

ASCIDIANS FROM THE NORTH-WESTERN PACIFIC REGION. 3. PYURIDAE

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ABSTRACT

The ascidians (Ascidiacea) of the family Pyuridae collected by several expeditions in the NW Pacific were examined. The collections contain 9 already known species-group taxa. Some morphological notes and taxonomic remarks are given.

Key words: North-Western Pacific, Pyuridae.

INTRODUCTION

Nine species-group taxa of the family Pyuridae were found in collections from the Aleutian, Commander and Kurile Islands, Kamchatka, the Bering Sea, Sea of Okhotsk and Sea of Japan.

The number of species is not large, but some of them are very abundant in the NW Pacific region. Especially *Halocynthia aurantium*, *Boltenia echinata* and *Boltenia ovifera* are common.

The following material was examined:

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

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

(C) R. V. "Ac. Oparin", Kurile Islands and Sea of Okhotsk. Dredging. Coll. E. N. Gruzov.

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

(E) Collection of the Far East State Sea Reservation (FESSR) from the Sea of Japan. 1980-1991. SCUBA diving. The collection was kindly placed at my disposal by the director of FESSR Dr. A. Osolinsk.

(F) Collection of the Kamchatka Institute of the Ecology and Environment (KIEE). 1984-1992. Commander Islands, East Kamchatka and Atlasov Island

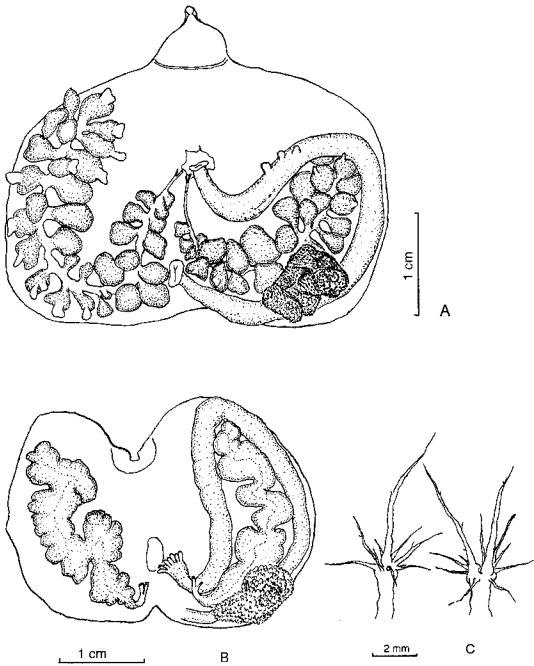


Fig. 1. A: *Pyura haustor*, inner view of the body wall. B, C: *Boltienia echinata echinata*, inner body wall (B) and test spines (C).

(North Kurile Group). SCUBA diving and dredging. Collectors: collaborators of the Lab. of Benthic Communities.

The collections are deposited: A, B, C, D – Zoological Institute (ZIN), St. Petersburg. E, F – Kamchatka Institute of the Ecology and Environment (KIEE), Petropavlovsk-Kamchatsky.

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Pyura haustor (Stimpson, 1864)

Fig. 1A

For synonymy see Van Name (1945).

Material examined: (D) Alaska Gulf, near the Sanak Island: 54°15.6'N, 161°46.6'W, st.40, 75m, stones, 17.8.1991. 1 spec.; 54°05.6'N, 162°09.6'W, st.38, 114m, stones, 17.8.1991, 2 spec.

Remarks. Some morphological features of the present specimens are: body length ranging from 3 to 5cm; test very hard, characteristic ridges on the surface of the test well developed; about 25 branchial tentacles, 6 branchial folds on each side; gut loop widely open, intestine without enlargement; only a few

endocarps on the dorsal surface of the intestine and some on the gonadal capsules, especially on the right gonad.

Pyura haustor is the only species of this genus occurring at the Pacific coasts of Alaska. A number of *Pyura* species were described from Japan and adjacent waters, but this genus does not occur at the Asiatic coasts north of Japan, although I have examined a single specimen from Paramushir Island (North Kurile Islands) probably belonging to the genus *Pyura*. The specimen was represented by several damaged pieces, and its definitive description can not be given.

