修士学位論文

相模湾におけるクラゲの分類及び季節的消長に関する研究

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Taxonomic study and seasonal occurrence of jellyfish in Sagami Bay

Contents

1. Introduction

Cnidarians are the polycellular animals which body plan is simplest next to Poriferans. The most unique character of cnidarians is the possession of tentacles with nematocysts. Cnidarians generally have two main stages in their life history, polypoid and medusoid, with some exception which have only one of these stages. Although the polypoid stage which is asexual and benthic is followed by the sexual, planktonic medusoid one in many cases, the life cycle of cnidarians highly varies. In siphonophores, for example, asexual planktonic polygastoric phase corresponds to the polypoid stages. In some cases, polyps form medusa-shaped gonophores which are never liberated, in other cases, medusa perform asexual reproduction.

Planktonic cnidarians are widely distributed from coastal to oceanic zones, and from the surface to deep waters, and reported to play an important role in the marine ecosystem (e.g. Huntley and Hobson, 1978; Möller, 1984). Biggs (1977) reported that they support primary productions in the oligotrophic oceanic surface zone as a main source of ammonia. With the recent development of sampling methods such as open-closed plankton nets or deep-sea research submersibles, the diversity and the abundance of jellyfish in the deep waters have been disclosed (e.g. Angel *et al.*, 1982; Larson *et al.*, 1991).

In Japanese waters, there are many taxonomic studies on jellyfish (e.g. Maas, 1909; Uchida, 1927; 1928; 1947; Kubota, 1978; 1981), and some studies on their seasonal occurrences in neritic waters (e.g. Yasuda, 1969; Sugiura, 1980; Toyokawa and Terazaki, 1994; Horita, 1996). On the other hand, the knowledge on the oceanic species has been accumulated (Bigelow, 1913; Kramp, 1965; 1968; Alvariño, 1971; Ikeda species has been accumulated (Bigelow, 1913; Kramp, 1965; 1968; Alvariño, 1971; Ikeda and Imamura, 1996). Furthermore, studies about siphonophores were conducted only by Kawamura (1910 a-b, 1911 a-c, 1915 a-e, 1922, 1943, 1953) and Alvariño (1971). As

for the deep water species, there is an only observation using the submersible, F.N.R.S. III (Pérès, 1959), and biological study using the submersible, SHINKAI 2000, just started in 1993 (Toyokawa, 1996).

Given above, needs of taxonomical and ecological studies about oceanic species, siphonophores, and deep water species increase. At first, we have to develop a partial checklist of the species occurring in Japanese waters. The main purpose of this study is to identify the fauna of planktonic cnidarians more accurately in Sagami Bay, and to discuss their seasonal occurrence in the surface waters of Sagami Bay.

Sagami Bay is located on the southeastern coast of the Honsyu, the biggest island of Japan, and graphically defined in a broad sense as the surrounded area by the Izu Peninsula, Izu Oshima, Sunosaki where is top of the Boso Peninsula, and the Miura Peninsula. The path of the Kuroshio Current which flows from south of Japan, has great influence on hydrography of this bay because it has widely open to the offshore. Rapid fluctuation of hydrographic conditions is prominent in this bay, as different water masses frequently appear in succession within a few days. When the cold-water mass is present off Shizuoka (Enshyunada) and the Kuroshio Current meanders around Izu Ridge, the mass intrusion of pelagic water into Sagami Bay is detected (Otsuka, 1972). As the cold Oyashio Current meets the Kuroshio Current off northern Honsyu Island, the former submerges, forming the so called Oyashio undercurrent. The undercurrent sometimes facilitate to introduce by the cold water species into Sagami Bay.

Planktonic studies in Sagami Bay have been well conducted. Ogawa (1982), who investigated structure of large diatom communities for two years, reported that the diatom-blooms occurred both in spring and autumn, and that the species the diatom-blooms occurred both in spring and autumn, and that the species compositions varied monthly and yearly because of the fluctuation of hydrographic

conditions. The yearly variation of the zooplankton wet weight corresponds to the hydrographic conditions as follows: in years with higher mean water temperature caused by a large-volume inflow of offshore water into the Bay, the total wet weight decreases. Because of the fluctuating hydrographic conditions of Sagami Bay influenced by oceanic conditions, the seasonal change of composition of planktonic species is different year to year, as well as the standing crop. Only a few studies on seasonal occurrences of zooplankton in Sagami Bay have been conducted: copepods (Kidachi, 1968), chaetognaths (Nagasawa and Marumo, 1977), euphausiids (Hirota 1982), salps and doliolids (Nishikawa, 1995). As for jellyfish, although some faunal studies have been conducted with 25 species recorded from Shimoda (Uchida, 1947), 44 species from Enoshima (Simura *et al.*, 1992), and 39 siphonophores from Misaki (Kawamura, 1953), there have been no ecological studies.

2. Materials and methods

A set of samples were collected every month in routinely from April 1996 to march 1997, in Sagami Bay from aboard the R/V "Seiyo Maru" or "Sinyo Maru". Five stations were situated mid Sagami Bay (Figure 1). The sampling was done at only one station in June, at two stations in July and October, at three stations in November, and at four stations in other months. Vertical hauls were made from 150 m to the surface with a NORPAC net (45-cm diameter, 0.33-mm mesh aperture) at a haul speed of 1 m/s. The volume of water filtered through the net was estimated using a flow-meter mounted on the mouth of the net.
the mouth of the net.

Additional samples were occasionally collected using an ORI net (1.6-m diameter,

0.33-mm or 1-mm mesh aperture; Omori, 1965a, b) from aboard the R/V "Seiyo Maru" at two stations 3 and 5. The net was towed obliquely at ship speed of 2 kt (ca. 1 m/s), with the reeling speed of 1 m/s. The maximum wire length was 2000 m. The volume of water filtered through the net was estimated using a flow-meter mounted on the mouth of the net. The maximum depth that the net reached was recorded by a RMD (® Digital Memory Depth Meter; Rigosha) mounted on the net frame.

The sampling records are summarized in Table 1. All samples obtained were fixed and preserved in buffered 5 % formalin-seawater immediately after sampling. For each sampling occasion except August, profiles of temperature and salinity were observed with a CTD system.

The materials were observed and measured under a dissecting microscope. No account was taken of the probable shrinkage during preservation of the materials. The seasonal occurrence of specimens taken with NORPAC net was analyzed. In Diphyidae, Sphaeronectidae, and Abylidae species of siphonophore, number of the individuals was counted by their anterior nectophores, and eudoxids were not counted because not all species of them were identified. Because physonectae and hippopodiidae species of siphonophore have many nectophores of identical shape in each individual, and only loose nectophores were identified in net samples, number of the individuals of these species could not counted, only presence or absence of them were examined. Densities of species were estimated by dividing the total numbers counted with the total water volume filtered for each month. Seven species obtained with the ORI net were described.

3. Result

3. Result

3-1. Environmental conditions

Vertical distributions of water temperature and salinity at Sta. 4 during the study period are shown in Figure 2. The temperature between 0 and 150 m ranged from 10.5 ℃ (April, Sta. 2, 150 m) to 25.1 ℃ (September, Sta. 3, 0 m), and salinity from 33.16 PSU (July, Sta. 3, 0 m) to 34.71 PSU (February, Sta. 4, 0 m). Structure of water column showed a seasonal variation in which two distinctive patterns were recognized, namely, stratificational period, from May to November, and convectional period, from December to April. The Kuroshio Current flowed straightly in most of the year, but meandered around Izu Ridge in May, July, November, and December.

3-2. Species composition

Both medusae and siphonophores were present in all 40 hauls of NORPAC net. In total 43 species of jellyfish, 14 medusae and 29 siphonophores, were identified (Table 2).

The identified medusae consisted of four anthomedusae, three leptomedusae, five trachymedusae, and two narcomedusae. Additionally, *Obelia* spp., *Clytia* spp., and *Nausithoë* sp. were collected. *Clytia gardineri* and *Persa incolorata* are the first records of the species from Japanese waters. *Obelia* spp. was numerically the most abundant medusa which occupied 21 % of total number of individuals of planktonic cnidarians, and *Solmundella bitentaculata*, *Rathkea octopunctata*, and *Sugiura chengshanense* followed. Eleven of the 14 identified species possessed ability of sexual or asexual production in their planktonic stages. All species of trachymedusae and narcomedusae are lack of benthic polypoid stages. *Podocoryne minima*, *Rathkea octopunctata*, *Sugiura chengshanense*, and *Eucheilota paradoxica*, possess polypoid stages and ability to reproduce medusae asexually in their planktonic medusan stages, stages and ability to reproduce medusae asexually in their planktonic medusan stages, and other three species, *Euphysa aurata*, *Euphysora bigelowi*, and *Clytia gardineri*, are

not known to perform asexual reproduction. Only one specimen were collected for *Euphysa aurata* and *Euphysora bigelowi*. Although *Clytia gardineri* was not reported to perform the asexual reproduction, this species was collected 168 individuals. Despite no report of the asexual reproduction of *Obelia* spp., a large number of specimens of this species were collected (4285 individuals).

The identified siphonophores consisted of three physonect species and 26 calyconect species. *Cordagalma cordiformis*, *Lensia cossack*, *L. hardy*, *L. leloupi*, *L. meteori*, *L. multicristata*, *L. subtiloides*, *Sphaeronectes gamulini*, *S. gracilis*, and *Enneagonum searsae* are the first records of the species from Japanese waters. *Muggiaea atlantica* was the most abundant siphonophore which occupied 47 % of the total number of individuals of planktonic cnidarians. *Lensia subtiloides*, *Abylopsis tetragona*, and *S. gracilis* followed. All siphonophores except *M. atlantica* were numerically less abundant, and occupied only 3 % of the total individuals of whole collection by NORPAC net. Only eudoxids were collected for *Enneagonum hyalinum* and *E. searsae*.

8 Medusae and 3 siphonophores were identified in samples taken with the ORI net (Table 3). Among the species, *Botrynema brucei* (trachymedusa) and *Nectopyramis diomedeae* (calycophore) are the first records of both species from Japanese waters. *Ptychogastria* sp. (trachymedusa) and *Aegina* sp. (narcomedusa) probably belong to new species.

3-3. Description

Genus *Clytia* Lamouroux, 1812

Genus *Clytia* Lamouroux, 1812

Diagnosis.-Campanulariidae with shallow umbrella, normal velum, numerous marginal tentacles, and statocyst.

Remarks-Type species: *Clytia hemishaericum* (Linné, 1767)

At first genus *Clytia* was named to polyp stage, while genus *Phialidium* was named to medusa stage. Many species of the polyp *Clytia* and medusa *Phialidium* have been reported in the world. However a few attempts to connect these polyps with medusae have been done (e. g. Kubota, 1978). Because medusae of the present genus are similar to each other, and easily damaged during net sampling, it is difficult to distinguish them by species.

From Japanese waters, medusae of two species, *C. hemisphaericum* and *C. mccradyi*, have been identified and six species and one variety of polyp have been collected (Yamazi, 1958; Yamada, 1959; Hirohito, 1969; Kubota, 1978).

Clytia gardineri (Browne, 1905)

Pseudoclytia gardineri: Mayer, 1910, p. 279; Burkenroad, 1931, p. 117.

Phialidium gardineri: Kramp, 1961, p. 166; Kramp, 1968, p. 79, fig. 211.

Material examined.-2 specimens, Sta. 4, Apr. 17 1996, by NORPAC net; 63 specimens Sta. 1, May 18 1996.

Description.-Umbrella nearly flat, up to 2.88 mm in diameter, mesoglea thin. Stomach short, with four or five simple lips. Base of stomach pentagonal. Five radial canals straight and narrow, arranged in one of two ways smaller specimens, four of five canals about 90° apart, the fifth situated between two of the four canals; in larger canals about 90° apart, the fifth situated between two of the four canals; in larger specimens, three canals about 90° apart from each other, dividing the circumference in

half, on the other half, two canals about 60° apart, dividing the half in thirds. The five small, oval gonads situated about mid-point on each radial canal. Eight to eleven marginal tentacles, with prominent basal bulb. Numerous shaftless marginal bulbs which vary in degree of development from slight swellings to prominent bulbs, irregularly spaced. From one to three, usually two, statocysts between successive tentacles, each with one concretion. Velum broad.

Remarks.-This species has a weak body, and the marginal portion is easily damaged during collection. At the base of the stomach, a solid gelatinous portion appears like a peduncle in the preserved specimens, but in live specimens have no such peduncle is visible. Although larval medusae of *Eirene hexanemalis* also have five radial canals, the present specimens are distinguished from *E. hexanemalis* by absence of the gastric peduncle.

Genus *Ptychogastria* Allman, 1878

Diagnosis.-Stomach has eight lobes corresponding to eight radial canals. With eight mesenterial partitions which connected between the lobes and the canals. Gonads situated on the sides of the lobes or on radial canals adjacent to stomach lobes. With marginal sensory clubs.

Remarks.-Type species: *Ptychogastria polaris* Allman, 1878

Genus *Ptychogastria* was established by Allman (1878) for *P. polaris*. And the present genus has been known to include two species and a doubtful species (Kramp, 1961). Although the grouped tentacles has been recognized as one of the generic characters, the materials collected in the present study form tentacle rows, not form the group. the materials collected in the present study form tentacle rows, not form the group. The gonads are situated on eight lobes which projected from stomach wall, although

other Trachymedusae have gonads on or along the radial canals. From Japanese water, no *Ptychogastria* species has been reported.

Ptychogastria sp.

Material examined.-3 specimens, Sta. 3, Nov. 13 1997; 2 specimens, Sta. 5, Nov. 14 1997.

Description.-Flatter than a hemisphere, up to 13.1 mm high, 19.0 mm wide. Jelly thin with slightly thickened apex. Eight radial canals and a ring canal broad and white in color. Numerous fat globules contained in these canals. Subumbrella muscle iridescent. Apical outline of subumbrellar muscular fields form an entire circle. Stomach short and cylindrical, with eight sided base and rounded mouth, without peduncle, bottom of it form rounded depression, orange in color. The stomach has eight lobes which situated longitudinally corresponding with the radial canals, developed varyingly, and orange in color. The largest lobe 3.6 mm high, 1.9 mm wide. longer and wider than stomach. Two gonads situated on the both sides of each lobes. A groove which halves gonads runs on the edge of each lobes. Apical part of each lobes supported by a mesenterial partition which connected with a radial canal. The partitions very narrow and reached to above mentioned entire circle, and a line elongated on center of each radial canals from the partition to umbrella margin. Marginal tentacles up to about 35 in number on each octant, in larger two specimens (more than 13.5 mm wide), they form two rows. All tentacles broken off and remained only their bases due to damage of collections. Each tentacles connected to ring canal. A marginal sensory club with a concretion situated on middle of each octant. Little A marginal sensory club with a concretion situated on middle of each octant. Little semicircular projection surround the club. Velum thin and broad.

Remarks.-These materials are distinguished from other three *Ptychogastria* species by following characters; (1) mouth is rounded, (2) there is no ridge or groove on exumbrella, (3) tentacles form two rows against cluster, (4) mesenterial partitions are narrow and not prominent. The present materials are more similar to *P. polaris* than *P. asteroides* because of presence of short stomach, absence of apical projection, and umbrella size.

P. polaris and *P. asteroides* were sketched by Haeckel (1881) as *Pectyllis arctica* and *Pectanthis asteroides* respectively. In these sketches the two species had prominent mesenterial partitions which reached umbrella margin. But the present materials has short ones. I can't understand either primitive form or degeneration form, perhaps the lines which elongate from the partitions to umbrella margin are a part of partitions.

In the previous study, sensory clubs of *P. polaris* was described as following; specimens of Haeckel (1881) as *Pectyllis arctica* had eight or 16 ones, correct number was unknown, however, specimens of Kramp (1961) had eight ones. Although not all sensory clubs are confirmed due to damage of marginal portions by collections, a sensory clubs of the present materials is situated middle of each octant, so total number of them is eight.

P. polaris have numerous tentacles which bear a terminal sucking cup (Haeckel, 1881; Kramp, 1961). This species is usually attached to the bottom of the sea by its sucker-bearing tentacles, but occasionally it swims toward the surface (Kramp, 1959). Tentacles of *P. asteroides* boar a terminal sucking cup too, and a live specimen climbed up the vertical walls of the glass vessel like a sea urchin (Haeckel, 1881). Because the ORI net was not open-closed net, I couldn't know the collected depths of the present materials. But on the sta. 3 and 5 of Sagami Bay, both depths are about 1500 m, they materials. But on the sta. 3 and 5 of Sagami Bay, both depths are about 1500 m, they were collected by 2000 m wire out oblique tow of ORI net which reached about 1000 m

depth, but no one collected by 1000 m wire out tow which reached about 500 m. So maybe they were collected from 500 m to 1000 m depth, and is planktonic. It is to be regretted that all tentacles of the present materials were broken off.

Genus *Botrynema* Browne, 1908

Diagnosis.-Halicreidae with eight radial canals, with a solitary tentacle at the basal margin of each one, and two or more groups of tentacles in a single row on each octant of the umbrella margin.

Remarks.-Type species: *Botrynema brucei* Browne, 1908

The genus *Botrynema* includes two species, *B. brucei* and *B. ellinorae*, distinguished from other genera of Halicreidae by grouped tentacles. Apical projection of *B. brucei* is character that distinguishes it from *B. ellinorae* (Kramp, 1959). Although previous studies have reported two groups of tentacles in each octant, the sole specimen collected in the present study has two or three groups. This is the first record of three groups of tentacles in an octant in a specimen of this species and genus.

Botrynema brucei Browne, 1908

Botrynema brucei: Russell, 1953, pp. 459-462, text-fig. 303-304, pl. XXVII, fig. 1; Kramp, 1959, pp. 44, 183-184, 254, 256, 259, 261, 263, 273, fig. 267; Kramp, 1968, p. 113, fig. 305.

Botrynema ellinorae: Bigelow, 1913, pp. 53-54, pl. 4, figs. 1-4.

Halicreas glabrum: Mayer, 1910, pp. 392-393, fig. 245.

Material examined.-1 specimen, Sta. 5, Nov. 14 1997, by ORI net.

Description.-Umbrella nearly hemispherical with a prominent apical projection, 15.1 mm in height and width. Jelly thick at apex, thin at lateral side. Exumbrella smooth, without wart-like papillae. Stomach short and cylindrical, with eight-cornered base, round mouth. Stomach, eight radial canals, and broad ring canal, reddish brown in color. Numerous fat globules inside these canals. Upper portions of radial canals swollen except portion connecting to stomach. Gonads on the swollen portion, slightly projecting toward cavity, white in color. Tentacles on umbrella margin arranged in two or three groups in each octant, alternate between two and three. Each group includes up to 12 tentacles ranged in order of their development, the basal width of each decreasing from one side of each group to the other. In each octant the sequence of development in the two or three groups runs in the same direction, but the direction alternates from octant to octant. Sole thick tentacle at the umbrella margin opposite to each radial canal. Others in group narrow. Almost all tentacles broken off, leaving only the bases, during collection. Only three complete narrow tentacles remained, distal end spine-shaped. Up to three marginal sensory clubs within spaces between adjacent groups or between the thick tentacle and the group. Velum very broad, about one-fifth of the umbrella height.

Remarks.-The present species was first described by Browne (1908, not seen) based on a single specimen from Cape Horn. Vanhöffen (1902, not seen) described *Halicreas glabrum* based on specimens from the west coast of Africa and central Indian Ocean, but the description was insufficiently for certain identification. Kramp (1947, not seen) proposed that *H. glabrum* might be a synonym of the present species, at present, the name of *Halicreas glabrum* is not used.

Although 16 groups of tentacles have been reported in previous studies, the

Although 16 groups of tentacles have been reported in previous studies, the present specimen which had a damaged octant during collection, had 17 groups in

seven octants. Each octant has two or three groups. Its a first report in this species. Sequential development of grouped tentacles is same as in previous reports (Russell, 1953; Kramp, 1959). As tentacles easily break off during collection, there are few descriptions of them. Number and arrangement of the marginal sensory clubs agree with description of Kramp (1942, not seen).

In previous studies, the umbrella width was reported up to 13 mm (Bigelow, 1913) and up to 25 mm (Kramp, 1961). The present material is as large as specimens collected from the North Pacific by Bigelow (1913).

This is the first record of this species from Japanese waters. Another *Botrynema* species, *B. ellinorae*, has not been collected from these waters.

Genus *Persa* McCrady, 1857

Diagnosis.-Rhopalonematidae with only two gonads, situated on opposite radial canals.

Remarks.-Type species: *Persa incolorata* McCrady, 1857

Monotypic genus for *P. incolorata*. Of the four genera of Rhopalonematidae that possess sausage-shaped gonads, only *Persa* has two gonads, the other three genera, *Aglantha*, *Aglaura*, and *Crossota*, have eight.

Persa incolorata McCrady, 1857

Persa incolorata: Mayer, 1910, pp. 406-409, fig. 261-262; Blackburn, 1955, pp. 418-419; Kramp, 1961, pp. 260-261; Kramp, 1965, p.125; Kramp, 1968, p. 119; Pagès *et al.*, p. 45, Kramp, 1961, pp. 260-261; Kramp, 1965, p.125; Kramp, 1968, p. 119; Pagès *et al.*, p. 45, fig. 54.

Material examined.-8 specimens, Sta. 1, Apr. 17 1996, by NORPAC net.

Description.-Bell-shaped umbrella, up to 2.56 mm in height, 2.00 mm in width. Apical projection hemispherical and prominent. Lateral jelly thin. Gastric peduncle conical. Four lips recurved. Eight radial canals, narrow. Only two sausage-shaped gonads hang in bell cavity attached to two opposite radial canals at about half to two-thirds meridional distance above umbrella margin. Well developed gonads reach near umbrella margin. Up to 32 marginal tentacles, all broken off in collection. Eight sensory-clubs, each situated at center of each octant of umbrella margin.

Remarks.-The present species is similar to *Aglaura hemistoma* and *Aglantha* species in general shape, but the present species is discriminated from these species by possession of only two gonads.

Specimens from Benguera Current area, southeastern Atlantic, were described as having 48 marginal tentacles by Pagès *et. al.* (1992). Kramp (1961) also reported 48 in his "synopsis of the medusae of the world". Blackburn (1955) described specimens with 32-40 based on material from southeast of Australia. Although all marginal tentacles were broken off in the present specimens caught by NORPAC net, Kramp (1961) described long tentacles with a terminal knob.

This species is widely distributed in the warm waters of the Atlantic Ocean and Mediterranean (Kramp, 1965, 1968), however, specimens have also been collected from Pacific waters: south-east of Australia(Blackburn, 1955), Sunda Strait (Kramp, 1961), Sagami Bay (present study). This is the first record of this species in Japanese waters.

Genus *Sminthea* Gegenbaur, 1856

Genus *Sminthea* Gegenbaur, 1856

Diagnosis.-Rhopalonematidae without gastric peduncle, with globular gonads on radial canals, with only eight tentacles, and with enclosed statocysts.

Remarks.-Type species: *Sminthea eurygaster* Gegenbaur, 1856

Although the genus *Sminthea* includes two species, one of two species, *S. arctica*, is doubtful species.

Sminthea eurygaster Gegenbaur, 1856

Sminthea eurygaster: Gegenbaur, 1856, pp. 245-246, pl. 9 figs. 14-16; Mayer, 1910, pp. 382-383, figs. 226-227; Groben, 1915, p. 5; Brown, 1916, pp. 171-172, 194-195; Broch, 1929, p. 499, fig. 11; Pell, 1938, p. 926; Vannucci, 1951, p. 117; Blackburn, 1955, pp. 415-416, 425-426; Kramp, 1957, pp. 55, 125, tab. 3; Kramp, 1959, pp. 54, 187, 242, 246, 248, 251, 253, 255-256, 259-260, 263, fig. 276; Kramp, 1961, pp. 263-264; Kramp, 1965, pp. 122-123; Kramp, 1968, pp. 116-117, 176, 178, 180, fig. 314.

Tracynema eurygaster: Haeckel, 1879, p. 260.

Marmanema mammaeforme: Haeckel, 1879, p. 262.

Material examined.-1 specimen, Sta. 3, Apr. 17 1996, by NORPAC net; 2 specimens, Sta. 1, May 18 1996, by NORPAC net; Jun. 10 1996, by NORPAC net.

Description.-Umbrella wider than high. Jelly thin, no apical projection. Eight radial canals narrow. Mouth very short, with four lips, without gastric peduncle. Eight tentacles short, some of them broken off during collection. Eight gonads globular, located on the radial canals just near the umbrella margin. Among five specimens, only one statocyst recognized on umbrella margin, middle of a octant. specimens, only one statocyst recognized on umbrella margin, middle of a octant. Circular canal uncertain. Velum broad, however weak.

Remarks.-The type specimen of Gegenbaur (1856) and specimens of Haeckel (1879) as *Tracynema eurygaster* had four statocysts, however, specimens of Haeckel (1879) as *Marmanema mammaeforme* had eight. Specimens identified as *Sminthea eurygaster* by Mayer (1910), Broch (1929), and Kramp (1961) had eight. Number of the statocysts of the present specimens is uncertain because of the damage during the collection.

Gegenbaur (1856) and Kramp (1961) described a small apical projection, however, apical portion of the present specimens had no projection. Apex of Australian specimens did not seen to project (Blackburn, 1955).

The present species is easily distinguished from other Rhopalonematidae by globular gonads located on the radial canals just near the umbrella margin.

Genus *Aegina* Eschscholtz, 1829

Diagnosis.-Aeginidae with same number of tentacles and peronia, typically four, occasionally five or six, with stomach pouches twice as many as tentacles, with peripheral canal system, without secondary marginal tentacles and otoporpae.

Remarks.-Type species: *A. citrea* Eschscholtz, 1829.

Many species had been described by many scientists, but Russell (1954) and Kramp (1965) described only one species, *A. citrea*, and regarded that other species described previously were synonym of it. From Japanese waters, *A. pentanema* originally described by Kishinouye (1910) and *A. rosea* were reported Uchida (1928, 1947) and Yamazi (1958), but both were synonymy of *A. citrea*.

The detailed synonym lists of *A. citrea* were provided by Russell (1954) and Kramp (1965).

Kramp (1965).

Aegina sp.

Material examined.-1 specimen, Sta. 3, May 11 1997, by ORI net; 1 specimen, Sta. 3, Nov. 13 1997, by ORI net.

Description.-Up to 27.83 mm in width, 22.0 mm in height, umbrella nearly hemispherical, the larger specimen has flat apex, the smaller one has not. Jelly thick at upper half. Four tentacles longer than width of umbrella, tip of them pointed and spine-shaped, base of them tapering and stuck into jelly toward the apex of the umbrella deeply. Four very narrow peronia run longitudinally from umbrella margin to tentacle base. Same number of peronial grooves along the peronia from umbrella margin to near apex and divide the umbrella margin into four lappets. Abovementioned tentacles stick on slight above of the middle of the peronial grooves. Below the tentacle base, the grooves deep and narrow, however, the bottom of them wide and pen-shaped above the tentacle base. In the smaller specimen, the groove widely open above the tentacle bases due to maybe looseness by collection or preservation. Stomach large, circular, and dorsal wall of it flattened with a central rounded depression. Mouth simple. Eight rectangular stomach pouches with a small median notch. Interradial clefts which separate pouches, three fourth as long as perradial ones. Peripheral canal system present. Without secondary marginal tentacles and otoporpae. In the larger specimen preserved shorter, outer portion of tentacles, stomach pouches, and subumbrellar margin yellow in color, basal sticking portion of tentacles colorless, in the smaller specimen preserved longer colorless.

Remarks.-The first specimen, smaller one, was collected in May 1997 by ORI net with small cod-end bucket, so that it was much damaged, and the less damaged second small cod-end bucket, so that it was much damaged, and the less damaged second specimen, larger one, was collected in Nov. 1997 by ORI net with large enclosed bucket.

The two specimens are different in color and shape of peronial grooves above the tentacle bases. However, I regard that both are same species, and the morphological differences are due to difference of damage of each specimen during collection or preservation.

The two specimens of *Aegina* sp. were compared directly with three specimens of *A. citrea* collected from Tokyo Bay in Apr. 1998, and the differences were: (1) peronial grooves of the former specimens were elongated to near apex of the umbrella while these of the latter were confined only below the tentacle base; (2) peronia of the former were narrower than these of the latter; (3) the former had four tentacles while the latter had five ones; (4) the former were yellow in color while the latter were pink. Although most specimens of *A. citrea* collected from Japanese waters were five tentacles and pink in color (Yamada and Kubota, 1982), number of tentacles and body color of *A. citrea* was reported much variations (e.g. Bigelow, 1938; Kramp, 1961). The present specimens of *Aegina* sp. are possibly distinct species from *A. citrea* although the latter two characters, number of tentacles and body color, are not substantial differences.

Genus *Aeginura* Haeckel, 1879

Diagnosis.-Aeginidae with number of primary tentacles equaling that of peronia, number of stomach pouches being double with secondary tentacles, no otoporpae.

Remarks.-Type species: *A. grimaldii* Maas, 1904

There are two species in the genus *Aeginura*, *A. beebei* and *A. grimaldii* (Kramp, 1961). Even though *A. beebei* has 22 stomach pouches, in previous studies e.g. Russell (1954)

Even though *A. beebei* has 22 stomach pouches, in previous studies e.g. Russell (1954)

and Kramp (1961), possession of 16 stomach pouches was defined as one of the generic

characters. Although *A. grimaldii* has been widely reported and appears to be distributed throughout the oceans of the world, *A. beebei* has only been reported by Bigelow (1940, not seen) from coastal Panama, Pacific Ocean.

Aeginura grimaldii Maas, 1904

Aeginura grimaldii: Mayer, 1910, pp. 470-472, fig. 309; Bigelow, 1913, pp. 61-63; Uchida, 1928, p. 93; Broch, 1929, p. 533, fig. 37; Russell, 1954, pp. 472-476, text-figs. 311-312; Kramp, 1959, p. 195, fig. 295; Kramp, 1961, p. 269; Kramp, 1968, p. 124, fig. 335.

Material examined.-1 female specimen, Sta. 3, Nov. 13 1997, by ORI net.

Description.-Umbrella hemispherical, 17.78 mm in height and 19.0 mm in width. Jelly thick at about upper one-third and very thin at marginal lappet. Seven primary tentacles long, with spine shaped terminal ends, issue from the exumbrella slightly above the level of the margin of the stomach pouches. Base of the tentacles originate deep in the gelatinous substance towards the apex, the basal ends tapering. Two unusual tentacle segments in gelatinous substance near level of the basal ends of the tentacles. Stomach large, with large, simple, rounded mouth. Dark, chocolate brown stomach pouches total 14, interradial clefts deeper than perradial ones. Peronia hardly visible because lappets very thin and fragile. Seven canals run from under the tentacles to the very narrow peripheral canal which unrecognizable in several place duo to damage by the collection. Two secondary tentacles remain on the margin of the lappets. Velum very thin, and badly damaged. Although marginal lappets slightly brown in color, the velum colorless. The uneven, pale brown subumbrella surface has brown in color, the velum colorless. The uneven, pale brown subumbrella surface has 11 white eggs, from 0.44 mm to 2.67 mm in diameter.

Remarks.-This species has been reported to have eight primary tentacles(e. g. Russell, 1954; Kramp, 1961). While the present specimen has only seven primary tentacles, and there are two fragments in the gelatinous substance (an abnormal specimen ?). Previously, Ranson (1936, not seen) recorded a specimen with only five tentacles. Because of collection damage, the margin of the umbrella is not clear, only two secondary tentacles remained, no sensory structure recognizable. Bigelow (1913) reported that the number of secondary tentacles, from two to five in each octant, increases with growth, but very irregularly. Furthermore, Bigelow (1913) described a specimen in which the interradial clefts were fully twice as deep as the perradial. He suggested that the stomach pouches were primary perradial as in *Cunina*, and that this was important phylogenetically. In the present specimen, perradial clefts are not clear because they are very short and darkly pigmented. Thus this specimen at first glance appears to be a Cuninidae medusa.

Aeginura grimaldii has been reported from three locations in Japanese waters, east of Kyushu, Surge Bay, east of Honshu (Bigelow, 1913), and this is the fourth.

Genus *Cordagalma* Totton, 1932

Diagnosis.-Agalmidae with heart-shaped nectophores, lateral canals forming a loop.

Remarks.-Type species: *Cordagalma cordiformis* Totton, 1932.

Monotypic genus for *C. cordiformis*.

Cordagalma cordiformis Totton, 1932

Cordagalma cordiformis: Totton, 1932, pp. 325-327, figs. 8-9; Totton, 1965, p. 61, fig. 25;

Carré, 1968, pp. 79-86, pls. I-III; Daniel, 1974, pp. 49-50, text-figs. 3 K-N; Pagès and Gili, 1992, p. 72, fig. 7.

Material examined.-3 loose nectophores, Sta. 1, Aug. 6 1996, by NORPAC net; 4 loose nectophores, Sta. 3, Feb. 6 1997, by NORPAC net; 6 loose nectophores, Sta. 4, Feb. 6 1997, by NORPAC net.

Description.-Nectophore: Very small, heart-shaped in both ventral and dorsal views. Up to 2.28 mm in height, 1.74 mm in width, higher than wide. Two apico-lateral projections that form rounded lobes in lateral view. A groove situated between these projections reaches almost both the junction of most canals in the ventral surface, and ostium in the dorsal surface. A pointed basal projection in all specimens extends straight down, except in the specimen shown in the figures, which bends ventrally. Nectosac large, with a median groove in the ventral surface, close to the abovementioned nectophore groove. Two lateral canals forming an ascending loop, rather than sigmoid curve. These and a ventral, dorsal, and short pedicular canals all emanate from a single point near the base of the nectosac. The ostial circular canal indistinct in some specimens because of collection damage.

Remarks.-The present species was originally described by Totton (1932) based on six loose nectophores from the Great Barrier Reef, Australia. Carré (1968) described a whole colony, while Pagès and Gili (1992) added further descriptions of the pneumatophore and nectosome. In the present study, only loose nectophores were collected. Maximum size of the nectophore in the present specimens was 2.28 mm in height and 1.74 mm width, which in previous reports was (height, width, respectively): 2.5 mm, 2.2 mm (Totton, 1932); 7 mm, 6 mm (Carré, 1968); 2 mm, 1.4 mm (Pagès and 2.5 mm, 2.2 mm (Totton, 1932); 7 mm, 6 mm (Carré, 1968); 2 mm, 1.4 mm (Pagès and Gili, 1992). The specimens reported by Carré (1968) were outstandingly large.

Although Totton (1965) described this genus as minute Agalmidae, Carré (1968) showed this was not so.

Genus *Nanomia* Agassiz, 1865

Diagnosis.-Agalmidae with an involucrum around only base of a cnidoband (Kawamura, 1915 c). The arrangement of the gonodendra is characteristic, male and female alternating on either side in pairs at the base of palpons (Totton, 1965).

Remarks.-Type species: *N. cara* A. Agassiz, 1865

The present genus include two species, *N. bijuga* and *N. cara*, they are distinguished by only its nectophore; other difference isn't determined (Totton, 1965). *N. bijuga* is well known in the Japanese waters. In the present study, I examined only loose nectophores of *Nanomia bijuga*.

Nanomia bijuga (Chiaje, 1841)

Nanomia bijuga: Totton, 1954, pp. 52-55, text-fig. 19 D; Barham, 1963, pp. 826-828, fig. 1; Pickwell *et al*, 1964, pp. 860-862, fig. 1, tab. 1-2; Totton, 1965, pp. 68-71, figs. 32-36, pl. X, figs. 1-10, pl. XIV, fig. 9; Barham, 1966 pp. 1399-1403, fig. 1-3; Daniel, 1974, pp. 51-54, text-figs. 4 A-G; Pugh, 1974, p. 32; Pagès and Gili, 1992, pp. 72-73, fig. 8.

Cupurita picta: Kawamura, 1911c, pp. 359-361, pl. 7, figs. 1-10.

Stephanomia bijuga: Totton, 1932, pp. 324-325, text-figs. 6-7; Kawamura, 1953, p. 110.

Material examined.-1 loose nectophore, Sta. 4, Apr. 17 1996, by NORPAC net; 15

Material examined.-1 loose nectophore, Sta. 4, Apr. 17 1996, by NORPAC net; 15

young nectophores, Sta. 3, Mar. 14 1997, by NORPAC net; 4 loose nectophores, Sta. 3,

Dec. 14 1996, by NORPAC net; 2 loose nectophores, Sta. 4, Feb. 6 1997, by NORPAC net.

Description.-Nectophore: Square in shape when viewed from ventral or dorsal side, flattened from ventral side to dorsal side, and L-shaped when viewed laterally because ostial mouth nearly right angled to nectosac. Lateral wings folded above the ventral surface. Lateral ridge prominence. Two pairs of vertical ridges present in the dorsal surface. A medial groove present among these vertical ridges. Two lateral, a dorsal, a lateral, a circular, and a pedicular canals present. Each canals except circular one originate from a point which situated on the center of the ventral side of the nectosac. The ventral canal short about a quarter of the length of the dorsal one. The lateral canals have three vertical turns. Basal and apical end of the thrust block slightly projected. Velum broad. Young nectophores about one mm in height, the lateral wings not prominent.

Remarks.-In the sample by hauling of the NORPAC net, only loose nectophores were obtained. The nectophore of this species differ from that of *N. cara* as follows: (1) nectophore is L-shaped when viewed laterally, (2) square in shape when viewed from ventral or dorsal side, (3) lateral wings folded above the ventral surface. The height of the nectophores reported previously are 2-3.5 mm (Kawamura, 1911 c; Totton, 1965; Pagès and Gili, 1992). The present specimens larger than these specimens. In the dorsal side of the nectophore, the upper half of the dorsal canal is not clear because it run on the medial groove. Good figures and detailed description of the whole animal were represented by Kawamura (1911 c) as *Cupulita picta*. Furthermore each part of other body portion were well described by Totton (1965). A sketch of the young nectophore by Totton (1932) is quite similar with my young specimens.

nectophore by Totton (1932) is quite similar with my young specimens.

The present species plays an important role in deep scattering layer (Barham

1963; Pickwell *et al*, 1964).

