

THE OPISTHOBRANCH MOLLUSCS COLLECTED DURING THE THAI-DANISH BIOSHELF PROJECT IN THE ANDAMAN SEA, THAILAND

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ABSTRACT: Six species of opisthobranch molluscs collected during the Thai-Danish BIOSHELF project are described. The material consisted of 25 specimens from eighteen samples. One specimen was too damaged to be identified. Opisthobranchs were only found in 4% of the samples. Four species were found at depths greater than 300 m. All of the species have been described previously from shallower water, mostly less than 100 m. All specimens were longer than 10 mm, and with the exception of four specimens, all were longer than 30 mm. A comparison with nudibranchs collected during the BIOFAR1 project from the NE Atlantic around the Faroe Islands clearly indicates the importance of using appropriate gear for collecting soft-bodied invertebrates from deep water.

INTRODUCTION

The Thai-Danish BIOSHELF project collected benthic samples in the Andaman Sea during the period 1996–2000, using several types of gear (Aungtonya *et al.*, 2000). Eighteen out of a total of 442 samples contained opisthobranch molluscs. Most of them were preserved in rather poor condition and were difficult to identify; one was too damaged to be identified. Only the 24 specimens that could be identified are included in the present study.

More than 70 species of shallow water opisthobranchs have been described previously from the Andaman Sea (Jensen, 1998) and from the Gulf of Thailand (Bergh, 1902; Swennen *et al.*, 2001). In addition a number of species have been photographed and listed on the Sea Slug Forum (<http://www.seaslugforum.net/>), and the total number of species occurring in Thailand may well be of the same magnitude as in other Indo-West Pacific localities, *i.e.* around 300 species (Rudman and Darvell, 1990; Gosliner, 1992).

SYSTEMATICS

Philine cf. orientalis A. Adams, 1854

Synonyms: *Philine quadripartita* Ascanius var. *siamensis* Bergh, 1902.

Four specimens of this species were included in the material. One specimen was collected at almost 700 m (Table 1), whereas the others were collected in shallow water (20–24 m). The specimen from deep water (Fig. 1) was also the largest specimen (45 mm long, 25 mm wide and 10 mm high). A specimen from station E 20m collected on 22 April 1996 was dissected. The specimen was 28 mm long, 18 mm wide and 3–4 mm high. The penis and the pharynx were partly everted. The shell and gizzard plates (Fig. 2) were very fragile and partly broke during dissection. The radula had the formula 17 x 1.0.1. The teeth had a denticulate inner margin with some composite denticles characteristic of *P. orientalis* (Rudman, 1998). The penial complex had a long, convoluted prostate, a thin incurrent sperm duct, a long vas deferens and a two-pronged penis (Fig. 3).

The dissected specimen was compared with a specimen of *Philine cf. orientalis* collected during the TMMP workshop in Nha Trang, Vietnam in August 2001. This specimen was 30 mm long, 19 mm wide and 6 mm high. Shell and gizzard plates were almost identical to the BIOSHELF specimen. The radula had the formula 20 x 1.0.1, and the shape of the teeth was also identical. The Vietnamese specimen had the gizzard full of foraminiferans whereas the Andaman Sea

specimen had an empty gizzard, but had fine calcareous powder in the intestine. It was also compared to a specimen of *P. aperta* from northern Kattegat, Denmark. This specimen was 35 mm long, 24 mm wide and 11 mm high. Shell and gizzard plates were very similar to the SE Asian specimens, but the radular teeth did not have composite denticles; the radular formula was 28 x 1.0.1. The intestine and gizzard were empty.

Remarks: Bergh (1902) described *Philine aperta* from the Gulf of Thailand (as *P. quadripartita* var. *siamensis*). Otherwise *P. aperta* is an Atlantic Ocean species occurring from northern Europe to South Africa (Thompson, 1976). *Philine orientalis* has been described from the South China Sea (Morton and Chiu, 1990), where it feeds on bivalves. Shells and gizzard plates are almost identical in the two species and also resemble those of the other large species of *Philine*, *P. angasi* and *P. auriformis* (Rudman, 1972). However, the radular teeth and also the penial complex differ. The present study has shown that the species found in Thailand is *P. orientalis* rather than *P. aperta*. The specimen from station K10 is no doubt a depth record for the species and possibly even for the genus *Philine*.