Distribution. American Pacific coasts from Alaska to California (Van Name 1945).

Boltenia echinata echinata (Linne, 1767)

Fig. 1B,C

For synonymy see Van Name (1945) and Nishikawa (1991).

Material examined: (A) Kurile Islands, Paramushir, 49°43.6'N, 156°16.7'E, st.80, 170-175m, 14.7.1954, 1 spec. (F) Kamchatka. Korfa Bay: 59°42.5'N, 165°49'E, st.504, 95m, 21.9.1988, 1 spec. Litke Strait: 58°57.5'N, 163°27'E, st.465, 56m, stones, mud, 23.9.1988, 1 spec.; 58°58.5'N, 163°27'E, st.464, 53m, stones, mud, 23.9.1988, 1 spec.; 59°5.5'N, 163°41'E, st.461, 49m, gravel, mud, 23.9.1988, 1 spec.; 59°21.5'N, 163°53'E, st.460, 57m, small stones, 24.9.1988, 1 spec. Kronotsky Bay: 53°36.9'N, 160°07.2'E, st.182, 100m, sand and gravel, 11.5.1988, 2 spec.; 53°46'N, 160°13.5'E, st.172, 100m, muddy sand, 12.5.1988, 2 spec.; 54°26.7'N, 161°28.5'E, st.165, 130m, muddy sand, 27.5.1988, 1 spec.; 54°46'N, 160°42.6'E, st.146, 80m, 13.5.1988, 1 spec.; 53°41'N, 160°04'E, st.141, 75m, sand with small stones, 11.5.1988, 1 spec. Avacha Bay: 53°15.5'N, 160°8.5'E, st.190, 100m, sand, 9.5.1988, 1 spec.; 53°0.4'N, 159°43.2'E, st.71, 79m, 25.5.1988, 1 spec.; 53°1.6'N, 159°44.9'E, st.52, 69m, mud, 28.5.1988, 1 spec.; 52°54.4'N, 159°13.1'E, st.47, 92m, 27.5.1988, 1 spec.

Remarks. All the specimens, 1-4cm in diameter have the test covered with the spines typical of this subspecies (Fig. 1C).

Distribution. Widely distributed in the Arctic regions, at the American Pacific coasts southward to British Columbia, on the Asiatic side it is common in the Bering Sea and at the Pacific coasts of Kamchatka. In Japan waters it is replaced by the subspecies *B. echinata iburi* (Oka, 1934) (Van Name 1945, present study).

Boltenia echinata iburi (Oka, 1934)

Fig. 2D

Cynthia iburi Oka 1934: 965.

Boltenia echinata iburi: Nishikawa 1991: 139 (synonymy).

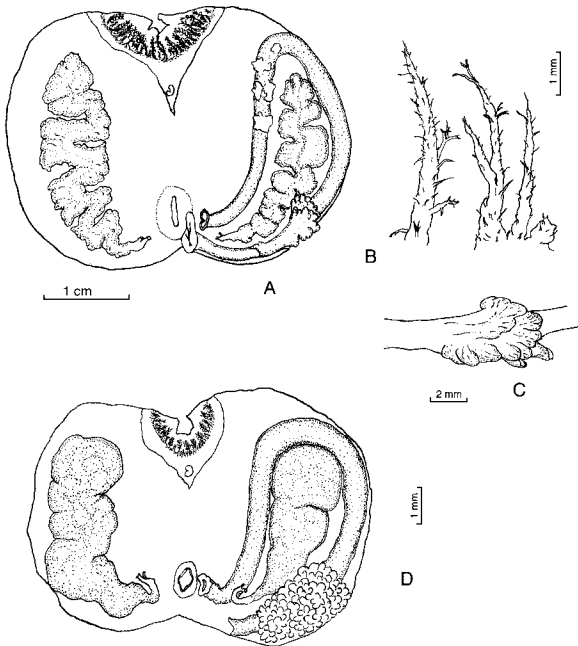


Fig. 2. A-C: *Boltenia* sp., inner body wall (A), test spines (B), liver (C). D: *Boltenia echinata iburi*, inner body wall.

