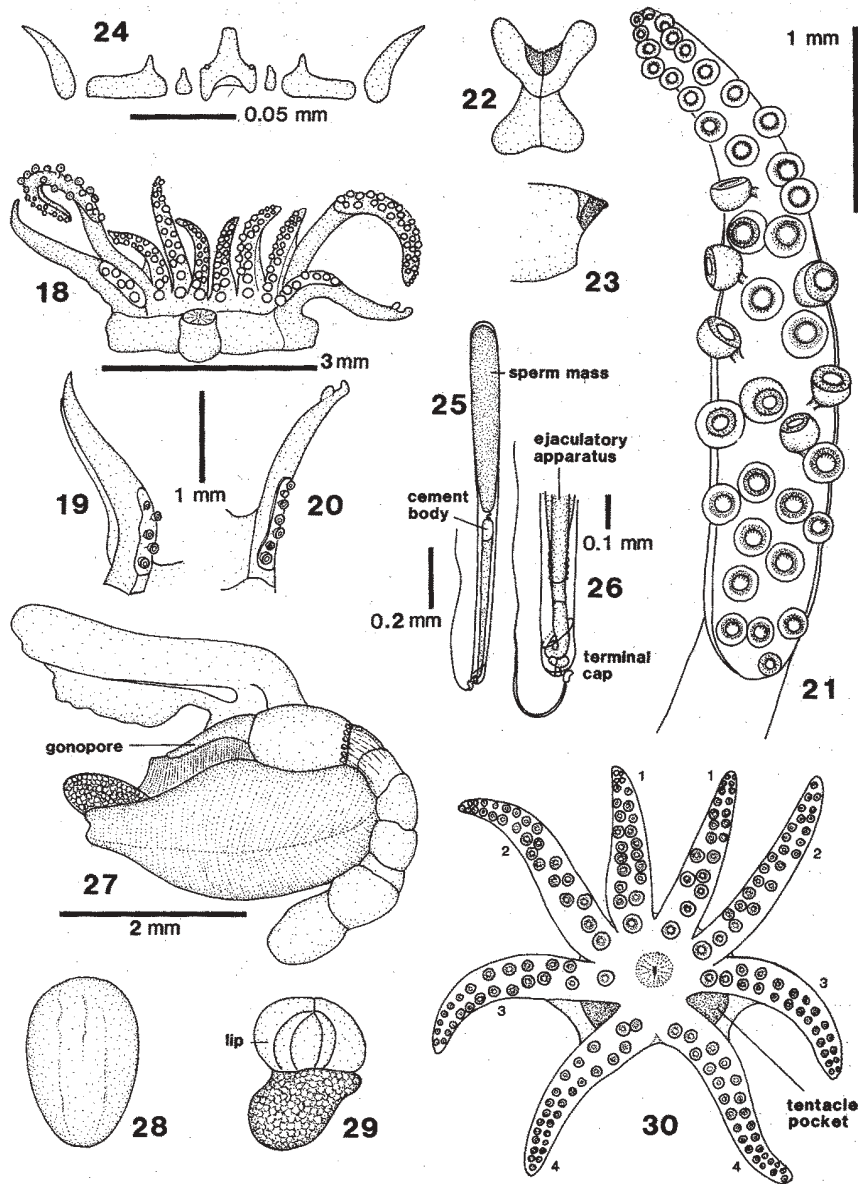
CIRCULATORY SYSTEM: The spacial pericardial coelom contains the heart, branchial hearts, branchial glands and renal sacs. The branchial hearts are muscular and connected to the rounded branchial glands (Figs. 16, 17). Clot of blood in the veins is not a prominent feature such as seen in *I. pygmaeus* (Hylleberg and Nateewathana, 1991).

The gills are attached to the inner surface of the mantle by a mesenterium (Fig. 6). The free side of each demibranch has about 25 lamellae in females.

REMARKS: Based on our studies of morphology and internal anatomy of the species *Idiosepius pygmaeus* and *I. biserialis*, we conclude that they are indeed very similar and closely related. The males of the two species can be distinguished on characters found on the hectocotylized arms. The shape and the number of suckers differ, although the latter character only works with either very high numbers (6-7 suckers) or very low numbers (1-2 suckers). The shape of the right hectocotylized arm constitutes the best character: short, stout and blunt in *I. pygmaeus*, against long, slender and pointed in *I. biserialis*.

In females we found small differences in the oviducal glands. The transition zone between the oviduct and the oviducal gland stained differently with weak methylene blue in water (Fig. 40 in Hylleberg and Nateewathana, 1991, against Fig. 27 in the present paper). Also the size and position of the accessory nidamental gland displayed differences. In *I. pygmaeus*, the small accessory glands are hidden under the lips of the nidamental glands, i.e. not immediately observed after removal of the mantle. In contrast, *I. biserialis* has accessory nidamental glands clearly projecting in front of the nidamental glands (Figs. 9, 27).

A number of other small differences have been pointed out in the above description. However, it is difficult to quantify the differences because measurements will depend upon



Figs. 18-30. *Idiosepius biserialis*. 18 dissected buccal area with arms and tentacles, male. 19 lateral view of the right hectocotylyzed arm of male. 20 lateral view of the left hectocotylyzed arm of male. 21 right tentacle, female. 22 upper mandible, female. 23 anterior part of lower mandible, female. 24 teeth of radula, female. 25 spermatophore. 26 enlarged terminal cap (cf. Fig. 25). 27 oviduct and glands from left hand side. 28 egg, dissected from ovary. 29 terminal view of nidamental gland and accessory nidamental gland. 30 buccal area and arms of female. Scales: Fig. 18: 3 mm; Figs. 27, 30: 2 mm; Figs. 21-23, 28-29: 1 mm; Figs. 19-20: 1 mm; Fig. 25: 0.2 mm; Fig. 26: 0.1 mm; Fig. 24: 0.05 mm.

the way the animals have been collected (damaged) and the way they are preserved (with and without prior relaxation). In accordance with Adam (1986) we found that the radula and beaks of the two species do not provide characters of significance for the identification of the species.

We found that both sexes of the two species can be separated by observing the eyes. *I. pygmaeus* has wrinkled, opaque secondary cornea, against smooth and transparent secondary cornea in *I. biserialis*.

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