OPHELIA 48 (2): 103-135 (June 1998)

ASCIDIANS FROM THE NORTH-WESTERN PACIFIC REGION 4. POLYCLINIDAE AND PLACENTELIDAE

Karen Sanamyan
Kamchatka Institute of the Ecology and Environment, Partyzanskaja 6,
Petropavlovsk-Kamchatsky, 683000, Russia.

ABSTRACT

The paper reports on the ascidians of the families Polyclinidae and Placentelidae collected during several expeditions in the NW Pacific. Twenty species in 6 genera of Polyclinidae and one species of Placentelidae were recognised in the material. *Neodictyon* n.g. (type species: *N. shumshu* n.sp.) which is characterised by absence of stigmata in the branchial sac, is described. The new genus is compared with *Pharyngodictyon* and *Protoholozea* both of which also lack stigmata in the branchial sac but are southern hemisphere genera. *Aplidium lebedi* n.sp. and *Ritterella tamarae* n.sp. are described. Larvae of several species are described.

Key words: Ascidiacea, North-Western Pacific, *Neodictyon, Macrenteron, Ritterella,* Polyclinidae, Placentelidae.

INTRODUCTION

About 40% of the ascidian species originating from the NW Pacific and kept in the collections of the Kamchatka Institute of Ecology and Zoological Institute belong to the family Polyclinidae. Although some of the species are very common in the region, most of them are still poorly known. Among 20 identified species 7 were found only for the second time. Is was interesting to find that additional specimens of some of these imperfectly known species came from the type localities, as, for example, *Aplidium dubium* (Ritter, 1899), from the Medny and Bering Islands, *A. coei* (Ritter, 1901), from Kodiak Island, and some species described by Beniaminson from the Kurile Islands.

Three new species were discovered, the most interesting being *Neodictyon shumshu* n.g. et n.sp. which lacks stigmata and resembles the genera *Pharyngodictyon* and *Protoholozoa* in the structure of the branchial sac; both these genera are presently known only from deep waters on the southern hemisphere. *Macrenteron ritteri* Redikorzev, 1927 is redescribed and the monotypic genus *Macrenteron,* originally placed by Redikorzev (1927a) between Polyclinidae and Polyci-

toridae, is assigned to Polyclinidae. Where possible, type specimens were examined to confirm identification. *Placentela crystallina* Redikorzev, 1913 (the only species of the family Placentelidae) is common in the waters around Kamchatka and the Kurile Islands.

Not all the collected material is recorded here. Several specimens without outstanding features or badly preserved are considered unidentifiable.

The following material was examined:

(A) R.V. *Lebed*, 1954. North Kurile Islands (mainly Paramushir and Shumshu). Dredging. Coll. A. Spirina.

(B) R.V. *Academic Oparin*, 1986. Sea of Okhotsk and Kurile Islands. Dredging. Coll. A. Smirnov.

(C) R.V. *Academic Oparin*, 1988. Kurile Islands and Sea of Okhotsk. Dredging. Coll. E. N. Gruzov.

(D) R.V. *Academic Oparin*, 1991. Alaska, Aleutian, Commander and Kurile Islands, East Kamchatka. Dredging and SCUBA diving. Coll. A. Smirnov.

(E) Specimens from the Sea of Japan: Collection of the Far East State Sea Reservation (FESSR), 1980-1991 presented by director of FESSR Dr. A. Osolinsh. Specimens collected by Dr. A. Chernyshev, autumn 1994.

(F) Collection of the Kamchatka Institute of the Ecology and Environment (KIEE). 1984-1994. Commander Islands, East Kamchatka and Atlasov Island (North Kurile Group). SCUBA diving and dredging. Collectors: collaborators of the Lab. of Benthic Communities. Specimens collected by Dr. B. Sheiko: F. V. *Pogranitchnik Petrov*, Sea of Okhotsk, 1991 and F.V. *Gefest*, East Kamchatka, 1994.

Collections A-D (above) are in the Zoological Institute, St. Petersburg (ZIN), and collections E, F – Kamchatka Institute of the Ecology and Environment, Petropavlovsk-Kamchatsky (KIE).

This work was partly supported by personal grant No. 95-04-1113a from the Russian Foundation of the Fundamental Researches.

FAMILY POLYCLINIDAE

Kott (1992) removed the genus *Ritterella* (from the subfamily Euherdmaniinae) and erected a new family, Ritterellidae. The diagnostic features for Ritterellidae are the absence of cloacal systems and the form of the atrial siphon (the latter feature is however associated with the absence of cloacal systems). Some species assigned to *Ritterella* (as for example *Ritterella compacta* Kott, 1992) have a rudimentary cloacal cavity, and the atrial siphon resembles those of some *Synoicum* spp. The mentioned features do not justify a family status for Ritterellidae. Thus, the family name Polyclinidae is used here for all aplousobranch genera with postabdomen containing heart and gonads.

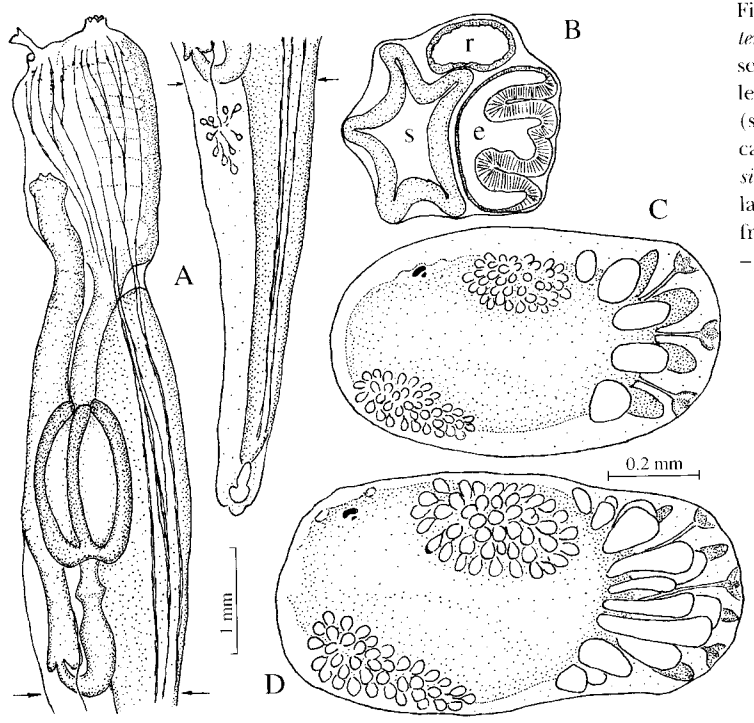

Fig. 1. *Macrenteron ritteri* – A, zooid; B, cross section at the stomach level showing stomach (s), rectum (r) and epicardium (e). *Aplidiopsis pannosum* – C, D, larvae (C – specimen from Lopatka Point; D – from Shumshu Island).

Macrenteron ritteri Redikorzev, 1927

Fig. 1A,B

Macrenteron ritteri Redikorzev, 1927a: 379; Tokioka 1963: 132 (only listed).

Material examined: – (A) Near Paramushir Island, st.153, 50°4.8′N, 155°30′E, 27m, 6.8.1954; st.94, 50°1.8′N, 155°34.6′E, 53m, 19.7.1954. (F) Commander Islands, Bering Island, Monati Point, 20m, 18.7.1991. East Kamchatka, 9m, 20.7.1985. North Kurile Islands, Shumshu Island, 20m, 3.8.1985; Atlasov Island, Vladimir Point, 20m, 15.7.1989; 17m, 30.7.1989. One colony at each station.

Redescription. – Colonies cushion-like, depressed, largest about 7 cm long, 1-1.5 cm thick. Test with various amount of encrusted and embedded sand, brownish or greyish. Systems indiscernible.

Vertical zooids 6-9mm long, thorax 1.5-2mm, abdomen about 2.5mm, postabdomen 2.5mm. Thorax usually strongly contracted, sometimes partly degenerated, separated from abdomen by a slight constriction. Oral aperture on short 6-lobed siphon, atrial with a languet from the anterior rim of the opening, its tip divided into three lobes. Stigmata in 10-(11?) rows, about 20 per half row, parastigmatic vessels absent. No longitudinal branchial vessels and papillae.

Twelve-15 strong branched longitudinal muscles on each side of thorax; they extend to end of postabdomen along ventral side of zooid. Oesophagus of moderate length. Elongate stomach in middle part of abdomen, with 5 (rarely 4) distinct longitudinal folds. Post-pyloric subdivision of the gut as in *Aplidium* spp. Two distinct rectal caeca. Postabdomen short, tapering. A loose cluster of minute testis follicles in posterior abdomen, just posterior to gut loop, no ovary in any examined specimen. Heart in posterior end of postabdomen. Single, very well developed epicardium extends from anterior part of abdomen to the end of the postabdomen. Ventral wall of this sac thicker than dorsal wall, with at least two deep longitudinal invaginations or folds.

Remarks. – It was not possible to examine the holotype of *Macrenteron ritteri*, but the present specimens are in good agreement with the original description (and figure) and are undoubtedly correctly identified.

The genus *Macrenteron*, with the single species *M. ritteri*, was defined by Redikorzev (1927a) as follows:

Colony irregular. Systems absent. Zooid divisible into thorax and abdomen. Oral siphon 6-lobed; atrial languet present. Branchial sac weakly developed, several rows of stigmata. Intestine long, stomach wide, with few distinct longitudinal folds; rectum crosses oesophagus. Gonad posterior to the intestine, in abdomen. Heart beside the intestine.

Examination of the present material has shown this definition to be incorrect in some features, has enabled the genus to be redefined, and has clarified its systematic position.

Redikorzev (1927a) possibly misinterpreted the epicardium, unusually well developed in *M. ritteri*, with the heart and pericardium. His figure of zooid (Redikorzev 1927a; fig. 3) apparently confirms this proposition (compare with fig. 1A in the present paper). The heart in this species is situated in the end of the zooid, as in all other Polyclinidae. Therefore, the posterior extension of the body is a true postabdomen that contains gonads and heart.

Redikorzev compares this genus with *Aphanibranchion* Oka, 1906, on the basis of similarity in weak development of the branchial sac, and mainly in the position of the heart near the gut loop. The last feature is now known to be incorrect. *Aphanibranchion* is considered to be a junior synonym of the diazonid genus *Syndiazona*, and is apparently not related to *Macrenteron*.

The genus apparently belongs to Polyclinidae, and most probably is related to *Aplidium*. Although the systems are obscured, they are undoubtedly present, as in all other species provided with atrial languet. It can be separated from *Aplidium* by its unusually well developed epicardium. In most polyclinids the epicardium is very hard to detect, while in *Macrenteron* it is large, filled up with pink parenchymal tissue and always clearly visible.

The species shows unusually little variation in general shape of zooids, form of thorax, stomach, postabdomen, etc. Variations occur only in degree of development of epicardium (but in all cases it is large and clearly visible) and the gonad.

Distribution. – East Kamchatka, Commander and North Kurile Islands (present study).

Aplidiopsis pannosum (Ritter, 1899)

Fig. 1C,D

Polyclinum pannosum Ritter, 1899: 519.
Polyclinum globosum Ritter, 1899: 518.
Aplidiopsis pannosum: Van Name 1945: 67; Tokioka 1960: 194; Nishikawa 1990: 80.
Aplidiopsis helenae Redikorzev, 1927a: 382.