***Pleurobranchaea brockii* Bergh, 1897**

This was the most common species in the BIOSHELF material. A total of 10 specimens were collected of which four were from depths greater than 480 m (Tables 1–2). The shallow water specimens had retained at least some of the reticulate pigment on the dorsal surface (Fig. 4). The deep-water specimens were generally very badly mangled and could only be identified from radular and jaw morphology, and to some extent on penial morphology (Fig. 5). The radula of the specimen from station K10 had 72–76 teeth in each half row and the teeth were distinctly bicuspid. Remarks: The anatomy of this species has been described in detail elsewhere (Marcus and Gosliner, 1984; Tsubokawa *et al.*, 1992; Jensen, 1994). This species has a very wide geographical distribution, covering almost the entire Indo-West Pacific Region, *i.e.* from South Africa to Japan (Marcus and Gosliner, 1984). In 1925 Thiele

described *Pleurobranchella nicobarica* from relatively deep water (approx. 300 m) in the Indian Ocean near the Nicobar Islands (Thiele, 1925). This species has unicuspid radular teeth and a widely overhanging mantle. The deep water specimens of the present material also had rather wide and overhanging mantles, but the radular teeth were distinctly bicuspid. Also, these specimens had a caudal spur as found in some species of *Pleurobranchaea*. The dissected specimens of the present material did not have any recognizable material in the stomach or intestine. *P. brockii* is a predator of other opisthobranchs and has been shown to be cannibalistic in some cases (Jensen, 1997).

***Euselenops luniceps* (Cuvier, 1817)**

Three specimens of this species were collected from fairly shallow water (Table 1). The specimens varied between 30 and 40 mm in preserved length. These specimens had retained most of their natural pigment (Fig. 6).

Remarks: This species has been thoroughly described by several authors (Bergh, 1897; Willan, 1987; Jensen, 1994) and is easily recognized. It is a fairly common species distributed from South Africa and possibly the Red Sea to Hawaii, and from Japan to Queensland, Australia.

***Kalinga ornata* Alder and Hancock, 1864**

Five specimens are included in the present material. Four of these had been collected in rather shallow water (28–34 m), whereas the fifth specimen had been collected at almost 500 m depth (Table 1). The specimens ranged from about 50 to about 75 mm in length preserved. The gut contents of the deep-water specimen consisted of skeletal parts of brittle stars. Other specimens had lots of sponge spicules or polychaete setae on the surface, but this was probably due to the rough collection method. The preserved specimen from station PB4 is shown in Fig. 7. Two specimens had the genitalia everted, at least in part (Fig. 8). Remarks: The species seems to be fairly common in trawl samples (Rudman and Darvell, 1990; Jensen, 2000). This is probably because of its considerable size and hardy structure. Very little is

known about the biology of this species. For description of anatomy see Alder and Hancock (1864) and Jensen (2000).

***Platydoris annulata* Dorgan, Valdès and Gosliner, 2002**

Only one specimen was collected. It was approximately 40 mm long (somewhat curled up), 25 mm wide and 10 mm high; the foot sole was about 7 mm wide with the edges rolled up. The preserved specimen had a pale beige ground colour and several dark purple-brown rings on the dorsal surface. The dorsal surface was densely covered with caryophyllidia (Fig. 9). A small, probably ectoparasitic, isopod was found on the dorsal surface, near the retracted gills.

Remarks: This species was recently described from a single specimen collected from the Philippines. The present specimen extends the distribution to the Andaman Sea and depth from 166–172 m to 303–313 m. The holotype was 46 mm preserved; the present specimen is approximately 40 mm long preserved. The dorsal colour and pattern of rings exactly matches the original description. Dorgan *et al.* (2002) described the ventral colour as uniformly cream. In the present specimen there is a little pigment at the base of genital papillae and

also a few indistinct spots on the ventral side of the mantle, close to the foot above the oral tentacles and along the anterior foot margin.

