

ASCIDIANS FROM THE NORTH-WESTERN PACIFIC REGION 7. STYELIDAE

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ABSTRACT

The ascidians (Asciacea) of the family Styelidae collected by several expeditions in NW Pacific region were examined. Collections contain 20 already known species-group taxa. Members of the genus *Styela* and *Dendrodoa* are most common in the region.

Key words: Ascidiacea, Styelidae, North-Western Pacific.

INTRODUCTION

The most common in the region are simple ascidians belonging to the subfamily Styelinae: *Dendrodoa aggregata* (Rathke, 1806), *Styela clavata* (Pallas, 1774) and *Styela macreteron* (Ritter, 1913). Subfamily Polyzoinae is represented only by two species: *Syncarpa oviformis* Redikorzev, 1913 and *Kukenthalia borealis* (Gottschaldt, 1894), both from the Sea of Okhotsk. Members of Botryllinae are more common in warmer waters, mainly in the Sea of Japan, although a few specimens were found on Kurile and Commander Islands.

The following collections were examined:

From the Zoological Institute, St. Petersburg (ZIN).

(A) RV *Lebed*, 1954, North Kurile Islands (mainly Paramushir and Shumshu); dredging, coll. A. Spirina.

(B) RV *Academic Oparin*, 1986, Sea of Okhotsk and Kurile Islands; dredging, coll. A. Smirnov.

(C) RV *Academic Oparin*, 1988, Kurile Islands and Sea of Okhotsk; dredging, coll. E. N. Gruzov.

(D) RV *Academic Oparin*, 1991, Alaska, Aleutian, Commander and Kurile Islands, East Kamchatka; dredging and SCUBA diving, coll. A. Smirnov.

From the Kamchatka Institute of the Ecology and Environment, Petropavlovsk-Kamchatsky (KIE).

(E) Collection of the Far East State Sea Reservation (FESSR), 1980-1991, Sea of Japan. Additional specimens collected by Dr. A. Chernyshev, autumn 1994.

(F) Collection of 1984-1995, Commander Islands, East Kamchatka and Atlasov Island (North Kurile Group); SCUBA diving and dredging, coll. collaborators of the Lab. of Benthic Communities. Additional specimens collected by Dr. B. Sheiko: FV *Pogranitchnik Petrov*, Sea of Okhotsk, 1991 and FV *Gefest*, East Kamchatka, 1994; RV *Volkanolog*, Sea of Okhotsk, Shantare Islands, 1995.

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Styela clava clava Herdman, 1881

Styela clava Herdman, 1881: 70.

Styela clava clava: Nishikawa 1991: 114 (and synonymy).

Botryorchis clava: Redikorzev 1916a: 219; 1941: 187 (part, only specimens from the Sea of Japan).

Material examined. – (F) Sea of Japan, Peter the Great Bay, 6-8m, muddy sand, 28.7.1988, 1 specimen.

Description. – Single specimen 11cm in height, gradually tapering to the peduncle. Peduncle about the same length as the body itself. Three gonads on the left, 7 on the right side. Gut forms simple narrow U-shaped loop; stomach large.

Remarks. – Redikorzev (1941) reported *Botryorchis clava* (= *Styela clava* Herdman, 1881) from the Commander Islands. However this species

was not present in the rich material from the Commander Island kept in KIE. The specimens from the Commander Islands labelled by Redikorzev as *Botryorchis clava* (kept in ZIN) were reexamined, and were found to belong to *Styela clavata* (Pallas, 1774), rather than to *Styela clava*. The specimens have two ventrally directed gonads on each side, sausage-shaped testes and distinct secondary gut loop. These features are characteristic of *S. clavata*, and not of *S. clava*. The latter species has from 2 to 4 gonads on the left and from 4 to 8 on the right, compact rounded testes and simple vertical gut loop. The two species are indiscernible externally, and this may explain Redikorzev's mistake. Thus Redikorzev's (1941) record of this species from the Commander Islands is considered to be erroneous and excluded here from the synonymy of *S. clava*.

Distribution. – Very widely distributed species, having been transported around the world with ships. It was recorded in the Pacific from "Kurile Strait" and Hokkaido in the north (Redikorzev 1916a; Tokioka 1951), from SE Australia in the south (Kott 1985), and from California in the east (Abbott & Newberry 1980). It was also recorded in Europe (Christiansen & Thomsen 1981).

Styela clavata (Pallas, 1774)

Ascidia clavata Pallas, 1774.

Styela clavata: Van Name 1945: 316 (and synonymy).

Botryorchis clava: Redikorzev 1941: 187 (part, only specimens from Commander Islands).

Material examined. – (F) Commander Islands, about 330 specimens from Pacific and Bering Sea coasts of Bering and Medny Island, summer 1991-1995, 0 to 31m. East Kamchatka, 94 specimens from Kronotsky Bay to Lopatka point (South Kamchatka), 5-30m, July - September 1985. North Kurile Islands, Uta-shud Island, 23m, 9.09.1985, 1 specimen; Atlasova Island, 17m, 14.08.1989, 1 specimen; 18m, 22.7.1989, 1 specimen. (C) Kurile Island, Rikorda Strait, 47°22'N, 152°40'E, 146m, 1.8.1988, 4 specimens.

Description. – Body up to 12cm long, gradually or abruptly tapering to the peduncle. Relative length of peduncle and body vary, in some specimens peduncle shorter, in others longer than the body itself. Siphonal spines 45-75 µm long, 4-5.5 µm wide, sharply pointed. Two gonads on each side consisting of central ovary and numerous branched or simple sausage-

shaped testis follicles. Stomach large, secondary loop widely opened, V-shaped. Numerous tailed larvae in specimens from Medny Island collected in late July. Larva up to 1.5mm in total length, the trunk is 0.4mm.

Remarks. – The present specimens correspond to the previous descriptions, especially to the excellent one given by Redikorzev (1916a). Redikorzev (1941) believed this species to be rare, which it is not. It is one of the most common ascidians in shallow waters of the East Kamchatka and Commander Islands.

Distribution. – North Kurile Islands, East Kamchatka, Commander Islands (present study), Aleutian and Pribilof Islands to Southern Alaska (Van Name 1945).

Styela coriacea (Alder and Hancock, 1848)

Fig.1

Cynthia coriacea Alder & Hancock, 1848: 195.

Styela coriacea coriacea: Nishikawa 1991: 117 (and synonymy).

Styela hemicaespitosa Ritter, 1913: 471.

Styela coriacea hemicaespitosa: Van Name 1945: 287.