Genus *Halistemma* Huxley, 1859

Diagnosis.-Agalmidae with unicornuate tentilla whose cnidobands lack a marked basal involucrum (Totton, 1965).

Remarks.-Type species: *Halistemma rubrum* (Vogt, 1852)

Three species are included in the present genus (Totton, 1965). In the present study based materials collected by plankton net, only nectophores were recognized and I could not examine other structure such as tentilla. We should use other sampling methods which is able to collect each whole specimen without damage such as direct catch by diving or using submersible.

Halistemma rubrum (Vogt, 1852)

Halistemma rubrum: Totton, 1954, pp. 46-52, figs. 12-18; Totton, 1965, pp. 66-68, figs. 21-22, pl. XII; Daniel, 1974, pp. 45-47, text-figs. 3 E-G; Pugh, 1974, pp. 30-31; Kirkpatrick and Pugh, 1984, pp. 34-35, fig. 8; Pagès and Gili, 1992, p. 75, fig. 9.

Material examined.-nectophores, Sta. 1, Apr. 17 1996, by NORPAC net.

Description.-Nectophore: Lateral wings wedge-shaped and large. Central thrust block conspicuously projected toward apico-dorsal direction. Nectosac large, occupy most part of the nectophore. Two lateral ridges, apicao-lateral and baso-lateral ridges, present in the lateral surface. The apico-lateral one not clear. Latero-bentral triangle cut off by the baso-lateral ridge to form a separate facet. In the dorsal view,

two ridges which form edges of the lateral wings curved and run on the central portion of the dorsal surface. A groove present among these two ridges. Nectosac Y-shaped, though inverted triangular swelling projected on the forked portion of the ventral side of the nectosac. Ventral and dorsal canals straight. Lateral radial canals extend straight at right angles to the ventral and dorsal ones on the ventral surface of the nectosac, and turn three times on the lateral surface. Lateral canals of only a nectophore which I sketched turn down on the ventral surface. Pedicular canal arise from the junction of above mentioned canals and extend through the central thrust block. Velum narrow.

Genus *Nectopyramis* Bigelow, 1911

Remarks.-Type species: *Nectopyramis thesis* Bigelow, 1911

Nectopyramis diomedeae Bigelow, 1911

Nectopyramis diomedeae: Bigelow, 1911, pp. 191-194, fig. A, pl. 1, figs. 1-6; Totton, 1965, pp. 131-134, fig. 75, pl. XXIII, fig. 5; Alvariño, 1971, pp. 14, 28, 418, fig. 52; Pugh, 1974. p. 40; Kirkpatrick and Pugh, 1984, pp. 64-65, fig. 22;

Material examined.-1 eudoxid, Sta. 5, Nov. 14 1997, by ORI net.

Description.-Bract: Triangular-shaped, compressed laterally, smooth surface, with no ridge, 18.4 mm in height, 10.7 mm in width. Basal margins in ventral and dorsal side projected below the opening level of hydroecium. Apical portion of phyllocyst long and projected below the opening level of hydroecium. Apical portion of phyllocyst long and narrow, reaching to near the apex of the bract, basal portion branches into three trunks

surrounding hydroecium, each sub-branching one time. Each tip of the branch slightly swelling. Hydroecium reaches near mid point of the bract.

Gonophore: Pear-shaped, smooth surface, with no ridges, 7.2 mm in height, 5.0 mm in width. Pedicular canal long and distinct.

Remarks.-In the present material, the inner surface of the gonophore cavity has been damaged during collection. So although three radial canals are visible, fourth may have been present as noted in previous studies (Bigelow, 1911; Kirkpatrick and Pugh, 1984). Bigelow (1911) noted that the branching of the phyllocyst is progressively more and more complex in larger and larger specimens, and the specimens he sketched more complex phyllocyst than the present specimen.

A mesopelagic species (Pugh, 1974), only a single specimen was collected in this study, and this was a eudoxid. This marks the first record of this species in Japanese waters. The genus *Nectopyramis* includes four species, however, the others have not collected around Japan.

Genus *Vogtia* Kölliker, 1853

Diagnosis.-Tentillum development in this genus, passes through a spirally coiled stage which closely resembles that of Agalmids. Adult specimens, consist of a large, sac-like cnidosac with a single terminal filament.

Remarks.-Before discovery of *V. glabra*, the genus *Vogtia* was distinguished from *Hippopodius* by the angular nectophores in the former, rather than against round ones in the latter. Bigelow (1918) discovered *V. glabra* with round nectophores, and determined that the structure of the tentillum was a much more important character determined that the structure of the tentillum was a much more important character for distinguishing these genera. The history of both generic names were discussed by

Bigelow (1918) in his remarks of the genus *Hippopodius*.

There is a good deal of variation from specimen to specimen in the amount and kind of spinosity, and probably between the series of nectophores that bud off any one specimen (Totton, 1965). Five species of the preset genus have been reported (Totton, 1965; Alvariño, 1967), but distinction between species is very difficult due to such variation. This genus requires more detailed study.

Vogtia glabra Bigelow, 1918

Vogtia glabra: Bigelow, 1918, pp. 407-408, pl. 4, figs. 2-7; Totton, 1965, pp. 142, fig. 81; Alvariño, 1971, pp. 13, 27, 205-207, 411, fig. 45; Daniel, 1974, pp. 100-103, text-figs. 8 E-F; Pugh, 1974, pp. 45-46, fig. 3; Kirkpatrick and Pugh, 1984, pp. 76-77, fig. 29; Pagès and Gili, 1991, p. 210, tab. 2; Pagès and Gili, 1992, pp. 79-80, fig. 19.

Material examined.-2 loose nectophores, Sta. 3, Nov. 13 1997, by ORI net.

Description.-Nectophore: Outline nearly round with two basal projections in ether ventral or dorsal view, one 13.8 mm in height, 14.7 mm in width; other 15.4 mm in height, 15.6 mm in width; slightly wider than high. Jelly thick and firm. Two apico-lateral projections situated at the dorsal surface. Apex of the ventral surface projected ventrally. Deep and broad hydroecial groove running on the ventral surface, with nearly circular enclosed wing. The groove shallower and wider in the larger specimen. Nectosac shallow, situated slightly lower than the center of the nectophore. Lateral radial canals long, arise separately. *Lete mirabile*, situated beneath the ventral radial canal, arrowhead-shaped in the smaller specimen and spindle-shaped in the other one. canal, arrowhead-shaped in the smaller specimen and spindle-shaped in the other one. Basal tip of the arrowhead-shaped one connected to the ring canal, and the tip of the

other, not connected. Each baso-lateral side has a hollow. Ventral sinus between two basal projections prominent.

Remarks.-The present species was originally described by Bigelow (1918) based on one specimen with three nectophores, and four loose nectophores all from the Straits of Florida. Until 1918, the angular nectophore of *Vogtia* distinguished the genus from *Hippopodius* by Bigelow (1911) and others. However, Schneider (1898, not seen) and Moser (1911, not seen) united the two genus, thinking this character too trivial to be given generic importance. Bigelow (1918) determined that the form of the nectophores was unsuitable for distinguishing between the two genera, and that the structure of the tentilla was a better character. In *Hippopodius*, tentilla consist of a large, sac-like cnidosac with a single terminal filament, and this state develops directly. Tentilla in *Vogtia* pass through a spirally coiled stage, and eventually resemble that of the former genus. Because of the spirally coiled tentilla, the present species, with round nectophores, is included in the genus *Vogtia*.

The present species is distinguished from others in the genus *Vogtia* by the round outline of nectophores, and from the monotypic genus *Hippopodius* by two apico-lateral projections on the dorsal surface. *H. hippopus* has four projections. Both specimens in the present species has an apical projection extending ventrally, when the apex is viewed dorsally or ventrally, it appears to look round like *H. hippopus*, although Bigelow (1918) noted that the apex pointed apically was one of the characters for distinguishing from *H. hippopus*.

Three developmental stages of the nectophore were described by Bigelow (1918). The youngest stage was about 7 mm long, elongate in outline, and its apex prolonged into a triangular process. Next older stage was about 17 mm long, round outline, and into a triangular process. Next older stage was about 17 mm long, round outline, and with an apical process. As the nectophore enlarges, the hydroecial groove becomes

shallower and wider, and the enclosed wing lowers. The large nectophores, about 27-30 mm in width, were nearly circular in outline, with a very broad and shallow hydroecium and an evident apical and dorso-lateral projections. The present materials agree with the abovementioned older stage except for the apical portion.

Alvariño (1971) reported the present species from off northern Japan. Pacific Ocean. This is the second record of the present species from Japanese waters.

Vogtia kuruae (Moser, 1925)

Vogtia kuruae: Alvariño, 1967, pp. 236-240, figs. 1-2; Alvariño, 1971, pp. 13, 27, 412, fig. 46.

Material examined.-7 loose nectophores, Sta. 3, Nov. 13 1997, by ORI net.

Description.-Nectophore: Outline nearly triangular with two basal projections in either ventral or dorsal view. Up to 29.33 mm in height, 40.83 mm in width, wider than high. Each ridges and facets smooth, not spinous. All angles of the triangles, round, not pointed. The apex of the dorsal triangular facet higher than ventral one. Jelly very thick and firm. Nectosac shallow and nearly circular with a basal depression, situated lower than the center of the triangle. Ring canal broad. Other canals narrow and not prominent, radial lateral canals long. Dorsal surface flat except ostium, hydroecium formed nearly pentagonal groove on ventral surface. Basal sinus situated between the two basal projections, and a hollow formed outside these projections. In the weak and damaged specimens, nectosac entirely circular, and the edge between the two basal projections flatter, not forming a sinus.

edge between the two basal projections flatter, not forming a sinus.

Remarks.-Among the four *Vogtia* species with angular nectophores, *V. kuruae* and *V.*

serrata have no spine on the ridges and the facets. Alvariño (1967) distinguished the former species from the latter by no serration on all ridges, and elongation of outline with pyramidal apex. Kirkpatrick and Pugh (1984) noted that *V. serrata* had smooth ridges, while Moser (1925) sketched serrated ridges of *V. serrata*. About the elongation of outline, the present materials are intermediate between the sketches by Moser (1925) and Totton (1965) as *V. serrata* and the sketch by Alvariño (1967) as *V. kuruae*. Are they actually distinguishable characters ? Because of no serration and slight elongation, I provisionally treat my specimens from Sagami Bay as *V. kuruae* in the present study.

Genus *Sulculeolaria* Blainville, 1834

Diagnosis.-Anterior nectophore with smooth surface, no longitudinal ridges. No hydroecial cavity. With or without ostial teeth. Some with transverse commissures on the lateral canals. Posterior nectophore lateral canals, sigmoid shaped, mouth-plate undivided.

Remarks.-Type species: *Sulculeolaria quadrivalvis* Blainville, 1834

Totton (1954) reviewed this genus. Generally the generic name, *Sulculeolaria*, had been used by earlier researchers for species with ostial teeth, while those without them were included in the genus *Galetta*. Totton (1954), however, unified them under the former, because sometimes *S. quadrivalvis* has no teeth. *S. biloba* has a tooth on the dorsal side of the ostium. Carré (1979, not seen) concurred that all species belonged to a single genus *Sulculeolaria*, and this genus included six species. Further, he reported on the considerable changes in the structure of successive nectophores, not least in the degree of development or loss of the basal tooth.

Sulculeolaria chuni (Lens and Van Riemsdijk, 1908)

Sulculeolaria chuni: Totton, 1932, pp. 342-345, text-fig. 20; Totton, 1965, pp. 150-151, fig. 90; Alvariño, 1971, pp. 13, 26; Daniel, 1974, pp. 111-112, text-figs. 8 G-I; Pugh, 1974, p. 50; Ianora and Scotto Di Carlo, 1981, pp. 57,59-60, tab. 1; Pagès and Gili, 1992, pp. 81-82, fig. 21.

Material examined.-1 anterior nectophore, Sta. 2, Nov. 14 1996, by NORPAC net.

Description.-Anterior nectophore: Slightly swollen body with blunt apex, 2.90 mm in height, and 1.84 mm in width. Four folds running longitudinally on the nectophore surface, close to four nectosac grooves. Nectosac large, filling most of the nectophore. Lateral canals originate from different levels, the right one higher than the left one. No transverse commissures on lateral canals. Somatocyst with very short stalk, straight, club shaped, reaching up to about three fifths of the nectophore. No hydroecial cavity, basal facet slightly projected, slanting upward toward the ventral side. No ostial teeth. Mouth-plate very short, divided into two wings. circular canal on velum.

Remarks.-Anterior nectophore of this species is similar to that in *Lensia* species because of the flat ostium, absence of the transverse commissures, and simple, divided mouth-plate. However, this species is included in the genus *Sulculeolaria*, since the posterior nectophore has sigmoid loops on the lateral canals. In the present study, the posterior nectophore was not collected.

Because of the smooth surface, basal facet slanting upward toward the ventral

Because of the smooth surface, basal facet slanting upward toward the ventral surface, and the somatocyst being club shaped, anterior nectophore of this species is

similar especially to those of *L. cossack* and *L. campanella*. But can be distinguished from the two *Lensia* species by the somatocyst reaching up to three fifths of the nectophore against one fourth.

Daniel (1974) reported on specimens with transverse commissures on the anterior nectophore, and these specimens were larger than those without them.

Genus *Diphyes* Cuvier, 1817

Diagnosis.-Anterior nectophore with five ridges, with three conspicuous teeth around the ostium, with deep hydroecium. The mouth-plate not divided. The dorsal tooth of *D. antarctica* exceptionally obscured. A posterior nectophore produced except in *D. chamissonis*.

Remarks.-Type species: *D. bojani* Cuvier, 1817

The present genus have four species (Totton, 1965). In Japanese waters, three species except *D. antarctica* have been reported (Kawamura, 1915 d; Kawamura, 1953).

Diphyes bojani (Eschscholtz, 1892)

Diphyes bojani: Kawamura, 1915d, pp. 434-435, pl. 12, fig. 18; Kawamura, 1953, p. 103; Totton, 1965, pp. 155-156, fig. 92; Alvariño, 1971, pp. 9, 18, fig. 6; Daniel, 1974, pp. 121-125, text-figs. D-E; Pugh, 1974, pp. 50-51; Pagès and Gili, 1992, pp. 84-85, fig. 25.

Diphyopsis bojani: Bigelow, 1918, pp. 424-425, pl. 8, figs.3-4.

Material examined.-1 anterior nectophore and 2 eudoxids, Sta. 3, May 18 1996, by

Material examined.-1 anterior nectophore and 2 eudoxids, Sta. 3, May 18 1996, by

NORPAC net; 8 anterior nectophores, Sta. 4, Aug. 1 1996 by NORPAC net; 1 anterior

nectophore and 1 eudoxid, St. 1,Aug. 6 1996, by NORPAC net; 3 anterior nectophores, Sta. 4, Sept. 19 1996, by NORPAC net.

Description.-Anterior nectophore: Slender but firm body, with five serrated longitudinal ridges converging at the apex. Serration of these ridges prominent at lower portion. Up to 4.88 mm in height, 1.43 mm in width. The apex of nectosac pointed. Somatocyst long and narrow, reaching three fourth or more of the nectophore length. Hydroecium deep, about one third of the nectophore. Hydroecial opening large and quadrangular. Margins of both the dorsal and ventral walls of the hydroecial cavity concave. Mouth-plate not divided, with medial crest. Terminal ends of the dorsal and lateral ridges form three ostial teeth of the same size. Velum firm. Circular canal unrecognizable.

Eudoxid: Thin but firm bract covers the front to the left side of gonophore in the apical region. Bract up to 3.18 mm in height, 2.18 mm in width. In the ventral view, the bract bears a tooth both at the bottom portion and the left side on its serrated margin. The serration moderate at the upper portion and between the teeth. Gonophore up to 4.05 mm in height, 1.50 mm in width, bearing four longitudinal serrated ridges. Basal ends of the dorsal ridges form the ostial teeth. Only two right ridges reach the apex. Left ventral ridge shortest and left dorsal ridge curved eminently. Mouth-plate wide and flat. Circular canal on the firm velum.

Remarks.-Three *Diphyes* species, *D. chamissonis*, *D. disper*, and the present species were collected in this study. Anterior nectophores of these three species are distinguished by the shape of nectosacs: cylindrical in *D. chamissonis*, constricted at about upper one fourth in *D. disper*, and tapering at apex in the present species. General shapes of the anterior nectophores in the lateral view of these species are as General shapes of the anterior nectophores in the lateral view of these species are as follows: slightly swelling in *D. chamissonis*, slender in the present species, and wider at

lower half than others in *D. disper*. The differences of serration of ridges are as follows: serrated prominently at lower half in *D. chamissonis*, only short sections serrated above margins in *D. disper*, and serrated from the apex to the base in the present species.

Present specimens are smaller in size (up to 4.88 mm in height) than previously reported (Kawamura, 1915, up to 15 mm; Totton, 1965, up to 14 mm; Pagès and Gili, 1992, 10 mm). However, the morphological character agrees with those of the previous studies.

Diphyes chamissonis Huxley, 1859

Diphyes chamissonis: Kawamura, 1953, p. 103; Totton, 1965, pp. 156-157, figs. 93-94,; Alvariño, 1971, pp. 9, 19; Daniel, 1974, pp. 125-126, text-figs. 10 G-I; Pagès and Gili, 1992, pp. 85-86, fig. 26.

Diphyopsis chamissonis: Bigelow, 1913, p. 78; Kawamura, 1915d, pp. 435-436, pl. 12, fig. 19.

Material examined.-1 nectophore, Sta. 2, May 18 1996, by NORPAC net; 7 nectophores, Sta. 4, Sep. 12 1996, by NORPAC net; 3 nectophores, Sta. 4, Oct. 20 1996, by NORPAC net.

Description.-Nectophore: Firm body, with five longitudinal ridges converging at the apex. The ridges serrated in about the lower half. Nectosac cylindrical. Somatocyst stick-shaped, reaching nearly three-fourth of the nectosac height. Hydroecium deep, reaching one-third of nectosac height. Hydroecial opening large and quadrangular, reaching one-third of nectosac height. Hydroecial opening large and quadrangular. Mouth-plate not divided and without medial crest. The basal margin of the mouth-

plate and ventral surface concave, with notch of the latter larger than the former. Terminal end of the dorsal and lateral ridges form three ostial teeth of the same size. The teeth serrated prominently on those edges. Circular canal unrecognizable. Velum firm.

Remarks.-Three *Diphyes* species, *D. bojani*, *D. disper*, and the present species were collected in this study. The morphological distinction of these species is discussed under the 'remarks' of the section of *D. bojani*. Anterior nectophore of this species is similar to *M. atlantica*. However, the present species is distinguished by its three ostial teeth and short somatocyst.

In the previous studies, the maximum height of anterior nectophore is various (Kawamura, 1915, 10 mm; Totton, 1965, 12 mm: Pagès and Gili, 1992, 5 mm). Present specimens are generally smaller in size than previously reported. Although posterior nectophore is not developed (Totton, 1965), I can't verify in the present study.

Diphyes disper Chamisso and Eysenhardt, 1821

Diphyes disper: Kawamura, 1953, p. 103; Totton, 1965, pp. 153-155, fig. 91, pl. XXXIII, fig. 3; Alvariño, 1971, pp. 9, 18-19, fig. 7; Daniel, 1974, pp. 115-121, text-figs. 10 A-C; Pugh, 1974, p. 50; Pagès and Gili, 1992, pp. 86-87, fig. 27.

Diphyopsis disper: Bigelow, 1913, pp. 77-78; Bigelow, 1918, pp. 422-423; Kawamura, 1915d, pp. 437-439, pl. 12, fig. 21.

Material examined.-3 anterior nectophore, Sta. 4, July 19 1996, by NORPAC net; 2 anterior nectophores, Sta. 3, Sep. 12 1996, by NORPAC net; 2 anterior nectophores, Sta. anterior nectophores, Sta. 3, Sep. 12 1996, by NORPAC net; 2 anterior nectophores, Sta. 3, Dec. 14 1996, by NORPAC net.

Description.-Anterior nectophore: Enlarged at the lower half. Five ridges converging at the apex, with the only short sections dentate above the margin. Up to 12.58 mm in height, 4.17 mm in width. Nectosac suddenly occluded at the upper one fourth and slightly swollen at apex. Top of the nectosac reaches near the apex of the nectophore. Junction of radial and pedicular canals situated near the margin of the ventral wall of the nectosac. Somatocyst fusiform and long but not reaches the apex of the nectosac, running in parallel to the ventral surface. Hydroecium deep as reaching one third or more of the nectophore, and large and quadrilateral at its opening. Mouth-plate not divided and without medial crest. Base of the mouth-plate slightly concave. Same size of three ostial teeth formed at terminal ends of the dorsal and lateral ridges. Edges of the teeth slightly serrated. Base of the ventral surface notched. Velum firm.

Remarks.-Three *Diphyes* species, *D. bojani*, *D. chamissonis*, and the present species were collected in this study. The morphological distinction of these species is discussed under the 'remarks' of the section of *D. bojani*.

Maximum height of the collected anterior nectophore is 12.58 mm, while Kawamura (1915) reported height of the anterior nectophores is up to 17 mm based on the specimens from Misaki, coastal Sagami Bay, central Japan. Both of above are smaller than previously reported (35 mm in Totton, 1965; 36 mm in Pagès and Gili, 1992). Totton (1965) and Pagès and Gili (1992) reported that the dorsal tooth is larger than lateral ones and that only dorsal ridge is serrated. However, in the specimens of this present study, three teeth are same size probably because of smaller size. Serration of the ridges in the present study differs from the previous. In the present specimens, a short section of each longitudinal ridge above terminal end is serrated as specimens, a short section of each longitudinal ridge above terminal end is serrated as well as edges of the teeth and mouth-plate.

Genus *Lensia* Totton, 1932

Diagnosis.-Small Diphyid. Anterior nectophore with a shallow hydroecium, with a divided small mouth-plate, without teeth around ostium. The somatocyst relatively short. Lateral canals of the posterior nectophore run along slightly sigmoid curve, not looped.

Remarks.-Type species: *Lensia subtiloides* (Lens and Van Riemsdijk, 1908)

Although species included this genus had been neglected because they were small and sometimes preserved in poor conditions, genus *Lensia* was established by Totton in 1932. Most of species among siphonophores belong to the genus *Lensia*. Daniel (1974) listed 30 species. Eudoxids of this genus have been described for only a few species. Five species have been reported from Japanese waters (Alvariño, 1971), and six species are added to the Japanese fauna of siphonophores in the present study.

Lensia campanella (Moser, 1925)

Lensia campanella: Totton, 1932, pp. 368-370, figs. 35-36; Totton, 1965, p. 165, figs. 100 A-B, pl. XXXI, fig. 4; Alvariño, 1971, pp. 10, 20, 378, fig. 12; Daniel, 1974, pp. 142-143, text-fig. 11 B; Pugh, 1974, pp. 55-56, fig. 6; Ianora and Scotto Di Carlo, 1981, p. 59, tab. 1; Mackie *et al.*, 1987, pp. 119-120; Pagès and Gili, 1992, p. 87, fig. 28.

Material examined.-1 set of nectophores, Sta. 4, Jun. 10 1996, by NORPAC net; 1 anterior nectophore, Sta. 4, Nov. 14 1996, by NORPAC net.
anterior nectophore, Sta. 4, Nov. 14 1996, by NORPAC net.

Description.-Anterior nectophore: Apex blunt and twisted. Degree of the twist varies

between specimens. Five ridges and four folds run longitudinally on the nectophore surface, but all ridges scarcely visible. Especially, lateral ones indistinct in well twisted specimen. 3.14 mm in height and 1.90 mm in width, slightly twisted in the first specimen. 2.08 mm in height and 1.34 mm in width, well twisted in the other. Nectosac large, occuping most of the nectophore. Lateral canals originate from dorsal canal at distinct level, left one from just above the nectosac margin, and right one from higher than left. Somatocyst club-shaped with short stalk, obliquely, reaching about one fourth of the nectophore length. No hydroecial cavity, basal facet slightly projected. No ridge divides the basal facet from the ventral facet. Mouth-plate very short and divided into two wings. Circular canal on the velum.

Remarks.-Anterior nectophore of this species is similar to that of *Lensia cossack*. Similarities and differences between the two species are discussed under the 'remarks' of the latter species.

Margulis (1984, not seen) and Alekseev (1984, not seen) have described some new subspecies of *L. campanella*, that basically differ in the configuration of their somatocyst.

Lensia conoidea (Keferstein and Ehlers, 1860)

Lensia conoidea: Totton,1965, pp. 162-164, fig. 99 A, pl. XXXI, fig.11; Alvariño, 1971, pp. 10, 20-21, 380, fig. 14; Daniel, 1974, pp. 132-133; Kirkpatrick and Pugh, 1984, pp.88-89, fig. 34; Pagès and Gili, 1992, pp.87-88, fig. 29.

Material examined.-1 anterior nectophore, Sta. 1, Apr. 17 1996, by NORPAC net; 2
Material examined.-1 anterior nectophore, Sta. 1, Apr. 17 1996, by NORPAC net; 2
anterior nectophores, Sta. 2, Apr. 17 1996, by NORPAC net; 2 anterior nectophores, Sta.

2, May 18 1996, by NORPAC net.

Description.-Anterior nectophore: Up to 9.89 mm in height and 3.94 mm in width. Five longitudinal ridges, all reaching the apex of the nectophore. The basal end of the dorsal ridge extending below the level of the ostium and forming a ostial tooth. Baso-ventral ridge prominent, dividing the ventral facet and the hydroecial cavity. Jelly thick in baso-ventral part of the nectophore. Nectosac deep, reaching near the top of the nectophore. Lateral canals arise from a point where a pedicular canal connected. The pedicular canal descending to the base of the somatocyst. Ring canal situated on velum. Somatocyst stick shaped, with a short stalk, and reaching about 40 or 50 % of the nectophore height. Hydroecium very shallow. Mouth-plate slanted upward toward the ventral surface, and divided into two rectangular wings. The left wing overlapping the other in the dorsal view.

Remarks.-The anterior nectophore of the present species is similar to that of *L. multicristata* with the long, filiform somatocyst and shallow hydroecium. However, the present species is distinguished from *L. multicristata* by presence of (1) five longitudinal ridges, (2) a ridge divided between the hydroecium and the ventral facet, and (3) a dorsal tooth at the ostium.

Lensia cossack Totton, 1941

Lensia cossack: Totton, 1941, pp. 150-152, figs. 8-9; Totton, 1965, p. 166, fig. 101; Daniel, 1974, pp. 143-144, text-fig. 10 T; Pugh, 1974, pp. 53-54.

Material examined.-1 anterior nectophore, St. 2, Aug. 6 1996, by NORPAC net.

Material examined.-1 anterior nectophore, St. 2, Aug. 6 1996, by NORPAC net.

Description.-Anterior nectophore: 4.83 mm in height and 1.97 mm in width. Apex

round, not twisted. Two ventral ridges, though scarcely visible, short and confined to the basal end, no other longitudinal ridges. Four longitudinal folds, two latero-ventral and two latero-dorsal, on the nectophore surface divide into four smooth areas; ventral, dorsal, and two laterals. The latero-ventral folds reach ostium, the latero-dorsal ones not, all reach near the apex of the nectophore. One longitudinal nectosac groove next to each nectophore fold. Nectosac deep, cylindrical, reaching near the apex of the nectophore. Each lateral radial canal arise from different point of the dorsal canal, left one from base of the nectophore and right one from slightly above it. Somatocyst oblong-shaped with a short stalk, reaching one fourth of the nectophore height. No hydroecial cavities, and basal facet projected and horse-shoe shaped. Mouth-plate very short, divided into two wings and overlapped each other.

Remarks.-Anterior nectophore of this species is similar to *Lensia campanella* in several points: longitudinal ridges are hardly visible, apex of the nectophore is round, somatocyst is club-shaped, hydroecium is flat, and mouth-plate is very short. However, this species is distinguished from the latter species by the nectophore apex without twist.

Margulis (1984) and Alekseev (1984) reduced the status of *L. cossack* to another subspecies of *L. campanella*, namely *L. campanella cossack*. Because I have not read these papers yet, I provisionally treat *L. cossack* as a distinct species in this study.

This is the first record of this species from Japanese waters.

Lensia hardy Totton, 1941

Lensia hardy: Totton, 1941, pp. 153-154, fig. 10; Totton, 1965, p. 173, fig. 111; Pagès and

Gili, 1992; p. 89, figs. 31 A-B.

Material examined.-1 anterior nectophore, Sta. 4, Dec. 14 1996, by NORPAC net.

Description.-Anterior nectophore: Slender body, with five longitudinal straight ridges, all reaching apex of nectophore, 3.28 mm in height, 1.32 mm in width. Nectosac pointed at the apex. Lateral canals originate from a point which connected with pedicular ones. A ring canal situated on the velum. Somatocyst compressed laterally, with short stalk, and round in lateral view, and situated above the ostium level. Hydroecium obliquely extends below the somatocyst at the dorsal edge, while above the ostium level at the ventral edge, and groove-shaped in ventral view. Baso-lateral ridges of the hydroecium rounded. Basal ridge of ventral facet not prominent. Small mouth-plate divided into two wings, one third in length of ostium width. Both wings same size, and left one overlaps the other in dorsal view.

Remarks.-In the original report by Totton (1941), position of the somatocyst was not described in the text but sketched above ostium level. However, Totton (1965), Daniel (1974), and Pagès and Gili (1992) noted the somatocyst was located at the level of ostium. In the present specimens, the somatocyst is situated above the ostium level as sketched by Totton (1941). Totton (1941) noted that only ventral portion of the hydroecium reached the level of the ostium and dorsal portion below the level while the whole hydroecium lay below the level in the other previous studies(Totton, 1965; Daniel, 1974; Pagès and Gili, 1992). The hydroecium of the present specimen extend above the level of the ostium in its ventral half.

This species is similar to *Lensia challengeri* and *Lensia fowleri* by its slender body, possession of five longitudinal ridges, and rounded somatocyst in lateral view. But possession of five longitudinal ridges, and rounded somatocyst in lateral view. But this species is distinguished from the two species by (1) extension of the hydroecium

below the somatocyst, (2) the laterally compressed somatocyst, (3) position of the somatocyst, not reaching the base of the nectophore.

This is the first record of this species from Japanese waters.

Lensia hotspur Totton, 1941

Lensia hotspur: Totton, 1941, pp. 155-158, figs. 13-16; Totton, 1954, pp. 110-112, text-figs. 54 C-D; Totton, 1965, p. 167, figs. 102 C-E; Alvariño, 1971, pp. 10, 21, 381, fig. 15; Daniel, 1974, pp. 133-135, text-figs. 11 C-D; Pugh, 1974, pp. 54-55, fig. 6; Kirkpatrick and Pugh. 1984, pp. 96-97, fig. 40; Pagès and Gili, 1992, p. 90, fig. 32.

Material examined.-1 anterior nectophore, Sta. 1, Apr. 17 1996, by NORPAC net; 1 anterior nectophore, Sta.3, May 18 1996, by NORPAC net.

Description.-Anterior nectophore: Slender, 4.38 mm in height and 1.55 mm in width in the specimen collected in April, and 3.82 mm in height, 1.36 mm in width in the other. Five longitudinal ridges complete, reaching the apex of the nectophore. Lateral ridges closer to the dorsal ridge than to the ventral one. Nectosac deep. Somatocyst tapering in the first specimen and filiform in the other, with a short stalk, tilted and situated at the ostium level. Hydroecium shallow, and located below the level of the ostium. Basal ridge of the ventral facet straight. Mouth-plate slanted toward the dorsal side, and divided into two overlapping wings. Ring canal situated on the velum.

Remarks.-Only two specimens were collected in this study. Great morphological varieties of the somatocyst have been noted (Totton, 1941; Pagès and Gili, 1992), and the shape of somatocysts of the present specimens were different each other. Totton the shape of somatocysts of the present specimens were different each other. Totton (1941) sketched the somatocysts with variety of forms from filiform-shaped to ovate-

shaped. Presence of hydroecial cavity was reported to be not consistent. Totton (1965) and Kirkpatrick and Pugh (1984) sketched specimens without the cavity while Pagès and Gili (1992) reported presence of the shallow cavity as seen in the present materials.

This species is similar to *Lensia fowleri* or *Lensia challengeri*, but distinguished by the location of somatocyst which is situated the level of the ostium obliquely, and by the presence of a short stalk of the somatocyst. Somatocysts of *L. fowleri* and *L. challengeri* are without stalk and located below the ostium level.

Lensia leloupi Totton, 1954

Lensia leloupi: Totton, 1954, p. 113, fig. 55 C; Totton, 1965, pp. 161-162, fig. 97 A; Daniel, 1974, pp. 138-139, text-fig. 10 Q-R.

Material examined.-1 anterior nectophore, Sta. 4, Jun. 10 1996, by NORPAC net; 1 anterior nectophore, Sta. 3, Feb. 6 1997, by NORPAC net.

Description.-The first specimen 4.26 mm in height and 2.83 mm in width, and the second one 4.33 mm and 1.93 mm, respectively. Five longitudinal ridges converges at the apex of the nectophore. Lateral ridges reach the ostium in the first specimen while ostial end of those uncertain in the second specimen as being damaged during collection. Nectosac large, occupies most area of the nectophore. Somatocyst filiform, reaching the level of one-third of the nectophore, running close to the ventral wall of the nectosac, not directed toward the ventral surface. Hydroecium shallow with the apex reaching above the ostium level. Mouth-plate divided into two rectangular wings with the left above the ostium level. Mouth-plate divided into two rectangular wings with the left one overlapping the other in the dorsal view. Circular canal situated on the velum.

Remarks.-Only two specimens were collected, both of which got damaged possibly during collection or preservation. The first one has damaged mouth-plate and subumbrella so that lateral canals are not visible, and compressed laterally so that baso-ventral ridge concave. On the other hand, ostial end of the lateral ridges of the second one is not visible because of the many folds caused by compression.

This species was originally described by Totton (1954) based on the materials collected from Gulf of Guinea, the Atlantic Ocean. However, he did not enough described it in details, especially in a comparison with *Lensia subtiloides*. Totton (1954, 1965) noted that the hydroecium is deeper and the mouth-plate is longer than those of *L. subtiloides*. However, these are not appropriate characters for distinction. The filiform somatocyst running along the ventral wall of the nectosac and reaching about one-third of the nectophore length is the only character for distinction of this species from *L. subtiloides*. The somatocyst of the *L. subtiloides* is swollen with a narrow stalk, and directed to the ventral surface of the nectophore.

Totton (1965) noted that the ostial end of the lateral ridges, though scarcely visible, reached the ostium. On the other hand, Daniel (1974) described that the ridges did not reach the ostium but terminated above the base. Ostial end of the ridges in the first specimen of the present study are clearly visible and reaches the ostium while those are not visible in the second specimen due to body damage.

Lensia meteori (Leloup, 1934)

Lensia meteori: Totton, 1954, pp. 116-117, figs. 60 A-G; Totton, 1965, pp. 170-171, figs. 107 A-G; Alvariño, 1971, pp. 11, 21,382, fig. 16; Daniel, 1974, pp. 145-146, text-figs. 11 107 A-G; Alvariño, 1971, pp. 11, 21,382, fig. 16; Daniel, 1974, pp. 145-146, text-figs. 11 Q-T; Pugh, 1974, p. 53, fig. 7; Kirkpatrick and Pugh, 1984, pp. 98-99, fig. 42; Pagès and

Gili, 1992, pp. 90-91, fig. 33.

Material examined.-1 anterior nectophore, Sta. 3, Apr. 17 1996, by NORPAC net; 1 anterior nectophore, Sta. 3, May 18 1996, by NORPAC net; 1 anterior nectophore, Sta. 2, Sep. 12 1996, by NORPAC net; 1 anterior nectophore, Sta. 4, Dec. 14 1996, by NORPAC net.

Description.-Anterior nectophore: Up to 3.44 mm in height, 1.46 mm in width. Smooth surface without longitudinal ridges. Apex rounded. Jelly thin. Nectosac large, occupying the most area of the nectophore. Radial canals originate from a point which situated on the nectosac margin. Somatocyst has a short pedicel and laterally swollen. Hydroecium shallow but open widely, slanting upwards ventrally. Mouth-plate divided into two quadrangular wings with the same size. The left one overlaps the other in dorsal view. Basal facet almost vertical. A stem arise from the pedicel of the somatocyst.

Remarks.-This species is similar to *Lensia subtilis* in absence of longitudinal ridges, and widely opened hydroecium. However, this species is distinguished by the following characters: (1) short pedicel of the somatocyst, (2) laterally swollen somatocyst, and (3) almost vertical basal facet.

This is the first record of this species from Japanese waters.

Lensia multicristata (Moser, 1925)

Lensia multicristata: Totton, 1965, pp. 163-165, fig. 99, B; Alvariño, 1971, pp. 11, 21-22, 383, fig. 17; Daniel, 1974, pp. 146-147, text-fig. 10 S; Pugh, 1974, p. 51-52, fig. 5; 383, fig. 17; Daniel, 1974, pp. 146-147, text-fig. 10 S; Pugh, 1974, p. 51-52, fig. 5; Kirkpatrick and Pugh, 1984, pp. 100-101, fig. 43; Pagès and Gili, 1992, p. 91, fig. 34.

Material examined.-1 anterior nectophore, Sta. 1, Aug. 6 1996, by NORPAC net; 1 anterior nectophore. Sta. 2, Aug. 6 1996, by NORPAC net.

Description.-Anterior nectophore: Slightly swollen, up to 7.60 mm in height, 3.40 mm in width. With seven longitudinal ridges which slightly serrate at lower two third. Ventro-lateral ridges reach neither apex nor basal margin while dorso-lateral ridges reach apex but basal margin. The basal end of dorso-lateral ridges extended closer to the basal margin than the other. Jelly thin. Nectosac large, occupying the most area of the nectophore. Lateral canals arise from just above the basal margin of the nectosac. The somatocyst long, filiform with thin peduncle, extending one third to more than half of the nectosac height. Hydroecium shallow and located below the level of the ostium. No ridge between the hydroecium and the ventral facet. Mouth-plate divided whit the left wing overlapping right one in the dorsal view. Each inner corner of the wings has a small tooth. Velum narrow. Circular canal uncertain.