Material examined. – (A) Near Paramushir Island, st.94, 50°1.8′N, 155°34.6′E, 53m, 19.7.1954, 1 colony. (D) The Bering Sea, near the Bering Island, st.44, 55°35.4′N, 165°0.4′E, 205m, 24.8.1991, 1 colony. North Kurile Islands, Shumshu Island, st.61, 50°38.1′N, 156°50.5′E, 80m, 3.9.1991, 1 colony. South Kurile Islands, st.94, 43°10.2′N, 146°18.2′E, 535m, 10.9.1991, 1 colony. (F) Shumshu Island, 20m, 3.8.1985, 1 colony. Commander Islands, Medny Island, st.87, 18-19m, 11.7.1992, 2 colonies, st.81, 5-6m, 4 irregular fragments; Korabelny Point, intertidal zone, under stone, 30.7.1992, numerous small colonies or fragments; Bering Island, st.199, Monati Point, 13.7.1991, several fragments possibly separated from one colony; Toporkov Island, st.237, 11m, 1 colony. South Kamchatka, Lopatka Point, 8-9m, 8.7.1985, 1 colony. The Sea of Okhotsk, F.V. *Pogranitchnik Petrov*, st.110, 56°14.0′N, 155°38.1′E 20m, 21.6.1992, 1 colony.

Remarks. – The species is characterised by a variable number of rows of stigmata: Ritter (1899) reported 10-13 rows for *Polyclinum pannosum* and 15 (x16 stigmata per half row) for *P. globosum*; a specimen described by Tokioka (1960) has 17-18 rows with 18 stigmata per half row; Nishikawa's (1990) material has "about two dozen stigmata in each half of 14-15 rows". Number of rows of stigmata in the present colonies vary from 12 to 16. The greatest variation in number of stigmata per half row (from 13 to 18) was found in one colony from Medny Island (st. 81). A colony from Korabelny Point has only 9-10 stigmata in each half of 13 rows, but this unusual small number may be connected with small colony size. The colony form also varies considerably, from flattened and irregular to massive, but the attachment area usually is small, and the colony often is attached by a short thick peduncle.

Mature larvae were found in several colonies. Those from the colony from the Shumshu Island (20m) have a trunk 0.9-1.0mm long, three adhesive organs alternating with four median ampullae, a number of large lateral ampullae in two more or less distinct rows or irregularly distributed anteriorly, and two separate compact clusters of vesicles on each side of the trunk: dorsal and postero-ventral (Fig. 1D).

The larvae from Lopatka Point (material (F), 8-9m) and from South Kurile Islands (material (D), 535 and 205m) are smaller, with the trunk being 0.85mm in the former and only 0.75mm in the latter and differ from the above described larva in the presence of only 4 or 5 lateral ampullae (Fig. 1C). Larvae from the Paramushir Island (53m) are 0.8-0.9mm long and have 7-8 lateral ampullae, i.e. are intermediate between the two above described types.

Great variation in metric characters of the branchial sac, colony form and larval morphology suggests that more than one species might be involved. But any stable character for subdividing *A. pannosum* into two or more distinct species has not been found.

Distribution. – Bering Sea (Ritter 1899, present study), Sea of Okhotsk (Redikorzev 1927a, present study), Sea of Japan (Nishikawa 1980).

Synoicum jordani (Ritter, 1899)

Fig. 2B

Aplidiopsis jordani Ritter, 1899: 521.
Macroclinum jordani: Hartmeyer 1903: 322.
Synoicum jordani: Van Name 1945: 64; Tokioka 1954a: 67.
Synoicum jacobsoni Redikorzev, 1927a: 394.
Synoicum pulmonaria: Tokioka 1960: 193.
Aplidiopsis knipowitschi Redikorzev, 1927b: 351.
? *Amaroucium kincaidi* Ritter, 1899: 524.
? *Amaroucium pribilovense* Ritter, 1899: 525; Hartmeyer 1903: 334.
? *Amaroucium snodgrassi* Ritter, 1899: 527.

Material examined. – (A) South Kamchatka, near Lopatka Point, st.111, 50°46.9′N, 157°13.4′E, 103-104m, 22.7.1954. Paramushir Island, st.49, 50°8.4′N, 156°29.4′E, 71m, 5.7.1954. (D) South Kamchatka, st.66, 50°40.5′N, 156°44.6′E, 62m, 3.9.1991. (F) East Kamchatka. Malaya Bay, 6-8m, 26.7.1990; Olutorsky Bay, 6-7m, 10.8.1994; Dezhneva Bay, 4-8m, 14.7.1990; 6-10m, 14.7.1990; Litke Bay, st.384, 59°07′N, 163°55′E, 27m, 23.9.1988; Korfa Bay, st.394, 60°07.5′N 165°57′E, 48m, 18.9.1988; Karaginsky Island, Kekkurny Point, 19m, 20.8.1988; Africa Point, 32m, 24.8.1985; Avacha Bay, Babushkin Kamen Island, 11-14m, date unknown, 8-15m, 11.8.1988. North Kurile Islands, Shumshu Island, 20m, 3.8.1985. Single colony at each station.

Redescription. – Massive spherical colonies 2.5 to 12 cm in diameter. Surface smooth, clear or with only few sand grains. Test gelatinous but hard, minute sand grains embedded in test in some colonies. Numerous more or less circular systems clearly visible on surface, each with 7-11 zooids. Stigmata in 15-18 rows, 20-27 stigmata per row. Length of abdomen and gut loop vary considerably. Stomach smooth-walled, nearly symmetrical. Large oval gastric reservoir, sometimes surrounded by whitish parenchymal tissue, present between stomach and

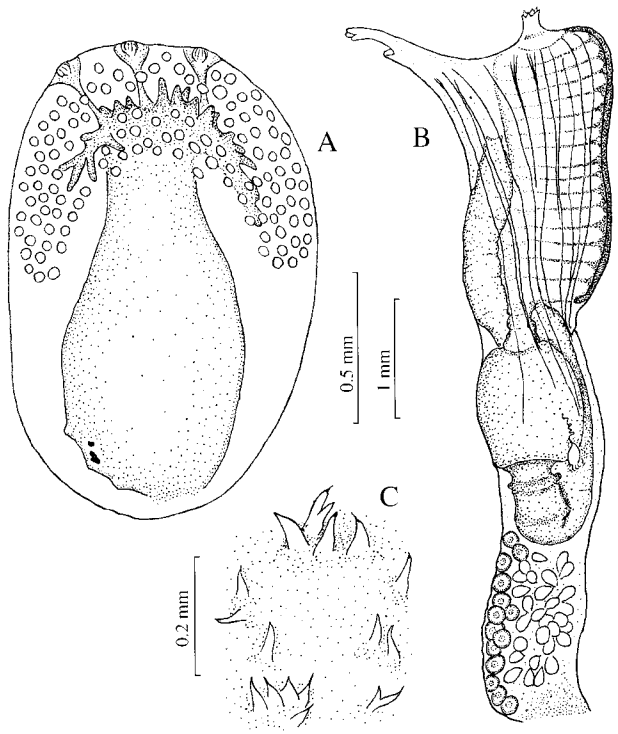

Fig. 2. *Synoicum turgens* – A, larva; C, processes on surface of the tunic. *Synoicum jordani* – B, zooid.

intestine on right side of abdomen at level of posterior end of stomach. Up to 20 immature larvae in degenerated zooids in colony from Dezhneva Bay. Larval trunk 1.1-1.2mm, 3 attachment processes, numerous small vesicles anteriorly and apparently several lateral (or median?) ampullae.

Remarks. – Tokioka (1954a) assigned a large spherical colony from West Kamchatka to *S. jordani*. This specimen is quite similar to the present ones in all features, including the number of rows of stigmata (15-18 in the present material and "15 or possibly more" (Tokioka 1954a: 68) in Tokioka's colony). It differs in the absence of a gastric reservoir. The gastric reservoir was found in all the present colonies. Usually it is clearly visible even without staining, but sometimes obscured by surrounding tissue or by contraction of zooids. It is highly probable, that Tokioka overlooked the gastric reservoir and that his specimen is conspecific with the present ones.

The original description of *S. jordani* (Ritter, 1899) was based on a single massive, "irregularly polyhedral" colony from the St. Paul Island, Pribilov group. Ritter's specimen has fewer rows of stigmata (12-13) and fewer stigmata per half row (about 15) than Tokioka's (1954a) and the present material. As for

Tokioka's material, the presence of a gastric reservoir is not recorded in the type specimen and it may have been overlooked. A reexamination of Ritter's type is required to confirm that the here recorded specimens are *S. jordani.*

Van Name (1945) referred a number of large colonies from the Bering Strait to *S. jordani,* and, although he did not record the number of rows of stigmata, this is a variable character, and careful study of the descriptions shows that Van Name's (1945), Tokioka's (1954a) and the present specimens are conspecific.

The three following species, known at present only from the Pribilov Islands, are related and possibly conspecific with *S. jordani*:

Amaroucium kincaidi Ritter, 1899, based on four colonies from St. Paul Island. Colonies are depressed, cake-like. Stigmata in 16 rows. Stomach wall "never with distinct longitudinal folds, but never smooth" (Ritter, 1899: 525).

Amaroucium pribilovense Ritter, 1899, based on six large, massive, subglobular colonies. "Fifteen series of stigmata ..., but apparently 12 or 13 in others – possibly immature ones." Stomach "folded longitudinally, but folds are irregular and are neither conspicuous nor numerous, the number being about seven. In addition to the folds, or rather furrows, which never involve the entire surface, there is a tendency for the surface between them to become areolated in many specimens." Hartmeyer (1903) reports 14-15 rows of stigmata for two colonies, referred by him to this species, which were also collected from St. Paul Island.

Amaroucium snodgrassi Ritter, 1899, based on 8 colonies from St. George Island. Colony variable in form but "always depressed and cake-like. Stigmata rows 12. Six distinct stomach folds, and in addition two or three shorter and narrower ones on one side; in some cases these strongly suggesting the areolated condition." (Ritter 1899: 528).

Van Name (1945) synonymized *A. pribilovense* and *A. snodgrassi* with *A. kincaidi* and placed it in the genus *Synoicum.* This view was supported by Tokioka (1963). According to Van Name (1945) *S. jordani* differs from *S. kincaidi* solely on the basis of its smooth stomach, although the "wall of the stomach is not described as smooth" in *A. kincaidi, A. snodgrassi* and *A. pribilovense* (Van Name 1945: 66). But Ritter (1899) did not describe the stomach of *S. jordani* as smooth, he wrote for this species: "stomach wall with a few irregular longitudinal thickenings, but no well defined folds" (Ritter 1899: 522) and for *A. kincaidi*: "never with distinct longitudinal folds, but never smooth" (Ritter 1899: 525). Thus, reported differences in the stomach wall are not significant. In the present material the stomach wall is quite smooth only in well expanded zooids, while various degree of irregular areolation occurs in contracted ones as artefacts. It seems very possible that in *A. kincaidi,* and also in *A. pribilovense* and *A. snodgrassi,* areolation or irregular folds on the stomach wall depend on contraction of the zooids. At present *A. kincaidi, A. pribilovense* and *A. snodgrassi* are placed in synonymy of *S. jordani* only provisionally.

Confirmation of these synonyms depends on the reexamination of the type specimens of *S. jordani* and the synonyms suggested above, to confirm the presence of a gastric reservoir and their identity with *S. jordani* and the present newly recorded specimens.

A number of related species were described by Redikorzev (1927a, 1927b) from the Sea of Okhotsk and Sea of Japan:

Aplidiopsis knipowitschi Redikorzev, 1927b based on 5 specimen from the Sea of Japan, is similar to *S. jordani* in the colony form, the number of rows of stigmata (15 rows with 18-22 stigmata per half row), smooth stomach and large gastric reservoir, and is undoubtedly conspecific with *S. jordani.*

Synoicum jacobsoni Redikorzev, 1927a, was described from the Sea of Okhotsk, Taujskaja Bay. It has a massive colony, 15 rows of stigmata with 20-22 stigmata per half row, stomach weakly areolated, nearly smooth, and differs only in having long gut loop behind the stomach. But, as was observed in the present material, the length of the gut loop in *S. jordani* varies considerably and cannot be used as a stable taxonomic character and therefore *S. jacobsoni* is probably also conspecific with *S. jordani.*

The three following species are also related to *S. jordani,* but seem to be distinct from it:

Aplidium polybunum (Redikorzev, 1927a) and *Aplidium soldatovi* (Redikorzev, 1937), both from the Sea of Okhotsk, have similar massive colonies to *S. jordani,* but differ in having more rows of stigmata (20-21 rows with 15-20 stigmata per half row), and well developed areolations on the stomach wall. These two species seem to be identical and belong to *Synoicum* rather than to *Aplidium.*

Synoicum derjugini Redikorzev, 1927a, from the Sea of Japan, has 10 rows of stigmata with 25 stigmata per half row, and, according to my examination of the holotype (deposited in ZIN), zooids lack gastric reservoir. The species therefore is distinct from *S. jordani.*

Distribution. – Common in the Bering Sea and Sea of Okhotsk, only 5 colonies are known from the Sea of Japan (present study).