Material examined: (E) Sea of Japan. Peter the Great Bay: Furugelm Island, 2-8m, rock, 17.7.1988, 4 spec.; Kalevala Bay, 0-2m, stones, 3.9.1988, 1 spec.; Butacova Point, 2-5m, rock, stones, 20.8.1988, 3 spec. Possjet Bay, 5-7m, stones, muddy gravel, 13.7.1988, 1 spec.

Remarks. *B. echinata iburi* differs from the nominotypical subspecies by the shape of the test spines (for discussion see Nishikawa 1991). In the present specimens the anal margin is slightly undulated (Fig. 2D), and never lobulated as in *B. echinata echinata*. Specimens from 5 to 15mm in diameter.

The two subspecies are separated geographically; Nishikawa (1991) very provisionally referred Ritter's (1913) specimens from Alaska to the subspecies *iburi* but this seems very doubtful.

Distribution. Waters around Japan, for list of localities see Nishikawa (1991).

Boltenia sp.

Fig. 2 A-C

? *Boltenia villosa*: Redikorzev 1941: 179.

Material examined: (E) Sea of Japan, Peter the Great Bay, 6-8m, muddy sand, 3 spec.

Description. Body somewhat irregular in outline, upright, ovoid, about 3cm wide and 4cm in height. Attachment surface about 1cm in diameter in one specimen and 1.5cm in the others. Test black, covered with stout, nearly straight spines.

About 40 branchial tentacles, of which 16 are large. Eight folds on each side, all folds well developed except one on each side of endostyle.

Intestinal loop widely open, anus smooth-edged. Liver composed of thin leaf-like lobes, enlarged posteriorly. Few large endocarps on intestine. One large, irregularly lobed gonad on each side, with short oviduct opening near atrial orifice.

Remarks. The specimens differ very distinctly from *B. echinata echinata* by the shape of spines and the smooth anus, and resemble *B. echinata iburi* and *B. villosa* (Stimpson). Externally the present specimens can easily be separated from *B. echinata iburi* by the large size and black colour, but, of course, these features are not taxonomically significant. Differences in structure of the gonad are no more significant. The presence of the endocarps on the intestine and the structure of the liver seem to have taxonomic significance. The liver of *B. echinata iburi* has the same structure as in the nominotypical subspecies, it is composed of relatively large caeca and has no leaf-like lobes as in the present specimens.

In internal structure, including shape of the liver and the smooth anus, the present specimens closely resemble *B. villosa* (see Monniot 1965, fig. 6), the only differences are in presence of endocarps and lacing of the peduncle. Moreover, *B. villosa* is an East Pacific species and does not occur in the Sea of Japan. Redikorzev's (1941) specimens referred by him to *B. villosa* are possibly similar to those described here. Redikorzev did not give a description except that the specimens lack peduncles but the attached area is very small.

Thus, the present specimens are intermediate between *B. echinata iburi* and *B. villosa*. The close similarity between these taxa was noted by Nishikawa (1991). It is possible that the specimens described above are *B. echinata iburi*, but to call them *Boltenia* sp. is at present more correct than referring the present material to *B. echinata iburi* or to *B. villosa* or to establish a new species.

Boltenia ovifera (Linne, 1767)

For synonymy see Van Name (1945).

Material examined: (F) North-East Kamchatka. Dezhnev Bay, 4-8m, rock, 14.7.1990, 1 spec.; Malaya Bay, Moristy Point, 4-11m, rock, 26.7.1990, 1 spec. Kamchatka. Korfa Bay: 60°8.5'N, 165°31'E, st.403, 27m, 20.9.1988, 2 spec.; 60°9.5'N, 165°43'E, st.406, 33m, 26.9.1988, 3 spec.; 60°4.3'N, 165°43'E, st.496, 55m, mud, 20.9.1988, 2 spec.; 59°42.5'N, 165°49'E, st.504, 95m, 21.9.1988, 2 spec. Litke Strait: 59°27.5'N, 163°23'E, st.386, 32m, mud, shells