***Ceratosoma sinuata* (van Hasselt, 1824)**

For synonyms and description of anatomy see Valdés and Gosliner (1999). Only one specimen of this species was collected from a depth of 40 m. The specimen was about 50 mm long preserved, and all coloration had disappeared (Fig. 10). The four paired lateral lobes are somewhat irregular, but still recognizable by the transverse ridges extending from the middorsal ridge to the tip of each lobe. Valdés and Gosliner (1999) mention a large tubercle middorsally behind the gill. In the present specimen this tubercle is located in front of the withdrawn gills, and looking at the figures in Valdés and Gosliner (1999), it also appears that this is the position in their specimens. Defensive glands are distinct on the posterior lobe, behind the gills.

Remarks: For many years this species was known as *Miamira sinuata* until phylogenetic analysis showed that it could be included in the genus *Ceratosoma* (Valdés and Gosliner 1999). In life it has a very distinct though variable colour pattern.

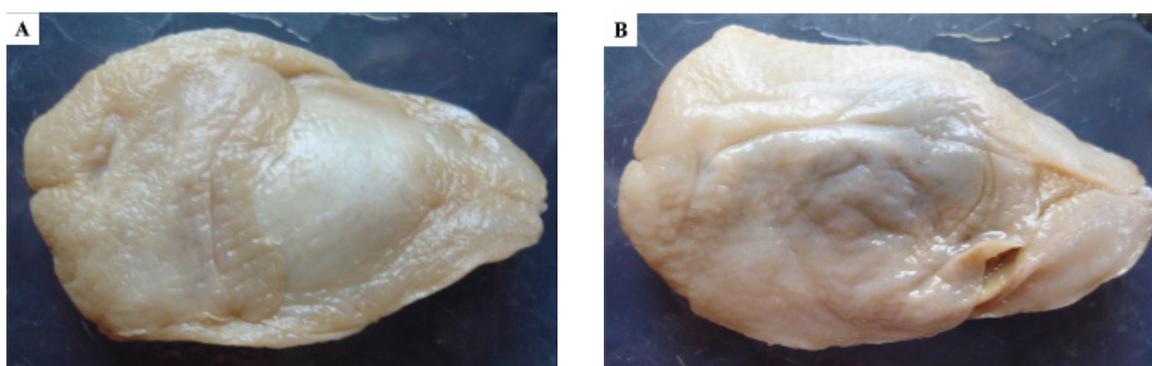


Figure 1. *Philine cf. orientalis*. A. Preserved specimen from station K10, dorsal view. B. Ventral view of the same specimen.

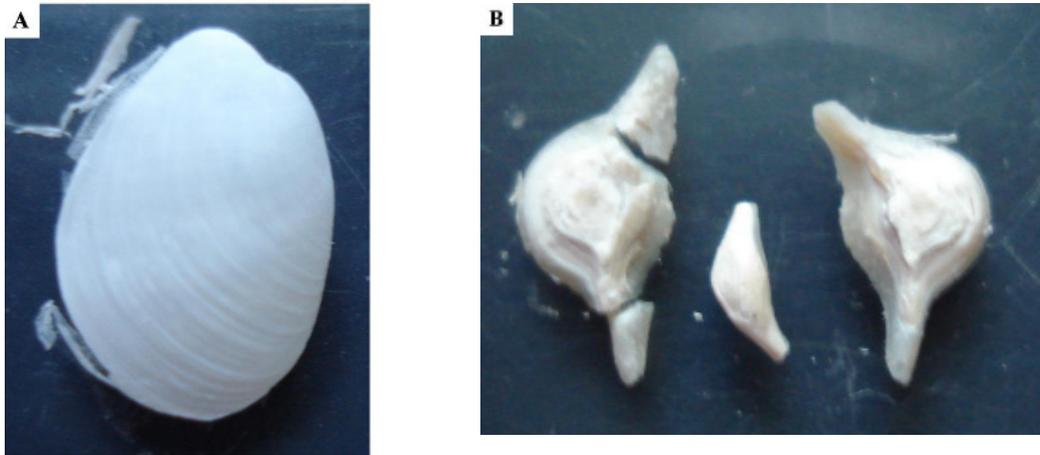


Figure 2. *Philine cf. orientalis*. A. Shell of specimen from station E20 m. B. Gizzard plates of the same specimen.