Synoicum turgens Phipps, 1774

Fig. 2A,C

Synoicum turgens: Hartmeyer 1903: 349; Tokioka 1960: 192; Millar 1966: 18.
Synoicum irregulare Ritter, 1899: 530; Van Name 1945: 64.

Material examined. – (F) East Kamchatka, Bering Sea coasts: Verhoturova Island, 16-17m, 1.8.1990, 1 colony; Chasovye Kamni, 6-10m, 29.7.1990, 3 colonies; Malaya Bay, 6-8m, 26.7.1990, 3 colonies; Govena Pointl 10-14m, 1 colony; Bogoslova Island, 6-18m, 27.7.1990, 1 colony; Olutorsky Point, 14m, 31.7.1990, 1 colony; Dezhneva Bay, 6-10m, 14.7.1990, 1 colony; 6-8m, 12.7.1990, 2 colonies, 4-8m, 14.8.1990, 1 colony; Litke Strait, st.384, 59°7.5′N, 163°55′E, 27m, 23.9.1988, 1 colony. East Kamchatka, Pacific coasts: Kronotsky Bay, st.146, 54°16.8′N, 160°42.6′E, 80m, 1 colony; Avacha Bay, st.36, 53°1.5′N, 159°51′E 77m,

28.5.1988, 1 colony. Commander Islands, Medny Island, 10m, 9.7.1992, 1 colony.

Redescription. – Colony consists of numerous, sometimes branched, cylindrical lobes, largest about 13 cm in diameter. Generally a single system in each lobe. Sometimes longitudinal furrows are between rows of zooids on lateral sides of colony lobes. Test surface covered with numerous small irregularly distributed groups of 1-5, sometimes branched, pointed processes. Stigmata in 13-18 rows. Stomach wall distinctly areolated. Larvae found in the colony from Medny Island are large, the trunk 1.7mm long, with three adhesive organs, numerous small epidermal vesicles and irregularly distributed conical ampullae around the anterior half of trunk (Fig. 2A).

Remarks. – As noted by Van Name (1945) and Millar (1966), *Synoicum irregulare* Ritter is similar or even might be identical with *S. turgens*. Ritter (1899: 530-531) suggested that the colony lobes of *S. turgens* are in general much more separate than in *S. irregulare*, it has systems "in the form of solid cylinders isolated or associated by their peduncles", and its systems are well visible while in *S. irregulare* systems are indistinct and apertures are not seen on the colony surface. Further, "*S. irregulare* has no traces of the channels on the surface of the lobes marking the intervals between the zooids as in *S. turgens*". The taxonomic significance of these features is very dubious. Longitudinal furrows on the test surface are clearly seen in some of the present colonies, but are completely absent in others. Zooids in Ritter's colonies were strongly contracted and degenerated ("in resting stage"), and this explains why the systems are not visible. According to Ritter (1839) there are 2-10 zooids in each lobe in his species, but *S. turgens* has similar systems with about the same number of zooids. Ritter's (1899) figure of the colony of *S. irregulare* somewhat resembles those of *S. cymosum* Redikorzev, but the latter species has large papillae on the test (see *Remarks* under *S. cymosum*).

Synoicum solidum Redikorzev, 1937, from the Sea of Okhotsk, is simiiar to the present species in colony form and structure of the zooids. However examination of the holotype (deposited in ZIN) shows this species to have a smooth test. It therefore is distinct from *S. turgens*.

Distribution. – Spitsbergen, Bear Island, North Norway (Millar 1966), Bering Sea (Ritter 1899, Van Name 1945, Tokioka 1960, present study).

Synoicum cymosum Redikorzev, 1927

Fig. 3

Synoicum cymosum Redikorzev, 1927a: 399.

Material examined. – (F) East Kamchatka. Verhoturova Island, 16-17m, 1.8.1990, 1 colony; Karaginsky Island, 19m, 20.8.1988, 3 colonies; Korfa Bay, st.504,

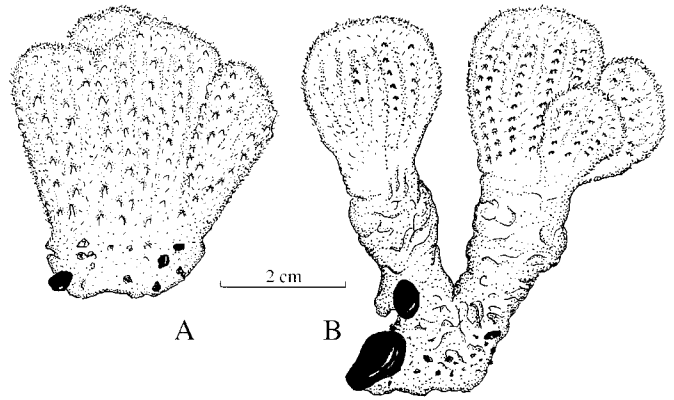

Fig. 3. *Synoicum cymosum* – A, compact colony (Verhoturova Island); B, pedunculated colony (Korfa Bay).

59°42.5′N, 165°49′E, 95m, 21.9.1988, 2 colonies; Avacha Bay, st.172, 53°46′N, 160°11′E, 100m, 12.5.1988, 1 colony. Sea of Okhotsk, F.V. *Pogranitchnik Petrov*, st.76, 51m, 54°45.0′N, 155°20.5′E, 15.6.1992, 1 colony.

Redescription. Colony consists of one to several wide lobes, sometimes on long peduncles. Test covered with minute pointed processes and relatively large conical projections usually, but not always, arranged in longitudinal rows. One or more systems in each lobe. Zooids as in *Synoicum turgens*.

Remarks. – The present species closely resembles *S. turgens* in the structure of zooids and the minute pointed processes on the test. *Synoicum cymosum* differs from *S. turgens* in having large conical projections of the test and usually more than one system in each lobe. However the taxonomic significance of these features is unclear and the two species might be identical.

Distribution. – The Bering Sea and Sea of Okhotsk (Redikorzev 1927a, present study).

Synoicum clavatum (Oka, 1927)

Fig. 4

Synoicum clavatum: Tokioka, 1954b: 69; Nishikawa 1990: 97. Not *Synoicum clavatum*: Millar 1975: 255.

Material examined. – (D) Kurile Islands, Shumshu Island, st.61, 50°38.1′N, 156°50.5′E, 80m, 3.9.1991, 2 colonies. (F) East Kamchatka, Avacha Bay, F.V. *Gefest*, 52°23.8′N, 158°47.6′E-52°21.8′N, 158°47.2′E, 300-500m, 1 colony. Atlasov Island, Vladimir Point, 40-41m, 16.8.1989, 1 colony.

Redescription. – Material from Atlasov Island. Colony upright, clavate (Fig. 4A), 26mm high, 17mm in greatest diameter, test smooth, colorless and translucent,

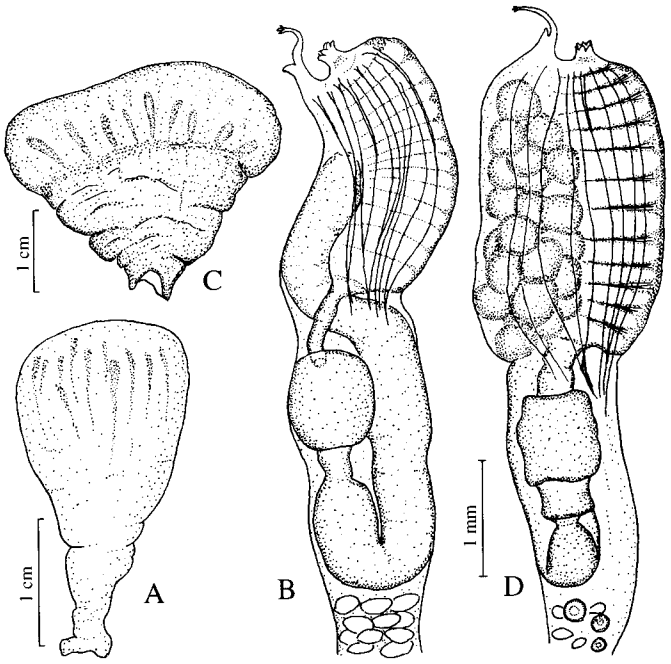

Fig. 4. *Synoicum clavatum*. Specimen from Atlasov Island – A, colony; B, zooid. Specimen from Shumshu Island – C, colony; D, zooid .

without sand. Zooids opening on upper surface of colony. Thorax about 2.5mm, abdomen 2.5mm, postabdomen up to 10mm. Stigmata in 14-15 rows with 15-16 per row. Atrial siphon long, with anterior languet three-lobed at the tip. Longitudinal thoracic muscles 12-14, fine (observed only microscopically), transverse muscles between rows of stigmata. Stomach smooth.

Material from Shumshu Island. Colony inverted cone-shaped (Fig. 4C), 2.5 cm high, 3.5 cm in greatest diameter, test transparent, yellowish. Zooids as in former specimen, but only 12 rows of stigmata, 17-18 per row, and strong transverse muscles between rows. Numerous embryos in atrial cavity.

Remarks. – The specimen from Atlasov Island agrees well with Tokioka's (1954b) redescription of *S. clavatum* and is undoubtedly this species. Presence of fine transverse thoracic muscles, firstly mentioned for this species by Nishikawa (1990), is confirmed here. Specimen from deeper water (300-500m, Avacha Bay) seems to be identical with that from Atlasov Island, although it has only 12 rows of stigmata and a slightly larger colony.

Colonies from Shumshu Island are more massive, flat-topped, their zooids have fewer rows of stigmata, and much stronger transverse muscles on the thorax. They are assigned to the present species only provisionally, as it is highly possible that they are not conspecific; additional material will be needed to establish the degree of intraspecific variation in colony form and zooids to clarify the specific status of these two forms.

Kott (1992) suggested that *S. clavatum* of Millar (1975) might be identical with *S. suarenum* Kott, 1985.

Distribution. – Kurile Islands (present study), Japan (Tokioka 1954b; Nishikawa 1990).

Aplidium spitzbergense Hartmeyer, 1903

Fig. 5A

Aplidium spitzbergense Hartmeyer, 1903: 341.
Amaroucium spitzbergense: Van Name 1945: 30 (with synonymy); Tokioka 1967: 26.

Material examined. – (A) South Kamchatka, near Lopatka Point, st.111, 50°46.9′N, 157°13.4′E, 103-104m, 22.7.1954, 1 colony. North Kurile Islands, Shumshu Island, st.121, 50°34.4′N, 157°19.6′E, 220-230m, 1.8.1954, 1 colony. (C) Sea of Okhotsk, st.3, 55°28′N, 146°15′E, 151m, 19.6.1988, 1 colony. (D) Small Kurile Islands, st.91, 43°23.5′N, 146°25.4′E, 10.9.1991, 1 colony. (F) East Kamchatka: Karaginsky Bay, Tonos Point, 10m, rock, 19.8.1988, 1 colony with fragments; Kronotsky Bay, st.132, 54°29.5′N, 161°03.2′E, 34m, 14.5.1988, 1 colony on *Molgula retortiformis;* Avacha Bay, F.V. *Gefest,* 52°19.0′N, 158°49.1′E – 52°21.2′N, 158°47.8′E, 300-500m, 25.5.1994, 1 colony. Bering Island: Vchodnoy Rif Point, 8m, 27.6.1991, 1 colony; Polydennaya Bay, 10m, 1 colony; Monati Point, 14-15m, 18.7.1991, several colonies with fragments. Kurile Islands, Atlasov Island, Vladimir Point, 25m, 24.7.1989, 1 colony.