Remarks.-The anterior nectophore of the present species is similar to that of *L. conoidea*. The similarities and differences between the two taxa are discussed under the 'Remarks' of the latter species.

This is the first record from Japanese waters.

Lensia subtilis (Chun, 1886)

Lensia subtilis: Totton, 1932, pp. 367-368, text-figs. 34 A-B; Totton, 1965, pp. 168-170, figs. 104-105; Alvariño, 1971, pp. 11, 21-22, 385, fig. 19; Daniel, 1974, pp. 144-145, text-figs. 11 I-O; Pugh, 1974, pp. 51-52, fig. 5; Kirkpatrick and Pugh, 1984, pp. 102-103, fig. 44; Pagès and Gili, 1992, pp. 91-92, fig. 35.

Material examined.-1 anterior nectophore, Sta. 1, Apr. 17 1996, by NORPAC net; 1 anterior nectophore, Sta. 2, Aug. 6 1996, by NORPAC net; 2 anterior nectophores, Sta. 3, Sep. 12 1996, by NORPAC net; 2 anterior nectophores, Sta. 3, Dec. 14 1996, by NORPAC net; a set of nectophores, Sta. 2, Feb. 6 1997, by NORPAC net; 1 anterior nectophore, Sta. 2, Mar. 12 1997, by NORPAC net; 2 anterior nectophores, Sta. 3, Mar. 14 1997, by NORPAC net.

Description.-Anterior nectophore: Apex rounded. No longitudinal ridges. Four folds divides the nectophore surface into four facet; a ventral, a dorsal, and two laterals. The folds close to four nectosac groove. Up to 3.72 mm in height, and 1.76 mm in width. Nectosac deep, cylindrical. Lateral radial canals originate from just above the nectosac margin. Somatocyst globular with a narrow and long peduncle, reaching the half of the nectophore height. Hydroecium shallow, slanting upward toward the ventral side. No ridges between the ventral surface and the hydroecial cavity. Small mouth-plate divided into two wings, the left one overlapped the other (in dorsal view). Circular canal on velum.

Remarks.-The present species is easily distinguished from other *Lensia* species by absence of longitudinal ridges and globular somatocyst with a narrow and long peduncle.

Lensia subtiloides (Lens and Van Riemsdijk, 1908)

Lensia subtiloides: Totton, 1932, pp. 364-367, figs. 31-33; Totton, 1954, pp. 112-113, fig. 55 D; Totton, 1965, pp. 159-161, figs. 95-96, 97 B; Daniel, 1974, pp. 130-132, text-figs. 10 55 D; Totton, 1965, pp. 159-161, figs. 95-96, 97 B; Daniel, 1974, pp. 130-132, text-figs. 10 J-N; Pagès and Gili, 1992, pp. 92-93, fig. 36.

Material examined.-1 set of anterior and posterior nectophores, Sta. 3, Sept. 12 1996;

Description.-Anterior nectophore: Five longitudinal ridges reach to the apex. Jelly thin. Nectosac deep, reaching near the nectophore apex. Lateral radial canals arise from just above the nectosac margin. Somatocyst partly swollen and has a narrow stalk, reaching one third of the nectophore height. Apical part of the somatocyst curving to the ventral surface. Hydroecium shallow with the summit just above the ostium level. Mouth-plate divided into two wings of the same size both of which have round borders, and extend below the ostium. The left wing overlaps the right one.

Posterior nectophore: The five longitudinal ridges. Apical facet slightly concave. Hydroecium situated between two ventral ridges, forming a deep groove. A small tooth situated at the apical end of the left hydroecial ridge. Nectosac depressed along the hydroecial groove. Lateral canals slightly bent. Basal lamella not divided, and has rounded margin

Remarks.-The connection between the anterior and posterior nectophore of the present species is weak. All but one of our NORPAC net specimens were separated each other on collection.

Totton (1965) described that top of the hydroecium of the anterior nectophore was slightly above the ostiun level. However, Daniel (1974) and Pagès and Gili (1992) noted that the summit of the hydroecium was at the same level of the ostium. In the present specimens, top of the hydroecium extends above the ostium level. For this reason, depth of the hydroecium is not appropriate character for distinction although Totton (1954) noted hydroecium of the similar species, *L. leloupi*, was deeper than that of the present species.

of the present species.

The distinctions between the two taxa are discussed under the 'Remarks' of the

latter species.

Presence of a small tooth at the apical end of the left hydroecial ridge of posterior nectophore is a unique character to this species. The tooth is recognized only in the ventral view.

Genus *Muggiaea* Busch, 1851

Diagnosis.-Nectophore has a complete dorsal ridge, deep hydroecium, divided mouth-plate, and no teeth around ostium. Somatocyst originates from apex of the hydroecium, close to nectosac wall. Posterior nectophore not developed.

Remarks.-Type species: *M. kochi* (Will, 1844)

Five species are included in the present genus (Totton, 1965; Alcazar, 1982, not seen). Only one species, *M. atlantica*, was reported from Japanese waters. The eudoxid phase of *M. kochi* and *M. atlantica* have been described, but they are quite similar (Russell, 1938).

Muggiaea atlantica Cunningham, 1892

Muggiaea atlantica: Cunningham, 1892, 212-215, figs. 1-2; Kawamura, 1915b, pp. 193-194, pl. 7, fig. 1; Russell, 1934, pp. 555-558; Russell, 1938, pp. 441-446, text-figs. 1-6; Kawamura, 1953, p. 191; Totton, 1954, pp. 120; Yamazi, 1958, p. 137; Totton, 1965, pp. 181-183, fig. 119 B, pl. XXXII, fig. 3; Daniel, 1974, pp. 149-150, text-fig. 12 F; Pugh, 1974, pp. 59-60; Purcell, 1982, pp. 39-54; Kirkpatrick and Pugh, 1984, pp. 104-105, fig. 46; Pagès and Gili, 1992, pp.93-95, fig. 38, Toyokawa and Terazaki, 1994, pp.71-75. fig. 2.

Pagès and Gili, 1992, pp.93-95, fig. 38, Toyokawa and Terazaki, 1994, pp.71-75. fig. 2.

Material examined.-20 nectophores, Sta. 4, Apr. 17 1996, by NORPAC net; 3 nectophores, Sta. 3, Sept. 12 1996, by NORPAC net.

Description.-Nectophore: Firm. Five ridges slightly serrated, and reaching the apex. Nectosac deep, but its apex distant from top of the nectophore. Lateral canals originate from a point near apex of the hydroecium, and have two loops. Somatocyst filiform, slightly swells at the apex, running along the nectosac, and reaching near the top of the nectosac. Hydroecium deep, about one third of nectosac length. The mouth of the hydroecium widens sharply. No basal teeth around ostium. Mouth-plate divided, left wing (in dorsal view) overlaps right one.

Remarks.-Cunningham (1892) originally described this species based on materials collected from off Plymouth, English Channel, on September 1891. The eudoxid stage and early development of this species were described by Russell (1938). Eudoxids of this species, are virtually indistinguishable from those of *M. kochi* (Russell, 1938). Posterior nectophore is not developed (Totton, 1965).

Anterior nectophore of this species is distinguished from that of *M. kochi* by a long somatocyst and deep hydroecium but other than these two characters, both species are quite similar. In *M. atlantica*, apex of the somatocyst reaches near the top of the nectosac, and apex of the hydroecium reaches to one third of the nectosac. In *M. kochi*, apex of the somatocyst reaches midway up the nectosac, and apex of the hydroecium reaches to 15-16% of the nectosac (Totton, 1965). Some specimens collected had somatocyst that reached half way up the nectosac, are regarded as abnormal specimen of *M. atlantica*, not *M. kochi*, because of the deep hydroecium.

Russell (1934) reported the occurrence of the above mentioned two species in the English Channel from 1913 to 1934. *M. atlantica* except for 1915, was found every year from 1913 to 1924, but from 1925 this species was replaced by *M. kochi*. He als

noted that both species are essentially inhabitants of coastal waters with low contamination. In the present study, *M. kochi* was not collected.

Feeding and growth of *M. atlantica* was reported by Purcell (1982). In her study, the growth rate and maturation time of eudoxids were also estimated. Such studies on eudoxids are still very rare.

Genus *Chelophyes* Totton, 1932

Diagnosis.-Anterior nectophore has a short dorsal ridge from the ostium towards the apex, and crow-shaped hydroecium. Only three ridges reach the apex.

Remarks.-Type species: *Chelophyes appendiculata* (Eschscholtz, 1829)

The present genus include two species, *C. appendiculata* and *C. contorta*. Although the polygastoric stage of these two species were previously included in the genus *Diphyes*, and the monogastric eudoxid stage as *Eudoxia* or *Eudoxoides*, Totton in 1932 separated these two species from *Diphyes* and established *Chelophyes*. Eudoxids of this genus and *Muggiaea* are very similar.

Chelophyes contorta (Lens and Riemsdijk, 1908)

Chelophyes contorta: Totton, 1965, pp.187-188, figs. 125-126; Alvariño, 1971, pp. 9, 17-18, 369, fig. 3; Daniel, 1974, pp. 156-159, text-figs. 12 O-Q; Pagès and Gili, 1992, pp. 96-97, fig. 41.

Diphyes contorta: Kawamura,1915d, pp.433-434, pl. 12, fig. 17; Browne, 1926, pp. 71-73; Kawamura, 1953, p, 103; Yamazi, 1958, p. 137.

Kawamura, 1953, p, 103; Yamazi, 1958, p. 137.

Material examined.-1 anterior nectophore, Sta. 4, Jul. 19 1996, by Norpac net; 5 anterior nectophores, Sta. 2, Sep. 12 1996, by Norpac net; 1 anterior nectophores, Sta. 4, Sep. 12 1996, by Norpac net.

Description.-Anterior nectophore: Up to 5.32 mm in height, 2.32 mm in width. Firm. Five longitudinal ridges, left ventral ridge and two lateral ones reach the apex, right ventral one reaches neither the apex nor the basal margin, only a short section of the dorsal ridge visible above the ostium. Lower half of both ventral ridges, basal margin of hydroecium, and margin of mouth-plate noticeably serrate. Lateral ridges and upper portion of the ventral ridges slightly serrated. Nectosac large, occupying most of the nectophore. Somatocyst, ovoid, originating from the apex of the hydroecium with a long and narrow peduncle, as it rises, it bends to the right. Hydroecium, horn-shaped, directed toward the ventral surface. Mouth-plate divided into two wings, left one overlaps the other. Each wing has a small tooth at the center of the margin.

Remarks.-The present species and *C. appendiculata* are similar in the following characters: only three ridges of the five reach the apex; the dorsal ridge is short; the hydroecium is horn-shaped. In *C. contorta*, the two lateral and left ventral ridges reach the apex, versus the two ventral and right lateral in *C. appendiculata*. The hydroecium of the former species is shallower than that of the latter, but the most distinct character is that the somatocyst of the former bends, rather than straight in the latter.

Daniel (1974) described the right ventral ridge as running from just below the apex to near the base (basal margin of the nectophore) as in the present specimens. Others (Kawamura, 1915; Totton, 1965; Pagès and Gili, 1992), sketched the ridge as reaching the basal margin. Kawamura (1915) sketched the present species based on reaching the basal margin. Kawamura (1915) sketched the present species based on material collected from Misaki, however, there were no teeth on the mouth-plate in his

figure.

Genus *Eudoxoides* Huxley, 1859

Diagnosis.-Small rigid nectophore. Anterior nectophore has a complete dorsal ridge, but no latero-ostial teeth. Mouth-plate of the anterior nectophore divided, its baso-lateral angles lancet-shaped. Hydroecium deep.

Remarks.-Type species: *Eudoxoides mitra* (Huxley, 1859)

The generic name *Eudoxoides* was used by Huxley for eudoxid of *E. mitra*. Because of presence of the deep hydroecium and absence of teeth around ostium except a dorsal tooth in *E. mitra*, however, the generic characters of this genus are similar to these of genus *Muggiaea*. However, the present genus is distinguished by the lancet-shaped wings of the mouth-plate with sharp baso-lateral angles. There are two species in this genus. In the previous studies, one of the generic characters has been described as absence of conspicuous ostial teeth (Totton, 1965; Kirkpatrick and Pugh, 1984). However, this descriptions is not suitable since *E. mitra* has a distinct dorsal tooth.

Eudoxoides mitra (Huxley, 1859)

Eudoxoides mitra: Totton, 1965, pp. 188-189, fig. 127, pl. XXXIII, fig. 4-5; Daniel, 1974, pp. 159-163, text-figs. 13 C-H; Pugh, 1974, pp. 62-64, fig. 9; Pagès and Gili, 1992, pp. 97-99, fig. 42.

Diphyopsis mitra: Bigelow, 1913, p. 78; Bigelow, 1918, pp. 423-424; Alvariño, 1971, pp. 9, 19, 67-71, 374, fig. 8.

19, 67-71, 374, fig. 8.

Material examined.-1 anterior nectophore, Sta. 3, Aug. 6 1996, by NORPAC net; 1 anterior nectophore, Sta. 3, Dec. 14 1996, by NORPAC net;

Description.-Five ridges converges at apex. These ridges serrated at lower two third. Nectosac cylindrical. Lateral radial canals not connected to dorsal canal, both rising from margin of the nectosac. Connection between lateral and ostial canals uncertain. Ostial canal situated on velum. Somatocyst short, spindle-shaped or carrot-shaped with short peduncle. Hydroecium cylindrical with truncated apex. Four basal corners of hydroecium pointed prominently. Ventral margin of the hydroecial opening V-shaped. Dorsal ridge elongated below ostium level and forming a tooth. No lateral teeth. Mouth-plate divided into two wings. The right wing, with a tooth at mid portion of the margin, wider than the other. The left wing has a secondary flap near the tooth on hydroecial side. This flap nearly semicircular but slightly pointed. The left wing overlaps the right one.

Remarks.-Genus *Eudoxoides* includes two species, the present species and *E. spiralis*. Anterior nectophore of both species has complete dorsal ridge and a mouth-plate divided into two lancet-shaped wings with sharp baso-lateral angle. These are generic characters of genus *Eudoxoides*. Moreover, in both species, hydroecial apex is truncated and lateral radial canals are not connected dorsal canal. However, the two species are easily distinguished by the spirally twisted nectophore of *E. spiralis*. Although the anterior nectophore of the present species is similar to that of *Chelophyes appendiculata* in general shape, they are distinguished by (1) five complete ridges, (2) truncate hydroecial apex, (3) presence of a dorsal tooth in *E. mitra*.

In the previous studies, there is no description about the portion where the lateral radial canals arise. In the present specimens, lateral radial canals are not connected radial canals arise. In the present specimens, lateral radial canals are not connected to dorsal canal, both rising from margin of the nectosac, and connection between lateral

and ostial canals are uncertain. Although Bigelow (1918) and Totton (1965) described that somatocyst of *E. mitra* reached only the mid-level of the nectosac, the somatocysts in the present specimens are shorter, not reaching the mid-level. In the specimens from Benguela Current, southeastern Atlantic, somatocysts are less than mid-level of the nectosac, too (Pagès and Gili, 1992). Various shapes of somatocyst have been reported: e.g. pear-shaped (Totton, 1965), sausage-shaped (Pagès and Gili, 1992), spindle-shaped or carrot-shaped (present study).

Eudoxoides spiralis (Bigelow, 1911)

Eudoxoides spiralis: Totton, 1965, pp. 189-191, fig. 128-129, pl. XXXII, fig. 5-6; Alvariño, 1971, pp. 10, 20, 81-86, 377, fig. 11; Daniel, 1974, pp. 163-164, text-figs. 12 R-U, 13 A-B; Pugh, 1974, pp. 63-64; Kirkpatrick and Pugh, 1984, pp. 110-111, fig. 49; Pagès and Gili, 1992, pp. 99-100, fig. 43.

Diphyes spiralis: Bigelow, 1913, p. 76;Kawamura, 1915d, pp. 432-433, pl. 12, figs. 15-16.

Muggiaea spiralis: Kawamura, 1953, p. 101; Yamazi, 1958, p. 138.

Material examined.-2 anterior nectophores, Sta.2, Feb. 6 1997, by NORPAC net; 2 eudoxids and 4 anterior nectophores, Sta. 3, Feb. 6 1997, by NORPAC net; 2 anterior nectophores, Sta. 4, Apr. 17 1997, by NORPAC net.

Description.-Nectophore: Firm and spiraled, up to 5.33 mm in height, 2.56 mm in dorso-ventral width. With five serrated ridges, only four of them reaches at apex. The left ventral ridges reaches neither apex nor base, meeting the right ventral one at the apical end, and ending near ostium level at the basal end. The lower half of the the apical end, and ending near ostium level at the basal end. The lower half of the ventral ridges serrated stronger than the upper half. Nectosac spiraled and has

rounded apex with four ridges. Lateral radial canals not connected to dorsal canal, rising from margin of the nectosac. Ostial canal uncertain. Somatocyst tapering, carrot-shaped, more than half as long as the nectosac, lies obliquely to the right of the main axis. Hydroecium, asymmetrical, compressed laterally. Each dorso-lateral margin of the hydroecium forms a prominent tooth. Right lateral margin of the hydroecium obliquely to and left margin parallel to ostium. The margins of the left lateral wall and right one not meet. No ostial teeth. Mouth-plate divided into two wings. Right wing larger than left one which covers the right one.

Bract: Slender, hood-shaped with two slightly serrated ridges. Up to 2.25 mm in height, 1.18 mm in width. Ventral surface form deep groove. Phyllocyst long and tapering, nearly reaching the apex of the bract. Neck-shield large. No basal teeth on margin of the neck-shield. Hydroecial cavity not deep.

Gonophore: Spirally twisted in reverse way to nectophore. Up to 2.68 mm in height, 0.98 mm in width. Four ridges slightly serrated. No basal teeth. Margin of mouth-plate rounded.

Remarks.-Although the present species and *E. mitra* are included in the same genus, anterior nectophores of the two species are fairly different at first glance. The similarity of the two species is discussed under 'remarks' of the *E. mitra*.

Posterior nectophore is not reported to develop in the previous studies (Totton, 1965; Pagès and Gili, 1992). Totton (1965) described that the left-hand wing of the mouth-plate bore a triangular flap or tooth as in *E. mitra*. However, in the present specimens, the left wing bears no flaps and teeth. There is no description about the flap in the previous studies except this Totton's.

Genus *Sphaeronectes* Huxley, 1859

Diagnosis.-Single nectophore nearly globular or hemispheric, fragile. Nectosac hemispheric or conical. Hydroecium, deep and hollow.

Remarks.-Type species: *Sphaeronectes gracilis* (Claus, 1873, 1874)

The family Sphaeronectidae is monogeneric, and the genus *Sphaeronectes* as reviewed by Carré (1968), presently continuous five species. Totton (1965) suspected that *Sphaeronectes* was a neotenous.

Yoshida (1896) described and sketched one *Sphaeronectes* collected from Misaki which he could not identify by species. Today, the specimen shown can be identified as *S. irregularis* due to shape of the somatocyst and looped lateral canal. This is the only report of this genus in Japanese waters. Two other species are added to the Japanese fauna of Siphonophores in the present study.

Sphaeronectes gamulini Carré, 1966

Sphaeronectes gamulini: Carré, 1966, pp. 1069-1076, figs. 1-4, photos 1-5: Carré, 1968, pp. 85-94, pls. 1-2, tab. 1-2; Ianora and Scotto Di Carlo, 1981, pp. 54, 59, tab. 1.

Material examined.-2 nectophores, Sta. 2, Mar. 12 1997, by NORPAC net.

Description.- Nectophore; Nearly spherical, but opening of hydroecium slightly projected (in lateral view). In ventral view, compressed laterally. Up to 2.60 mm in height, 2.46 mm in width. Jelly thick and firm. Nectosac bell-shaped, width about half that of the nectophore. Two lateral canals, forming an arc, a central dorsal canal, a ventral canal, and a short pedicular canal all emanate from a single, central point a ventral canal, and a short pedicular canal all emanate from a single, central point within the nectosac. Lateral canals asymmetric, right one higher than left, and left

emanating horizontally before turning upward. Somatocyst about halfway up the nectosac, ovoid with narrow stalk extended out horizontally, from the nectosac. Pedicular canal joins stalk almost at its basal point. Hydroecium deep, opening wide. Hydroecial cavity slightly faces left (in ventral view), apex reaching up to half of nectosac height. Upper wall of this cavity nearly horizontal. Velum uncertain.

Remarks.-Carré (1966) originally described this species based on nectophores and eudoxids collected from Villefrance-sur-Mar, France, Mediterranean.

Nectophore of this species is similar to that of *S. gracilis* and *S. irregularis*. This species and *S. irregularis* are distinguished from *S. gracilis* by somatocyst arising mid-nectosac and arched lateral canals. *S. gamulini* differs from *S. irregularis* by: (1) somatocyst composed of an ovoid swollen part and a stalk extending horizontally; and (2) asymmetric lateral canals.

Carré (1966) sketched a well developed velum. In the two specimens examined, however, the velum is uncertain due to damage of the body parts during collection. His description, "in ventral view, the left lateral canal and the dorsal one are about 45° apart, and the right and dorsal ones are about 90° apart" fits present specimens.

Carré (ibid.) described eudoxids of three *Sphaeronectes* species: *S. gamulini*, *S. gracilis*, and *S. irregularis* based upon those released by reared polygastric colonies. The eudoxid of *S. gamulini* differs from the other two species by: (1) the phyllocyst consists of a swollen part and stalk; (2) the hydroecium is not developed; and (3) basal surface of the bract is almost flat. The eudoxid of *S. gracilis* is distinguished from that of *S. irregularis* by the fusiform shape and higher phyllocyst.

This is the first record of this species in Japanese waters.

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Sphaeronectes gracilis (Claus, 1873, 1874)

Sphaeronectes gracilis: Totton, 1965, pp. 202-203, fig. 138, pl. XXX VI, fig.1; Carré, 1968, pp. 85-94, pls. 1-2, tabs. I-II; Daniel, 1974, pp. 173-175, text-figs. 14 C-D; Purcell, 1980, p. 1045; Ianora and Scotto Di Carlo, 1981, pp. 55-61, fig. 2C, 3C, 4-2, tab. 1; Purcell and Kremer, 1983, pp. 95-104; Kirkpatrick and Pugh, 1984, pp. 126-127, fig. 56; Pagès and Gili, 1992, p. 100, fig. 44.

Material examined.-8 nectophores, Sta. 4, Feb. 6 1997, by NORPAC net; 2 nectophores, Misaki, Feb. 7 1997 by hand net.

Description.-Nectophore: Near spherical, up to 3.93 mm in height and 4.08 mm in width. Jelly, thick, especially in upper half, but fragile. Surface of the nectosac adhesive. Nectosac hemispherical, height about half that of the nectophore. All canals except circular one emanate from a single point above the apex of the nectosac. Lateral canals not arched, symmetrical, but bent slightly just below apex, emanating at almost right angles to the dorsal and ventral canals. Pedicular canal, short but distinctive, connecting the common point with the somatocyst. Somatocyst fusiform, above the nectosac, usually running along it, occasionally extending upward obliquely. Hydroecium tubular, deep, along the nectosac reaching the juncture of somatocyst and pedicular canal.

Remarks.-This species is similar to *S. irregularis* and *S. gamulini*, differences previously discussed under 'Remarks' of the latter species.

Totton (1965) stated that "the somatocyst varies in shape, probably with age. Instead of curving over toward the dorsal side the tip may continue to grow spirally to Instead of curving over toward the dorsal side the tip may continue to grow spirally to form even more than one complete turn." Kirkpatrick and Pugh (1984) sketched this

turn. In the present study, however, no specimen had such a spiral somatocyst. Purcell and Kremer (1983) noted that on the specimens they caught by scuba diving had a chain of some 17-60 gastrozooids extending <10 cm. In the present specimens caught by hand or NORPAC net, the outer part of hydroecium of the chain were apparently torn off. Feeding behavior and metabolism of the present species was also reported by Purcell and Kremer (1983). In an earlier paper, Purcell (1980) noted that *S. gracilis* is a strong swimmer.

This is the first record of this species in Japan.

Sphaeronectes irregularis (Claus, 1873)

Sphaeronectes irregularis: Totton, 1965, p. 203: ; Carré, 1966, pp. 1070, 1072, 1074, 1076; Carré, 1968, pp. 85-94, pls. 1-2, tabs. I-II; Ianora and Scotto Di Carlo, 1981, pp. 54, 56-57, 59, 61, fig. 4, tab. 1;

Material examined.-7 nectophores, Sta. 3, Dec. 14 1996, by NORPAC net; 1 nectophore, Misaki, Feb. 7 1997, by hand net; 4 nectophores, Sta. 3, Mar. 14 1997 by NORPAC net.

Description.-Nectophore: In lateral view, somewhat rounded four-sided approaching hemispherical, up to 3.04 mm in height, 3.34 mm in width. Slightly wider than high. Jelly, thick, especially in apex and ventral side. Nectosac nearly conical, apex often pointed. Lateral and dorsal canals arise from a point on the side of the nectosac that also meets the apex of the hydroecium. Somatocyst also originates at this point. Pedicular canal absent. Lateral canals arced prominently, and symmetric. Pedicular canal absent. Lateral canals arced prominently, and symmetric. Somatocyst club-shaped or globular, extending up the side of the nectosac vertically.

Hydroecium deep and conical, slightly compressed laterally, cavity reaching one-third to half the height of the nectosac, rarely a bit more. Velum narrow and weak, easily broken.

Remarks.-This species is similar to *S. gracilis* and *S. gamulini*, differences of their nectophores and eudoxids previously discussed under 'remarks' of the latter species.

Totton (1965) noted that the nectophore is up to 7.1 mm in height and 5.7 mm in width, though Carré (1968 b) described some of 3 mm in height. Specimens in this study were closer in size to those of Carré.

Ianora and Scotto Di Carlo (1981) reported vertical distribution of the *S. irregularis* in the Gulf of Naples, Italy, Mediterranean as being found in the upper 40 m.

In many specimens, velum is damaged during collection.

Genus *Abylopsis* Chun, 1888

Diagnosis.-Anterior nectophore polyhedric with seven facets of which two apico-lateral facets joined at the apical ridge. Each lateral side divided into two; apico-lateral and baso-lateral facets. Somatocyst swollen and ovoid, with a small apical diverticulum. Bottom of somatocyst located on side of the hydroecium.

Remarks.-Type species: *A. tetragona* (Otto, 1823)

Two species are included in this genus, both well known in Japanese waters.

Abylopsis eschscholtzi (Huxley, 1859)

Abylopsis eschscholtzi: Bigelow, 1913, p. 69; Kawamura, 1915 e, pp. 584-585, pl. 15, figs.

37-38; Kawamura, 1953, p. 104; Sears, 1953, pp. 84-86, figs. 2 D, 25 B, E, 26 B; Totton 1965, pp. 218-219, pl. XL, figs. 2, 4, 6; Daniel. 1974, pp. 200-203, text-figs. 17 J-R; Pugh, 1974, p. 70; Pagès and Gili, 1992, p. 108, fig. 51.

Material examined.-1 bract, Sta. 3, Dec. 14 1996, by NORPAC net; 1 anterior nectophore, Sta. 3, Feb. 6 1997, by NORPAC net;

Description.-Anterior nectophore: Polyhedron with seven facets. Ventral, dorsal and two baso-lateral facets pentagonal, two apico-lateral facets rectangular, baso-ventral facet trapezoid. Median apical ridge minutely serrated, other ridges serrated prominently. Nectosac deep. Lateral radial canals arise from a point connected with pedicular canal, descending to ostial canal, not forming a loop. Velum narrow. Somatocyst large and globular, with apical diverticulum, top of which reaching level to that of nectosac. Base of somatocyst located on upper side of hydroecium. Hydroecium deep, reaching nearly to the mid point of the nectophore.

Posterior nectophore: Prism-shaped with five longitudinal ridges. Two ventral ridges strongly serrated, two lateral and a dorsal ones slightly, all ridges form teeth at basal ends. Basal horizontal ridges all serrated. Apophysis long, elongated bending sharply dorsally. Left, upper ventro-lateral portion truncated appearing as a triangular facet. Hydroecium overlapped by two lappets, right one overlapping left, which project from both sides of ventral surface. Basal margin of right lappet strongly serrated while that of left one smooth.

Bract: Symmetric polyhedron with seven facets. Apical and apico-lateral facets rectangular, dorsal one pentagonal, and ventral one hexagonal with basal edge concave. Both basal edges of hydroecium have a tooth. All ridges and the hydroecial edges Both basal edges of hydroecium have a tooth. All ridges and the hydroecial edges below the teeth serrated. Phyllocyst has large lateral process. Hydroecium deep,

opening wide.

Remarks.-Anterior nectophore of this species is quite similar to that of *A. tetragona*. The differences between the two species are discussed under 'Remarks' of the next species. Anterior and posterior nectophores are almost always separated during collection by the NORPAC or ORI net. The connection between both nectophores of this species is weaker than that of *A. tetragona*.

Abylopsis tetragona (Otto, 1823)

Abylopsis tetragona: Bigelow, 1913, pp. 68-69; Kawamura, 1915d, pp. 581-584, pl. 15, figs. 32-36; Kawamura, 1953, p. 104; Sears, 1953, pp. 80-84, figs. 2, 25; Totton, 1954, pp. 155-157, text-figs.82-83; Yamazi, 1953 p. 137; Totton 1965, pp. 216-218, fig. 149-150, pl. XL, figs. 1, 3; Daniel, 1974, pp. 195-200, text-figs. 17 A-I; Pugh, 1974, pp. 69-70; Kirkpatrick and Pugh, 1984, pp. 132-133, fig. 58; Pagès and Gili, 1992, pp. 106-108, fig. 50.

Material examined.-1 nectophore, Sta. 3, July 15 1997, by NORPAC net;1 set of nectophores, Sta. 1, Aug. 6 1996, by NORPAC net; 11 anterior nectophores, Sta. 2, Sep. 12 1996, by NORPAC net; 2 eudoxids, Sta. 3, Sept. 12 1996, by NORPAC net.

Description.-Anterior nectophore: A stout heptahedron with seven facets. Ridges slightly serrated, however strongly dentate in basal region. Ventral and dorsal surface pentagonal. Dorsal facet smaller and narrower than ventral one. Nectosac deep and cylindrical reaching near the top of the nectophore. Radial canals arise from a point connected with the pedicular canal and rising toward the apex of the nectosac, a point connected with the pedicular canal and rising toward the apex of the nectosac, forming an arc, and running down to the circular canal. Somatocyst large and

globular, with an apical diverticulum, the apex of which reaches level to that of the nectosac. Base of the somatocyst located on side of the hydroecium. The hydroecium deep and cylindrical reaching near the mid point of the nectophore. Basal margins of both ventral and dorsal wall of the hydroecium concave, ventral concaveness larger.

Posterior nectophore: Long, and nearly pentagonal in cross section. Five longitudinal ridges serrated. Tooth at basal end of each ridge. Left ventral and right lateral teeth larger than others. Apophysis prominent. Nectosac large and cylindrical. Four radial canals rising from a point connected with pedicular canal at the apex of the nectosac. Right lateral one divides, part continuing at the mid point of the nectosac, the other part turns perpendicular and then downward, joining the ostial canal at a right angle. A short canal extends obliquely upward from near the basal margin of the left ventral canal. Tip of the short canal swollen. Hydroecium at right side of the ventral surface covered by two lappets. Left one (inner) comb-shaped, projected from center of the ventral surface. Right one (outer) serrated only at transverse basal margin, projected from the right ventral ridge. Small projection on the basal surface near each lateral tooth.

Bract: Dorsal facet pentagonal. Apical, ventral, and lateral facets almost rectangular. All ridges serrated except apical ones. Phyllocyst with ascending diverticulum reaching nearly to the apical facet, dorsal branch, and two large lateral processes above the hydroecium,. Hydroecium deep, reaching halfway up the bract. Each baso-lateral margin of the hydroecium has a prominent tooth. Margin serrated only below the teeth.

Gonophore: Nearly a rectangular prism with four acute lateral teeth.

Remarks.-Anterior nectophore of the present species is quite similar to that of *A.*

Remarks.-Anterior nectophore of the present species is quite similar to that of *A.*

eschscholtzi. The most easily distinguished character between the species is the

course of the lateral radial canals. *A. tetragona* forms an upward loop while that of *A. eschscholtzi* solely descends. Dorsal facet in the former species is smaller and more compressed than the ventral one, while in the latter species, both facets are the same size. In previous studies, ridges of *A. tetragona* were reported to be not strongly serrated while those of *A. eschscholtzi* were heavily (Sears, 1953, Pagès and Gili, 1992). However, in this study, serration of the ridges in *A. tetragona* was found to vary.

The posterior nectophore of the present species is distinguished from *A. eschscholtzi* by: (1) longer body; (2) shorter apophysisis; (3) more complicated canal system; (4) more prominent ventral teeth.

In previous studies, anterior and posterior nectophores measured up to 6 mm and 18 mm in height respectively (Bigelow, 1913; Kawamura, 1953: Pagès and Gili, 1992), except for British specimens which were larger, up to 10 mm and 40 mm in height respectively (Kirkpatrick and Pugh, 1984). This is the most common Diphyid species found in coastal Japan (Kawamura, 1953).

Genus *Bassia* Agassiz, 1862

Diagnosis.-Arrangement of facets and ridges of the anterior nectophore resemble that of *Abylopsis* species. The somatocyst without apical diverticulum located on the apex of the hydroecium.

Remarks.-Type species: *Bassia bassensis* (Quoy and Gaimard, (1883) 1884)

This is a monotypic genus for *Bassia bassensis* which is well known in Japanese waters.

Bassia bassensis (Quoy and Gaimard, (1883) 1884)

Bassia bassensis (Quoy and Gaimard, (1883) 1884)

Bassia bassensis: Kawamura, 1915e, pp. 585-587, pls. 15, figs. 39-42; Kawamura, 1953, p. 104; Sears, 1953, pp. 94-98, figs. 2 F, 28 B-C; Totton, 1965, p. 219-220, fig. 151, pl. XL, fig. 5; Daniel, 1974, pp. 204-208, text-figs. 18 A-G; Pugh, 1974, p. 70-72, fig. 11; Kirkpatrick and Pugh, 1984, pp. 134, 137, fig. 60, not fig. 59; Pagès and Gili, 1992, pp. 109-110, fig. 52.

Material examined.-1 anterior nectophore, Sta. 1, Aug. 6 1996, by NORPAC net; 1 bract. Sta. 3, Sept. 12 1996, by NORPAC net; 1 eudoxid, Sta. 1, Mar. 12 1997, by NORPAC net.

Description.-Anterior nectophore: Polyhedral with seven facets. Arrangement of facets and ridges similar to that of the genus *Abylopsis*. Dorsal and baso-lateral facets pentagonal, apico-lateral facets quadrangular, ventral facet pentagonal star-shaped, baso-dorsal facet which has ostium rectangular and flat. All ridges obviously serrated. Somatocyst globular located above top of the hydroecium. Apical diverticulum absent. Deep hydroecium has V-shaped baso-ventral margin. Nectosac small. Radial canals descending to ostium canal with a slight curve.

Posterior nectophore: Inner and outer flaps of the hydroecium fused each other so that the hydroecium appears tube-shaped although only basal portion of it divided into two flaps. Hydroecial tube located right side of the hydroecium. Right flap serrated prominently. Apophysis short.

Bract: Up to 3.8 mm in height. Dorsal surface rhomboidal, ventral surface hexagonal with prominent basal concave, and two apico-lateral surface quadrangular. Both baso-ventral ridges have a tooth. Hydroecium deep, reaching the mid point of the bract. Phyllocyst swelling in upper part toward the apex of the bract, and narrow in bract. Phyllocyst swelling in upper part toward the apex of the bract, and narrow in lower part running along the hydroecium, without lateral processes.

Remarks.-Anterior nectophore of this species is similar to *Abylopsis* species in its outline. The differences from *Abylopsis* species are; there is no diverticulum at apex of the somatocyst, and the somatocyst located at apex of the hydroecium. The connection between anterior and posterior nectophores is weak. They are almost always separated during collection by NORPAC or ORI net. Fused hydroecium of the posterior nectophore is unique character that appears in no other species.

Genus *Enneagonum* Quoy & Gaimard, 1827

Diagnosis.-Lopsided cube of eight facets. Four upper facets joined at the apex of the nectophore. Each lower facet situated between two upper ones. Elongated somatocyst with apical diverticulum situated on the apex of the hydroecium. Posterior nectophore not produced. Bract nearly cubic.

Remarks.-Type species: E. *hyalinum* Quoy and Gaimard, 1827

Although the present genus was regarded as monotypic for *E. hyalinum* (e. g. Sears, 1953; Totton, 1965), until Alvariño (1968) described the second species, his description of *E. searsae* was only of the eudoxid phase. As yet, the polygastric phase has not been identified.

Enneagonum hyalinum Quoy and Gaimard, 1827

Enneagonum hyalinum: Sears, 1953, pp. 98-102, figs. 28 A, 29; Totton, 1965, pp. 220-221, fig. 153; Alvariño, 1971, pp. 12, 25, fig. 39; Daniel, 1974, pp. 209-212, text-figs. 18 H-M; Pugh, 1974, pp. 72-73, fig. 12; Kirkpatrick and Pugh, 1984, pp. 135-136, fig. 59, not fig. 60; Pagès and Gili, 1992, pp. 110-111, fig. 53.

not fig. 60; Pagès and Gili, 1992, pp. 110-111, fig. 53.

Material examined.-1 eudoxid, Sta. 1, Aug. 6 1996, by NORPAC net.

Description.-Bract: Nearly cubical with five concave facets, dorsal one largest. Phyllocyst has large lateral process and prominent apical diverticulum, but lacks descending dorsal branch. Hydroecium deep, reaching mid point of the bract, and widely open.

Gonophore: Complicated multi-horned structure. Large hydroecial surface slightly curved. Left ventral ridge turned behind hydroecial surface, reaching to one-third the gonophore. Prominent hook on left side of hydroecial surface. Five basal teeth; two ventral large and prominent, two lateral not prominent and at about ostium level, and a dorsal not prominent. Serration on lateral ridges only just above basal margin. Dorsal ridge not serrated and shortest. Three lappets, a ventral and two lateral, overlap the ostium. Triangular cavity in left side of latero-dorsal portion. Apex of the cavity higher than that of nectosac.

