

Northwestern Pacific ascidians (Tunicata: Ascidiacea). Part 1. Order Aplousobranchia

K.E. Sanamyan

Kamchatka Branch of Pacific Geographical Institute, Far-Eastern Branch of the Russian Academy of Sciences, Partizanskaya 6, Petropavlovsk-Kamchatsky, 683000, Russia.

E-mail: ascidiacea@sanamyan.com

K.E. Sanamyan: ORCID 0000-0002-7460-3985

ABSTRACT: A taxonomy of aplousobranch ascidians from the NW Pacific coasts of Russia, including Bering Sea, Sea of Okhotsk and northern part of the Sea of Japan, is presented. Order Aplousobranchia currently comprises 14 families, 7 of which are represented in the region by at least several species. Sixty-nine species and 19 genera are recognized as valid. Three new genera and four new species are described: *Bathyplacentela* gen.n., *Kussakinia* gen.n., *Protosynoicum* gen.n., *Bathyplacentela pedunculata* sp.n., *Holozoa okhotensis* sp.n., *H. shimushirensis* sp.n., *H. urupensis* sp.n. A new name *Neodiction* nom.n. is suggested for *Neodictyon* Sanamyan, 1998 and *Eudistoma okai* nom.n. for *Eudistoma parvum* (Oka, 1927). All known species from this region are included and most of them redescribed based on newly collected specimens and/or on museum material. Many type species are reexamined and illustrated. Identification keys and quality photographic images are provided to simplify a task of species identification for a wide range of biologists. Special attention is paid on nomenclature of discussed families, genera and species, a subject that received little attention from most ascidian experts previously. Several serious long-standing nomenclatural problems were revealed, especially the problems associated with so called “nomina conservanda”, a category uncritically and incorrectly applied to several most widely used generic names in Ascidiacea. Possible solutions of these problems are suggested.

How to cite this article: Sanamyan K.E. 2022. Northwestern Pacific ascidians (Tunicata: Ascidiacea). Part 1. Order Aplousobranchia // Invert. Zool. Vol.19. No.3. P.199–294. doi: 10.15298/invertzool.19.3.01

KEY WORDS: Biodiversity, Ascidiacea, Cionidae, Didemnidae, Holozoidae, Placentelidae, Polycitoridae, Polyclinidae, Ritterellidae, Sea of Okhotsk, Bering Sea, Sea of Japan.

Асцидии северо-западной части Тихого океана. Часть 1. Отряд Aplousobranchia (Tunicata: Ascidiacea)

К.Э. Санамян

Камчатский филиал Тихоокеанского института географии ДВО РАН, ул. Партизанская, 6, Петropавловск-Камчатский 683000, Россия. E-mail: ascidiacea@sanamyan.com

РЕЗЮМЕ: В работе дана таксономическая информация по всем асцидиям отряда Aplousobranchia, известным из Российских вод северо-западной части Тихого океана, включая Берингово море, Охотское море и северную часть Японского моря. Отряд Aplousobranchia в настоящее время объединяет 14 семейств, 7 из которых представлены в регионе. Шестьдесят девять видов и 19 родов нами считаются валидными. Описаны три новых рода и четыре новых вида: *Bathyplacentela* gen.n., *Kussakinia* gen.n., *Protosynoicum* gen.n., *Bathyplacentela pedunculata* sp.n., *Holozoa*

okhotensis sp.n., *H. shimushirensis* sp.n., *H. urupensis* sp.n. Новое название *Neodiction* nom.n. предложено для *Neodictyon* Sanamyan, 1998 и *Eudistoma okai* nom.n. для *Eudistoma parvum* (Oka, 1927). В работу включены все известные из данного региона виды и большинство из них переописано на основе новых сборов и/или музейного материала. Исследовано большое количество типовых экземпляров. Для облегчения идентификации асцидий широким кругом биологов даны ключи для определения всех таксонов. Особое внимание уделено номенклатуре обсуждаемых семейств, родов и видов — этому аспекту специалисты по данной группе ранее уделяли очень мало внимания. Выявлено несколько серьезных номенклатурных проблем, особенно связанных с так называемой категорией “*nomina conservanda*”, которую некорректно применяли ранее ко многим широко используемым названиям таксонов в классе Ascidiacea. Предложены решения данных проблем.

Как цитировать эту статью: Sanamyan К.Е. 2022. Northwestern Pacific ascidians (Tunicata: Ascidiacea). Part 1. Order Aplousobranchia // Invert. Zool. Vol.19. No.3. P.199–294. doi: 10.15298/invertzool.19.3.01

КЛЮЧЕВЫЕ СЛОВА: Биоразнообразие, Ascidiacea, Cionidae, Didemnidae, Holozoidae, Placentelidae, Polycitoridae, Polyclinidae, Ritterellidae, Охотское море, Берингово море, Японское море.

Introduction

The region covered by the present paper includes the eastern coasts of Russia and adjacent waters: western half of the Bering Sea, Pacific waters around Commander Islands and Kamchatka, Sea of Okhotsk and Kuril Islands and northern part of the Sea of Japan. This huge region (more than 3500 km in meridional direction) is usually referred as “Far East seas of Russia”. The first ascidian from this region was described more than 230 years ago by Pallas (1788). His Latin description was quite short but informative and accompanied by a figure allowing easy identification; currently this ascidian is known as *Halocynthia aurantium* Pallas (1788). At the beginning of the 20th century Vladimir Redikorzev published several works describing ascidians from Far Eastern Seas of Russia, mainly from the Sea of Okhotsk, with descriptions of 24 nominal species (Redikorzev, 1911a, b, 1913, 1916b, 1927a, b, 1937). For a long time, these papers and several by Japanese authors (Oka, 1926; Tokioka, 1954a, 1960) were the main source of information on colonial ascidians of this region. The first volume of “Fauna of Russia” (Redikorzev, 1916a) contains descriptions and keys to species of ascidians of the order Stolidobranchia (excluding colonial Styelidae) known at that time from the waters around Russia, and some were recorded from the Sea of Okhotsk. Redikorzev

planned to publish a second volume, presumably with descriptions of ascidians of the orders Phlebobranchia and/or Aplousobranchia (announced as “in preparation” on a cover of his book), but it was not published. In 1941, at the request of K.M. Derjugin, he published a survey of ascidians inhabiting Far East Seas of Russia (Redikorzev, 1941). This publication contained descriptions of 44 species, but again all colonial species of the order Aplousobranchia were omitted. Subsequently Tokioka (1954a, 1960) reported several already known species from the Sea of Okhotsk; ten new colonial species were described from the Kuril Islands by Beniaminson (1974, 1975a, b) and Skalkin (1957). The works of the two latter authors are of a rather poor quality, some of their species are now regarded invalid and descriptions of others often lack important details (e.g. the number of stomach plications for *Aplidium* spp.). Many new colonial ascidians of the family Didemnidae were described by Romanov. In his monograph on Didemnidae from the Seas of Russia (Romanov, 1989) he reported 52 species of didemnid ascidians including 36 species recorded from Far East seas of Russia. Finally, many ascidians from the region covered by the present paper were described during the last three decades by the author of the present work (Sanamyan, 1992, 1993a, c, 1996, 1998a, b, 1999, 2000a, b; Sanamyan, Sanamyan, 2017a, b).

In 2019 ascidians collected during cruise 56 of RV *Academic Oparin* in the Sea of Okhotsk and Kuril Islands were sent to me for identification by Dr. Vladimir Mordukhovich and Dr. Anastaiia Maiorova. The material collected during this cruise contained an unusually large number of species of ascidians (about 60), although the specimen numbers were not large. Many poorly-known taxa were rediscovered; several are new for the region and for science. This material, together with the samples from a collection of Kamchatka Branch of Pacific Geographical Institute, gave me an opportunity to write the present account on all ascidians of the order Aplousobranchia (except Didemnidae), known from the Far East seas of Russia. Ascidians of two remaining orders, Phlebobranchia and Stolidobranchia, will be presented in a separate work. In the present work I will concentrate solely on the taxonomy and nomenclature of included taxa and avoid any zoogeographical considerations or discussion of ecology-related questions. It is necessary to say, however, that the ascidian fauna (or, to be more precise, a set of known species) of the Kuril Islands appears to be most diverse in the region, many species reported from Kuril Islands are not known from other localities and have limited distribution (e.g. known from only one or several neighboring islands). Some of these species, being repeatedly reported from the same geographically limited localities, appear to be true endemics rather than just rare species not yet reported from other places. Surprisingly, ascidian fauna of the Russian coasts of the Sea of Japan, including the region around Vladivostok city (where large marine biological institutes are located) is known very poorly with a limited material available for study. This region certainly should contain several (or, probably, many) species not reported in the literature. In contrast, the rest of the Sea of Japan is well studied by Japanese authors (summarized by Nishikawa, 1990, 1991, 1992).

Identification keys. To make this publication more useful for a wide range of biologists the identification keys to species are provided. Traditionally most ascidian taxonomists prefer not to use them because there is a belief, with which I agree, that their usefulness for identification of ascidians is limited. Van Name (1945: 16) in his famous monograph on American

ascidians wrote: “*There are some groups of animals for which keys can be made that really work in a considerable number of instances, but the ascidians are not among them [...] It is hardly possible to make any statement about them that does not need qualifications and allowances for exceptions, which either introduce vagueness or make impossible the brevity and conciseness of language which is necessary in a key if we are to avoid uncertainty and confusion in the minds of those who try to use it*”. Nevertheless, I believe that in the combination with the quality photographic images and for a particular geographic region, the keys may be useful as a starting point for a wide range of zoologist who wish try to identify ascidians.

For the same reason brief characteristics of each genus, outlining its main distinguishing features, are provided. These short characteristics should not be regarded as official diagnoses which, as used in some other taxonomic groups (e.g. in sea anemones, where each genus is firmly associated with a diagnosis and any new added species with slightly different characteristics requires its emendation), are, fortunately, not used by ascidian taxonomists. Genera in Ascidiacea are defined by rather flexible sets of characteristics but this does not create difficulties for identification. Instead, the identification of the genus in most cases is an easy task, most genera (with a few exceptions) may be easily recognized by examination of a zooid of a colonial ascidian or opened specimen of a solitary ascidian, and the classification of ascidians at the generic level is very stable.

Material and methods

The main part of the material on which the present paper is based was collected during cruise 56 of RV *Academic Oparin* in the summer 2019 (*Ac. Oparin-56*, expedition was conducted by G.B. Elyakov Pacific Institute of Bioorganic Chemistry and A.V. Zhirmunsky National Scientific Center of Marine Biology, Far Eastern Branch of Russian Academy of Sciences). In addition, the samples stored in the collection of Kamchatka Branch of Pacific Geographical Institute collected by other expeditions and persons were used. The general locations from where the samples originated are presented in Fig. 1. The precise locality data are

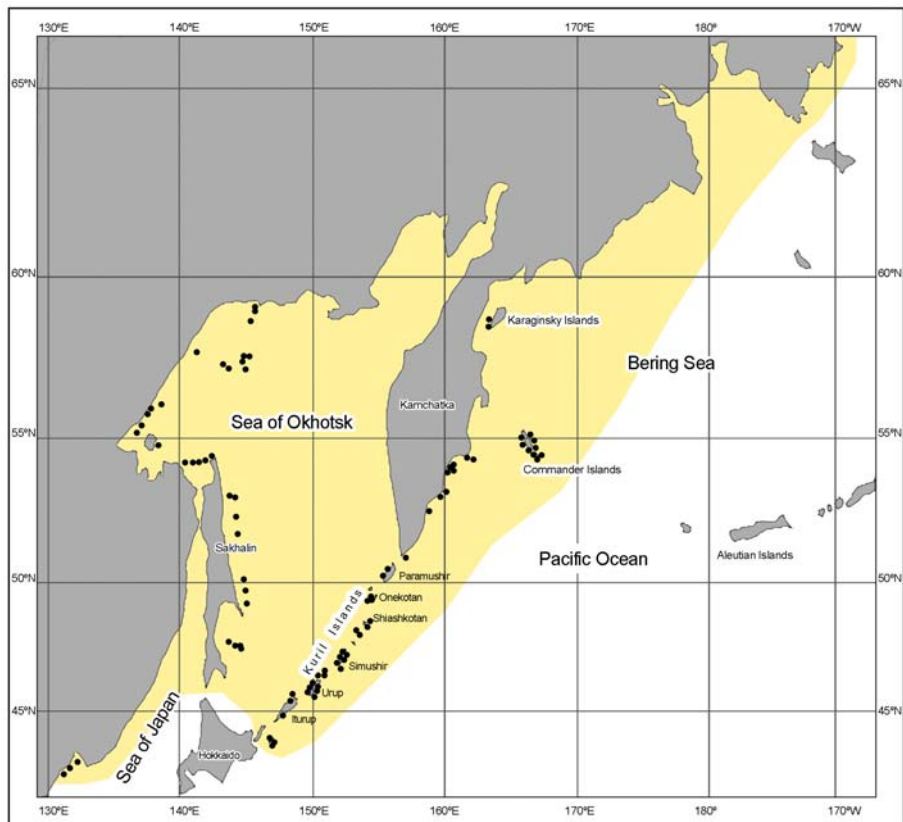


Fig. 1. Map of NW Pacific region covered by the present work (yellow area). Approximate locations of recently collected samples are shown by black dots, each dot represents one or more localities. The precise locality data are given in the Material examined sections under description of each species.

Рис. 1. Карта, показывающая регион в северо-западной части Тихого океана, охваченного настоящей работой (желтая область). Приблизительные места недавно собранных образцов показаны черными точками, каждая точка представляет собой одну или несколько станций. Точные данные о местах сбора всех образцов даны в разделе «Исследованный материал» перед описанием каждого вида.

given in the “Material examined” sections under the description of each species. All dates in these sections are in Day.Month.Year format. Exact geographic coordinates are given for all samples for which they were provided by collectors. In the case of some older samples, for which geographic coordinates were not originally recorded, I sometimes provide approximate coordinates for quick location on the map (e.g. by copy/paste of coordinates from this paper to Google Earth or other similar services). In all such cases these approximate coordinates are preceded by “~” sign, e.g. “Krabovaya Bay, ~43°52.5’N, 146°49’E”.

All specimens were initially fixed in formalin, sometimes with a small sample of the same

specimen placed directly into 96% ethanol for future molecular study. After examination the formalin-preserved specimens were transferred to 70–80% ethanol for long term storage. In my experience ethanol is a better preservative for storing ascidians than formalin, but samples in ethanol are more difficult to manipulate, e.g. remove the test in solitary species. On the other hand, ethanol is not acceptable as an initial fixative and the samples initially fixed in ethanol are, in most cases, brittle, opaque and poorly suitable for morphology-based taxonomic work.

Photographic illustrations were made by a simple setup consisting of DSLR camera Nikon D800 mounted on a stand, macro lens MicroNikkor 60, and, when necessary, a set of extension

rings. To illuminate objects an external flash remotely controlled by camera built-in flash was used. Simple reflectors and diffusors made of white sheets of paper produced evenly illuminated shadow-less images. All photographs were taken in manual focus mode and in manual exposure program. The shutter speed was set to the highest value allowing synchronization with the flash (1/250 s for this camera) to eliminate impact of the ambient light. F-stop was usually set to 16, this value was found to be a reasonable compromise between too low depth of field on lower f-stop numbers and image degradation because of diffraction at higher numbers.

The specimens, when necessary, were slightly stained either by hemalum or toluidine blue in different concentrations: a more concentrated solution of toluidine blue better stains the surface of the specimen and reveals fine details, but hides inner structures, and vice versa, a diluted solution applied for a prolonged time (e.g. overnight) better reveals inner structures. Toluidine blue is a metachromatic stain, i.e. it stains different tissues and organs in different colors. It usually produces better results than hemalum, especially for small zooids of colonial species, but it is soluble in alcohol and cannot be applied to a material in alcohol. The sample must be transferred to water first. This stain may be fixed (made alcohol-resistant) by applying a solution of phosphomolybdic acid (or any salt containing molybdenum), but in this case polychromatic coloration disappears and all tissues become of the same (blue) colour.

The specimens are deposited in the: 1) Museum of the Institute of Marine Biology, A.V. Zhirmunsky National Scientific Center of Marine Biology FEB RAS, Vladivostok (MIMB); 2) Kamchatka Branch of the Pacific Geographical Institute (KBPGI); 3) Zoological Institute of the Russian Academy of Sciences, St Petersburg (ZIN).

The International Code of Zoological Nomenclature Code (ICZN, 1999) is referenced as “Code”; relevant articles of the Code as “Article ...”; International Commission on Zoological Nomenclature as “Commission”.

Citations from other works, when they are long or when there are several citations in the same sentence, are *italicized* for better separation from the main text.

Synonymic lists under each species are not

exhaustive. They always include the original description, and references to the most important works containing useful descriptions and new records; references where the species is just mentioned are generally omitted.

In the synonymic lists (see Dubois, 2011: 26 for the usage of this term) a traditional convention accepted by several prominent ascidian taxonomists (e.g. Patricia Kott, Claude and Françoise Monniot) is used: a reference to the original description of the species is not separated from the species name by any punctuation while the references to subsequent records are separated by a semicolon. Example:

Ascidia clavata Pallas, 1774: 25 [page number in the original description, Pallas (1774) is the author of this species].

Katatropa clavata: Redikorzev, 1916a: 204 [Subsequent record and page number for the same species, Redikorzev (1916a) is not the author of this species].

I prefer to use traditional terminology as it was used in virtually all papers on ascidian taxonomy (in particular see “Annotated glossary” in Kott, 1985, 1990, 1992) during the last century and not to alter traditionally used terms in favor of possibly more precise ones (e.g. “branchial sac” vs. “pharynx”, etc.). This decision is based on the fact that attempts of some modern authors to provide “more precise” or “more correct” terms instead of traditionally used in some other taxonomic groups (e.g. sea anemones) had, in my opinion, too many unwanted consequences. In the cases when slightly different synonymous terms or descriptive phrases were used by modern authors I prefer to follow the usage of Kott (1985, 1990, 1992) (e.g. “posterior abdomen” rather than “postabdomen” or “rows of stigmata” rather than “stigmatal rows”, etc.).

In all cases when the number of stigmata “per row” is given it refers to a number of stigmata counted in a row on one side of the thorax. In taxonomic ascidian literature this feature is referred either as a “number of stigmata per row”, or “per half row”, or “per row on each side” (sometimes by the same author in the same publication) but in virtually all cases the meaning is the same: the stigmata are counted on one side of the thorax. The same apply to the number of longitudinal muscles in zooids of aplousobranch ascidians.

Notes on the nomenclature of Ascidiacea

There are many problems in the taxonomic nomenclature of Ascidiacea. The most serious are connected with the so called *nomina conservanda*, a rather strange category introduced into taxonomy of ascidians by Hartmeyer (1915) and uncritically accepted by almost all subsequent authors. In 1915, a member of International Commission of Zoological Nomenclature, Apstein, published a long list of many taxonomic names belonging to different groups of animals, which he suggested should be conserved (Apstein, 1915: 119). This list was prepared in collaboration with many taxonomists who were dissatisfied by the dropping of commonly used and well-known names as a result of strict application of the principle of priority: “*Die strikte Anwendung des Prioritätsgesetzes hat zu so zahlreichen — bei Aufstellung des Gesetzes wohl nicht vorausgesehenen — Änderungen allbekannter Tiernamen geführt, daß sich eine große Zahl von Zoologen dagegen ausgesprochen hat*” (=The strict application of the principle of priority has led to so many — probably not foreseen when the principle was drawn up — changes of well-known names that a large number of zoologists have spoken out against it). As explained in Direction 72 (ICZN, 1957a: 174), the expression *nomina conservanda*, as used in Apstein’s (1915) paper, bore its simple meaning of “*names which ought to be preserved*” rather than “*technically defective names which ought nevertheless to be preserved*” and many names in this list are “*perfectly valid*”. The ascidian part of this list was prepared by Hartmeyer in collaboration with Sluiter and Michaelsen. In addition, Hartmeyer (1915) published a paper entitled “*Ascidiarum nomina conservanda*” where he provided a more detailed information on the names he suggested to conserve and said that in his future work he will use the names he suggested regardless of whether they are correct or not. Huntsman (1922: 211) was categorically against such ignorance of the rules of zoological nomenclature, it is worth citing his text completely: “*The International Rules of Zoological Nomenclature are the result of a careful attempt by an International Committee of zoologists to put nomenclature on a fundamentally just basis. The Rules have received the approval of the International Congress. There is, consequently, no more generally accepted guide for proper usage in the naming of animals. The outstanding object in the formulation of the rules has been to attain uniformity and stability. We believe that this object will be achieved only by a strict adherence to the rules unless and until they are changed or abrogated in special instances by such general consent as*

approval by an international congress. For these reasons we do not propose to adopt the arbitrary list of Ascidiarum nomina conservanda prepared by Hartmeyer in consultation with Michaelsen and Sluiter”. Unfortunately, his voice has not been heard and most other authors, except Redikorzev, accepted Hartmeyer’s (1915) *Nomina conservanda*. In particular, Van Name (1945: 3) wrote: “*The acceptance of many nomina conservanda in the nomenclature of the ascidians is unavoidable, for any satisfactory application of the law of priority is in many cases impossible*”. All authors who refer to Hartmeyer’s (1915) work as a source of conservation of certain ascidian names (e.g. Van Name, 1945; Kott, 1998), miss the fact that the Commission (Opinion 74, ICZN, 1922) ruled it could not adopt Apstein’s list. Later some small parts of it were adopted (Opinion 94 and Direction 72, ICZN, 1926; 1957a) but it was made in such a way that not one name of ascidian taxa was affected. The precedence of older names cannot be suppressed just because such an intention was published by a prominent taxonomist; a decision of the Commission is required in most cases (Article 23.9.3). For some names such a decision exists (e.g. the precedence of *Paessleria* Michaelsen, 1907 was suppressed in favor of *Eudistoma* Caullery, 1909, see Opinion 1865, ICZN, 1997) but not for many others. As a result, now we have several widely used ascidian names, e.g. *Distaplia* Della Valle, 1881 in Aplousobranchia and several generic names in Stolidobranchia which are not valid according to the Code. All these nomenclatural issues and possible solutions are discussed in details under the relevant taxa in the present work on Aplousobranchia and in the planned work of the two other orders of Ascidiacea.

Several issues, less critical for stability of the nomenclature, are discussed below. They include incorrect authorship or wrong year of publication of many taxa widely accepted in literature on ascidian taxonomy.

Authorship and date of publication of certain papers

1. Authorship of the species described by Albany Hancock. Hancock (1870: 355) ascribed the authorship of some species and genera he described to Alder and Hancock: “*I shall avail myself of the present opportunity to describe several new species of the Simple Ascidiaceans, some of which were determined before Mr. Alder’s death, others since that sorrowful event, by myself: the former will stand in our joint names; for the latter I am alone responsible*”. Authorship of “Alder and Hancock” for these taxa was accepted by virtually all subsequent authors; however, according to Articles 50.1 and 50.1.1 authorship of all new taxa described in that paper should be attributed only to Hancock (1870). Article

50.1.1 states: “if it is clear from the contents that some person other than an author of the work is alone responsible both for the name or act and for satisfying the criteria of availability other than actual publication, then that other person is the author of the name or act”. The word “alone” in this article means that Alder may be regarded as an author of the taxa described in Hancock (1870) only if he is “alone responsible” for them, but this is not so.

2. Date of publication of some papers of Fernand Lahille. Lahille is the author of the names of the three orders of Ascidiacea (Aplousobranchia, Phlebobranchia and Stolidobranchia) and several family and genus rank names (of which *Cionidae*, *Aplidiopsis* and *Herdmania* are currently considered valid). Dates of publication of these names are inconsistent in different sources, e.g. authorship of the names of the orders sometimes indicated as “Lahille, 1886” (e.g. see Millar, 1960: 4) or “Lahille, 1887” (e.g. see Kott, 1990: 18). Sometimes the dates are confused even within the one publication, e.g. Kott (1998), in her catalogue, indicates the authorship of *Cionidae* as “Lahille, 1887” and the authorship of *Herdmania* as “Lahille, 1888” although these two taxa were established in the same paper.

Lahille published ordinal names Aplousobranchia, Phlebobranchia and Stolidobranchia (as “Aplousobranches”, “Phlebobranches” and “Stolidobranches”) in volume 102 of *Comptes rendus hebdomadaires des séances de l’Académie des Sciences* (Lahille, 1886). The date indicated in the title page of this volume is 1886 (and also as “Janvier–Juin 1886”). The same date, 1886, is indicated for this volume in the *Nomenclator Zoologicus* (Neave, 1940: 57, see a record for *Rhopalana*). It is possible that it was actually published a year later, in 1887, but I failed to find any evidence of that. Thus the correct date of publication of the names of the three orders should be 1886: Aplousobranchia Lahille, 1886, Phlebobranchia Lahille, 1886 and Stolidobranchia Lahille, 1886.

The family name *Cionidae* and several generic names were published by Lahille in “*Session 16, Part 2*” of “*Compte Rendu de la Association Française pour l’Avancement des Sciences*” for 1887. The taxa described in this work are sometimes referred to 1887, in other cases to 1888. According to the *Nomenclator Zoologicus* (Neave, 1939: 622, see a record for *Herdmania*) it was published in 1888. Thus the date of publication of *Cionidae* appears to be 1888, not 1887 as currently accepted.

3. Date of publication of some species described by William Herdman. Herdman studied ascidians collected by the Challenger Expedition and published the results in several preliminary reports (Parts 1, 2, 3 and 4: Herdman, 1880a, b, 1882a, b) and then the main reports and supplements to them (Herdman,

1882c, 1886). Preliminary reports were first read in the meetings of the Royal Society of Edinburgh. The dates of these meetings, indicated in the proceedings published later, are almost universally confused with the date of publication. In particular, Herdman’s Preliminary Reports Parts 3 and 4 (Herdman, 1882a, b) were read in January and June 1881, and this date, 1881, is universally accepted for about 50 new taxa described in these reports. However, the year of publication of Volume 11 of Proceedings of the Royal Society of Edinburgh, where these reports were published, appears to be 1882 as indicated on its title page: “Printed by Neill and Company. MD-CCCLXXXII” (=1882), so the correct date of publication of numerous species and genera, described in this work, is 1882, not 1881.

4. Huntsman’s papers published in 1912. Huntsman published descriptions of several new species twice in 1912 (Huntsman, 1912a, b). These descriptions differ from each other in details and it is important to clarify which publication has priority. According to ICZN (1978) the date of the latter publication is given simply as “1912” and must be taken as 31 December 1912, while the date of the former is given as “May 1912” and therefore it has priority. Thus Huntsman (1912a) has priority over Huntsman (1912b).

Taxonomy

KEY TO FAMILIES OF ASCIDIACEA KNOWN FROM FAR EAST SEAS OF RUSSIA

- 1 Body not divided into regions, gut loop on the side of the branchial sac
 - **Phlebobranchia+Stolidobranchia**
(will be described in a separate work).
 - Gut loop below branchial sac (**Aplousobranchia**) 2
- 2 Large solitary ascidians **Cionidae**
- Colonial ascidians 3
- 3 Zooids arranged in cloacal systems (i.e. atrial apertures of zooids open into common cloacal cavity within colony, atrial siphon in most cases modified and has atrial languet, or atrial opening of zooids sessile) 4
- Zooids not arranged in cloacal systems (i.e. both siphons open directly to exterior) 7
- 4 Colonies contain numerous stellate calcareous spicules (usually < 0.1 mm in diameter)
 - **Didemnidae**
 - Calcareous spicules not present 5
 - 5 Zooids composed of thorax and abdomen, gonads in abdomen, four rows of stigmata 6
 - Zooids composed of thorax, abdomen and posterior abdomen, gonads usually in posterior abdomen **Polyclinidae**

- 6 Atrial languet present, proximal end of sperm duct straight **Holozoidae**
 – Either atrial languet not present or proximal end of sperm duct coils around male gonad composed of one or several testis follicles
 **Didemnidae** (aspicular species)
 7 Three rows of stigmata
 *Eudistoma* (**Polycitoridae**)
 – More than three rows of stigmata 8
 8 Heart in the end of posterior abdomen, colonies sandy **Ritterellidae**
 – Heart in the thorax beside or just below the gut loop, colonies contain no sand, often composed of oval zooid-bearing lobes on the ends of thin stalks or thick branches containing serially arranged oval reddish parenchymatous bodies (survival buds) **Placentelidae**

Order APLOUSOBANCHIA Lahille, 1886

Order Aplousobranchia currently includes 14 families, seven of which are represented in the region covered by the present work. Most (but not all) ascidians belonging to this order are colonial.

Family Polyclinidae Milne-Edwards, 1842

The family comprises colonial ascidians with zooids having thorax, abdomen and posterior abdomen; gonads (at least male follicles) in the posterior abdomen; heart in the posterior end of the posterior abdomen; zooids are embedded in a common test and arranged into cloacal systems.

The family includes eight genera: *Aplidiopsis* Lahille, 1890, *Aplidium* Savigny, 1816, *Morchellium* Giard, 1872, *Neodiction* nom.n. for *Neodictyon* Sanamyan, 1998, *Polyclinella* Harant, 1931, *Polyclinum* Savigny, 1816, *Sidneioides* Kesteven, 1909 and *Synoicum* Phipps, 1774. In *Aplidiopsis*, *Polyclinum*, *Polyclinella* and *Sidneioides* the posterior abdomen is attached to the abdomen by a narrow neck-like region. In practice this feature should be used with caution; other polyclinid genera may have a kind of constriction between the thorax and posterior abdomen and it is always necessary to consider other features, e.g. the shape and the orientation of the stomach. *Polyclinum* is unique in possessing papillae on the transverse branchial vessels between the rows of stigmata, *Sidneioides* in the ovary located in the thorax. *Polyclinella* resembles *Aplidiopsis* but has stomach folds, while *Aplidiopsis* has a smooth-walled stomach. In the remaining genera the posterior abdomen is more or less in direct continuation of the abdomen. *Aplidium* has a stomach wall with longitudinal folds. *Synoicum* and *Morchellium* have either smooth or areolated stomach; the latter genus

is distinguished by the presence of eight branchial lobes. The taxonomic status of the species having eight branchial lobes assigned previously to *Sidneyum* (currently considered a synonym of *Aplidium*), to *Morchellium* (which is considered valid) and to several other nominal genera is far from being resolved. *Neodiction* nom.n. differs from other polyclinid genera by gonads positioned mostly in the abdomen and by lacking true stigmata. Its assignment to Polyclinidae is provisional.

Four genera are known in the region covered by the present paper: *Aplidium*, *Synoicum*, *Aplidiopsis* and *Neodiction* nom.n.

KEY TO GENERA OF THE FAMILY POLYCLINIDAE KNOWN FROM FAR EAST SEAS OF RUSSIA

- 1 Stomach with longitudinal folds *Aplidium*
 – Stomach smooth or areolated (with irregular swellings) 2
- 2 Stomach obliquely oriented, smooth, posterior abdomen attached to abdomen by narrow neck-like region *Aplidiopsis pannosum*
 – Stomach vertical, posterior abdomen in more or less direct continuation of abdomen 3
- 3 Branchial sac without stigmata
 *Neodiction* nom.n.
 – Branchial sac of usual type, with transverse rows of stigmata *Synoicum*

Genus *Synoicum* Phipps, 1774

Type species: *Synoicum turgens* Phipps, 1774 by monotypy.

Nomenclatural note: Kott (1998) stated that *Synoicum turgens* is a type species by subsequent designation with a reference to Hartmeyer (1924). In fact, *Synoicum turgens* was indicated as the type species of *Synoicum* much earlier (by Fleming, 1822). Phipps (1774) originally included only one species in his genus, thus *S. turgens* is a type species by monotypy.

The genus comprises polyclinid ascidians having a smooth-walled or areolated stomach, and posterior abdomen is not separated from abdomen by constriction.

The main feature separating this genus from the more common and more diverse *Aplidium* is the structure of the stomach wall. This difference is usually quite distinct though in some *Synoicum* species the warts or swellings of the stomach wall may be arranged in longitudinal series, while in some *Aplidium* species the longitudinal stomach folds are irregular and may be broken into a series of swellings obscuring the main difference between these genera. *Synoicum* is a diverse genus comprising about 80 species. The taxonomy of the species of

this genus in the NW Pacific is rather complex. Although many nominal species are described, the boundaries between them are obscured: the zooids have limited number of useful distinguishing features and the shape of the cloacal systems (a feature distinguishing many related *Aplidium* species) is the same (circular) in all known species of *Synoicum* inhabiting the NW Pacific. The shape of colony is also difficult to use to differentiate species; although two main groups may be distinguished (species with massive colonies or with colonies composed by separate lobes) the degree of variation within each group appears to be too high for one species but numerous intermediate forms prevent the species separation. Currently I am inclined to synonymize all nominal species with areolated stomach with *S. turgens* Phipps, 1774 and many species having smooth-walled stomach with *S. jordani* (Ritter, 1899). Other definitely valid species known from the Far Eastern Seas of Russia are *S. derjugini* Redikorzev, 1927 and *S. polyzoinum* Sanamyan et Sanamyan, 2017. Taxonomic affinity of two species described by Redikorzev, *S. pellucens* Redikorzev, 1927 (based on a small colony collected in the vicinity of Vladivostok) and *S. parvum* Redikorzev, 1937 (one small specimen from the Sea of Okhotsk) is not clear, most probably they are young colonies of other species and I prefer not to consider them as valid species.

KEY TO SPECIES OF THE GENUS *SYNOICUM* KNOWN FROM FAR EAST SEAS OF RUSSIA

- 1 Stomach wall areolated (with distinct irregular thickenings), colony consists of more or less distinct lobes *S. turgens*
- Stomach wall smooth 2
- 2 Colony composed of poorly differentiated lobes, not densely impregnated by sand, stomach asymmetrical (as in *Aplidiopsis*) *S. polyzoinum*
- Colony entire and may be massive, globular or potato-like 3
- 3 Ten rows of stigmata, pyloric reservoir absent .
..... *S. derjugini*
- Twelve or more rows of stigmata, pyloric reservoir usually present *S. jordani*

Synoicum turgens Phipps, 1774
Figs 2, 3.

Synoicum turgens Phipps, 1774: 199. Hartmeyer, 1903: 349. Tokioka, 1960: 192. Millar, 1966: 18. Sanamyan, 1998a: 111.

? *Synoicum irregulare* Ritter, 1899: 530. Van Name, 1945: 64.

? *Synoicum cymosum* Redikorzev, 1927a: 399. Sanamyan, 1998a: 112.

? *Synoicum solidum* Redikorzev, 1937: 125.

MATERIAL EXAMINED. *Ac. Oparin-56*, St.8, Urup Island (Sea of Okhotsk side), 45°54.5'N, 149°42.6'E, 128 m, 28.06.2019, one colony; St.67, Paramushir Island (Sea of Okhotsk side), 50°17.93'N, 155°18.09'E, 7–13 m, 11.08.2019, one colony.

DESCRIPTION. The colonies are composed of several upright lobes joined basally. The lobes are regular in shape, flat-topped, gradually tapering to the base, about 1 cm in diameter and 2–3 cm in height. Each lobe contains a single system with about ten zooids. The outer test is leathery, significantly firmer than the inner gelatinous layers. The whole surface of the colony is covered with minute (0.1 mm long) crowded spines (Fig. 2C). The small oval common cloacal cavity is situated on the level of thoraces of zooids, it does not extend down along the length the lobe.