Material examined. – Typical specimens: (F) Commander Islands, Bering Island, 0m, 19.7.1990, 3 specimens; Toporkov Island, 32-33m, 5.9.1986. North Kurile Islands, Atlasov Islands, 19m, 8.8.1989. East Kamchatka, Avacha Bay, 70m, 53°03.6'N, 159°43.2'E, 25.5.1988; 52°21.2'N, 158°46.6'E - 52°19.7'N, 158°49.5'E, 300-500m, 28.5.1994; 58°17.1'N, 163°57.0'E - 58°13.6'N, 163°58.3'E, 280-720m, 5.7.1994; 52°23.8'N, 158°43.6'E - 52°21.0'N, 158°47.2'E, 200-300m, 24.5.1994; 52°25.5'N, 158°44.2'E - 52°28.3'N, 158°43.9'E, 300-500m, 27.5.1994.

Specimens with hair-like processes: (E) Sea of Japan, Peter the Great Bay, depth unknown, 12.8.1984; 15m, 2.9.1983; 45m, 8.8.1983; 42°38'53"N, 131°16'55"E, 47m, muddy sand, 6.5.1984. (F) East Kamchatka, Kronotsky Bay, 54°06.5'N, 160°23.5'E - 54°04.1'N, 160°28.8'E, 470-600m, 28.6.1994. One specimen from each station.

Description. – Some specimens have the lower half of body densely covered by hair-like processes adhering sand and other particles, while the upper half is free from hairs and foreign particles. Other features of these specimens are as follows: body almost spherical, 1.5-8cm long, and 1.5-6cm in greatest diameter. Apertures sessile, rather close to each other in the middle

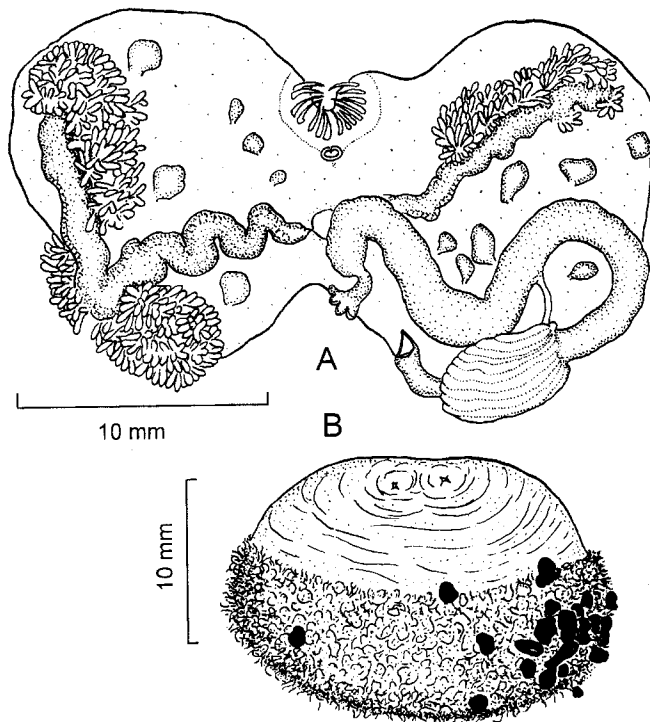


Fig.1. *Styela coriacea* – A, inner body wall; B, external appearance.

of the upper surface. Four branchial folds better developed in smaller specimens than in large ones where the folds are broad and rounded, although always distinct. Testes are usually represented by a solid compact mass, but in one specimen from Kronotsky Bay they consist of numerous small branched follicles closely adhering to each other (Fig.1, A).

Other specimens lack hairs and conform well to the previous descriptions of typical *S. coriacea*.

Remarks. – Specimens with hair-like processes are consistent with Ritter's (1913) description of *S. hemicaespitosa*. Hartmeyer (1923) included *S. hemicaespitosa* in the synonymy of *S. coriacea* on the basis of similarity of internal features. Van Name (1945: 287) gave subspecies status to *S. hemicaespitosa*: "it is a geographic race differing so strikingly from the typical *coriacea*". However *S. hemicaespitosa* is not "a geographic race" of *S. coriacea*, because both taxa occur sympatrically. Hairs are probably developed in specimens from sandy or muddy substrates. Other differences in external characters are not sig-

nificant, as Ritter (1913: 474) stated, that *S. coriacea* "runs through a range of shape variations ... almost exactly parallel with that presented by our [= *S. hemicaespitosa*] species".

Distribution. – Widely distributed in Arctic and northern regions (Van Name 1945). Southern California and Bering Sea (Ritter 1913), Commander Islands, Pacific coasts of Kamchatka (present study). There are many records from the Sea of Japan listed by Nishikawa (1991).

Styela macrenteron Ritter, 1913

Styela macrenteron Ritter, 1913: 466.

Styela rustica macrenteron: Van Name 1945: 290.

Material examined. – (F) East Kamchatka. Korfa Bay: 60°9.5'N, 165°43'E, 33m, 26.9.1988, 5 specimens; 60°3.5'N, 165°43'E, 55m, 20.9.1988, 10 specimens; 59°52.5'N, 165°27'E, 72m, 21.9.1988, 15 specimens; 59°54.5'N, 165°27'E, 72m, 21.9.1988, 6 specimens. Litke Bay: 58°57.5'N, 163°27'E, 56m, 23.9.1988, 5 specimens; 58°58.5'N, 164°25'E, 53m, 23.9.1988, 2 specimens; 59°21.5'N, 163°53'E,

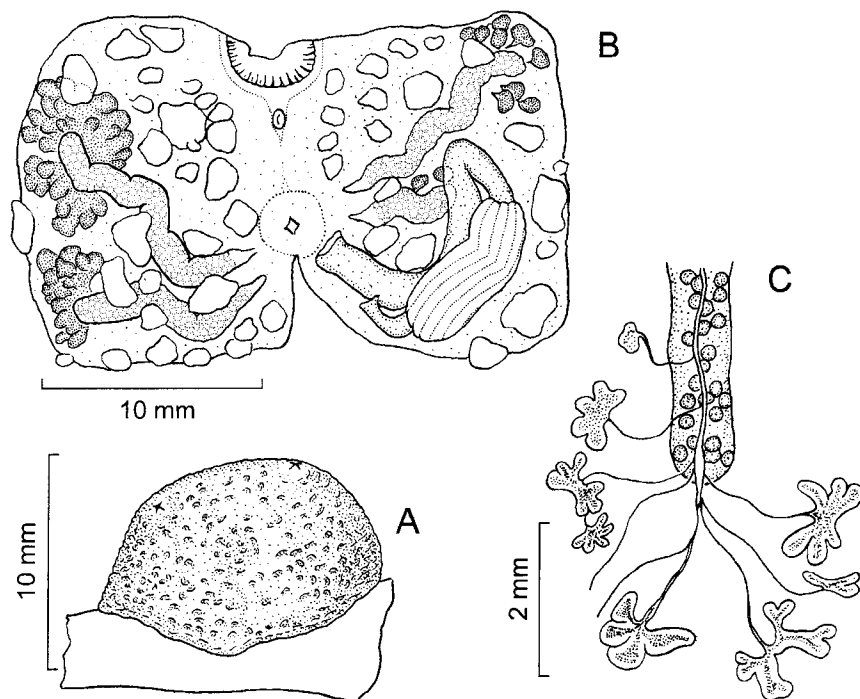


Fig. 2. *Styela sigma* – A, external appearance; B, inner body wall, specimen with crowded testis follicles at left; C, proximal part of the ovary with sparsely distributed testis follicles.