Remarks.-The similarities and differences between two *Enneagonum* species are discussed under the 'remarks' of the *E. searsae*.

Enneagonum searsae Alvariño, 1968

Enneagonum searsae: Alvariño, 1968, pp. 340-346, fig. 1; Alvariño, 1971, pp. 13, 26; Daniel, 1974, pp. 212-213, text-figs. 18 N-P.

Material examined.-1 eudoxid, Sta. 2, Aug. 6 1996, by NORPAC net

Description.-Bract: Four footed cube of five facets, apical, ventral, dorsal, and two lateral. All facets conspicuously concave. Apical facet almost square, ventral a ones lateral. All facets conspicuously concave. Apical facet almost square, ventral a ones trapezoid. Dorsal one nearly hexagonal and larger than the ventral. Two lateral

facets same size. Four longitudinal ridges descending vertically from each corner of the apical facet to the mid point of the bract, them extending outward to give the bract an appearance of a truncated square pyramid with four feet. Pair of dorso-longitudinal ridges longer than ventro-longitudinal ones. Pointed portion of the basal margin of the dorsal facet serrated. but other margins not serrated. Basal margins of the lateral facets prominently concave. Phyllocyst has swollen lateral branches and a pointed apical diverticulum, but lacks descending dorsal branch. Hydroecium reaches to mid point of the bract, and widely open.

Remarks.-The present species originally described by Alvariño (1968) was based only on eudoxids collected from the South China Sea. A polygastric specimen has not been collected to date.

The eudoxid of the present species is similar to that of *E. hyalinum*. However, the bract of the present species is distinguished from the latter species by the following characters: (1) general shape is a truncated square pyramid rather than cubic, (2) each basal corner is projected prominently, (3) each facet is more strongly concave. The phyllocyst of the both species lacks the descending dorsal branch which distinguish them from all other known genera of Abylids (Sears, 1953).

In the present study, the gonophores of the two species are very similar. Alvariño (1968) noted that the dorsal and lateral teeth of the gonophore of *E. searsae* are more prominent than that of *E. hyalinum*, and these teeth are emphasized by ridges like wings and by strong serrations. However, such distinguishing characters could not be identified in the collected specimens. So it is impossible to distinguish the gonophores between the two species.

The present material is slightly smaller than the specimen (bract, 7 mm high;

The present material is slightly smaller than the specimen (bract, 7 mm high;

gonophore. 2.7 mm high) sketched by Alvariño (1968). The bract of the present

material has conspicuously concave facets more bowed in the center, while specimen in Alvariño's sketch did not have this shape. The dorsal and lateral teeth of the present gonophore are not prominent.

In the collected gonophore, the dorsal tooth is especially short, not reaching the level of the lateral teeth while the dorsal one in Alvariño's specimen does.

This is the first record of this species in Japanese waters.

3-4. Seasonal occurrence in Sagami Bay

Density of total planktonic cnidarians (inds. / m^3) peaked in spring (figure 45). The density was 66.73 inds. / m^3 in April. and declined rapidly after that. Especially it was low level from October to January with the minimum of 0.76 inds / m^3 in November. and suddenly increased to the maximum level (68.69 inds. / m^3) in March.

Seasonal occurrence of the dominant species are summarized in Figure 46.

Muggiaea atlantica: This species occurred every month during the study. Three distinctive patterns were observed in the seasonal occurrence: most abundant period, April and March in which water temperature was lowest; abundant period, from May to September and February; less abundant period, from October to January. In April, the density of this species was maximum (47.4 inds. / m^3). From May to September, it decreased suddenly, ranging between 2.66 and 6.13 inds. / m^3. It was low level below 1 inds. / m^3 in next four month , and increased to the level of 3.54 inds. / m^3 in February, and 32.8 inds. / m^3 in March.

Obelia spp.: This species occurred in all months except November. There were three peaks of the appearance in May, September, and March, with the densities of 16.7, 2.98, and 12.8 inds. / m^3, respectively. These species were dominant in May.

and 12.8 inds. / m^3, respectively. These species were dominant in May.

Solmundella bitentaculata: This species were abundant from April to June with the

densities ranging between 6.59 and 4.21 inds. / m^3, while less dense from July to February with the level below 1 inds. / m^3, not collected in October and November, and suddenly increased after that, reaching the maximum of 9.85 inds. / m^3 in March.

Rathkea octopunctata: This species occurred only in March with the density of 11.1 inds. / m^3.

Sugiura chengshanense: This species appeared in April, May and March. The maximum density was 6.46 inds. / m^3 in April. Only a single specimen was collected in August.

Liriope tetraphylla: This species occurred all months and abundant from July to September with the densities ranging between 1.07 and 1.38 inds. / m^3, but was less abundant with the level below 1 inds. / m^3 in other nine months.

Aglaura hemistoma: This species was collected in all months. The seasonal occurrence of this species shows two peaks, spring and end of summer. The densities were 1.05 and 0.67 inds. / m^3 in April and March respectively, and it reached the maximum of 1.46 inds. / m^3 in September. This was the dominant species in October and November.

Eucheilota paradoxica: In April, from June to September, and in March, this species was abundant with the maximum density of 0.88 inds. / m^3 in April, while not collected October , November , and January. Although the density was prominently low in May, this species was generally abundant spring and summer.

Although only a small number of specimens were collected, clear seasonal occurrence patterns emerge for many other species as follows.

Persa incolorata: During the study, this species was collected all months. The maximum density (1.28 inds. / m^3) appeared in April, and it decreased after August.

Abylopsis tetragona: This species was collected all months except June. From July to

Abylopsis tetragona: This species was collected all months except June. From July to

September, this species was abundant reaching the maximum density of 0.37 inds. / m^3

in September.

Sphaeronectes gracilis: This species was collected except in June and November. In April and January to March, the density increased and reached the maximum density of 0.29 inds. / m^3 in March.

Sphaeronectes irregularis: This species was collected in all months. The pattern of its occurrence was similar to *S. gracilis*, with the maximum density of 0.27 inds. / m^3 in February.

Solmaris rhodoloma: This species occurred only in April, and the density was 0.69 inds. / m^3.

Diphyes chamissonis: This species was abundant in September with the maximum density of 0.17 inds. / m^3.

4. Discussion

4-1. Species composition of Sagami Bay

Simura *et al.* (1992) reported 28 hydroidmedusae (12 anthomedusae, eight leptomedusae, four limnomedusae, two trachymedusae, and two narcomedusae) from Enoshima, coastal of Sagami Bay. Among the 28 species, only 5 species, *Rathkea octopunctata*, *Sugiura chengshanense*, *Liriope tetraphylla*, *Solmundella bitentaculata*, *Obelia* spp., were collected in this study. The former four species have an ability to produce medusae either sexually or asexually in planktonic stage. Hydroidmedusan fauna of mid Sagami Bay is much different from that of coastal Sagami Bay. Especially, the diversity of anthomedusae, leptomedusae, and limnomedusae are low in mid Sagami Bay. Many species of these three orders are lack of ability of the asexual reproduction in their planktonic stages. Therefor only a few species with the ability reproduction in their planktonic stages. Therefor only a few species with the ability may expand the distribution to mid Sagami Bay, resulting in their low diversity in the

area. Although *Obelia* spp. and *Clytia gardineri* were not reported to reproduce in their planktonic stages, a lot of specimens of these species were collected in this study. One of the *Obelia* species, *O. geniculata*, was reported that its hydroid grew on drift woods or ship's hulls and that its medusae were produced by the floating colonies (Vannucci, 1957). Hydroid of this species was reported from Sagami Bay (Hirohito, 1995). The reason of the high abundance of both species is not clear, but liberation of medusae from the floating colonies is one reasons in the case of *Obelia* spp., possibilities of asexual reproduction in their planktonic stages of the both species is for both.

4-2. Seasonal occurrence

Toyokawa and Terazaki (1994) reported that *Muggiaea atlantica* was abundant in Tokyo Bay in end of October with the maximum density of 48 inds. / m^3. It is known that the oceanic water flows into the bottom layer of the Tokyo Bay through during September through May (Hasunuma, 1979). Toyokawa and Terazaki (1994) suggested that the species may be introduced from south part of the bay or out side of the bay by such a water inflow. In this research, however, since abundance of *M. atlantica* was low level (below 1 inds. / m^3) from October to January in Sagami Bay in 1996, the result don't confirm their hypothesis. The production of eudoxids, which is sexual stage, of this species increase with increasing prey availability (Purcell, 1982). Generally, standing crop of zooplankton in Sagami Bay increases rapidly in April and May, and shows a small peak in autumn (Nakata, 1985). *Muggiaea atlantica* which occurs in all season, may increase its number rapidly in spring corresponding with the zooplankton bloom, and this species possibly occurs abundantly again in autumn as relative increase of zooplankton. Furthermore Purcell (1982) reported that *M. atlantica* consumed of zooplankton. Furthermore Purcell (1982) reported that *M. atlantica* consumed copepods of 0.1 to 0.9 mm in length, and that 5.5 to 10.5 individuals of copepods were

captured by each *M. atlantica* per day. Applying this numerical value to the case of April in Sagami Bay, because the obtained density of *M. atlantica* was 47.4 inds. / m^3, their potential feeding pressure on copepods was estimated as 260.7 to 497.7 preys / day / m^3, if disregarding predation by eudoxids. According to Purcell (1982) who reported the appearance of 2604 gastrozooids of 117 siphonophores, the number of gastrozooids was about 22 per each siphonophore. Because of the possession of many gastrozooids, *M. atlantica* can feed on a large number of prey. *Sagitta nagae* (chaetognath) is one of the abundant carnivorous species in Sagami Bay, with its density reaching 36.6 inds. / m^3 in August (Nagasawa and Marumo, 1977). Because each *S. nagae* feeds on 1.8 copepods a day (Nagasawa and Marumo, 1972), the potential feeding pressure is up to 65.9 prey / day / m^3. Although roles of siphonophores in marine ecosystem have seldom been discussed, *M. atlantica* may be one of a key species because of its high abundance and high feeding pressure.

Toyokawa and Terazaki (1994) reported that *Obelia* spp. occurred occasionally in Tokyo Bay, reaching the maximum of 0.8 inds. / m^3 in June and second maximum of 0.5 inds. / m^3 in September. Sugiura (1980a) collected 152 individuals by 80-m surface towing of a conical net (30-cm diameter) in Tokyo Bay in September, the density was estimated 26.9 inds. / m^3 assuming that the water filtration rate was 100%. In the present study in Sagami Bay, seasonal occurrence of *Obelia* spp. showed the maximum density of 16.7 inds. / m^3 in May and small peak of 2.98 inds. / m^3 in September. The observed occasional occurrence pattern of this species is similar to that of the previous studies mentioned above. The *Obelia* medusae collected in the present study probably includes some species, and this may be the reason for the occasional occurrence. Hirohito (1995) reported four *Obelia* hydroids from Sagami Bay. The maximum Hirohito (1995) reported four *Obelia* hydroids from Sagami Bay. The maximum densities of this species were near between in Sagami Bay and in Tokyo Bay. Even in

the case of asexually reproductive species, *Rathkea octopunctata*, the maximum density in coastal part of Tokyo Bay was about 50 times higher than that in mid Sagami Bay. Probably, bloom of *Obelia* medusae more abundantly occurred in coastal area of Sagami Bay such as coastal part of Tokyo Bay which sustaining its high density in the mid bay, or it was true that medusae were produced by floating colonies mentioned in the previous section. Study about seasonal occurrence in coastal Sagami Bay is needed.

Solmundella bitentaculata was abundant in spring, and in low density or not collected in other seasons in Sagami Bay. On the other hand, this species was common both in spring and summer in Tanabe Bay, Wakayama prefecture (Yamazi, 1958), while occurred in only November in Toba Bay, Mie prefecture (Horita, 1996).

Rathkea octopunctata was abundant in February and March in coastal part of Tokyo Bay (Sugiura, 1980a; Toyokawa and Terazaki, 1994), and was abundant in March in Sagami Bay in the present study. The maximum densities were 588 inds. / m^3 in Tokyo Bay (Toyokawa and Terazaki, 1994), and 11.1 inds. / m^3 in Sagami Bay. Because this species may disperse from coastal to mid Sagami Bay by the asexual reproduction, the prominent difference of the both densities is reasonable.

Sugiura chengshanense was reported to reproduce most actively in April and May when the water temperature ranged 17-18 ℃ around Misaki (Sugiura, 1980b), however, this species was abundant in colder temperature condition, and few specimens were obtained in May when surface water temperature increased to about 17 ℃ in this study. Therefor, the factor other than water temperature such as prey density might induce its active reproduction. This species occurred intermittently from February to September in Toba Bay (Horita, 1996), and occurred in October in Tokyo Bay (Toyokawa and Terazaki, 1994). Medusae of this species are present in coastal areas (Toyokawa and Terazaki, 1994). Medusae of this species are present in coastal areas most of a year, when environmental conditions turn favorable, the medusae may

increase the individuals by asexual reproduction and expand its distribution to mid Sagami Bay.

Toyokawa and Terazaki (1994) reported that *Liriope tetraphylla* reached the maximum density of 105 inds. / m^3 in the end of October in Tokyo Bay, and they considered that the abundance of this species depended on the intrusion of oceanic waters just as *M. atlantica*. On the other hand, the species was abundant from July to September with the maximum density of 1.38 inds. / m^3 in Sagami Bay, 1996. The density of this species in Sagami Bay might remain high to the end of October in year of the study of Toyokawa and Terazaki (1994), however, the numerical value of the maximum density in Tokyo By was too large and was not consistent to that of the present study. The occurrence pattern in this study was also different from many other previous studies which reported abundance of the species in autumn and winter in coastal areas of Japan (Uchida, 1928) and in Tanabe Bay (Yamazi, 1958), and additionally, in winter of normal years, and in autumn of rich years in Villefranche-sur-Mer, Mediterranean (Buecher *et al.*, 1997). Moreover Kanashiro and Senta (1985) reported two peaks of its occurrence, end of August and December, from Nagesaki peninsula.

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Tab. 1 Sampling records

NORPAC net

Station	Date	Wire out (m)	Time in	Water filtered
1	96/04/17	150	12:15	21.3
2	96/04/17	158	14:27	20.9
3	96/04/17	150	10:44	18
4	96/04/17	164	9:19	26.6
1	96/05/18	164	no data	30.7
2	96/05/18	177	no data	40.2
3	96/05/18	195	no data	34.5
4	96/05/18	204	no data	44.6
4	96/06/10	158	17:06	25.9
3	96/07/19	169	11:37	29.8
4	96/07/19	154	10:35	25.7
1	96/08/06	209	10:20	46.1
2	96/08/06	173	9:05	29.7
3	96/08/01	212	11:05	51.9
4	96/08/01	154	10:00	22.6
1	96/09/12	150	13:35	23.8
2	96/09/12	160	15:08	20.2
3	96/09/12	155	10:55	25.1
4	96/09/12	183	9:30	35.8
2	96/10/20	160	6:45	35.8
4	96/10/20	173	8:30	27.3
1	96/11/14	155	10:31	25.3
2	96/11/14	160	9:10	25.6
4	96/11/14	155	12:26	25.8
1	96/12/14	165	10:53	26.4
2	96/12/14	170	9:39	34.5
3	96/12/14	165	12:15	27.4
4	96/12/14	150	13:34	21.8
1	97/01/19	151	10:39	21.9
2	97/01/19	164	9:38	30.2
3	97/01/19	155	11:55	24.7
4	97/01/19	170	13:03	26.1
1	97/02/06	160	14:03	27.6
2	97/02/06	190	15:09	31
3	97/02/06	151	11:23	21.9
4	97/02/06	150	10:13	18.7
1	97/03/12	152	10:11	21
2	97/03/12	160	9:07	24.2
3	97/03/12	151	9:38	19.4
4	97/03/12	160	10:54	20.8

ORI net

Station	Date	Wire out (m)	Time in	Max. depth (m)
3	97/4/18	2000	12:00	726.6
3	97/5/11	2000	14:28	1228
3	97/11/13	2000	13:23	no data
5	97/11/14	2000	12:15	1041
5	97/11/14	2000	12:15	1041

Table 2 List of species collected by NORPAC net in Sagami Bay.

Class Hydrozoa
Subclass Hydroidmedusae
Order Anthomedusae
Family Euphysidae
Euphysa aurata Forbes, 1848
Euphysora bigelowi Maas, 1905
Family Hydractiniidae
Podocoryn minima (Trinci, 1903)
Family Rathkeidae
Rathkea octopunctata (M. Sars, 1835)
Order Leptomedusae
Family Campanulariidae
Obelia spp.
Clytia gardineri (Brown, 1905)
Clytia spp.
Family Sugiuridae
Sugiura chengshanense (Ling, 1937)
Family Lovenellidae
Eucheilota paradoxica Mayer, 1900
Order Trachymedusae
Family Rhopalonematidae
Liriope tetraphylla (Chamisso and Eysenhardt, 1821)
Rhopalonema velatum Gegenbaur, 1856
Aglaura hemistoma Peron and Lesueur, 1809
Persa incolorata McCrady, 1857
Sminthea eurygaster Gegenbaur, 1856
Order Narcomedusae
Family Aeginidae
Solmundella bitentaculata (Quoy and Gaimard, 1833)
Family Solmarisidae
Solmaris rhodoloma (Brandt, 1838)
Subclass Siphonophora
Order Physonectae
Family Agalmatidae
Halistemma rubrum (Vogt, 1852)
Cordagalma cordiformis Totton, 1932
Nanomia bijuga (Chiaje, 1841)
Order Calycophorae
Family Dyphyidae
Subfamily Sulculeolariinae
Sulculeolaria chuni (Lens and van Riemsdijk, 1908)
Subfamily Dyphyinae
Diphyes bojani (Eschscholtz, 1829)
D. chamissonis Huxley, 1859
D. dispar Chamisso and Eysenhardt, 1821
Muggiaea atlantica Cunningham, 1892
Lensia campanella (Moser, 1925)
L. conoidea (Kefferstein and Ehlers, 1860)
L. cossack Totton, 1941
L. hardy Totton, 1941
L. hotspur Totton, 1941
L. leloupi Totton, 1954
L. hotspur Totton, 1941
L. leloupi Totton, 1954
L. meteori (Leloup, 1934)
L. multicristata (Moser, 1925)
L. subtilis (Chun, 1886)
L. subtiloides (Lens and van Riemsdijk, 1908)
Chelophyes contorta (Lens and van Riemsdijk, 1908)
Eudoxoides mitra (Huxley, 1859)
E. spiralis (Bigelow, 1911)

Family Sphaeronectidae
Sphaeronectes gamulini Carre, 1966
S. gracilis (Claus, 1873, 1874)
S. irregularis (Claus, 1873)
Family Abylidae
Subfamily Abylopsinae
Abylopsis eschscholtzii (Huxley, 1859)
A. tetragona (Otto, 1823)
Bassia bassensis (Quoy and Gaimard, (1833) 1834)
Enneagonum hyalinum Quoy and Gaimard, 1827
E. searsae Alvarino, 1968

Class Scyphozoa
Order Coronatae
Family Nausithoidae
Nausithoe sp. ?

Table 3 List of species collected by ORI net in Sagami Bay

Class Hydrozoa
Subclass Hydroidmedusae
Order Trachymedusae
Family
Ptychogastoria sp.
Family Halicreatidae
Botrynema brucei Brown, 1908
Halicreas minimum Fewkes, 1882
Family Rhopalonematidae
Colobonema sericeum Vanhoffen, 1902
Crossota brunea Vanhoffen, 1902
Order Narcomedusae
Family Aeginidae
Aegina sp.
Aeginura grimardii Maas, 1904
Subclass Siphonophora
Order Calycophorae
Family Prayidae
Nectopyramis diomedeae Bigelow, 1911
Family Hippopodiidae
Vogtia kuruae Alvarino, 1967
V. glabra Bigelow, 1918
Class Scyphozoa
Order Coronatae
Periphylla periphylla (Peron and Lesueur, 1809)

Table 4 Seasonal occurrence of planktonic cnidarians (numbers per m^3) in Sagami Bay

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Euphysa aurata	0	0	0	0	0	0	0	0	0	0	0.01	0
Euphysora bigelowi	0	0	0	0	0	0	0	0	0	0	0	0.01
Podocoryn minima	0	0	0	0	0	0	0	0	0	0	0	0.06
Rathkea octopunctata	0	0	0	0	0	0	0	0	0	0	0	11.1
Obelia spp.	1.61	16.7	1.58	0.32	0.4	2.98	0.08	0	0.27	0.08	0.75	12.8
Sugiura chengshanense	6.46	0.4	0	0	0.01	0	0	0	0	0	0	0.11
Clytia galdineri	0.03	0.82	0	0	0.28	0	0	0	0	0	0	0
Clytia spp.	0.16	0.19	0	0.11	0.09	0	0	0.08	0.05	0	0.15	0.18
Eucheilota paradoxica	0.88	0.13	0.5	0.72	0.53	0.42	0	0	0.04	0	0.03	0.27
Liriope tetraphylla	0.17	0.37	0.08	1.26	1.07	1.38	0.05	0.16	0.19	0.21	0.54	0.4
Rhopalonema velatum	0.06	0	0	0	0.01	0.02	0	0	0	0.01	0.05	0.11
Aglaura hemistoma	1.05	0.05	0.04	0.2	0.26	1.46	0.46	0.21	0.42	0.02	0.01	0.67
Persa incolorata	1.28	0.27	0.46	0.29	0.09	0.1	0.05	0.05	0.16	0.04	0.02	0.09
Sminthea eurygaster	0.01	0.01	0.08	0	0	0	0	0	0	0	0	0
Solmaris rhodloma	0.69	0	0	0	0	0	0	0	0	0	0	0
Solmundella bitentaculata	6.59	4.84	4.21	0.18	0.49	0.09	0	0	0.02	0.03	0.08	9.35
Halistemma rubrum	+	0	0	0	0	0	0	0	0	0	0	0
Cordagalma cordiformis	0	0	0	0	+	0	0	0	0	0	+	0
Nanomia bijuga	+	+	0	0	0	0	0	0	0	0	+	+
Sulculeolaria chuni	0	0	0	0	0	0	0	0.01	0	0	0	0
Diphyes bojani	0	0.01	0	0.09	0.08	0.07	0	0	0.02	0	0	0
D. chamissonis	0	0.01	0	0.02	0	0.17	0.05	0	0.02	0.01	0.05	0.04
D. disper	0	0	0	0.07	0.01	0.04	0	0	0.02	0	0	0
Muggiaea atlantica	47.4	6.13	2.66	5.26	3.91	4.4	0.4	0.08	0.59	0.44	3.54	32.8
Lensia campanella	0	0	0.04	0	0	0	0	0.01	0	0	0	0
L. conoidea	0.03	0.01	0	0	0	0	0	0	0	0	0	0
L. cossack	0	0	0	0	0.01	0	0	0	0	0	0.01	0
L. hardy	0	0	0	0	0	0	0	0	0.01	0	0	0
L. hotspur	0	0.01	0	0	0	0	0	0	0	0	0	0
L. leloupi ?	0	0	0.04	0	0	0.02	0.02	0.01	0	0	0.01	0
L. meteori	0.01	0.01	0	0	0	0.01	0	0	0.01	0	0	0
L. multicristata	0	0	0	0	0.01	0	0	0	0	0	0	0
L. subtilis	0.01	0.01	0	0	0.01	0.05	0	0.03	0.02	0.01	0.04	0.04
L. subtiloides	0.1	0.09	0.31	0.27	0.31	0.29	0.05	0	0.1	0.01	0.02	0.02
Chelophyes contorta	0	0	0	0.02	0	0.08	0	0	0.01	0.01	0	0.01
Eudoxoides spiralis	0.03	0.01	0	0	0	0	0	0.01	0.02	0.06	0.06	0.02
E. mitra	0	0	0	0.02	0.01	0	0	0	0	0.01	0	0
Sphaeronectes gamulini	0	0	0	0	0	0	0	0	0	0	0	0.01
S. gracilis	0.15	0.01	0	0.02	0.05	0.05	0.02	0	0.05	0.17	0.24	0.29
S. irregularis	0.02	0.01	0.04	0.02	0.05	0.03	0.02	0.01	0.05	0.1	0.27	0.23
Abylopsis eschscholtzi	0	0	0	0	0	0.04	0.02	0	0	0	0.01	0
A. tetragona	0.01	0.01	0	0.13	0.21	0.37	0.02	0.04	0.1	0.02	0.05	0.01
Bassia bassensis	0	0	0	0.09	0.05	0.05	0	0.05	0.05	0.01	0.03	0
Nausithoe sp.	0	0.01	0	0	0.01	0	0	0	0	0	0	0
ephyra larva	0	0	0	0	0	0	0	0	0.01	0	0	0
total	66.7	30.1	10	9.08	7.96	12.1	1.2	0.76	2.2	1.23	5.98	68.7
number of species	22	24	12	18	24	21	12	13	22	17	23	23

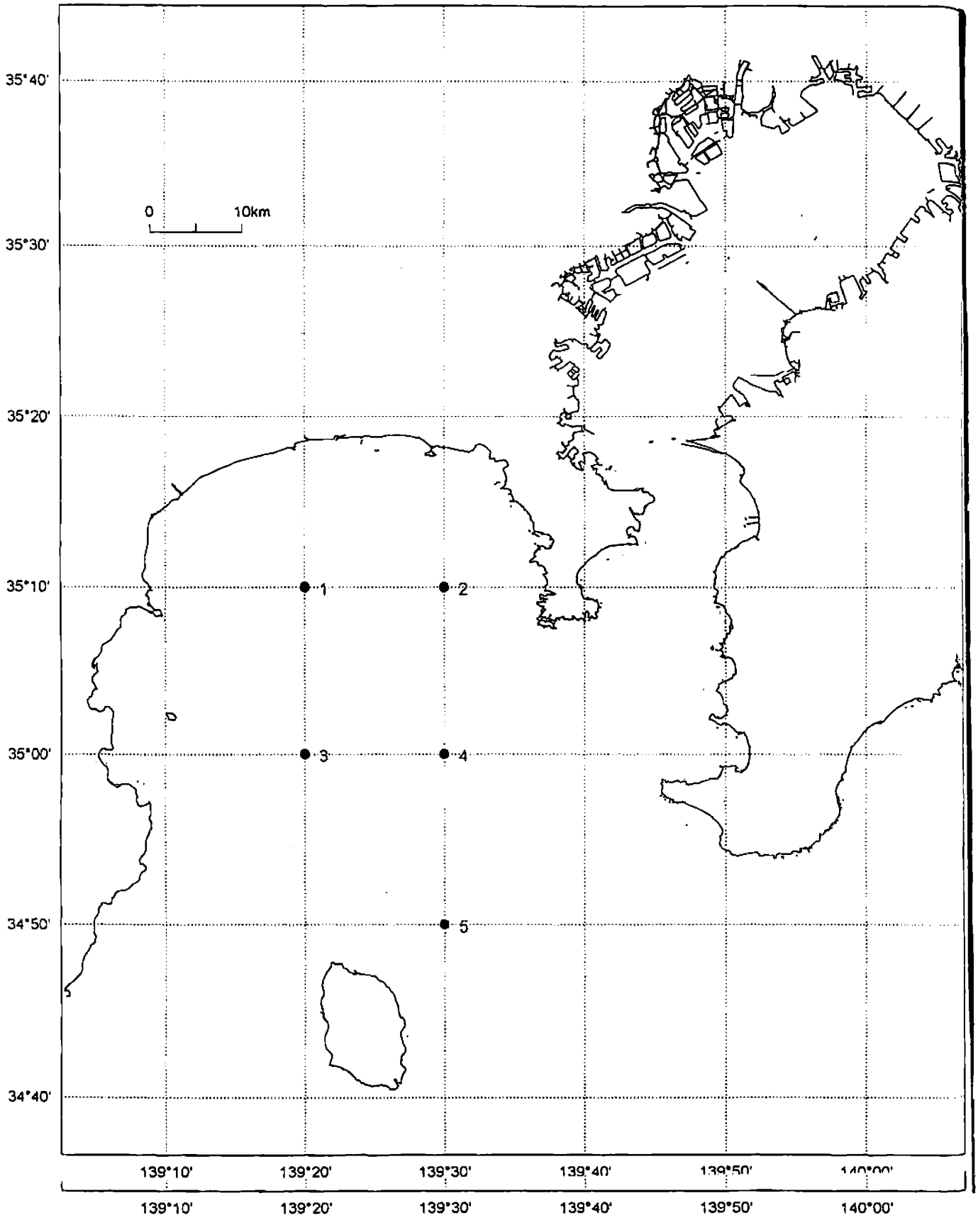

Fig. 1. Location of sampling stations in Sagami Bay.

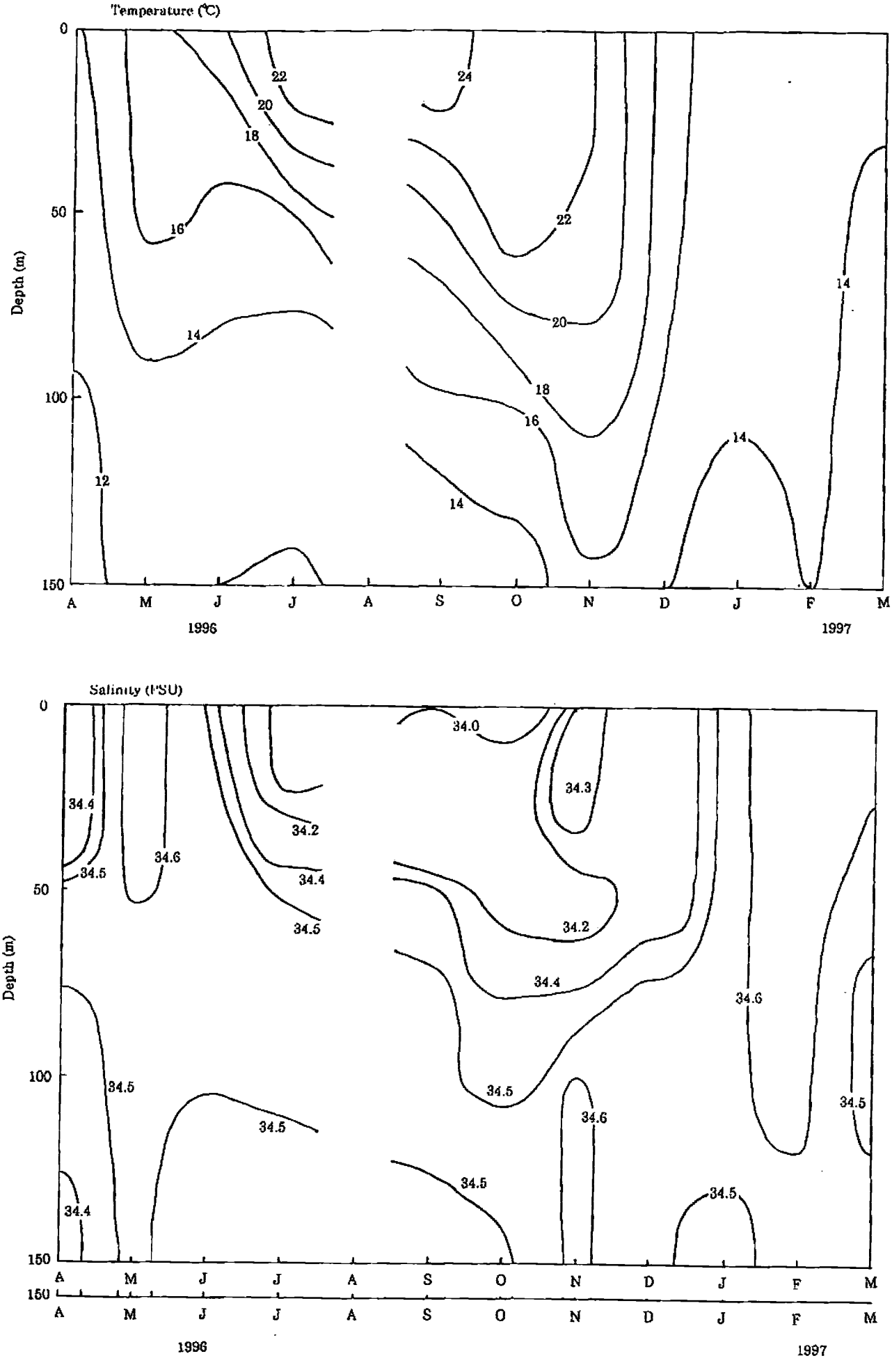

Fig. 2. Temporal and vertical changes in water temperature and salinity.

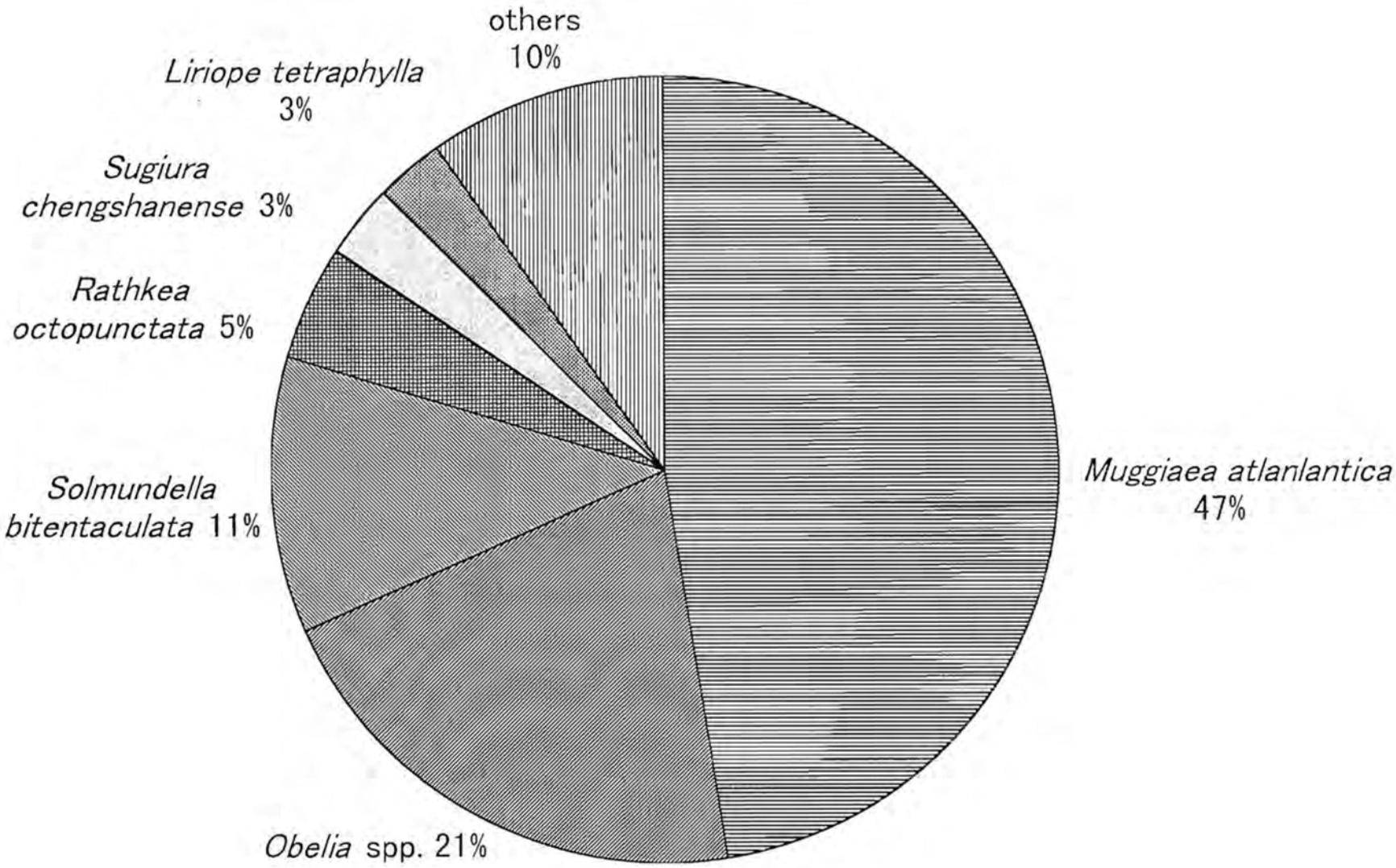

Fig. 3. Percentages of planktonic cnidarians, based on total numbers of specimens collected by NORPAC net in Sagami Bay.