The zooids are robust, up to 30 mm long and 2 mm in diameter, and extend the entire length of the lobe. The atrial siphon is longer than the branchial and well-formed, conical with a long atrial languet divided into three short lobes at the end. The tentacles are very numerous, about 40 in number, short but rather thick and set in several circles (not in a single line) on a low velum. The branchial sac has 15 or 14 rows of stigmata, sometimes 15 on the right and 14 on the left, up to 37 stigmata per half row. The stomach is in the middle of the abdomen and in the present specimens resembles that of *Aplidium*: it is barrel-shaped, more or less radially symmetrical and vertical; the oesophagus enters at its cardiac end almost vertically. The stomach wall has prominent swellings. Some of these swellings in the present material seem (unlike the specimens of the same species examined previously) are arranged into longitudinal series (Fig. 2A). The posterior abdomen is filled with parenchymatous tissue, and gonads not discernible although the thick sperm duct running along the rectum is well visible.

REMARKS. *Synoicum turgens* is widely distributed and common in the Arctic seas. In the Pacific it is known from the Bering Sea and Sea of Okhotsk. Zooids of specimens reported here have an unusually high number of stigmata per row; it is necessary to pay more attention to this feature in future collections to check its variability.

The taxonomy of this species, or perhaps a group of several closely related species, in the North Pacific is far from being resolved. The identity of the colonies consisting of several cylindrical lobes (Fig. 2B) with *S. turgens* is obvious — the original description is short, but original figures (Phipps, 1774, plate 13, fig. 3A–C) left no doubt of their specific assignment. However, the distinction of several nominal species described from the North Pacific, which differ from *S. turgens* mainly in the shape of their colonies, is not clear. These species are:

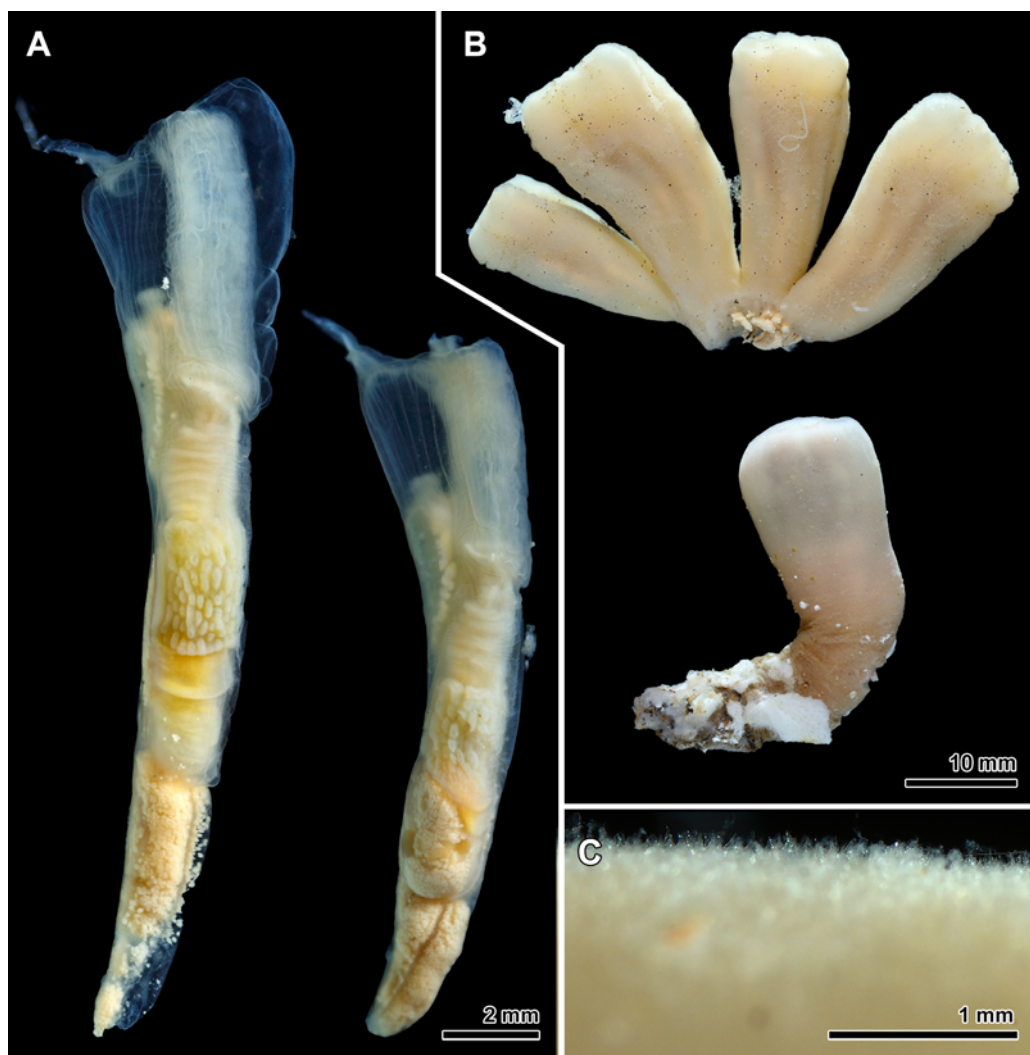


Fig. 2. *Synoicum turgens*. A — zooids; B — colonies; C — minute spines on test surface.
 Рис. 2. *Synoicum turgens*. A — зооиды; B — колонии; C — мелкие шипики на поверхности туники.

Synoicum irregulare Ritter, 1899. A colony from Bering Sea (59°15'N, 164°14'E, 14 m) referable to *S. irregulare* is shown in Fig. 3B. The lobes of this colony are thicker than in typical *S. turgens* and contain more numerous zooids, and the thickest central lobe contains at least three round systems. The test surface is covered with minute spines exactly as in *S. turgens*. Van Name (1945) synonymized *S. irregulare* with *S. turgens* but he was not sure and used the junior name *S. irregulare* as a valid name for specimens from the Pacific. Sanamyan (1998a) also treated *S. turgens* and *S. irregulare* as being conspecific, but later expressed an opinion that the conspecificity between European *S. turgens* and Pacific *S.*

irregulare is not firmly established (Sanamyan, Sanamyan, 2017b). A record of a very typical *S. turgens* colony (Fig. 2B) from the North Pacific suggests that this species is indeed conspecific with *S. irregulare*.

Synoicum cymosum Redikorzev, 1927. A colony from Bering Sea (58°37'N, 163°04'E, 56 m) referable to this species is shown in Fig. 3A. The colonies are distinguished by the presence of longitudinal rows of rather large papillae on the lobes. The general shape of the single lobe figured by Redikorzev (1927a, fig. 19) resembles the lobe of *S. turgens*, the lobes of the colonies reported by Sanamyan (1998a, fig. 3) are less regular and closer to those of *S. irregulare*. Redikorzev (1927a) reported 14 or 15

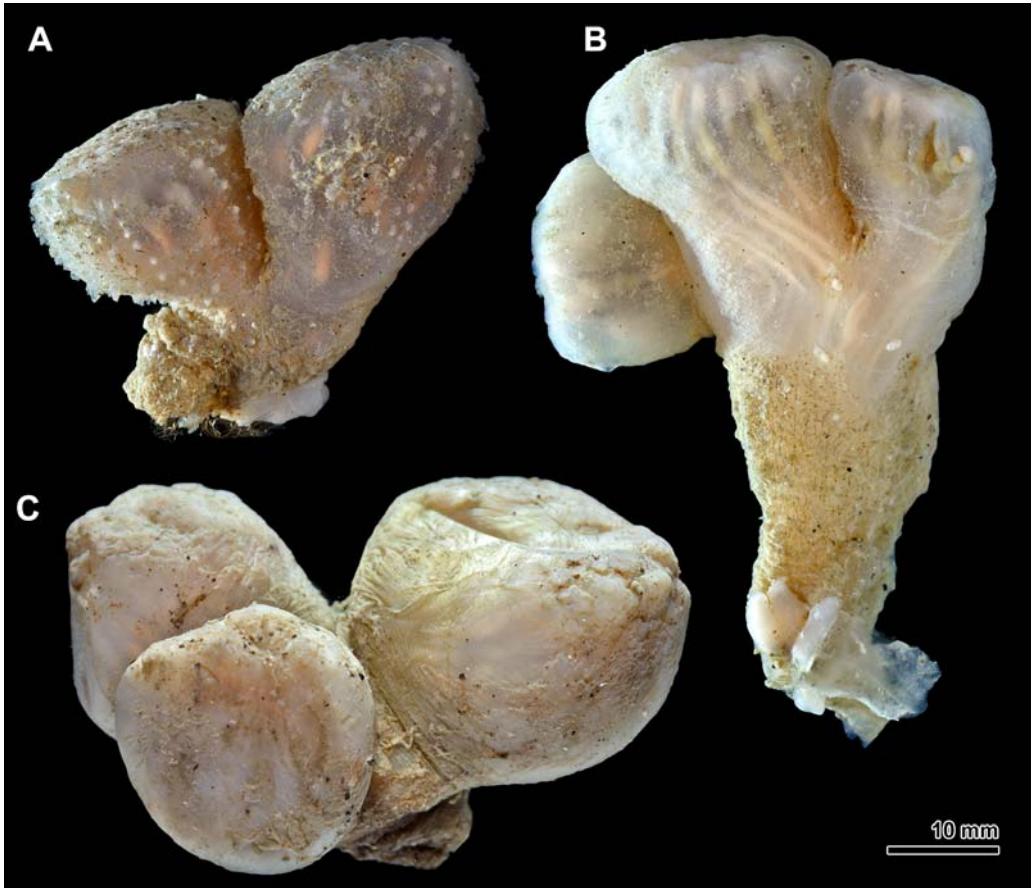


Fig. 3. *Synoicum turgens*. A — colony assignable to “*S. cymosum*”; B — colony assignable to “*S. irregulare*”; C — colony assignable to “*S. solidum*”.

Рис. 3. *Synoicum turgens*. А — колония, условно относимая к “*S. cymosum*”; В — колония, условно относимая к “*S. irregulare*”; С — колония, условно относимая к “*S. solidum*”.

rows of stigmata with 20–25 stigmata in each. The surface of the test is covered with minute papillae as in *S. turgens* and *S. irregulare*. Sanamyan & Sanamyan (2017b) synonymized *S. cymosum* with *S. irregulare* because the presence and degree of development of large test papillae vary significantly from colony to colony.

Synoicum solidum Redikorzev, 1937. Fig. 3C shows a colony referable to this species collected together with *S. cymosum* reported above. The lobes are more rounded, thick, systems not recognizable. The test is smooth, not covered with minute papillae. The zooids are not distinguishable from those of other nominal species discussed above: the stomach has well-marked areolations on its wall, the branchial sac of this specimen has 16 or 17 (including one or two incomplete) rows of 27–29 stigmata (14 or 15 rows of 20–25 stigmata according to the original

description). Absence of minute test papillae may constitute a distinguishing feature but is a difficult character to use in practice and may relate to the physiological state of the colony (the colonies in resting state usually have a smooth surface).

Many other colonies I examined previously have intermediate characters and cannot be assigned with certainty to one or another species discussed above. In the present paper I prefer to treat all these nominal species as doubtful synonyms of *S. turgens*. This group of species deserves molecular study which has not yet been performed.

Synoicum jordani (Ritter, 1899)
Figs 4–6.

Aplidiopsis jordani Ritter, 1899: 521
Macroclinum jordani: Redikorzev, 1910: 157.

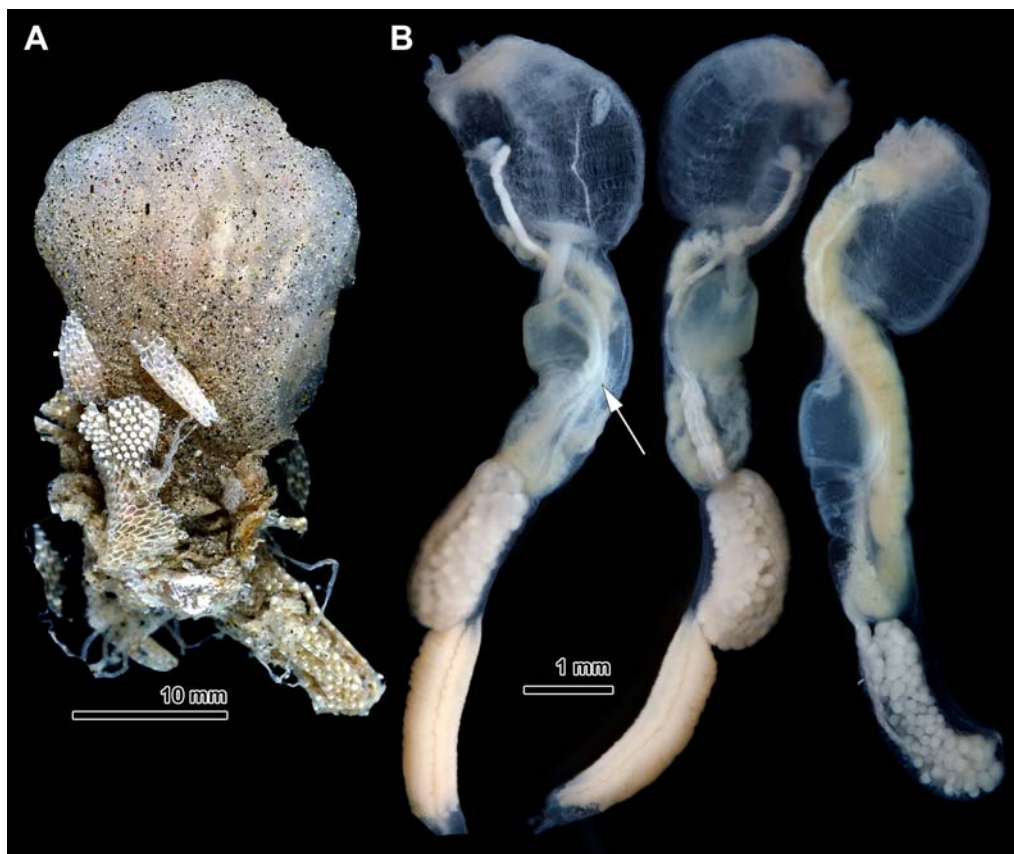


Fig. 4. *Synoicum jordani*, specimen from the Sea of Okhotsk (St. 47). A — colony; B — zooids. Arrow points to gastric reservoir.

Рис. 4. *Synoicum jordani*, экземпляр из Охотского моря (ст. 47). А — колония; В — зооиды. Стрелка показывает на гастральный пузырек.

Synoicum jordani: Van Name, 1945: 64. Tokioka, 1954a: 67. Sanamyan, 1998a: 108.

Synoicum jacobsoni Redikorzev, 1927a: 394.

Aplidiopsis knipowitschi Redikorzev, 1927b: 351.

Amaroucium kincaidi Ritter, 1899: 525.

Amaroucium pribilovense Ritter, 1899: 525. Hartmeyer, 1903: 334.

Amaroucium snodgrassi Ritter, 1899: 527

Synoicum pulmonaria: Tokioka, 1960: 193.

Synoicum clavatum: Sanamyan, 1998a: 113.

MATERIAL EXAMINED. *Ac. Oparin-56*, St.47, NW Sea of Okhotsk, 56°17.6'N, 137°58.2'E, 47 m, 1.08.2019, one colony; St.67, Paramushir Island (Sea of Okhotsk side), 50°17.93'N, 155°18.09'E, 7–13 m, 11.08.2019, one colony. West of Bering Sea, 58°33'N, 162°31'E, 28 m, one colony; 62°2'N, 176°8'E, 41 m, one colony.

DESCRIPTION. The colonies are rounded, not divided into lobes. The smooth surface layer of the test is noticeably firmer than the gelatinous soft inner

test. The test is not coloured, looks gray due to embedded sand. Zooids are arranged into numerous crowded circular systems with five to ten zooids in each system. In smaller colonies (Fig. 4) the zooids appear to stand vertically, parallel to each other and open on the top of colony, but in the larger globular colonies the systems open both over the top and the sides of the colony. The zooids are long; thorax and abdomen together in contracted state are about 10 mm long and the total length of many zooids is more than 20 mm due to the length of the posterior abdomen. In most colonies the zooids are robust (Fig. 6D) but occasionally colonies with very slender (not feeding?) zooids occur (Fig. 5A). Zooids have a short atrial siphon with its anterior (upper) border drawn into a short simple atrial lip. The branchial sac in the specimen from the Sea of Okhotsk (St. 47) has 13 rows of about 25 stigmata; zooids of two specimens from the Bering Sea have a longer but

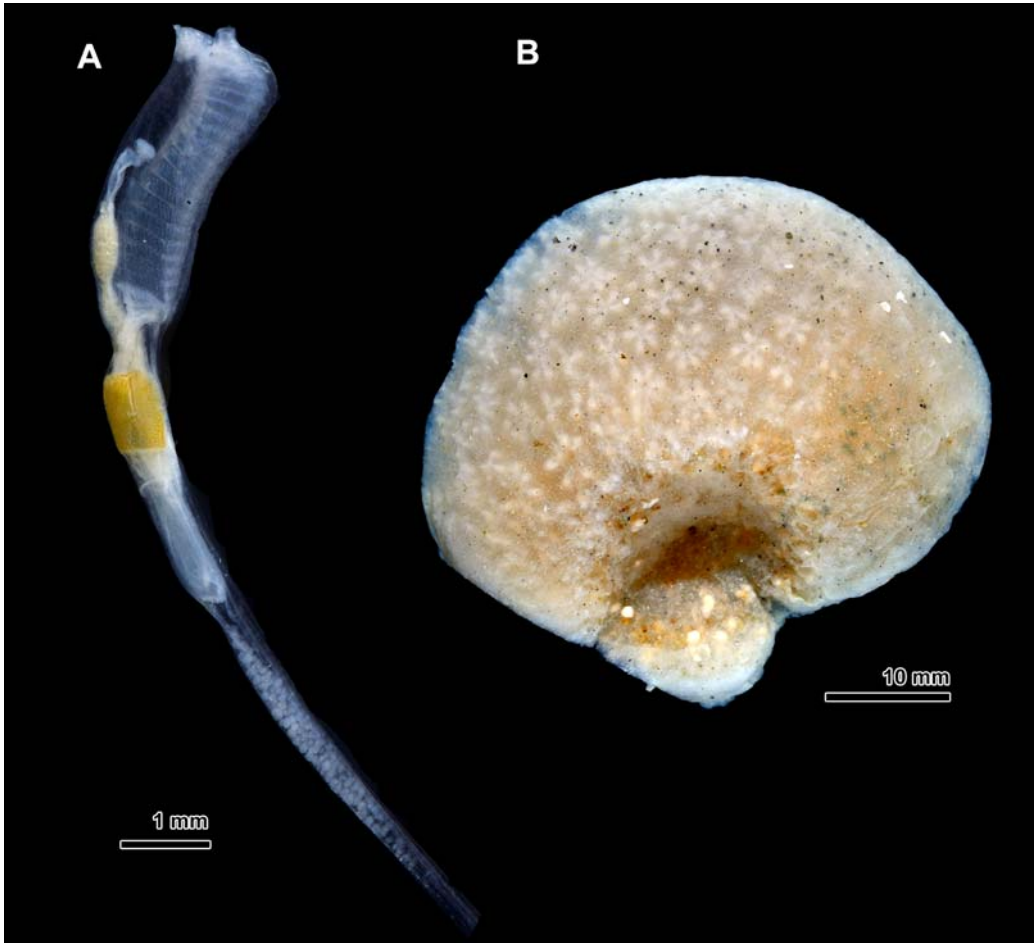


Fig. 5. *Synoicum jordani*, specimen from the Bering Sea with slender zooids. A — zooid; B — colony.
 Рис. 5. *Synoicum jordani*, экземпляр из Берингова моря с тонкими зооидами. А — зооид; В — колония.

narrower branchial sac with 17 or 18 rows of about 17 or 18 stigmata on each side; the specimen from Paramushir Island (St. 67) has 15 or 16 rows of stigmata with about 28 stigmata per row. The oesophagus is a narrow tube entering the stomach vertically. The stomach is smooth-walled, barrel-shaped, more or less symmetrical, located in the middle of the long abdomen. The orientation of the stomach is vertical, the oesophagus enters its cardiac end nearly vertically. A distinct pyloric vesicle at the level of the pyloric end of the stomach is present in all examined zooids (arrow in Fig. 4B and Fig. 6D). When fully developed, numerous male follicles form compact short sausage-shaped masses in the anterior part of the posterior abdomen clearly separated by constriction from the parenchymatous tissue that fills the posterior part of the posterior abdomen. Male follicles do not extend to the abdomen. Several

parallel thick male ducts form a wide band in the posterior part of the abdomen (Fig. 4B), they join together only at the level of the stomach or above it.

Many larvae were present in the atrial cavity of zooids in specimen from St. 67. The trunk is 1.3 mm long, there are three adhesive organs, several long median ampullae (usually more than one between two adhesive organs) and smaller lateral ampullae and very numerous crowded epidermal vesicles forming a wide band on the sides of the anterior part of the trunk and also along almost the whole dorsal and entire ventral sides.

REMARKS. *Synoicum jordani* is widely distributed in the Bering Sea and Sea of Okhotsk and not known outside the North Pacific. The species is common, especially where water is turbid. Large globular colonies are very characteristic and easily identifiable even on photographs, though younger

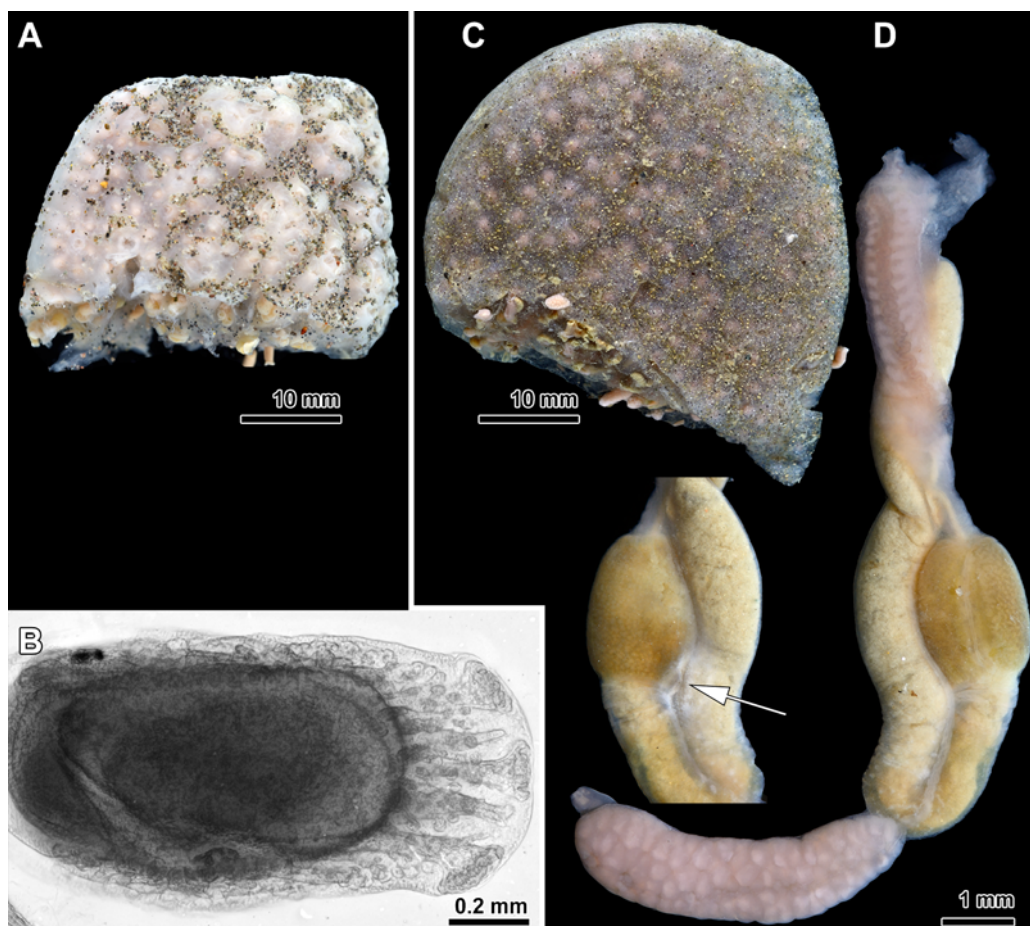


Fig. 6. *Synoicum jordani*, specimens with robust zooids. A, B — specimen from Paramushir Island (St. 67), colony and larva; C, D — specimen from the Bering Sea, colony and zooids; arrow points to gastric reservoir. Рис. 6. *Synoicum jordani*, экземпляры с толстыми зооидами. А, В — экземпляр с о. Парамушир (ст. 67), колония и личинка; С, D — экземпляр из Берингова моря, колония и зооид; стрелка указывает на гастральный пузырек.

specimens may have more elongated (clavate) colonies, translucent test and resemble other polyclinids. The species is characterized by massive, entire (not divided into lobes) colonies; stomach wall always smooth; gastric reservoir usually well-discernible; a band of several sperm ducts in the posterior part of the abdomen; posterior abdomen clearly divided into two parts as described above.

Although several similar species were described previously from the Bering Sea and the Sea of Okhotsk (see synonymic list above) they are not distinguishable from each other. This group of nominal species was discussed in detail by Sanamyan & Sanamyan (2017b). In the region including Commander Islands, Kamchatka, and north and middle Kuril Islands, Sanamyan & Sanamyan (2017b) rec-

ognized only one species of the genus *Synoicum* which forms large massive colonies and has a smooth stomach wall — *S. jordani*.

The specimens described here most closely resemble the specimen from the Sea of Okhotsk described by Redikorzev (1927a) as *Synoicum jacobsoni*. The shape of systems and zooid structure, including the characteristic posterior abdomen with its thick compact gonad in the anterior part (see Redikorzev 1927a, fig. 16), are very similar to those of the present specimens. Sanamyan & Sanamyan (2017b) examined the type specimen of this species and found that the stomach is smooth (although Redikorzev (1927a) figured sparse fine areoles on it), as in *S. jordani*. However, they failed to find a gastric reservoir in the holotype, a feature consid-

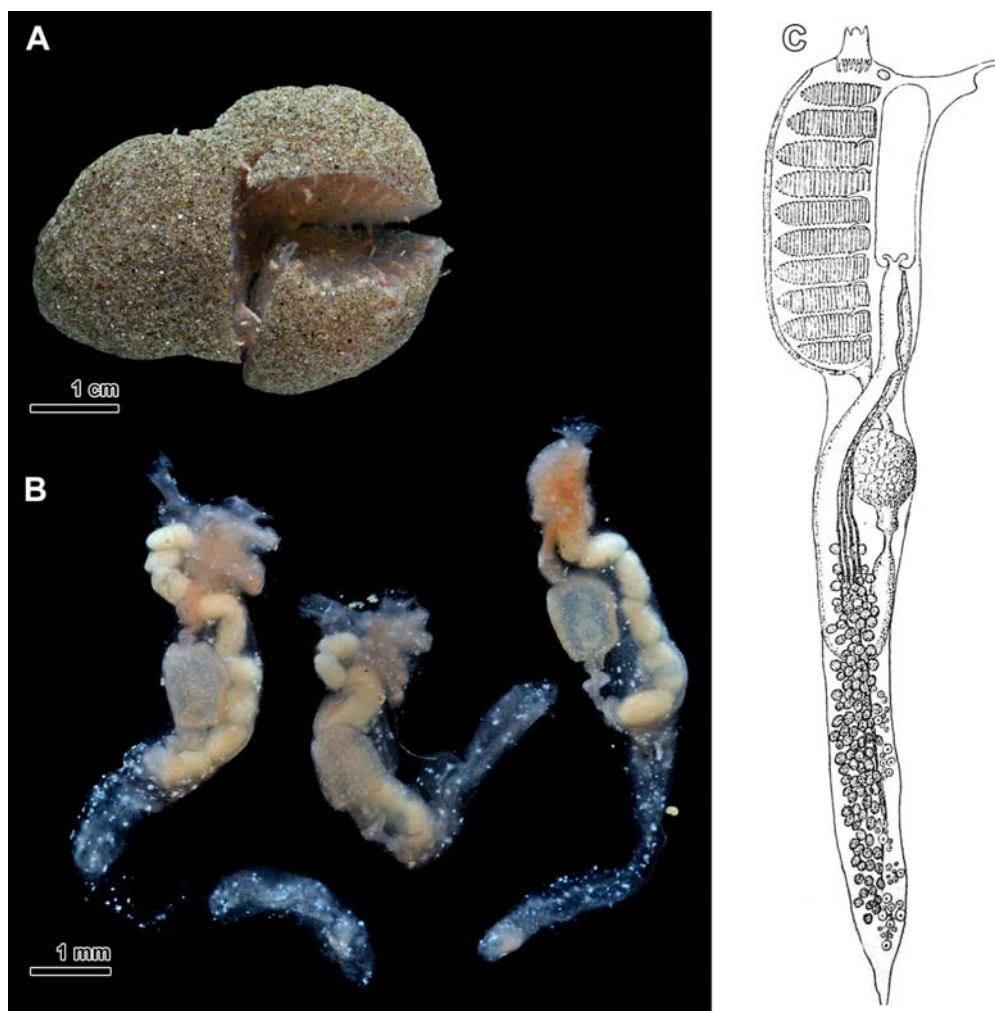


Fig. 7. *Synoicum derjugini*. A — colony; B — zooids; C, zooid (after Redikorzev, 1927a).
Рис. 7. *Synoicum derjugini*. A — колония; B — зооиды; C, зооид (по Redikorzev, 1927a).

ered to be characteristic for *S. jordani*. Nevertheless, there is no doubt that the present specimens (which have gastric reservoir) are conspecific with *S. jacobsoni* and that this species is identical with *S. jordani*.

The material described as *Synoicum clavatum* (Oka, 1927) by Sanamyan (1998a) appears to be young specimens of *S. jordani*. *Synoicum clavatum* is a warm-water species and does not occur in the region covered by the present paper (see Seo, Rho, 2016).

Synoicum derjugini Redikorzev, 1927
Fig. 7.

Synoicum derjugini Redikorzev, 1927a: 297.

MATERIAL EXAMINED. Tanfilieva Island (~43°26.23'N, 145°56.4'E), intertidal pool, 11.08. 1987, one colony.

DESCRIPTION. The potato-shaped colony is 4 cm in length and about 2 cm in height (Fig. 7A), covered with a thin layer of fine sand with sparse sand grains present in inner layers of the gelatinous, colourless and translucent test. The shape of the systems is not recognizable. Zooids are poorly preserved, very soft and difficult to extract. All zooids have a rather long atrial siphon with a short and probably simple languet. Longitudinal thoracic muscles are numerous and rather thick, in all zooids the thoraces are contracted. The branchial sac has ten rows of stigmata, the number of stigmata per row

cannot be counted but stigmata seem to be not numerous. The smooth-walled stomach is large, ovoid or barrel-shaped, symmetrical, situated in the middle part of the abdomen and occupies a significant part of it. Post-pyloric subdivision of the intestine is distinct with well-discernible duodenum and mid-intestine. There is no pyloric vesicle. The long posterior abdomen is “empty” in all zooids.

REMARKS. The colony from Tanfilieva Island (southern group of Kuril Islands) described above is a first record of this species since its original description. The species is too poorly known and its taxonomic status is not clear. In most features it resembles *S. jordani* but zooids have only ten rows of stigmata and lack the gastric vesicle which usually (but probably not always) is present in *S. jordani*; at present I prefer to treat it as distinct. The original description of *S. derjugini* is based on three colonies collected near Vladivostok (Sea of Japan). Redikorzev (1927a) described a compact colony with zooids arranged in small circles around common cloacal openings exactly as in *S. jordani*. In zooids he figured several parallel male ducts forming a band in the posterior part of the abdomen (Fig. 7C), a feature reported in the present paper for *S. jordani*. Type specimens were reexamined by Sanamyan & Sanamyan (2017b). They have a hard and clear test without any sand on the surface or internally.

Synoicum polyzoinum Sanamyan et Sanamyan, 2017

Synoicum polyzoinum Sanamyan, Sanamyan, 2017b: 121; 2020: 301.

MATERIAL EXAMINED. None.

DESCRIPTION. This recently described species is based on a large colony from Matua Island (middle group of Kuril Islands). The species forms extensive (about 10 cm in extent) colonies composed of several groups of short lobes, sometimes partially fused, sometimes completely separated from each other, of various shape and size. Zooids have 12 rows of 25–27 stigmata and a smooth-walled stomach. They are arranged in circular systems as in *S. turgens*, *S. jordani* and *S. derjugini*. The stomach is asymmetrical with the rounded cardiac end being narrower than the pyloric end. See Sanamyan & Sanamyan (2017b) for more detailed description and photographic images of live and preserved colonies and zooids.

REMARKS. The colony is divided into lobes containing one or few systems and has some (but rather distant) resemblance with colonies of *S. turgens*, but the stomach in *S. polyzoinum* is smooth and therefore conspecificity with *S. turgens* is excluded. The shape of the stomach differs from the barrel-like or ovoid symmetrical stomach of *S. jordani* and *S. derjugini* and more closely resembles the stomach of

Aplidiopsis pannosum, but in *S. polyzoinum* the stomach is vertically oriented (as in most *Synoicum* species) while in *Aplidiopsis* the stomach is oriented obliquely with characteristically curved oesophagus. Thus, although only one colony was collected and possible variations are not known, it appears to be a distinct species.

Genus *Aplidium* Savigny, 1816

Type species: *Aplidium lobatum* Savigny, 1816 by subsequent designation by Michaelsen (1921).

The genus comprises polyclinid ascidians having a stomach with longitudinal folds and the posterior abdomen not separated from the abdomen by constriction.

In the NW Pacific *Aplidium* is the most common genus of colonial ascidians, represented by many species. Despite the fact that *Aplidium* is a very large genus (about 300 valid species worldwide), species identification is in general easier than in much less diverse *Synoicum* because *Aplidium* has more numerous morphological features usable to species delimitation and these features appear to be more stable than in *Synoicum*. In most cases when the system structure could be observed (preferably in photographs of live relaxed colonies) and also when zooids contain mature larvae, species identification is easy. On the other hand, even when colonies are poorly preserved and larvae are absent, a specimen may be assigned to one or another group of species within the genus. Fifteen species of *Aplidium* are known in Far East Seas of Russia. For easier identification Sanamyan & Sanamyan (2017b) divided them into three groups:

1) Species with five prominent and sharply defined stomach folds: *A. spitzbergense* Hartmeyer, 1903, *A. redikorzevi* Sanamyan et Sanamyan, 2011 and *A. macreteron* Sanamyan et Sanamyan, 2017.

2) Species with more than five but less than 18 (usually from seven to 15) stomach folds: *A. dubium* (Ritter, 1899), *A. polybunum* Redikorzev, 1927, *A. vinogradovae* (Beniaminson, 1974), *A. disiphonium* (Beniaminson, 1975), *A. lebedi* Sanamyan, 1998, *A. eborinum* Sanamyan et Sanamyan, 2011 and *A. matua* Sanamyan et Sanamyan, 2017.

3) Species with 20 or more stomach folds: *A. strandi* (Redikorzev, 1937), *A. oculatum* (Beniaminson, 1974), *A. tenuicaudum* (Beniaminson, 1974), *A. confusum* Sanamyan, 2000 and *A. dissectum* Sanamyan et Sanamyan, 2011.