24.9.1988, 1 spec.; 58°58.5'N, 164°25'E, st.464, 53m, 23.9.1988, 2 spec. Karaginsky Island: 59°7'N, 164°51'E, 5m, gravel, stones, 21.8.1988, 1 spec.; Kekkurny Point, 10m, 29.8.1988, 2 spec. Avacha Bay: 53°5.8'N, 159°38.1'E, st.39, 50m, muddy sand, 25.5.1988, 1 spec.; 52°55.5'N, 159°23'E, st.40, 102-103m, sand, 21.9.1988, 1 spec.; 52°54.4'N, 159°31.1'E, st.47, 92m, 27.3.1988, 1 spec. 53°4.6'N, 157°47'E, st.52, 69m, mud, 28.5.1988, 1 spec.; 53°0.4'N, 159°43.2'E, st.71, 79m, 25.5.1988, 3 spec.; Starichkov Island, 20-24m, rock, 8.9.1984, 1 spec. South Kamchatka: Lopatka Point, 50m, large stones, 13.7.1985, 3 spec. Kurile Islands. Shumshu Island, Kekkurny Point, 20m, large stones, no date, 2 spec.

Distribution. The Chuckchi Sea, the Bering Sea, the Sea of Okhotsk, northern part of the Sea of Japan (Sakhalin Island), the east and west coasts of Greenland, and the Atlantic coast of North America up to 40°N (Redikorzev 1916, Van Name 1945).

Halocynthia aurantium aurantium (Pallas, 1787)

For synonymy see Kott (1969).

Material examined: (D) Alaska Gulf, near the Kodiak Island: 58°22.4'N, 150°56.8'W, st.15, 61m, sand, 12.8.1991, 1 spec. Kurile Islands. Small Kurile Islands: 43°33.5'N, 146°36.2'E, st.90, 161m, muddy sand, 10.9.1991, 3 spec.; Shumshu Island, Pacific coast, 50°38.1'N, 156°50.5'E, st.61, 80m, sand, 3.9.1991, 10 spec. (E) Sea of Japan, Peter the Great Bay, Butakova Point, rock, 20.8.1988, 1 spec. (F) Kamchatka. Litke Strait: 59°5.5'N, 163°41'E, st.461, 49m, 23.9.1988, 14 spec.; 59°21.5'N, 163°53'E, st.460, 57m, 24.9.1988, 14 spec.; 59°18.5'N, 163°59'E, st.4, 53m, 24.9.1988, 1 spec.; 59°7.5'N, 163°55'E, st.384, 27m, 23.9.1988, 1 spec. Korfa Bay: 59°42.5'N, 165°49'E, st.504, 95m, 21.9.1988, 5 spec. Kamchatsky Bay: 55°36.5'N, 160°15'E, st.227, 128m, 24.6.1988, 1 spec. Kronotsky Bay: 53°39'N, 160°13.5'E, st.184, 149m, 11.5.1988, 5 spec.; 53°36.9'N, 160°7.2'E, st.182, 100m, 11.5.1988, 10 spec.; 53°46'N, 163°13.5'E, st.172, 100m, muddy sand, 12.5.1988, 1 spec.; 53°32.5'N, 160°3.1'E, st.155, 80m, 11.5.1988, 1 spec. Avacha Bay: 53°3.7'N, 160°5.4'E, st.86, 118m, 13.5.1988, 1 spec.; 52°55.5'N, 159°31'E, st.58, 89m, mud, sand, 26.5.1988, 2 spec.; 52°57.5'N, 159°13.1'E, st.56, 90m, 25.5.1988, 1 spec.; 52°54.4'N, 159°13.1'E, st.47, 92m, 25.5.1988, 1 spec. Kurile Islands. Shumshu Island: Kekkurny Point, 20m, no date, 1 spec. Atlasov Island: 14-15m, rock, 3.8.1989, 1 spec.; 18-20m, rock, 2.8.1989, 1 spec.; 18m, large stones, 22.7.1989, 1 spec.

Remarks. This species consists of two subspecies: the Arctic and Atlantic *H. aurantium pyriformis* (Rathke) and the Pacific *H. aurantium aurantium* separated from each other morphologically by different numbers of gonads. Ritter (1913) reported that Atlantic specimens have 12 or more gonads (total num-

ber), while Pacific ones have 8 or fewer gonads. Among 20 dissected specimens 18 had 3 gonads on each side and 2 had 3 on the right and 4 on the left side of the body.