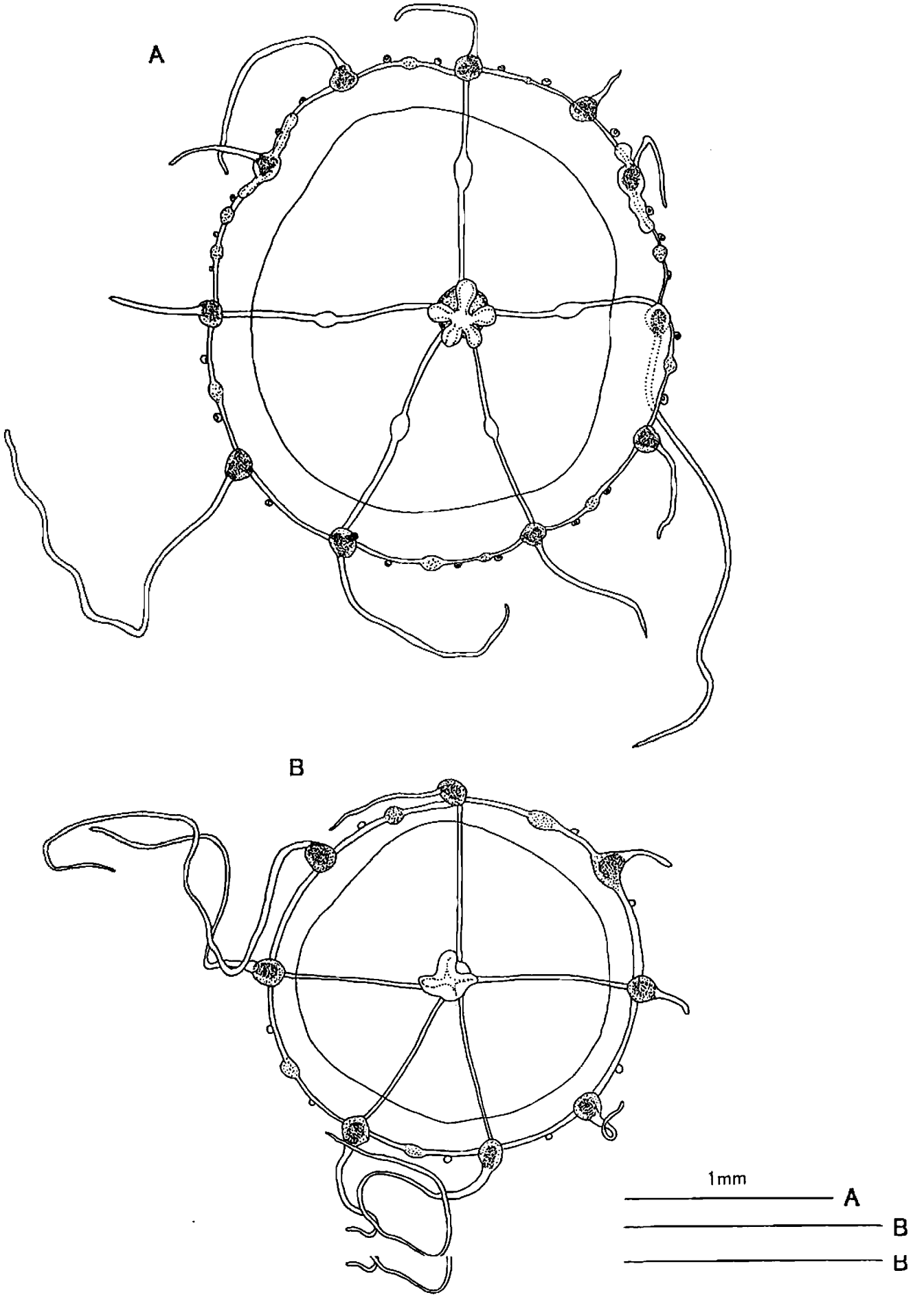

Fig. 4. *Clitia gardineri.* Ventral view of two immature specimens.

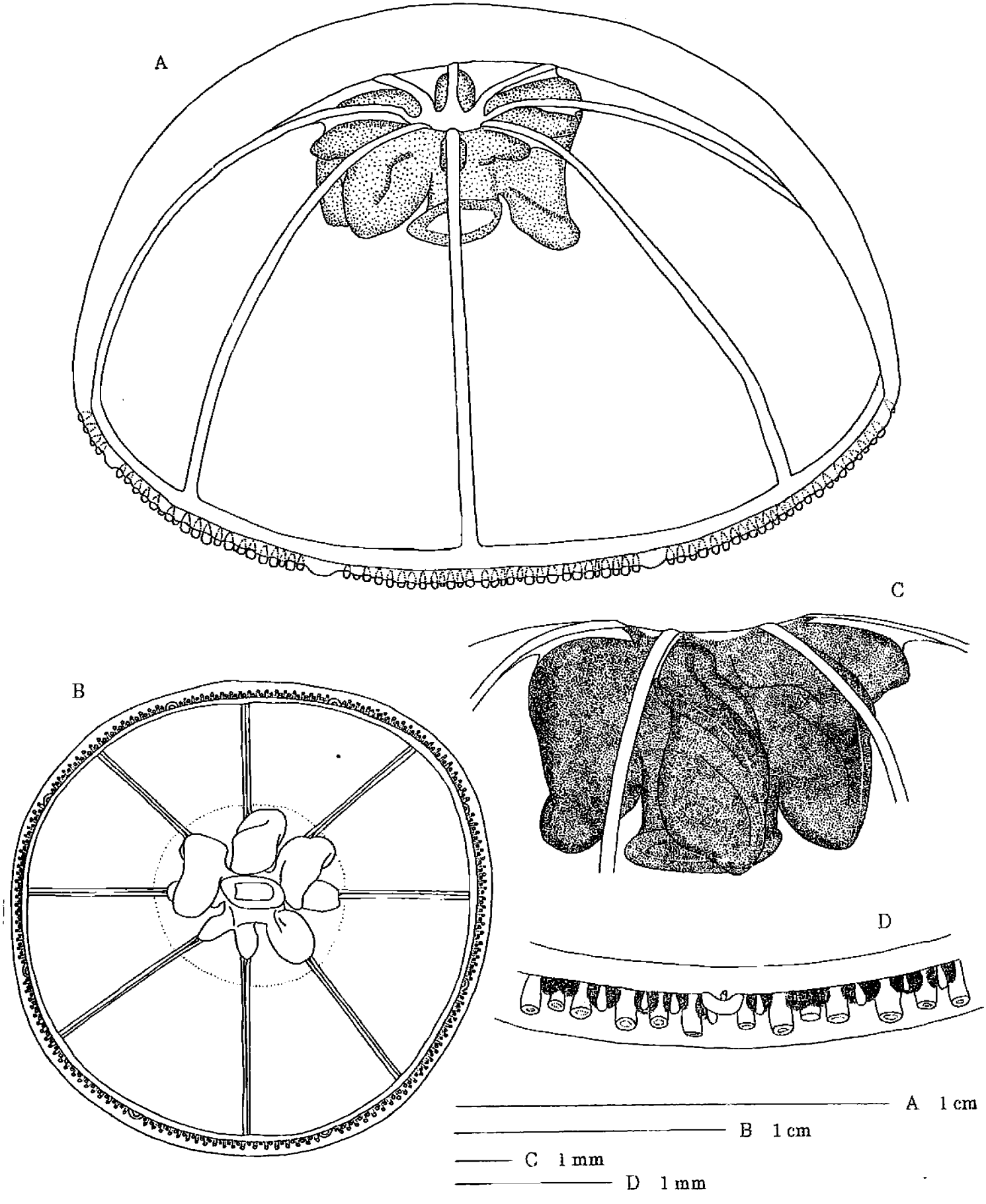

Fig. 5. *Ptychogastria* sp. Lataro-apical view of whole specimen (A). Ventral view of whole specimen (B). Lateral view of stomach (C). Ventral view of marginal tentacles (D).

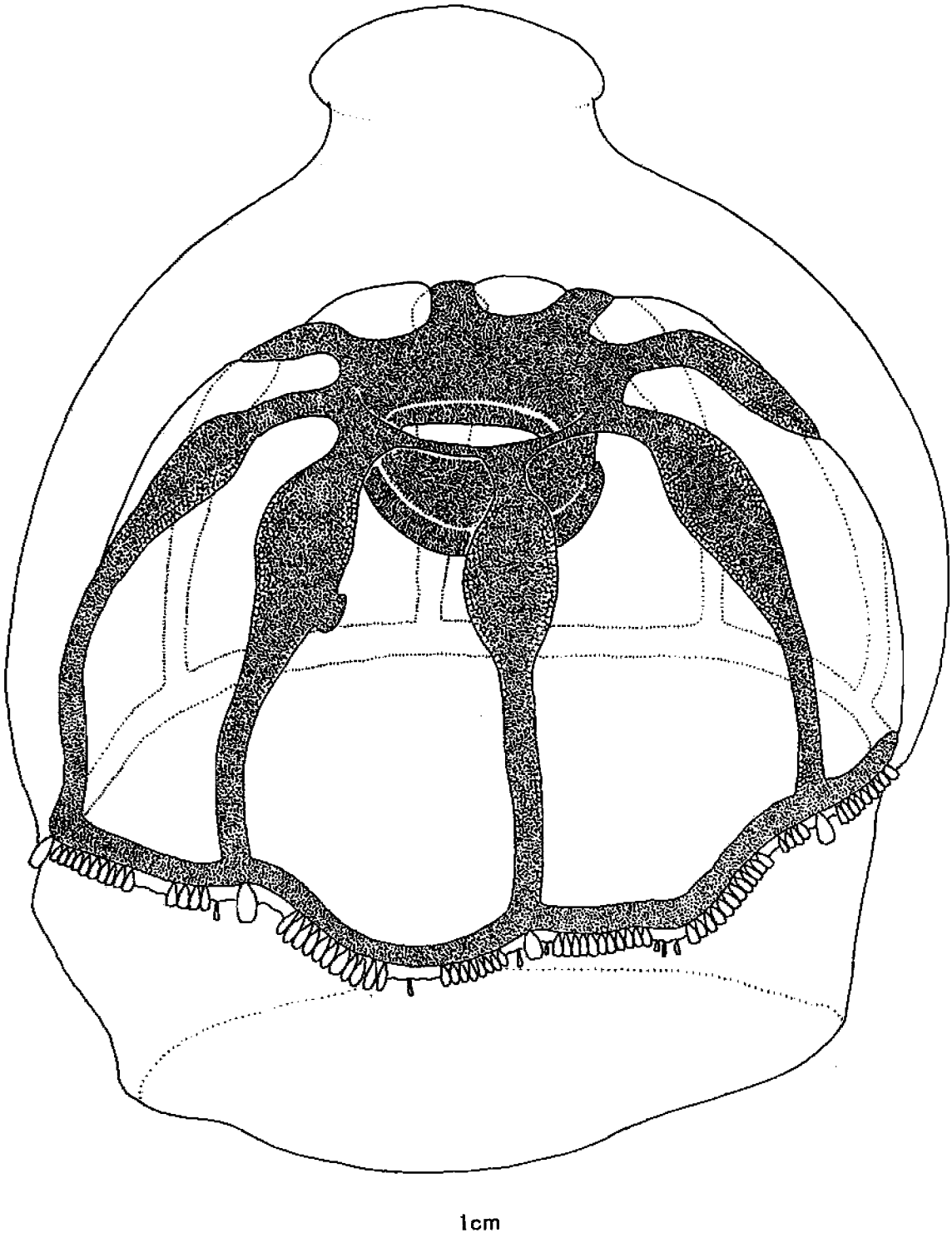

Fig. 6. *Botrynema brucei*. Apico-lateral view.

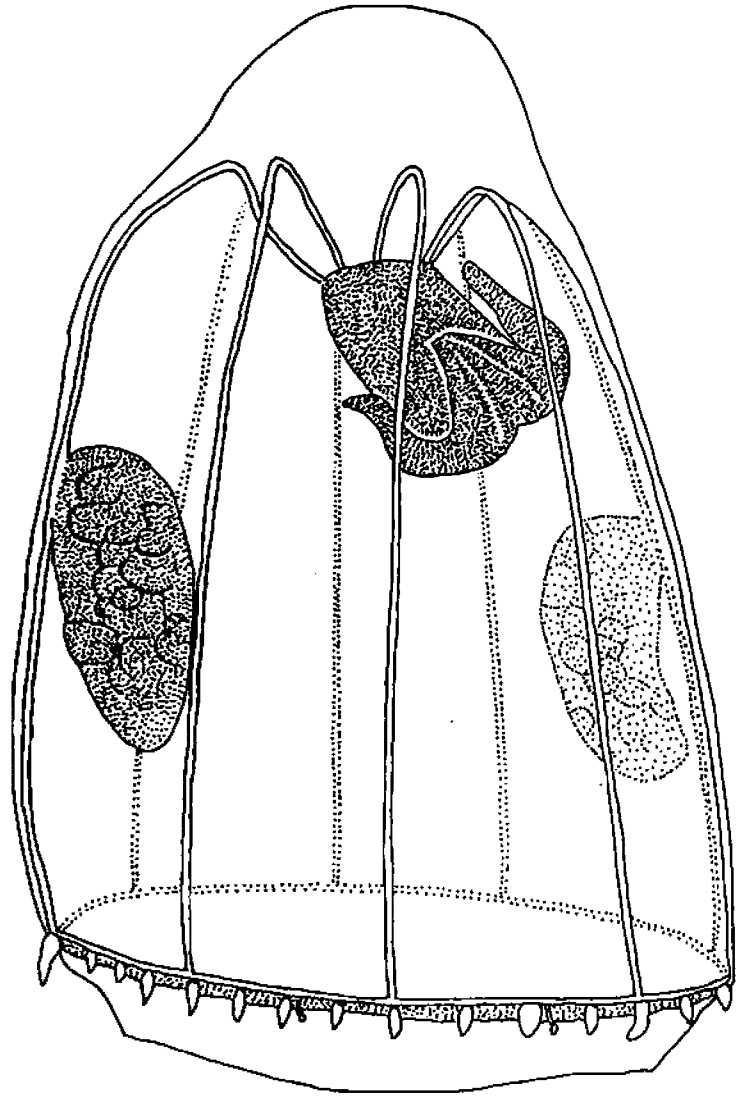

Fig. 7. *Persa incolorata*. Lateral view.

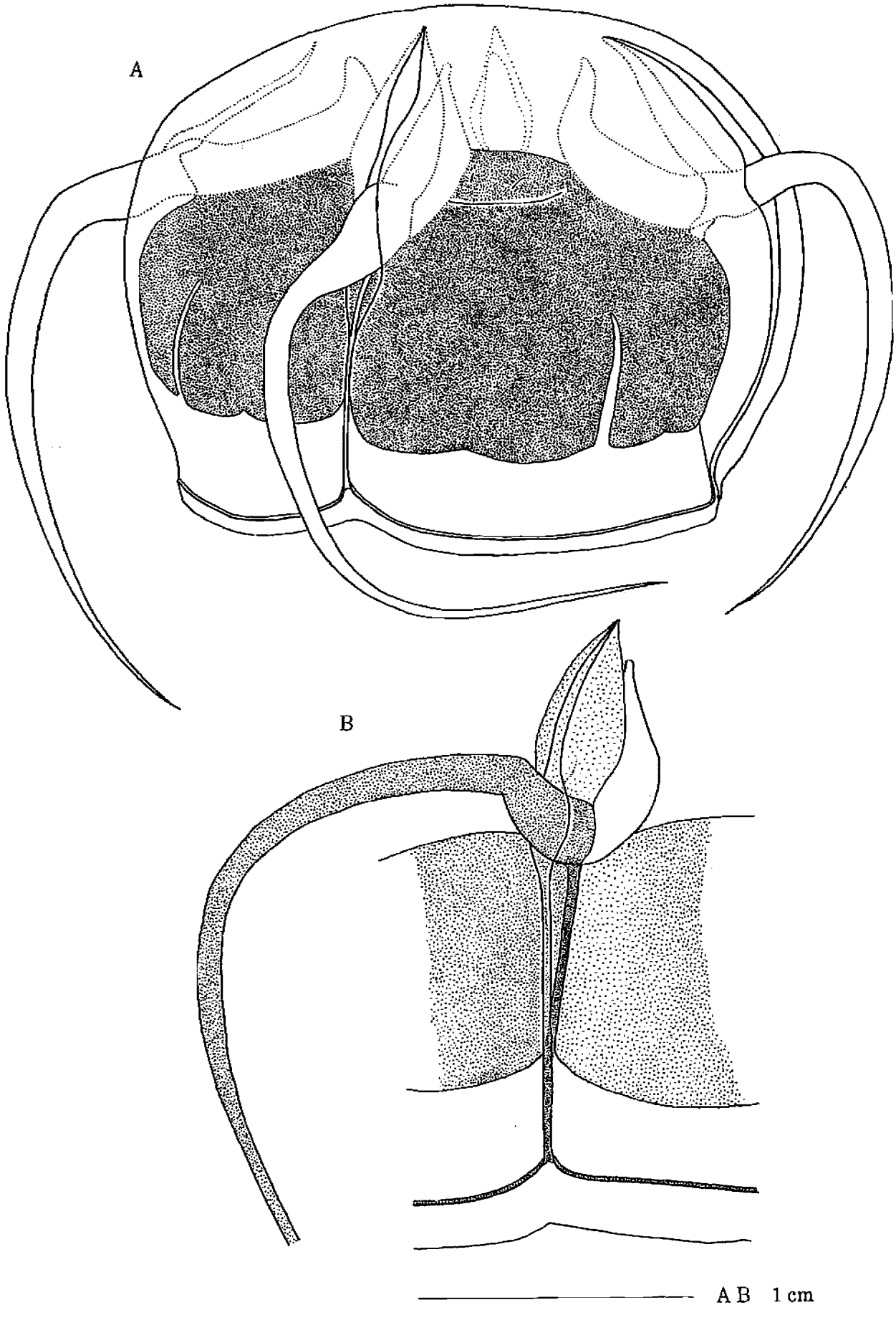

Fig. 9. *Aegina* sp. Latero-apical view (A). Lateral view of peronial groove (B).

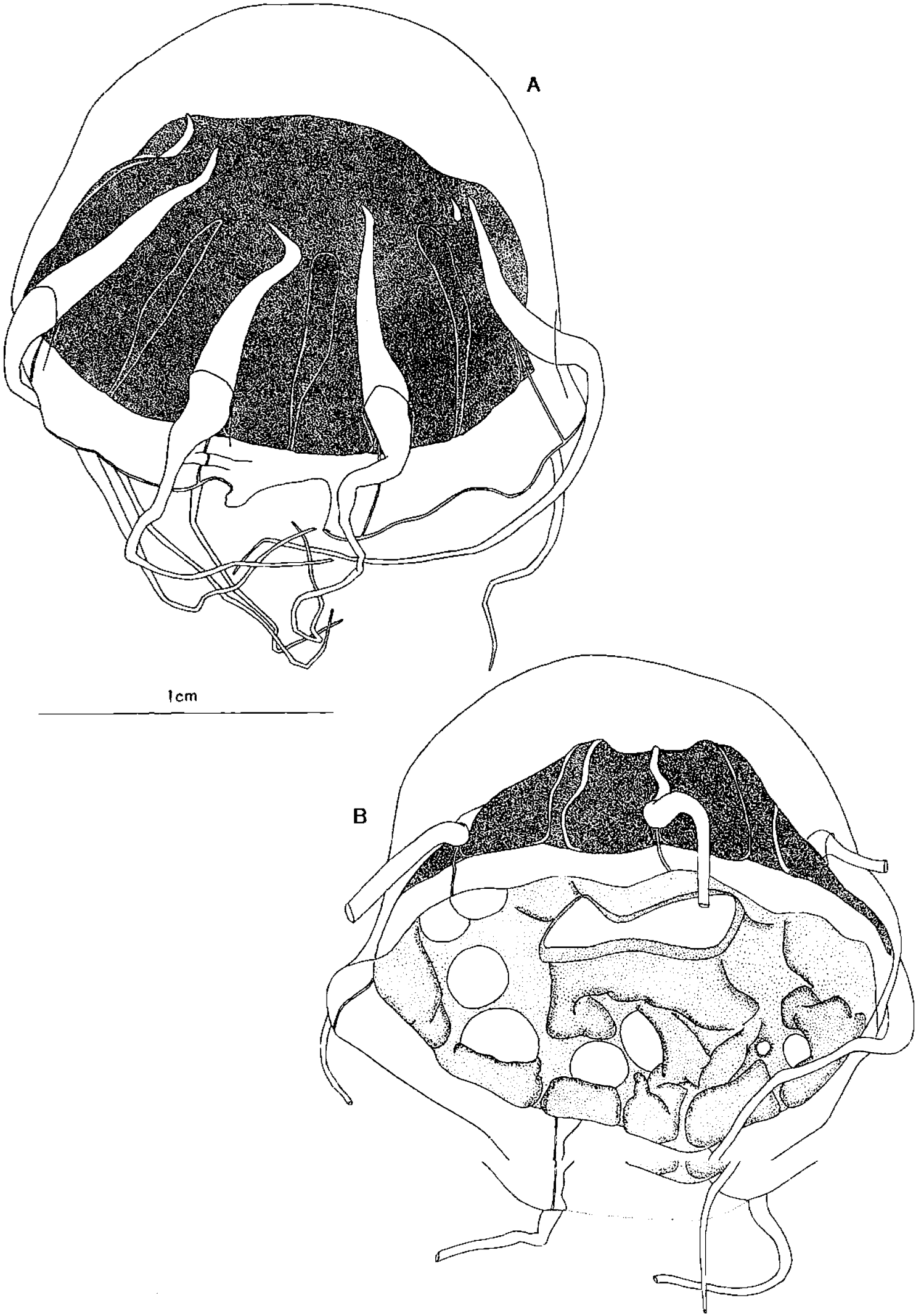

Fig. 10. *Aeginura grimardii*. Apico-lateral view (A), and baso-lateral view (B).

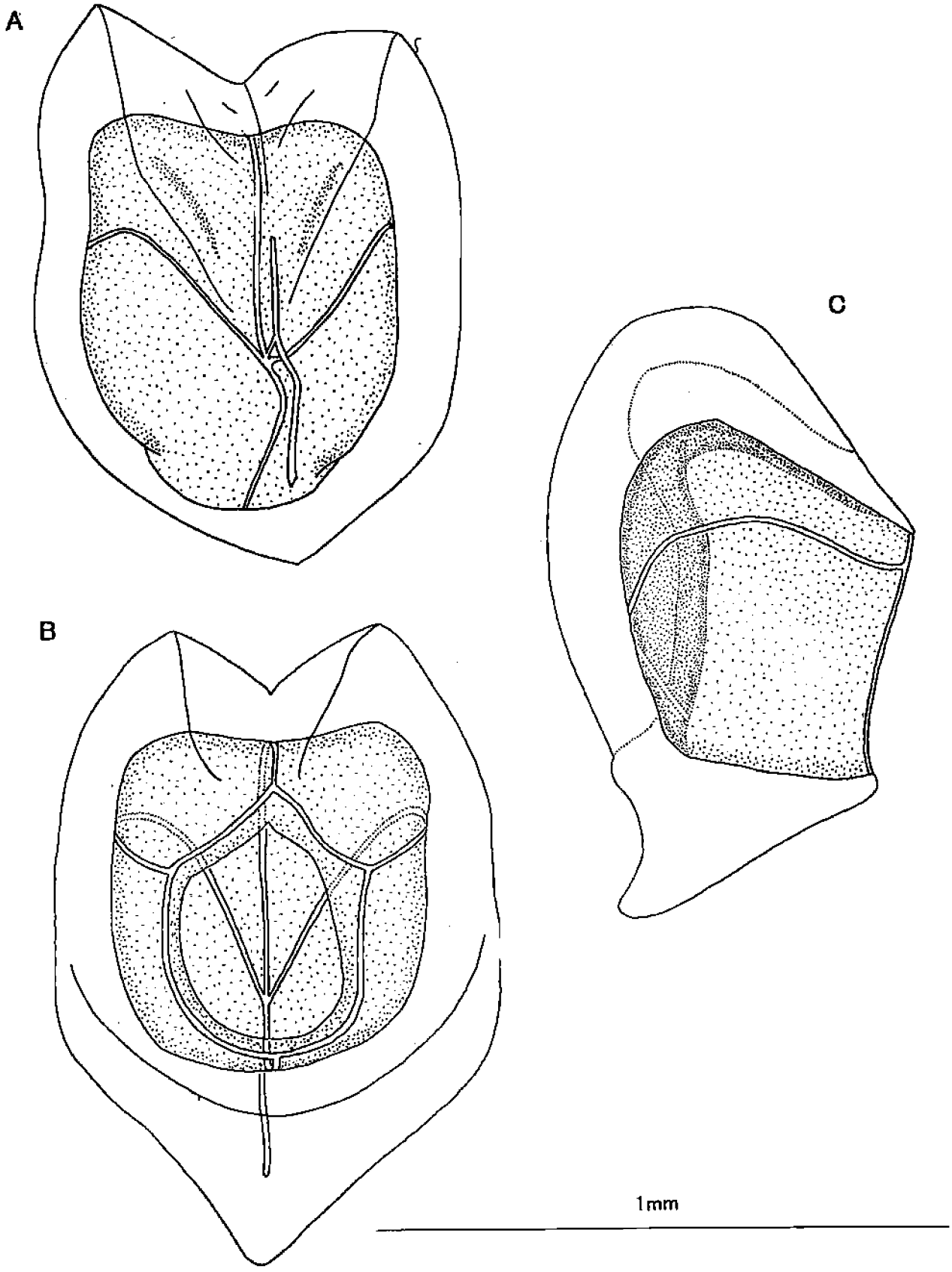

Fig. 11. *Cordagalma cordiformis.* Nectophore in ventral view (A), in dorsal view (B),

Fig. 11. *Cordagalma cordiformis.* Nectophore in ventral view (A), in dorsal view (B),
and in lateral view (C).

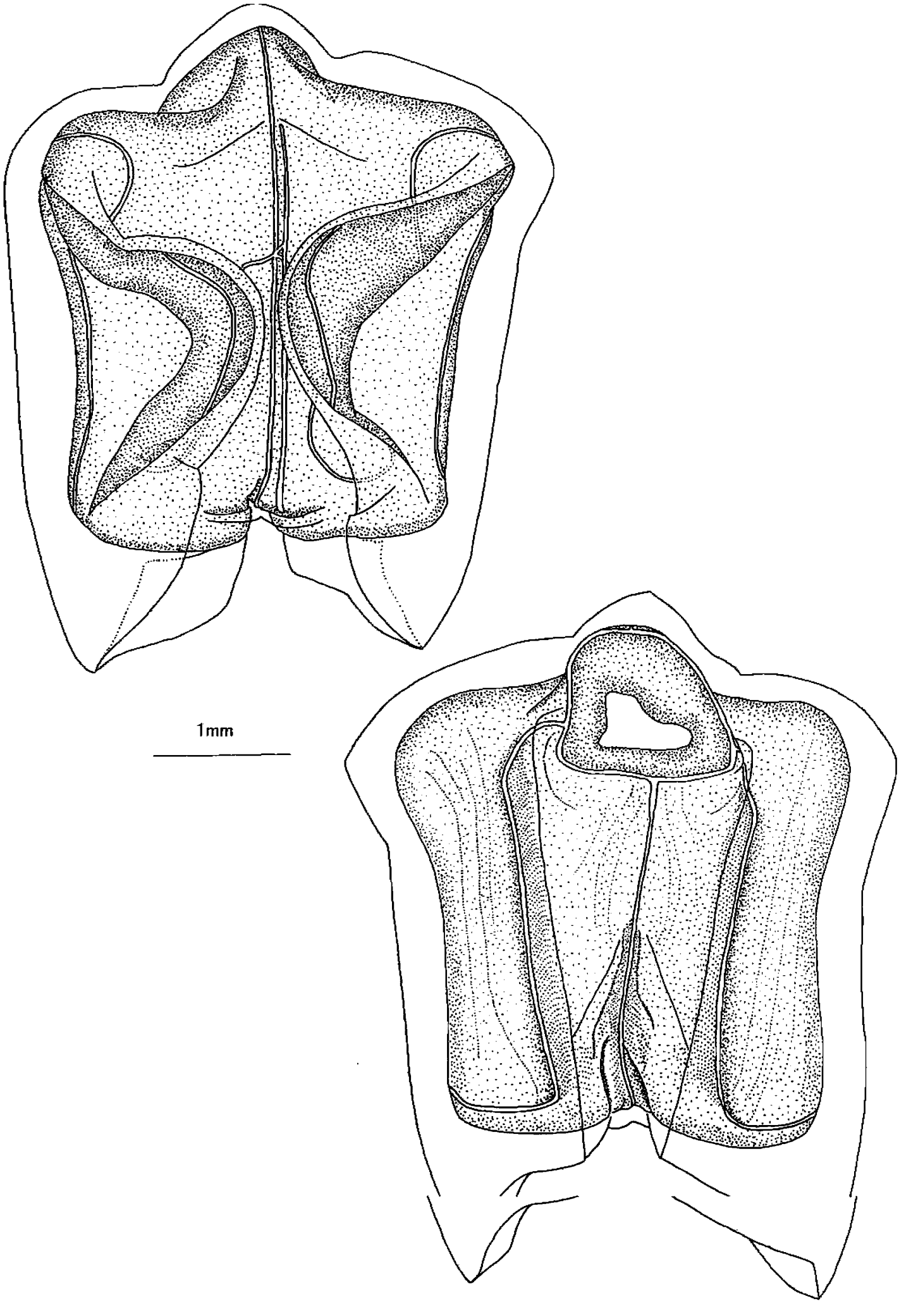

Fig. 12. *Nanomia bijuga*. Nectophore in ventral view (A), and in dorsal view (B).

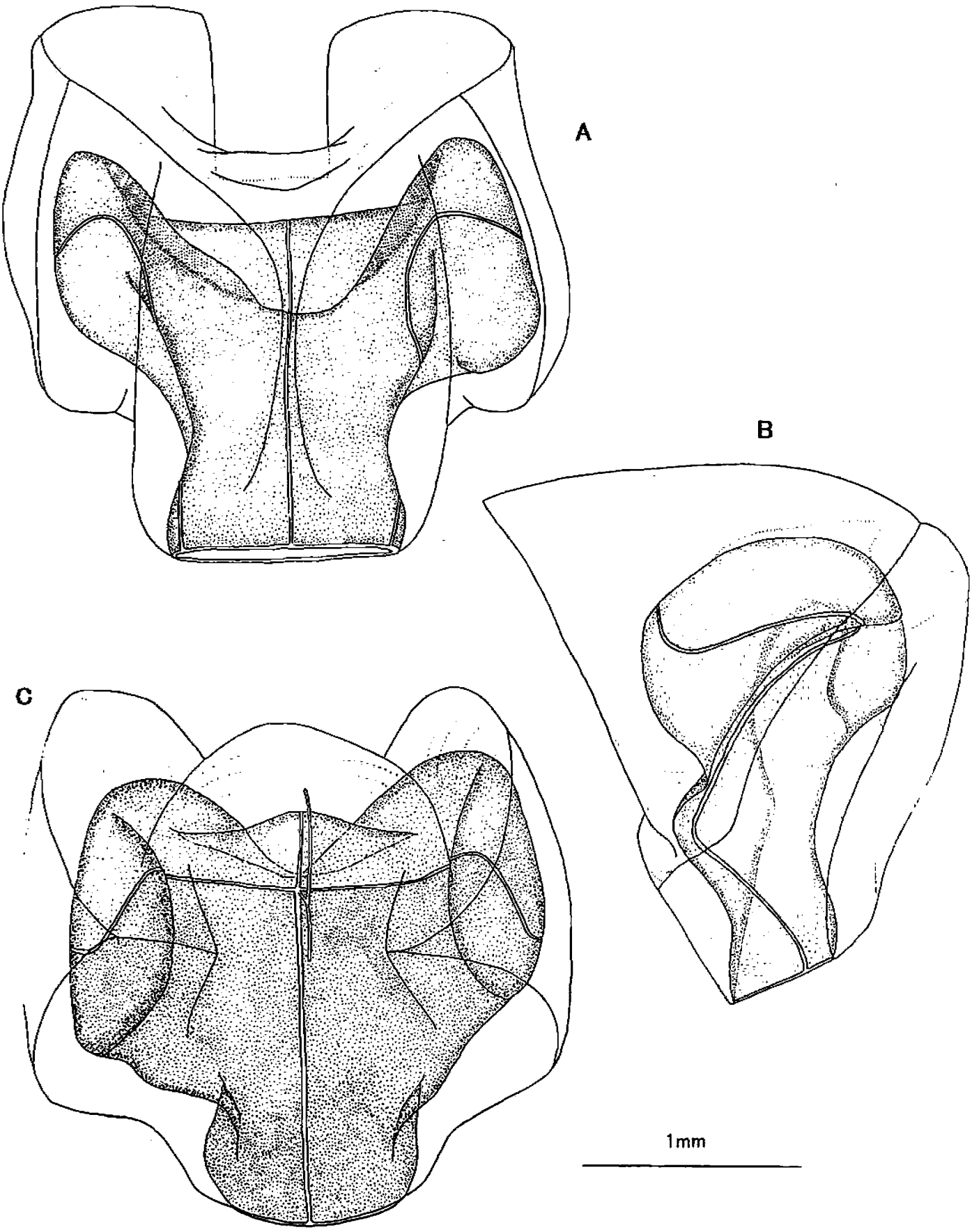

Fig. 13. *Halistemma rubrum.* Nectophore in dorsal view (A), in lateral view (B), and in ventral view (C).

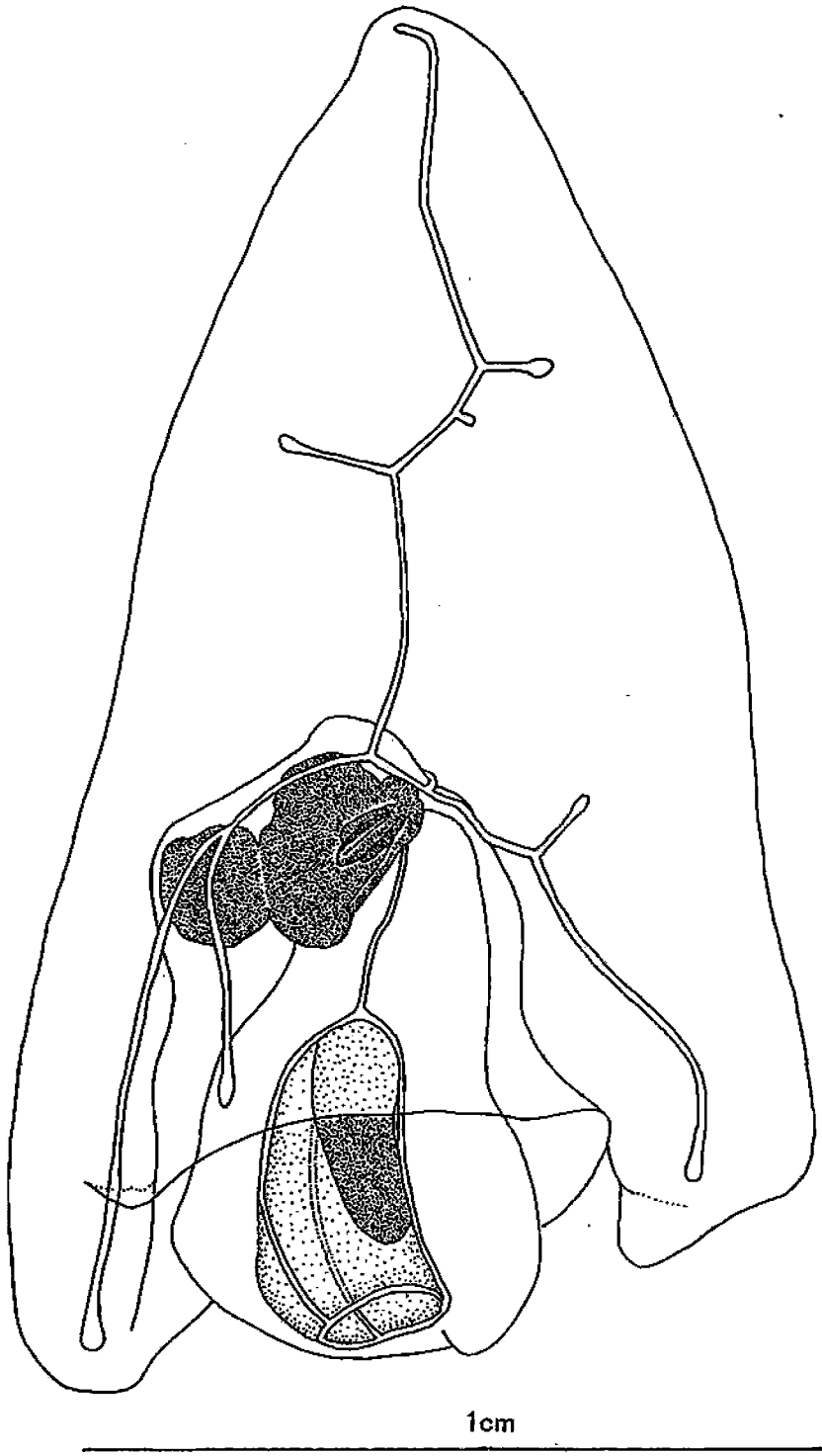

Fig. 14. *Nectopyramis diomedeae.* Eudoxid in lateral view.

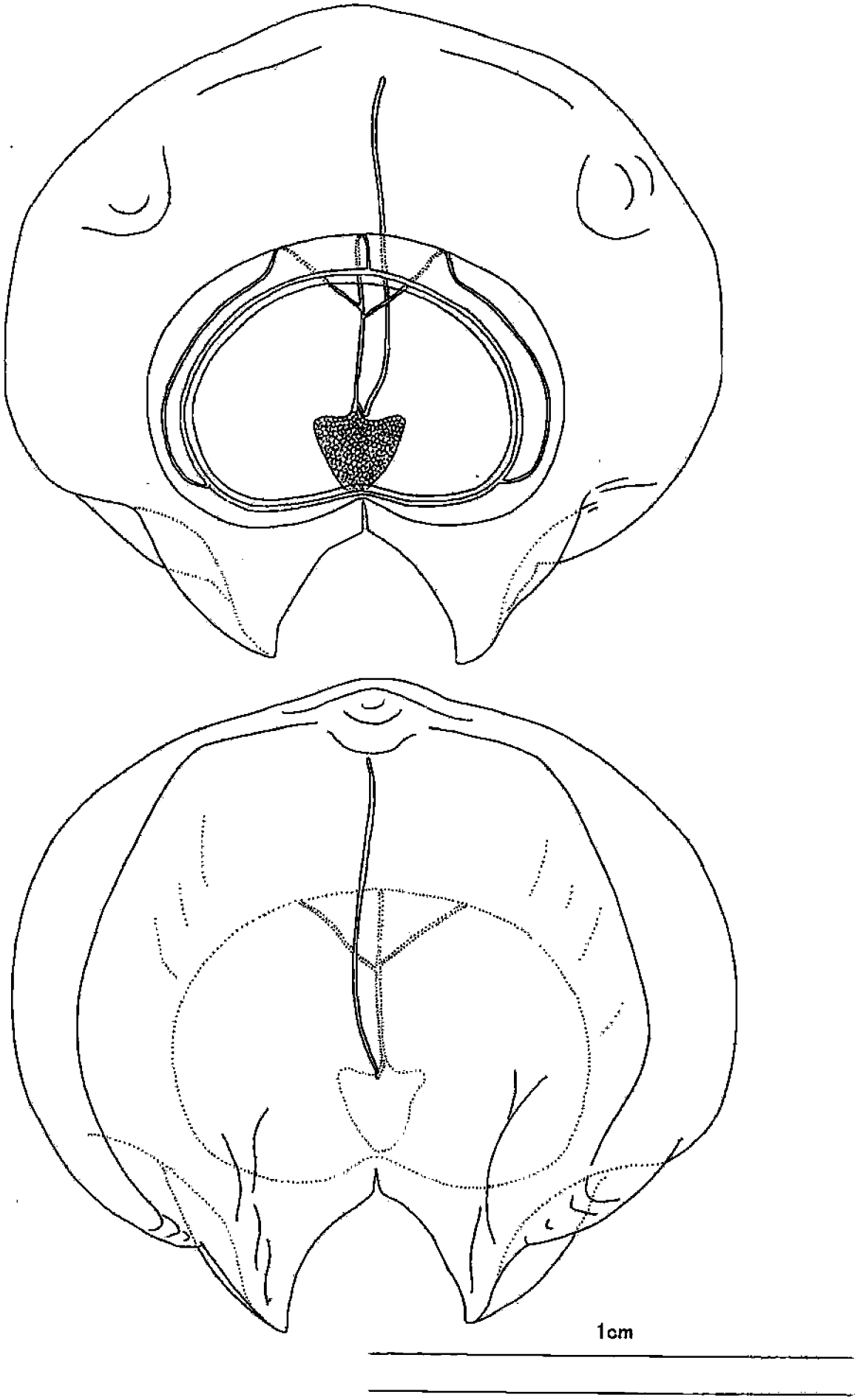

Fig. 15. *Vogtia glabra*. Nectophore in dorsal view (A), and in ventral view (B).