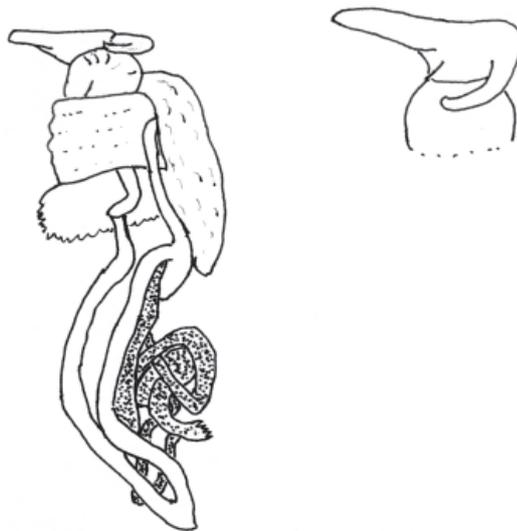


Figure 3. *Philine cf. orientalis*. Penial complex.

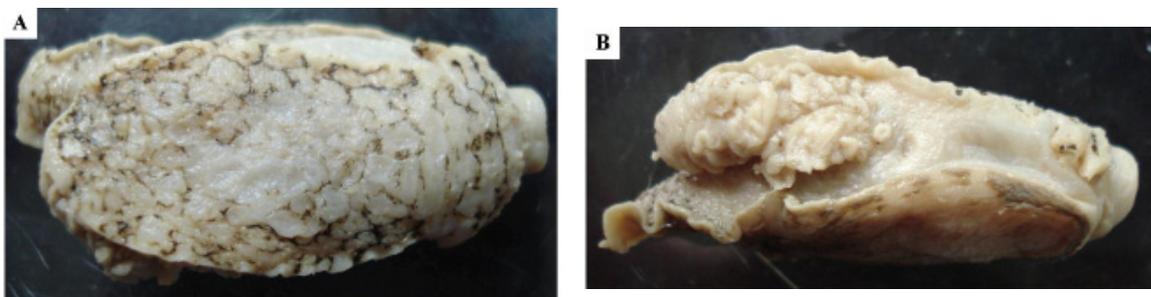


Figure 4. *Pleurobranchaea brockii*. A. Dorsal view of preserved specimen from station G2. B. Lateral view of the same specimen.

THE OPISTHOBRANCH MOLLUSCS OF THE BIOSHELF PROJECT

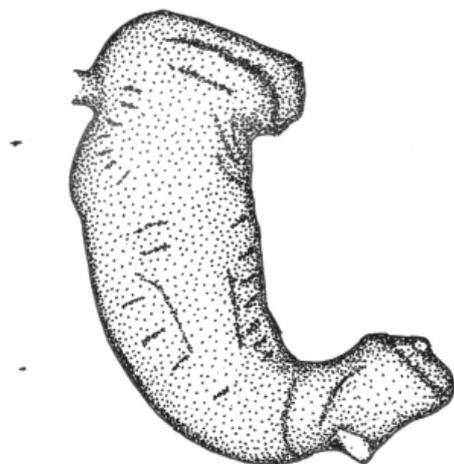


Figure 5. *Pleurobranchaea brockii*. Partly everted penis of specimen from station K10.

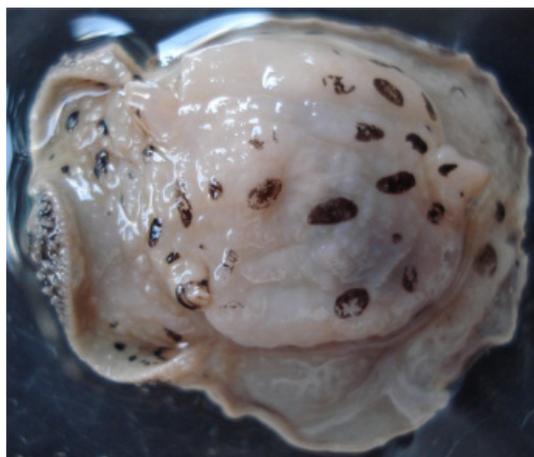


Figure 6. *Euselenops luniceps*. Dorsal view of preserved specimen from station E20 m.