Distribution: The Bering Sea, the Sea of Okhotsk, the Sea of Japan, Alaska to Puget Sound (Redikorzev 1941).

Halocynthia hispida (Herdman, 1881)

For synonymy see Kott (1969) and Abbot & Newberry (1980).

Material examined: (D) Alaska Gulf, near the Kodiak Island, 58°21'N, 150°56.6'W, st.16, 57m, 12.8.1991, 1 spec.

Remarks. The single specimen, 5cm in diameter, densely covered by long spines conforms with the descriptions of *H. igaboja* Oka. Monniot (1965) in his review of the family Pyuridae listed this species as *H. hilgendorfi* (Traustedt) var. *igaboja* Oka. Kott (1969) included *H. hilgendorfi*, *H. igaboja* and a number of other related species in the synonymy of *H. hispida*. Later (Kott 1985) wrote that these species may be distinct from *H. hispida*. Nishikawa (1991) examined a large number of specimens from Japan and reexamined the type specimen of *H. hispida*, and came to the conclusion that Kott (1969) rightly synonymized *H. hilgendorfi* with *H. hispida*. Thus the present specimen is listed here as *H. hispida*.

Distribution. Widely distributed in the Pacific and Indian Oceans: Alaska to California, Japan, Australia, New Caledonia, Galapagos Islands, Sri Lanka (Kott 1969, Nishikawa 1991, Millar 1988), but seems to be absent from the Russian coasts.

Bathypera ovoida (Ritter, 1907)

Halomolgula ovoida Ritter 1907: 3.

Bathypera ovoida: Van Name 1945: 369 (synonymy); Nishikawa 1981: 187; Sanamyan 1992: 188.

Material examined: (D) Commander Islands, near the Bering Island: 55°36'N, 164°53.7'E, st.42, 158m, 24.8.1991, 3 spec.; 55°32.3'N, 165°27.6'E, st.46, 112m, 24.8.1991, 3 spec. Near the Medny (Cooper) Island: 54°25.8'N, 168°12.6'E, st.2, 101m, stones, 1.8.1991, 1 spec.

Remarks. Specimens 25-45mm in diameter. Test surface coated with calcareous spicules, about 30-36 spicules per mm². The shape and structure of the spicules conform very well with the description given by Nishikawa (1981), but they are a little larger in the present material (about 0.15mm in both diameter and height in all specimens) than in Nishikawa's specimens (0.1mm and 0.125mm spicules for 35mm and 43mm long specimens, respectively).

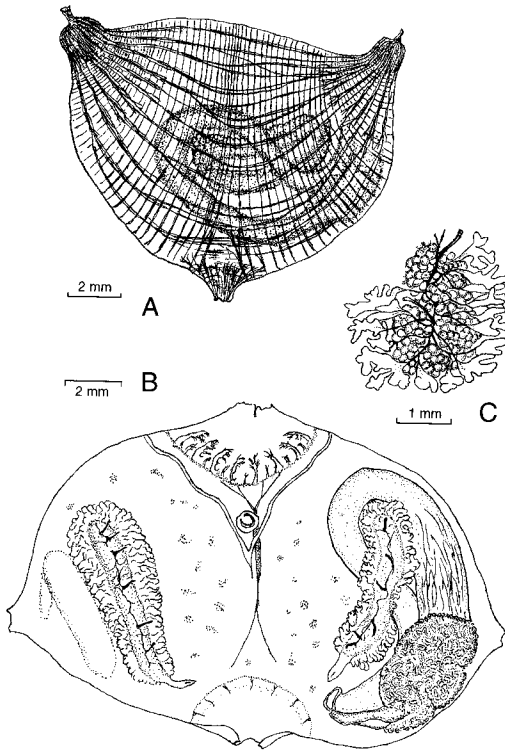


Fig. 3. *Hartmeyeria triangularis*. A: left side of mantle body; B: inner body wall; C: distal part of gonad.

The present specimens collected near the Commander Islands connected previous records from the Asiatic and American Pacific coasts.