57m, 24.9.1988, 1 specimen. Kronotsky Bay: 52°12.5'N, 160°8.5'E, 100m, 9.5.1988, 1 specimen; 53°46'N, 160°17.9'E, 135m, 12.5.1988, 2 specimens. Avacha Bay: 53°0.4'N, 159°43.2'E, 79m, 1 specimen, 25.5.1988, 1 specimen; 53°2.5'N, 159°33'E, 71m, 25.6.1988, 1 specimen; 52°57.5'N, 159°43.2'E, 90m, 25.5.1988, 1 specimen; 53°3.7'N, 160°5.4'E, 118m, 16.5.1988, 2 specimens; 53°1.5'N, 159°51'E, 77m, 28.5.1988, 1 specimen.

Remarks. – This species was usually cited as subspecies or variety of *Styela rustica* Linné. *Styela macranteron*, however, lives sympatrically with *S. rustica*, as both species were recorded from the Sea of Okhotsk, Bering Sea and some other regions, wherefore a subspecific status is impossible. *S. macranteron* can be separated from *S. rustica* by presence of a very large stomach and long and remarkably curved (even in small specimens) intestine. Therefore the two taxa probably represent separate species.

Distribution. – Bering Sea, Sea of Okhotsk, Arctic coasts of eastern Siberia (Redikorzev 1941).

Styela sigma Hartmeyer, 1906

Fig. 2

Styela sigma Hartmeyer, 1906: 12. Nishikawa 1991: 123 (and synonymy).

Material examined. – (F) FV *Gefest*, East Kamchatka, Karaginsky Bay: 58°06.1'N, 163°53.6'E - 58°04.8'N, 163°49.3'E, 600-660m, 3.7.1994, 1 specimen; 58°59.6'N, 165°03.3'E - 58°57.3'N, 164°58.1'E, 300-800m, 8.8.1994, 2 specimens; 58°56.1'N, 164°56.1'E - 58°54.4'N, 164°52.5'E, 240-580m, 10.7.1994, 1 specimen. Kronotsky Bay: 54°04.1'N, 160°28.8'E - 54°06.5'N, 160°23.5'E, 540-470m, 28.6.1994, 5 specimens; 54°06.5'N, 160°23.5'E, - 54°04.1'N, 160°28.8'E, 470-540m, 2 specimens.

Description. – All the specimens small, 13-18mm in diameter, roundish-oval or somewhat depressed, attached by relatively broad surface to siliceous sponges. Test surface brown, wrinkled or covered by small tubercles, nearly free from foreign matter. Both apertures sessile and inconspicuous.

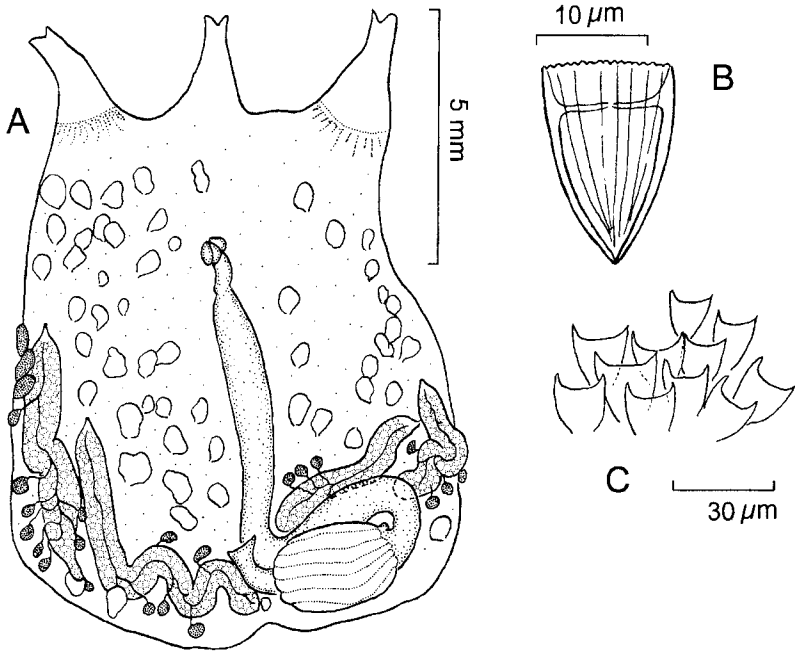


Fig. 3. *Styela truncata* – A, inner body wall; B and C, siphonal spines.

About 30 small simple tentacles of 2 or 3 sizes. Dorsal tubercle has simple longitudinal slit-like opening. Branchial formula is: R.E.1(5)3(9)4(8)4(16)2D, L.E.3(4)5(10)5(8)7(6)1D. Gut loop occupying half or somewhat more of the left side of the body, first loop narrow, secondary loop widely opened. Elongated stomach with 11-13 internal longitudinal folds. Anus smooth-edged. Two gonads on each side with the only exception in the specimen of KIE 6/894, which has one gonad on the right and two on the left side. Testis follicles relatively large, arranged sparsely (Fig.2, C) or crowded (Fig.2, B) around proximal end of ovary. Large upright endocarps attached to the body wall by thin neck are numerous and crowded.

Remarks. – The present specimens are in good agreement with the previous descriptions of *S. atlantica* especially to Tokioka's (1967) one.

Nishikawa (1991) examined the holotype of *S. sigma* Hartmeyer, 1906 and found it to be conspecific with the other specimens from the Pacific, previously recorded as *S. atlantica*. Thus, the name *S. sigma* should be used instead of *S. atlantica* at least for the Pacific specimens.

Distribution. – In the NW Pacific from Japan (Kyushu, Sagami Bay) in the south (Nishikawa 1991) to East Kamchatka in the north (present study).

Styela truncata Ritter, 1901

Fig.3

Styela truncata Ritter, 1901: 241. Van Name 1945: 314 (and synonymy). Abbott & Newberry 1980: 208.

Material examined. – (F) Commander Islands, Medny Island, st.70 and st.71, 6m, 11.8.1995, 2 specimens.