Redescription. – Up to 3 larvae in peribranchial cavity of several zooids in colony from South Kamchatka, material (A). Larval trunk 0.7mm long. Three adhesive organs on narrow stalks, 30-35 vesicles in single row along each side of dorsal and ventral mid-lines, vesicles more irregularly arranged in anterior end of trunk; ampullae absent.

Distribution. – Arctic waters (Van Name 1945), Bering Sea and Pacific coasts of Kamchatka, North Kurile Islands (Tokioka 1967, present study), Sakhalin Island (Skalkin 1959).

Aplidium sagamiense (Tokioka, 1967)

Fig. 5B,C

Aplidium sagamiense: Nishikawa 1990: 86 (with synonymy).

Material examined. – (F) East Kamchatka: Avacha Bay, st.82, 52°53′N, 159°13′E, 107m, sand with mud, 4.5.1988, 1 colony on piece of *Molgula retortiformis* (?) tunic; st.113, 52°51′N, 159°19′E, 119m, 27.5.1988, 1 colony on *Boltenia echinata* (Fig. 5B); Kronotsky Bay, st.166, 53°46′N, 160°17.9′E, 135m, 12.5.1988, 1 colony on *Styela rustica.*

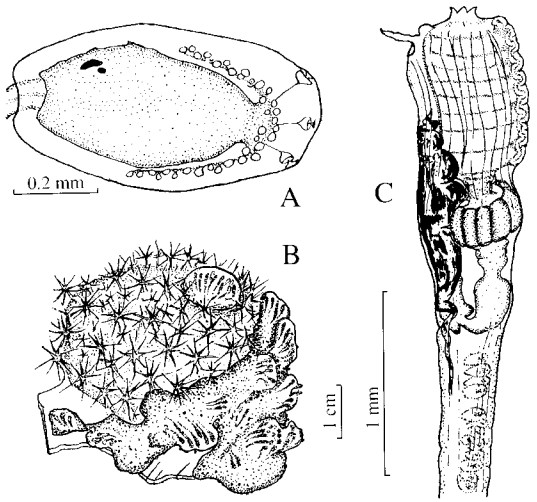

Fig. 5. *Aplidium spitzbergense* – A, larva. *Aplidium sagamiense* – B, colony on *Boltenia echinata;* C, zooid.

Redescription. – Colony encrusting, irregularly lobed, sparsely covered by sand. Test soft, translucent, colorless. Systems indistinct.

Zooids red, clearly visible through test, strongly contracted. Thorax with abdomen 1.5-2.5mm, postabdomen up to 3mm. Atrial languet simple. Eleven to sixteen fine longitudinal muscles on each side of thorax extending to end of postabdomen. Eight rows of stigmata, about 10 stigmata per row. Stomach in upper third of abdomen, with (9)10-11 parallel, unbroken folds. Posterior stomach and rectal caeca present. Serially arranged testis follicles in postabdomen, sperm duct very robust in some zooids.

Remarks. – The present material agrees well with existing descriptions, except that most previously recorded colonies are free from encrusting material.

It is noteworthy that all present colonies grow on other ascidians. This may be because the small inconspicuous colonies are overlooked by collectors and only specimens attached to other ascidians are taken.

Distribution. – East Kamchatka (present study) to Kyushu and Korea (see Nishikawa 1990).

Aplidium coei (Ritter, 1901)

Fig. 6

Amaroucium coei Ritter, 1901: 251.

Material examined. – (D) Alaska Gulf, near Kodiak Island, 12.8.1991, st.20, 57°42.8′N, 151°00.9′W, 70m, sand, 1 colony; st.15, 58°22.4′N, 150°56.8′W, 61m, sand, 3 colonies.

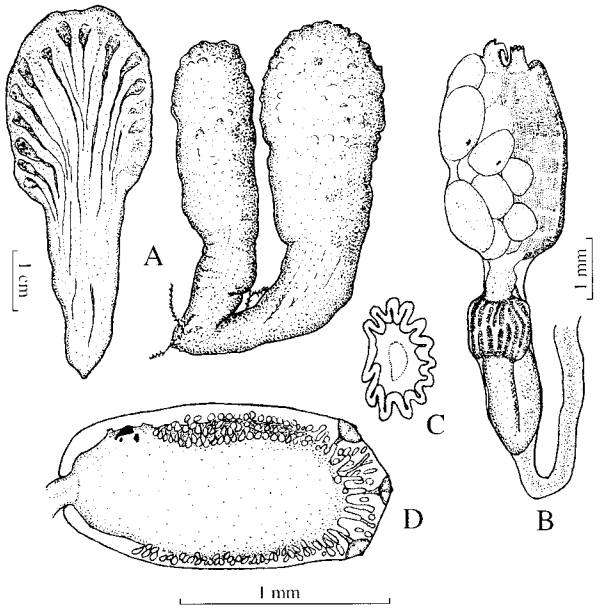

Fig. 6. *Aplidium coei* – A, colony and cross section along longitudinal axis of colony lobe showing arrangement of zooids; B, zooid; C, cross section of the stomach; D, larva.

Redescription. – Colony consists of 1-4 nearly cylindrical lobes arising from common base and enlarged posteriorly. Largest lobe 5.5 cm long and 2 cm in diameter. Test hard, brown, without encrusted and embedded sand, a few hydrozoan epibionts on surface. Systems obscure, zooids not visible through test.

Zooids with thorax about 3mm (slightly contracted), abdomen 3mm, postabdomen up to 30mm long. Both siphons terminal, branchial aperture distinctly 6-lobed, atrial elongated, obscurely lobed, with a well developed simple atrial languet. Twenty – 25 longitudinal muscles on each side of thorax. Fourteen – 16 rows of stigmata, 28-32 stigmata per half row. Stomach in anterior third of abdomen, with about 13 deep irregular folds. Anus at level with stigmata row 6 or 7 (counted from bottom of branchial sac). Postabdomen narrow, empty or filled by parenchymal tissue, gonads indiscernible.

Up to 15 embryos and large larvae in peribranchial cavity. Trunk of fully matured larva 1.6mm in length and 0.8mm wide. Three adhesive organs; numerous small epidermal vesicles arranged in several rows on each side of larva, anteriorly some of them arising on branching stalks resembling ampullae, but true ampullae seemingly absent (Fig. 6D).

Remarks. – The species was previously known only from Ritter's (1901) original description based on a large number of specimens from Kodiak Island, Alaska. The present material also was collected near this island. According to Van Name (1945: 54) "*A. coei* approaches the genus *Synoicum* in the form of the atri-

al siphon" and some other features. Nevertheless this type of atrial siphon does occur in *Aplidium* and the stomach is clearly characteristic of that genus.

Distribution. – Kodiak Island (Ritter 1899, present study).

Aplidium dubium (Ritter, 1899)

Amaroucium dubium Ritter, 1899: 528.

Material examined. – Commander Islands, Bering Island: 18 lots of specimens from Pacific and Bering Sea coasts collected from 5-25m, July 1991; Medny Island: 22 lots of specimens (more than 40 colonies) from all coasts, 5-23m, June-July 1992.

Redescription. – Colony irregular, variable in shape, from flat and incrusting to numerous more or less regular upright lobes each 10-20mm high, 8-15mm in diameter; flattened forms 5-12mm thick, up to 15 cm long. Test hard, with embedded sand grains, surface heavily encrusted with sand. Rarely tops of lobes bear only few sand grains, test dark brown here, color and systems obscured by sand in other parts of colony. Zooids opening on top of lobes or on marginal enlarged part of colony.

Zooids 4-8mm long. Branchial siphon 6-lobed, atrial one with short 3-lobed languet. Seventeen – 25 strong longitudinal muscles on each side of thorax; 11-12-15 rows of stigmata, 15-18 stigmata per row. Stomach in middle part of abdomen, with 8-10 deep, longitudinal, usually regular and rarely broken folds. Postabdomen filled by parenchymal tissue, gonads not developed.

Remarks. – This species was previously known only from three fragments of colonies from Cooper (Medny) Island described by Ritter (1899). Ritter's specimens were strongly damaged "apparently from having been torn from their anchorage and washed about by the waves" and all have zooids in strongly contracted condition (Ritter 1899: 528). This may explain some differences between the original description and the present specimens. According to Ritter *A. dubium* has a 5-lobed branchial siphon and a simple atrial languet. The present specimens, as all other *Aplidium* species have a 6-lobed oral siphon and an atrial languet at least divided at the tip. In other features, including zooid size, number of rows of stigmata and stomach folds, the specimens conform to the original description.

Two colony types – flat and lobed, suggest that more than one species may be involved. Nevertheless, despite the large number of colonies examined, differences in structure of zooids were not found, and both colony types seem to have identical zooids. Further, the presence of numerous intermediate forms tend to confirm that only one species is involved.

Distribution. – Only Commander Islands (Ritter 1899, present study). This is one

of the most common ascidians on Commander Islands. It is interesting to note that the species was not found on Kamchatka coasts.

Aplidium glabrum (Verrill, 1871)

Amaroucium glabrum: Van Name 1945: 31 (with synonymy); Tokioka 1967: 30.

Material examined. – (A) North Kurile Islands: Shumshu Island st.121, 50°34.4′N, 157°19.6′E, 220-230m, 1.8.1954, 1 colony. Paramushir Island, st.79, 49°50′N, 156°7.4′E, muddy sand, 130-135m, 14.7.1954, 1 colony. (D) Bering Sea, near Bering Island, st.45, 55°34.2′N, 165°16.0′E, 65m, 24.8.1991, 1 damaged colony. Shumshu Island, st.61, 58°38.1′N, 156°50.5′E, 80m, sand, 3.9.1991, 1 colony. (F) East Kamchatka: Avacha Bay, 52°53′N, 163°01′E, 142m, 24.5.1988, 5 colonies with fragments; F.V. *Gefest*, 52°19.0′N, 158°49.1′E – 52°21.2′N, 158°47.0′E, 300-500m, 25.5.1994, 1 colony; 52°41.2′N, 158°43.5′E, 300-500m, 5.6.1994, 1 colony. Commander Islands: Bering Island, Dikaja Bay, 18-19m, 24.7.1991, 3 colonies.

Redescription. – Colonies capitate, consisting of one to several upright lobes. In Avacha Bay specimens the test is transparent, brownish or colorless, while in others it is opaque, milky or yellowish white, without encrusting or imbedded sand. The atrial opening is plain-edged, with a long, narrow, undivided anterior atrial languet. Branchial sac has 10-12 rows of stigmata, but 13-14 in one of the *Gefest* specimens, 16(?) stigmata per row. Eight to 13 thin longitudinal muscles on the thorax. The stomach has 11-16 deep, regular folds. Postabdomen filled by parenchymal tissue.

Remarks. – The present specimens conform well to previous descriptions in most respects, the only exception being the absence of lateral lobes at the base of the atrial languet, which Van Name (1945) supposed to be an important character. Such lobes were also absent from specimens described as *A. glabrum* by Tokioka (1967), their occurrence apparently is variable. Although Arctic specimens have thicker longitudinal muscles than the fine ones generally found in Pacific specimens, they appear to be conspecific.

A. glabrum is known as a northern cold water species. The occurrence of presently recorded specimens in relatively deep (65-500m, except colony from Bering Island from 18m), cold waters, confirms their assignment to this species. Other known Pacific specimens also came from relatively deep waters.

Distribution. – N.E. coast of N. America, Greenland, Spitsbergen to Siberian Sea (Millar 1966). Commander Islands, East Kamchatka, Kurile Islands (present study), Sakhalin to Hokkaido (Tokioka 1967).