KEY TO SPECIES OF *APLIDIUM* KNOWN FROM FAR EASTERN SEAS OF RUSSIA

- 1 Stomach with 5 sharply defined regular folds .. 2
– Stomach folds more numerous 4

- 2 Four rows of stigmata *A. spitzbergense*
 – More than 4 rows of stigmata 3
- 3 Colonies large sandy masses, not lobed.
 *A. macreteron*
 – Colonies composed of many closely set cylindrical
 lobes, each with single circle of zooids
 *A. redikorzevi*
- 4 Stomach with up to 15 (rarely up to 18) folds 5
 – More than 20 stomach folds 11
- 5 Stigmata in 20–22 rows *A. polybunum*
 – Less than 18 rows of stigmata 6
- 6 Seven to 10 stomach folds 7
 – More than 10 stomach folds 9
- 7 Upright club-shaped colony lobes, test contains no
 sand *A. lebedi*
 – Colonies are low cushions, test contains signifi-
 cant amount of sand 8
- 8 Stigmata in 11–12 rows, Commander Islands ..
 *A. dubium*
 – Stigmata in 15–17 rows, Kuril Islands
 *A. matua*
- 9 Atrial languet three-lobed; larvae with many small
 epidermal vesicles in several irregular rows and
 large median ampullae *A. disiphonium*
 – Atrial languet simple; larvae with large epidermal
 vesicles in a single row on each side, without
 median ampullae 10
- 10 Rows of stigmata 8–10, South Kuril Islands ..
 *A. vinogradovae*
 – Rows of stigmata 12–15, more northern localities
 *A. eborinum*
- 11 Colonies massive, not lobed, with round systems.
 White or yellow pigment spot often marks each
 row of stigmata on each side of the endostyle
 *A. oculatum*
 – Colonies not massive, usually divided into several
 small irregular cushions or inverted cone shaped
 cormidia. No pigment spots on the thoracic wall
 along the endostyle 12
- 12 Larva with many small epidermal vesicles in
 several rows; colonies small irregular cushions,
 North Kuril Islands *A. tenuicaudum*
 – Larva with few large epidermal vesicles in single
 row on each side and/or colony composed of
 inverted cone shaped cormidia 13
- 13 Rows of stigmata 7, atrial languet trifid (3 long
 lobes) *A. strandi*
 – Rows of stigmata 9–13, atrial languet simple or
 tridentate (3 short lobes on the end of languet)
 14
- 14 Stigmata in 9 or 10 rows, South Kuril Islands
 *A. confusum*
 – Stigmata in 12 or 13 rows, Kamchatka
 *A. dissectum*

Group 1. *Aplidium* species having five stom-
 ach folds

This group comprises three easily distinguished
 species: *A. macreteron*, *A. redikorzevi* and *A.*
spitzbergense.

Aplidium macreteron Sanamyan et Sanamy-
 an, 2017
 Fig. 8.

Macreteron ritteri Redikorzev, 1927a: 379. San-
 amyan, 1998a: 105.

Aplidium macreteron Sanamyan, Sanamyan, 2017a:
 315.

MATERIAL EXAMINED. *Ac. Oparin-56*, St.54,
 Sea of Okhotsk, Iona Island, 56°56.9'N, 143°15.2'E,
 117–116 m, 4.08.2019, one colony; St.67, Para-
 mushir Island (Sea of Okhotsk side), 50°17.93'N,
 155°18.09'E, 7–13 m, 11.08.2019, one colony.

DESCRIPTION. Colonies are grey shapeless
 masses, 4–5 cm in extent and up to 1 cm in thickness.
 The smaller colonies may be oval or almost globular,
 with a small attachment area; the larger ones are wide
 and flattened, attached by the whole lower surface.
 The surface is covered with sand, superficial layers
 of the test also contain large amount of sand but inner
 layers are usually free from foreign matter and the
 test there is transparent and colourless. The systems
 of zooids (even hints of them) cannot be recognized
 on the preserved colonies; moreover, in most cases
 they are hardly discernible even on inflated live
 colonies underwater (see Sanamyan, Sanamyan,
 2020). Most colonies of this species that I examined
 are either entire (not lobed), or have rather indistinct
 poorly developed lobes separated by shallow fur-
 rows.

The zooids are rather robust, short (8–9 mm) but
 thick and the body wall appears to be firm and less
 translucent than in similar species. In the colony they
 are crowded, arranged vertically and parallel to each
 other. The thoraces are always strongly contracted
 and very short in such condition (1.5 mm). The
 branchial sac has about 13 rows of stigmata. The
 abdomen is the longest part of the zooids (4 mm); in
 most cases it is filled by parenchymatous tissue and
 hypertrophied epicardia. Vertical symmetrical stom-
 ach is in the posterior third of the abdomen, its side
 adjacent to the intestine is flat, while the outer side
 adjacent to the body wall has five sharp, high, widely
 separated folds (well visible in Fig. 8B). The poste-
 rior abdomen in this species is always very short,
 shorter than the abdomen. In the present specimens
 it is filled by a compact mass of ova (Fig. 8B), male
 follicles not developed.

REMARKS. This species cannot be confused
 with other species; its short zooids with large stom-

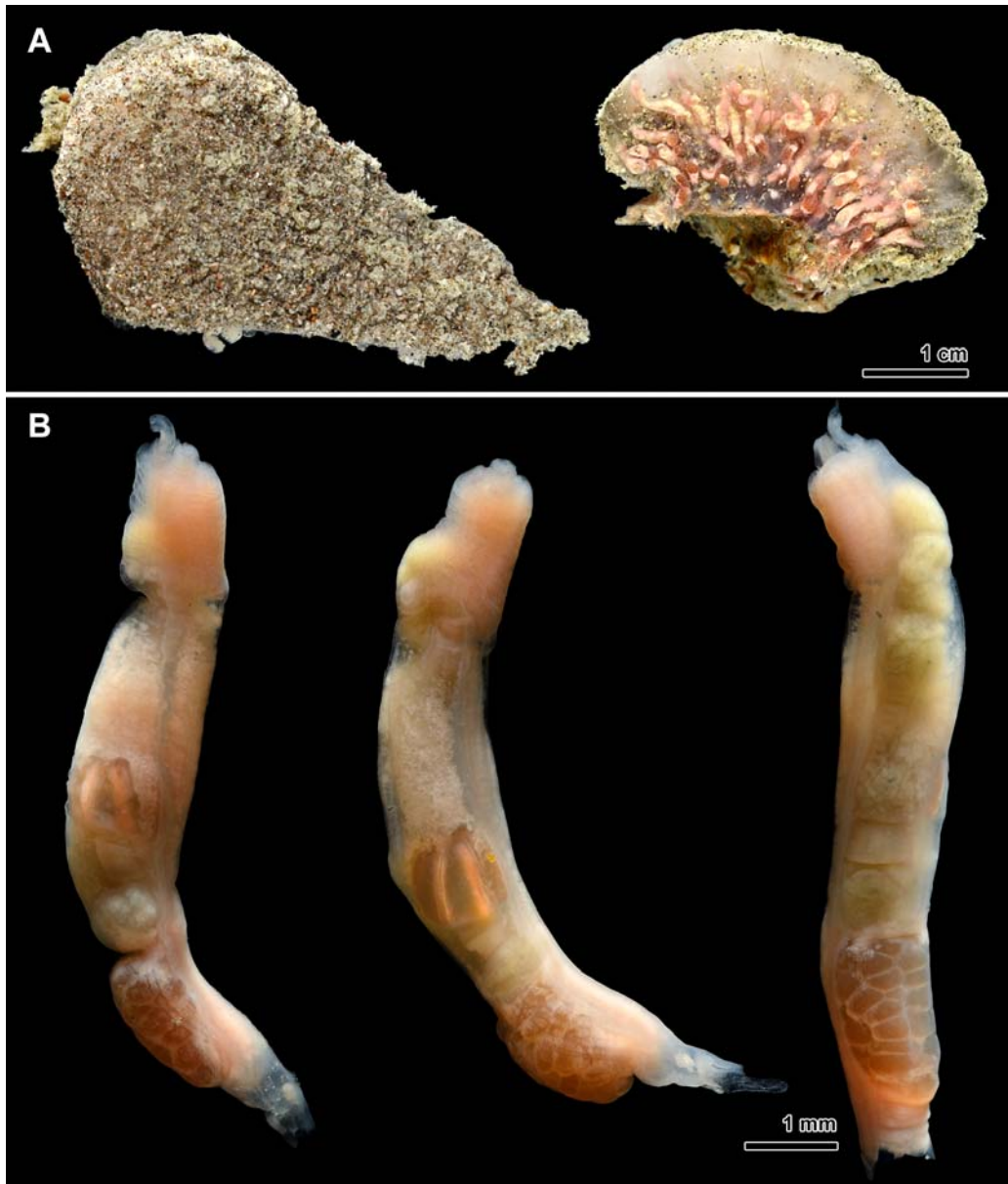


Fig. 8. *Aplidium macreteron*. A — colony; B — zooids (note prominent longitudinal ridges on the stomach).

Рис. 8. *Aplidium macreteron*. А — колония; В — зоид (видны высокие продольные ребра на желудке).

ach with five high ridges are very characteristic allowing easy identification. It was described by Redikorzev (1927a) under the name *Macreteron ritteri*. According to him, his monotypic genus *Macreteron* Redikorzev, 1927 has at least two features distinguishing it from *Aplidium*: the short (rather

than long) posterior abdomen and the heart placed beside the intestine in the abdomen. In our opinion Redikorzev (1927a) misinterpreted the large epicardial sacs, well developed and well visible in the abdomen of this species, with the heart. In reality the heart is located in the end of the short posterior



Fig. 9. *Aplidium redikorzevi*. A — colonies; B — zooids, strongly contracted (see also Fig. 11A).
 Рис. 9. *Aplidium redikorzevi*. A — колонии; B — зооиды, сильно сокращены (см. также рис. 11A).

abdomen (as in *Aplidium* and other Polyclinidae). Sanamyan & Sanamyan (2017a) synonymized the genus *Macreteron* with *Aplidium*. Since the genus *Aplidium* already contained a species named *Aplidium ritteri* (Sluiter, 1895), a senior secondary homonym of *Aplidium ritteri* Redikorzev (1927), a new replacement name *Aplidium macreteron* was suggested for Redikorzev's species by Sanamyan & Sanamyan (2017a).

Redikorzev (1927a) was not able to determine the precise location of a single colony (the holotype) he described. According to him the label attached to this specimen said only "Hydrographische Expedition des Nördlichen Stillen Ozeans. 1913. Dr. E. Arnhold gesammelt". This expedition explored a wide region from Bering Sea, Kamchatka and to the Sea of Japan (Vladivostok). Previously (see synonymic list above) I reported this species from Commander Islands, East Kamchatka, north and middle groups of Kuril Islands and now from the middle part

of the Sea of Okhotsk (Iona Island). The species is not rare, but sandy shapeless colonies rarely catch the attention of divers and collectors and the specimens in existing collections are not numerous.

Aplidium redikorzevi
 Sanamyan et Sanamyan, 2011
 Figs 9, 11A.

Amaroucium fragile Redikorzev, 1927a: 384.
Aplidium redikorzevi Sanamyan, Sanamyan, 2011: 47 (nom.n. for *Amaroucium fragile* Redikorzev, 1927a).

MATERIAL EXAMINED. Pacific and Bering Sea coasts of Medny Island (Commander Islands), several colonies collected from 0 to 19 m in 1992 and 1995. The material was already described by Sanamyan & Sanamyan (2011).

DESCRIPTION. The colonies are composed of cylindrical lobes 5–6 mm in diameter joined basally or growing from a common basal mass of the test.

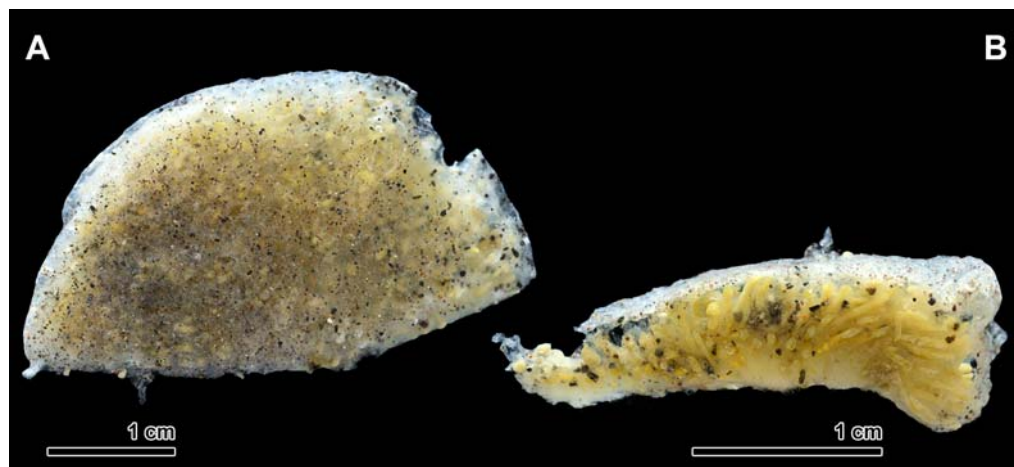


Fig. 10. *Aplidium spitzbergense*. A — colony, top view; B — cross section of the same colony to show arrangement of zooids.

Рис. 10. *Aplidium spitzbergense*. А — колония, вид сверху; В — срез той же колонии, видны вертикально стоящие зооиды.

The length of the lobes is variable, short in some colonies, much longer in others, up to 35 mm. The test is densely covered and impregnated with sand. Each lobe contains one system of zooids arranged in a circle around a small central cloacal cavity (the shape of the system is the same as in *Synoicum turgens*). The zooids have strong longitudinal muscles and in most colonies are very strongly contracted and deformed (Fig. 9B). Several less contracted zooids were found in some colonies (see Sanamyan, Sanamyan, 2011, Fig. 6), but they are not in good condition now. The atrial languet has three small lobes and is on the upper rim of the short atrial siphon (not separated from the siphon as in *A. spitzbergense*). According to Sanamyan & Sanamyan (2011) zooids have 12 rows of about 15 stigmata. Redikorzev (1927a) reported and figured 10 or 11 rows of about 15 stigmata in his specimens (his figure is informative and reproduced here, see Fig. 11A). The stomach has five very prominent folds.

REMARKS. *Aplidium fragile* (Redikorzev, 1927a) is a secondary junior homonym of *Aplidium fragile* (Herdman, 1891). These two species were initially described in different genera (*Amaroucium* and *Psammaplidium*) but both are currently assigned to *Aplidium*. The fact that *A. fragile* (Herdman, 1891) is not considered valid (it is a junior subjective synonym of *Aplidium solidum* (Herdman, 1891), see Kott, 1992; 1998) is not important, Redikorzev's and Herdman's species remain homonyms (Article 53.3, 57.3.1). A new replacement name, *Aplidium redikorzevi*, was proposed for Redikorzev's species by Sanamyan & Sanamyan (2011) (Article 60.1).

Aplidium redikorzevi appears to be a rare species. The original description (Redikorzev, 1927a) is based on two colonies collected in 1899 and 1912 in the vicinity of Shantar Islands (west part of the Sea of Okhotsk). Subsequently it was recorded only once, by Sanamyan & Sanamyan (2011) who reported several colonies from material collected in 1992 and 1995 around Pacific and Bering Sea coasts of Commander Islands. Despite extensive searching we failed to find this species along the east coasts of Kamchatka, where we have worked during many years, and it is not present in the material recently collected in the Sea of Okhotsk and Kuril Islands. Sandy colonies of *A. redikorzevi* are inconspicuous and easy to overlook, but the characteristic structure of colonies and zooids having only five stomach folds allows easy identification even if the material is in a poor condition. The number of rows of stigmata and stomach folds are the same as in zooids of *A. macrenteron*, but in almost all cases the zooids of the latter species are well distinguishable by a characteristic shape (they usually have a wider abdomen due to development of large epicardia and short tapering posterior abdomen).

Aplidium spitzbergense Hartmeyer, 1903
Figs 10, 11B.

Aplidium spitzbergense Hartmeyer, 1903: 341; Van Name, 1945: 30 (synonymy); Tokioka, 1967: 25; Sanamyan, 1998a: 115; Sanamyan, Sanamyan, 2017b: 129.

MATERIAL EXAMINED. *Ac. Oparin-56*, St.7, Urup Island (Sea of Okhotsk side), 45°52.2'N, 149°37.0'E, 142 m, 28.06.2019; St.13, Chirpoy Is-

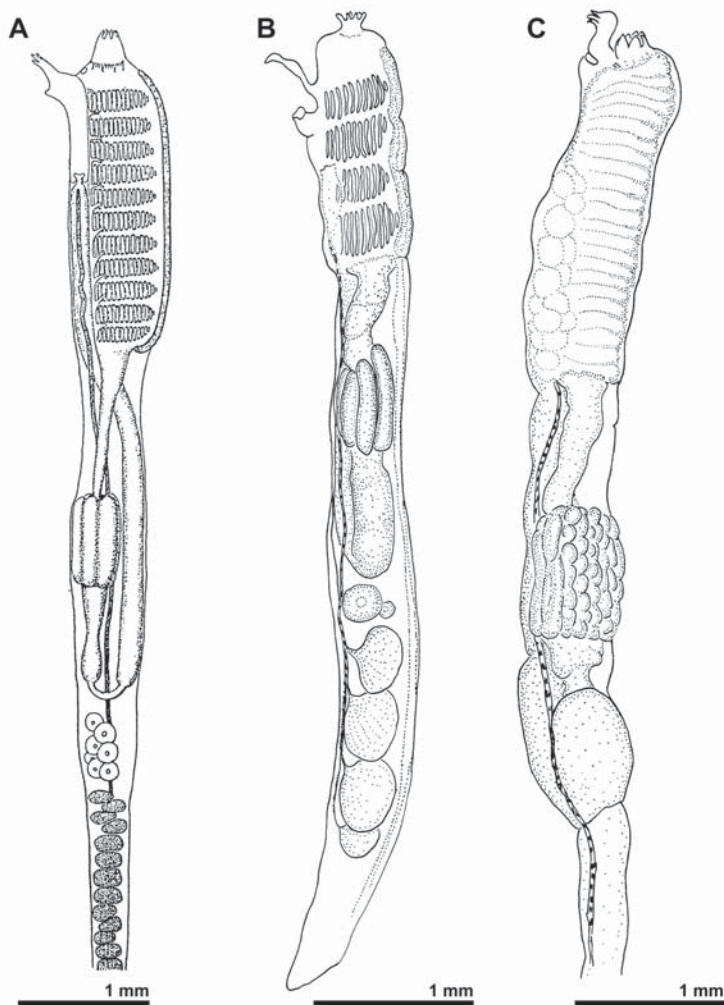


Fig. 11. A — *Aplidium redikorzevi* (after Redikorzev, 1927); B — *Aplidium spitzbergense*; C — *Aplidium polybunum*.

Рис. 11. A — *Aplidium redikorzevi* (no Redikorzev, 1927); B — *Aplidium spitzbergense*; C — *Aplidium polybunum*.

lands, 46°21.3'N, 150°48.2'E, 160–157 m, 30.06.2019; St.22, Shimushir Island (Sea of Okhotsk side), 47°15.4'N, 152°10.0'E, 222–205 m, 3.07.2019; St.24, Urup Island (Sea of Okhotsk side), 46°15.9'N, 150°15.4'E, 450–460 m, 5.07.2019; St.47, NW Sea of Okhotsk, 56°17.6'N, 137°58.2'E, 47 m, 1.08.2019; St.56, N Sea of Okhotsk, Erineyaskaya Bay, 59°18.7'N, 145°39.6'E, 55–53 m, 7.08.2019.

DESCRIPTION. Most colonies of the present material are gray masses having no definite shape: smaller colonies are often oval or even globular while larger are usually flattened. Most of them are

poorly preserved; one better preserved specimen (St. 13) in the material examined is represented by a piece about 3.5 cm in extent and 5 mm thick (Fig. 10). All colonies contain some amount of sand on surface and in the inner layers of translucent test, with zooids usually visible although systems are not recognizable.

The zooids are up to 5.5–6 mm long in a more closely examined colony (Fig. 11B), but may be much shorter in other specimens especially if strongly contracted. The branchial siphon has six lobes; the atrial is short, tubular, with apparently plain (not

lobed) margin, significantly displaced posteriorly along the mid-dorsal line of the thorax. A simple long atrial languet arises from the thoracic wall between the atrial and branchial siphons (not from the upper rim of the branchial siphon as in most other *Aplidium* species). The branchial sac has only four rows of stigmata. In rare less contracted zooids the stigmata appear to be rather long and not numerous, I counted about 14 stigmata but the condition of the material does not allow to count them precisely. The stomach is vertical, in the middle of the abdomen, with five well defined high folds. The posterior abdomen is about the same length as the abdomen (2 mm). In the examined specimen it contained several small ova in its anterior part (just below the gut loop) and several large densely packed male follicles arranged in one or two short series. Zooids of this species almost always have two whitish or yellowish cords (epicards?) running along the ventral side of the zooid from the bottom of the thorax (or branchial sac) to the posterior end of the posterior abdomen. This feature is rarely reported in descriptions of this species but actually is a characteristic feature found in most specimens of this species I examined previously and now. The present colonies contain no larvae though they were described previously by Sanamyan (1998a). They are 0.7 mm long (not including the tail), with a single row of numerous (30–35) epidermal vesicles running along each side of the anterior half of the larval trunk and absence of ampullae.

REMARKS. Although small sandy shapeless colonies are remarkably featureless and do not show any valuable features allowing identification, the zooids, with only four rows of stigmata and five stomach folds, easily distinguish this species even in poorly preserved colonies. It is known from Arctic waters (e.g. see Millar, 1966) and the North Pacific, where it was previously reported from Bering Sea, Pacific coasts of Kamchatka, North group of Kuril Islands and Sakhalin (Tokiooka, 1967; Sanamyan, 1998a) and now is reported from the Sea of Okhotsk and from the middle and south groups of Kuril Islands.

Group 2. *Aplidium* species having (5)6–15(18) stomach folds (Table 1)

Currently in the region covered by the present paper I recognize seven species belonging to this group (see Table 1). Of them *A. polybunum* is well characterized with very numerous rows of stigmata (20–22) and is certainly valid; *A. lebedi* and *A. disiphonium* also are certainly valid species distinguished by the structure of their larvae, and also by characteristic club-shaped colonies in *A. lebedi*. The remaining four species are more problematic: *Aplid-*

ium eborinum is probably the best known species and all characters necessary for its identification (including shape of systems and larval structure) are known and described in detail, but it may be conspecific with the poorly known *A. vinogradovae*. This latter species has slightly fewer rows of stigmata; the shape of its systems is not known. The geographic ranges of these two species do not overlap and in the present paper I prefer to keep them as two separate species. The same is true for another pair of species: *A. dubium*, known only from Commander Islands, and *A. matua*, known only from Kuril Islands. They have similar colonies, but zooids differ somewhat in the number of rows of stigmata (11 or 12 in *A. dubium* and 15–17 in *A. matua*) and degree of development of the thoracic muscles. I am not sure whether this difference is enough to separate them but prefer to keep them distinct especially because some key features are not known (e.g. larval structure and system shape).

Aplidium polybunum (Redikorzev, 1927)
Figs 11C, 12.

Amaroucium polybunum Redikorzev, 1927a: 389.
Amaroucium soldatovi Redikorzev, 1937: 123.

MATERIAL EXAMINED. *Ac. Oparin-56*, St.69, Onekotan Island (Sea of Okhotsk side), 49°24.0'N, 154°16.1'E, 146–147 m, one colony, 12.08.2019; St.77, Shiashkotan Island (Pacific side), 48°48.7'N, 154°13.8'E, 128–127 m, 15.08.2019, one colony.

DESCRIPTION. Two available colonies are massive, one is about 12 cm in diameter and 6 cm thick, the other is of about the same size but more flattened, up to 4 cm in thickest part. The test surface is densely covered with a thin layer of sand (Fig. 12B). Sparse sand grains are present in the inner layers of test. The test is colourless, translucent (but not transparent) and very slimy (the latter feature may depend on fixation — a rather large proportion of “slimy” colonies is present in the material collected by this expedition and may be due to poorly buffered formalin). Zooidal systems are not recognizable in the preserved colonies but most probably zooids are arranged in small circular systems: small shallow cloacal cavities are seen beneath the superficial sandy layer of test. The zooids are long and fragile, difficult to extract. The thorax (contracted) and abdomen together are about 10–12 mm long. The branchial siphon has six pointed lobes. I failed to detect any small secondary lobes on the sides of the main ones which were described for this species originally. A short atrial siphon is on the antero-ventral corner of the thorax; the atrial languet is short with three pointed lobes at the end. The oral tentacles are difficult to count, about ten long ones are present and probably about the same number of smaller ones

Table 1. *Aplidium* species having more than 5 and less than 20 stomach folds.
Таблица 1. Виды рода *Aplidium*, имеющие более 5, но не менее 20 складок желудка.





	<i>A. polybunnum</i>	<i>A. lebedi</i>	<i>A. dubium</i>	<i>A. matua</i>	<i>A. disiphonitum</i>	<i>A. vinogradovae</i>	<i>A. eborinum</i>
languet rows of stigmata	3-dentate 20-22	3-dentate (always?) 11-12 (up to 16?)	3-dentate 11-12	3 short lobes 15-17	3-dentate 14-15	1 8-10	1 12-14
stomach folds	about 15, irregular, as series of swellings	5-7 (often irregular)	8-10	8	~10 (up to 15?)	13 or 14	12-15 very regular
colony	massive and round	club-shaped lobes, no sand	irregular	sandy cushions	cushion with short crowded round elevations on surface	irregular cushions or crusts, no sand	large thick masses with uneven surface, no sand
systems	small circular	?	sandy crusts ?	round	round	?	elongated with branched cloacal canals
larva	?		?	?			
distribution	Sea of Okhotsk, N Kuril Islands	Kuril Islands, deeper water (142-296 m)	Commander Islands	Middle and south groups of Kuril Islands	N Kuril Islands	S Kuril Islands	Kamchatka to middle Kuril Islands



Fig. 12. *Aplidium polybunum*. A — zooids; B — colony.

Рис. 12. *Aplidium polybunum*. А — зоиды; В — колония.

between them. The branchial sac is long and narrow, with 22 rows of stigmata and about 17–20 stigmata per row on each side. The abdomen is very long, in most zooids longer than the thorax. The vertically oriented, barrel-shaped stomach is in the middle of the abdomen or slightly closer to its posterior end. Longitudinal folds of the stomach wall are irregular, sometimes well-formed (especially the folds located closer to the typhlosole), in other cases broken into longitudinal series of prominent swellings (Figs 11C, 12A). Due to irregularity the number of stomach folds is difficult to determine. On cross sections of the stomach about 15 or slightly more folds may be counted. The post pyloric subdivision of the

intestine includes a short duodenum and mid-intestine. A rectal valve was not detected (although it is present in Redikorzev's, 1927a figure of this species). The rectum opens approximately in the middle of the thorax. The posterior abdomen of all examined zooids is long, thinner than the thorax and filled by loose parenchymatous tissue. Gonads were not seen although a thick white sperm duct is visible on many zooids. Several embryos are incubated in the thorax of many zooids but fully developed larvae were not found.

REMARKS. The original description of this species (Redikorzev, 1927a) is based on a single colony about 30 mm in diameter recorded in the

northern part of the sea of Okhotsk (59°17'N, 145°40'E). Unlike the present colonies the type specimen has a smooth clear surface not covered with sand. The most characteristic feature is a high number of the rows of stigmata (22 in the present specimens, 21 in the type specimen); all other *Aplidium* species known in the region have fewer rows of stigmata. The shape of the stomach wall is also characteristic (but not unique). Redikorzev (1927a) stated that swellings of the stomach wall in his material form about ten longitudinal series (=“folds”), while in the present specimens they form more numerous “folds”. However, due to irregularity, all these numbers are not precise and cannot be used to separate species.

Amaroucium soldatovi is a synonym of *A. polybunum*. It was described from the western part of the Sea of Okhotsk (Shantar Islands, 54°33'N, 137°23'E). According to the original description the type specimens have 20 rows of stigmata with 15–20 stigmata per row on each side. The colonies are large and covered with sand as well as also present inside the colonies. Redikorzev (1937) recognized the close similarity with *A. polybunum* but stated that in *A. soldatovi* the swellings of the stomach wall are not so regularly arranged into longitudinal series as in *A. polybunum*. As it becomes clear now, the degree of irregularity in distribution of the swellings and stomach folds in this species is variable.

The structure of the stomach wall in *Aplidium polybunum* is intermediate between *Aplidium* and *Synoicum*. In particular, the specimens of *Synoicum turgens* (the type species of the genus) described in the present work, have large swellings of the stomach wall arranged in more or less distinct longitudinal series, as in *A. polybunum* (while usually their distribution in *S. turgens* is less regular). The colonies of *A. polybunum* are very similar to colonies of *Synoicum jordani*, but zooids of the latter species have a smooth stomach.

Previously this species was known only from original descriptions of *A. polybunum* and *A. soldatovi*. The known distribution is limited to the Sea of Okhotsk (Redikorzev, 1927a, 1937) and north group of Kuril Islands (present work).

Aplidium lebedi Sanamyan, 1998

Fig. 13

Aplidium lebedi Sanamyan, 1998a: 124.

MATERIAL EXAMINED. RV «Lebed», st.122, Kuril Islands, Shumshu Island, near Krasivy Point, 50°32.5'N, 157°27'E, 280 m, 1.08.1954, coll. Spirina (holotype KBPGI 1/882 and paratype KBPGI 2/883); st.132, 296 m, 50°21.3'N, 157°14.1'E, 3.08.1954 (paratype KBPGI 3/884). *Ac. Oparin-56*, St.3, Urup Island (Pacific side), 45°35.5'N, 149°47.7'E, 145–142 m, 27.06.2019, one colony.

DESCRIPTION. The colonies from the type material (Fig. 13A) are upright club-shaped lobes up to 45 mm in height, attached to small stones by a narrow base. The holotype is represented by two such lobes joined at the base. The test contains no sand and the surface is clean. Zooids open in the slightly expanded upper third of these lobes while the lower two thirds contain the posterior abdomens standing vertically and parallel to each other. The shape of the systems cannot be recognized. The zooids are contracted and fragile and difficult to examine. According to the original description (Sanamyan, 1998a) they have 11 or 12 rows of stigmata and seven stomach folds but reexamination of the type material reveals that the number of stomach folds may be fewer than seven and in many cases the stomach wall is too irregularly folded for the folds to be counted. The trunk of a fully developed larva is about 1 mm long, with three adhesive organs, long and thin finger-shaped median papillae and an arc of lateral ampullae on each side; the latter are strongly expanded at their ends (see Fig. 12C and also Sanamyan, 1998a, fig. 8A).

A colony from Urup Island (Fig. 13D) is tentatively assigned to this species. It is smaller than the colonies from the type material (about 2 cm in height), the test is clear, soft and translucent internally. The shape of the systems is also not distinguishable. The zooids are 6.5–7.5 mm long. They have 15 (or maybe up to 16) rows of stigmata. The number stomach folds is not easy to determine; I counted six or five folds in some zooids; they are not prominent and often irregular. The ovary contains a compact group of oocytes situated at some distance from the pole of the gut loop, down along the posterior abdomen. Larvae not present.

REMARKS. The original description of this species (Sanamyan, 1998a) is short but quite informative. Sanamyan (1998a) reported that the zooids are arranged in the heads of the colony in indistinct longitudinal rows. This may be correct, but as was revealed by reexamination of the type material, the rows are too indistinct and it is better to say that the shape of systems is not recognizable rather than to made an incorrect assumption that the zooids are arranged in rows. It is quite surprising that the species has not been recorded again since its original description (which itself was based on the historical material collected in 1954). A recently collected specimen from Urup Island is assigned to it only tentatively; it has a slightly larger number of the rows of stigmata (15 or may be 16 in comparison to 11 or 12 reported for *Aplidium lebedi*) and slightly smaller number of stomach folds. The latter feature may not be very reliable in this case because in all examined colonies the stomach folds are rather irregular. All other North Pacific *Aplidium* species with few stom-

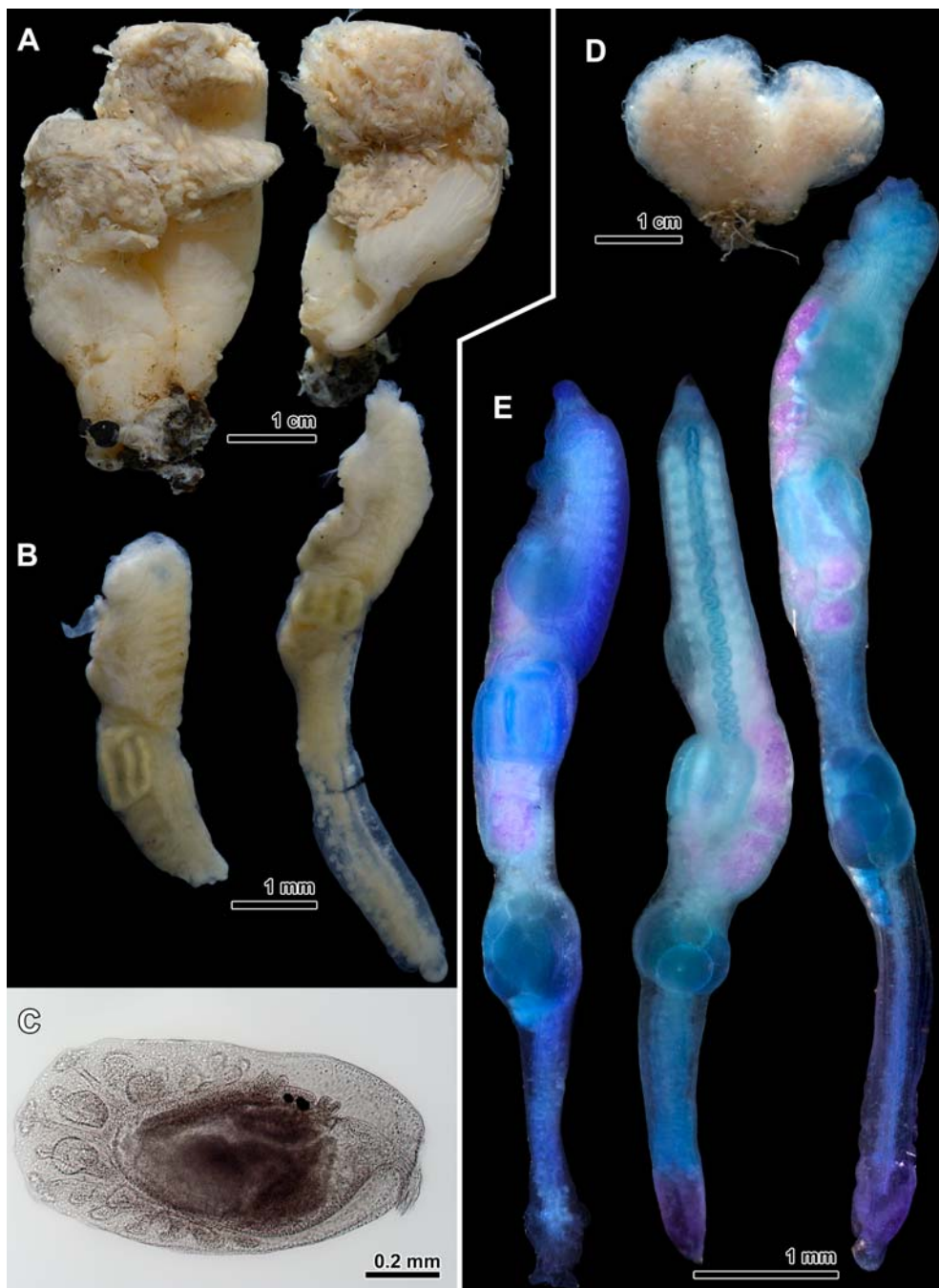


Fig. 13. *Aplidium lebedi*. A — colonies (holotype KBPGI 1/882 on the left and paratype KBPGI 2/883 on the right); B — zooids from the type colonies; C — larva (from holotype); D — colony from Urup Island; E — zooids from the same colony (lightly stained by toluidine blue).