Distribution. Southern California (Ritter 1907), Vancouver Island (Millar & Goodbody 1974), Sagami Bay, Japan (Nishikawa 1981), Sea of Okhotsk (Sanamyan 1992).

Hartmeyeria triangularis Ritter, 1913

Figs 3, 4

Hartmeyeria triangularis Ritter 1913: 461; Redikorzev 1941: 181; Van Name 1945: 358.

Hartmeyeria orientalis Oka 1929: 351; Tokioka 1953: 295; 1967: 224.

Hartmeyeria longistigmata Tokioka 1949: 11.

Material examined: (F) North Kurile Islands, Atlasov Island, Vladimir Point: 14-15m, 10.8.1989, 1 spec.; 24m, volcanic slag, 1 spec. Collection "F" has 6 other specimens without collection data, but apparently from South Sakhalin.



Fig. 4. *Hartmeyeria triangularis*. Siphonal spines. Scale 20 μ .

Description. Body 10-16mm in largest diameter, peduncle up to 3cm long. Body surface densely covered with sand or volcanic slag, peduncle nearly free from incrustation. Sand grains attached directly to test, without hair-like processes. One specimen furnished with rather well developed diverging siphons, while others have very short ones.

Siphonal spines (see Fig.4) 35-50 μ long.

Mantle nearly transparent; thin blood vessels and numerous embedded dense spherical bodies (cells?) of unknown nature easily seen through it. Mantle musculature composed of longitudinal bundles covering both siphons, and fine circular fibres; their arrangement quite similar to Ritter's (1913) original description. Fine circular and radial muscle fibres near base of peduncle. Branchial tentacles 16, larger and smaller ones alternating, branched in 3 orders. Dorsal tubercle C-shaped. Ganglion very long. Dorsal lamina plain-edged, or slightly dentate. Branchial sac with 6 folds on each side; stigmata long and straight between folds, while forming infundibula in folds; each infundibulum divided into two summits. Arrangement of longitudinal vessels in 15mm specimen:

R: D0(8)0(1)0(9)0(7)0(5)0(1)0E,

L: D0(8)0(1)0(8)0(7)0(5)0(1)0E.

Fine longitudinal plications on the intestine wall. Large papillated liver

often divided indistinctly on the ventral side into three equal parts by two ridges (Fig.3, B). Anus smoothly margined.

A single gonad on each side, with central ovary and numerous peripheral, strongly branched testis follicles; 5-6 male openings on mesial surface of ovary. Large, thin walled heart along ventral margin of right gonad.

Remarks. As noted by Redikorzev (1941), Van Name (1945) and Nishikawa (1991), *Hartmeyeria triangularis* and *H. orientalis* Oka are very similar and might be conspecific. According to Monniot & Monniot (1976) the main difference between these two species is that the liver in the latter is undivided, while in the former it is divided into two parts. Ritter, (1913) in his original description of *H. triangularis* mentioned "two folds on stomach wall". The liver in his figure 10 is similar to that of the present specimens, although its lobulation is more indistinct than in our specimens. Ritter (1913) described "few structures resembling the so-called endocarps of *Styela*" in his species.

These may be the dense bodies in the body wall described above; they sometimes protrude but they are never so well developed as in the genus *Styela*. Siphonal spines described and figured by Redikorzev (1941) for specimens from Tatarsky Strait and, especially, by Tokioka (1953) for specimens from Japan are similar to those of the present specimens. Unfortunately, the size and shape of siphonal spines are unknown for Ritter's specimens from the Aleutian Islands. Thus, *H. orientalis* is here included in the synonymy of *H. triangularis*.

The present specimens differ from the previous descriptions of both *H. triangularis* and *H. orientalis* (including *H. longistigmata* Tokioka) in the complete absence of hair-like processes of the test and the slightly dentate dorsal lamina. The single specimen from Tatarsky Strait described by Redikorzev (1941) also lacks hairs. The branchial sac of this specimen was abnormally developed, some longitudinal vessels are interrupted and do not reach the edge of the branchial sac. Among 8 examined specimens in the present material one has a similar branchial sac, this feature may be considered abnormal.