Description. – Large specimen 2cm long and 8-10mm wide. Test reddish, densely wrinkled. Long narrow diverging siphons seen only after removing of the test. Siphonal spines (Fig.3, B,C) triangular, 15-16 µm long and 12 µm wide, densely crowded.

About 20 branchial tentacles of 2 sizes. Six-8 longitudinal vessels on each branchial fold, one vessel in each interval between folds. Stomach barrel-shaped, stomach wall longitudinally plicated. Long rectum at a sharp angle with gut loop. Two gonads on each side of the body with the openings directed ventrally.

Remarks. – The specimens were found in a cluster of individuals of *Styela clavata* and despite the absence of the peduncle superficially closely resemble young specimens of this species. They agree well with earlier descriptions of *S. truncata* in all features, and especially in the form and structure of the ventrally directed gonads and the presence of only one longitudinal vessel between the branchial folds.

Distribution. – Yakutat Bay (Alaska) to San Diego (Abbott & Newberry 1980), Commander Islands (present study).

Dendrodoa (Dendrodoa) aggregata
(Rathke, 1806)

Ascidia aggregata Rathke, 1806: 11.

Dendrodoa aggregata: Van Name 1945: 275 (and synonymy).

Material examined. – (F) East Kamchatka: about 210 specimens from Dezhnev Bay in the north to Lopatka Point in the south, 2-100m. Commander Islands, about 150 specimens from Medny and Bering Islands, 0-35m.

Distribution. – Widely distributed in the Arctic (Van Name 1945). The species is one of the commonest and most often recorded ascidians in the Bering Sea.

Dendrodoa (Dendrodoa) lineata
(Traustedt, 1880)

Styela lineata Traustedt, 1880: 413.

Dendrodoa lineata: Van Name 1945: 279 (and synonymy).

Dendrodoa microstigma Redikorzev, 1916a: 323.

Material examined. – (F) East Kamchatka. Dezhnev Bay: 4-8m, 14.7.1990, 20 specimens; 6-8m, 12.7.1990, 1 specimen. Avacha Bay, 52°59.5'N, 159°31'E, 82m, 25.5.1988, 1 specimen; 53°0.4'N, 159°43.2'E, 79m, 25.5.1988, 6 specimens; 52°54.4'N, 159°13.1'E, 47m, 27.5.1988, 5 specimens; 53°4.6'N, 159°47'E, 69m, 28.5.1988, 4 specimens. Anapka Bay, 60°10.5'N, 165°3'E, 34m, 18.9.1988, 2 specimens.

Remarks. – This species was treated as conspecific with *D. aggregata* by Millar (1966). However, all the specimens examined in connection with the present work are clearly separated from *D. aggregata* in the relative position of male and female parts of gonad (as shown by Huus 1929). This difference seems to be significant. Longitudinal ridges and so-called "additional apertures" (longitudinally arranged tubercles with a

pit) on the test surface also are characteristic of *D. lineata*.

Two specimens from Anapka Bay have very small stigmata, characteristic of *D. microstigma*, on some parts of the branchial sac. The latter species was described from the Bering Sea coasts of Kamchatka. According to Redikorzev (1916a, 1941) it differs from *D. lineata* in being larger, with a longer intestine, different distribution of the internal longitudinal vessels on and between branchial folds, and especially by the presence of minute stigmata. Some specimens have small stigmata on some limited parts of the branchial sac and this does not appear to constitute a diagnostic feature. Other mentioned features also seem to be insignificant species characters and *D. microstigma* is here considered as a junior synonym of *D. lineata*.

Distribution. – From Greenland and Spitsbergen to Siberian coasts (67°7'N, 173°24'E), Bering Sea and Sea of Okhotsk (Redikorzev 1941).

Dendrodoa (Dendrodoa) pulchella
(Verrill, 1871)

Cynthia pulchella Verrill, 1871: 98.

Dendrodoa pulchella: Van Name 1945: 277 (and synonymy).

Material examined. – (F) East Kamchatka. Avacha Bay: st.36, 53°1.5'N, 159°51'E, 77m, 25.5.1988, 22 specimens; st.39, 53°05.8'N, 159°38.1'E, sandy mud, 50m, 25.5.1988, 7 specimens; st.52, mud, 53°4.6'N, 159°47'E, 69m, 28.5.1988, 8 specimens; st.62, 53°4.5'N, 159°35'E, 62m, 25.5.1988, 8 specimens; st.64, 53°3.6'N, 159°43.2'E, 70m, 25.5.1988, 1 specimen; st.68, muddy sand, 60m, 53°5.7'N, 159°40.8'E, 25.5.1988, 2 specimens; st.72, 70m, 28.5.1988, 18 specimens; st.86, 53°3'N, 160°5'E, 118m, 16.5.1988, 1 specimen. Kronotsky Bay: st.172, 53°46'N, 160°13.5'E, 100m, 12.5.1988, 6 specimens. Karaginsky Island, 10m, 19.8.1988, 15 specimens.

Remarks. – All the specimens are more or less the same externally, being nearly globular, grey in colour, with a smooth and relatively thin tunic. These features are constant and useful to identify the species even without dissection. The largest specimen examined was 25 mm in diameter, while others were only 10-17 mm. The species often is found growing on other ascidians or in large clusters of many individuals.

D. pulchella is distinguished from other species of the genus by its invariably 3-branched gonad and numerous oral tentacles.

Distribution. – “Circumpolar Arctic species” (Van Name 1945), in the Pacific from East Kamchatka (present study) to Bering Strait (Van Name 1945) and Alaska, Nunivak Island (Ritter 1913).

Dendrodia (Styelopsis) sp.

Material examined. – (F) FV *Gefest*, East Kamchatka, Karaginsky Bay, 58°17.1'N, 163°57.0'E - 58°13.6'N, 163°58.3'E, 280-720m, 5.7.1994, 1 specimen.

Remarks. – The specimen is 2cm in height, has one tubular gonad on the right side of the body and a single well-developed fold on the right side of the branchial sac only. The branchial formula is: E22(14)ODL35. The specimen conforms to the many previous descriptions of the solitary form of *D. grossularia* nearly in all features, but has significantly more numerous longitudinal branchial vessels. Van Name (1945) reported for American specimens of *D. grossularia* 17 vessels on the right and 16 on the left, although the aggregated form of this species usually has more numerous longitudinal branchial vessels than the solitary form, up to 29 on the right and 20 on the left. Further, the branchial vessels in *D. grossularia* usually are grouped “to indicate distinctly four folds on each side” (Van Name 1945, p.281), while in the present specimens they are equally spaced. These differences might be significant, but more material is required to establish the morphological variations in this possibly new species.