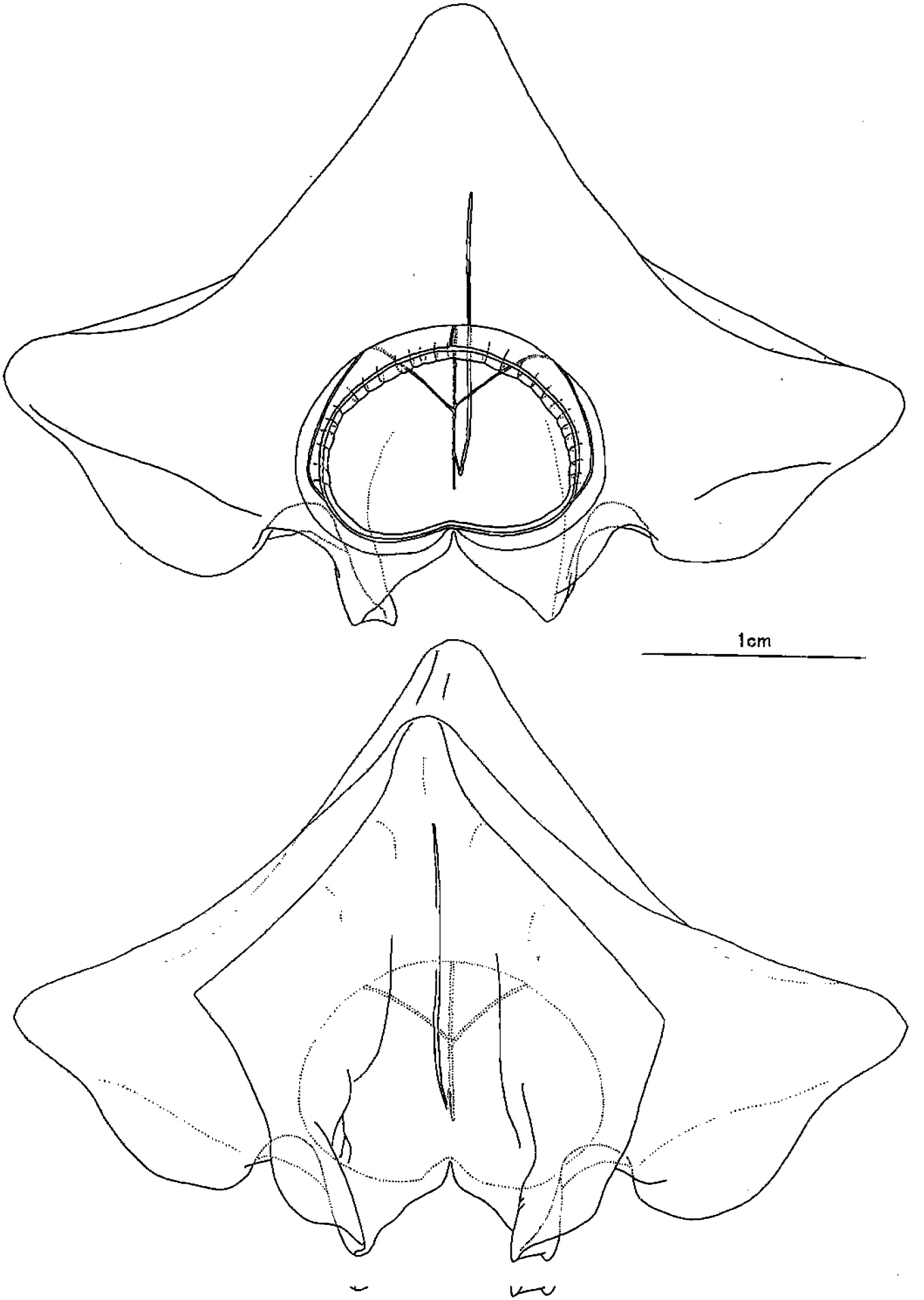

Fig. 16. *Vogtia kuruae.* Nectophore in dorsal view (A), and in ventral view (B).

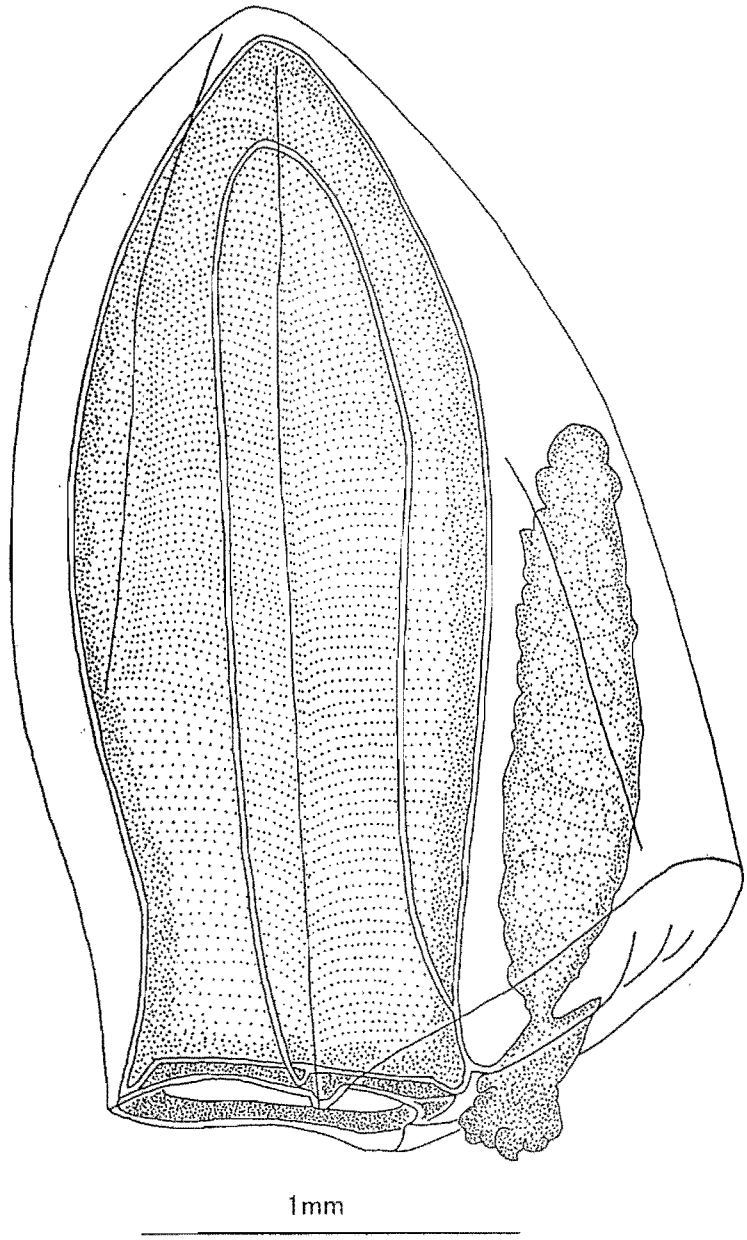

Fig. 17. *Sulculeolaria chuni*. Lateral view.

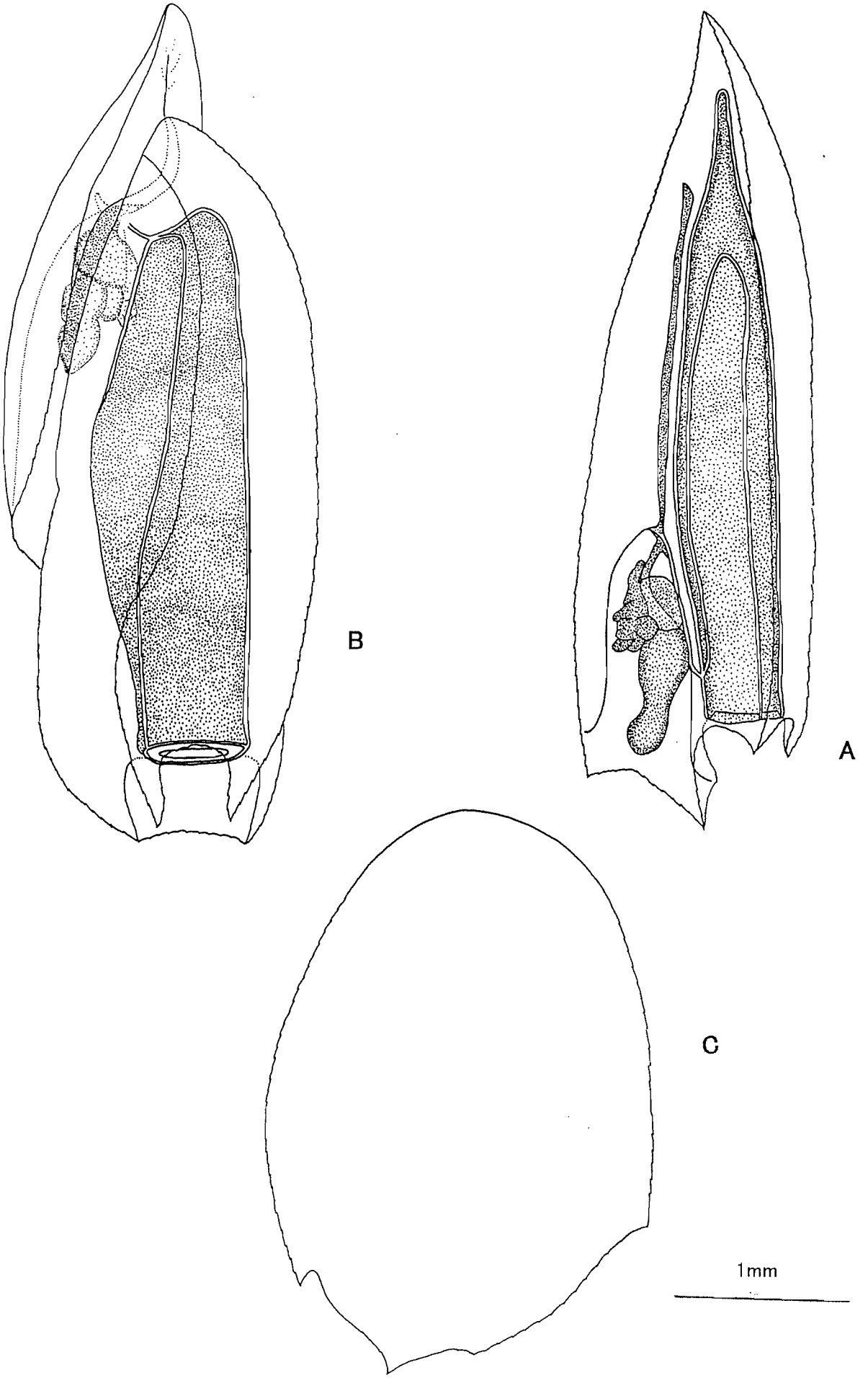

Fig. 18. *Diphyes bojani.* Lateral view of anterior nectophore (A). Dorsal view of eudoxid (B). Bract (C).

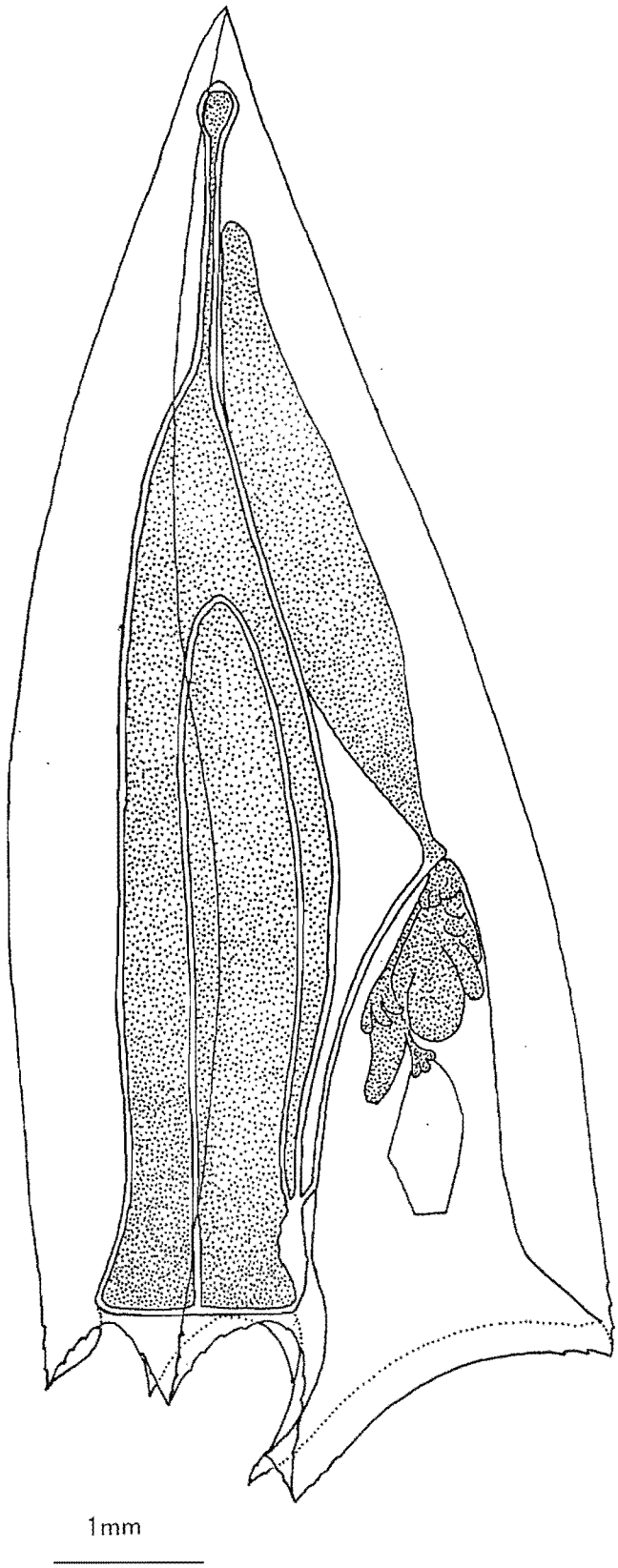

Fig. 19. *Diphyes disper*. Lateral view of anterior nectophore.

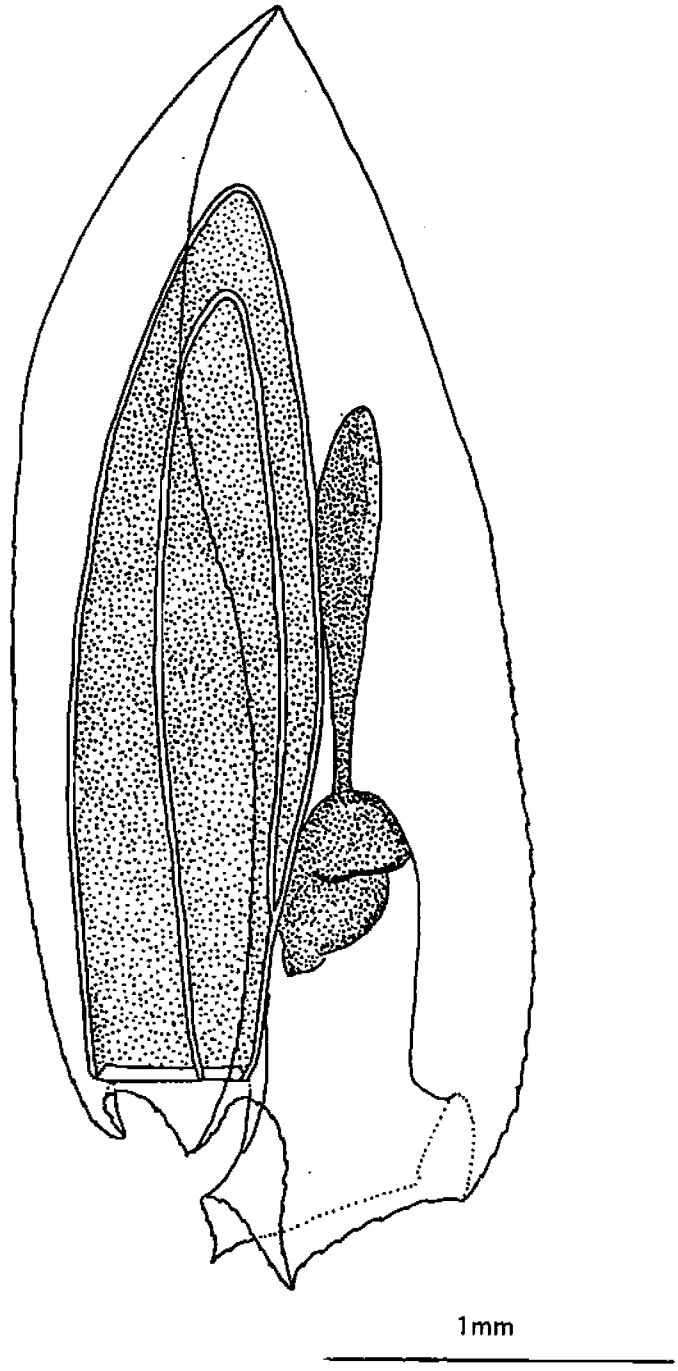

Fig. 20. *Diphyes chamissonis.* Lateral view of nectophore.

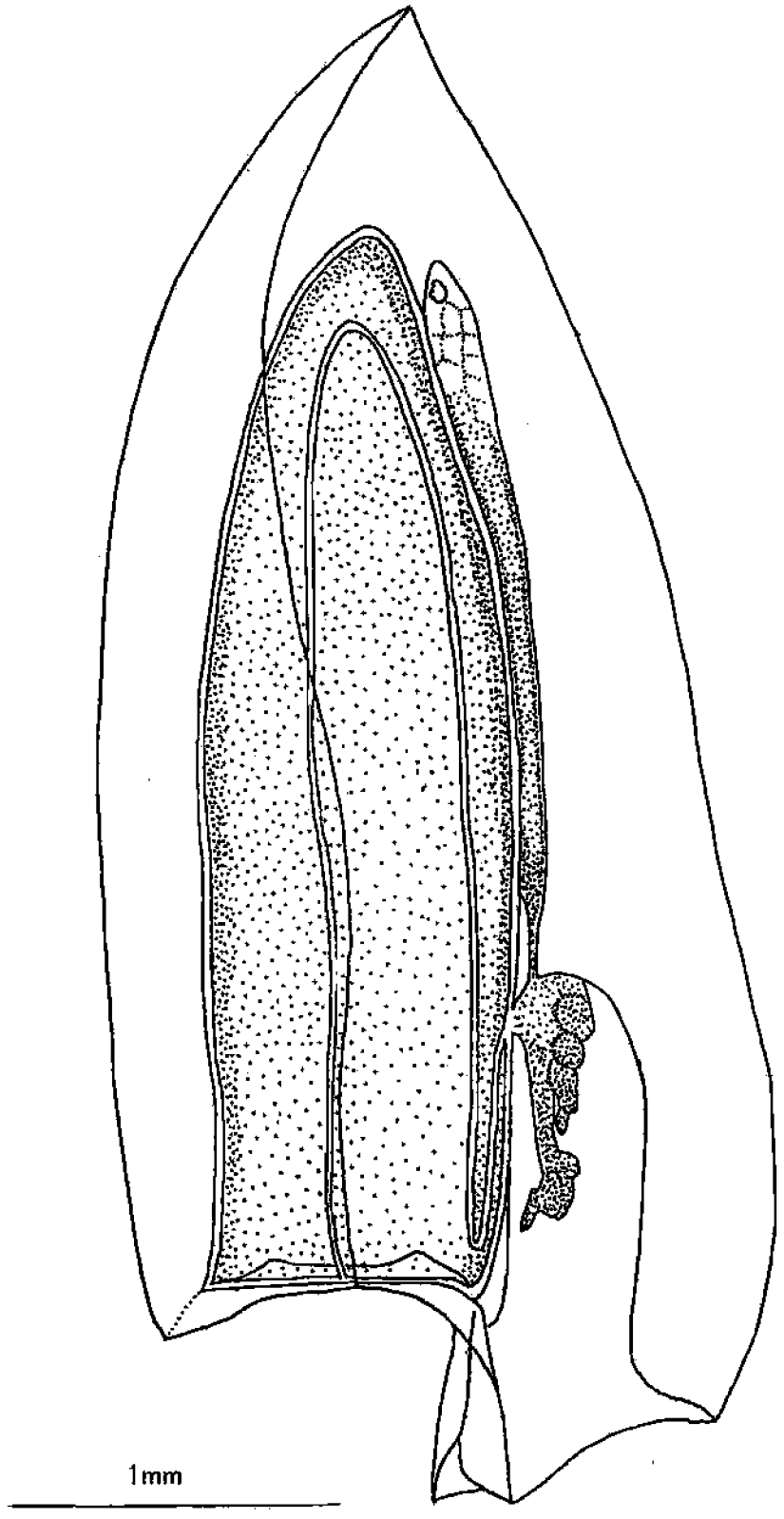

Fig. 21. *Muggiaea atlantica.* Lateral view of nectophore.

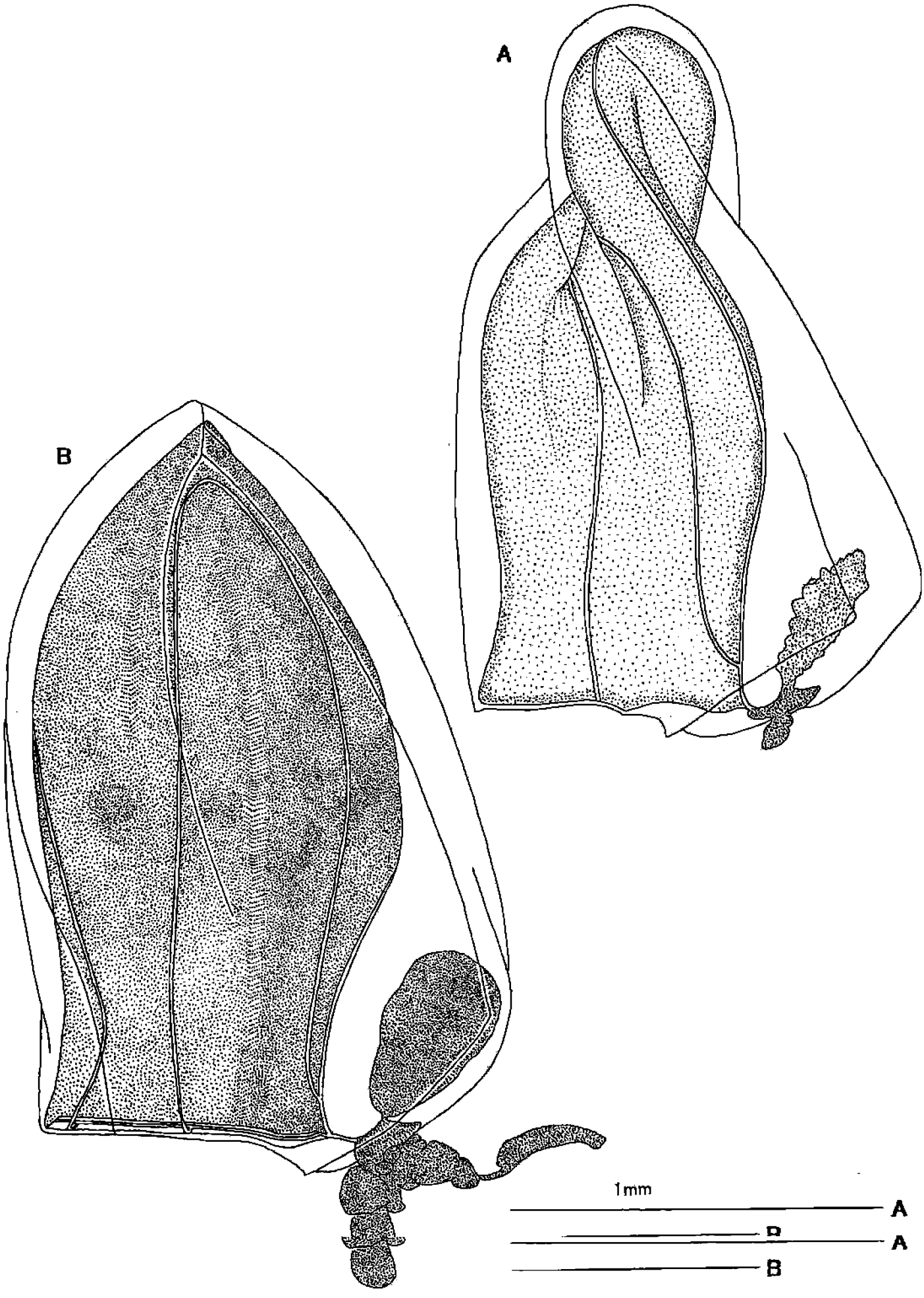

Fig. 22. *Lensia campanella.* Lateral view of anterior nectophores, well twisted specimen (A), and slightly twisted specimen (B).

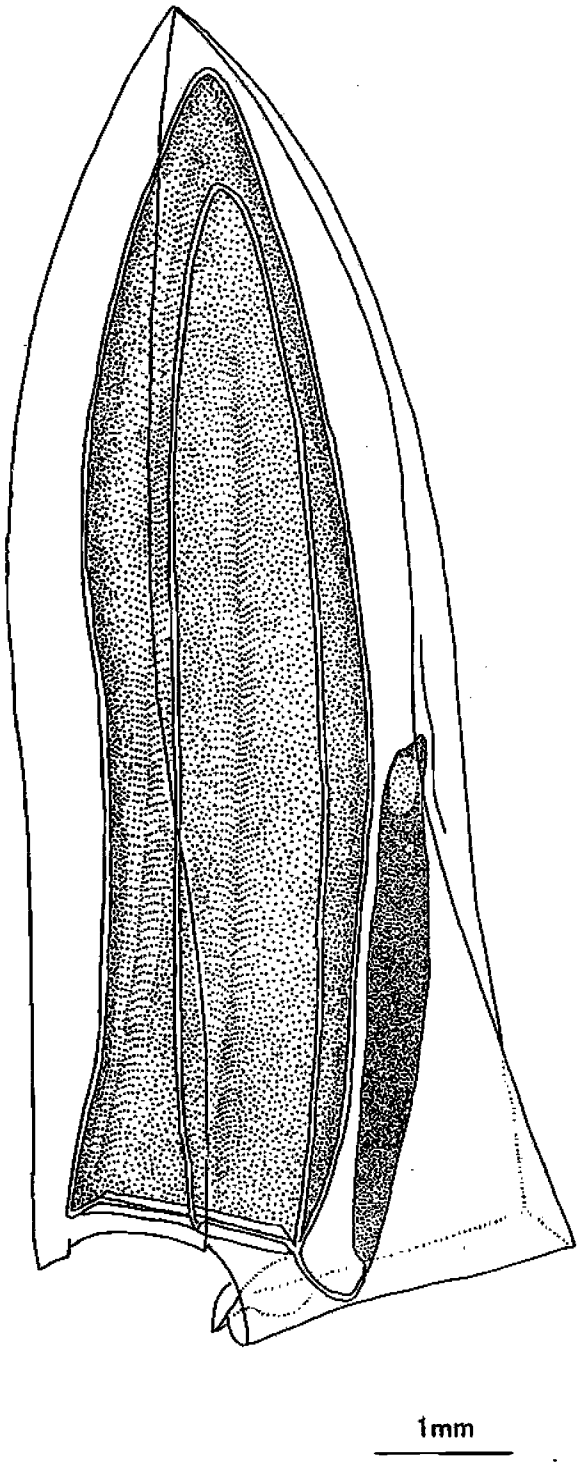

Fig. 23. *Lensia conoidea.* Lateral view of anterior nectophore.

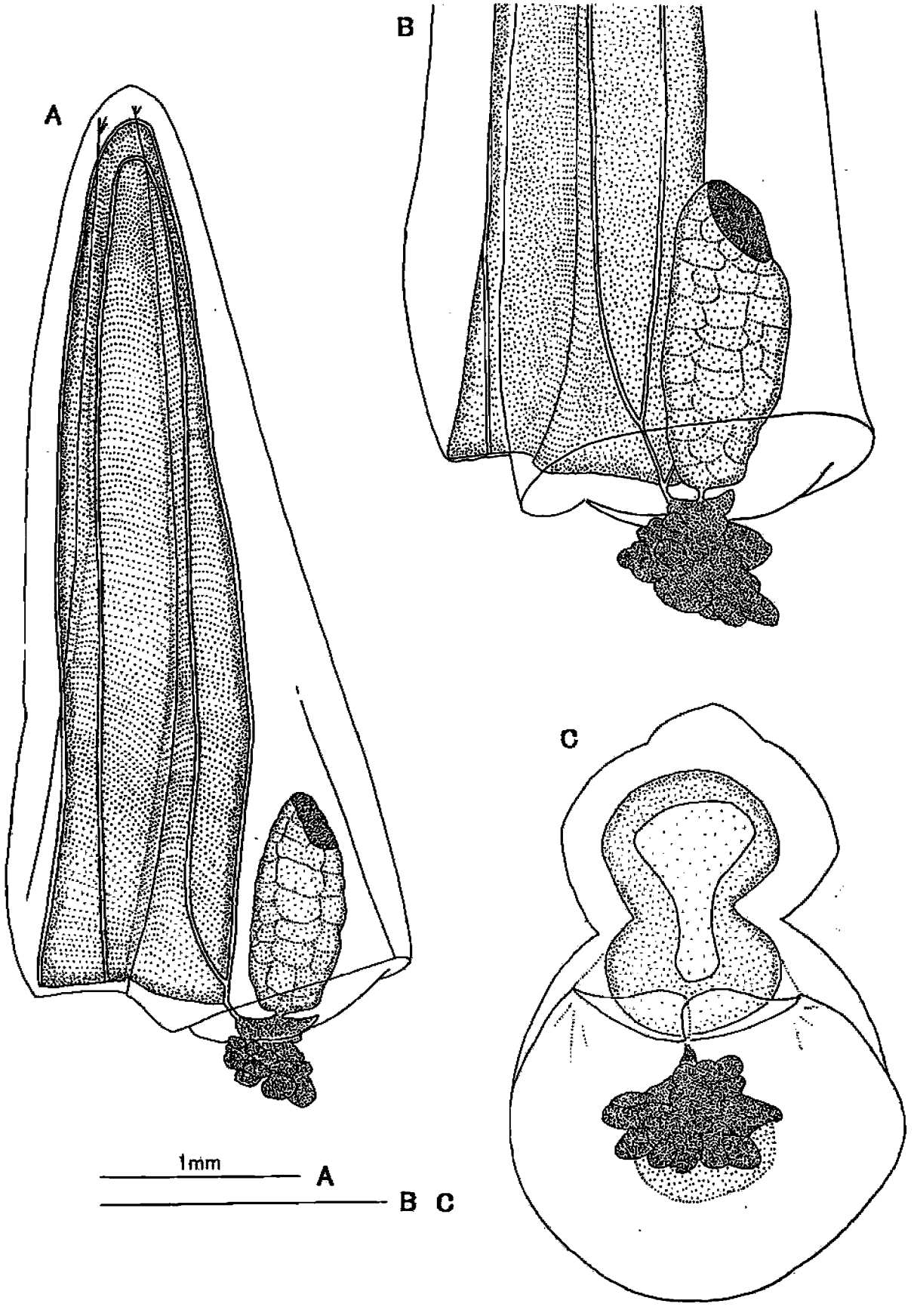

Fig. 24.. *Lensia cossack*. Anterior nectophore in lateral view (A), basal portion in

Fig. 24.. *Lensia cossack*. Anterior nectophore in lateral view (A), basal portion in

latero-ventral view (B), and in basal view(C).

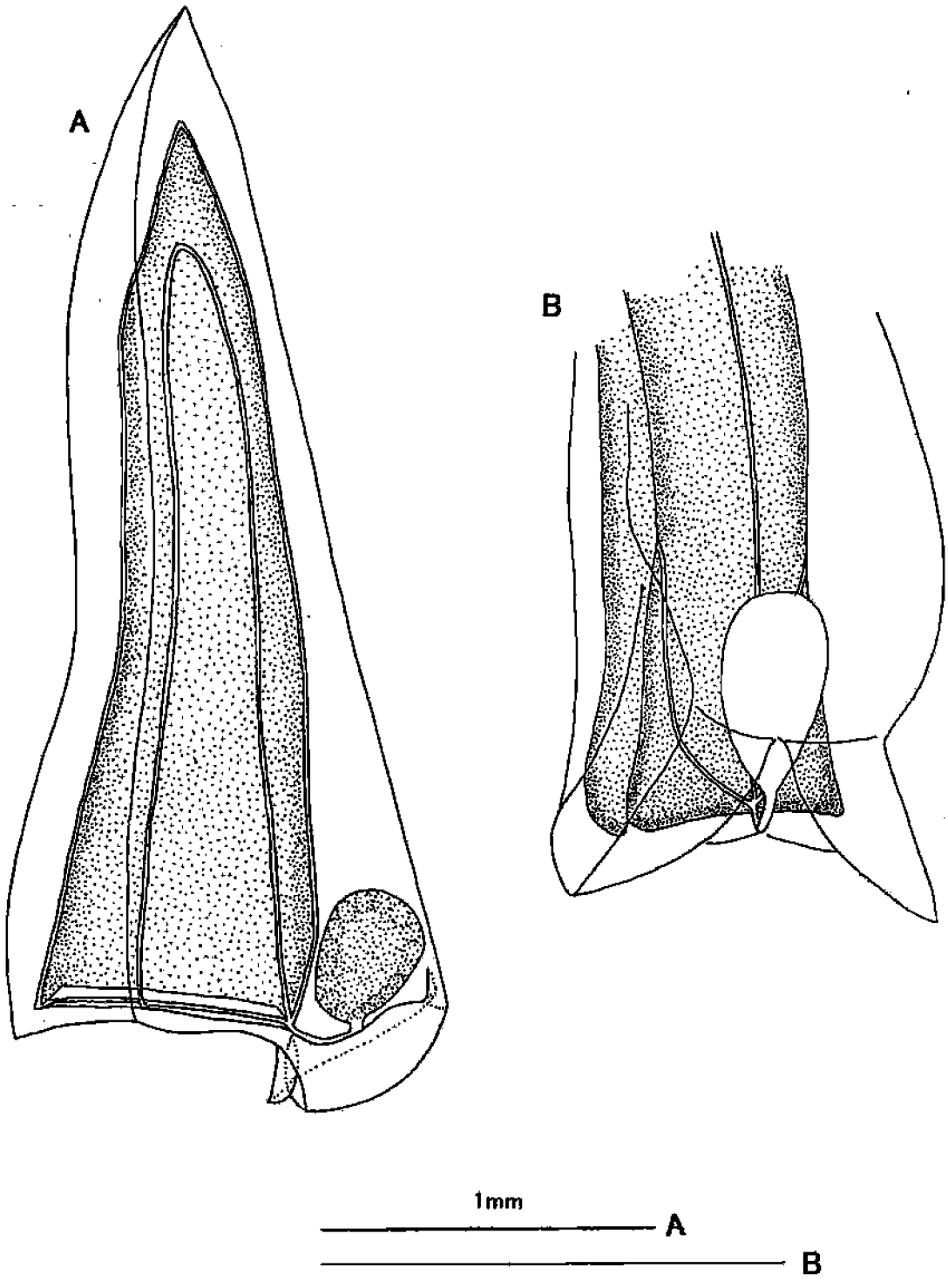

Fig. 25. *Lensia hardy*. Anterior nectophore in lateral view (A), and in baso-ventral view (B).

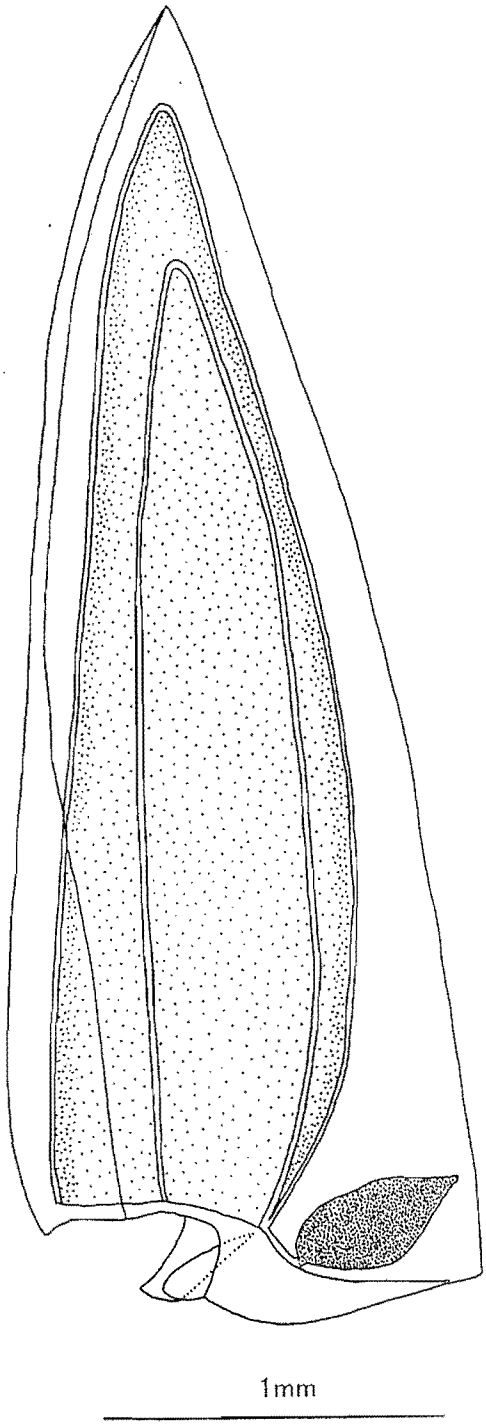

Fig. 26. *Lensia hotspur*. Lateral view of anterior nectophore.