Рис. 13. *Aplidium lebedi*. А — колонии (голотип KBPGI 1/882 слева и паратип KBPGI 2/883 справа); В — зоиды из голотипа; С — личинка (из голотипа); D — колония с о. Уруп; E — зоиды из той же колонии (слегка окрашены толуидиновым синим).

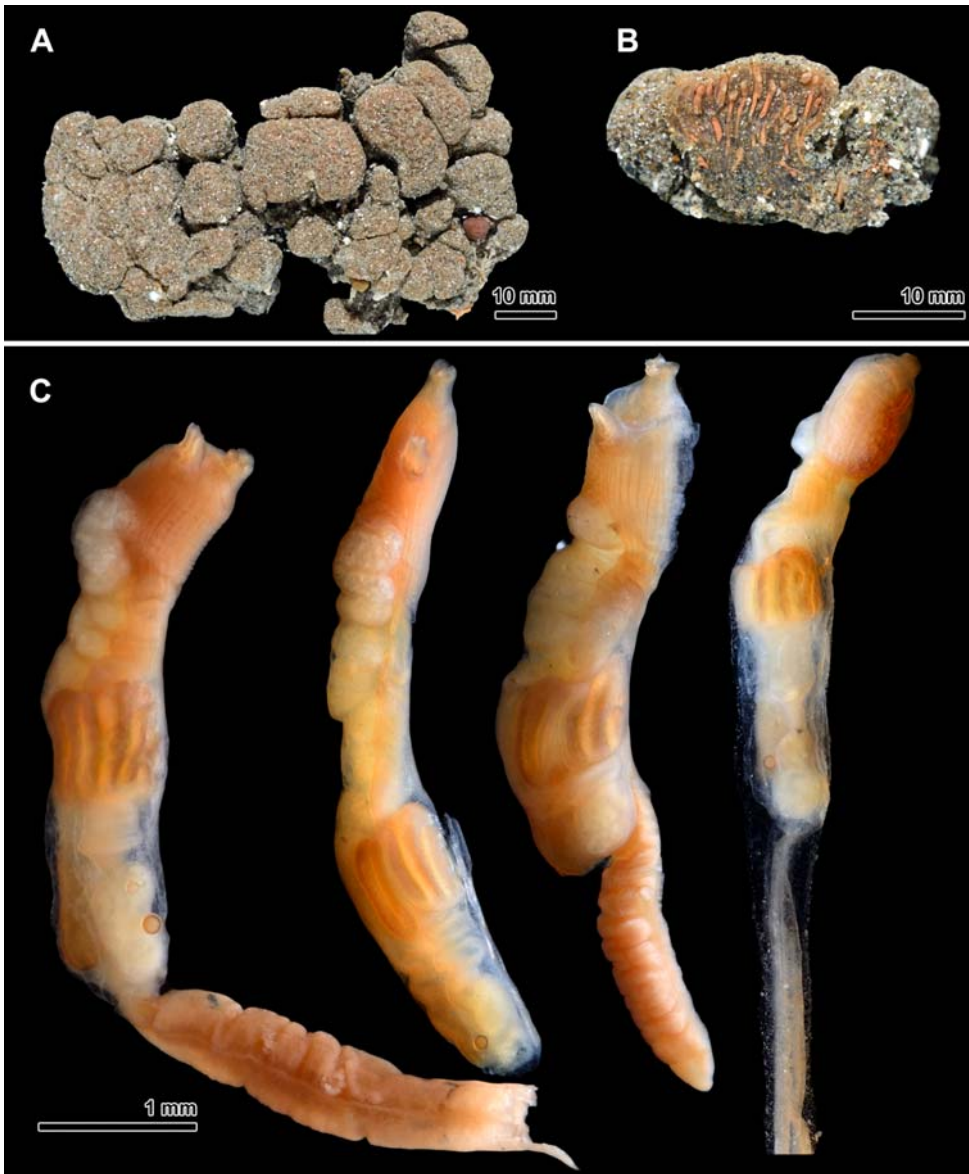


Fig. 14. *Aplidium dubium*. A — colony; B — a lobe separated from the same colony and sectioned longitudinally; C — zooids.

Рис. 14. *Aplidium dubium*. A — колония; B — долька, отделенная от колонии и разрезанная продольно; C — зооиды.

ach folds (*A. spitzbergense*, *A. redikorzevi*, *A. mactreteron*, *A. dubium* and *A. matua*) have quite distinct sandy colonies and the colony from Urup Island indeed appears to be most closely related to *A. lebedi* despite some difference in the number of rows of stigmata.

Aplidium lebedi is currently known only from Kuril Islands: the type material is from the north

group and another colony, tentatively assigned to this species, from the southern group. Known depth range is limited to 142–296 m.

Aplidium dubium (Ritter, 1899)
Fig. 14.

Amaroucium dubium Ritter, 1899: 528.

Aplidium dubium Sanamyan, 1998a: 118 (part, lobed colonies are *Aplidium redikorzevi*).

MATERIAL EXAMINED. Commander Islands, Medny (=Cooper) Island, many colonies collected from 5 to 23 m collected in 1992.

DESCRIPTION. Although many specimens are available most of them contain strongly contracted and often poorly preserved zooids. All colonies are densely impregnated by sand, often with patches of brown on the upper surface (as in *A. matua*, see Fig. 15A) and in most cases the shape is very irregular.

This brief description is based on a single better preserved specimen collected at Medny Island at 9–12 m (KBPGI 599/11). The colony is composed of many crowded cushions 1–2 cm in diameter and up to 1.5 cm in height, joined together basally and also along the lower sides (Fig. 14A, B). The whole colony is about 10 cm in greatest dimension. The zooids are arranged vertically and parallel to each other; they open only on the upper surface of the lobes (but not on their sides). The shape of the systems cannot be recognized. The zooids are up to 1 cm in length (including the long posterior abdomen), but, as in most other colonies they are strongly contracted. The branchial siphon has six well developed lobes (original description says that only five lobes are present). The atrial aperture is almost sessile, with tridentate atrial languet (Fig. 14C). Zooids have strong longitudinal thoracic muscles visible on the photographs (Fig. 14C), a feature characteristic for this species. There are 11 or 12 rows of stigmata. The stomach is large, symmetric, with prominent longitudinal folds quite regular, eight or nine in number in most zooids.

REMARKS. The original description was based on three colonies washed up on the shore of Medny Island collected by L. Stejneger and described by Ritter (1899). Several other authors mentioned or discussed this species (Redikorzev, 1910; Hartmeyer, 1924; Van Name, 1945) but none of them saw it until Sanamyan (1998a) reported many specimens from the type locality. Although Ritter's (1899: 529) description may not be precise in some details (e.g. he reported five well marked lobes of the branchial siphon), there is no doubt in identification, *Aplidium dubium* is probably the most common colonial ascidian in the Commander Islands and its sandy colonies can often be found between rhizoids of *Laminaria* washed up on the shore of Medny Island. Ritter (1899) especially noted that the zooids were "all in condition of extreme contraction", a condition in which zooids of almost all subsequently collected colonies are. Ritter (1899) says his specimens have ten rows of stigmata, Van Name (1945) reported 10 to 12 rows but it is not clear from his description where he gathered this information (reexamined type material?). Sanamyan (1998a: 118) reported

"11–12–15 rows of stigmata" but now I was not able to find any zooids in the available material in which more than 12 rows of stigmata could be counted. In most colonies the thoraces of zooids are so strongly contracted that the rows of stigmata cannot be counted precisely.

Currently *Aplidium dubium* is known only from the Commander Islands. *Aplidium matua* from the middle group of Kuril Island is very similar and it may be conspecific. See remarks under *A. matua* for comparison and discussion.

Aplidium matua

Sanamyan et Sanamyan, 2017

Fig. 15.

Aplidium matua Sanamyan, Sanamyan, 2017b: 126; 2020: 295.

MATERIAL EXAMINED. *Ac. Oparin-56*, St.27, Urup Island (Sea of Okhotsk side), 45°51.03'N, 149°43.37'E, 6–12 m, 5.07.2019, several colonies.

DESCRIPTION. The colonies are composed of one or several low wide cushions up to 3 cm in extent and mostly less than 1 cm in height. They were attached to the substratum by the entire lower surface and in part along the sides of the cushions and probably were collected among thick rhizoids of *Laminaria*-like brown algae. The test is densely impregnated with sand. Upper surface of the cushions, where the zooids open, is characteristically brownish in formalin. Freshly collected colonies were reddish.

The shape of the systems is not recognizable in preserved material, however underwater photos of inflated live specimens clearly show that the zooids are arranged in circular systems around several large cloacal openings evenly distributed over the upper surface of the colony (see Sanamyan, Sanamyan, 2017b, 2020). The zooids are up to 6 mm long. The long branchial siphon has six branchial lobes which are not prominent in most zooids. The atrial siphon is also rather well developed (long), with a wide atrial languet issued from its upper rim. The atrial languet has three very short, inconspicuous lobes at its end. The branchial sac has 15 rows of stigmata (17 were reported originally in the type material). The abdomen may be slightly longer than the contracted thorax. The stomach is short and wide, barrel shaped, cylindrical, with eight well-marked and high longitudinal folds (Fig. 15B). Post-pyloric subdivision of the intestine is well visible (Fig. 15B). Posterior abdomens in examined zooids are short and contain no gonads. Larvae were not found.

REMARKS. The original description of this species is based on a single colony collected at Matua Island (middle group of Kuril Islands). The

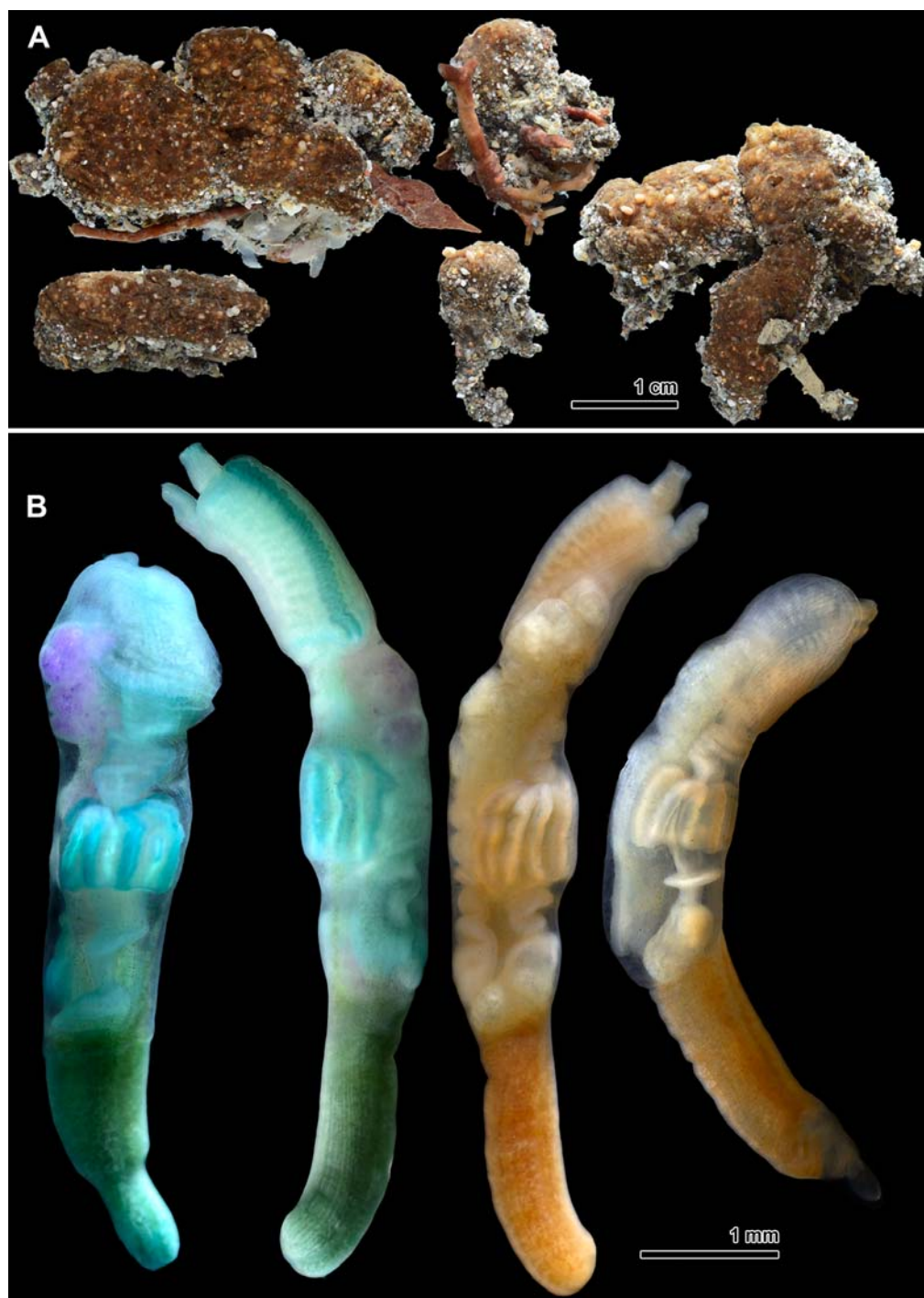


Fig. 15. *Aplidium matua*. A — colonies; B — zooids (two zooids on the left are stained by toluidine blue).
Рис. 15. *Aplidium matua*. А — колонии; В — зоиды (два зоида с левой стороны фотографии окрашены толуидиновым синим).

present record extends the known range of distribution to Urup Island in the south group of Kuril Islands. As was discussed by Sanamyan & Sanamyan (2017b) *Aplidium matua* is most closely related to *A. dubium*, a species which is very common around Commander Islands but not known in other regions. In particular, preserved colonies of these two species look very similar: they are sandy masses with very characteristic patches of brown on the upper surface of the cushions. However, *A. dubium* from Commander Islands apparently has much stronger body muscles and possibly has fewer (11 or 12) rows of stigmata. At present I prefer to keep them as two separate species. Larvae of both species are not known.

Aplidium disiphonium (Beniaminson, 1975)
Fig. 16.

Amaroucium disiphonium Beniaminson, 1975b: 66.

Aplidium disiphonium Sanamyan, 1998a: 126.

MATERIAL EXAMINED. Paramushir Island, Lavashova Point, 18 m, 27.08.1969 (holotype ZIN 1/2334).

DESCRIPTION. This description is based on the type colony. According to the original description it was 68 mm in length, 47 mm in maximal width and about 20–25 mm thick, but then the specimen was probably sectioned and examined part was smaller (Fig. 16A). The test is gray, opaque, almost free from sand on the surface and only a few sand grains in the inner layers. Upper part of the colony divided into numerous short flat-topped lobes irregular in outline, in a rather mutilated condition now (Fig. 16A). Zooids are arranged in circular systems: each lobe has one or two larger common cloacal openings surrounded by a circle of branchial openings of several zooids.

Zooids are up to 25 mm long but generally shorter (Fig. 16B). The most peculiar feature is the long atrial siphon with a quite distinct wide tridentate atrial languet on its upper rim. Atrial siphon is long in all examined zooids. The branchial sac in two more closely examined zooids has 15 rows of stigmata (14 or 15 in the original description). The stomach is short, cylindrical and more or less symmetric. Longitudinal stomach folds are irregular and their number is now hard to determine exactly; in two zooids extracted from the holotype during the present study there are about 10 folds, although Sanamyan (1998a) reported 15 stomach folds for this species. As in many *Aplidium* species with a small number of stomach folds, the folds are not present on the side of the stomach wall adjacent to the intestine. Typical for this genus, the post-pyloric subdivision of the intestine is well visible (Fig. 16B, right zooid).

Most zooids have several (up to five or possibly slightly more) developing larvae in the peribranchial cavity. Larvae are large; the trunk in fully developed larvae is 1.2 mm long. There are three rather short-stalked adhesive organs and four median ampullae alternating with them. Median ampullae have a wide conical base and small spherical tip. Numerous small epidermal vesicles form a wide arc on each side of anterior half of the trunk (Fig. 16C).

REMARKS. This species is known only from the original description (Beniaminson, 1975b) and a colony collected from about the same location (Paramushir Island) but from greater depth (200–358 m) described by Sanamyan (1998a). Beniaminson (1975b) stated that the long atrial siphon is the most important distinguishing feature of her species. In reality it is probably not a very reliable feature. On the other hand, in all zooids extracted from the holotype the atrial siphon is long and resembles the atrial siphon of many *Synoicum* species. Its shape in polyclinids depends on the structure of the systems. Small regular circular systems of *A. disiphonium*, one or several in each lobe, also resemble those of many *Synoicum* species but the structure of the stomach left no doubt on its generic assignment. The colony shape of this species is also distinctive. Although existing material is rather mutilated now, from available information it may be assumed that in life this species resembles *Synoicum polyzoinum* (Sanamyan, Sanamyan, 2017b, fig. 2) which also consists of poorly separated lobes with circular systems in each.

Zooid and larval structure of *Aplidium disiphonium* (but not colony shape) is reminiscent of *Aplidium coei* (Ritter, 1901) known from Kodiak Island (Alaska). The latter species also has zooids with long atrial siphons (especially mentioned in its original description by Ritter, 1901 and by Sanamyan 1998a), similar number of stomach folds (13) and rows of stigmata (14–16). Its larva also has numerous small vesicles arranged in a wide band on each side of the anterior part of the trunk but is larger (1.6 mm long) and has no median ampullae. Its colony consists of large separate club-shaped lobes which do not resemble *A. disiphonium*.

Aplidium disiphonium cannot be confused with other *Aplidium* species known from the NW Pacific which have more than 5 and less than 20 stomach folds: three (*A. lebedi*, *A. vinogradovae* and *A. eborinum*) have different larvae, *A. polybunum* has very numerous rows of stigmata (20–22) and *A. dubium* and *A. matua* are sandy colonies without regular cylindrical lobes on the upper side.

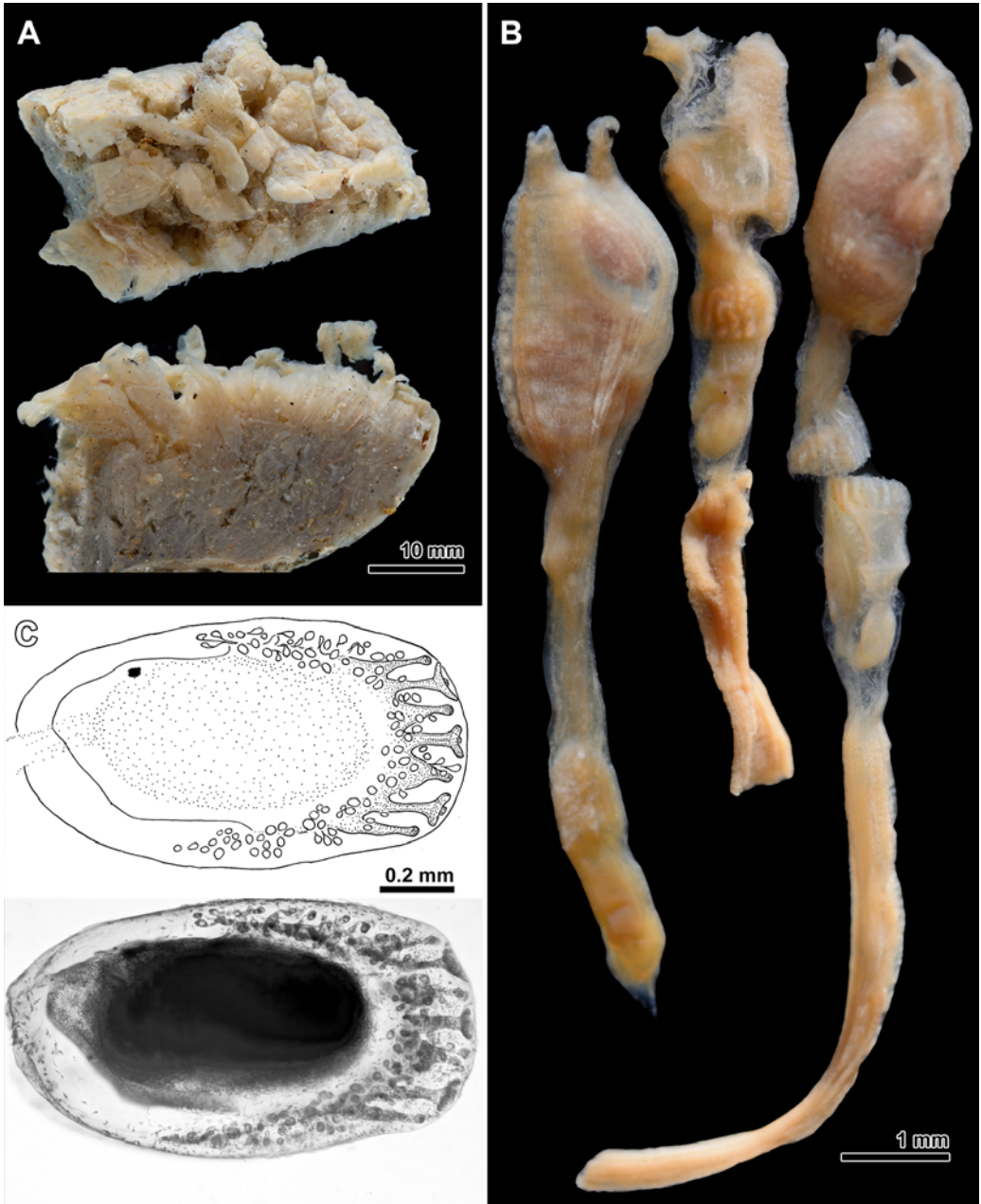


Fig. 16. *Aplidium disiphonium* (holotype). A — colony from the top and longitudinal section; B — zooids; C — larva.

Рис. 16. *Aplidium disiphonium* (голотип). А — колония, вид сверху и продольный разрез; В — зооиды; С — личинка.

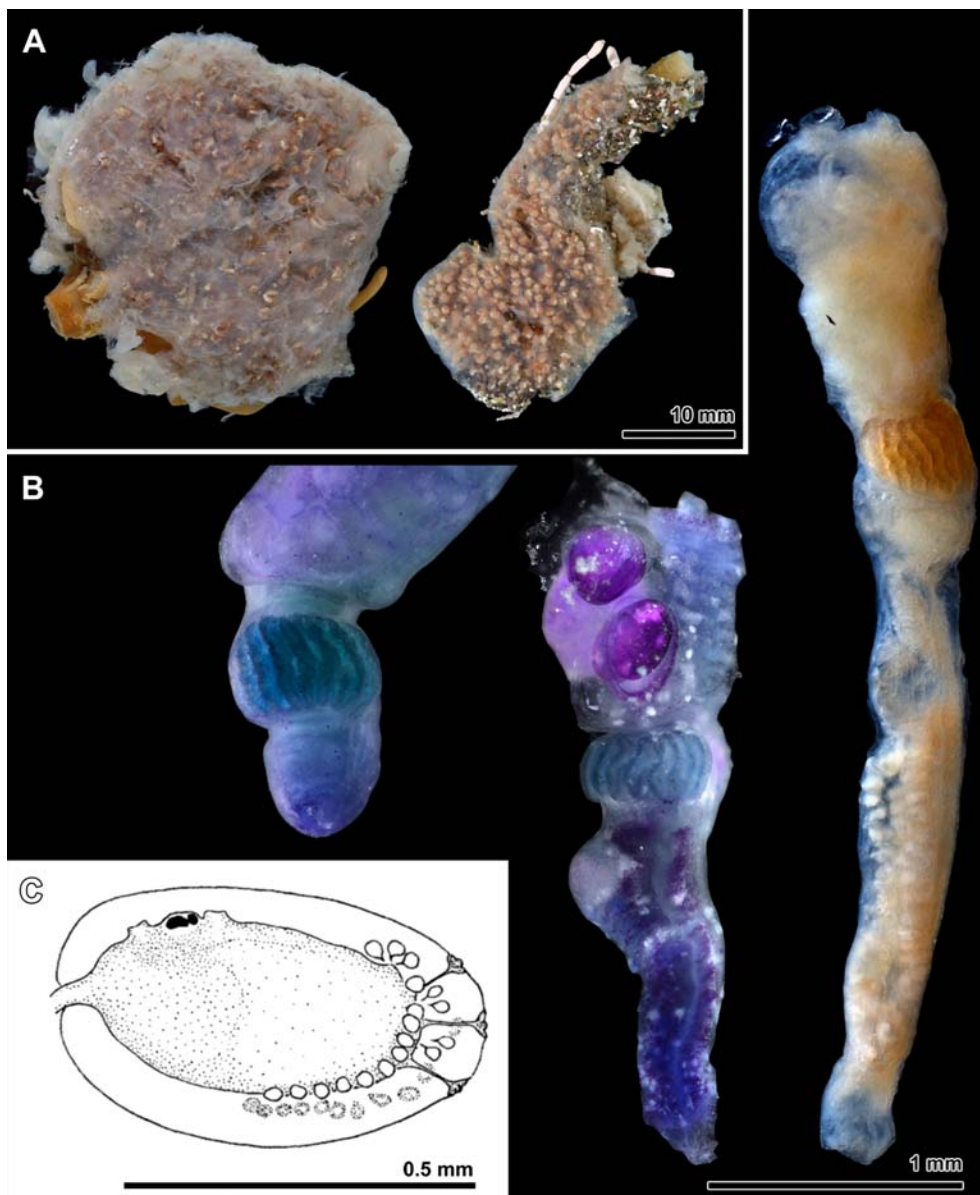


Fig. 17. *Aplidium vinogradovae*. A — colonies; B — zooids; C — larva (after Sanamyan 2000a).

Рис. 17. *Aplidium vinogradovae*. А — колонии; В — зооиды; С — личинка (по Sanamyan 2000a).

Aplidium vinogradovae Beniaminson, 1974

Fig. 17.

Amaroucium vinogradovae Beniaminson, 1974: 320.

Aplidium glabrum: Sanamyan, 2000a: 213 (part, only specimens from south group of Kuril Islands, not specimens from Kamchatka = *Aplidium eborinum*).

Not *Amaroucium glabrum* Verrill, 1871: 288.

MATERIAL EXAMINED. Southern Kuril Islands: Shikotan Island, Tserkovnaya Bay (~43°44'N, 146°41.5'E), 14.07.1987; Krabovaya Bay (~43°52.5'N, 146°49'E), 31.08.1997; Yury Island, Shirokaya Bay (~43°25.5'N, 146°5'E), 7.08.1987; Tanfilieva Island (~43°26'N, 145°56'E), 11.08.1987; Polonskogo Island (~43°39'N, 146°19'E), 22.07.1987. Several colonies and fragments in each station, all collected in the intertidal zone.

DESCRIPTION. The material is represented by numerous fragments, most of them 2–4 cm in greatest dimension. Some were apparently low and cushion-like in life (left colony in Fig. 17A) but most others are now shapeless and their shape in life is unknown. Most colonies have a clear surface with no sand and only rarely is some sand present at the base of the colony (as in the right colony in Fig. 17A). The colonies are not in good condition and the shape of the systems is difficult to identify. On some colonies several common cloacal openings are recognizable but it is not clear whether the zooids are arranged in circles around them or they form elongated or other systems. The zooids are tiny, 3–4 mm long in contracted state. They have a simple atrial languet but it is poorly preserved in many colonies and hard to examine. The branchial sac has nine or ten rows of stigmata. The stomach is short, barrel-shaped, symmetrical, with 13 or 14 quite regular high folds (Fig. 17B). Many zooids contain larvae but only a few are fully developed. The trunk is 0.55–0.6 mm long, with three adhesive organs on long thin stalks and a row of small regularly arranged epidermal vesicles forming an arc on each side of the anterior part of the trunk (Fig. 17C). Larvae lack any medial or lateral ampullae.

REMARKS. The original description of *Aplidium vinogradovae* is based on one colony collected in 1949 in the intertidal zone of Shikotan Island (Beniaminson, 1974). The author focused on detailed description of various insignificant features, e.g. shapes of contracted colonies or zooids, but omitted several important characters. The colony is described as cushion-like, rather irregular in outline, 38x22x16 mm, with a clear (free from foreign matter) surface. The zooids have a simple atrial languet and eight rows of stigmata. The atrial cavity contains numerous (up to 18) larvae, but their structure was not reported. The exact number of stomach folds in the holotype is not known; Beniaminson (1974) wrote that the stomach has folds but did not specify the number. Her figures are confusing; she included several figures of zooids (Beniaminson, 1974, Fig. 2) and three show different numbers of stomach folds: two figures show very regular wide and not numerous folds (five and eight folds are visible on one side of the stomach) while the third figure shows much more numerous and thinner folds (about 14 are visible, therefore the total number is presumably larger). The first two figures appear to be more reliable, so most probably the holotype has from 12 to 15 folds. Unfortunately, I had no chance to reexamine the type material, however some colonies assigned to this species in the present paper come from Krabovaya Bay of Shikotan Island, the type locality of Beniaminson's (1974) species and are considered conspecific.

The material from several Southern Kuril Islands briefly described above, together with the colonies from Kamchatka, was previously examined and identified by Sanamyan (2000a) as *Aplidium glabrum* (Verrill, 1871). However, *A. glabrum* is a northern species inhabiting Atlantic waters which does not occur in the Pacific. The identity of the specimens identified as *Aplidium glabrum* from Kamchatka was clarified by Sanamyan & Sanamyan (2011), who created a new species *A. eborinum* for it. The identity of the specimens from the southern group of Kuril Islands was not resolved at that time; Sanamyan & Sanamyan (2011: 47) wrote that southern specimens differ from both *A. glabrum* and *A. eborinum*: “Specimens from South Kuril Islands identified by Sanamyan (2000a) as *A. glabrum* appear to be distinct from the *A. eborinum*, the structure of systems is not recognizable, the larva is very similar but smaller, and zooids have only 9 or rarely 10 rows of stigmata”. This opinion is considered to be correct: colonies from Shikotan and other southern Kuril Islands indeed belong to a different species and its valid name is *A. vinogradovae*. At present *A. vinogradovae* is known only from the intertidal zone of several southern Kuril Islands where it is quite common.

Aplidium eborinum
Sanamyan et Sanamyan, 2011
Fig. 18.

Aplidium eborinum Sanamyan, Sanamyan, 2011: 46; 2017a: 313.

Aplidium glabrum: Sanamyan, 1998a: 119; 2000a: 213 (part); Sanamyan, Sanamyan, 2010: 242.

Not *Amouroucium glabrum* Verrill, 1871: 288.

MATERIAL EXAMINED. Kamchatka, Avacha Bay, Pyramidny Point, 18 m, 14.02.2007, two colonies.

DESCRIPTION. Two examined colonies are oval masses with large round lobes or swellings on the upper surface (Fig. 18A), about 6 cm in greatest extension and 2 cm thick. The test is opaque, pale brownish in alcohol. Surface is completely free from any kind of attached foreign matter and contains no embedded sand. Zooids are arranged into complex systems consisting of branched canals converging to several rather large cloacal openings situated on the tops of lobes. The zooids have long and always simple atrial languet. The branchial sac has 13 rows of stigmata (12 and 14 were recorded previously). Stomach folds are very regular; 14 were counted in the present material (13–15 previously reported). The present colonies contain no larvae. In the holotype they were 0.9 mm (length of the trunk) and had closely set epidermal vesicles arranged in a single row around each side of the anterior half of the larval trunk, but no median or lateral ampullae (Fig. 18C).

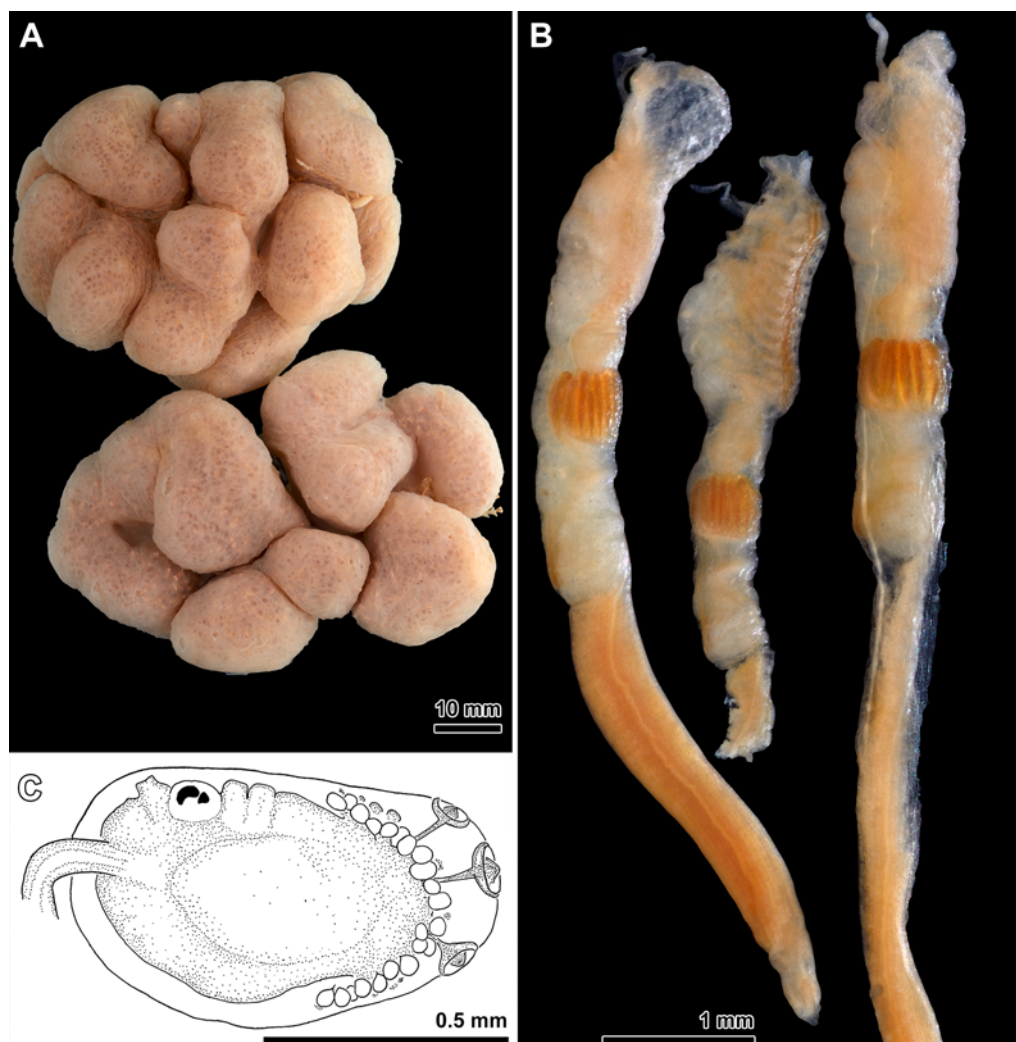


Fig. 18. *Aplidium eborinum*. A — two colonies; B — zooids; C — larva (from holotype, after Sanamyan, Sanamyan, 2011).

Рис. 18. *Aplidium eborinum*. А — две колонии; В — зоиды; С — личинка (из голотипа, по Sanamyan, Sanamyan, 2011).