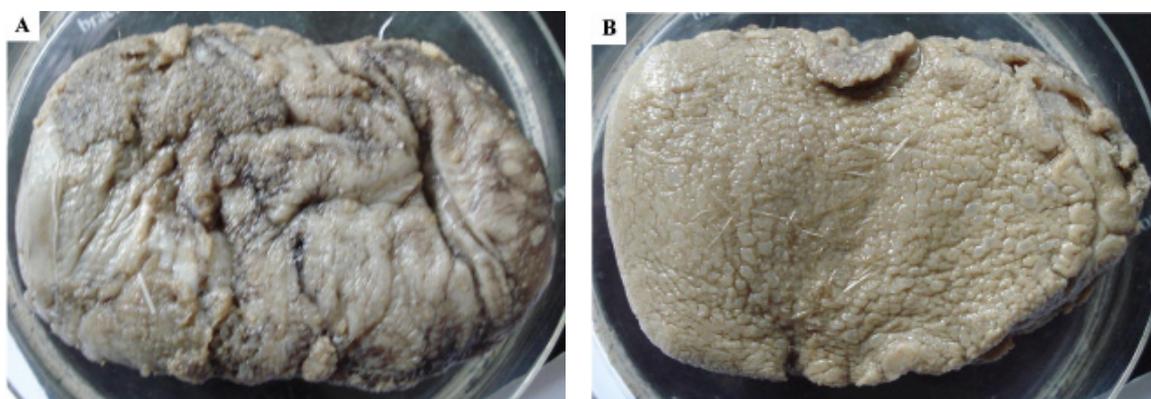


Figure 7. *Kalinga ornata*. A. Dorsal view of preserved specimen from station PB4. B. Ventral view of the same specimen.

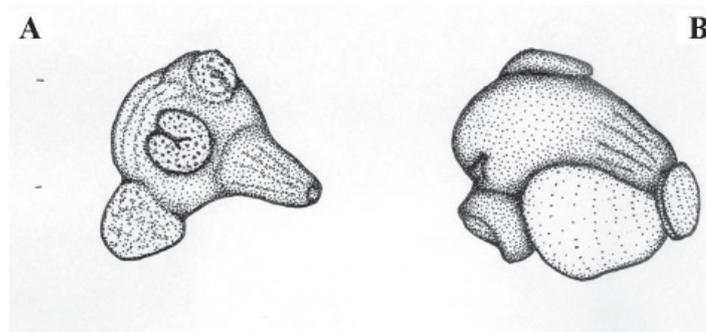


Figure 8. *Kalinga ornata*. A. Partly everted genitalia of specimen from station PB7. B. Everted genitalia of specimen from station PB3.

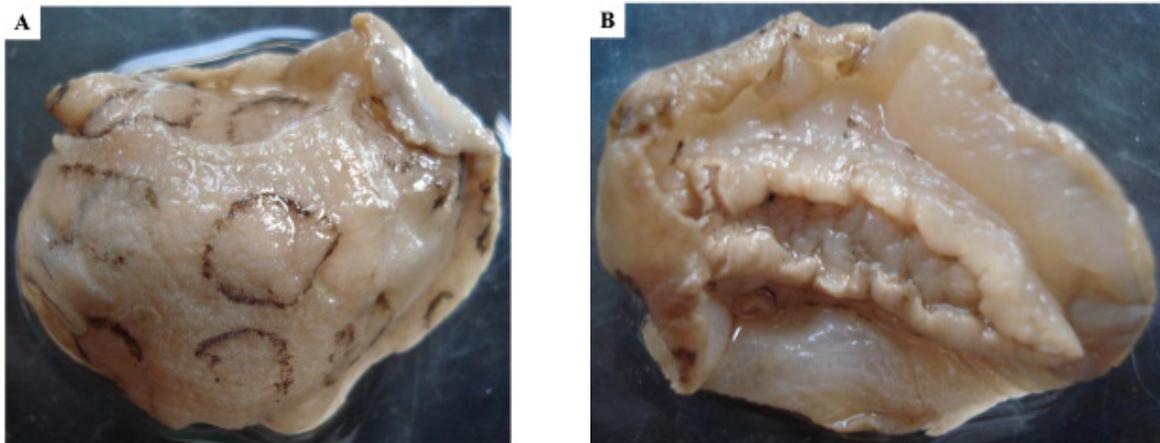


Figure 9. *Platydoris annulata*. A. Dorsal view of preserved specimen. B. Ventral view of the same specimen.