Aplidium translucidum (Ritter, 1901)

Fig. 7E

Amaroucium translucidum Ritter, 1901: 249; Van Name 1945: 54 (and synonymy).

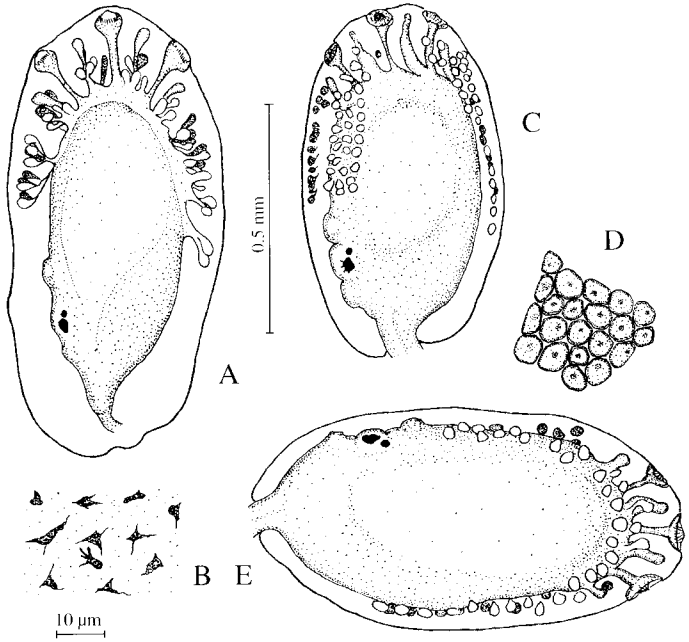

Fig. 7. *Aplidium pliciferum* – A, larva; B, sparse granulation of the larval test. *Aplidium tenuicaudum* – C, larva; D, dense granulation of the larval test. *Aplidium translucidum* – E, larva.

Amaroucium strandi Redikorzev, 1937: 122.

Material examined. – (A) South Kamchatka, near Lopatka Point, st.111, 50°46.9′N, 157°13.4′E, 103-104m, 22.7.1954, 1 colony. (D) Alaska Gulf, near Kodiak Island, st.14, 58°23.9′N, 150°50.8′W, 64m, 12.8.1991, 4 colonies; st.15, 58°22.4′N, 150°56.8′W, 61m, 14.7.1991, 10 large colonies; near the Sanak Island, st.38, 54°5.6′N, 162°09.6′W, 114m, 17.8.1991, 1 colony. (F) East Kamchatka: Shipunsky Point, 18m, 8.9.1985, 1 colony; Starichkov Island, 20-30m, 8.9.1984, 1 colony. Commander Islands: Bering Island, 8 lots of specimens, 5-15m, 2.7.-9.8.1991; Medny Island, 5 lots of specimens from Pacific and Bering Sea coasts, 0-10m, 11.7.1992-23.7.1992.

Redescription. – Specimens from Commander Islands. Upright lobes attached to substratum by narrow base, about 2 cm high, 1.5 cm in greatest diameter. Test surface densely covered by sand, (no embedded sand), transparent, reddish. Zooids 5.5-15mm long. Atrial languet always 3-lobed or even trifid, 10-12 rows of stigmata. Stomach has 20-25 longitudinal ridges. Several embryos in one colony, but no mature larvae.

Specimens from Alaska Bay and Kamchatka differ from Commander Islands specimens by larger size (3 cm high, up to 5.5 cm in greatest diameter), and absence of encrusting sand in some specimens. Test less transparent, whitish or lightly pink. Zooids arranged in numerous circular systems seen through test.

Atrial languet with 3 long terminal lobes, 12 rows of stigmata and 25-27 stomach folds. Up to 10 larvae in peribranchial cavity. Larval trunk 0.9-1.0mm in length in specimens from Alaska and 0.7-0.85mm in colony from Starichkov Island. Three, very rarely four, adhesive organs. Four median ampullae alternating with adhesive organs. About 35 vesicles in single, but not very regular curve on each side of mid-line around anterior two thirds of trunk. Larval test densely granulated.

Remarks. – Despite some difference in colony features, all specimens seem to fall in the range of variation for *A. translucidum*. Nevertheless, some large colonies from Alaska Bay are reminiscent of *A. pliciferum*, especially when they have the test without sand. The material was assigned to *A. translucidum* mainly on the form of the atrial languet; this is 3-lobed or trifid in *A. translucidum* but simple in *A. pliciferum* (but see also *Remarks* under *A. pliciferum*). Larvae found in specimens from Alaska Bay resemble those of *A. pliciferum* and *A. tenuicaudum* Beniaminson, adding to the uncertainty about their identity. All specimens from Commander Islands are undoubtedly *A. translucidum*, but they did not have mature larvae to compare with those from the Alaskan colonies.

Specimen(s?) assigned to *A. translucidum* by Beniaminson (1976) conform to this species in colony features, but have a large, simple atrial languet (Beniaminson 1976: fig. 287) rather than the 3-lobed languet. The description lacks information about zooid morphology, and therefore this record is somewhat dubious.

Distribution. – Alaska (Ritter 1901, Van Name 1945), Kodiak Island, Commander Islands, East Kamchatka (present study), Sea of Okhotsk (Redikorzev 1937), ?Sea of Japan (Beniaminson 1976).

Aplidium pliciferum (Redikorzev, 1927)

Fig. 7A,B; Table 1

Amaroucium pliciferum Redikorzev, 1927a: 387; Tokioka 1967: 32.
? *Amaroucium oculatum* Beniaminson, 1974: 318.
Not *Aplidium pliciferum:* Kott 1963: 106, 1972: 13, 1976: 62.
? Not *Aplidium pliciferum*: Nishikawa 1990: 94.
? Not *Amaroucium pliciferum:* Tokioka 1953: 183, 1962: 2.

Material examined. – (F) East Kamchatka. Avacha Bay: Zapadny Point, 4.5m, 16.9.1985; Babushkin Kamen Cliff, 5-7m, rock, 19.11.1986; Staritchkov Island, 6m, 7.9.1985; st.182, 53°36′N, 160°07′E, 100m, 11.5.1988; Babushkin Kamen Island, 11-14m, 7.7.1984; 5m, 6.8.1988; Kronotsky Bay, Morzhovaja Bay, 10m, 30.8.1985, several colonies and fragments; Karaginsky Bay, st.444, 58°25′N, 162°41′E, 55m, 3.10.1988; Dezhnev Bay, 6-8m, 12.7.1990. Commander Islands, Bering Island, Poludennaya Bay, 10m, 17.7.1991; Medny Island, st.149, 16m, 28.7.1992; Gavrilovskaya Bay, 15m, 9.7.1992. North Kurile Islands, Atlasov Is-

Table 1. Characteristics of specimens of *Aplidium pliciferum*

Catalogue number	Pigment spots on thorax	Rows of stigmata (stigmata per half row)	Stomach plications	Thoracic muscles	Larva	Locality
9/630	+	10-11(18)	20-24	15	–	Commander Isls., 16 m
10/631	+	10-11(14-15)	25	?	_	Commander Isls., 15 m
16/636	+	10(11?)	24	12	_	Commander Isls., 10 m
4/190	+	12-14(14-15)	26	15	_	Avacha Bay, 6 m
1/161	+	12-13(14)	23	10-12	_	Avacha Bay, 4.5 m
2/162	+	11	24-28	10?	_	Avacha Bay, 5-7 m
7/628	–	10?-11	24	16	_	Avacha Bay, 100 m
11/275	–	11(12-13)	26-29	14	_	Avacha Bay, 11-14 m
12/632	+	10?-11(15)	25	?	_	Avacha Bay, 5 m
3/171	–	11(14-15)	23-24	11-14	_	Kronotsky Bay, 10 m
8/629	–	14(?)	23-26	12?	+	Karaginsky Bay, 55 m
17/311	–	13(10-13?)	22-25	10?	_	Dezhnev Bay, 6-8 m
–	–	11?	23	14	+	Shumshu Island, 80 m
5/191	–	13-15(16)	25	12	_	Atlasov Island, 3 m
14/633	–	12(14)	25	20-25	_	Sea of Okhotsk, 80 m
15/634	–	13(13-16?)	28	18-24	_	Sea of Okhotsk, 80 m
6/296	–	15-16(16)	23-28	18	–	Atlasov Island, 2 m

land, Vladimir Point, 3m, 15.7.1989; 2m, 10.7.1985. Sea of Okhotsk, F.V. *Pogranitchnik Petrov*, st.87, 55°13.9′N, 154°55.5′E, 80m, 17.6.1992; st.75, 54°45.0′N, 154°50.6′E, 80m, 15.6.1992. (D) Shumshu Island, st.61, 50°38.1′N, 156°50.5′E, 80m, 3 9.1991.

Redescription. – Colony variable in size, form and color. Those from Commander Islands yellowish, flat or hemispherical, up to 2-3 cm. Those from Avacha Bay flat or massive, irregular, yellowish, brownish or reddish, up to 10 cm in diameter. Colony from Karaginsky Bay consists of several flattened lobes, closely adherent to one another, each with a smooth upper surface, 1 cm high, 3-4 cm in diameter. Test transparent to translucent, soft and gelatinous (especially in specimens from depths of more than 50m.), without encrusting or embedded sand. Systems of 7-20 zooids, round to oval.

Zooids to 30mm long in large colonies. Atrial languet undivided, sometimes with undulating side margins. In some specimens yellow pigment spots in thorax may mark each row of stigmata near the endostyle. Rectal caeca present. Testicular follicles numerous, arranged irregularly or serially in one or two irregular rows. For other features see Table 1.

About 10 mature larvae present in each zooid in colony from Karaginsky Bay and immature ones in colony from Shumshu Island. Larval trunk 0.9-1.0mm. Four median ampullae alternating with three adhesive organs. About 25 vesicles arise on relatively thick stalks along each side of mid-line in anterior half of larval trunk. Stalks of anterior vesicles arising near base of lateral ampullae. Larval test sparsely granulated (Fig. 7B).

Remarks. – According to the original description, *A. pliciferum* has 13 rows of stigmata, 15 stigmata per half row, 30 stomach plications and an undivided atrial languet.

Specimens with a trifid atrial languet referred to this species by Tokioka (1953, 1962) and Nishikawa (1990) apparently belong to *A. tenuicaudum* Beniaminson. Usually the form of the atrial languet is supposed to be variable and not a significant character, but this may not be so for the present species. All specimens of *A. pliciferum* from the present material invariably have a simple undivided atrial languet, whereas specimens from more southern locations, assigned to this species by Tokioka (1953, 1962) and Nishikawa (1990), and one colony from present material from the Sea of Japan (assigned here to *A. tenuicaudum*, see below) have a trifid or 3-lobed one. Specimens with undivided and trifid atrial languets apparently have larvae (see Fig. 7A-D and Tokioka 1953: pl. 6, fig.10) with differences in the size of the larval trunk and arrangement of vesicles. Unfortunately only one specimen assigned to *A. pliciferum* contains mature larvae. The taxonomic significance of these features is not clear. Nevertheless it seems that specimens here assigned to *A. pliciferum* and specimens assigned to this species by Tokioka (1953, 1962) and Nishikawa (1990) belong to different species. It should be noted that this proposition is provisional and should be confirmed when more specimens with mature larvae become available. If it can be shown that the above mentioned features have no taxonomic significance, *A. tenuicaudum* should be treated as a junior synonym of *A. pliciferum*. A reexamination of the holotype of *Aplidium pliciferum* is required to confirm presence of a simple atrial languet and to clarify the specific assignment of above mentioned specimens.

Kott (1992) moved specimens previously assigned by her to *A. pliciferum* (Kott 1963, 1972, 1976) to the synonymy of *A. opacum* Kott, 1963, on the basis of slightly different number of stomach plications and geographical isolation. In addition to these features the 3-lobed atrial languet in Australian species and the presence of only 1-2 larvae in the atrial cavity (instead of numerous larvae in North-Western Pacific *A. pliciferum* and *A. tenuicaudum*) should be noted.