REMARKS. *Aplidium eborinum* is known from Commander Islands, Kamchatka and the middle group of Kuril Islands. Original and subsequent descriptions (Sanamyan, Sanamyan, 2011, 2017a) are very detailed and include underwater photographs of fully inflated live colonies showing the structure of the systems. Large fully developed colonies are very characteristic in their shape and color in life (always pale, whitish or with yellow tint) and easily distinguished from other *Aplidium* species. Smaller colonies, especially in preserved state, when

the shape of the systems cannot be recognized, are more difficult to separate from similar species. *Aplidium vinogradovae* from the southern group of Kuril Islands is probably a related species or even may be conspecific. Its zooids have slightly fewer rows of stigmata (eight or ten) but otherwise their features are similar. Larvae are also similar. The shape of the systems and colony in life (the features which constitute the most distinctive characters of *A. eborinum*) cannot be compared because these features are not known for *A. vinogradovae*.

Group 3. *Aplidium* species having 20 or more stomach folds (Table 2)

This is a difficult group comprising several similar species characterized by a high number of stomach folds and relatively low number of rows of stigmata. Initially, when I started to study *Aplidium* species from North Pacific, I identified all specimens with numerous stomach folds and upright colony lobes as *A. translucidum* (Ritter, 1901) while other similar species, but with large unlobed colonies, as *A. pliciferum*. Later, when we started to collect specimens along with high-quality underwater photographs, it became clear that colonies differ significantly in the shape and structure of zooid systems and certainly belong to different species; this feature is easily observable on the underwater photographs of live inflated colonies but may be very difficult to study on preserved specimens. Also, it was shown that larval structure also differs in different colonies. As a result, this group was split into several species and currently in the region covered by the present paper I recognize five species of *Aplidium* with 20 or more stomach folds (see Table 2). Two of them, *A. oculatum* and *A. tenuicaudum* are well characterized and are certainly valid: *A. oculatum* usually has very characteristic pigment dots along the sides of the endostyle and *A. tenuicaudum* is characterized by its larvae with numerous epidermal vesicles arranged in several rows. The taxonomic status of the other three species, *A. strandi*, *A. confusum* and *A. dissectum*, is more problematic. Their colonies are similar in general shape but the structure of the systems is known only for one species (*A. dissectum*) and therefore more precise comparison is not possible. Zooids are also similar and differ slightly only in the number of rows of stigmata and, possibly, in the shape of the atrial languet, and at least two of them (*A. confusum* and *A. dissectum*) have similar larvae. *Aplidium translucidum* from NE Pacific (Alaska) also belongs to this group and in the case of synonymization it will have priority. Geographic ranges of all these species do not overlap and currently I prefer to keep them as separate valid species for the reasons explained below (see Remarks under *A. dissectum*).

Aplidium oculatum (Beniaminson, 1974)

Fig. 19.

Amaroucium oculatum Beniaminson, 1974: 318.

Aplidium oculatum: Sanamyan, Sanamyan, 2011: 41.

Aplidium pliciferum: Sanamyan, 1998a: 121 (part).

MATERIAL EXAMINED. *Ac. Oparin-56*, St.47, NW Sea of Okhotsk, 56°17.6'N, 137°58.2'E, 47 m, 1.08.2019, one colony; St.51, NW Sea of Okhotsk, Auan Bay, 56°25.41'N, 138°03.88'E, 4–9 m, 3.08.2019, one colony.

DESCRIPTION. Available colonies are entire (not divided in lobes) cushions up to 5 cm in greatest diameter and 2–5 cm in height. The area of attachment to substrate is not large. The surface is even, smooth and free from foreign matter. The test is colourless and translucent; zooids are clearly seen through it.

The zooids in examined colonies are up to 12 mm long. They are crowded and arranged in oval or elongated systems but the limits of the systems are difficult to see even on well-preserved colonies. The atrial languet is short and simple. The branchial sac has 13 (?) rows of stigmata (difficult to count due to strong contraction of the thorax, 12 or 13 rows were recorded for this species by Sanamyan & Sanamyan (2011)). The stomach is barrel-shaped to rounded (in zooids from the same colony), with about 24 not very regular longitudinal folds. The posterior abdomen contains several large ova just below the gut loop; numerous male follicles arranged in several rows fill almost its entire length. Numerous developing embryos are in the thorax but tailed larvae not present — this situation is very characteristic for this species, many of the previously reported colonies had developing embryos but no fully developed larvae. For more detailed description see Sanamyan & Sanamyan (2011).

REMARKS. The original description of this species (Beniaminson, 1974) is based on the specimens from Paramushir Island (north group of Kuril Islands) and is too superficial. The species was redescribed by Sanamyan & Sanamyan (2011). Fully developed colonies are quite distinguishable — they are large and massive, undivided, often more or less globular and always with a smooth clear surface. Arrangement of the zooids in oval systems distinguishes it from *A. eborinum* in underwater photographs (the two species often occur together). Smaller colonies may resemble *A. dissectum* but lobed colonies of *A. dissectum* have a different pattern of systems (unfortunately this feature is clearly seen only on fully inflated live colonies) and zooids may have a three-lobed atrial languet, while in *A. oculatum* the atrial languet is always simple (obviously this feature depends on a shape of the systems). The species is rather common; many colonies erroneously identified as *A. pliciferum* were reported by Sanamyan (1998a) from the east coast of Kamchatka. Zooids often have white or yellow pigment spots on the thoracic wall on each side of the endostyle marking each row of stigmata (hence the species name “*oculatum*”), but they are not always present and are lacking in the present specimens.

Aplidium tenuicaudum (Beniaminson, 1974)

Fig. 20.

Amaroucium tenuicaudum Beniaminson, 1974: 324.

Table 2. *Aplidium* species having more than 20 stomach folds.
Таблица 2. Виды рода *Aplidium*, имеющие более 20 складок желудка.


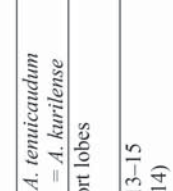

	<i>A. oculatum</i>	<i>A. tenuicaudum</i> = <i>A. kurilense</i>	<i>A. translucidum</i>	<i>A. strandi</i>	<i>A. confusum</i>	<i>A. dissectum</i>
languet	1	3 short lobes	3 long lobes (trifid)	3 long lobes (trifid)	1	1 or 3 short lobes
rows of stigmata (stigmata per row)	12 or 13 (13)	(11) 13–15 (12–14)	usually 10, rarely 11 or 12 (18–20)	7 (15–18)	9 or 10 (12–14)	10–12 (12–14)
colony	massive	small irregular cushions	inverted cone shaped cormidia	inverted cone shaped cormidium	small irregular cushions	lobed, inverted cone shaped cormidia
systems	round	?	?	?	?	short elongated and branched cloacal canals
other features	pigment dots mark rows of stigmata					
larva	?		?	?		
distribution	Kamchatka, North Kurile Islands, Sea of Okhotsk	South Kurile Islands	NE Pacific (Alaska)	N of Sea of Okhotsk	South Kuril Islands	Kamchatka



Fig. 19. *Aplidium oculatum*. A — colony; B — zooids; C — details of stomach of two zooids.

Рис. 19. *Aplidium oculatum*. А — колония; В — зооиды; С — детальный вид на стенку желудка двух зооидов.

Aplidium tenuicaudum: Sanamyan, 1998a: 124; 2000a: 215.

Amaroucium kurilense Beniaminson, 1974: 322.

MATERIAL EXAMINED. South group of Kuril Islands: Shikotan Island, Tserkovnaya Bay (~43° 44'N, 146°41.5'E), 6.09.1949 (holotype ZIN 2235/1); 12.07.1987, two colonies; Tanfilieva Island, Tanfilieva Bay (~43°26.23'N, 145°56.4'E), 10.08.1987,

one colony; Polonskogo Island, Moryakov Bay (~43°39'N, 146°19'E), one colony. All specimens are collected in the intertidal zone.

DESCRIPTION. Preserved colonies are low wide cushions up to 4 cm in diameter with smooth and slightly convex upper surface. Area of attachment is rather wide, about half of the lower surface. Some sand is present on the upper surface of most colonies.

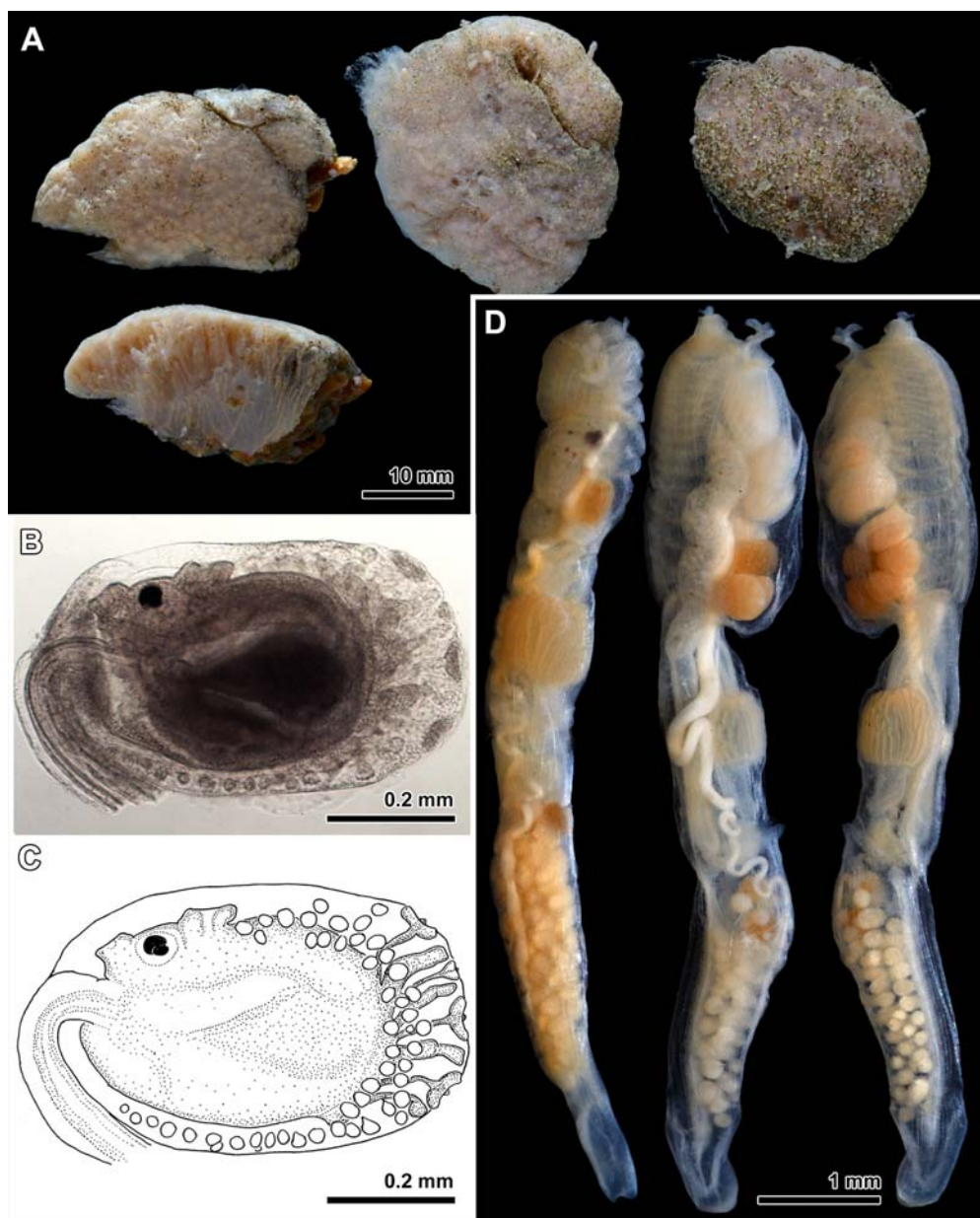


Fig. 20. *Aplidium tenuicaudum*. A — colonies (two photos on the left are the holotype, top view and longitudinal section); B, C — larva (from holotype); D — zooids (from holotype).

Рис. 20. *Aplidium tenuicaudum*. А — колонии (на двух фотографиях слева голотип, вид сверху и продольный разрез); В, С — личинка (из голотипа); D — зоиды (из голотипа).

Several common cloacal openings are recognizable on the holotype; the zooids are apparently arranged into rather elongate systems around them, but the real shape of the systems is unclear. The zooids are robust, stand vertically, perpendicular to the upper

surface of the colony. In the holotype most are 6–7 mm long, but some are longer, with posterior abdomens reaching the bottom of the colony. Zooids have a short but well-developed tubular atrial siphon; its upper margin has a wide languet with three distinct

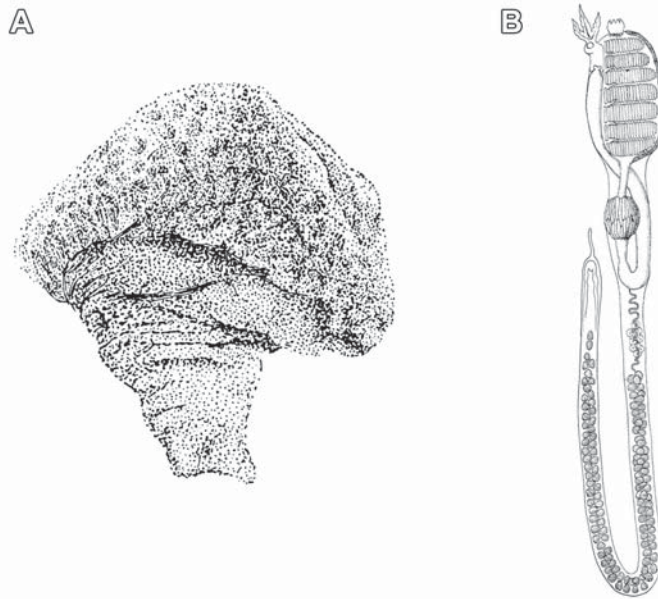


Fig. 21. *Aplidium strandi*. A — colony; B — zooid. After Redikorzev, 1937.

Рис. 21. *Aplidium strandi*. А — колония; В — зооид. По: Redikorzev, 1937.

lobes (which are easily torn off when zooids are extracted from old ethanol specimens) (Fig. 20D). The branchial sac (holotype) has 13–15 rows with 12 or 13 stigmata in each (Beniaminson, 1974 in the original description says 11 or 12 rows with 22–24 stigmata in each for the same specimen, she possibly counted the stigmata on both sides of the branchial sac). Another specimen had 11 rows of about 14 stigmata in each. The short symmetrical stomach has 22–25 narrow and often broken folds (Fig. 20D). The post pyloric subdivision of the intestine is very clear. The posterior abdomen is not especially long, in most zooids it attains about half the length of the zooid. A small ovary with several not large ova is just behind the pole of the gut loop. The male follicles arranged in several rows occupy the most of the posterior abdomen except its most posterior part. Most zooids in the holotype contain developing eggs and larvae. The larval trunk is 0.7 mm in length; three or rarely four (as in the larva shown in Fig. 20B, C) adhesive organs alternate with finger-shaped median ampullae which may have slight lateral expansions at the base. Epidermal vesicles are numerous, arranged somewhat irregularly (i.e. not in a single regular row), as shown in Fig. 20C.

REMARKS. The original description (Beniaminson, 1974) is based on a colony from the intertidal zone of Shikotan Island (south group of Kuril Islands). Several subsequently recorded colonies described by Sanamyan (1998a, 2000a) are from the

same region and the species is not known in other localities. In the same paper Beniaminson (1974) described another species, *Aplidium kurilense* (as *Amaroucium kurilense*), recorded in the intertidal zone of Iturup Island (which also belongs to the southern group of Kuril Islands). A single colony (the holotype) of *A. kurilense* had no larvae, and I was not able to examine it. Beniaminson (1974) provides no differential diagnosis and it is not clear why she decided that these two species, *A. kurilense* and *A. tenuicaudum*, differ from each other, since all the main features she listed are similar. In the present work I consider them conspecific. *Aplidium kurilense* has page priority over *A. tenuicaudum*, however the latter species is better known, its holotype is in good condition and was reexamined, and the structure of its larvae is known. Acting as First Reviser (Article 24.2.2) I here give a precedence to *Amaroucium tenuicaudum* over *Amaroucium kurilense*. Valid name of this species is therefore *Aplidium tenuicaudum*, while *Aplidium kurilense* is considered its junior subjective synonym.

Aplidium tenuicaudum is closely related to *A. dissectum* but has a different larva (compare Fig. 20C and Fig. 23D).

Aplidium strandi (Redikorzev, 1937)

Fig. 21.

Amaroucium strandi Redikorzev 1937: 122.

MATERIAL EXAMINED. None.

REMARKS. This species was recorded only once, by Redikorzev (1937), from the north coast of the Sea of Okhotsk, 59°11' N, 148°56' E, 29–57 m. Only one specimen was collected. The colony is inverted cone shaped (Fig. 21A), 25 mm in height and 35 in diameter of its upper part. Zooids have a trifid atrial languet, seven rows of 15–18 stigmata and more than 20 longitudinal stomach folds as estimated from the original figure reproduced here (Fig. 21B), which are described and figured as being arranged in two rows. I was not able to examine the holotype of this species and have no similar colonies from the same location. This species was synonymized with *A. translucidum* Ritter, 1901 by Van Name (1945), and Sanamyan (1998a) followed his opinion. This synonymization may be correct, but I prefer to keep them separate until more material is available for study. *Aplidium strandi* is related to *A. dissectum* and *A. tenuicaudum*; they all may have a three-lobed atrial languet and more than 20 stomach folds. *Aplidium strandi* differs from the other two mentioned species by its small number of rows of stigmata (seven). Most descriptions by Redikorzev are quite precise (unlike those of Beniaminson) and his figures usually fit very closely to the material he studied. Most probably the zooids in this specimen indeed have seven rows of stigmata, and it is not a mistake. Also, the colony is not small and cannot be young. Unfortunately, the shape of the systems and the structure of the larva are not known and the taxonomic status of this species may be confirmed only when new material from the type location will be available.

Aplidium confusum Sanamyan, 2000

Fig. 22.

Aplidium confusum Sanamyan, 2000a: 211.

MATERIAL EXAMINED. South group of Kuril Islands: Polonskogo Island, Moryakov Bay (~43°39'N, 146°19'E), one colony (holotype KBPGI 1/1009); Polonskogo Island, Moryakov Bay (~43°39'N, 146°19'E), one colony (paratype KBPGI 2/1010); Polonskogo Island, Severny Point (~43°39'N, 146°19'E), 22.07.1987, 7 colonies (paratypes KBPGI 3/1011); Shikotan Island, Krabovaya Bay (~43°52.5'N, 146°49'E), 31.08.1997, one (paratype KBPGI 4/1012); Yury Island, Katernaya Bay (~43°25.5'N, 146°3.5'E), 8.08.1987, eight specimens (paratypes KBPGI 5/1013). All specimens collected in the intertidal zone.

DESCRIPTION. The colonies are small cushions, sometimes entire, sometimes composed of poorly differentiated low lobes (Fig. 22A). Larger colonies are depressed, smaller are often oval or almost spherical. Upper surface is clear and the test contains

no sand. The shape of the systems cannot be determined on the preserved material.

The description of zooids below is based on those from the holotype. The length of examined zooids varied from 6 to 12 mm. The simple atrial languet is very distinct in most zooids examined (Fig. 22B). The branchial sac has nine or ten rows of stigmata. The stomach in most cases is symmetrical, the longitudinal folds are narrow, most are regular and not interrupted (Fig. 22B), 20–24 counted in the several zooids examined. The posterior abdomen may be short or long, most of its length is filled by large male follicles arranged in two or several rows; the ovary is poorly developed, located anterior to the testis, just behind the gut loop. All zooids contain many larvae. The trunk is 0.6 mm long. The larva has three adhesive organs, four long finger-shaped median ampullae alternating with adhesive organs and a row of short mostly paired median ampullae with greatly expanded ends forming an arc on each side of anterior part of the larval trunk (Fig. 22C).

REMARKS. *Aplidium confusum* is known only from the type colonies described by Sanamyan (2000a) and briefly redescribed here. It was reported from the intertidal zone of several southern Kuril Islands. There are no new collections of ascidians from these islands and, in consequence, no new specimens referable to this species.

Aplidium dissectum

Sanamyan et Sanamyan, 2011

Fig. 23.

Aplidium dissectum Sanamyan, Sanamyan, 2011: 43.

MATERIAL EXAMINED. East Kamchatka, Vilucha Bay, Laperuza Rock, 12 m, 25.07.2006, KBPGI 1448/4; same data, paratype KBPGI 1441/3; Avacha Bay, Starichkov Island, 10 m, 15.09.2002, holotype KBPGI 1439/1.

DESCRIPTION. See Sanamyan & Sanamyan (2011) for detailed description and underwater photographs of live colonies. The material briefly described below (KBPGI 1448/4) was collected together with a specimen designated as a paratype (KBPGI 1441/3) by Sanamyan & Sanamyan (2011), these two specimens may be fragments of one larger colony. The colony is composed of rather numerous inverted cone shaped lobes joined basally and, in part, by their sides (Fig. 23A). The upper surface on preserved material is slightly convex, sometimes almost flat. Sand is present basally and, in part, on the lateral sides of the lobes while the upper surface is always free from foreign particles. Zooids are about 13 mm long (while in the type material they half as long, compare Fig. 23B and C); most have a long simple atrial languet. The branchial sac has 11 rows of stigmata in all examined zooids of this

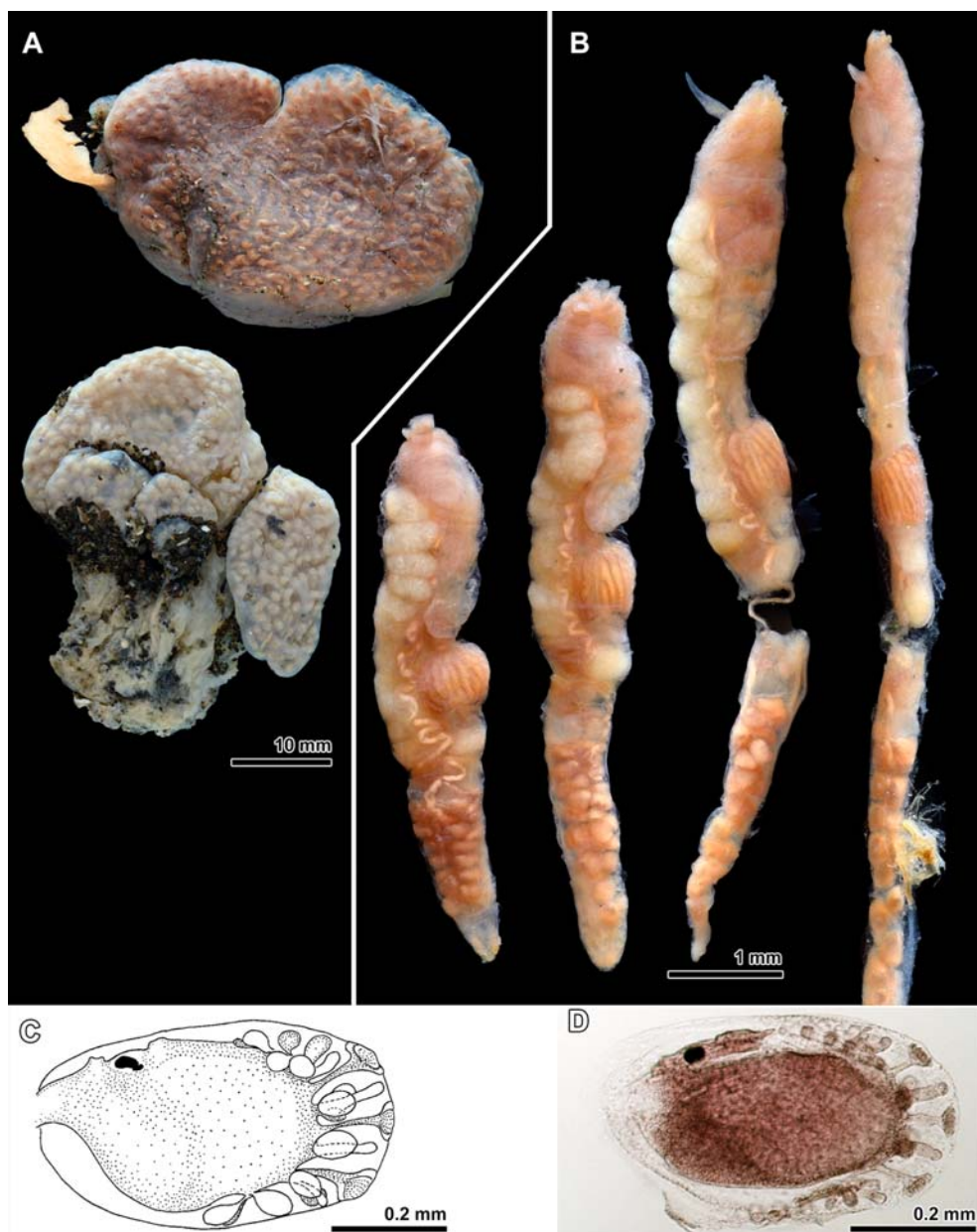


Fig. 22. *Aplidium confusum*. A — colonies, holotype (on the top) and paratype; B — zooids (from holotype); C, D — larva (C — after Sanamyan, 2000, D — from holotype).

Рис. 22. *Aplidium confusum*. А — колонии, голотип (вверху) и паратип; В — зоиды (из голотипа); С, D — личинки (С — по Sanamyan, 2000, D — из голотипа).

colony with 18 or 19 stigmata in each row (holotype has 11, sometimes 10 or 12 rows of 12–14 stigmata). Longitudinal folds of the stomach wall are narrow and numerous, irregular, interrupted, about 21–23 were counted in several zooids. Larvae were imma-

ture in this specimen. Larvae in the holotype were reexamined (Fig. 23D). They vary in minor details, e.g. some (rare) larvae have only two adhesive organs (instead of three), the stalks of adhesive organs may be thick or thin, etc., but general structure is

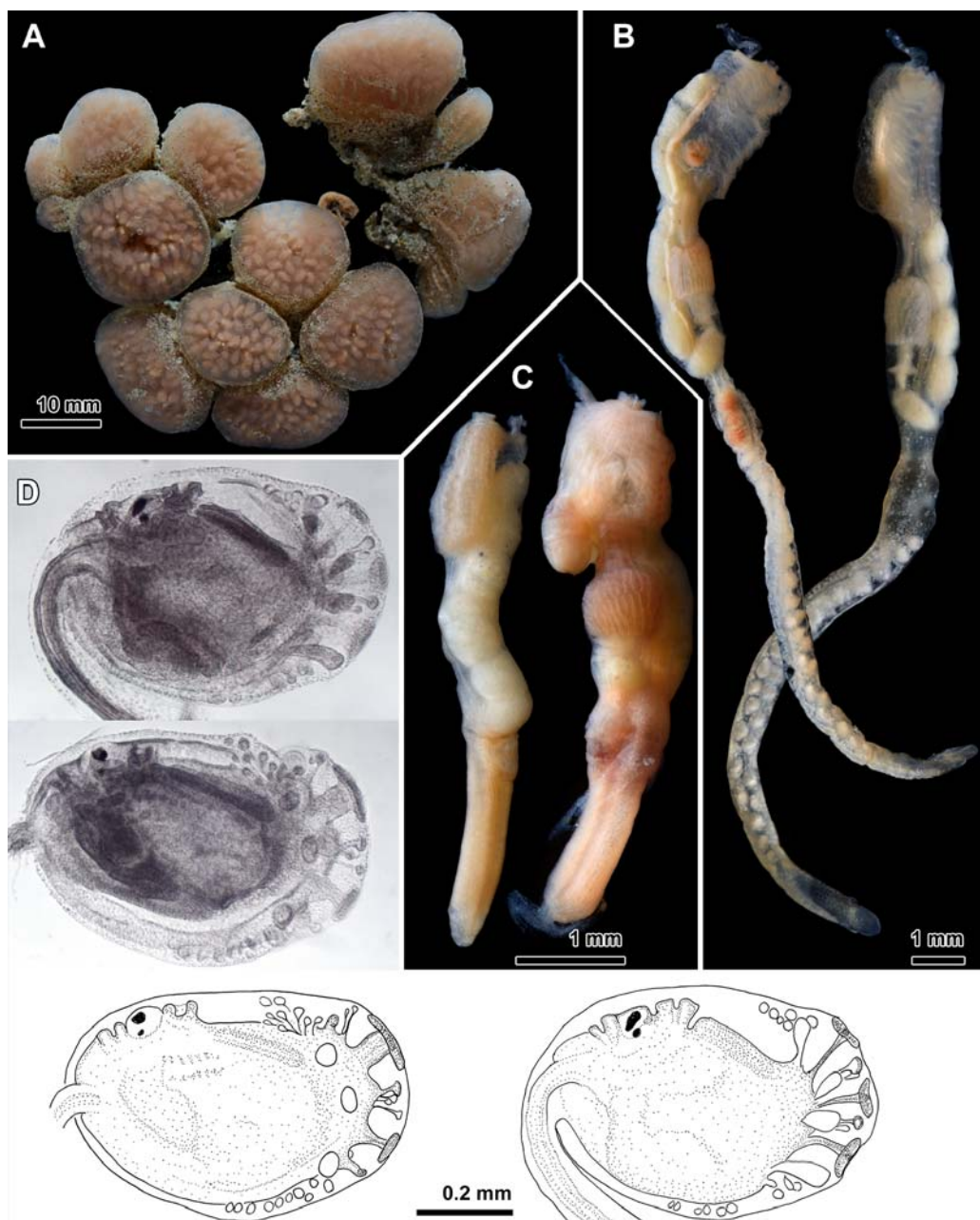


Fig. 23. *Aplidium dissectum*. A — colony; B — zooids from the same colony; C — zooids from the type material (left, from the holotype, note three-lobed atrial languet; right, from the paratype KBPGI 1441/3); D — larvae from the holotype.

Рис. 23. *Aplidium dissectum*. А — колония; В — зоиды из этой же колонии; С — зоиды из типового материала (слева зоид из голотипа, виден трехлопастный атриальный язычок; справа зоид из паратипа KBPGI 1441/3); D — личинки из голотипа.

stable and corresponds to the original description. The trunk of examined larvae was 0.7 mm long, with thin-stalked median ampullae (often with spatulate ends) and four noticeable bulbous lateral ampullae on each side of the trunk. Epidermal vesicles are not numerous, located along the mid-dorsal and mid-ventral lines but not in the anterior part of the trunk.

REMARKS. The original description of *Aplidium dissectum* states that the zooids have occasionally simple but usually three-lobed atrial languet and that zooids with either simple or three-lobed languet may occur together within the same colony lobe and the shape of the languet probably depends on the position of a particular zooid in the system (Sanamyan, Sanamyan, 2011). However, in the present specimen, which without any doubt belongs to the same species (and even may be part of the paratype colony), I failed to detect zooids with three-lobed languet. The holotype of *A. dissectum* was reexamined to clarify this feature; some zooids in the holotype indeed have three-lobed atrial languet, but zooids with simple languet appear to be more numerous (at least in the examined part of colony which is composed of several cormidia). This fact makes a distinction between *A. dissectum* and *A. confusum* less reliable than initially believed by Sanamyan & Sanamyan (2011). The latter species is currently known only from the southern group of Kuril Islands, where it appears to be common, a region inhabited by a relatively large proportion of species not occurring in more northern localities. No specimens of *A. dissectum* or *A. confusum* are known from the middle Kuril Islands (although at least one of these islands, Matua Island, is well sampled for ascidians, see Sanamyan & Sanamyan (2017a, b)). Further, the shape of the systems, an important feature used to characterize *A. dissectum*, is not known for *A. confusum*. Two other very similar species are *A. translucidum* from Alaska (type locality listed as “Orca, Prince William Sound”, approximately 60°35′N, 146°15′W, see Ritter, 1901: 251) and *A. strandi* from the Sea of Okhotsk (see above). Both have colonies similar to the colony described above. Zooids of *A. translucidum* have a similar number of rows of stigmata (“usually ten, rarely nine or eleven”) and stomach folds (“twenty or more”) (Ritter, 1901: 251). The larvae of both species are not described and the shape of the systems is not known. Both species have a trifid atrial languet, i.e. the atrial languet has three equally long lobes.

The colonies which seemingly belong to *A. dissectum* do not always have such a characteristic shape as described above (Fig. 23A). Lobes of some colonies (e.g. paratype KBPGI 1440/2) may be larger and such colonies may be indistinguishable from the colonies of *A. oculatum* or *A. tenuicaudum* if they contain no larvae or systems are not recognizable.

The shape of the systems, a very important feature separating *A. confusum* from *A. oculatum*, is easy to see in underwater photographs but in most cases obscured in preserved material. It is quite clear that this group of *Aplidium* contains several species, but the boundaries between them are not easy to draw and some of them may be synonyms. In the present paper I prefer not to change their status and to leave the taxa known from relatively distant locations (*A. translucidum* from Alaska, *A. dissectum* from Kamchatka, *A. confusum* from South Kuril Islands and *A. strandi* from the Sea of Okhotsk) as separate valid species. Although I do not fully believe that they all are separate species, such “splitting” approach seems to be more productive than the “lumping” approach I followed in my early papers (e.g. Sanamyan, 1998a). In Sanamyan (1998a) all *Aplidium* species with numerous stomach plications and massive colonies were identified as *A. pliciferum* and the lobed colonies as *A. translucidum*. Certainly, several different taxa from different regions were mixed by Sanamyan (1998a) under both names and as a result, the value of the morphological information he gave (e.g. larval structure) is diminished because it not always clear from which species it was obtained. Such a situation has occurred too often in ascidian taxonomy, especially in the works of older authors (e.g. Van Name, 1945) and I would like to avoid it here.

As currently defined, *Aplidium dissectum* is known with certainty only from the east coasts of Kamchatka.

Genus *Aplidiopsis* Lahille, 1890

Type species: *Aplidiopsis vitreus* Lahille, 1890 by subsequent designation by Hartmeyer (1924).

Nomenclatural note: Kott (1998) stated that “*Aplidium vitreum* Lahille, 1887” is a type species of *Aplidiopsis* by monotypy. This statement is not correct: Lahille (1890: 207) originally included five species in his new genus *Aplidiopsis* (listed as *A. spongiformis*, Herd., *A. incertus*, Herd., *A. minutus*, Herd., *A. pyriformis*, Herd. and *A. vitreus*, Lah.). Moreover, *Aplidium vitreum* Lahille, 1887 is a *nomen nudum* and not available (Article 12.1). Type species of *Aplidiopsis* was fixed subsequently by Hartmeyer (1924: 187) who indicated it as “Sp. typ.: *Aplidiopsis vitreus* Lah”.

Aplidiopsis comprises polyclinid ascidians with smooth stomach, posterior abdomen separated from the abdomen by a narrow neck, male and female gonads in posterior abdomen (a difference from *Sidneioides*) and no papillae on the transverse branchial vessels (a difference from *Polyclinum*).