D. grossularia was reported from Bering Sea by Ritter (1913). His material was represented by a “very compact mass containing 35 or 40 individuals ranging in size from 1mm to 12mm” (Ritter 1913: 479). Unfortunately Ritter has not reported the branchial formula, although he failed to find any reliable differences between his specimens and descriptions of *D. grossularia*.

Cnemidocarpa clara (Hartmeyer, 1906)

Styela clara Hartmeyer, 1906: 13.

Cnemidocarpa clara: Nishikawa 1991: 99 (and synonymy).

Cnemidocarpa heterotentaculata Beniaminson 1971: 295.

Cnemidocarpa monnioti Beniaminson 1971: 297.

? *Styela joannae* Herdman 1898: 264.

? *Polycarpa finmarkiensis* Kiaer 1893: 60.

Material examined. – (D) Alaska Gulf, Kodiak Island, st.13, 58°14.0'N, 149°32.9'W, 79m, 11.8.1991, 1 specimen; st.20, 57°42.8'N, 151°00.9'W, 70m, 12.8.1991, 1 specimen. Com-

mander Islands, west off Medny Island, st.4, 54°11.9'N, 168°36.5'E, 508m, 2.8.1991, 1 specimen; st.5, 54°12.0'N, 168°37.3'N, 569m, 2.8.1991, 1 specimen. North Kurile Islands, Shumshu Island, st.58, 50°39.5'N, 156°43.0'E, 66m, 3.9.1991, 2 specimens; st.61, 50°38.1'N, 156°50.5'E, 80m, 3.9.1991, 2 specimens. (F) North Kurile Islands, Atlasova Island, 18m, 22.8.1989, 1 specimen. FV *Gefest*, near Commander Islands, 55°34.9'N, 164°50.9'E, 400-600m, 1.7.1994, 1 specimen. Sea of Japan, Vostok Bay, intertidal, 1.3.1995, 2 specimens.

Description. – Body slightly depressed, sometimes cone-shaped with wide attachment surface and well-developed basal membrane, or nearly globular in some large specimens. Greatest specimen 32mm high and 40mm wide. Test thin, smooth, sprinkled with minute flecks as described by Nishikawa (1991). Apertures placed close to each other, on low inconspicuous siphons, except in two specimens from the Japan Sea that have well-developed siphons. From 14 to 45 simple branchial tentacles, but one large specimen from Atlasova Island has 14 branched tentacles. Atrial tentacles present. Dorsal lamina with serrated margin.

Long sinuous gonads attached to the body wall by thin and high membrane which often is reduced to fine ligaments. From 4 to 12 gonads on the left and 5 to 14 on the right. Stomach occupies about one third of the gut loop length in specimen from Commander Islands (569m) and about half of the gut loop length in others. Secondary intestinal loop deep or shallow, widely opened, anal margin obscurely lobed.

Remarks. – The present specimens from the North Pacific fall within the range of variation reported for *Cnemidocarpa clara* (see Nishikawa 1991). They are also consistent with the descriptions of *Cnemidocarpa finmarkiensis joannae* by Redikorzev (1916a) from the Sea of Okhotsk, as well as the original description of *Styela joannae* from the Pacific coast of North America (from Port Townsend), except only in the dorsal lamina, which was erroneously reported by Herdman (1898: 264) as a “plain narrow membrane”. Thus, the suggestion (Nishikawa 1991) that *S. joannae* and *C. clara* are probably conspecific appears to be correct, though reexamination of Herdman’s specimens is required to make certain conclusion. It is probable that *C. clara* also is conspecific with *C. finmarkiensis* (Kiaer, 1893). Its small, rounded stomach was thought to distinguish the species from *C. clara* (see Van Name 1945; Nishikawa 1991). Howev-

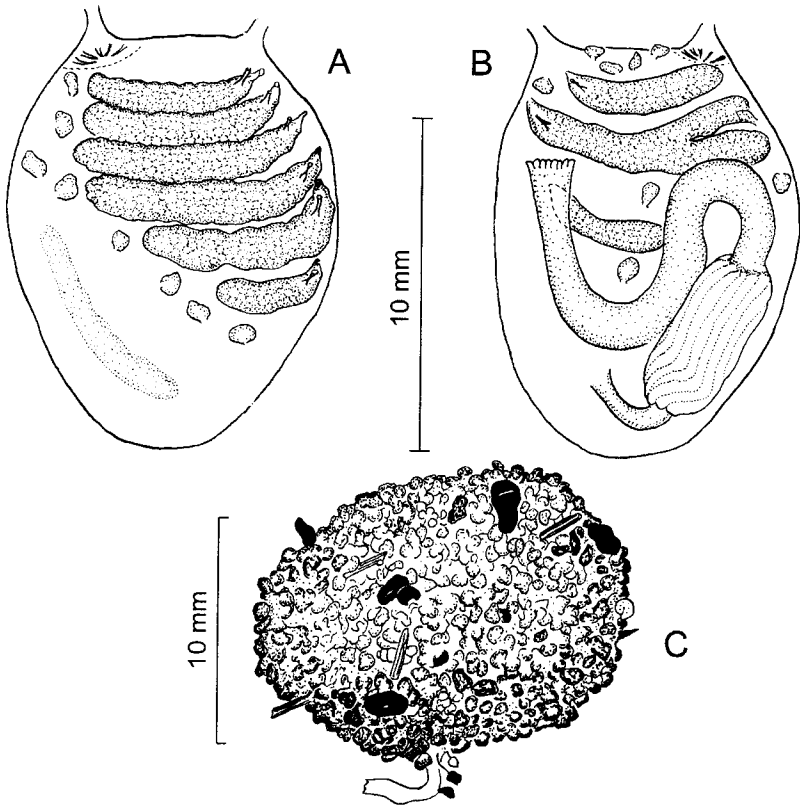


Fig.4. A, *Cnemidocarpa rhizopus* – A, right and B, left side of the inner body wall; C, external appearance.

er, in figures given by Redikorzev (1916a, fig.55) and especially by Millar (1966, fig.52) it is shown as elongated. The size of stomach in the present specimens varies, and although in some it might be described as “large and voluminous” in others it is only slightly larger than that figured by Millar (1966). New material from northern seas is required to confirm the conspecificity of these two taxa.

No significant differences were found between the specimen with the branched branchial tentacles and those with simple ones. Specimens with the branched tentacles recorded from the Sea of Japan as *C. clara* by Redikorzev (1941: 191, Fig.15) and as *C. heterotentaculata* by Beniaminson (1971: 296, Fig.1,B) were suggested as possible synonyms of *C. clara* by Nishikawa (1991).