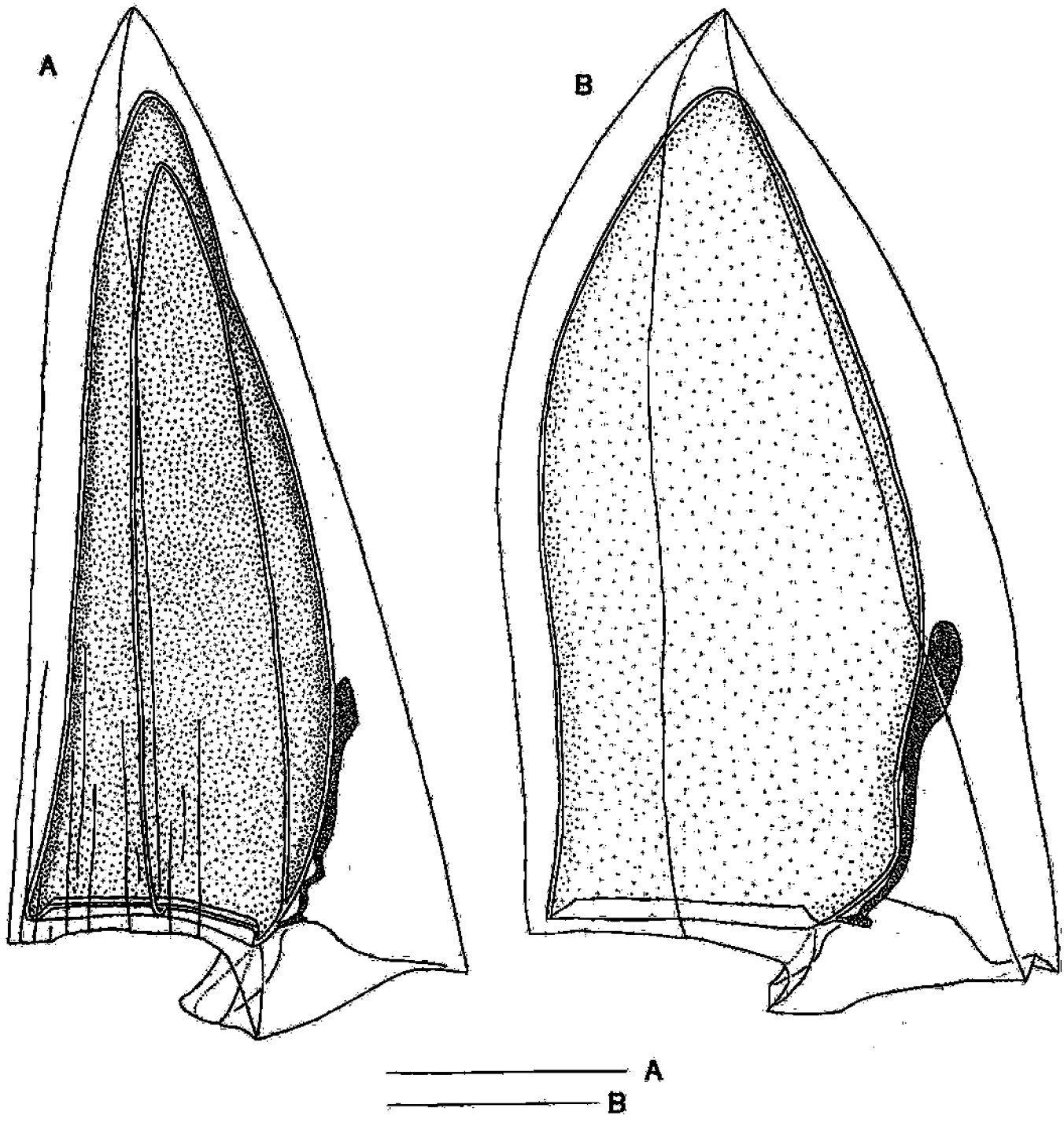

Fig. 27. *Lensia leloupi*. Lateral view of anterior nectophores.

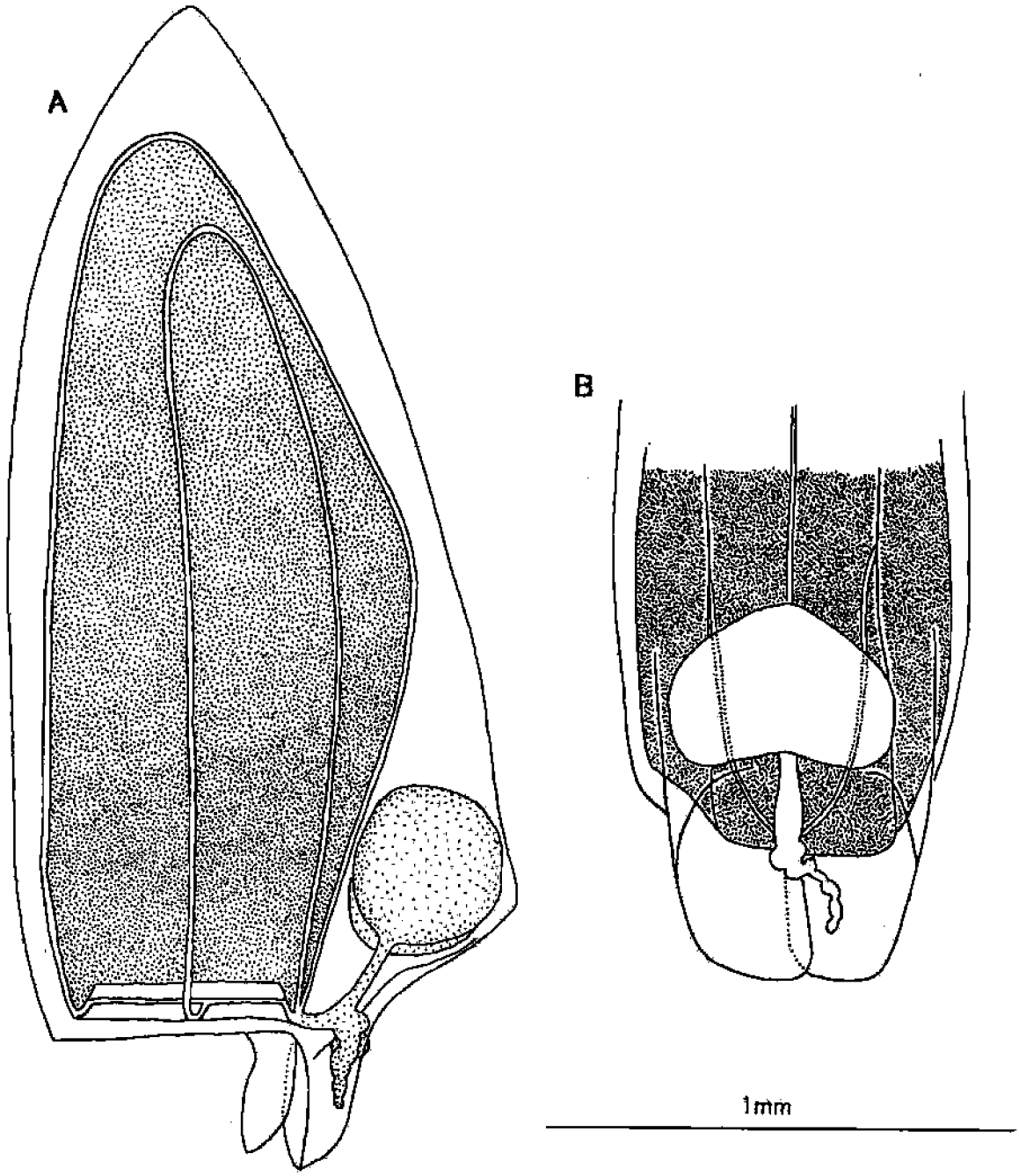

Fig. 28. *Lensia meteori.* Anterior nectophore in lateral view (A), and in baso-lateral view (B).

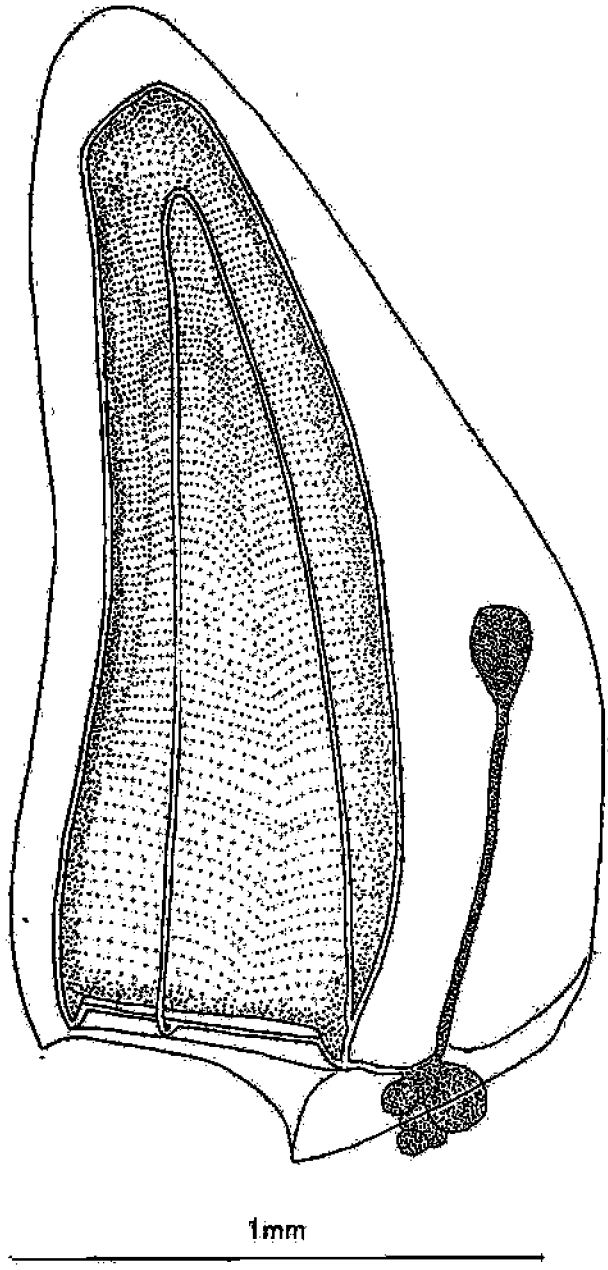

Fig. 30. *Lensia subtilis.* Anterior nectophore in lateral view.

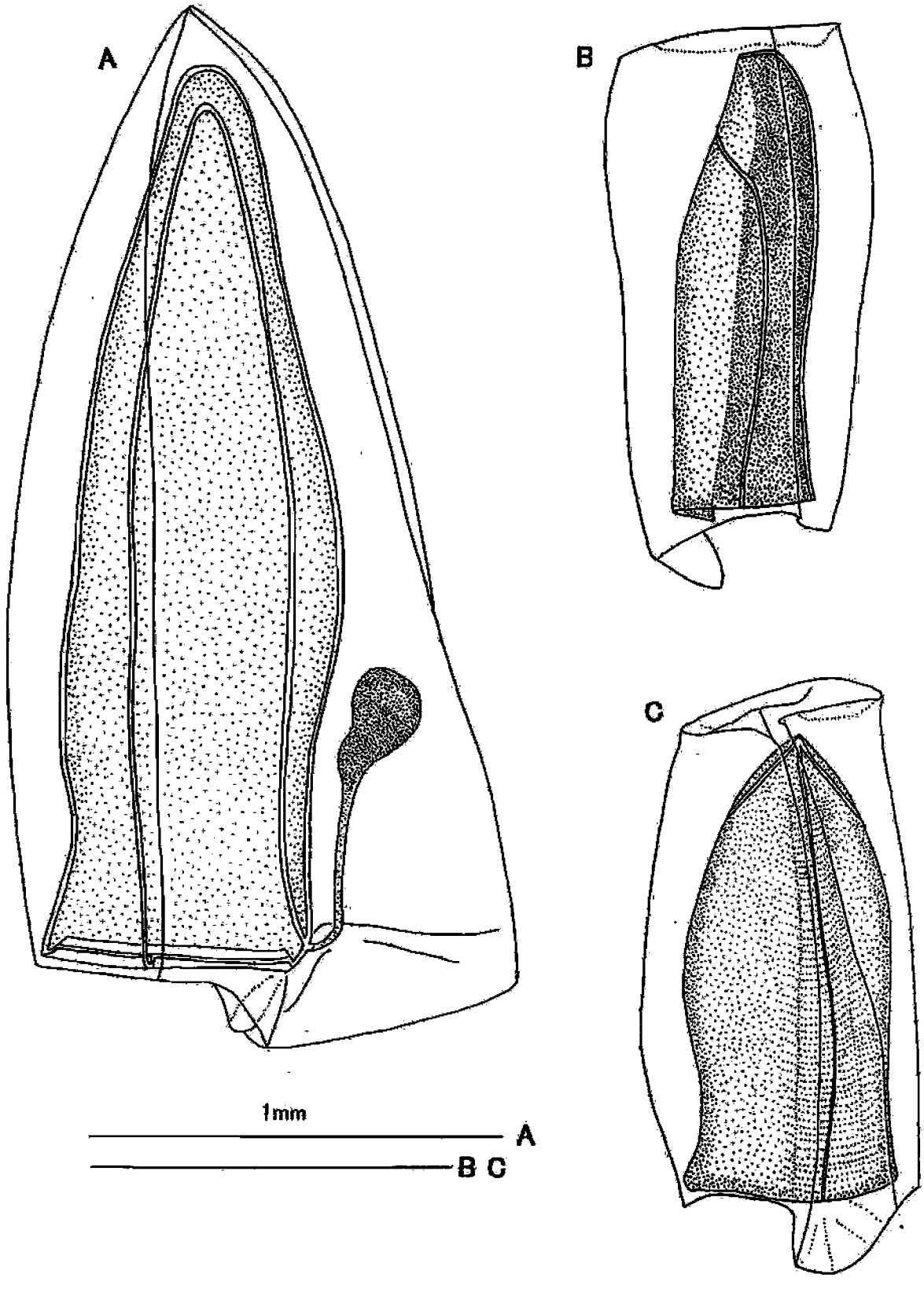

Fig. 31. *Lensia subtiloides.* Anterior nectophore in lateral view (A). Posterior nectophore in lateral view (B), and in ventral view.

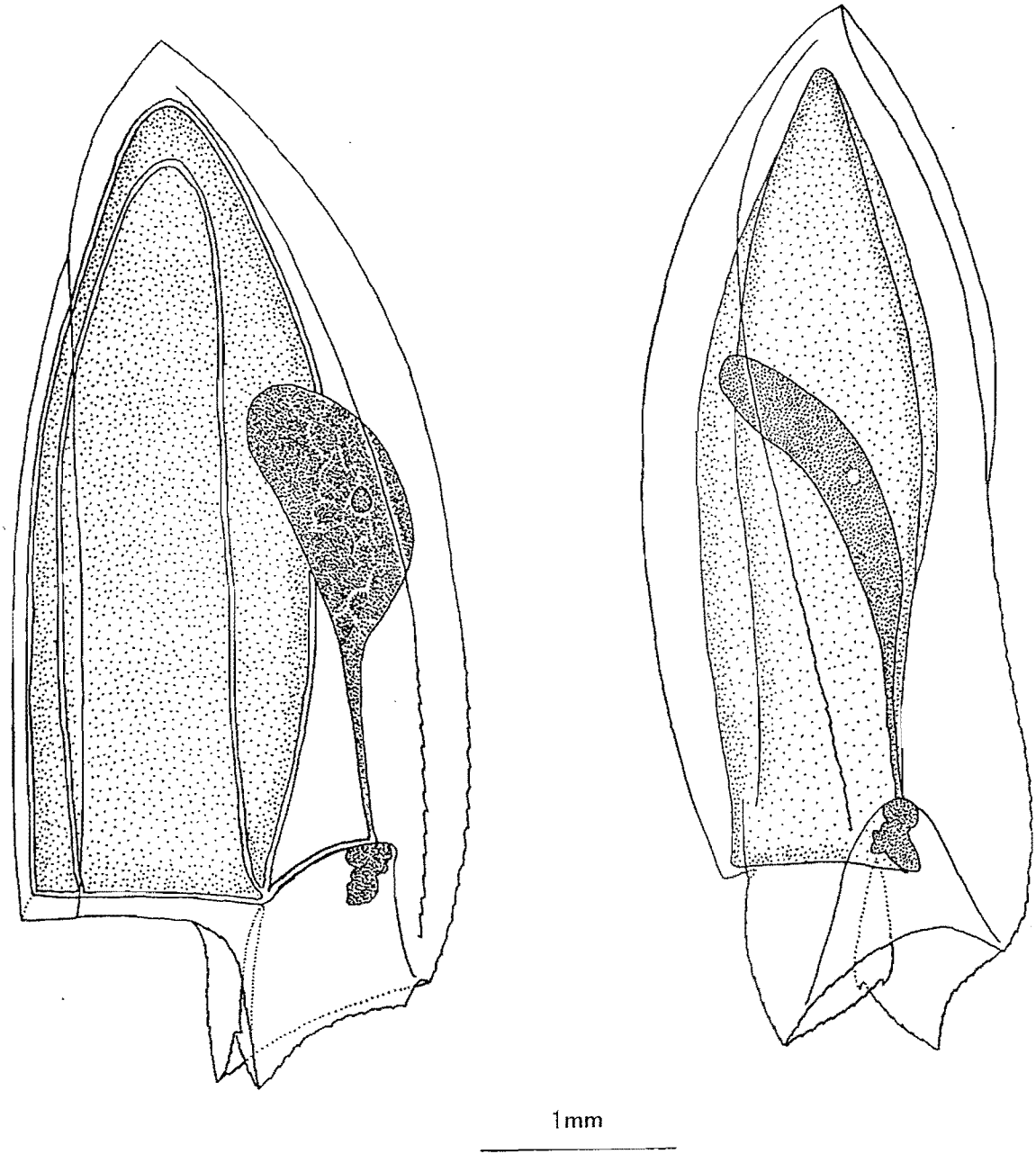

Fig. 32. *Chelophyes contorta*. Anterior nectophore in lateral view (A), and in ventral view (B).

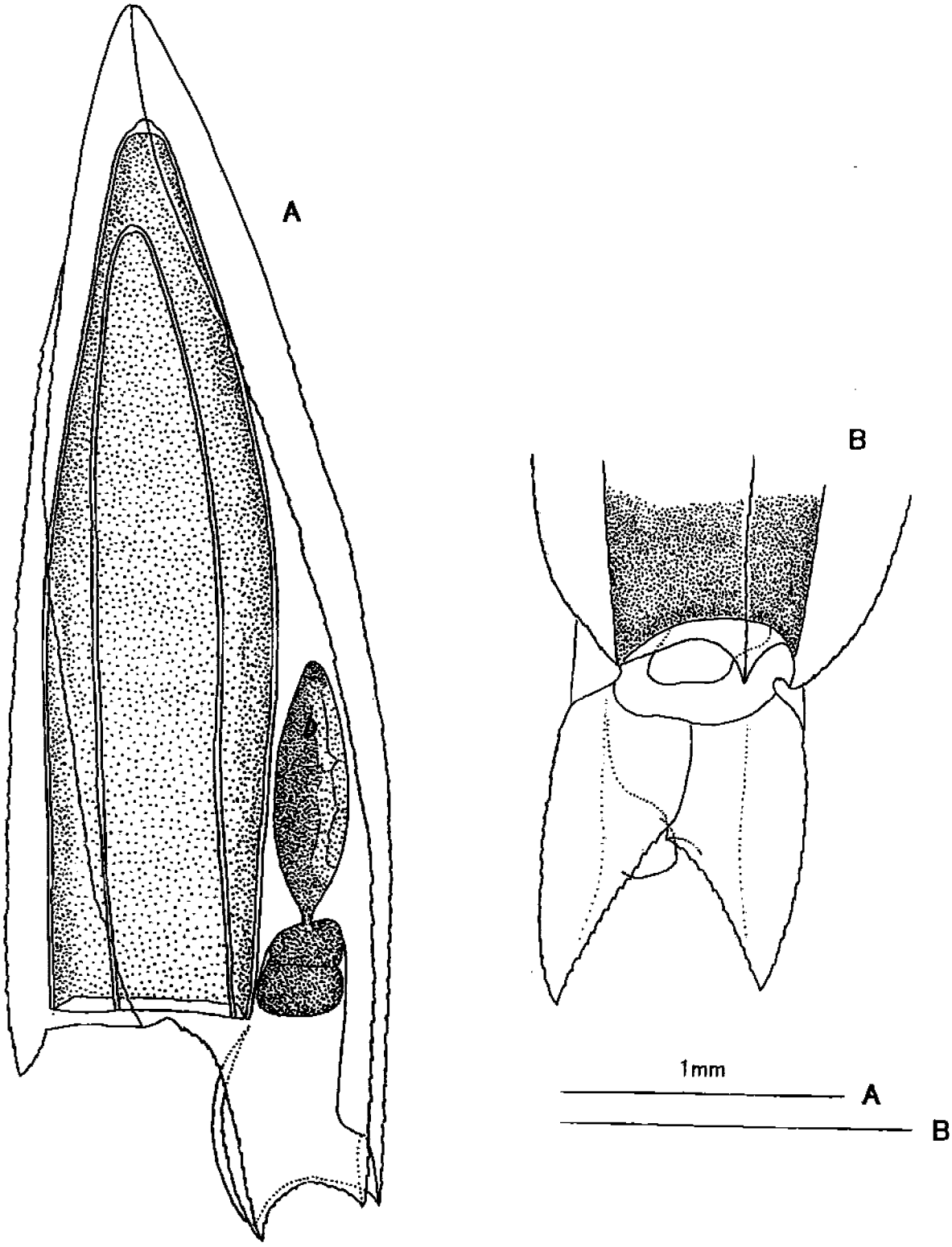

Fig. 33. *Eudoxoides mitra.* Anterior nectophore in lateral view (A), and mouthplate (B).

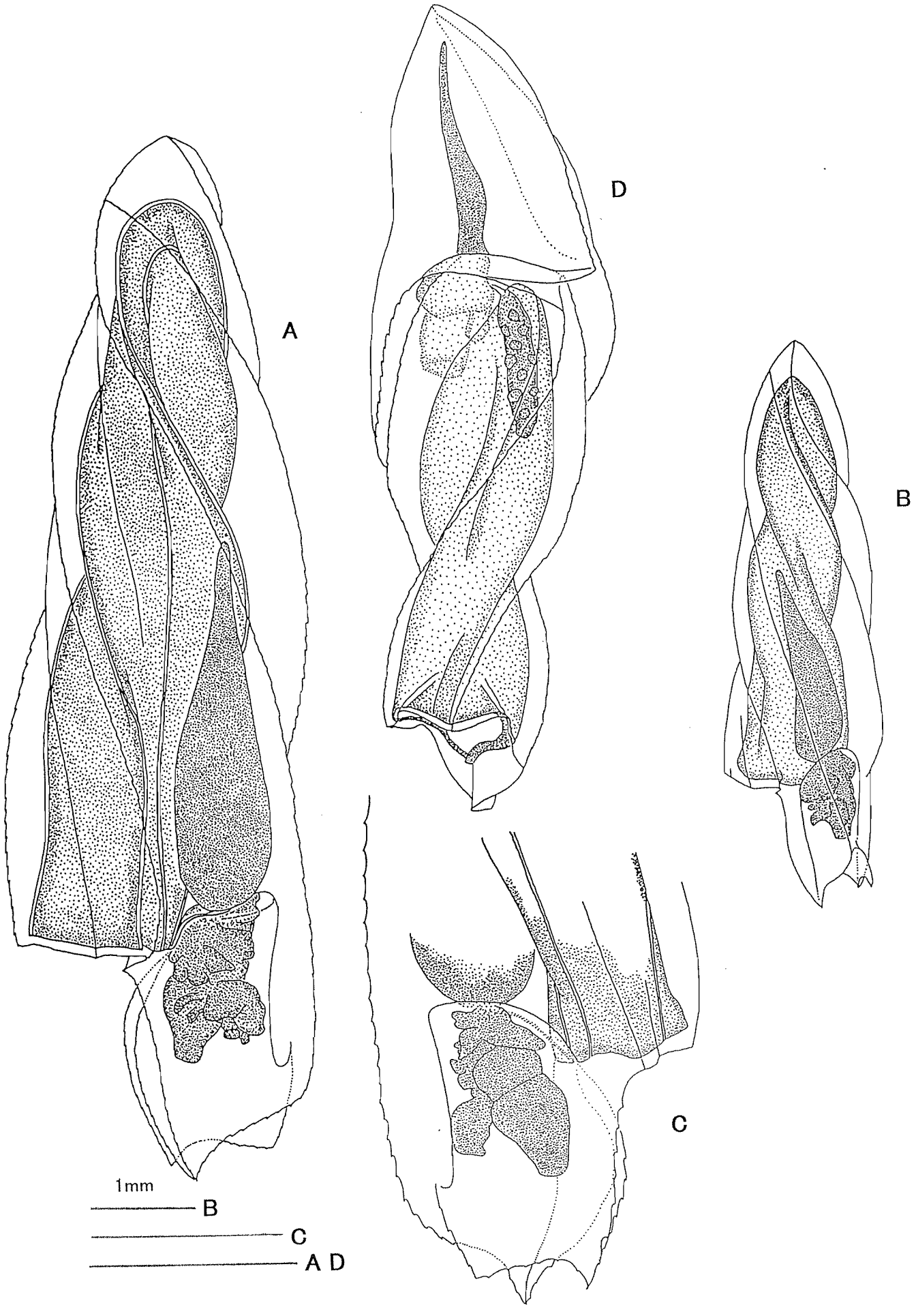

Fig. 34. *Eudoxoides spiralis*. nectophore in lateral view (A), in ventral view, (B), hydroecium in lateral view (C), and eudoxid in lateral view (D).

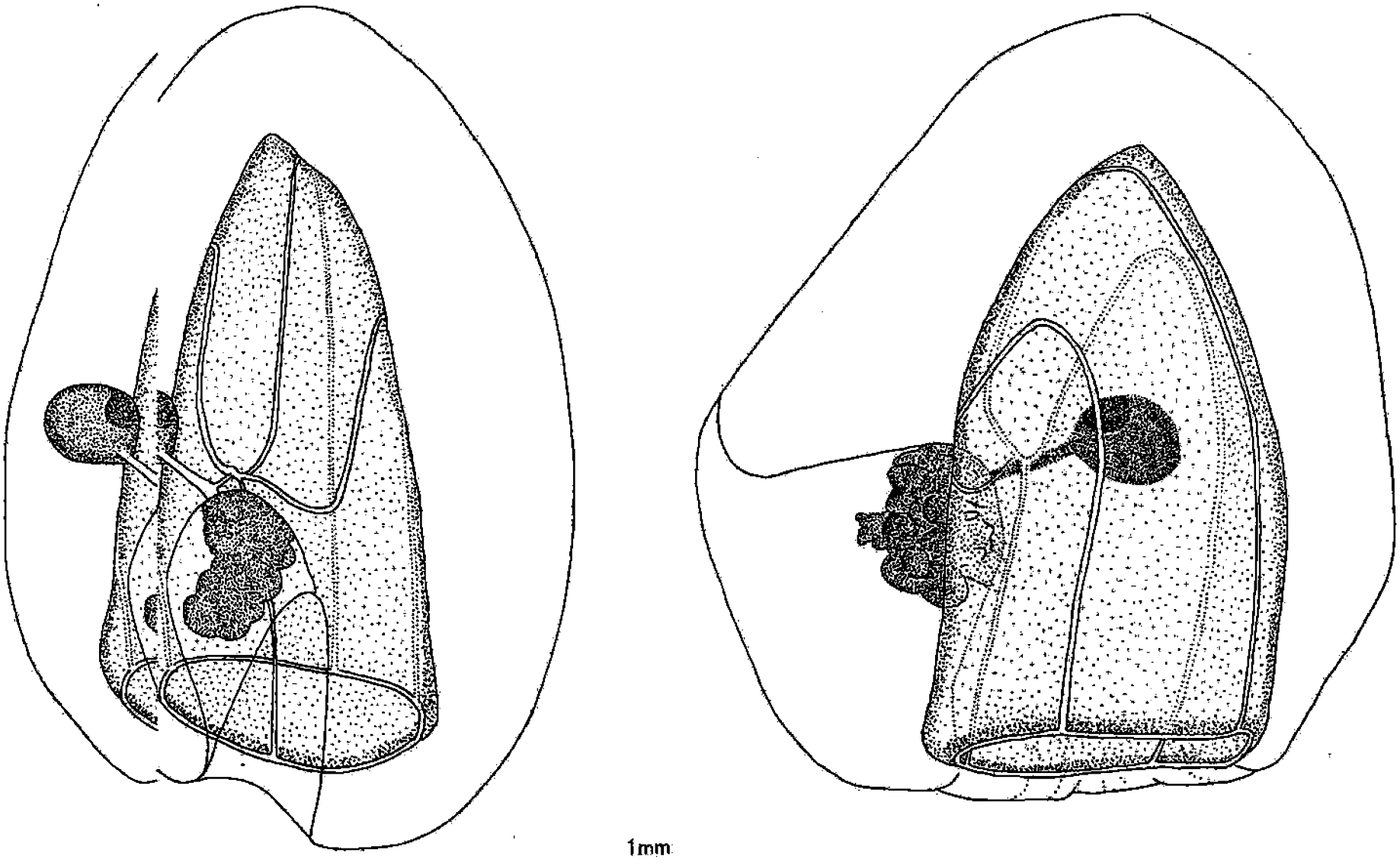

Fig. 35. *Sphaeronectes gamulini*. Nectophore in ventral view (A), and in lateral view (B).

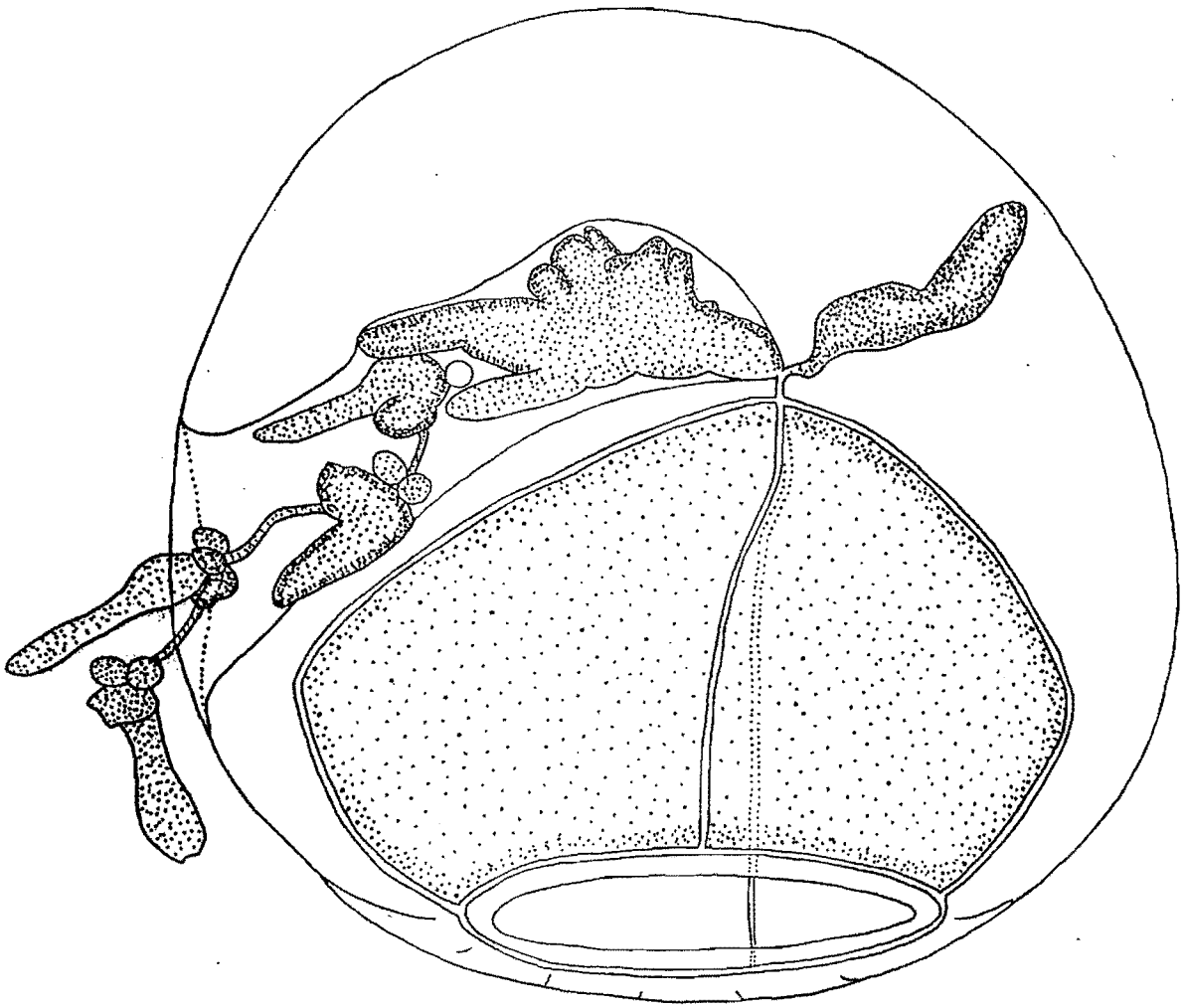

Fig. 36. *Sphaeronectes gracilis*. Lateral view of nectophore.

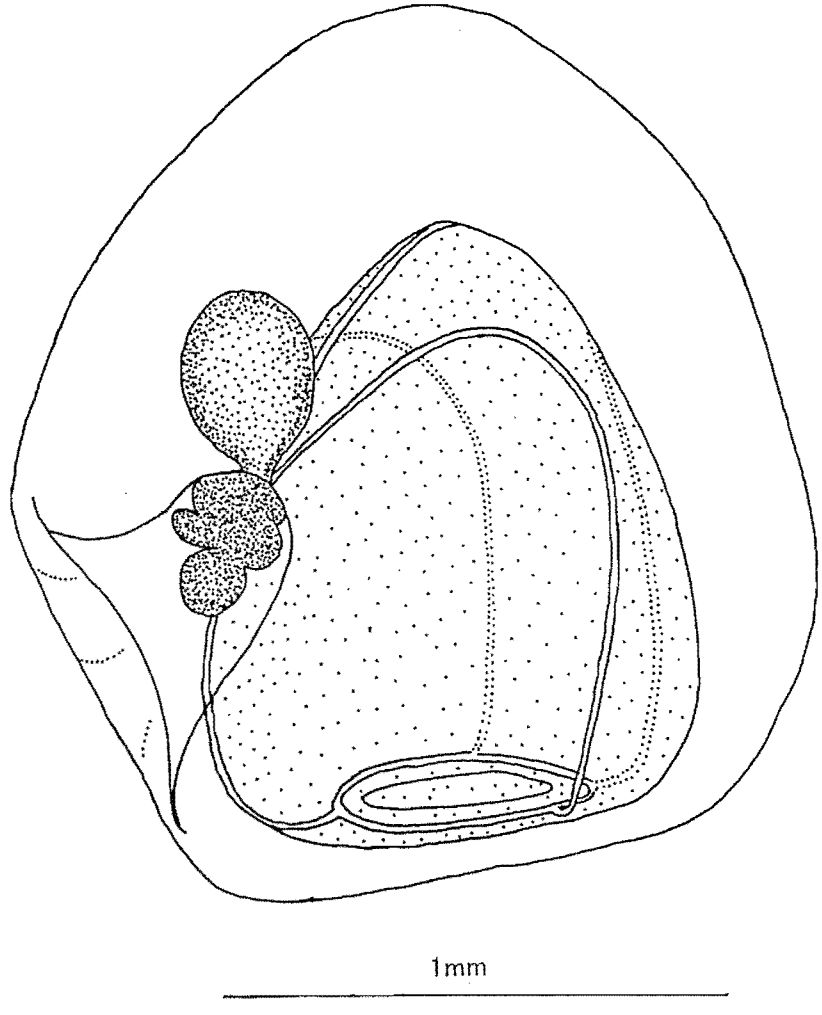

Fig. 37. *Sphaeronectes irregularis*. Lateral view of nectophore.