Aplidiopsis is not a diverse genus, it comprises less than 20 species and some of them, including the type species of the genus, are poorly known. In cold

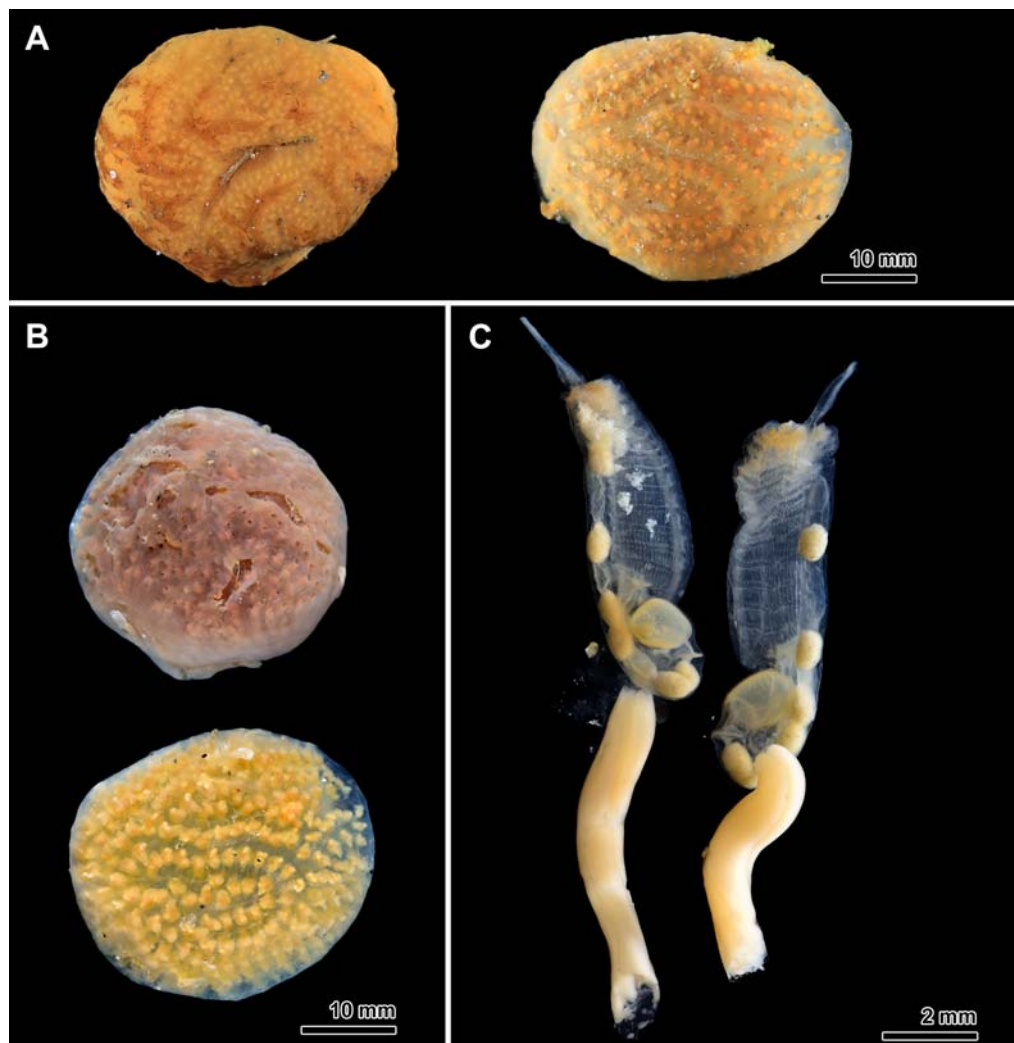


Fig. 24. *Aplidiopsis pannosum*. A — two freshly collected colonies (photo of A.S. Maiorova, NSCBM FEB RAS); B — the same two colonies, preserved; C — zooids.

Рис. 24. *Aplidiopsis pannosum*. А — две колонии сразу после сбора (фото А.С. Майоровой, NSCBM FEB RAS); В — те же колонии, зафиксированные в формалине; С — зооиды.

waters of the North Pacific only one species, *Aplidiopsis pannosum* (Ritter, 1899), is currently recognized.

Aplidiopsis pannosum (Ritter, 1899)
Fig. 24.

Polyclinum pannosum Ritter, 1899: 519.

Polyclinum globosum Ritter, 1899: 518.

Aplidiopsis pannosum: Van Name, 1945: 67. Tokioka, 1960: 194. Nishikawa, 1990: 80. Sanamyan, 1998a: 107; Lambert, 2003: 671; Sanamyan, Sanamyan, 2017a: 312.

Aplidium [sic] *pannosum*: Sanamyan, Sanamyan, 2017b: 129.

Aplidiopsis helenae Redikorzev, 1927b: 382.

MATERIAL EXAMINED. *Ac. Oparin-56*, St. 19, 2.07.2019, Shimushir Island (Pacific side), 46° 40.6'N, 151°58.4'E, 436 m; St. 22, Shimushir Island (Sea of Okhotsk side), 47°15.4'N, 152°10.0'E, 222–205 m, 3.07.2019; St. 25, Urup Island (Sea of Okhotsk side), 46°17.0'N, 150°17.0'E, 193–148 m, 5.07.2019; St. 57, N Sea of Okhotsk, Erineyaskaya Bay, 59° 24.02'N, 145°52.81'E, 1–20 m, 7.08.2019; St. 77, Shiashkotan Island (Pacific side), 48°48.7'N, 154°

13.8'E, 128–127 m, 15.08.2019; St.82, Raikoke Island (Sea of Okhotsk side), 48°12.3'N, 153°22.0'E, 476–519 m, 16.08.2019. One colony in each station.

DESCRIPTION. Examined colonies are either massive and irregular potato-like masses attached by the entire lower surface or almost globular with a small area of attachment (Fig. 24A, B). They are entire, not divided into lobes. The consistency and color of the test is variable; in some (usually smaller) colonies it is translucent and the zooids are clearly visible, in others it is darker. Living colonies may be dirty-yellow, yellow with irregular dark brown patches, opaque brown or red. Zooids are arranged in complex systems and form double rows around the branched cloacal canals. Each system has one or several large cloacal openings.

The zooids are large and have either fully expanded or at least not strongly contracted thoraces in preservative (Fig. 24C). Most zooids have a very long simple (or with three minute indentations on the tip) atrial languet. The branchial sac in examined zooids has 14–16 rows of stigmata (one zooid had 14 on the right and 16 on the left) with about 21–23 stigmata in each row. The abdomen is short, about half the length of the thorax, and often sac-like. The stomach is smooth-walled, globular or slightly elongated, always obliquely oriented. The post-pyloric subdivision of the intestine is well visible in most zooids (Fig. 24C). The posterior abdomen is filled by parenchymatous tissue and attached to the left posterior side of the abdomen by a narrow neck.

REMARKS. The species is widely distributed in the North Pacific. A posterior abdomen connected with the abdomen by a thin neck is a feature characteristic for the genus, but is not always easy to observe and sometimes colonies may be readily confused with *Synoicum jordani*. The latter species has similar large zooids with smooth-walled but vertically oriented stomach while in *A. pannosum* the stomach is oriented obliquely and the abdomen is much shorter. Further, *S. jordani* always has round systems while in *A. pannosum* they are not round.

Genus *Neodiction* nom.n.
for *Neodictyon* Sanamyan, 1998

Type species: *Neodictyon shumshu* Sanamyan, 1998 by original designation.

Colonial ascidians with completely embedded zooids; zooids probably arranged in cloacal systems; branchial sac without stigmata but with transverse branchial vessels not connected with each other; gonads in abdomen and anterior end of posterior abdomen.

The generic name *Neodictyon* Sanamyan, 1998a is preoccupied by *Neodictyon* Mikuláš, 1992, a trace fossil from Early Silurian graptolitic shales (Mikuláš,

1992) and therefore, a new replacement name *Neodiction* nom.n. is suggested here for *Neodictyon* Sanamyan, 1998.

The genus is monotypic and very unusual. Sanamyan (1998a) placed it in the Polyclinidae basing on his conclusion that it has a true posterior abdomen (with gonads at least in its anterior part and with the heart at its posterior end) and on the putative presence of cloacal systems. Although the systems cannot be directly demonstrated in the existing material, the shape of the atrial siphon suggests that they are present. The position of most of the gonad in the abdomen is, however, not characteristic for Polyclinidae. Further, it is not clear whether the heart is indeed at the end of the posterior abdomen (see description of *N. shumshu* below). Transverse muscles on the thoracic wall are also not characteristic for Polyclinidae; thus placing this genus in Polyclinidae is problematic. Sanamyan (1998a) compared this genus with *Pharyngodictyon* and *Protoholozoa*, the only two genera of colonial ascidians known at that time having no true stigmata. Both differ from *Neodiction* nom.n.: *Pharyngodictyon* has gonads in the posterior abdomen while *Protoholozoa* (and recently described similar *Scotiazoa*) have *Holozoa*-like zooids with no more than four transverse branchial vessels. The general structure of the zooids of *Neodiction* nom.n. resembles the *Bathyplacentela* gen.n. but details differ significantly. Although both genera lack true stigmata, transverse branchial vessels in *Bathyplacentela* gen.n. are connected by longitudinal strips forming a rectangular meshwork while in *Neodiction* nom.n. the transverse vessels are not connected with each other. Also, the atrial siphon in *Bathyplacentela* gen.n. is six-lobed and opens directly to the exterior. Position of the gonads (in abdomen and anterior part of the posterior abdomen) is similar, but the gut loop of *Neodiction* nom.n. is much longer. Unfortunately, the position of the heart in the *Neodiction* nom.n., a crucial feature for correct assignment to a family, is not quite clear and cannot be revealed on existing material. Thus I prefer not to change the family assignment of this genus although it is clear that Polyclinidae is not an appropriate family for it.

Neodiction shumshu (Sanamyan, 1998)
Figs 25, 26.

Neodiction shumshu Sanamyan, 1998a: 131.

MATERIAL EXAMINED. *Ac. Oparin-14*, St. 61, Kuril Island, Shumshu Island, 50°38.1'N, 156°50.5'E, 80 m, 3.09.1991, two colonies (holotype and paratype).

DESCRIPTION. The species forms depressed (in the preserved state) cushion-like colonies, the holotype is 1.5 cm in height and about 5 cm in width.

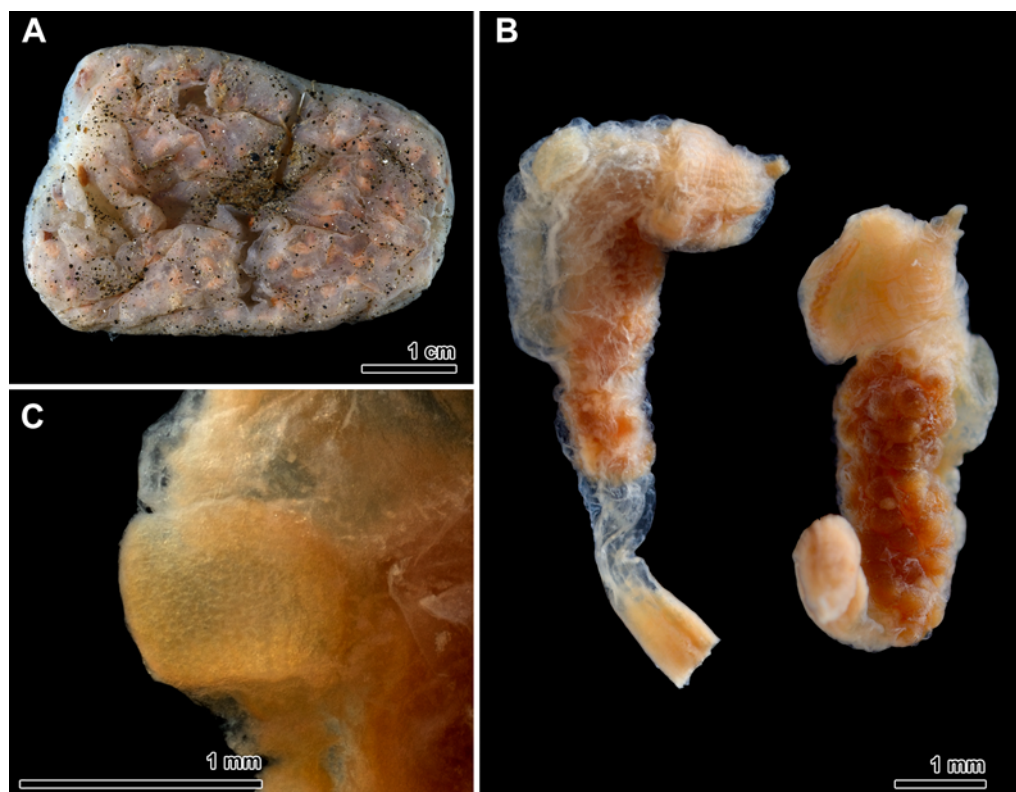


Fig. 25. *Neodiction shumshu*. A — colony (holotype); B — zooids; C — stomach, enlarged.
 Рис. 25. *Neodiction shumshu*. А — колония (голотип); В — зоиды; С — желудок, увеличено.

The test has small patches of surface sand but in general is clear and there is no sand inside the colony. The zooids are clearly seen through the test but it was not possible to determine whether they are arranged into any kind of systems. In the colony they stand vertically, parallel to each other and extend from the base of the colony to its top. Zooids are strongly contacted and opaque (Fig. 25B). The short branchial siphon has six lobes. The atrial siphon in most cases has its upper side drawn into a distinct languet with three small lobes at the end. Longitudinal thoracic muscles are thick and apparently strong, the thoraces of most zooids are significantly contracted longitudinally. These muscles continue along the abdomen, becoming much thinner. The branchial sac consists of 11–13 transverse vessels attached to the thoracic wall ventrally and dorsally. Also each vessel on each side of the thorax has two connectives joining it with the thoracic wall but adjacent vessels do not connect with each other. The oesophagus is short and straight and enters the rounded stomach vertically in the anterior part of the abdomen. The external stomach wall is smooth; internally very fine

uplications may be present (Fig. 24C). The gut loop posterior to the stomach is long (Fig. 26A). Numerous large eggs form an elongated mass filling the abdomen and extending into the posterior abdomen. Very small but numerous whitish bodies, probably immature male follicles, are distributed along the ovary. All zooids have a posterior abdominal extension filled by parenchymatous tissue. The original description (Sanamyan, 1998a) states that the heart is at the end of the posterior abdomen; I was not able to confirm it on reexamination, though there are some thin-walled tubular (?) structures in the end of the posterior abdomen of some zooids but whether this is a heart I cannot say with confidence.

REMARKS. This unusual colonial ascidian with an “abyssal” type of branchial sac was described from the north Kuril Islands from rather shallow water (80 m). It has not been recorded again. The only other colonial ascidian lacking true stigmata known in the region is *Bathylacentela pedunculata* sp.n.; it has very different colonies and cannot be confused with this species. For more information see discussion under the genus *Neodiction* nom.n. above.

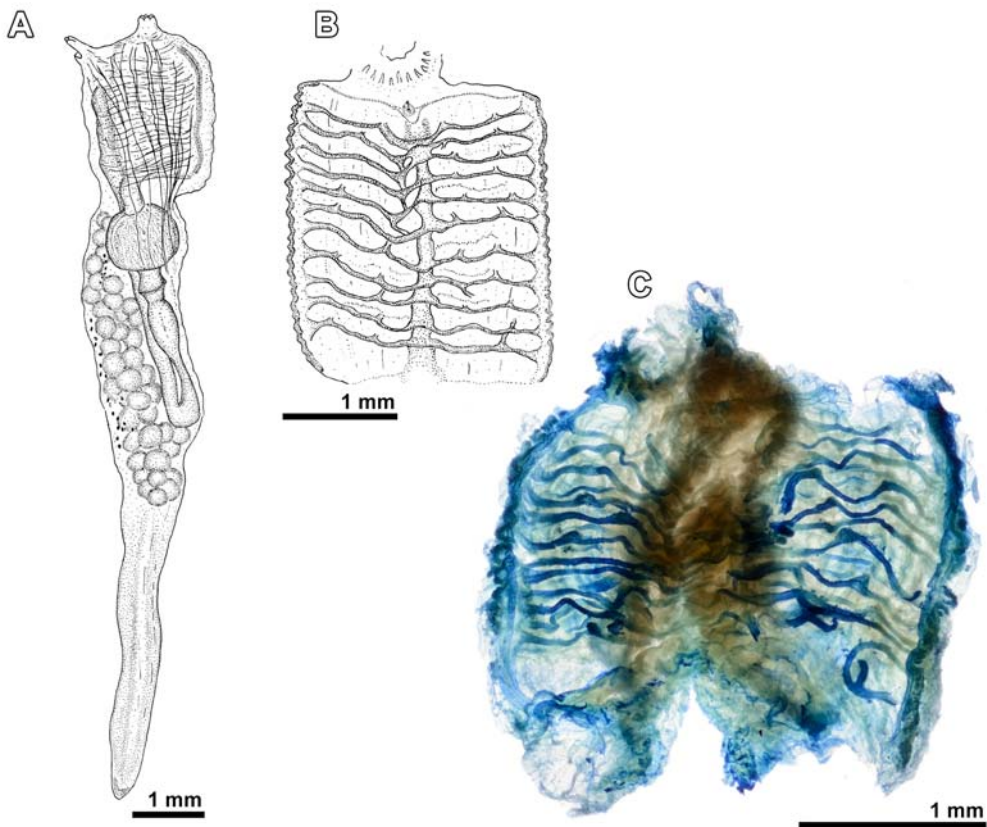


Fig. 26. *Neodiction shumshu*. A — zooid; B — branchial sac opened ventrally; C — branchial sac opened ventrally (stained by toluidine blue). (A and B modified after Sanamyan, 1998a).

Рис. 26. *Neodiction shumshu*. А — зооид; В — вскрытый жаберный мешок; С — вскрытый жаберный мешок (окрашен толуидиновым синим). (А и В по Sanamyan, 1998a).

Family Ritterellidae Kott, 1992

(Protopolyclinidae Kott, 1992 is a junior subjective synonym).

This family comprises colonial ascidians characterized by zooids composed of thorax, abdomen and posterior abdomen; branchial and atrial apertures usually six-lobed; atrial siphon opens directly to the exterior or into a rudimentary (=very small) cloacal cavity; stigmata in more than three rows; oesophagus short and stomach located in the middle of the relatively short abdomen (not at the posterior end of a long abdomen as in Euherdmaniidae); gonads in posterior abdomen; heart at posterior end of posterior abdomen.

Originally two genera, *Ritterella* Harant, 1931 and *Dumus* Brewin, 1952 were included and in addition, *Pharyngodictyon* Herdman, 1886 was assigned to this family tentatively by Kott (1992).

However, if we accept the assignment the latter genus to Ritterellidae, then Ritterellidae becomes a junior subjective synonym of Pharyngodictyonidae Seeliger, 1907. Whether *Pharyngodictyon* is indeed related to *Ritterella* is an open question and currently I prefer not to include it in Ritterellidae. In this case Ritterellidae may be used as a valid family name while *Pharyngodictyon* may be treated as a sole member of Pharyngodictyonidae pending more detailed study.

The family Protopolyclinidae Kott, 1992 was created for genera *Protopolyclinum* Millar, 1960, *Monniotus* Millar, 1988 and *Condominium* Kott, 1992. In addition, Kott (2008a) transferred *Pseudodiazona* Millar, 1963 to Protopolyclinidae. Initially Kott (1992: 393 and 399) distinguished Ritterellidae from Protopolyclinidae by their “*narrow zooids, usually with testis follicles in one or 2 longitudinal series and vertical barrel-shaped stomach*” and dis-

tinguished *Ritterella* from Protopolyclinidae by its “smaller, narrower zooids with fewer male follicles in a long, thread-like or stumpy but never tapering posterior abdomen, barrel-shaped stomach with more pronounced folds and smaller, shallower adhesive organs”. In her key these two families are distinguished by whether the posterior abdomen is constricted from the abdomen or not (Kott, 1992: 379). However, these differences in the shape of the posterior abdomen appear to be not important. Many species assigned to Protopolyclinidae (e.g. *Monniotus paucistigma* F. Monniot et C. Monniot, 2008, *Condominium florem* Kott, 2008, *Pseudodiazona longigona* (Tokioika, 1959)) have very long posterior abdomens with serially placed testis follicles, a feature more characteristic for Ritterellidae according to Kott (1992). Later Kott (2008a: 1126 and 1120) concluded that “the length of the posterior abdomen and the arrangement of the testis follicles may be artefacts caused by the post-mortem events affecting the zooid” and listed only “distinct parallel external folds in the stomach wall” as a (single?) feature separating Ritterellidae from Protopolyclinidae. The latter statement is obviously not correct; *Dumus* (Ritterellidae) has a smooth stomach. I do not see significant family-level differences between the type genera of these two families, *Protopolyclinum* and *Ritterella*. They differ only in the presence or absence of branchial papillae and whether the stomach is smooth or folded. In the present paper I place *Protopolyclinum* and *Ritterella* in the same family and, acting as first reviser (Article 24.2.1), give precedence to Ritterellidae Kott, 1992 rather than to Protopolyclinidae Kott, 1992. Ritterellidae Kott, 1992 becomes a valid family name while Protopolyclinidae Kott, 1992, established in the same year, is deemed its junior (=invalid) synonym.

The family assignment of the remaining genera of Protopolyclinidae is discussed below.

The largest genus of the former Protopolyclinidae, *Monniotus*, appears to be more closely related to *Ritterella* than was suggested by Kott (1992), and their separation into different families not justified. Kott (1992) herself misidentified a species of *Monniotus* with *Ritterella* (*R. multistigmata* Kott, 1992 = *Monniotus australis* (Kott, 1957), see Kott, 2008a: 1120). Established here the new genus *Kussakinia* gen.n. combines features of *Monniotus* and *Ritterella*, and colonies of *Dumus* (Ritterellidae) strikingly resemble colonies of *Monniotus*. All these facts suggest that *Monniotus* may be safely moved to Ritterellidae.

Pseudodiazona, a genus initially assigned to Diazonidae, was transferred to Protopolyclinidae by Kott (2008a) basing on the position of the gonads in a long posterior abdomen rather than in the gut loop as in Diazonidae. Internal longitudinal branchial vessels in this genus constitute a significant differ-

ence from *Ritterella* and I do not think that they should be placed in the same family. The better solution would be to leave *Pseudodiazona*, at least at present, in Diazonidae despite its long true posterior abdomen. Alternatively, it may be placed into its own separate family but this is not formalized here.

Familial assignment of *Condominium* is difficult to access. It's very wide thorax (in the type species) appear to be a significant character distinguishing it from most species placed in Ritterellidae (although some *Monniotus* species also have wide thoraces). The genus is here tentatively placed to Ritterellidae.

Thus, after synonymization of Ritterellidae and Protopolyclinidae the following genera are assigned to Ritterellidae: *Ritterella*, *Dumus*, *Protopolyclinum*, *Monniotus* and *Condominium*. In addition, two new genera are added to this family: *Protosynoicum* gen.n. and *Kussakinia* gen.n.

Ritterella, as defined in the present work, comprises only species with folded stomach and embedded zooids (species with smooth stomach are excluded); *Dumus* has smooth stomach, only four rows of stigmata and solitary zooids in the ends of thin terminal branches of colony; *Condominium* has smooth stomach but very wide thoraces and peculiar colonies; *Protosynoicum* gen.n. is erected here to accommodate two species with colonies and zooids similar to *Ritterella* but having smooth stomach; *Monniotus* has separate zooids, transverse branchial vessels with papillae and comprises species either with faint longitudinal stomach folds, or with almost smooth stomach; *Kussakinia* gen.n. has separate zooids as in *Monniotus*, well-marked stomach folds and no branchial papillae.

The presence of the branchial papillae is a striking feature characteristic for all species of *Monniotus*, *Protopolyclinum*, for several species of *Ritterella* but not for *Condominium*, *Dumus*, *Protosynoicum* gen.n. and *Kussakinia* gen.n. Most probably it may be used to separate genera and *Ritterella* may be divided into at least two genera basing on this feature, but it requires addition study of involved species.

KEY TO GENERA OF RITTERELLIDAE KNOWN FROM FAR EAST SEAS OF RUSSIA

- 1 Zooids separate, stomach with longitudinal folds.
..... *Kussakinia* gen.n.
- Zooids embedded 2
- 2 Stomach with longitudinal folds *Ritterella*.
- Stomach smooth *Protosynoicum* gen.n.

Genus *Ritterella* Harant, 1931

Type species: *Amaroucium aequalisiphonis* Ritter et Forsyth, 1917 by monotypy.

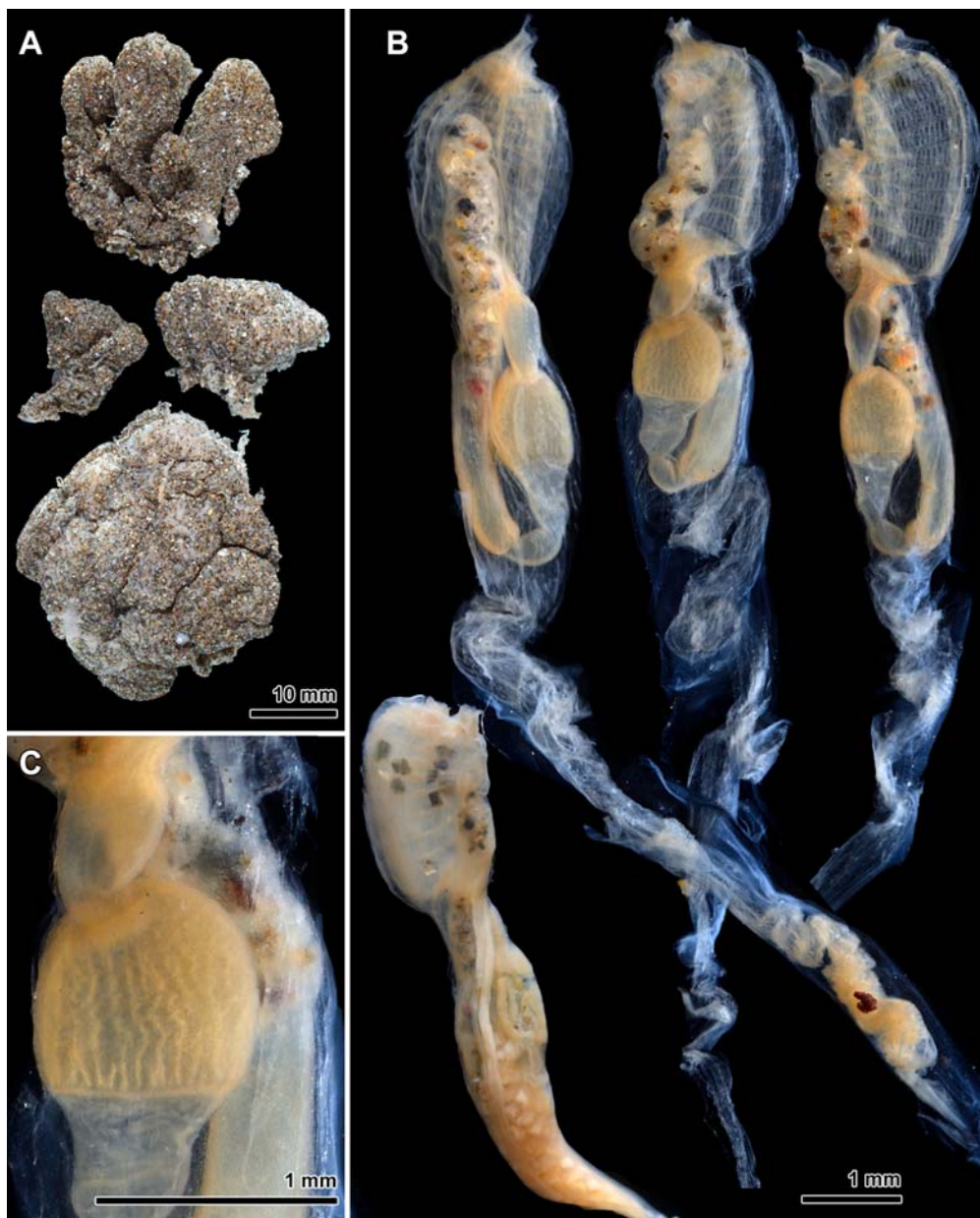


Fig. 27. *Ritterella iturupica*. A — colonies; B — zooids; C — stomach, enlarged.

Рис. 27. *Ritterella iturupica*. A — колонии; B — зоиды; C — желудок, увеличено.

Ritterella is characterized by completely embedded *Aplidium*-like zooids with longitudinal stomach folds. In most species both siphons open directly to the exterior, sometimes zooids are arranged into colonial or even rudimentary cloacal systems (see Glossary in Kott, 1990: 10). Species with smooth-walled or areolated stomach, formerly included in

Ritterella, as well as the species with separate zooids, are excluded from this genus in the present work (see *Protosynoicum* gen.n. and *Kussakinia* gen.n.).

Currently *Ritterella* contains about 20 species but some are probably not correctly assigned. In particular, the status of several species having branchial papillae needs reinvestigation.

Only one species of this genus is known in the region covered by the present paper, *R. iturupica* Beniaminson, 1974.

Ritterella iturupica Beniaminson, 1974
Fig. 27.

Ritterella iturupica Beniaminson, 1974: 235; Sanamyan, 1998a: 128.

Ritterella gurjanovae Beniaminson, 1974: 327.

MATERIAL EXAMINED. Iturup Island, Kasatka Bay, 13.09.1954, one colony with fragments; 18.07.1954, several colonies with fragments. All specimens collected by O. Kussakin intertidally.

DESCRIPTION. The colonies are composed of upright lobes attached to a common base. The shape and the size of the lobes are variable, wide and rounded in the upper parts and narrowing toward the base. Sometimes the lobes are flat-topped. Larger colonies consist of many lobes tightly adhering to each other. The lobes are completely and densely covered with sand, but sand is not present in the inner layers of test.

The thorax and abdomen together are in most cases 5–6 mm in length but all zooids have a very long posterior abdomen reaching the bottom of the colony. Zooids are arranged vertically and parallel to each other and open on the tops of the lobes but not on their sides. The branchial siphon is terminal, with six well-formed lobes. The atrial siphon is elongated, slightly displaced to the dorsal side. Its upper rim has a short languet, often three-lobed. The zooids are arranged in rudimentary cloacal systems. Stigmata are in usually nine, rarely ten rows. The oesophagus is relatively short, its distal (=closer to the stomach) half is much wider than the proximal half (Fig. 27B); this is not an artifact of contraction. The oesophagus enters the stomach slightly obliquely. The stomach is almost globular, shortened dorsally, in the middle of the abdomen. The stomach wall has many (about 25 but in most cases not possible to count) fine longitudinal plications (Fig. 27C). The post-stomach subdivision of the intestine is very well formed: there is a wide duodenum, mid intestine with oval posterior stomach and short but quite distinct rectal valves. In one colony zooids have male gonads composed of many crowded follicles and several thick male ducts running parallel to each other (left zooid in Fig. 27B).

REMARKS. Colony shape is characteristic for *Ritterella* species, with long upright lobes densely covered with sand. Zooids, however, have some features deviating from typical *Ritterella* species and the assignment to this genus is not well founded. In particular, most species of *Ritterella* have a vertically oriented symmetrical barrel-shaped stomach with distinct external folds, while *R. iturupica* has glob-

ular asymmetrical (shortened dorsally) stomach with faint plications. *Protosynoiicum sabuliferum* (Redikozhev, 1937) has a comparable colony but its zooids have a smooth stomach and different thoracic musculature represented by a fine meshwork of longitudinal and transverse muscle fibers, while *R. iturupica* has only longitudinal thoracic muscles.

Beniaminson (1974) described two species of *Ritterella* from the same location (Iturup Island, Kasatka Bay), *R. iturupica* and *R. gurjanovae*; both were collected by academician Oleg Kussakin in 1954. The material described above is a part of the same collection presented to me many years ago by the collector. Beniaminson (1974: 327) failed to provide any features to differentiate her two species. Most probably she treated the differences in colony shape (composed of “inverted pear-shaped” lobes in *R. gurjanovae* and “rounded-triangular” masses in *R. iturupica*) as characters sufficient to separate two species. Sanamyan (1998a) synonymized them and, acting as first reviser (Article 24.2.1), selected *Ritterella iturupica* as the name having precedence.

Currently *Ritterella iturupica* is known only from its type locality and only from several lots of specimens collected in 1954 by Kussakin in the intertidal zone of Iturup Island (southern group of Kuril Islands).

Genus *Kussakinia* gen.n.

Type species: *Ritterella tamarae* Sanamyan, 1998 designated herein.

Colonies composed of separate zooids, not embedded in common test; zooids have thorax, abdomen and long posterior abdomen; gonads in posterior abdomen; heart at posterior end of posterior abdomen; both siphons open directly to the exterior, six-lobed; no papillae on transverse branchial vessels; stomach with well-marked external longitudinal folds.

The genus is named after the collector, academician Oleg Grigorievich Kussakin. The gender is feminine.

The morphology of this genus is intermediate between *Ritterella* and *Monniotus*: it has separate zooids joined basally as in *Monniotus* but lacks branchial papillae characteristic for the latter genus and zooids have prominent external stomach folds as in *Ritterella*. *Ritterella*, however, has completely embedded zooids. For more detailed discussion see Remarks under *Kussakinia tamarae* below.

Kussakinia tamarae (Sanamyan, 1998)
Fig. 28.

Ritterella tamarae Sanamyan, 1998a: 129.

MATERIAL EXAMINED. Iturup Island, Kuishevsky Bay (~45°05'N, 147°39.7'E) low intertid-

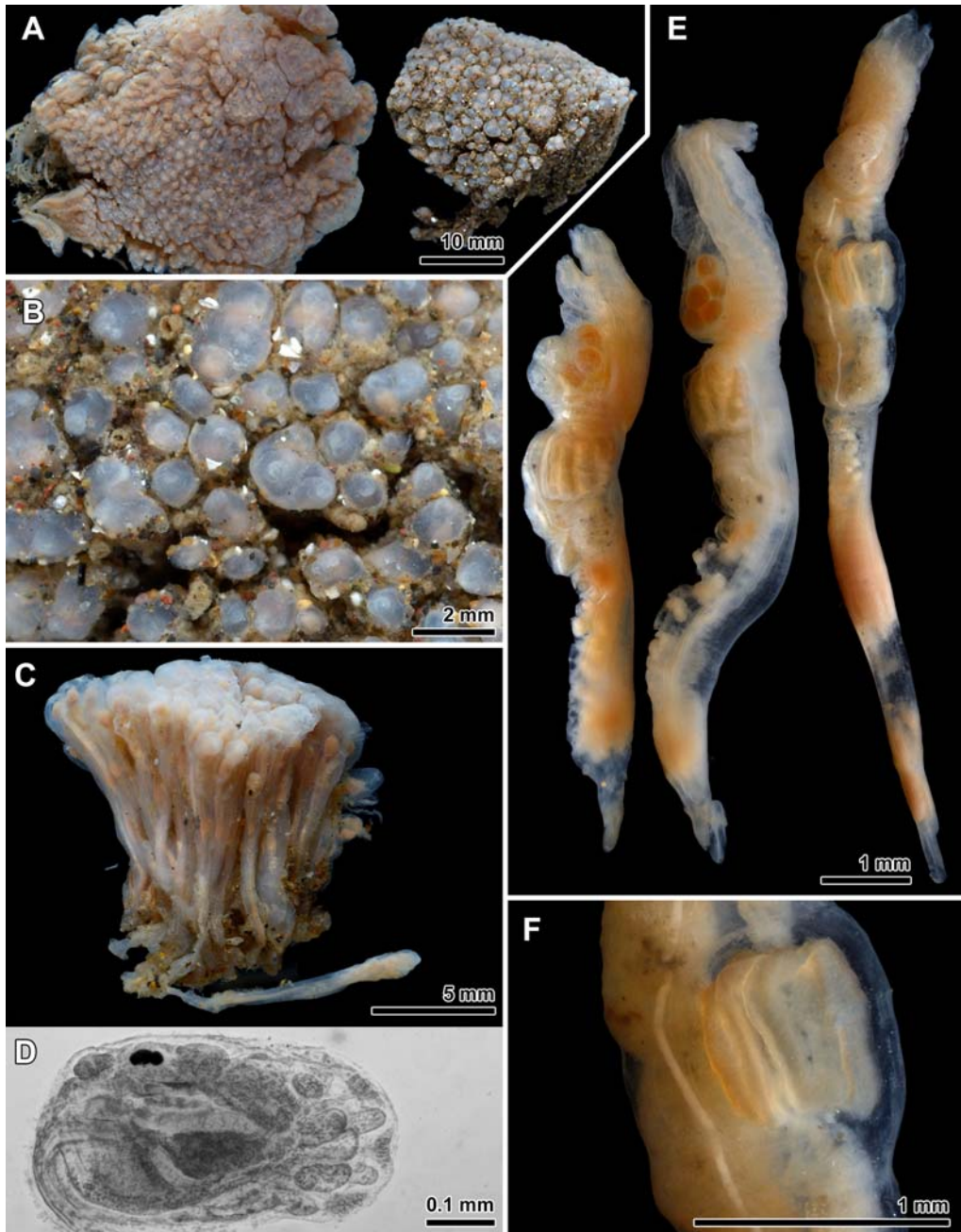


Fig. 28. *Kussakinia tamarae*. A — two colonies; B — upper surface of the sandy colony, enlarged; C — a piece separated from the larger colony to show vertical club-shaped separate zooids; D — larva; E — zooids; F — stomach, enlarged.