Distribution. – Pacific coasts of North America, from Alaska, Kodiak Island (present study) to Puget Sound (Herdman 1898) and from the

Bering Sea, Commander Islands and Sea of Okhotsk (Redikorzev 1916a; present study) to the Sea of Japan and Japanese coasts (Nishikawa 1991).

Cnemidocarpa rhizopus (Redikorzev, 1907)

Fig.4

Styela rhizopus Redikorzev, 1907: 523.

Tethyum rhizopus var. *murmanense* Redikorzev, 1911: 61.

Cnemidocarpa rhizopus: Van Name 1945: 265 (and synonymy). Millar 1966: 82.

Material examined. – (A) Kurile Islands, Paramushir Island, st.103, 50°44.2'N, 156°40.6'E, 38-43m, 21.7.1954, 7 specimens.

Description. – Body ovoid, slightly flattened laterally, densely covered by sand, 18mm wide, 14-15mm in height. A rooting process devoid of sand is thin and long (30mm) in one specimen, but short (3-5mm) and thick in others.

About 10 branchial tentacles. Branchial folds

low and inconspicuous, arrangement of longitudinal vessels as: R.V.(3)(5)(2)(11)D., L.V.(4)(7)(3)(6)D. Six elongated, transversely oriented gonads on the right, four on the left. One specimen has only 3 gonads on the left, but the second one being divided posteriorly into two branches. Stomach elongated, second loop deep and wide, anal margin has numerous small lobes. Some endocarps distributed sparsely mainly on anterior part of the body. Long thin-walled heart on the right side somewhat resembles renal sac of Molgulidae.

Remarks. – The present species is distinguished from *C. mollis* (Stimpson, 1852) by the internal longitudinal branchial vessels, which are more numerous in the latter species (see Redikorzev 1916a).

Lützen (1970) erroneously believed that *C. rhizopus* could be distinguished from *Cnemidocarpa cirrata* Årnäck by the rhizoid-like processes scattered over a large part of the body.

Distribution. – Greenland, Siberian waters, Arctic N. America (Millar 1966). Bering Sea (Ritter 1913; Van Name 1945), Kurile Islands (present study). Skalkin's (1959) record from South Sakhalin is excluded here, because it lacks a description. It is known that several species in Skalkin's paper were incorrectly identified.

Pelonaia corrugata corrugata
Goodsir & Forbes, 1841

Pelonaia corrugata Goodsir & Forbes, 1841: 138. Van Name 1945: 318 (and synonymy).

Pelonaia corrugata corrugata: Nishikawa 1991: 128.

Material examined. – (E) Sea of Japan, Peter the Great Bay, 47m, 29.10.1982, 1 specimen; 40m, 13.8.1982, 7 specimens; 37m, 5.9.1983, 3 specimens; 53m, 13.8.1983, 30 specimens; 45m, 13.9.1985, 12 specimens; 47m, 23.9.1988, 7 specimens.

Distribution. – Widely distributed in the Arctic: North America, Greenland, Iceland, Spitsbergen, North Sea, White Sea, Barents Sea, Kara Sea, Bering Strait, Bering Sea, Sea of Okhotsk, Sea of Japan (Redikorzev 1941).

Syncarpa oviformis Redikorzev, 1913

Syncarpa oviformis Redikorzev, 1913: 204; 1941: 194.

Syncarpa corticiformis Beniaminson, 1975: 31.

Syncarpa longicaudata Skalkin, 1957: 297.

Material examined. – (F) Sea of Okhotsk, Kusova Island, 8-9m, 7.8.95, 1 colony, collector B. Sheiko. (D) Small Kurile Islands, Green Island,

st.96, 43°29.7'N, 146°05.3'E, 1.5-5m, 11.9.1991, 1 colony.

Description. – Colony massive, dark brown. Test hard. Zooids cylindrical, up to 3cm long and 5-8mm in diameter. Branchial sac with up to 50 rows of stigmata, sometimes crossed by parastigmatic vessels. The arrangement of the longitudinal branchial vessels as: L.E1-3(3)2(6-9)0D; R.E1(2)2(7)0D. One 3-4-branched (rarely 2-branched) gonad on the right side only. In some zooids gonad has 2 long branches and a short additional branch.

Remarks. – Only 3 species were assigned to the genus *Syncarpa*: *S. oviformis* with 2-branched gonad, *S. longicaudata* with 3- and *S. corticiformis* with 4-branched gonad. Differences in the structure of gonads appear to vary intraspecifically. Differences in the structure of the branchial sac, reported by Beniaminson (1975) also are not significant. All zooids from the present material have one well developed fold on each side of the branchial sac close to the dorsal lamina, whereas the second fold (close to the endostyle) is low and inconspicuous (as in *S. corticiformis*) and often absent (as in original description of *S. oviformis*).

Distribution. – SW-part of the Sea of Okhotsk (Redikorzev 1913; present study), South Kurile Islands (Skalkin 1957), Kunashir Island (Beniaminson 1975).

Kukenthalia borealis (Gottschaldt, 1894)

Goodsiria borealis Gottschaldt, 1894

Kukenthalia borealis: Årnäck 1921: 187. Van Name 1945: 234 (and synonymy).

Diandrocarpa okai Redikorzev, 1916b: 31.

Symplegma okai: Redikorzev 1941: 195.

Material examined. – (C) Sea of Okhotsk, st.6, 53°23'N, 146°34'E, 163m, 19.6.1988, 1 colony; st.7, 55°22'N, 146°34'E, 161m, 19.6.1988, 1 colony. Holotype of *Diandrocarpa okai* (ZIN 803): Sea of Okhotsk, 56°18'N, 145°4'E.

Description. – Colony large, up to 8cm in diameter and 3cm thick, test soft and gelatinous, spicules absent. Zooids up to 7mm long. Branchial sac with 4 longitudinal vessels and 9 or 10 rows of stigmata crossed by thin parastigmatic vessels. Gonads consisting of two testes and a single ovary on left side only, are in outgrowth embedded in the common test. Brood pouch, situated slightly anterior to the gonad, contains 1 or 2 large eggs. Small oval sac-like outgrowth (buds?) is on the middle part of the

right and sometimes also the left side of the body.

Remarks. – The present specimens agree with the earlier descriptions of *Kukenthalia borealis* (especially with the detailed one given by Årn-bäck (1921)) in all characters except large size of colony and the absence of spicules in the test.