Amaroucium oculatum Beniaminson, 1974 from Paramushir Island is similar and might be conspecific with *A. pliciferum* (or *A. tenuicaudum*) but I had no chance to examine the holotype of this species.

Distribution. – From Commander Islands to Middle Japan (present study; Redikorzev 1927a; Tokioka 1967).

Aplidium tenuicaudum (Beniaminson, 1974)

Fig. 7C,D

Amaroucium tenuicaudum Beniaminson, 1974: 324.
? *Amaroucium pliciferum*: Tokioka 1953: 183; 1962: 2.
? *Aplidium pliciferum*: Nishikawa 1990: 94.

Material examined. – Kurile Islands, Shikotan Island, Cerkovnaya Bay, low intertidal zone, 6.9.1949, holotype (ZIN 1/2235). (F) Sea of Japan, Butakova Point, 0-2m, 20.8.1988, 1 colony.

Redescription. – Colony 4 cm long, 1.5 cm wide, 0.7 cm high, strongly deformed, opaque, lightly pinkish. Sand only on wide attachment area, systems were not detected. Thorax 2mm, abdomen 2mm, postabdomen 2-2.5mm, contracted zooids up to 2mm in total length. Zooid with well developed trifid atrial languet. Thoracic muscles 10-15 on each side; about 11-12 stigmata in each half of 10(?)11-12 rows. Stomach in middle part of abdomen, with 24-25 plications. Rectal caeca present. Larva (Fig. 7C) with trunk 0.65mm. Four median ampullae alternating with 3 attachment processes, about 50 vesicles dorsally and ventrally on each side, but not around anterior end of trunk. Larval test densely granulated.

Remarks. – Beniaminson (1974) reported a 2-3-lobed atrial languet for *A. tenuicaudum* although an undivided languet is figured (Beniaminson 1974: fig. 4). Reexamination of the holotype shows all zooids to have a trifid atrial languet. Other important features of the holotype not mentioned by Beniaminson are: thorax with 13-16 longitudinal muscles; 12-13 stigmata in each half of 11-12 rows; 24-25 stomach plications. Larva (not fully matured), with trunk 0.65mm long, four median ampullae alternating with 3 attachment processes (only 2 attachment processes in one larva), clusters of vesicles anteriorly, dorsally and ventrally and the larval test densely granulated.

The present specimen from the Sea of Japan with a trifid atrial lanquet conforms well to the descriptions of *A. pliciferum* given by Tokioka (1953) and Nishikawa (1990) in structure of zooid and larva, and all these specimens apparently are conspecific.

The relationship of *A. tenuicaudum* to *A. pliciferum* is discussed above (see *Remarks, A. pliciferum*).

Distribution. – Shikotan Island (Beniaminson 1974), Sea of Japan to (probably) Korean Strait.

Aplidium lebedi n.sp.

Fig. 8

Material examined. – Holotype (KIE 1/882) – (A) Kurile Islands, near Shumshu Island, st.122, 50°32.5′N, 157°27′E, 280m, 1.8.1954, 1 colony. Paratypes – same

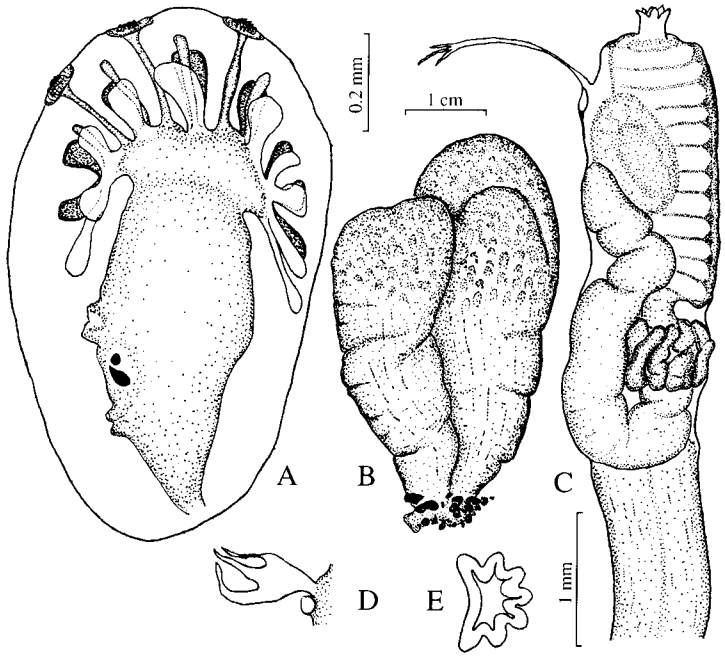

Fig. 8. *Aplidium lebedi* n.sp. – A, larva; B, colony; C, zooid; D, atrial languet; E, cross section of the stomach. (A-D, holotype; E, paratype).

data, 1 colony (possibly single cormidium separated from the holotype) and longitudinally dissected fragments labelled "*Polyclinum*"79 by anonymous investigator (KIE 2/883); st.132, 50°21.3′N, 157°14.1′E, 296-346m, 1 colony represented by single cormidium (KIE 3/884).

Description. – Holotype composed of 2 club-shaped lobes, the largest 45mm high, 18mm in greatest diameter. Upper zooid-bearing part of each lobe slightly expanded, tapering to the base. Test milky white, opaque, soft but firm, spongy, free from foreign matter; whitish zooids indistinctly seen through test. Few sand grains only on narrow attachment area. Zooids arranged in indistinct longitudinal rows, common cloacal aperture(s) and cloacal systems not determined.

Thorax 2mm (in contracted state), abdomen 1mm, postabdomen 3-12mm. Oral siphon terminal, high, with 6 wide pointed lobes. Atrial aperture displaced dorsally, plain-edged. Atrial languet extend from upper rim of atrial opening or directly above it, very long and narrow or short and wide, with 3 thread-like lobes at tip. Twelve – 13 thin longitudinal muscles in each side of thorax. Stigmata in 11-12 rows, about 11-13 per half row. Abdomen strongly contracted in most zooids. Oesophagus short. Stomach short, cylindrical, in middle of abdomen. Seven low, broken and irregular stomach folds in holotype, those in paratype from same station deep and regular. Subdivision of intestine into regions

obscured by contraction of abdomen. Rectal caeca absent (?). Anus opens in middle part of thorax. Postabdomen filled by parenchymal tissue, gonads absent.

One or two mature larvae in right peribranchial cavity. Larval trunk 0.9-1.15mm long. Three small, disk-shaped adhesive organs on long narrow stalks. Median ampullae long and narrow, finger-like, 2 anteriorly between adhesive organs, and 1 or 2 dorsal and 1-3 ventral to adhesive organs. About 8-10 pairs of large, regularly distributed lateral ampullae. Vesicles absent.

Remarks. – The present specimens were probably already examined by an unknown person and are somewhat damaged, so that the structure of systems is obscured.

The species is characterised by its colony form and especially its large larva with regularly distributed ampullae but without vesicles. According to Kott's (1992) classification of larvae of *Aplidium* species from Australia, the larva of the present species belongs to the *A. coniferum* group, which includes the following five species: *A. coniferum* Kott, 1963, *A. gastrolineatum* Kott, 1992, *A. lodix* Kott, 1992, *A. inflorescens* Kott, 1992 and *A. rubricollum* Kott, 1963. The two last mentioned species somewhat resemble *A. lebedi* n.sp., whereas the others are obviously distinct, possessing numerous significant features. The *Aplidium inflorescens* colony is more or less similar to the present species, but zooids clearly differ by more numerous rows of stigmata (15) and more numerous stomach folds (20) *A rubricollum* has the stigmata in a similar number of rows, and 5 stomach folds, but is quite distinct from the present species in the structure of colony. These species are, in any case, geographically isolated from the present one and conspecificity is unlikely.

Also *Amaroucium* sp. aff. *multiplicatum* Tokioka, 1953 from Japan has a similar larva, but differs in structure of colony and zooid .

Among North Pacific species *A. coei* and *A. glabrum* have colony composed by upright lobes, but differs from the present species in larval morphology and some other significant features.

Aplidium disiphonium (Beniaminson, 1975)

Fig. 9A,B

Amaroucium disiphonium Beniaminson, 1975: 66.

Material examined. – Paramushir Island, Lavashova Point, 18m, 27.8.1969, holotype (ZIN 1/2334). (A) Paramushir Island, Vasiliev Bay, st.69, 49°51.7′N, 155°12.1′E, 200-358m, 11.7.1954, 1 colony.

Redescription. – Colony 3.5 cm long, 2.2 cm high, 2 cm wide, densely covered and impregnated by sand. Surface with irregular elevations and depressions. Systems indistinguishable.

Thorax 3mm, abdomen 3mm, postabdomen 3-6mm. Atrial siphon in most

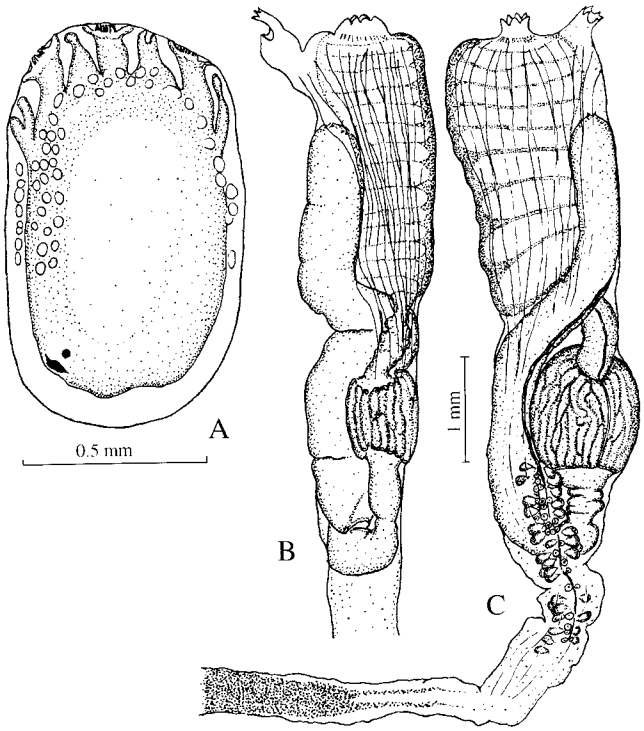

Fig. 9. *Aplidium disiphonium* – A, larva from the holotype; B, zooid. *Ritterella iturupica* – C, zooid.

zooids long and wide, with short 3-lobed languet. About 20 thin longitudinal muscles on each side of thorax. Fourteen rows of about 12 stigmata per half row. Stomach in central part of abdomen, stomach wall with about 15 somewhat irregular longitudinal folds. Small rectal caeca present. Postabdomen filled by parenchymal tissue. Gonads and larvae absent.

Remarks. – The present specimen is consistent with the original and so far single description based on one colony from the same place (Paramushir Island), but from only 18m, instead of more than 200m. The only difference, that might be significant, is the encrusted and embedded sand in the present colony, while the holotype, according to my examination, has no sand.

Some significant features of holotype not mentioned in the original description are: thorax with 16-20 longitudinal muscles, stomach with about 15 irregular folds, 10-12 stigmata per half row. Up to 4-5 larvae in the peribranchial cavity. The larvae seem to be mature but somewhat macerated, nevertheless the internal structure is clearly visible (Fig. 9A). The trunk is 1.1-1.2mm long, with four conical median ampullae sometimes with bifid tips, three adhesive organs on thick stalks, and numerous epidermal vesicles along each side of the midline in anterior half to two thirds of trunk.

The species is unusual in its relatively long atrial siphon, which resembles the condition in some *Synoicum* spp. *Aplidium coei* has a similar atrial siphon, but is clearly distinct in colony form and structure of zooid and larva.

Aplidium sp.

Aplidium multiplicatum: Nishikawa 1990: 88.
Not *Aplidium multiplicatum* Sluiter, 1909; Kott 1992.