The systematic position of the genus *Hartmeyeria* was clarified by Monniot (1968), who showed that the structure, once regarded as "renal sac" is a heart, and that the genus should be definitely placed in Pyuridae.

Distribution. Kyska Harbor (Aleutian Islands) (Ritter 1913), North Kurile Islands (present study), Tatarsky Strait (Redikorzev 1941), South Sakhalin (questionable, Oka 1929, present study), Pacific and Japan Sea coasts of Japan (for list of Japanese records see Nishikawa 1991).

REFERENCES

- Abbot, D.P. & A.T. Newberry, 1980. Urochordata: the tunicates. – In R.H. Morris, D.P. Abbot & E.C. Haderlie (eds): Intertidal invertebrates of California: 177-226. Stanford Univ. Press, California.

- Kott, P., 1969. A review of the genus *Halocynthia* Verrill, 1879. – Proc. Linn. Soc. N.S.W. **93**: 76-88.
- Kott, P., 1985. The Australian Ascidiacea, Part 1. Phlebobranchia and Stolidobranchia. – Mem. Qd. Mus. **23**: 1-140.
- Millar, R.H., 1988. Ascidians collected during the South-east Pacific Biological Oceanographic Program (SEPBOB). – J. Nat. Hist. **22**: 225-240.
- Millar, R.H. & I. Goodbody, 1974. New species of ascidians from the West Indies. – Stud. Fauna Curaçao **45**: 142-161.
- Monniot, C., 1965. Etude systématique et évolutive de la famille des Pyuridae (Ascidiacea). – Mem. Mus. Natn. Hist. Nat. Paris, Ser. A. **36**: 1-203.
- Monniot, C., 1968. *Hartmeyeria pedunculata* (Peres, 1951), et le problème du “rein” chez les Pyuridae. – Bull. Mus. Natn. Hist. Nat., Paris, Ser.2 **40**(3): 485-491.
- Monniot, C. & F. Monniot, 1976. Ascidies de la Côte du Mozambique. – Rev. Zool. Bot. Afr. **90**(2): 357-393.
- Nishikawa, T., 1981. Contribution to the Japanese ascidian fauna 34. Record of *Bathypera ovoida* (Ritter, 1907) from Sagami Bay. – Publ. Seto Mar. Biol. Lab. **26**(1/3): 187-190.
- Nishikawa, T., 1991. The ascidians of the Japan Sea. 2. – Publ. Seto Mar. Biol. Lab. **35**(1/3): 25-170.
- Oka, A., 1929. Über eine neue *Hartmeyeria* aus Japan. – Proc. Imp. Acad. Japan **5**: 351-353.
- Oka, A., 1934. Über *Cynthia iburi* n.sp., eine neue Cynthia-Art mit quergerichteten Kiemenpalten. – Proc. Imp. Acad. Japan **10**: 695-697.
- Redikorzev, V., 1916. Tuniciers. – Faune de la Russie **1**: 1-339. (In Russian with Latin diagnoses).
- 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., 1907. The ascidians collected by United States Fisheries Bureau Steamer Albatross on the coast of California during the summer of 1904. – Univ. Calif. Publ. Zool. **4**: 1-52.
- Ritter, W.E., 1913. The simple ascidians from the northeastern Pacific in the collection of the United States National Museum. – Proc. U.S. natn. Mus. **45**: 427-505.
- Sanamyan, K., 1992. Ascidians from the Sea of Okhotsk collected by R.V. “Novoulyanovsk”. – Ophelia **36**(3): 187-194.
- Tokioka, T., 1949. Contribution to the Japanese ascidian fauna. 1. Ascidians collected by Prof. Miyadi and Mr. Masui during the bottom survey 1939-40. – Publ. Seto Mar. Biol. Lab. **1**: 1-17.
- Tokioka, T., 1953. Ascidiens of Sagami Bay. – Iwanamishoten, Tokyo. 315 pp.
- Tokioka, T., 1967. Pacific Tunicata of the United States National Museum. – U.S. Natn. Mus. Bull. **251**: 1-247.
- Van Name, W.G., 1945. The North and South American ascidians. – Bull. Amer. Mus. Nat. Hist. **84**: 1-476.