Diandrocarpa okai Redikorzev from the Sea of Okhotsk strongly resembles *Kukenthalia borealis* in nearly all features, including the size of zooids, the branchial sac having 4 internal longitudinal vessels, 9 rows of stigmata and parastigmatic vessels, the form of the stomach, and the thick gelatinous colony. It differs principally in the presence of outgrowths on both sides of the body, which Redikorzev thought were gonads consisting of an ovary and two large testes. He reported the ovary and each of the testes as an elongated pear-like shape; the ovary situated above the testes (Redikorzev 1916b: 33). The gonads in his figure (Redikorzev 1916b: 32) strongly resemble the sac-like outgrowth described above. I was unable to determine the nature of “sac-like outgrowths” in the present specimens, although they could be buds, rather than gonads, because well developed gonads are present on the left side of the body in nearly all zooids. Thus, *D. okai* and *K. borealis* appear to belong to the same genus.

All *Symplegma* (= *Diandrocarpa*) species are known only from warm waters and they lack parastigmatic vessels. Reexamination of the holotype of *Diandrocarpa okai* (ZIN 803) confirms that it is identical with the present specimens in all features, including presence of well-developed gonads in an outgrowth on the left side only.

Distribution. – Baffin Bay, Greenland, Spitsbergen, Iceland, Norway (Millar 1966), Sea of Okhotsk (present study).

Botryllus magnus Ritter, 1901

Botryllus magnus Ritter, 1901: 255. Hartmeyer 1923: 361. *Botrylloides magnum*. Van Name 1945: 230.

Material examined. – (F) Commander Islands, Medny Island, 9-11 m, 4.7.1992, 1 colony.

Description. – Colony encrusting, 2-3 mm thick. Living colony was dark blue, but became brownish in formalin. Systems circular, consisting of about 7-9 zooids. Zooids 2.5-3.3 mm long. Atrial aperture on more or less distinct siphon. Sixteen tentacles of 3 sizes. Stigmata in 13 rows, second row complete, arranged between the

endostyle, the three longitudinal vessels and the dorsal lamina as follows: E 9-10, 6-7, 5, 9-11 D. Stomach barrel-shaped, with 11 longitudinal folds and a straight pyloric coecum of moderate length. Secondary loop narrow and nearly closed, rectum short. Gonads indiscernible. Larvae absent.

Remarks. – Among Botryllinae only *Botryllus magnus* is known from the North Pacific. Hartmeyer (1923) suggested this species might be conspecific with *Botrylloides aureus* Sars, 1851. Van Name (1945) also supported this view, but listed it as a valid species (Van Name 1945: 230). The present specimen resembles *Botryllus magnus* in its circular systems and large zooids. Further, *Botrylloides aureus* is known as the Arctic and North Atlantic species and was not recorded from the Pacific (but a single and extremely doubtful record from South Sakhalin). Thus, the colony from Medny Island is tentatively assigned to *Botryllus magnus*. Until specimens with well-developed gonads are known the generic assignment of *B. magnus*, as well as its possible conspecificity with *Botrylloides aureus* cannot be resolved.

Distribution. – Kodiak Island, Popoff Island (Ritter 1901), Commander Islands (present study).

Botryllus sp.

Material examined. – (B) Kurile Islands, Urup Island, st.21, 45°47.0'N, 150°02'E, 125 m, 27.7.1986, 1 colony. (A) Kurile Islands, Paramushir Island, st.89, 50°02.5'N, 156°0.4'E, 87-102 m, 18.7.1954, 1 colony.

Description. – Colony from Urup Island is encrusting, 2 mm in thickness with circular systems, composed of 8-14 zooids. Colony from Paramushir Island more thick, systems indistinct. Zooids large, up to 3.5-4.5 mm long in fully expanded condition. Atrial aperture on short siphon. Eight tentacles. Stigmata, in 15 rows, second row incomplete and short, are arranged between the endostyle, the three longitudinal vessels and the dorsal lamina as follows: E 10-11, 6-7, 5-6, 9-11 D. Stomach with 10 longitudinal folds, pyloric coecum curved, of moderate length. Second loop widely opened, rectum long. Gonads and larvae were not observed.

Remarks. – The specimens lack gonads and are assigned to *Botryllus* according to form of systems. They differ from all botryllids described from Japanese waters. They resemble the speci-

men from Medny Island tentatively assigned to *B. magnus* (see above), but differ in the shape of gut loop and incomplete second row of stigmata.

Botryllus tuberatus Ritter & Forsyth, 1917

Botryllus tuberatus Ritter & Forsyth, 1917: 461. Monniot 1983: 426 (and synonymy). Nishikawa 1991: 73.
Botrylloides eligulatus Beniaminson, 1975: 40.

Material examined. – (E) Sea of Japan, Possjet Bay, 0-2m, 1.8.1988; 5-7m, 13.7.1988; Peter the Great Bay, Butakova Point, 0-2m, 2-5m, 20.8.1988; Furugelm Island, 0-3m, 12.7.1988. Ussuriusky Bay, 3-3.5m, 23.8.1994; 3-4m, 5.9.1994.

Description. – Colonies with transparent and nearly colourless test and dark brown zooids forming usually distinct circular systems. Zooid with 4 rows of stigmata. Gonads and larvae are not found.

Distribution. – Very common along the Russian coasts of the Sea of Japan. Widely distributed in the Pacific, from Peter the Great Bay in the north to Australia in the south, see Nishikawa (1991) for full list of localities.

Botrylloides violaceus Oka, 1927

Botrylloides violaceus: Tokioka 1953: 241.
Botrylloides violaceus: Saito, Mukai & Watanabe 1981: 360. Nishikawa 1991: 77 (and synonymy).
? *Botrylloides lateritium* Beniaminson 1975: 39.

Material examined. – (D) Small Kurile Islands, Green Island, 43°29.7'N, 146°05.3'E, 1.5-5m. (E) Sea of Japan, Possjet Bay, 5-7m, 13.7.1988; Peter the Great Bay, 5-7m, 30.7.1988; Ussuriusky Bay, 0m, 1.9.1994. One colony in each station.

Description. – Colony from Green Island dark violet, with opaque test; colonies from the Sea of Japan reddish, with transparent test and dark red zooids. Zooid 0.9-1.8mm long, arranged in ladder systems. Stigmata in 9-12 rows; stomach with about 9 longitudinal folds. No gonads, but numerous larvae found in all colonies. Larva with a trunk 1.1mm long, about 35 lateral ampullae.

Remarks. – The present specimens conform well with *Botrylloides violaceus* Saito, Mukai & Watanabe, 1981, especially in larval morphology.

Distribution. – “This is the commonest botryllid in Japanese waters” (Tokioka 1953: 241).