Material examined. – (F) The Sea of Japan, Ussuriusky Bay, intertidal zone, under a stone, 1.9.1994, 1 colony.

Description. – Cushion-like colony 10mm in diameter, 3mm thick. Test transparent, reddish. Surface smooth, without sand. Zooids 4-5mm in length, abdomen strongly contracted. Short 3-lobed atrial languet. About 11 fine thoracic muscles. Nine rows of stigmata, about 10 stigmata per row. Stomach has about 20 somewhat irregular folds. Postabdomen short or even completely absent.

Remarks. – *A. multiplicatum* was recorded from the Sea of Japan by Nishikawa (1990), and the present specimen conforms well to his description. Kott (1992) excluded Nishikawa's (1990) record from the synonymy of *A. multiplicatum* Sluiter mainly on the basis of larval morphology. Having only one small colony with strongly contracted zooids and without larvae, it is not possible to resolve the relationships of the specimens assigned to *A. multiplicatum* except to say that the specimen resembles Nishikawa's material.

Ritterella iturupica Beniaminson, 1974

Fig. 9C

Ritterella iturupica Beniaminson, 1974: 325.
Ritterella gurjanovae Beniaminson, 1974: 327. **New synonymy.**

Material examined. – (A) Iturup Island, Kasatka Bay, st.2, 14.9.1954, collector O. Kussakin, 2 colonies; st.1, 18.5.1954, 1 colony; st.1a, low intertidial zone, 16.7.1954, 2 colonies; st.2, 18.7.1954, 1 large colony; st.6, 13.9.1954, 1 large colony with fragments.

Redescription. – Colonies from st.1a and st.2 cushion-like, 1.5 cm high, up to 3 cm wide, those from other stations consist of several upright flat-topped lobes. Test densely encrusted with sand, but none is embedded. No systems. Zooids with thorax 1.5-3mm, abdomen 2.5-4mm, postabdomen 2-9mm. Oral siphon terminal, atrial 6-lobed, sub-terminal, directed dorsally. Thorax with 15-20 longitudinal muscles. Stigmata in 7-10 rows of 16-27 per half row. Oesophagus curved. Asymmetrical stomach in middle part of abdomen. Stomach wall has about 25 irregular longitudinal folds. Rectal caeca absent. Gonad in postabdomen, in some specimens in posterior part of abdomen as well; numerous small ova beside testis follicles. Middle and posterior part of postabdomen filled by parenchymal tissue. Heart in the end of postabdomen.

Remarks. – The original, and so far single description of this species (Beniaminson 1974) was based on six colonies also collected by acad. Kussakin in Kasatka Bay, Iturup Island. Beniaminson (1974: fig.5) shows about 12-13 stigmata. Although she reports the thorax to be narrow, she has not recorded the number of stigmata and the figure may not be exact. The present specimens show unusually high variation in this feature, but in all cases the number of stigmata per half row is more than 16-17. In all other features the present material conforms well to the original description.

Ritterella gurjanovae Beniaminson, 1974 was also described on material from Kasatka Bay. Its colony consists of several upright lobes, expanded at the top, up to 5 cm high. Zooids are similar to those of *R. iturupica* in the number of rows of stigmata (8), structure of the stomach wall and, possibly, in the number of stigmata per half row (the author wrote "25 stigmata per row", but possibly it should be "per half row"). According to the original description, these two species differ only in the colony form and in position of the gonad in the very long postabdomen in *R. gurjanovae*. The latter feature seems to depend on the development stage. The colony form also is greatly variable. The present colonies vary from flattened (as in original description of *R. iturupica*) to short or long upright lobes (as in *R. gurjanovae*). Consequently, *R. gurjanovae* is here regarded as a junior synonym of *R. iturupica* (n.syn.).

R. iturupica strongly resembles *Synoicum sabuliferum* Redikorzev, 1937, especially in colony form. The latter species was described from East Kamchatka and is known only from the original description. According to my examination, the holotype of *S. sabuliferum* (deposited in ZIN) lacks cloacal systems and the atrial siphons open directly to the exterior, as in *Ritterella* rather than *Synoicum*. The exact systematic position of this species is unclear however, because it has a smooth or only slightly areolated stomach, rather than the longitudinal plications of *Ritterella*. *S. sabuliferum* differs from the present species in having a few more rows of stigmata (12) and a smooth stomach.

Distribution. – Iturup Island (Beniaminson 1974, present study).

Ritterella tamarae n.sp.

Fig. 10

Material examined. – (A) Holotype (KIE 1/885) – South Kurile Islands, Iturup Island, Dobroe Nachalo Bay, intertidal zone, 12.8.1954, collector O. Kussakin; paratypes – same data, 1 colony (KIE 3/887); Kuibushevsky Bay, low intertidal zone, 27.7.1954, about 10 colonies with fragments, collector O. Kussakin, 8 colonies and fragments (KIE 2/886).

Description. – Colony of holotype nearly spherical, 2 cm in diameter, consisting

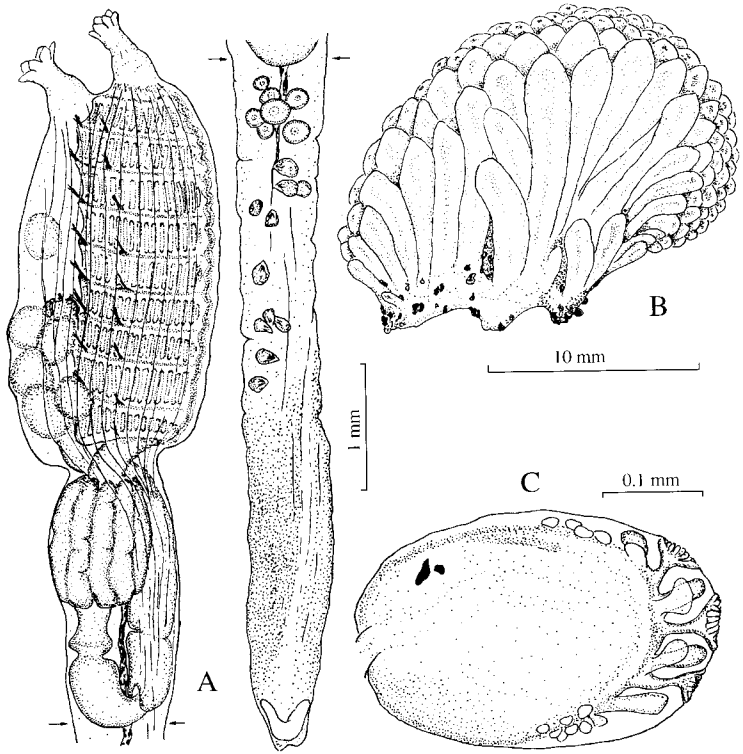

Fig. 10. *Ritterella tamarae* n.sp., holotype – A, zooid; B, part of colony; C, larva.

of a crowded cluster of separate, vertical club-shaped lobes to 8mm long, expanded at the top, arising from common basal test, shorter lobes at the margin, longer ones in the central part of the colony. Test lightly pinkish, free from foreign matter, sparse sand grains only on basal adherent portion of colony. Each lobe usually contains a single zooid. Rarely 2-3 or exceptionally 4 (in some paratypes) zooids are irregularly placed in each lobe, without forming any sort of system.

Colonies of paratypes flattened, about 1.5 cm high, largest up to 4.5 cm long. Basal test and test surrounding each zooid partly free from foreign matter, partly densely and wholly covered by sand, except for tops of zooids.

Thorax 3-4mm, abdomen 2-3mm, postabdomen up to 6mm. Siphons long, each with 6 large lobes; branchial terminal, atrial antero-dorsal. Eight large branchial tentacles alternate with 8 tentacles of moderate size, and a number of small ones. Thoracic longitudinal muscles fine, about 16-18 on each side, continue to end of postabdomen. In holotype 9 rows of stigmata, 16-17 stigmata per row in each side of thorax. In paratypes stigmata in 10-12 rows, 17-20 per half row. Long dorsal languets slightly displaced on right side of branchial sac.

Transverse vessels without papillae, parastigmatic vessels absent. Oesophagus short; stomach elongate, barrel-shaped, in anterior part of abdomen, with 6-7 regular parallel longitudinal folds. Duodenum and proximal part of mid-intestine wide. Rectal caeca present. Rectum, accompanied by sperm duct, opens at level of fourth row of stigmata (counted from bottom of branchial sac). Gonads in somewhat degenerate condition. Ovary in anterior part of abdomen, few testis follicles sparsely distributed behind ovary. Posterior part of postabdomen filled with parenchymal tissue. Heart in posterior end of postabdomen.

Up to 4 embryos and up to 2 larvae in posterior end of right peribranchial cavity in holotype and up to 17 embryos in some zooids from paratypes. Larvae seem not fully mature. Larval trunk 0.45-0.5mm long. Four median ampullae alternate with 3 adhesive organs, single lateral ampulla arises at base of each median ampulla on each side of trunk. Adhesive organs similar to those of *Aplidium* spp. Few vesicles on each side of ventral and dorsal mid-lines, but not in anterior part of trunk.

Remarks. – Specimen from Dobroe Nachalo Bay designated here is possibly part of the holotype colony.

Polyclinid genera with separately opening zooids without cloacal systems include the present genus, *Monniotus* and *Euherdmania*. The present species differs clearly from *Euherdmania* by its short oesophagus, and from *Monniotus* by absence of papillae on transverse vessels of the branchial sac, relatively long postabdomen and its larvae. *Ritterella tamarae* n.sp. clearly differs from most *Ritterella* species by its separate zooids. *Ritterella multistigmata* Kott, 1992, has at least some separate zooids, although the colony consists of narrow branching sandy stalks, a ridged stomach and branchial papillae, distinguishing it from the present species.

Neodictyon n.gen.

Type species. – *Neodictyon shumshu* n.sp., present designation.

Diagnosis. – Colony depressed, cushion-like. Atrial aperture subterminal, in anterodorsal position. Branchial sac without stigmata, with 11 transverse vessels which are not connected via longitudinal vessels. Stomach wall nearly smooth. Postpyloric part of gut loop long, occupying two thirds of abdomen. Gonad placed alongside gut loop. Ovary large, with large ova. Heart placed in the posterior end of postabdomen.

Neodictyon shumshu n.sp.

Fig. 11

Material examined. – Holotype (KIE 1/880)- (D) North Kurile Islands, Shumshu Island, st.61, 50°38.1′N, 150°50.5′E, 80m, sandy bottom, 3.9.1991. Paratype (KIE 2/881) – same data, 1 colony.

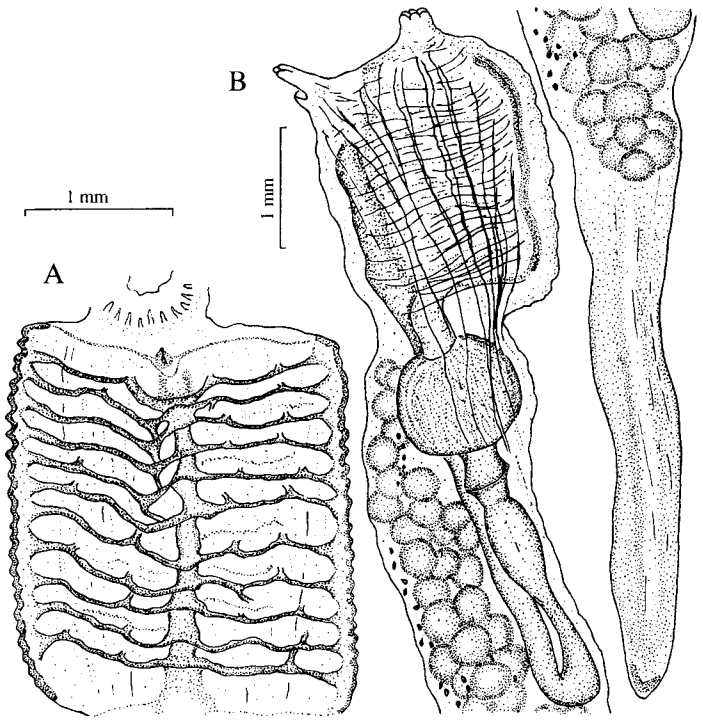

Fig. 11. *Neodictyon shumshu* n.g., n.sp., holotype – A, branchial sac; B, zooid.