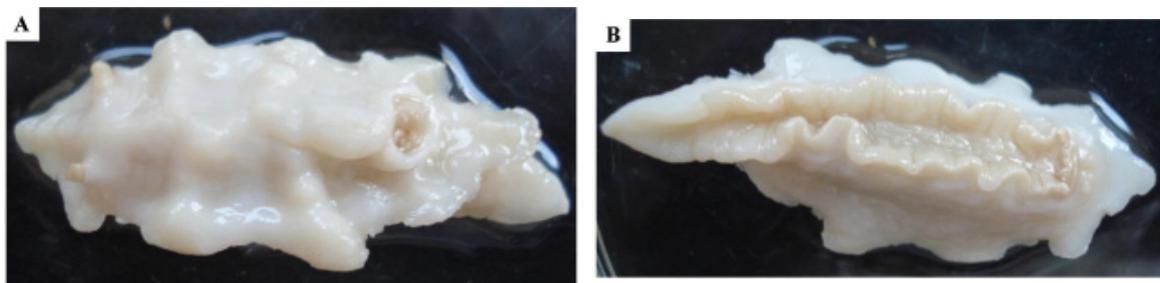


Figure 10. *Ceratosoma sinuata*. A. Dorsal view of preserved specimen. B. Ventral view of the same specimen.

THE OPISTHOBRANCH MOLLUSCS OF THE BIOSHELF PROJECT

Table 1. Collecting data for opisthobranchs of the BIOSHELF project. Gear: TD – triangular dredge; OS – Ockelmann sledge; AT – Agassiz trawl; T – otter trawl. An * indicates that sediment type was identified from a different sample (and usually different gear) at the same station.

Species	Station	Sediment	Lat & Long	Date	Depth (m)	Gear
<i>Philine cf. orientalis</i>	E20m	muddy sand*	8°29' N; 98°12' E	22 Apr 1996	20	TD
<i>Philine cf. orientalis</i> (2 specimens)	PB3	sand w. shell fragments	7°48' N; 98°31' E	27 Feb 1998	24	OS
<i>Philine cf. orientalis</i>	K10	mud*	7°01' N; 97°20' E	17 Nov 1999	690–684	AT
<i>Pleurobranchaea brockii</i>	F3	NA	8°15' N; 97°58' E	16 Feb 1998	78	TD
<i>Pleurobranchaea brockii</i>	A1	sand w. shell fragments*	9°30' N; 97°56' E	18 Feb 1998	49	TD
<i>Pleurobranchaea brockii</i>	G2	muddy sand*	7°59' N; 98°09' E	20 Feb 1998	68	TD
<i>Pleurobranchaea brockii</i>	H2	soft mud*	7°46' N; 98°14' E	20 Feb 1998	57	TD
<i>Pleurobranchaea brockii</i>	PB6	sand w. shell fragments*	7°44' N; 98°33' E	21 Feb 1998	34	TD
<i>Pleurobranchaea brockii</i>	PB6	sand w. shell fragments*	7°45' N; 98°36' E	27 Feb 1998	24	T
<i>Pleurobranchaea brockii</i> (2 specimens)	E8	sand*	8°32' N; 96°04' E	6 Feb 1999	488–478	T
<i>Pleurobranchaea brockii</i>	B10	sand	9°11' N; 96°12' E	11 Feb 1999	689–504	T
<i>Pleurobranchaea brockii</i>	K10	mud*	7°01' N; 97°20' E	17 Nov 1999	690–684	AT
<i>Euselenops luniceps</i>	E20m	muddy sand*	8°29' N; 98°12' E	22 Apr 1996	20	TD
<i>Euselenops luniceps</i>	PB3	sand w. shell fragments*	7°52' N; 98°31' E	23 Apr 1997	22	TD
<i>Euselenops luniceps</i>	PB6	sand w. shell fragments*	7°44' N; 98°33' E	21 Feb 1998	34	TD
<i>Kalinga ornata</i>	PB3	sand w. shell fragments*	7°51' N; 98°32' E	21 Feb 1998	33	TD
<i>Kalinga ornata</i>	PB4	sand w. shell fragments*	7°52' N; 98°40' E	21 Feb 1998	28	TD
<i>Kalinga ornata</i>	PB6	sand w. shell fragments*	7°44' N; 98°33' E	21 Feb 1998	34	TD
<i>Kalinga ornata</i>	PB7	sand w. shell fragments*	7°44' N; 98°40' E	21 Feb 1998	32	T
<i>Kalinga ornata</i>	G8	muddy sand*	8°00' N; 97°11' E	9 Feb 2000	495–488	AT
<i>Platydoris annulata</i>	L6	sand w. shell fragments*	6°45' N; 98°06' E	23 Feb 2000	303–313	AT
<i>Ceratosoma sinuata</i>	C1	muddy sand*	9°02' N; 98°03' E	20 Apr 1996	40	T