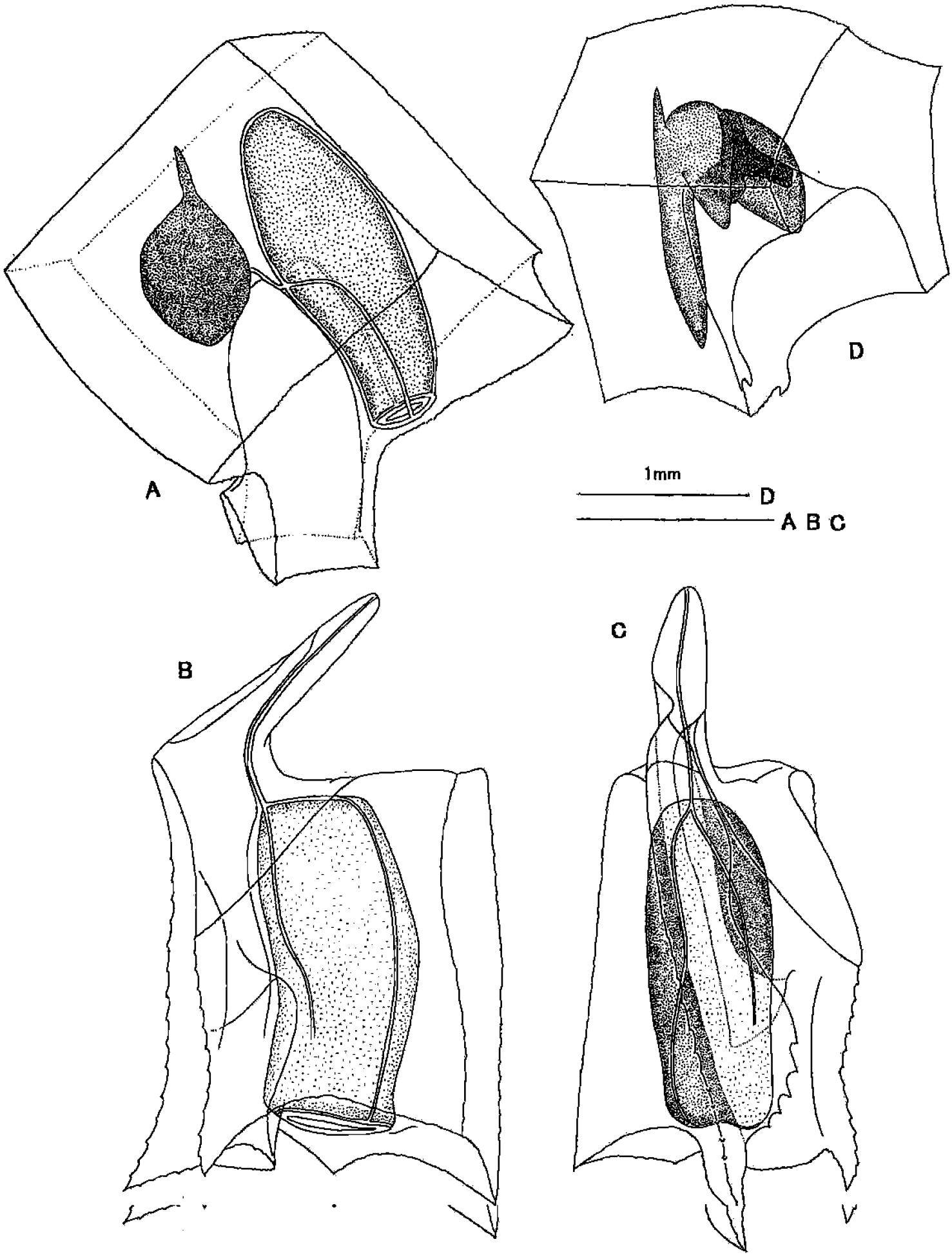

Fig. 38. *Abylopsis eschscholtzi*. Lateral view of anterior nectophore (A). Posterior nectophore in lateral view (B), and in ventral view (C). latero-ventral view of

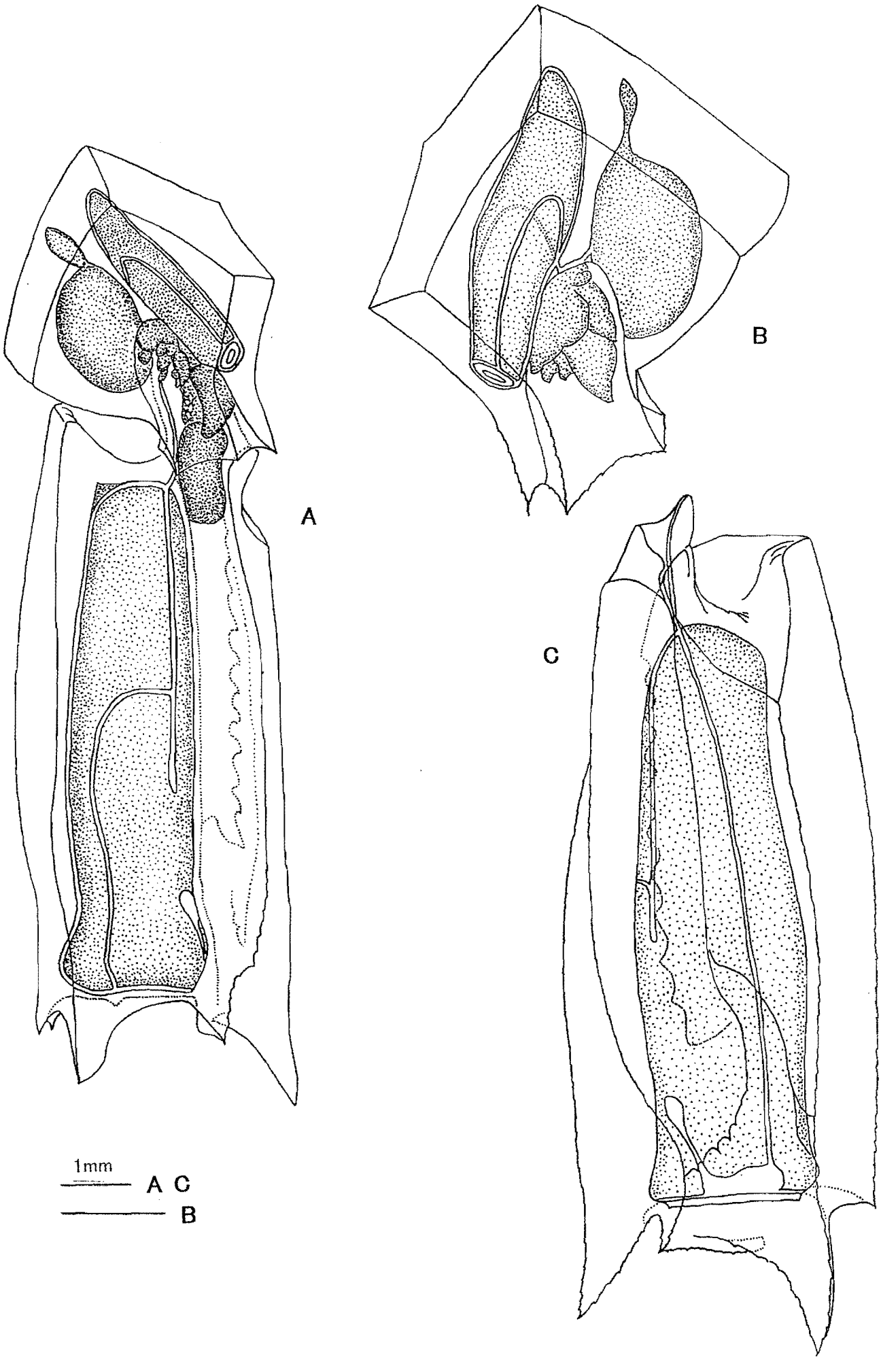

Fig. 39 *Abylopsis tetragona*. Nectophores of polygastoric stage in lateral view (A). Lateral view of anterior nectophore (B). Ventral view of posterior nectophore (C).

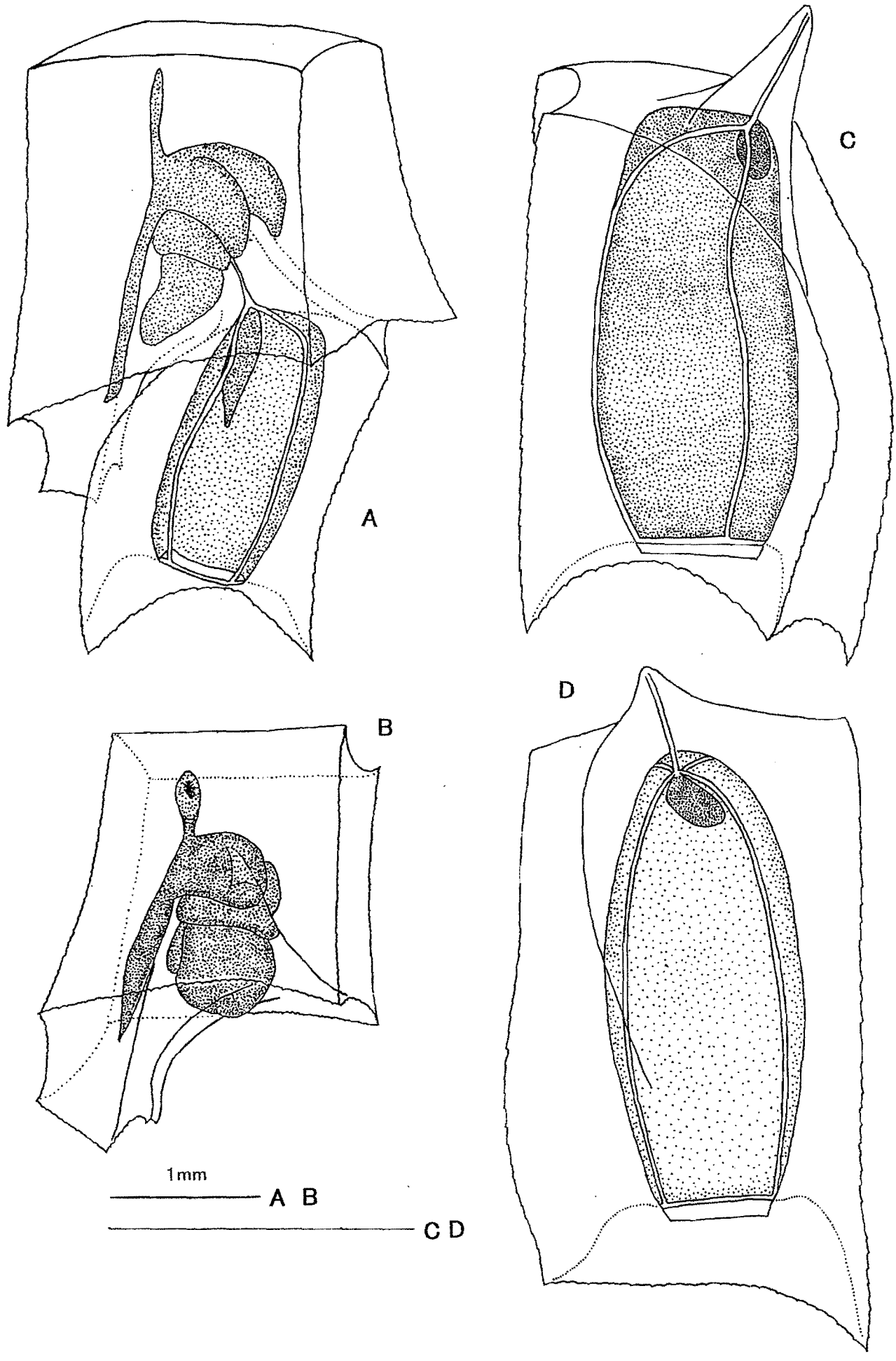

Fig. 40. *Abylopsis tetragona*. Latero-ventral view of eudoxid stage (A). Latero-ventral view of bract (B). gonophore in lateral view (C), and in ventral view (D).

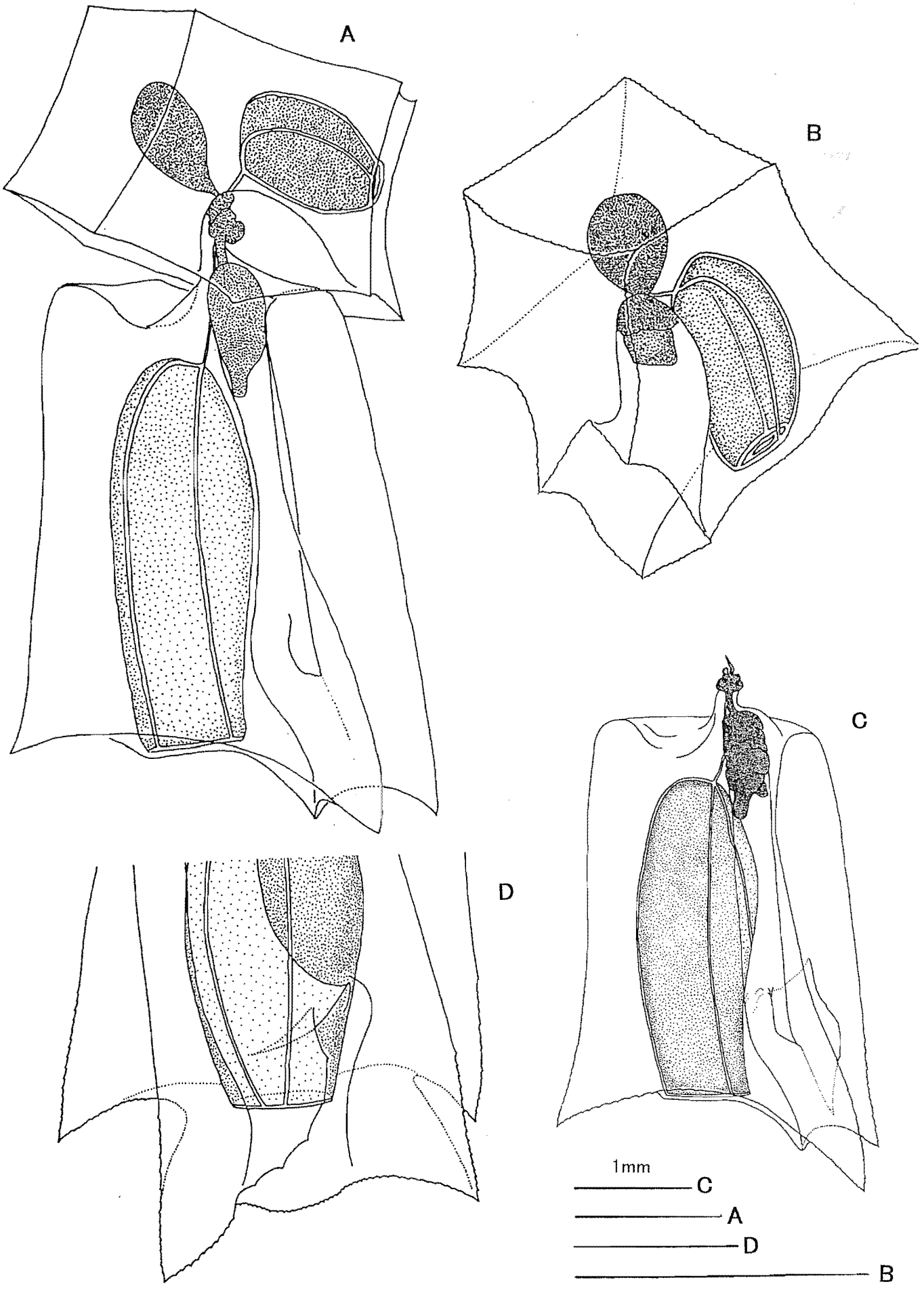

Fig. 41. *Bassia bassensis.* Nectophores of polygastoric stage (A). Latero-ventral view of anterior nectophore (B). Posterior nectophore in lateral view (C), and baso-ventral view (D).

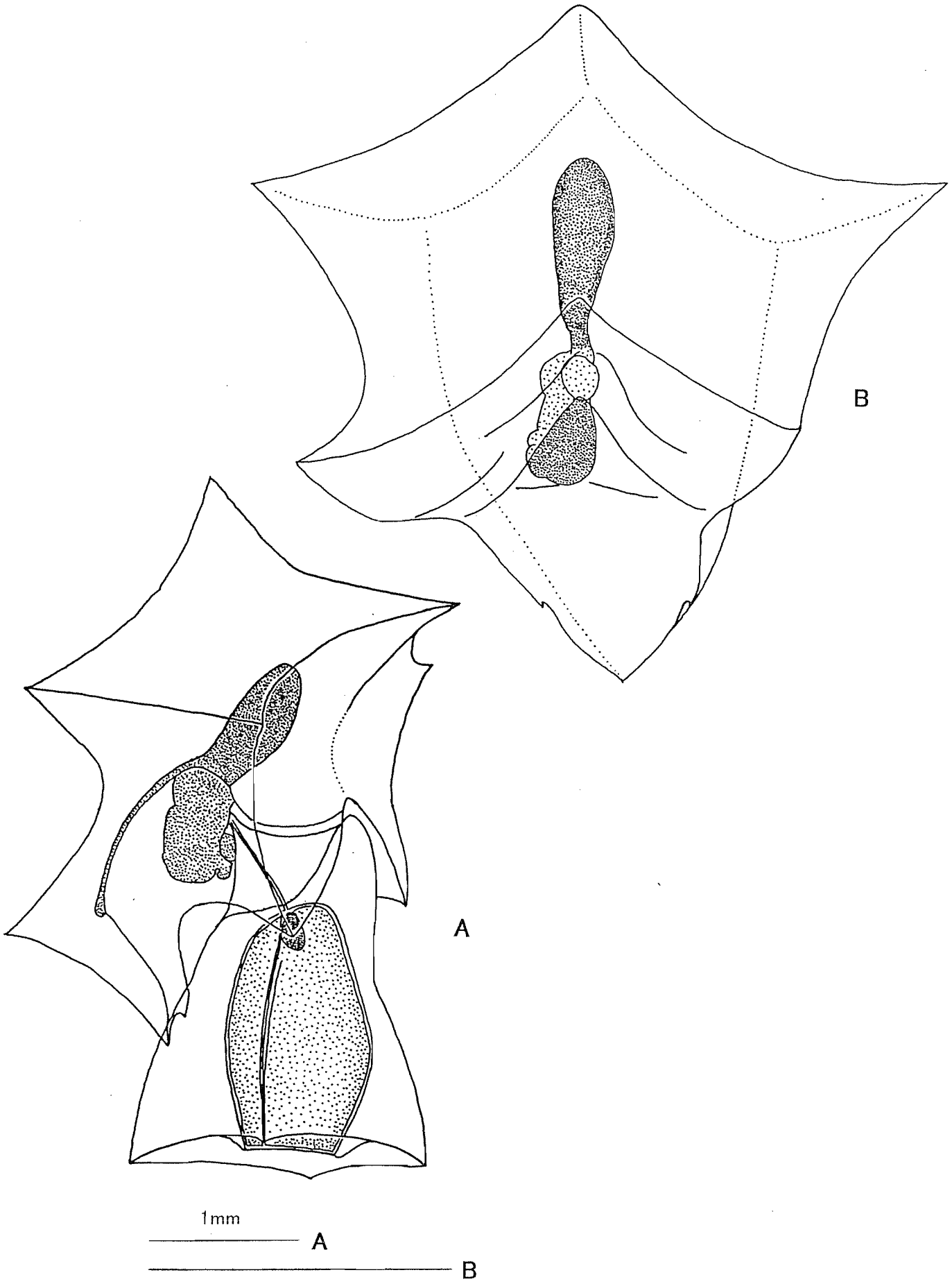

Fig. 42. *Bassia bassensis*. Latero-ventral view of eudoxid stage (A). Ventral view of bract (B).

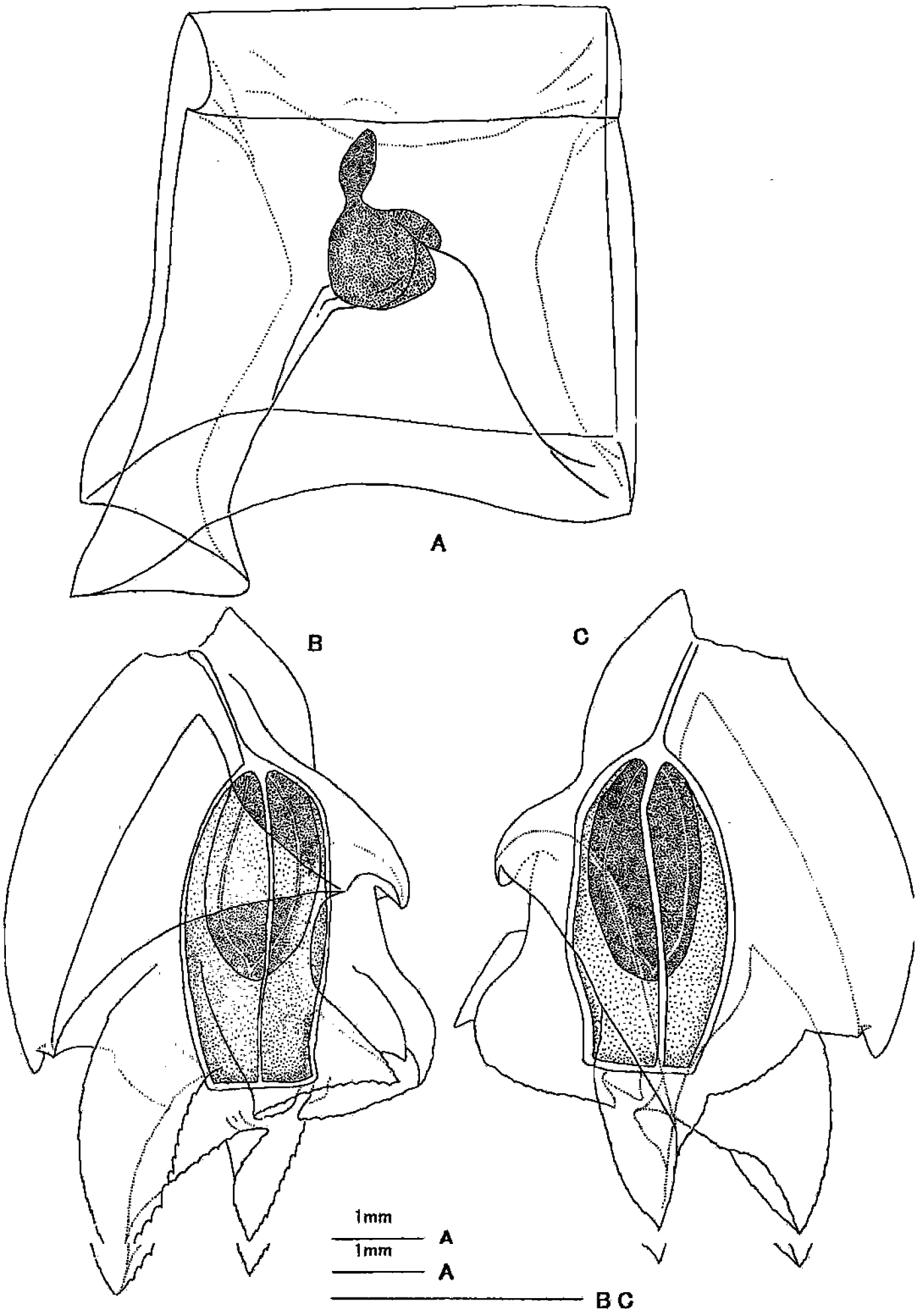

Fig. 43. *Enneagonum hyalinum*. Latero-apical view of bract (A). Gonophore in latero-dorsal view (B), and in latero-ventral view (C).

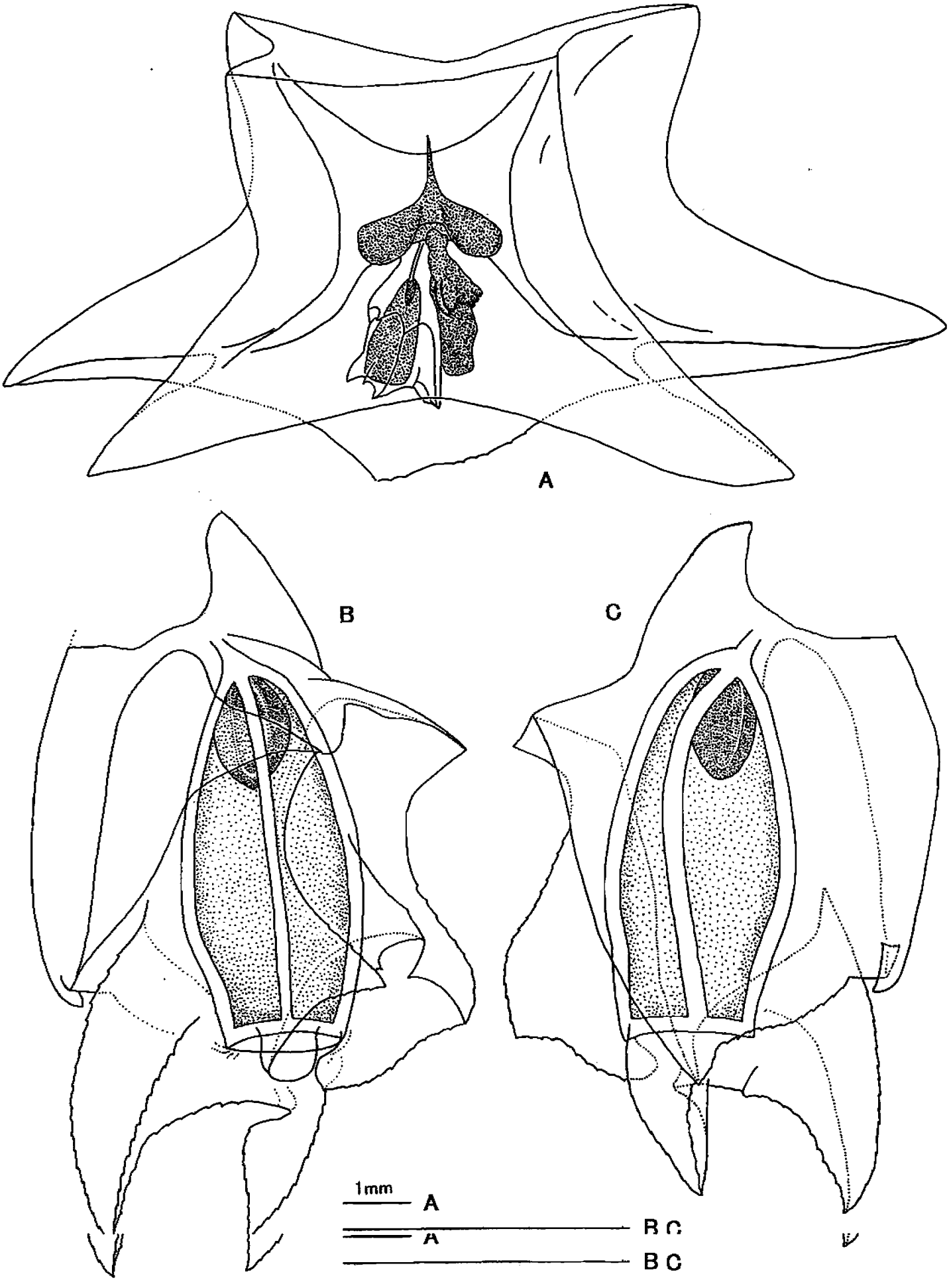

Fig. 44. *Enneagonum searsae*. Ventral view of bract (A). Gonophore in latero-dorsal view (B), and in latero-ventral view (C).

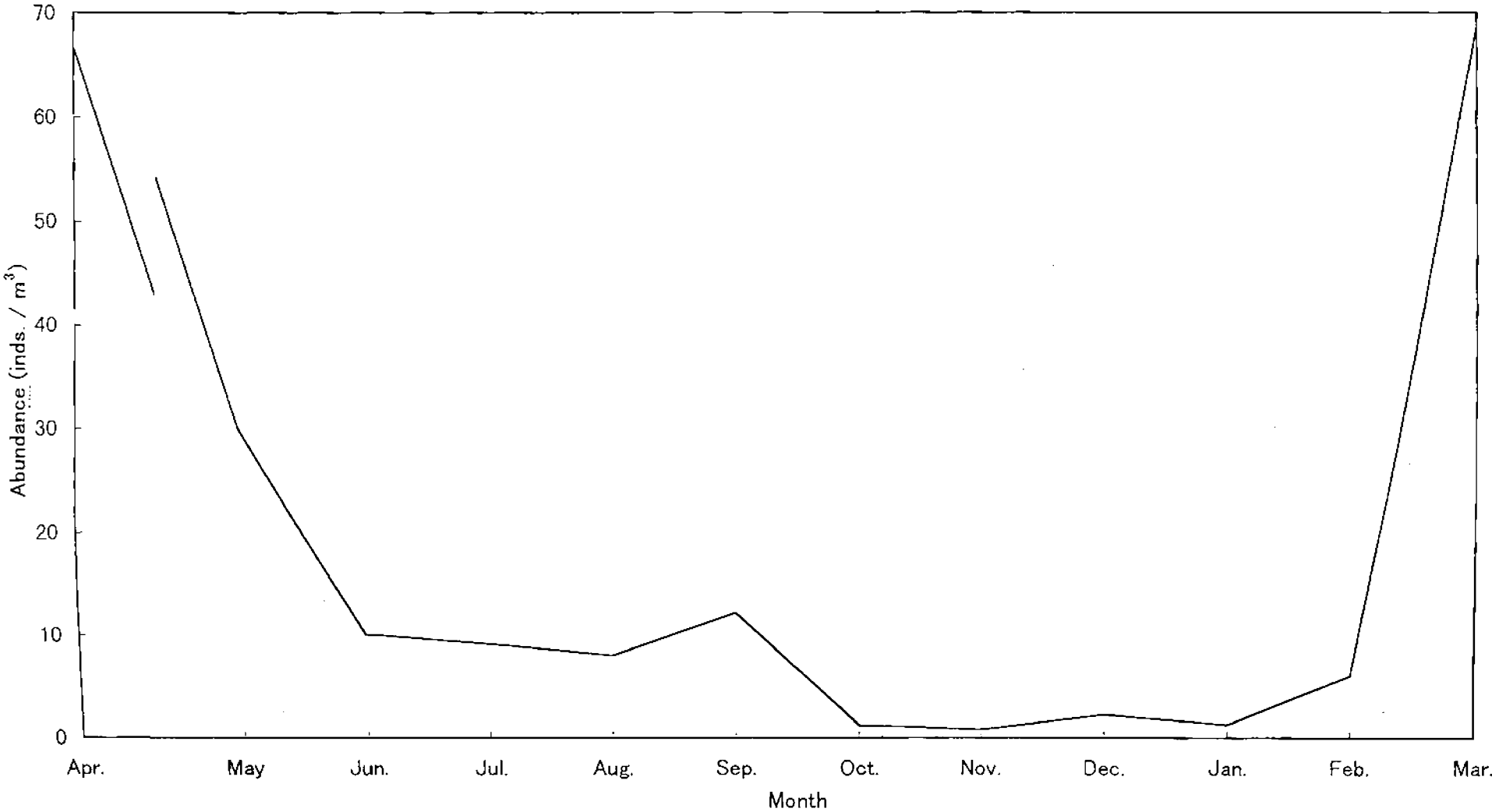

Fig. 45. Seasonal change in density of planktonic cnidarians in Sagami Bay.

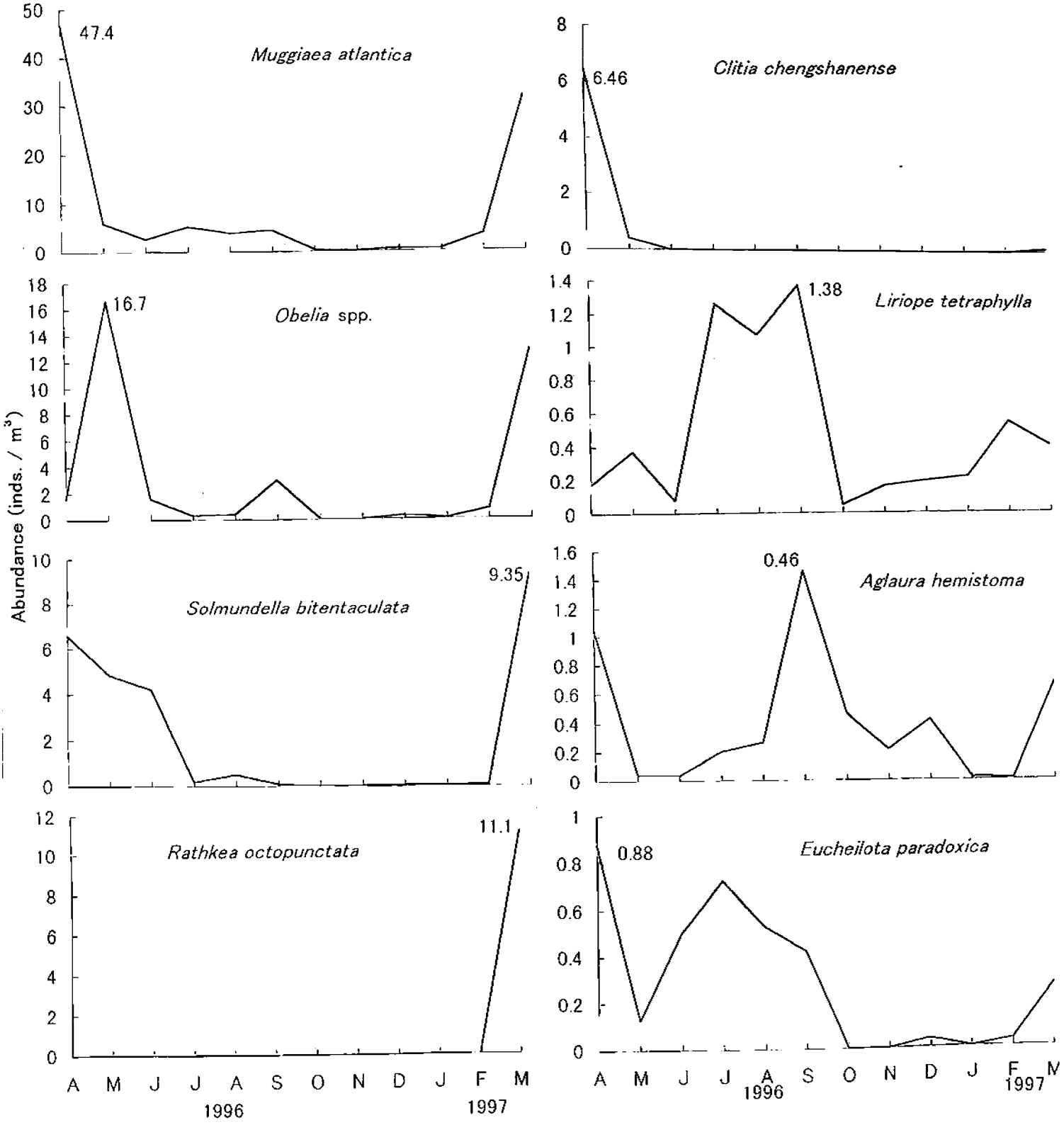

Fig. 46. Seasonal occurrence of major eight taxa in Sagami Bay.

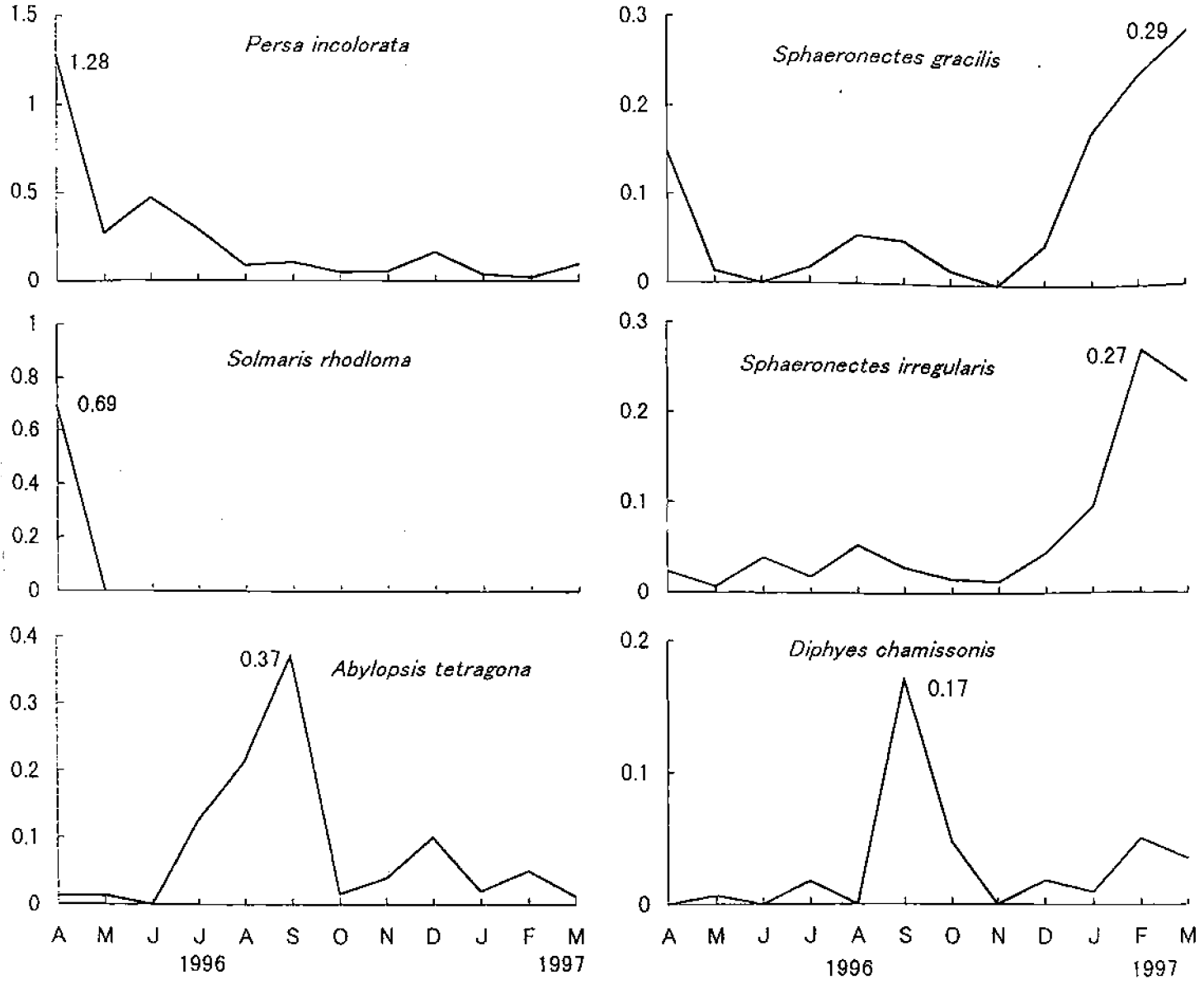

Fig. 47. Seasonal occurrence of six species in Sagami Bay.