Description. – Colony depressed, cushion-like, holotype 48mm long, 30mm wide, 16mm high, paratype 28x17x17mm. Test transparent, colorless, soft, surface layer firm, sparsely covered by minute sand grains on basal part of colony, nearly free from encrusting matter on upper surface. Sparse embedded sand in inner layers of colony. Upright vertical reddish zooids indistinctly seen through test. Systems indistinguishable.

Zooids up to 14mm long, divisible into thorax, abdomen and postabdomen. Thorax wide, nearly rectangular in outline, 22.5mm in contracted state, turned ventrally to lie at right angle to the abdomen at least in some zooids. Branchial aperture on short, 6-lobed terminal siphon; atrial siphon subterminal, provided with short, 3-lobed atrial languet. Eleven – 12 wide longitudinal branched thoracic muscles, which continue along ventral side of abdomen and postabdomen, becoming thinner than on the thorax. Numerous thin transverse muscles on thorax. About 10 short, papilla-like branchial tentacles. Peripharyngeal band makes shallow dorsal V around large spherical ganglion and oval dorsal tubercle with simple opening on its anterior margin. The 11 transverse vessels of the branchial sac, which is without stigmata, are attached to thoracic body wall both dorsally and ventrally, and additionally each vessel is attached to parietal thoracic wall by two short connecting vessels (Fig. 11A). Dorsal languets inconspicuous, slightly displaced to right side when present.

Abdomen 4-5mm long. Oesophagus short, nearly straight. Stomach short, symmetrical, hemispherical, and with wide pyloric end in anterior part of abdomen. The nearly smooth stomach wall is indistinctly areolated or has numerous indistinct internal longitudinal striations (which can be observed only after staining). The long postpyloric part of the gut loop is subdivided into a wide duodenum, and mid-intestine and posterior sections. Rectal caeca absent. Anus placed just under atrial opening at level of third transverse branchial vessel (counted from anterior end of branchial sac). Gonad beside gut loop occupies whole length of abdomen and only slightly protrudes into the anterior part of the postabdomen. The ovary contains numerous large ova. The testis follicles are extremely small, sparsely distributed mainly along dorsal wall of abdomen.

Postabdomen as long as or longer than abdomen, filled by pinkish parenchymal tissue, with heart at its posterior end. No constriction between abdomen and postabdomen.

Remarks. – The most conspicuous feature of the present new genus is the absence of stigmata, a feature usually found in abyssal phlebobranch and stolidobranch ascidian genera. Only two aplousobranch genera are known to have a similar branchial sac: *Pharyngodictyon* (Polyclinidae) and *Protoholozoa* (Polycitoridae); both are recorded from abyssal or moderate depths on the southern hemisphere. *Neodictyon* differs from *Protoholozoa* in the position of the heart, in the number of transverse branchial bars, in the form of the gut loop, and in the atrial opening (see *Diagnosis*, above). The relationship with *Pharyngodictyon* may be closer, but all six known species of this genus are readily separated from *Neodictyon* by their different colony form, and by possessing fewer transverse vessels in the branchial sac. Five of the 6 species are further distinguished by their folded stomachs, only *P. bisinus* Monniot & Monniot, 1991 having a smooth stomach, (and only two branchial vessels). All *Pharyngodictyon* also have the atrial aperture at the base of thorax opening direct to the exterior. In the new genus the atrial aperture is anterodorsal, and although systems were not detected, the form of the aperture and the presence of an atrial languet suggest that they exist.

The presence of a true postabdomen containing heart and gonads (at least anteriorly) makes it likely that *Neodictyon* is a member of the Polyclinidae rather than the Polycitoridae, although both male and female gonads are mainly placed in the abdomen, which is an unusual location in Polyclinidae.

Occurrence of a species with an "abyssal" type of branchial sac at only 90m depth is surprising.

FAMILY PLACENTELIDAE KOTT, 1992

Placentela Redikorzev, 1913

The genus was formerly assigned to the polyclinid subfamily Euherdmaniinae (Nishikawa 1984), or to the polycitorid subfamily Holozoinae (Sanamyan 1993). It is characterised by the presence of a long, well developed postabdomen with epicardium and gonad, as in all polyclinid genera, but in *Placentela* the heart is in the abdomen, as in Polycitoridae. Kott (1992) established a new family for *Placentela*; this view is adopted here.

Placentela crystallina Redikorzev, 1913

Placentela crystallina Redikorzev, 1913: 212; Nishikawa 1984: 39 (with synonymy); Sanamyan 1993: 307, fig.3,b-c (only figures).
Homoedistoma michaelseni Redikorzev, 1927a: 376.

Material examined. – (B) Sea of Okhotsk, st.39, 53°41.3′N, 137°50.0′E, 18m, sand, small stones, 1.8.1986, 1 colony. (F) East Kamchatka: Avacha Bay, Baby Kamen Island, 5-7m, rock, 6.1983, 1 colony; 11-14m, 7.7.1984, 1 colony; 8-9m, 29.8.1984, 1 colony; 8-15m, 11.8.1988, 1 colony. South Kamchatka: Lopatka Point, 8-9m, 8.7.1985, several fragments of a colony; 18m, stones, 11.7.85, 1 colony. Sea of Okhotsk, F.V. *Pogranitchnik Petrov*, st.65, 54°16.5′N, 155°36.0′E, 30m, 14.6.1992, 1 colony; st.102, 57°00.1′N, 156°1.0′E, 40m, 19.6.1992, 1 colony; st.123, 55°15.3′N, 155°17.2′E, 30m, 23.6.1992, 1 colony.

Remarks. – Although a relatively large number of colonies was collected, well developed gonads were found only in a few ones (see Sanamyan 1993); most specimens had their gonads in a mutilated condition. A number of colonies were in a resting state, completely lacking zooids, but even in such condition they can be easily identified as *P. crystallina* by the peculiar colony form with numerous spherical pinkish parenchymal bodies arranged in longitudinal series.

Distribution. – The Sea of Okhotsk, East Kamchatka, Kurile Islands, Sakhalin, Hokkaido (Nishikawa 1984).

REFERENCES

Beniaminson, T.S., 1974. Ascidians (Ascidiacea) from the intertidal zone of the Kurile Islands. – *In* Flora and Fauna of the intertidal zone of the Kurile Islands, pp. 318-331. Novosibirsk. (In Russian).

Beniaminson, T.S., 1975. New species of colonial ascidians of the Kurile Islands. – Mar. Biol. **5:** 71-73. (In Russian).

Beniaminson, T.S., 1976. Tunicata. – *In* A. Zhirmunsky (ed.): Animals and plants of the Peter the Great Bay, pp. 122-124. Nauka Press, Leningrad. (In Russian).

Hartmeyer, R., 1903. Die Ascidien der Arktis. – Fauna Arctica **3**(2): 93-412.

Kott, P., 1963. The ascidians of Australia 4. Aplousobranchiata Lahille: Polyclinidae Verrill (continued). – Aust. J. mar. Freshwat. Res. **14:** 70-118.

Kott, P., 1972. The ascidians of South Australia 1. Spencer Gulf, St. Vincent Gulf and Encounter Bay. – Trans. R. Soc. S. Australia **69:** 1-52.

Kott, P., 1976. The ascidian fauna of Western Port, Victoria, and a comparison with that of Port Phillip Bay. – Mem. Natn. Mus. Victoria **37:** 53-95.

Kott, P., 1992. The Australian Ascidiacea part 3, Aplousobranchia (2). – Mem. Qd Mus. **32**(2): 375-620.

Millar, R.H., 1966. Tunicata, Ascidiacea. – Marine Invertebrates of Scandinavia **1:** 1-123.

Millar, R.H., 1975. Ascidians from the Indo-West-Pacific region in the Zoological Museum, Copenhagen (Tunicata, Ascidiacea). – Steenstrupia 3: 205-336.

Monniot, C. & F. Monniot, 1991. Tunicata: peuplement d'ascidies profondes en Nouvelle-Caledonie. Diversite des strategies adaptatives – *In* A. Crosnier (ed.): 'Resultats des Campagnes Musorstom, Volume 8'. Mem. Mus. natn. Hist. nat. (A) **151:** 357-448.

Nishikawa, T., 1984. Contributions to the Japanese ascidian fauna 38. Notes on the morphology and systematic position of *Placentela crystallina* Redikorzev from the North Pacific. – Proc. Japn. Soc. Syst. Zool. **29:** 37-56.

Nishikawa, T., 1990. The ascidians of the Japan Sea. 1 – Publs Seto Mar. Biol. Lab. **34**(4/6): 73-148.

Redikorzev, V., 1913. Neue Ascidien. – Zool. Anz. **43:** 204-213.

Redikorzev, V., 1927a. Zehn neue Ascidien aus dem fernen Osten. – Zool. Jb. **53:** 373-404.

Redikorzev, V., 1927b. Eine neue Ascidie. – Festschr. für Knipowitsch, Moscow, pp.351-353.

Redikorzev, V., 1937. Neue Ascidien aus dem fernen Osten. – Festschr. Prof. Embrik Strand **3:** 122-127.

Ritter, W.E., 1899. A contribution to the knowledge of the tunicates of the Pribilof Islands. – *In* D.S. Jordan: Fur seals and fur-seal islands of the north Pacific ocean. Washington, pt.3: 511-537.

Ritter, W.E., 1901. The ascidians. – *In* "Papers from the Harriman Alaska Expedition." Proc. Washington Acad. Sci. **3:** 225-266.

Sanamyan, K., 1993. *Pseudoplacentela smirnovi* gen. et sp.n. (Tunicata, Ascidiacea), with a discussion of its phylogenetic relationships. – Zoologica Scripta **22**(3): 305-307.

Skalkin, B.A., 1959. Class Ascidiae. – *In* G.U. Lindberg (ed.): A list of the fauna of the sea waters of the South Sakhalin and South Kurile Islands, pp. 245-246. Vladivostok.

Sluiter, C.P., 1909. Die Tunicaten der Siboga-Expedition. Pt.2. Die merosomen Ascidien. – Siboga-Expeditie **56**b: 1-112.

Tokioka, T., 1953. Ascidians of Sagami Bay. – Iwanamishoten, Tokyo. 315 pp.

Tokioka, T., 1954a. Contributions to Japanese ascidian fauna 8. Sporadic memorandum. – Publ. Seto Mar. Biol. Lab. **4**(1): 67-69.

Tokioka, T., 1954b. Contributions to Japanese ascidian fauna 9. Re-descriptions of Oka's species found in "Figuraro de Japanaj Bestoj". – Publ. Seto Mar. Biol. Lab. **4**(1): 69-74.

Tokioka, T., 1960. Contributions to Japanese ascidian fauna 16. On some ascidians from the northern waters of Japan and the neighbouring subarctic waters. – Publ. Seto Mar. Biol. Lab. **8**(1): 191-210.

Tokioka, T., 1962. Contributions to Japanese ascidian fauna 18. Ascidians from Sado Island and some records from Sagami Bay. – Publ. Seto Mar. Biol. Lab. **10**(1): 1-20.

Tokioka, T., 1963. Contributions to Japanese ascidian fauna 20. The outline of Japanese ascidian fauna as compared with that of the Pacific coasts of North America. – Publ. Seto Mar. Biol. Lab. **11**(1): 131-156.

Tokioka, T., 1967. Pacific Tunicata of the United States National Museum. – Bull. U.S. natn. Mus. **251:** 1-247.

Van Name, W.G., 1945. The North and South American ascidians. – Bull. Am. Mus. nat. Hist. **84:** 1-476.