Рис. 28. *Kussakinia tamarae*. А — две колонии; В — верхняя поверхность колонии с песком, увеличено; С — фрагмент, отделенный от большей колонии, видны отдельные вертикальные зоиды; D — личинка; E — зоиды; F — желудок, увеличено.

al zone, 27.7.1954, several colonies with fragments, collector O. Kussakin (Paratype KBPGI 2/866).

DESCRIPTION. Examined material includes several large parts probably separated from one or several larger colonies. The parts are up to 4.5 cm in extent and about 1.5 cm in height (Fig. 28A). Colonies are composed of many vertical club-shaped lobes tightly adherent to each other. Most lobes contain only one zooid. Some lobes contain several (usually no more than four) zooids but such lobes are probably formed by fusion of several individual zooid-bearing lobes. The basal parts of the lobes anastomose into an irregular dense network forming the basal layer of the colony. Some colonies are free from sand, in others sand is present at the base of the colony and between the lobes. In the latter case zooids appear to be better separated and fused lobes are less frequent (Fig. 28B). Both apertures of zooids open directly to the exterior and the zooids are oriented without any order, i.e. colonial systems are not formed.

Both siphons are long, close to each other, six-lobed, directed vertically upward. Longitudinal muscles continue from the thorax to the end of the posterior abdomen. Stigmata are in ten rows in examined zooids (original description states nine in the holotype and 10–12 in paratypes) with up to 24 stigmata per row on each side. Transverse branchial vessels have no papillae and there are no parastigmatic vessels. The abdomen is usually slightly shorter than the contracted thorax but probably significantly shorter in expanded zooids. The oesophagus is very short and straight, enters the stomach vertically. The stomach is barrel-shaped and wide, symmetrical (not shortened dorsally), located in the middle of the abdomen. The stomach wall has six or seven regular well-marked external longitudinal folds. The posterior abdomen is not constricted from the abdomen and is about half the total zooid length. A small ovary is sometimes present at the top of the posterior abdomen, just behind the pole of the gut loop. Male follicles in several rows are just behind the ovary, and the heart is at the end of the posterior abdomen. Several (five or six) large ova are incubated at the end of the oviduct in the posterior half of the atrial cavity. A few fully formed larvae are present. The trunk is 0.5 mm in length. Four thick finger shaped median ampullae alternate with three adhesive organs on long thin stalks. One lateral ampulla arises at the base of each median ampulla on each side of the trunk. Vesicles were not observed.

REMARKS. The taxonomic position of this species is not clear and originally it was assigned to *Ritterella* despite the fact that all species of *Ritterella* have embedded zooids. The only exception was *R. multistigmata* Kott, 1992, in which the terminal branches of the colony contain one to three zooids, and it was used by Sanamyan (1998a) to justify the

assignment of his species to *Ritterella*. All described features of *R. multistigmata*, including the structure of the colony, the shape of the zooids with wide thoraces, numerous branchial papillae and muscular meshwork on the thoracic wall, are characteristic for *Monniotus* rather than for *Ritterella* and this species was subsequently synonymized with *Monniotus australis* (Kott, 1957) (see Kott, 2008a: 1120). Thus, the position of the present species with its separate zooids in *Ritterella* was not justified. In the general structure of the colony, with narrow vertical stalks containing isolated zooids, the present species closely resembles members of the genus *Monniotus*. The structure of the present colony is essentially identical to that of *Monniotus australis* (Kott, 1957) or *M. radiatus* Kott, 1992 as figured by Kott (1992, figs 1a and 2a). The only difference is that the basal stolons in the present species are more profusely developed and partially fused with one another, and the vertical zooids are more crowded than in Australian species. Most species of *Monniotus*, however, have parastigmatic vessels and all species have papillae on the transverse branchial vessels, while the present species lacks them. The presence or absence of parastigmatic vessels appear to be not a very significant feature for delimitating genera (many genera unite species with or without parastigmatic vessels), but the presence of branchial papillae may constitute a significant difference of generic importance (e.g. as in polyclinid genera *Polyclinum* and *Aplidiopsis*). The situation is complicated by the fact that the branchial papillae are present in some species currently assigned to *Ritterella*, but many other species of this genus, including its type species, *R. aequalisiphonis* (Ritter et Forsyth, 1917), lack them and thus the genus appears to be heterogeneous. The absence of branchial papillae in the present species excludes its assignment to *Monniotus* (known so far from the Southern Hemisphere only). Thus, I prefer to create a new genus *Kussakinia* gen.n. for this species rather than place it with *Ritterella* or *Monniotus*. The structure of the colony distinguishes it from *Ritterella* and absence of branchial papillae from *Monniotus*.

Kussakinia tamarae (as well as *Ritterella iturupica*) is known only from its type locality and only from the several lots of specimens collected in 1954 by O. Kussakin in the intertidal zone of Iturup Island (southern group of Kuril Islands). When covered with sand some colonies of *K. tamarae* may resemble externally sandy colonies of *R. iturupica*, but the latter species has embedded zooids arranged in rudimentary cloacal systems rather than separate zooids joined only at the base. Its zooids differ in having a globular asymmetrical stomach with many faint plications while in *K. tamarae* the stomach is symmetrical and has six or seven prominent folds.

Genus *Protosynoicum* gen.n.

Type species: *Synoicum sabuliferum* Redikorzev, 1937 designated herein.

Other species included: *Protosynoicum arenosum* (Brewin, 1950) (= *Sigillinaria arenosa* Brewin, 1950).

Colonies composed of completely embedded zooids with a narrow thorax, abdomen and long posterior abdomen; gonads in posterior abdomen; heart at posterior end of posterior abdomen; both siphons usually six-lobed, open directly to the exterior; no papillae on transverse branchial vessels; stomach smooth.

In the structure of zooids, the genus resembles the polyclinid genus *Synoicum* but both siphons open directly to the exterior and zooids are not arranged into cloacal systems. The genus is distinguished from *Ritterella* by its smooth stomach. For more detailed discussion see Remarks under *Protosynoicum sabuliferum* below.

Protosynoicum sabuliferum (Redikorzev, 1937)

Fig. 29.

Synoicum sabuliferum Redikorzev, 1937: 125.

MATERIAL EXAMINED. East coast of Kamchatka, Kronotsky Bay, 54°04'N, 159°58'7"E, lower part of the intertidal zone, 30.07.1934. Coordinates from the label; they are not precise (they point to the land although the locality is not far from the shore).

DESCRIPTION. The examined colony is probably a part separated by Redikorzev from a larger colony. It consists of high inverted cone-shaped lobe, narrow at base and wider at the top (Fig. 29A). The upper part of the colony is partially subdivided into short, crowded, flat topped cylindrical lobes up to 7 mm in diameter. The shape of the colony suggests that it was extracted from a crevice in a rocky bottom with only the small upper part exposed to the exterior. The whole colony, including the upper surface and sides of the cylindrical lobes, is densely covered with sand. Less abundant sand is present in the inner layers of the transparent colorless test.

The zooids stand vertically and at least some of them are very long (Fig. 29D), extending the entire length of the colony. They open on the top of cylindrical lobes. In each lobe the zooids are arranged in a single circle. The branchial siphons open to the exterior on the periphery of the circle while atrial siphons are directed toward its center. Thus the arrangement of the zooids is essentially the same as, for example, in *Synoicum turgens* and other polyclinids with circular systems. In this species, however, atrial siphons open directly to the exterior, not

into a common cloacal cavity. Zooids have two well-developed siphons and both are directed upward. Each siphon usually has six well developed lobes. Longitudinal thoracic muscle fibers are very fine but numerous and continue along the entire length of the body to the end of the posterior abdomen. There are also fine but numerous transverse thoracic muscles and bands of transverse muscles between the rows of stigmata. The branchial sac has 12 rows of stigmata (Redikorzev 1937 gives the same number) with about 23 stigmata in a row on each side. The gut loop is relatively short (Fig. 29B, D). The oesophagus enters the oval smooth-walled stomach slightly obliquely but the stomach is almost symmetrical. The post pyloric intestinal subdivision is not distinct, with one constriction on the descending limb of the intestine (Fig. 29D) which is otherwise isodiametric. The anus opens at the middle of the thorax. The very long posterior abdomen is a direct continuation of the abdomen. Male follicles form several clusters in the anterior part of the posterior abdomen. Several thick sperm ducts run parallel to each other and fuse only in the middle of the abdomen. The heart is at the end of the posterior abdomen.

REMARKS. The species is known only from the type material originally described by Redikorzev (1937) and redescribed in the present paper. All type specimens were collected in the same locality in Kronotsky Bay. It is very strange that this species has not been found again since its original description. Although we were never able to work directly in the type locality of this species, the neighboring coasts and bays of Kamchatka are very well sampled for ascidians but no similar species were found.

Sandy colonies with short terminal cylindrical lobes bear some resemblance to colonies of *Aplidium redikorzevi* (see Fig. 9A) but zooids are very different.

Assignment to a family and a genus. Redikorzev (1937) assigned his species to *Synoicum* due to its smooth stomach and overall similarity. He, however, overlooked the fact that the atrial siphons of zooids open directly to the exterior and there are no true cloacal systems and therefore the assignment to *Synoicum* and to the family Polyclinidae is excluded. The presence of transverse thoracic muscles also is an unusual feature for Polyclinidae.

The species is a member of the family Ritterellidae as it is currently defined. In this family the genus *Ritterella* is characterized by embedded zooids. However, most species of *Ritterella*, including its type species, have well-marked longitudinal stomach folds as in *Aplidium*. The only exception was *Ritterella rubra* Abbott et Trason, 1968, but its curved oesophagus and obliquely oriented (as in *Aplidiopsis*) asymmetric mulberry-like stomach, strongly shortened dorsally, are important charac-

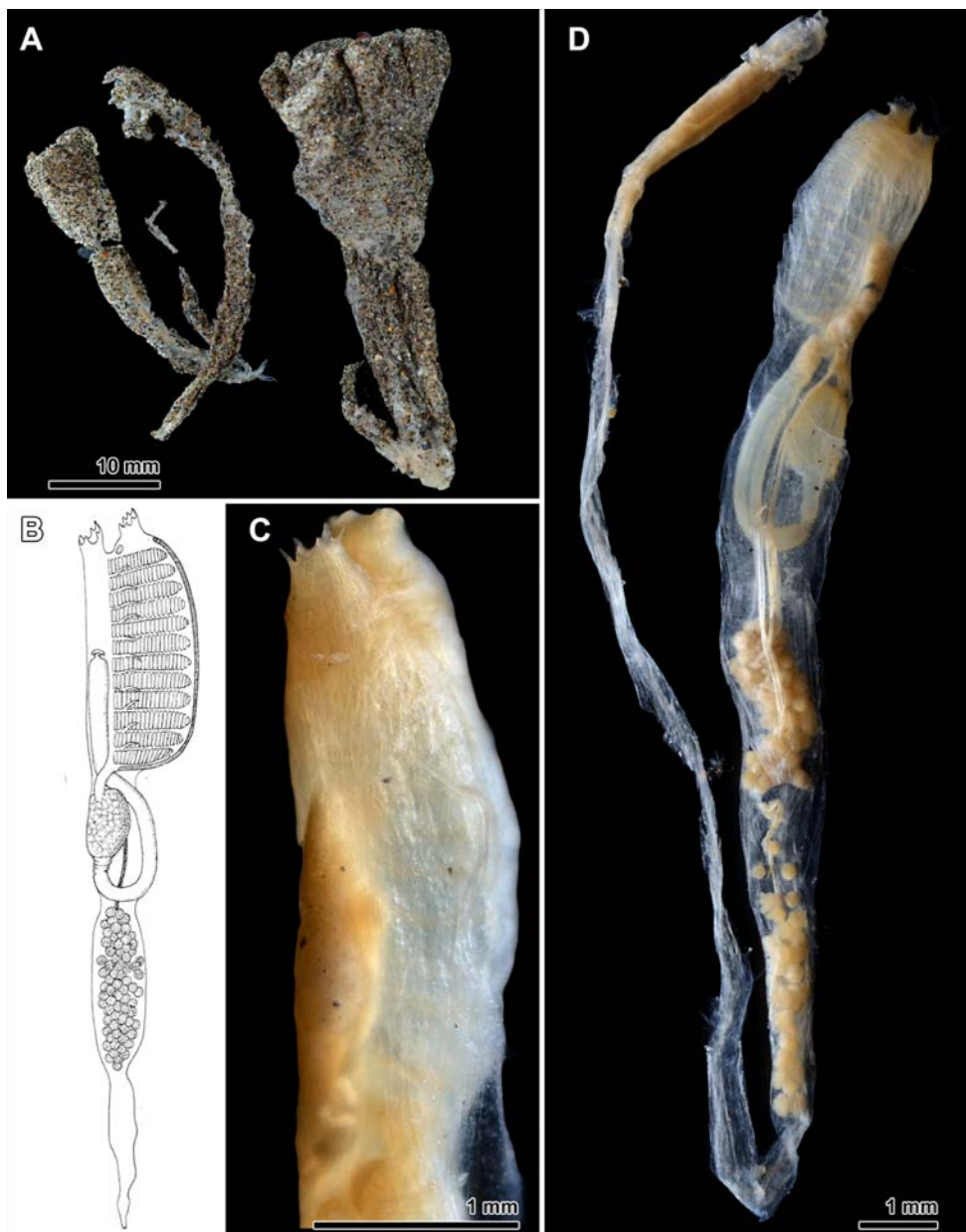


Fig. 29. *Protosynoicum sabuliferum*. A — colony; B — zooid (after Redikorzev, 1937); C — thorax of the zooid, enlarged to show details of the atrial siphon; D — whole zooid.

Рис. 29. *Protosynoicum sabuliferum*. А — колония; В — зооид (по Redikorzev, 1937); С — торакс зооида, увеличено, чтобы показать детали строения атриального сифона; D — зооид.

ters separating it from all members of *Ritterella*. This species was excluded from *Ritterella* by Kott (1992), an opinion which I support. Brunetti (2007) transferred it to *Synoicum* and created a new name *Synoicum californianum* Brunetti, 2007 to remove hom-

onymy with *Synoicum rubrum* Coldstream, 1830. His opinion was probably based on a not quite correct interpretation of Kott's (1992: 400) words who said that *Ritterella rubra* "appears to have a similar relationship with *Synoicum* to that of *Ritter-*

ella with *Aplidium*". Anyway, *Ritterella rubra* certainly cannot be placed to *Synoicum* and therefore not requires a replacement name. Correct generic assignment of *Ritterella rubra* remains unresolved.

Several species with zooids that resemble the zooids of *Synoicum sabuliferum* (with smooth stomach and siphons open directly to the exterior) were assigned previously to *Homoeodistoma* Redikorzev, 1927. F. Monniot & C. Monniot (2008) list the following five members assigned to this genus: *H. omasum* F. Monniot, 1987, *H. arenosum* (Brewin, 1950), *H. areolatum* (Kott, 1963), *H. longigona* Tokioka, 1959 and *H. michaelseni* Redikorzev, 1927. However, there is a serious nomenclatural problem: *Homoeodistoma* is a junior synonym of *Placentela* Redikorzev, 1913 (because their type species, *H. michaelseni*, and *P. crystallina* Redikorzev, 1913, are synonyms). Being a junior synonym, *Homoeodistoma* cannot be used as a valid generic name for any species and the remaining *Homoeodistoma* species require other generic names. *Homoeodistoma longigona* was transferred to *Pseudodiazona* by Kott (2008a) and a new generic name *Condominium* Kott, 1992 has been created for *H. omasum* and *H. areolatum* (the latter was originally described as *Placentela areolata* Kott, 1963). F. Monniot (2012: 22) noted that Kott's genus *Condominium* is not retained in her paper and preferred to use the generic name *Homoeodistoma*. However, a selection of correct generic name in this case is a pure nomenclatural question (not depending on opinion of taxonomists): the name *Homoeodistoma*, as explained above, is a junior synonym and therefore not valid, while *Condominium* is the only other available generic name for *H. omasum* and *Placentela areolata*. The remaining species, *H. arenosum* (Brewin, 1950), most closely resembles *Synoicum sabuliferum*. Originally it was described as *Sigillinaria arenosa* Brewin, 1950. Kott (1992) preferred (with some hesitation as seems from her text) to assign it to *Ritterella*, but stated that this species has no affinity with other *Ritterella* species. The assignment of this species, having smooth stomach, to *Ritterella* is not justified. It cannot be left in the genus *Sigillinaria* Oka, 1933 because *Sigillinaria*, as *Homoeodistoma*, is a junior synonym of *Placentela* (see comments under *Placentela*) and is invalid. And it cannot be assigned to *Condominium* because it significantly differs in morphology from the type species of *Condominium* and they certainly are not congeneric. A very wide thorax (50 or more stigmata per row) of *Condominium areolatum* is a feature significant enough to separate it on the generic level from *Sigillinaria arenosa* and *Synoicum sabuliferum*. Therefore, a new genus *Protosynoicum* gen.n. is established here for *Synoicum sabuliferum* Redikorzev, 1937 and *Sigillinaria arenosa* Brewin, 1950.

Family Placentelidae Kott, 1992

The family Placentelidae was erected by Kott (1992) for a single genus *Placentela* Redikorzev, 1913 characterized by embedded zooids with six-lobed siphons open directly to the exterior, oesophagus of variable length depending on the state of zooids (but usually long) and the presence of a long posterior abdominal extension (terminology according to Kott, 1992: 391) containing most of the gonads, while the heart is in the abdomen. In the present work two other genera are added to this family: *Pseudoplacentela* Sanamyan, 1993 and *Bathyplacentela* gen.n. Zooids of these two genera differ in some significant characters from those of *Placentela*, e.g. gonads are in the abdomen (*Pseudoplacentela*) or in the abdomen and posterior abdominal extension (*Bathyplacentela*), and short oesophagus in contrast with *Placentela*. Nevertheless, these three genera appear to be closely related. They all have six-lobed apertures, similar thoracic musculature with diagonal muscles, many of which originate ventrally (at the endostyle); known larvae have similar almost sessile simple cup-like adhesive organs and no trace of ampullae or vesicles, and colony structure is similar and unusual, all of which suggests a close affinity.

Kott (1992) discussed some similarity of Placentelidae and Holozoidae, in particular in Holozoidae the gonad often extends into a posterior abdominal extension and larvae have similar simple and almost sessile adhesive organs and well-developed adult organs but suggested that a common ancestor is more likely than a direct relationship. Discovery of *Pseudoplacentela* and *Bathyplacentela* gen.n. support affinity of Placentelidae with Holozoidae, the zooids of these genera, in which most of the gonad is located in the abdomen, bear stronger resemblance with zooids of Holozoidae than zooids of *Placentela*.

Three included genera are monotypic and known exclusively from NW Pacific.

Genus *Placentela* Redikorzev, 1913

Type species *Placentela crystallina* Redikorzev, 1913 by monotypy.

Colonial ascidians with embedded zooids. Zooids divided into thorax, abdomen and posterior abdominal extension. Both siphons six-lobed, open directly to exterior. Branchial sac wide, with numerous (up to 50) stigmata per row. Oesophagus long in fully functional (feeding) zooids, stomach in posterior half of abdomen, smooth or with weak, poorly defined irregular folds. Anus at top of thorax; gonads in posterior abdominal extension. Heart beside and in part below the pole of the gut loop. Placental membrane in atrial cavity attached to rectum.

The genus was erected by Redikorzev (1913) for a specimen from the Sea of Okhotsk (collected at “St. Nikolaus-Bucht”) described as *Placentela crystallina* Redikorzev, 1913. Later, a specimen from Kamchatka (later determined to be the same species) was described by him (Redikorzev, 1927a) as a new genus and species *Homoeodistoma michaelsoni* Redikorzev, 1927. Oka (1933) again described this species as a new genus and species *Sigillinaria clavata* Oka, 1933. Several other, probably unrelated, species were subsequently assigned to genera *Placentela*, *Homoeodistoma* and *Sigillinaria* but were subsequently transferred to other genera and the synonymy of all three genera is now firmly established (see Nishikawa, 1984 and an overview and comments in Kott, 1992). At present the genus *Placentela* contains two species, *P. crystallina* and *P. translucida* Kott, 1969. The latter species is known from the original description only, based on three specimens from the Antarctic (Kott, 1969) which were apparently in poor condition. The assignment of this species with short oesophagus, rather narrow branchial sac (18 stigmata per row while up to 50 in *P. crystallina*), larva with two (rather than three) adhesive organs and unknown position of the heart to *Placentela* is poorly justified. Most probably they are not congeneric and the genus *Placentela* should be treated as monotypic. Kott (1992) wrongly reported that that *Placentela* has a short oesophagus. In fully-functional feeding zooids of *P. crystallina* the oesophagus is always long. A relatively short oesophagus may occur in zooids which are in the non-feeding stage, or in a process of degeneration, e.g. in cormidia already detached from the main part of colony.

Placentela crystallina Redikorzev, 1913

Fig. 30.

Placentela crystallina Redikorzev, 1913: 212. Nishikawa, 1984: 39. Sanamyan, Sanamyan, 2017a: 310.

Homoeodistoma michaelsoni Redikorzev, 1927a: 376.

Sigillinaria clavata Oka, 1933: 78. Tokioka, 1968: 199.

MATERIAL EXAMINED. *Ac. Oparin-56*, St.10, Urup Island (Sea of Okhotsk side), 46°03.78'N, 149°59.29'E, 6–16 m, 29.06.2019, one colony; St.23, 3.07.2019, Shimushir Island (Sea of Okhotsk side), 47°07.38'N, 152°09.58'E, 1–6 m, one colony; St.67, 11.08.2019, Paramushir Island (Sea of Okhotsk side), 50°17.93'N, 155°18.09'E, 7–13 m, two colonies. KBPGI 7/448, 1.08.1986, west part of the Sea of Okhotsk, 53°41'3"N, 137°50'E, 18 m.

DESCRIPTION. The colonies from Urup and Shimushir islands are small and contain only several contracted zooids; the following description is based on material from Paramushir Island (St. 67, Fig.

30A, B), consisting of several fragments which probably belong to one or two colonies. The structure of the colony lobes is typical for this species: the basal parts are very hard and contain elongated parts of the zooids filled by pinkish parenchyma and lacking any identifiable structures. Distally, the cormidia are much softer and contain the zooids. In one, larger (3 cm in diameter) cormidium, which is detached from the hard basal part of the colony, the thoraxes and abdomens of all zooids are present, while in another sample the proximal parts of the abdomens (including the stomach and the heart), are immersed into the hard basal test and filled by parenchyma.

The thoraces and abdomens together are about 20 mm long. The siphons are close together and open directly to exterior, the atrial is terminal, the branchial slightly displaced along the ventral side. Both siphons have six well-developed lobes. Thoracic muscles are represented by ten to twelve widely spaced longitudinal (originating from the siphons) and oblique (originating from the ventral, endostylar, part of the thorax) bands; transverse muscle fibers are lacking. Despite rather well developed thoracic muscles the thoraxes of most zooids are not strongly contracted — this is a feature that seems to be characteristic for the species. A band of circular muscles forms a rather strong sphincter in the most distal part of the abdomen. The longitudinal muscles continue along the entire abdomen and also the posterior abdominal extension (when the latter is present). The branchial sac has ten rows of about 45 stigmata in each row per side. Transverse vessels, separating rows of stigmata, are very high. The dorsal languets are narrow and long, significantly displaced to the left from the dorsal mid-line.

The zooids in the examined colonies are apparently in a non-feeding state (with empty alimentary tracts). The length of the oesophagus differs in zooids extracted from different cormidia: in the larger cormidium the zooids have a comparatively short oesophagus, the stomach being in the middle of the abdomen, while in the smaller cormidium the thoraces, especially their distal part, are very elongated and, accordingly, have a very long oesophagus (Fig. 30B). The elongated stomach has several shallow poorly defined longitudinal folds. The anus has two smooth lobes. The V-shaped heart, with unequal branches, is well visible as a thin-walled transparent tube lying beside and in part below the pole of the gut tube. Gonads are not developed. To show their position in the posterior abdomen I provide a photograph of a zooid from a colony KBPGI 7/448 collected in 1986 in the Sea of Okhotsk (Fig. 30C).

Newly collected specimens contain no larvae and I failed to find any trace of the placental membrane. According to Sanamyan & Sanamyan (2017a), larvae have an elongated (not round as in *Pseudopla-*



Fig. 30. *Placentela crystallina*. A — colonies; B — zooids; C — zooid with well-developed gonads from a specimen from Kamchatka (KBPGI 7/448), lightly stained by toluidine blue.

Рис. 30. *Placentela crystallina*. А — колонии; В — зооиды; С — зооид с хорошо развитыми гонадами, экземпляр с Камчатки (KBPGI 7/448), слегка окрашенный толуидиновым синим.

centela) trunk 1.1 mm long, three large cup-shaped adhesive organs on short stalks (almost sessile) arranged in a vertical row and no epidermal vesicles or ampullae. Otolith and ocellus are present.

REMARKS. *Placentela crystallina* is known from the Sea of Okhotsk, SW coast of Sakhalin, and from the east coasts of Kamchatka to Hokkaido. The

species is well studied, especially by Japanese authors (Tokioka, 1968; Nishikawa, 1984). Colony shape may vary depending on environment (Tokioka, 1968, fig. 1, Nishikawa, 1984, fig. 2) but in most cases the colonies, especially when large and fully developed, are very distinctive and cannot be confused with other species. Zooids also show signifi-

cant degree of variations in details of their morphology (e.g. the length of the oesophagus as described above) depending on their physiological condition. The number of rows of stigmata may vary from eight to 16, as reported in the literature, which seems to be too large for a species. Redikorzev (1913) reported 16 rows of stigmata in the type specimen. Nishikawa (1984) for the same specimen reported 13–16 rows, but from eight to 12, rarely 13 rows in the other material he examined. Tokioka (1968: 202) reported “11 to 13, most frequently 11 to 12” rows for *Sigillinaria clavata* (= *P. crystallina*) and discussed higher numbers (16) given for this species by Oka (1933). According to him, these higher numbers may be reported erroneously because of incorrect counting: “As the free edge of the horizontal membranes [= transverse vessels] cuts the stigmatal rows into the anterior and posterior halves when they are flapped down, it is not impossible that some posterior rows were counted under microscope twice as much” (Tokioka, 1968: 203). I agree that this is quite possible, in my material I counted from ten rows (in the specimens described here and by Sanamyan & Sanamyan (2017a)) to 13 rows (in the specimen KBPGI 7/448, Fig. 30C). Well-developed gonads in this species are rare; none were found in the present material. In most other specimens I examined previously, with few exceptions (e.g. Fig. 30C) the gonads were in mutilated condition or absent completely.

Genus *Pseudoplacentela* Sanamyan, 1993

Type species: *Pseudoplacentela smirnovi* Sanamyan, 1993 by monotypy.

The genus is characterized by the following features: zooids with atrial and branchial siphons open separately to the exterior by six-lobed apertures; thorax with longitudinal and oblique (but not transverse) muscles; wide branchial sac with numerous rows of numerous stigmata separated by high transverse vessels; no branchial papillae or internal longitudinal vessels; atrial membrane present; abdomen with gut and gonads; heart (probably) in abdomen or just below gut loop; posterior abdomen with muscles; larva with simple cup-shaped adhesive papillae.

Sanamyan (1993b) compared *Pseudoplacentela* with *Placentela* (Placentelidae), *Sigillina* (currently in Pseudodistomidae Harant, 1931 but thought to be in Holozoidae at that time), *Hypodistoma*, *Polydistoma* and *Hypsistozoa* (Holozoidae) and provisionally assigned *Pseudoplacentela* to Holozoidae. In the present work, after examination of additional specimens and after discovery of *Bathypalcentela* gen.n. (see below) I prefer to place this genus, together with *Bathypalcentela* gen.n., in Placentelidae. The general structure of colonies of these three

genera is similar and unique. Although the type species of *Placentela*, *P. crystallina*, has, when well developed, branched colonies, and the branches are much thicker than the stalk in colonies of *Pseudoplacentela*, the general structure of the colony is the same: each branch, or cormidium has a distal soft part (head) containing zooids, and one or several sequentially arranged hard proximal segments containing serially arranged survival buds (see, e.g., Nishikawa, 1984, fig. 2). The structure and the shape of the thoraces of *Pseudoplacentela* and *Placentela* also are similar: both genera have six siphonal lobes (especially on the atrial siphon), wide branchial sac with usually nine or ten rows of numerous (about 40–45) stigmata, longitudinal as well as oblique (originating from the endostyle) muscles, the anus at the top of the thorax, just below the atrial siphon, and similar atrial (=“placental”) membrane located in the same position as the rectum. Cup-shaped larval adhesive organs of *Pseudoplacentela* resemble those of *Placentela* (see Fig. 8E in Sanamyan & Sanamyan (2017a)), although smaller and less regularly arranged. *Placentela* differs principally by its long oesophagus and gonads located mainly in the posterior abdomen. However, *Bathypalcentela*, which is undoubtedly closely related to *Pseudoplacentela*, has its gonad in an intermediate position being in part emerged into the posterior abdominal extension, that makes the affinity with *Placentela* more probable.

Relationship to the genus *Sigillina* (Pseudodistomidae), suggested by Sanamyan (1993b), seems to be more remote. In *Sigillina*, as in *Pseudoplacentela*, the longitudinal body muscles extend along the length of the posterior abdominal extension and it has a short oesophagus, but the structure of the thorax is different: only longitudinal, but not oblique, thoracic muscles are present, in *Sigillina* they originate from the siphons but not from the endostyle, and the structure of larval adhesive organs is also different (see Kott, 1990).

Pseudoplacentela smirnovi Sanamyan, 1993 Figs 31, 32, 34A.

Pseudoplacentela smirnovi Sanamyan, 1993b: 305.

MATERIAL EXAMINED. *Ac. Oparin-56*, St.31, Sakhalin Island, Terpenia Bay, 47°42.5'N, 144°30.3'E, 240–209 m, 28 July 2019; St.65, N Sea of Okhotsk, Erineyaskaya Bay, 56°43.4'N, 144°40.7'E, 286 m, 9 August 2019; St.69, Onokotan Island (Sea of Okhotsk side), 49°24.0'N, 154°16.1'E, 146–147 m, 12 August 2019. One colony in each station.

DESCRIPTION. The length of the largest colony is 11.5 cm. It consists of a long stalk 1.5–5 mm in diameter and bunched zooids at its top which form a head-like structure, two other colonies are much

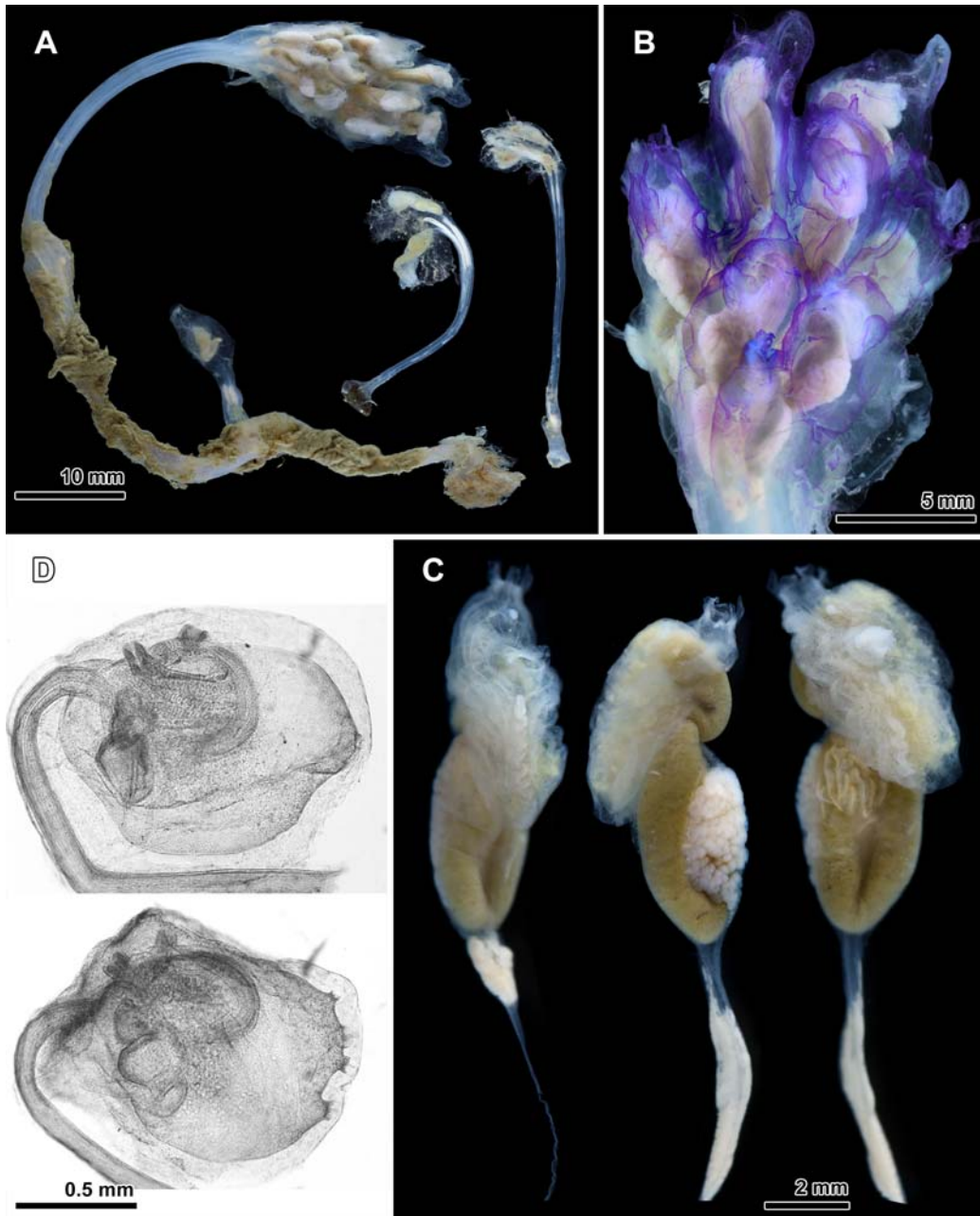


Fig. 31. *Pseudoplacentela smirnovi*, A — three colonies, preserved in formalin; B — a head of a larger colony, surface lightly stained by toluidine blue to better show independent distal parts of zooids; C — zooids; D — larva (from the holotype).