REFERENCES

- Abbott, D.P. & A.T. Newberry 1980. Urochordata: The Tunicates. – In R.H. Morris, D.P. Abbott & E.C. Haderlie (eds): *Intertidal invertebrates of California*, pp. 177-226. Stanford Univ. Press, California.
- Alder, J. & A. Hancock 1848. Additions to the mollusca of Northumberland and Durham. – *Trans. Tyneside Naturalists' Field Club* 1: 195-207.
- Årnäck-Christie-Linde, A. 1921. On the reproductive organs of the ascidian *Kukenithalia borealis* (Gottschaldt). – *Proc. Zool. Soc. London* 14: 187-196.
- Beniaminson, T.S. 1971. New species of ascidians from the Possjet Bay of the Sea of Japan. – In Fauna and Flora of the Possjet Bay of the Sea of Japan. *Exploration of the Fauna of the Seas* 8(16): 295-301.
- Beniaminson, T.S. 1975. Morphology and systematic position of genus *Syncarpa* Redikorzev with description of *Syncarpa corticiformis* sp.n. (Asciadiacea). – *Mar. Biol. (Vladivostok)* No. 3: 29-36. (In Russian).
- Christiansen, J. & J.C. Thomsen 1981. *Styela clava*, new record for the Danish fauna (Tunicata, Ascidiacea). – *Steenstrupia* 7: 15-24.
- Goodsir, J. & E. Forbes 1841. On *Pelonaia*, a new genus of ascidian Mollusca. – *Rep. Br. Ass. Advmt Sci.*, abstr. 10th meeting, pp.137 – 139.
- Gottschaldt, R. 1894. *Die Synascidien der Bremen Expedition nach Spitzbergen im Jahre 1889*. Jena, 29pp.
- Hartmeyer, R. 1906. Ein Beitrag zur Kenntniss der japanischen Ascidiendfauna. – *Zool. Anz.* 31: 1-31.
- Hartmeyer, R. 1923. Ascidiacea. Part 1. – *Danish Ingolf Expedition*, Copenhagen 2(6): 1-368.
- Herdman, W.A. 1881. Preliminary report on the Tunicata of the Challenger expedition. Cynthiidae. – *Proc. R. Soc. Edinburgh* 11(3): 52-88.
- Herdman, W.A. 1898. Description of some simple ascidians collected in Puget Sound, Pacific coast. – *Proc. Trans. Liverpool Biol. Soc.* 12: 248-267.
- Huus, J. 1929. Ascidien aus dem sibirischen Eismeer. – *Scienc. Results Norwegian N. Polar Exped. Maud, 1918-1925* 5(9): 1-15.
- Kiaer, J. 1893. Oversigt over Norges Ascidiæ Simplices. – *Forh. i Vidensk. Selsk. Kristiania* 9: 1-105.
- Kott, P. 1985. The Australian Ascidiacea, Part 1. Phlebobranchia and Stolidobranchia. – *Mem. Qd Mus.* 23: 1-440.
- Lützen, J. 1970. The ascidians of Jørgen Brønlund fjord, North Greenland. – *Meddr Grønland* 184(7): 15-22.
- Millar, R.H. 1966. Tunicata, Ascidiacea. – *Marine Invertebrates of Scandinavia* 1: 1-123.
- Monniot, C. 1983. Ascidies littorales de Guadeloupe 4. Styelidae. – *Bull. Mus. natn. Hist. nat. Paris*, Ser. 4, 5, Sect. A, 2: 423-456.
- Nishikawa, T. 1991. The ascidians of the Japan Sea 2. – *Publ. Seto Mar. Biol. Lab.* 35(1/3): 25-170.
- Pallas, P.S. 1774. *Specilegia zoologica*. Berlin (1767-1780) 1(10): 25.
- Rathke, J. 1806. Tunicata. – In O.F. Müller (ed.): *Zoologica Danica*, 4. Copenhagen.
- Redikorzev, V. 1907. Die Ascidien der russischen Polar-Expedition, 1900-1903. – *Zool. Anz.* 31: 521-525.
- Redikorzev, V. 1911. Neue Ascidien. – *Annuaire Mus. Zool. Acad. St. Petersbourg* 16: 215-218.
- Redikorzev, V. 1913. Neue Ascidien. – *Zool. Anz.* 43(5): 204-213.
- Redikorzev, V. 1916a. Tuniciers. – *Faune de la Russie* 1: 1-

339. (In Russian with Latin diagnoses).
- Redikorzev, V. 1916. A new species of the genus *Diodorcarpa*. – *Annuaire Mus. Zool. Acad. Sci. St. Petersbourg* **21**: 31-33.
- Redikorzev, V. 1941. Ascidiens der Meere des fernen Ostens der Ud.S.S.R. – *Invest. Far E. Seas U.S.S.R.* **1**: 164-212. (In Russian with German descriptions).
- Ritter, W.E. 1901. The ascidians. Papers from Harriman Alaska expedition. – *Proc. Washington Acad. Sci.* **3**: 225-266.
- Ritter, W.E. 1913. The simple ascidians from the north-eastern Pacific in the collection of the United States National Museum. – *Proc. U.S. natn. Mus.* **45**: 427-505.
- Ritter, W.E. & R.A. Forsyth 1917. Ascidians of the littoral zone of southern California. – *Univ. Calif. Publ. Zool.* **16**: 439-512.
- Saito, Y., H. Mukai & H. Watanabe 1981. Studies on Japanese compound styelid ascidians 2. A new species of the genus *Botrylloides* and redescription of *B. violaceus* Oka. – *Publ. Seto Mar. Biol. Lab.* **30**: 227-240.
- Skalkin, V.A. 1957. A new species of *Ascidia* of the Pacific – *Syncarpa longicaudata*, sp.n. (family Styelidae). – *Zool. Zh.* **36**(2): 297-298.
- Skalkin, V.A. 1959. *Class Ascidiaceae*. – In G.U. Lindberg (ed.): *A list of the fauna of the sea waters of the South Sakhalin and South Kuril Islands*, pp. 245-246. Vladivostok.
- Tokioka, T. 1951. The fauna of Akkeshi Bay 18. *Ascidia*. – *Publ. Akkeshi Mar. Biol. St.* **1**: 1-22.
- Tokioka, T. 1953. *Ascidians of Sagami Bay*. Iwanamishoten, Tokyo, 315pp.
- Tokioka, T. 1967. Pacific Tunicata of the United States National Museum. – *Bull. U.S. natn. Mus.* **251**: 1-247.
- Traustedt, M.P.A. 1880. Oversigt over de fra Danmark og dets nordlige Bilande kjendte *Ascidiae simplices*. – *Vidensk. Meddr. naturh. Fore. i Kjøbenhavn*, ann. 1879-1880: 397-443.
- Van Name, W.G. 1945. The North and South American ascidians. – *Bull. Amer. Mus. nat. Hist.* **84**: 1-476.
- Verrill, A.E. 1871. Descriptions of some new and imperfectly known ascidians from New England. – *Amer. Jour. Sci.* ser. 3 **1**: 54-58, 93-100, 211-212, 288-294, 443-446.