Table 2. Size measurements of *Pleurobranchaea brockii* from the BIOSHELF project. The 2 specimens from St. E8 were too badly mangled to be measured.

Station/Date	Length (mm)	Width (mm)	Height (mm)
PB6 (21 Feb 1998)	40	20	20
PB6 (27 Feb 1998)	35	25	11
A1 (18 Feb 1998)	40	30	10
G2 (20 Feb 1998)	40	17	12
H2 (20 Feb 1998)	45	25	13
F3 (16 Feb 1998)	35	15	12
B10 (11 Feb 1999)	25	16	8
K10 (17 Nov 1999)	40	30	10

DISCUSSION

The present opisthobranchs material is very small, but in one way it is also unique. It contains a number of species that have been collected from deep water. Only in recent years have thorough surveys of deep-water localities yielded a large number of opisthobranchs (Valdés, 2001a,b). This author found almost all new, undescribed species whereas the present material consists of species that have been described from shallower water previously.

Most samples contained only one specimen of one species, three samples contained 2 specimens of the same or different species, and two samples contained 3 specimens, one of which was the unidentified one. This does not necessarily mean that opisthobranchs are rare; it just indicates that the sampling gears were inadequate. By-catch from shrimp-trawling in several Asian countries (India, Vietnam, Hong Kong and Cambodia) often contains many specimens of some opisthobranch species, including several of the species found in the present material (Taylor and Jensen, 1991; Leung and Morton, 1997; Jensen pers. obs.). The most common species in these shrimp-trawl samples appear to be *Armina* spp., which were not present in the BIOSHELF material.

The poor condition of most of the specimens shows how important it is to use sampling gear that is suitable for soft-bodied invertebrates. Only the large and tough species remain in a recognizable

shape after being hauled in a full trawl-net from 400–700 m depth. Notaspideans and dorid nudibranchs are among the hardest opisthobranchs and these groups also dominate the present material even from shallow water stations. Only 4% of the BIOSHELF samples contained opisthobranchs, and no specimen was less than 10 mm long. In the BIOFAR1 project from the Faroe Islands, which also contained many deep water stations, nudibranchs were found in 7% of the samples (Jensen, 2005), and many of the specimens were only a few mm long. In the BIOFAR1 project the most successful sampling gear was the modified Percy-Rothlisberg epibenthic sledge (25% of the samples contained nudibranchs), whereas this gear was only used for 13 samples, none of which contained nudibranchs, in the BIOSHELF project. In the BIOFAR1 project only 3.3% of the samples collected by triangular dredge contained nudibranchs, whereas 7.9% of the triangular dredge samples of the BIOSHELF project contained opisthobranchs. Unfortunately Valdés (2001a,b) did not mention the type of gear used for sampling in the New Caledonia deep water expeditions.

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