Рис. 31. *Pseudoplacentela smirnovi*, А — три колонии, зафиксированные в формалине; В — головчатая часть более крупной колонии, поверхность слегка окрашена толуидиновым синим для лучшей визуализации свободных дистальных частей зоидов; С — зоиды; D — личинка (из голотипа).

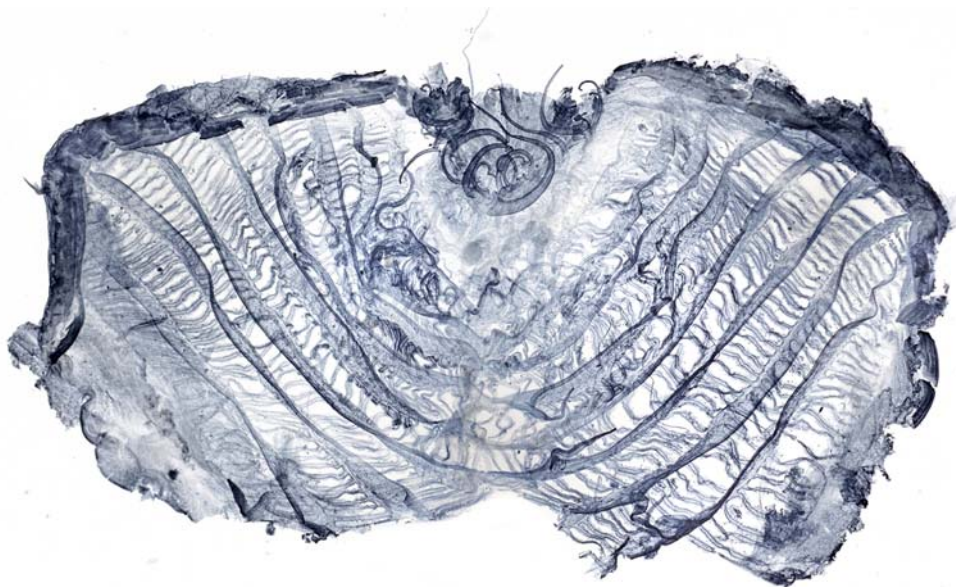


Fig. 32. *Pseudoplacentela smirnovi*, branchial sac.
Рис. 32. *Pseudoplacentela smirnovi*, жаберный мешок.

smaller (Fig. 31A). The proximal half of the stalk in the largest colony is covered with sediment (probably damaged tubes of polychaetes), otherwise the test is free from incrustation. There are several short root-like outgrowths at the base around the area of attachment. Several spherical parenchymal bodies (survival buds) are present in the middle part of the stalk.

The zooids are divided into thorax, abdomen and vascular posterior abdominal extension. The zooids are partially separate, in preserved and strongly contracted condition their thoraces and, at least in part, abdomens project separately (not embedded in a common test). In life the colonies probably have a peculiar appearance with the head formed by long finger-shaped zooids which are free along most of their length. In contracted zooids the combined length of the thorax and abdomen is about 7 mm. The thoraxes are strongly contracted. The atrial aperture is terminal, on a well-defined siphon with six prominent lobes. The branchial siphon is on the antero-ventral side of the thorax, obscurely lobed. Its dorsal (upper) lobe is significantly larger than the rest and forms a kind of hood. In the colony the openings of the branchial siphons of all zooids are directed down and the hoods formed by their dorsal lobes and the test which covers them are very distinct.

Both siphons are furnished by bunches of fine circular muscles forming a sphincter. Longitudinal thoracic muscles are very thin and difficult to see even on stained zooids. About five of them originate

from the ventral side of the thorax and two or three from the branchial siphon and intersiphonal area. Longitudinal muscles continue along the length of the abdomen and most of the posterior abdominal extension. Transverse muscles are not present.

The branchial tentacles are slender, long and numerous, about 25 in number, of different sizes. The prepharyngeal band runs along an oval line, without a noticeable dorsal V around the dorsal tubercle which is mid-way between the siphons. The branchial sac has nine or ten rows of stigmata separated by eight or nine transverse vessels, with 40–45 ciliated stigmata on each side. The dorsal languets are long but slender.

The oesophagus is very short. The stomach is barrel shaped. In most zooids its wall has irregular longitudinal folds, about ten to 14 in number (they cannot be counted precisely), sometimes they are difficult to see. These folds may be artifacts of fixation — the stomach is thin-walled and easily loses its form when the zooid contracts in the fixative. The gut loop is vertical. The gut is isodiametric and show no visible subdivisions. The anus is just below the atrial aperture, at the top of the zooid. Its border has 15–20 long cylindrical lobes.

Male follicles are profusely developed in all examined zooids from the larger colony, they are very numerous, oval or round, form a compact mass on the left side of the abdomen but do not extend into the posterior abdominal extension. The robust sperm duct forms tight sinuous plications along its course

along the rectum and opens just below the anus. The ovary is small, underdeveloped, located between the mass of testis follicles and the abdominal wall. A small atrial (=“placental”) membrane is attached to the rectum on the right side of the thorax (Fig. 34A, arrow).

The zooids from newly collected colonies contain no larvae, but larvae were present in the originally described specimens (Sanamyan, 1993b) and were reexamined (Fig. 31D). Larvae are almost round in outline, higher than larvae of any colonial ascidian known in the NW Pacific. The trunk is 0.8–1.2 mm in length. The tail is unusually long and makes 1.25 turns around the trunk. Originally Sanamyan (1993b) reported the presence of only two adhesive organs. In fact the larvae vary in this feature, some have two but others may have one, three or four adhesive organs. Adhesive organs are small, simple, sessile cup-like structures situated in the anterior part of the trunk. Their arrangement varies to some extent, and in most cases at least some of them are slightly shifted from the anterior mid-line to one or the other side of the body. There are no vesicles or ampullae. The larva has a well-developed blastozooid with four rows of stigmata, which occupies about half of the larval trunk. No otolith or ocellus is present.

Zooids have a thin-walled tubular structure in the distal (upper) portion of the postabdominal vascular extension, just below the gut loop, but I could not determine whether this is the heart. The postabdominal vascular extension in most zooids contains parenchymal tissue.

REMARKS. This is a first record of a member of the genus *Pseudoplacentela* since its original description. *Pseudoplacentela smirnovi*, the type and the single species of this genus, was based on three colonies, one of which (the holotype) was collected at the southern end of chain of the Kuril Islands (43°33.5'N, 146°36.2'E), the other two near Paramushir Island (northern end of Kuril Islands chain) at depths of 101–246 m. The present specimens come from the same depth range (146–289 m), one colony was collected within the known geographic range of *P. smirnovi* (Kuril Islands) and two from more western locations (Sakhalin Island and north part of the Sea of Okhotsk). In the original description Sanamyan (1993b: 306) stated that the surface of the stomach in *P. smirnovi* is “quite smooth”. In the present material the stomach wall has longitudinal folds, a feature that may constitute a species specific difference. These folds, however, are not sharply defined in all zooids, although in most cases they are noticeable. The reexamination of the holotype of *P. smirnovi* showed that in some zooids the stomach shows some hints of folds but in general appears to be smoother than in the newly collected material. Further, the zooids in the type material of

P. smirnovi, unlike those of the present specimens, are said to be completely embedded in the common test of the colony head. This feature also should be taken with caution because it is possible that in the case of strong contraction the zooids may be drawn into the colony, especially if the material initially was fixed in alcohol. On the other hand, the record of *Bathypalcentela pedunculata* sp.n., a species which in almost all features is identical with *P. smirnovi*, but which has a different branchial sac (a feature leaving no doubt of its separate taxonomic status), suggests that similarity in most features of the colony and zooids in these similar looking pedunculated colonial ascidians does not necessarily mean that these taxa are conspecific. Nevertheless, at this stage I prefer to not separate the newly described colonies from *P. smirnovi*.

Genus *Bathypalcentela* gen.n.

Type species: *Bathypalcentela pedunculata* sp.n. designated herein.

The genus is characterized by: zooids with atrial and branchial siphons opening directly to the exterior or by six-lobed apertures; thorax with longitudinal and oblique (but not transverse) muscles which extend to the end of the posterior abdominal extension; branchial sac lacking stigmata and composed of several (eight in the type species) inner transverse vessels connected by widely spaced longitudinal strips, together forming large square meshes; no branchial papillae or internal longitudinal vessels; the presence of an atrial membrane; gonads partly in abdomen, partly in posterior abdominal extension; heart in anterior part of posterior abdominal extension, just below the gonad.

In most features *Bathypalcentela* is similar to *Pseudoplacentela* and is assigned to Placentelidae. It differs from *Pseudoplacentela* in the structure of the branchial sac lacking true stigmata and of an “abyssal” type.

Only the following four genera of colonial ascidians have a branchial sac without true stigmata: *Pharyngodictyon* (Pharyngodictyonidae), *Neodiction* nom.n. for *Neodiction* Sanamyan, 1998 (Polyclinidae), *Protoholozoa* and *Scotiazoa* (Holozoidae). They are assigned to different families and despite some similarity in the structure of the branchial sac are apparently not related to each other and to *Bathypalcentela*. Only *Neodiction* nom.n. is known from the Northern Hemisphere.

In *Neodiction* nom.n. the shape of the atrial aperture is similar to other Polyclinidae species (especially *Synoicum* spp.) suggesting that the zooids are arranged into cloacal systems. *Neodiction* nom.n. has a similar number of transverse branchial vessels (about eleven) but, in contrast to *Bathypala-*

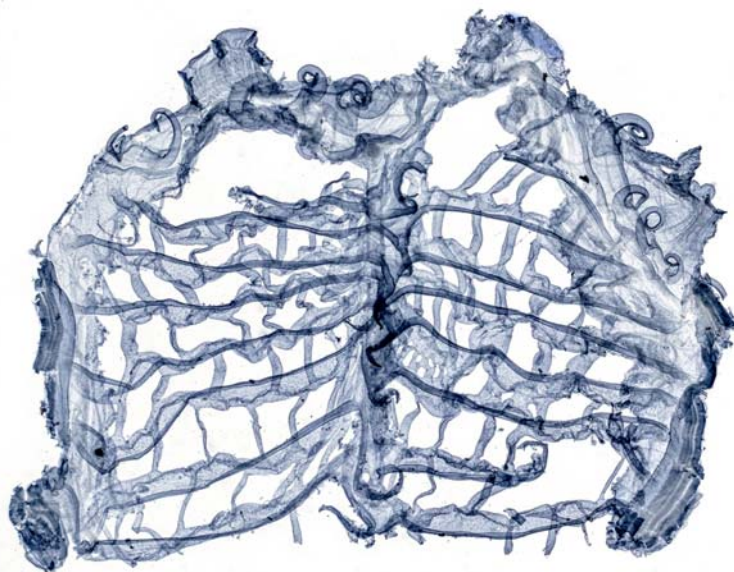


Fig. 33. *Bathylacentela pedunculata* sp.n., branchial sac.
Рис. 33. *Bathylacentela pedunculata* sp.n., жаберный мешок.

centela, they are not connected by longitudinal strips. Instead, each vessel is connected to the lateral thoracic wall by two thick connectives (absent in *Bathylacentela*). There may be also a significant difference in the position of the heart; in *Neodiction* nom.n. it is thought to be in the end of the posterior abdomen.

Pharyngodictyon has a true posterior abdomen with the heart at its end. The atrial aperture in this genus is located at the bottom of the thorax, while in *Bathylacentela* it is in its top. Transverse branchial vessels in *Pharyngodictyon* may be connected by longitudinal strips but they are far less numerous than in *Bathylacentela*.

In *Protoholozoa* and morphologically similar *Scotizoa* the transverse branchial vessels are limited to two or three (one species has four). These genera have a long posterior abdominal extension but the gonads are located mainly in the gut loop and do not extend into the posterior abdominal extension.

Bathylacentela pedunculata sp.n.

Figs 33, 34B, 35.

MATERIAL EXAMINED. Holotype MIMB 43163. *Ac. Oparin-56*, St.19, Shimushir Island (Pacific side), 46°40.6'N, 151°58.4'E, 436 m, 2 July 2019. Paratypes MIMB 43164, same data, seven colonies.

DESCRIPTION. All eight colonies are very similar. Each consists of an inverted conical zooid-bearing head, up to 2 cm long and 1–1.5 cm in greatest diameter, raised on a long wiry stalk up to 9 cm long and 1–1.5 mm in diameter. The proximal end of the stalk is expanded into a small flat disc by which the colonies are attached. The stalk is translucent and firm while the head is soft, transparent and colourless. The surface, including the attachment area, is free from any outgrowths and attached inorganic particles although a few hydrozoan colonies are present on the stalks of some colonies. The stalks are composed of several (two to four) segments, each may represent an annual growth (Fig. 35A). The distal part of each segment is slightly dilated and contains several (usually two to six) longitudinal series of oval parenchymal bodies. They are considered to be survival buds remaining from the previous seasons. The stalks in all colonies are not branched.

Zooids are divided into thorax, abdomen and vascular posterior abdominal extension (Figs 34B, 35C). The zooids are about 15 mm in strongly contracted condition, with the thorax and abdomen half of this length while the posterior abdominal extension in some zooids may be much longer. Four to six or sometimes a few more zooids are in each head, arranged vertically, more or less parallel to the axis of the colony and to each other. They are not arranged into systems; the branchial and atrial siphons open to the exterior separately.

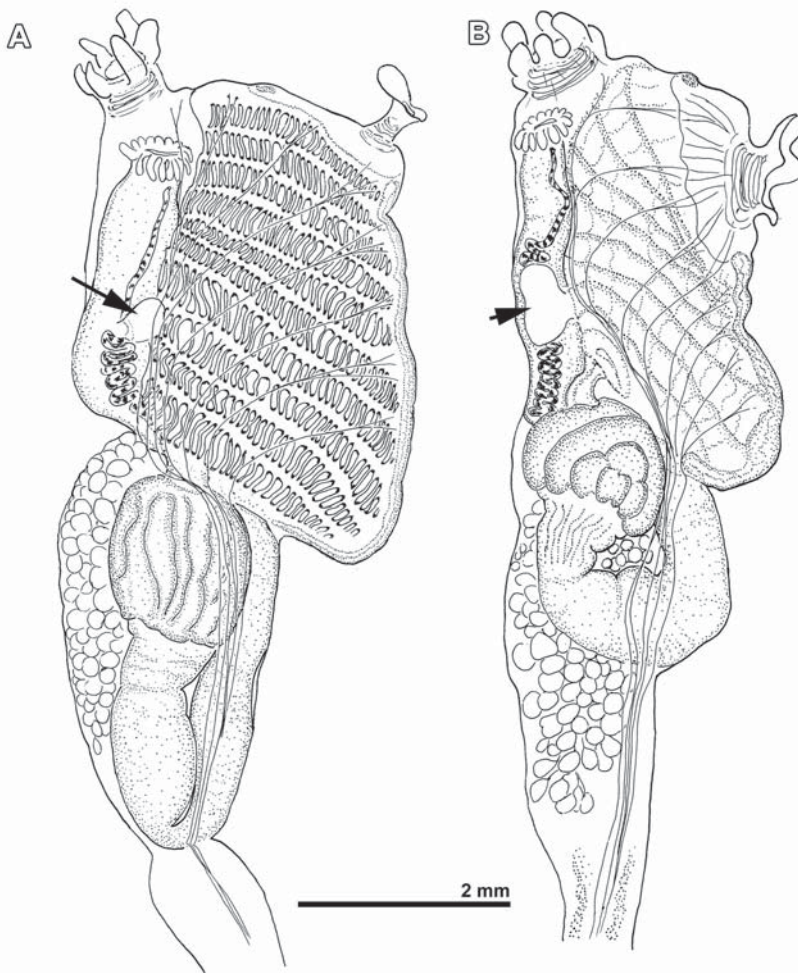


Fig. 34. A — *Pseudoplacentela smirnovi*, zooid; B — *Bathylacentela pedunculata* sp.n., zooid. Arrow point to a placental membrane.

Рис. 34. А — *Pseudoplacentela smirnovi*, зооид; В — *Bathylacentela pedunculata* sp.n., зооид. Стрелка указывает на плацентарную мембрану.

The middle and proximal parts of each zooid are embedded in a common test but their distal ends, (probably the thorax and possibly the distal part of the abdomen (difficult to determine in preserved colonies with contracted zooids) are free and have their own test. The postabdominal vascular extensions extend only partway down the stalk and do not penetrate into the next segment (presumably formed in a previous season). The atrial siphon is on the top of the zooid and opens in anterior direction. It has six very prominent lobes. The branchial siphon is significantly displaced ventrally and at a distance from the atrial siphon. Its margin is obscurely lobed and although sometimes six lobes may be recognized, in

most zooids they are indistinct and irregular. The dorsal (upper) lobe of the branchial siphon is usually significantly larger than the other lobes. Branchial siphons open on the sides of the colony head and are curved in such a way that their openings are directed posteriorly (i.e. down, toward the base of the colony).

There are fine crowded circular muscles around the bases of the siphons and about ten spaced longitudinal or oblique thoracic muscles on each side, half of which originate from the branchial siphon and half from the ventral side of the thorax. These longitudinal muscles extend the length of the zooid as two bands, one on each side of the body, becoming much thinner. There are no transverse thoracic muscles.

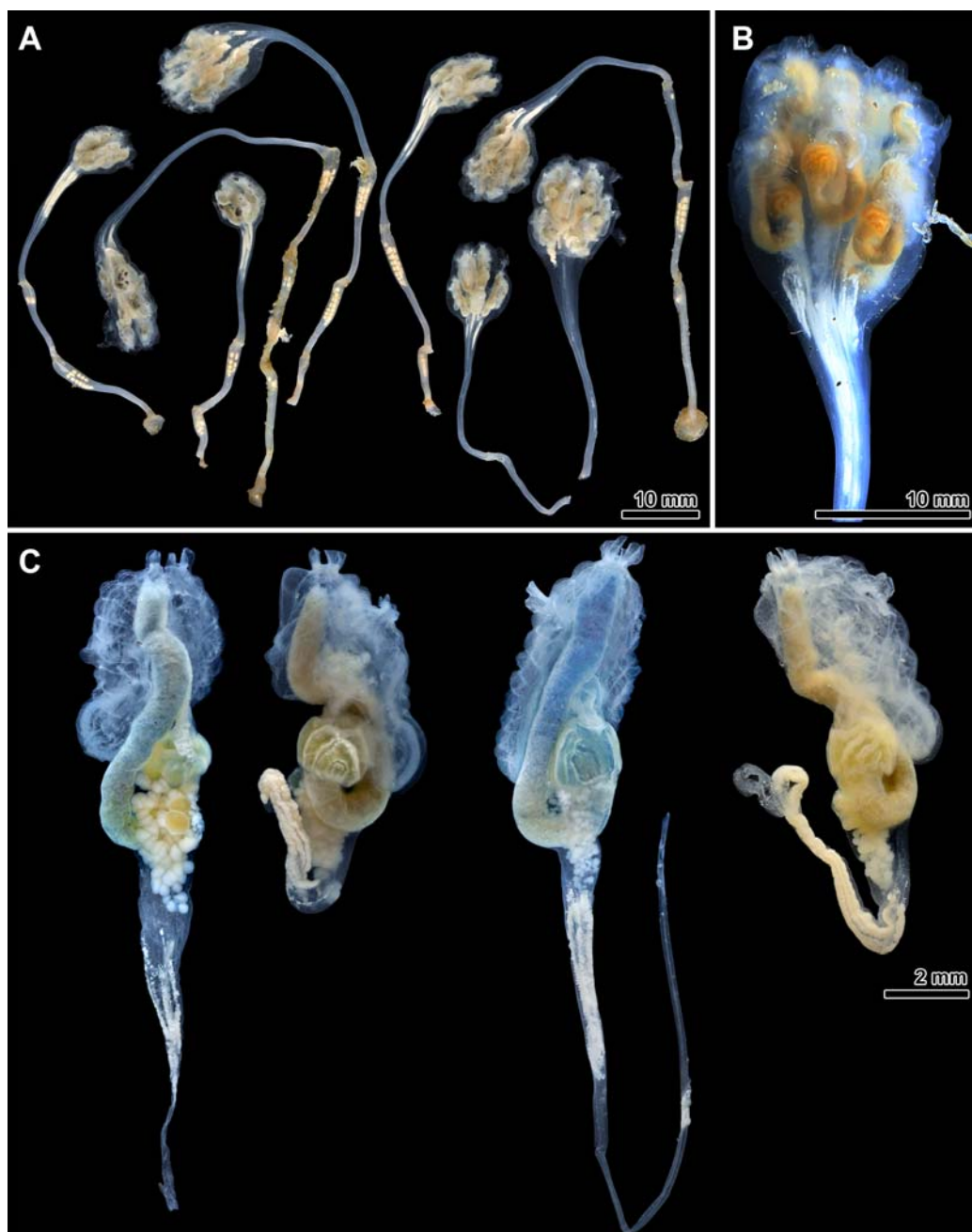


Fig. 35. *Bathylacentela pedunculata* sp.n. A — all available colonies, preserved in formalin; B — freshly collected live specimen, note sculpture of the stomach wall in zooids; C — zooids (lightly stained).
Рис. 35. *Bathylacentela pedunculata* sp.n. A — все исследованные колонии, зафиксированы в формалине; B — колония сразу после сбора, видна скульптура стенки желудка у зоидов; C — зоиды (слегка окрашены).

The prepharyngeal band runs along an oval undulating line. The neural ganglion is large, midway between the siphons. The branchial tentacles are robust, with wide bases, much curved, about ten to 12 in number, all of about the same size, well-spaced.

The branchial sac has no true stigmata (Fig. 33). It has eight high inner transverse vessels attached to the thoracic wall only by their ventral and dorsal ends; I failed to find any additional lateral connectives which usually fasten the branchial sac to the wall of the thorax in other ascidians. The dorsal languets are long, with wide triangular bases, either slightly displaced to the left or arranged almost along the mid-dorsal line. Otherwise the edges of the transverse vessels are smooth (no papillae), connected by seven or eight outer (in relation to them) longitudinal strips which are quite irregular. The transverse vessels and the longitudinal strips together form nine transverse rows of eight or nine large square meshes on each side of the branchial sac. Cilia are present on the transverse vessels and on the dorsal languets but totally absent on the longitudinal strips. On the transverse vessels they form a thin dense cord running along the free (inner) edge of these vessels.

The oesophagus is short, its opening is significantly displaced to the dorsal side of the branchial sac. The stomach is more or less barrel-shaped, with usually rounded cardiac and flattened pyloric ends, but this is not obvious in all zooids. The stomach wall has about ten or a few more prominent but irregular folds which cannot be counted precisely. In most examined zooids they form a peculiar pattern of concentric ridges (Fig. 34B). The gut loop is short and vertical. The gut is isodiametric and smooth, without any clear subdivisions. The rectum opens in the top of the thorax, just below the atrial siphon. The anal margin is furnished with about 15–20 cylindrical lobes.

Numerous crowded testis follicles are in the posterior part of the abdomen, where they form grape-like clusters on the left side of the gut loop, and extend significantly into the anterior part of the posterior abdominal extension. The robust sinuously curved sperm duct runs along the rectum and opens just below the anus. The ovary in the examined zooids is small, containing only a few large ova, situated in the posterior half of the abdomen, between the testis follicles and the body wall. The proximal part of the oviduct runs along the sperm duct but I failed to trace its distal part and to find where it opens. The small atrial (=“placental” membrane, probably not fully developed because of absence of larvae, is attached to the rectum on the right side of the thorax (Fig. 34B, arrow).

The heart is just below the gonad, in the anterior (upper) part of the posterior abdominal extension.

Most of the posterior abdominal extension in many zooids is filled in part by parenchymal tissue.

REMARKS. The colonies so closely resemble *Pseudoplacentela smirnovi* that the material was initially identified as that species. The zooids are also very similar in most features leaving no doubt that these taxa are closely related. The structure of the branchial sac, which in *P. smirnovi* is of a usual type, with transverse rows of true ciliated stigmata, while in *Bathyplacentela pedunculata* sp.n. completely lacks any traces of them, is cardinally different. Other differences include: the branchial tentacles in *B. pedunculata* sp.n. are more robust, more spaced and much less numerous than the slender branchial tentacles in *P. smirnovi*; the gonad extends into the vascular posterior abdominal extension in *B. pedunculata* sp.n. but are apparently always limited to the abdomen in *P. smirnovi*; the stomach wall folds in *B. pedunculata* sp.n. have a tendency to be arranged concentrically, while in *P. smirnovi* they are less prominent and may be artifacts of fixation.

The species is currently known only from the vicinity of Shimushir Island (central group of Kuril Islands).

Family Holozoidae Berrill, 1950

The family comprises colonial ascidians with small zooids consisting of short thorax with four rows of stigmata in most genera and abdomen with gut loop and gonads. Posterior abdominal extension may be conspicuous and may contain gonads in its anterior part.

The family comprises nine genera which may be divided into the following groups:

1) Three genera with very similar zooids lacking atrial siphon and arranged into highly organized cloacal systems: *Holozoa* Lesson, 1831 (= *Distaplia* Della Valle, 1881), *Sycozoa* Lesson, 1831 and *Hyp-sistozoa* Brewin, 1953.

2) Two deep-water genera lacking true stigmata: *Protoholozoa* Kott, 1969 and *Scotiazoa* Monniot F. et Tatián, 2020.

4) One monotypic genus with more than four rows of stigmata: *Neodistoma* Kott, 1990.

5) Two genera having tubular atrial siphon: *Hypodistoma* Tokioka, 1967 and *Polydistoma* Kott, 1990.

The genus *Sigillina* Savigny, 1816, assigned to this family by Kott (1990), has been transferred to family Pseudodistomidae (see Kott, 2007; 2008a).

The genus *Pseudoplacentela* Sanamyan, 1993, originally assigned to Holozoidae, is transferred to Placentelidae in the present work.

Only one genus of the family, *Holozoa*, is known in the region covered by the present paper.

Nomenclatural notes on the genera Distaplia Della Valle, 1881 and Holozoa Lesson, 1831.

Hartmeyer included *Distaplia* in his “Ascidiarium nomina conservanda” (Hartmeyer, 1915: 256) with the following statement: “Wir wollen den Gattungsnamen *Distaplia* vor einem nomenklatorisch korrekten Ersatz durch *Holozoa* schützen” (=We would like to protect generic name *Distaplia* over correct *Holozoa*). Van Name (1945: 143) treated these genera as closely related but distinct and commented that “if the two genera are united, the name *Holozoa* has priority, but *Distaplia* has been accepted as a nomen conservandum”. Brewin (1953) synonymized these genera. She cited Van Name’s (1945) words quoted above and used the junior name *Distaplia* as a valid generic name instead of *Holozoa*. Millar (1960) and all subsequent authors accepted synonymization of *Distaplia* and *Holozoa* and not questioned the correctness of the usage of junior name *Distaplia*. Kott (1998: 97) also placed *Holozoa* in the synonymy of *Distaplia* with the statement “senior synonym, suppressed in favour of *Distaplia*, see Hartmeyer (1915)”. All these statements are incorrect. The priority of older name *Holozoa* cannot be suppressed just because Hartmeyer (1915) included it in his paper. Hartmeyer (1915) failed to prepare a correct proposal to International Commission of Zoological Nomenclature. As a result, the generic name *Distaplia* Della Valle, 1881, has been placed in the Official List of Generic Names in Zoology, but its priority over *Holozoa* has not been stated (Opinion 94 and Direction 72, ICZN, 1926, 1957a). It is not clear for which purpose it was done and this fact does not change the nomenclatural status of *Distaplia* Della Valle, 1881 in any way. According to Article 80.6 “a name entered in an Official List is an available name”. This means that the fact of inclusion of *Distaplia* Della Valle, 1881 in Official List (without any additional ruling(s), see Article 80.6.2) just made this name available. However, *Distaplia* Della Valle, 1881 always was available. Article 80.6.4 says: “If a name entered in an Official List is thought to be a synonym of another available name (whether in an Official List or not), their relative precedence is determined by the normal application of the Code unless the Commission rules or has ruled otherwise”. Therefore, in the case of synonymization the valid name will be *Holozoa* but not *Distaplia*: both names are available but *Holozoa* is older. In contrast to the statement of Van Name (1945), *Distaplia* has not been “conserved” and in contrast to the statement of Kott (1998) *Holozoa* has not been suppressed in favor of *Distaplia*. Thus, any author accepting synonymy of *Holozoa* and *Distaplia*, must use the name *Holozoa* for all former *Distaplia* species, as is done in the present work. Alternatively, an author who wishes to contin-

ue to use the generic name *Distaplia* must prepare a proposal to the International Commission of Zoological Nomenclature for suppressing precedence of *Holozoa* over *Distaplia* (Article 23.9.3). However, since the name *Holozoa* was in wide use in the middle of the 20th century, and appeared in many papers as valid, and the genus *Holozoa* is the type genus of the currently accepted family Holozoidae, it is difficult to expect that its precedence will be suppressed. Unfortunately, this loss of a widely used name is a result of poor knowledge or ignorance of nomenclatural rules by ascidian experts for many years.

Genus *Holozoa* Lesson, 1831

(=*Distaplia* Della Valle, 1881)

Type species: *Holozoa cylindrica* Lesson, 1831 by monotypy.

Nomenclatural note: Date of publication of Lesson’s work in accordance with Cretella (2010) is 22 December 1831, not 1830 as widely accepted in the taxonomic literature on ascidians.

The genus *Holozoa*, formerly known as *Distaplia*, is characterized by the following features: zooids divided into thorax and abdomen; cloacal systems present; branchial siphon six-lobed or obscurely lobed; atrial aperture with an atrial lip; stigmata in four rows; parastigmatic vessels usually (but not always) present; gonads in abdomen or in a sac attached to its side or posterior end; longitudinal body muscles do not extend into posterior vascular stolon and largely confined to thorax; larvae incubated in brood pouch attached to thorax.

About 60 species of *Holozoa* are currently considered valid. The genus is most diverse in the tropics, with a smaller number of cold-water species. According to older authors, zooids of this genus present little information for species delimitation. Van Name (1945: 144) wrote: “The zooids are very uniform in the majority of their characters throughout the genus and may be described here [at the definition of the genus] to avoid repetition under the species”. As a result a diversity of the cold-water members of the genus, which were studied mainly by older authors and not revised by modern taxonomists, is probably strongly underestimated. Only two species are known from the Arctic and from northern seas bordering Europe: *H. clavata* (Sars, 1851) and *H. livida* (Sars, 1851). The first species includes all specimens with club-shaped colonies, while all specimens with flat colonies were automatically assigned to the second species (see, e.g. Millar, 1966). Meanwhile, published figures of *H. clavata* show zooids which certainly belong to several different species (e.g. compare small grape-like cluster of male follicles figured by Van Name, 1945, fig.

69 and elongated, arranged as a rosette, follicles figured for the same species by Millar, 1966, fig. 4). The same applies to the Pacific *H. occidentalis* (Bancroft, 1899), which is thought to be distributed along the Pacific coasts of North and South America from Alaska to Chile and which is very variable in shape of colony and color (Van Name, 1945; Lambert, Sanamyan, 2001; Sanamyan *et al.*, 2010; Lambert, 2019). In most cases the zooids of *Holozoa* present enough information for species delimitation. Among the most important features are the position of the gonads (beside the gut loop or in the sac posterior to abdomen), the presence or absence of parastigmatic vessels, the structure of the stomach wall and number of stigmata per half row.

Seven species of *Holozoa* are known from Far Eastern Seas of Russia.

KEY TO SPECIES OF THE GENUS *HOLOZOA* KNOWN FROM FAR EAST SEAS OF RUSSIA

- 1 Gonads in the gut loop or beside it 2
 - Gonads mostly or completely in the sac posterior to the pole of gut loop 6
- 2 Zooids 2 mm in height or smaller 3
 - Zooids larger than 3 mm in height 5
- 3 Stomach wall with well-marked areolation or swellings *H. okhotensis* sp.n.
 - Stomach wall smooth or with faint longitudinal plications, abundant on algae near Vladivostok 4
- 4 Stomach wall smooth, only one larva in the brood-pouch *H. unigermis*
 - Stomach wall with faint longitudinal plications, up to three larvae in brood-pouch *H. dubia** (no confirmed records of *H. dubia* in the region but it may be present here, see *H. unigermis*)
- 5 Colony a flat crust, deep brown in preservative; parastigmatic vessels absent, stomach wall with regular longitudinal folds *H. matua*
 - Colony composed of several thick cushion-like lobes; parastigmatic vessels present, stomach wall with coarse areolation *H. rzhavskii*
- 6 Colony consists of a zooid-bearing head supported by a long thin (diameter 4 mm or less) cylindrical stalk *H. alaidi*
 - Colony different 7
- 7 Colony flat, attached by the entire lower surface; stomach wall finely reticulated; 15–17 stigmata per half-row *H. shimushirensis* sp.n.
 - Colony consists of upright lobes supported by a short thick stalk; stomach wall with a fine pattern of mostly longitudinal branched lines; 26–32 stigmata per half-row *H. urupensis* sp.n.

Holozoa alaidi (Sanamyan, 1993)
Fig. 36.

Distaplia alaidi Sanamyan, 1993a: 170. Sanamyan, Sanamyan, 2017a: 316.

MATERIAL EXAMINED. *Ac. Oparin-56*, St. 71, Shiashkotan Island (Sea of Okhotsk side), 48°48.3'N, 154°17.7'E, 285–304 m, 12.08.2019, one colony.

DESCRIPTION. The colony consists of a zooid-bearing head supported by a long stalk. The stalk is 4.5 cm long and about 3–4 mm in diameter, slightly tapering toward the base. The head is 3 cm long and 1.5 cm wide, slightly flattened, clearly demarcated from the stalk. The test of the stalk and the head is of the same color and consistency, whitish, slightly translucent, spongy and rather firm. The zooids are arranged in several double rows along one side of the head (Fig. 36A). On the opposite side of the head numerous long yellow brood-pouches are visible through the test (Fig. 36B). They are rather crowded, parallel to each other and to the longitudinal axis of the colony, with up to 15, or possibly more, developing eggs, embryos and larvae in each.

The zooids are identical to those described previously (see Sanamyan, Sanamyan, 2017a). In the present colony they are up to 8 mm long (with strongly contracted thoraces, so that in a case of perfect fixation may be significantly longer). The stigmata are in four rows with 28 stigmata per row on each side. The parastigmatic vessels, crossing the stigmata, are so strong that they are hardly distinguishable from the transverse vessels separating rows of stigmata; as a result, an impression exists that the stigmata are arranged in eight (rather than four) rows. The gonads are well developed, located mostly below the pole of the gut loop in a sac-like extension protruding from the posterior-right side of the abdomen. A well discernible gastric reservoir is in the gut loop, on the right side of the abdomen. The V-shaped thin walled heart clearly discernible, it lies beside the gut loop on the left side of the abdomen. Many zooids have a brood pouch attached to them. Fully developed tailed larvae have trunk 1.8–2.2 mm, with a well-formed ocellus and otolith. The stalk of each of the three adhesive organs may be rather long in some larvae (Fig. 36C) or short in other larvae from the same colony; the adhesive organs are arranged in a triangle. The base of the stalks may be slightly expanded; ampullae are not present.

REMARKS. The present colony differs from previously recorded specimens by the elongated flattened head and the zooids arranged into distinct double rows on one side. All previously recorded colonies had round heads with the zooids being mostly at the top. This difference may suggest a distinct species. The zooids, however, are so similar in all minor details (compare Fig. 36D in the present

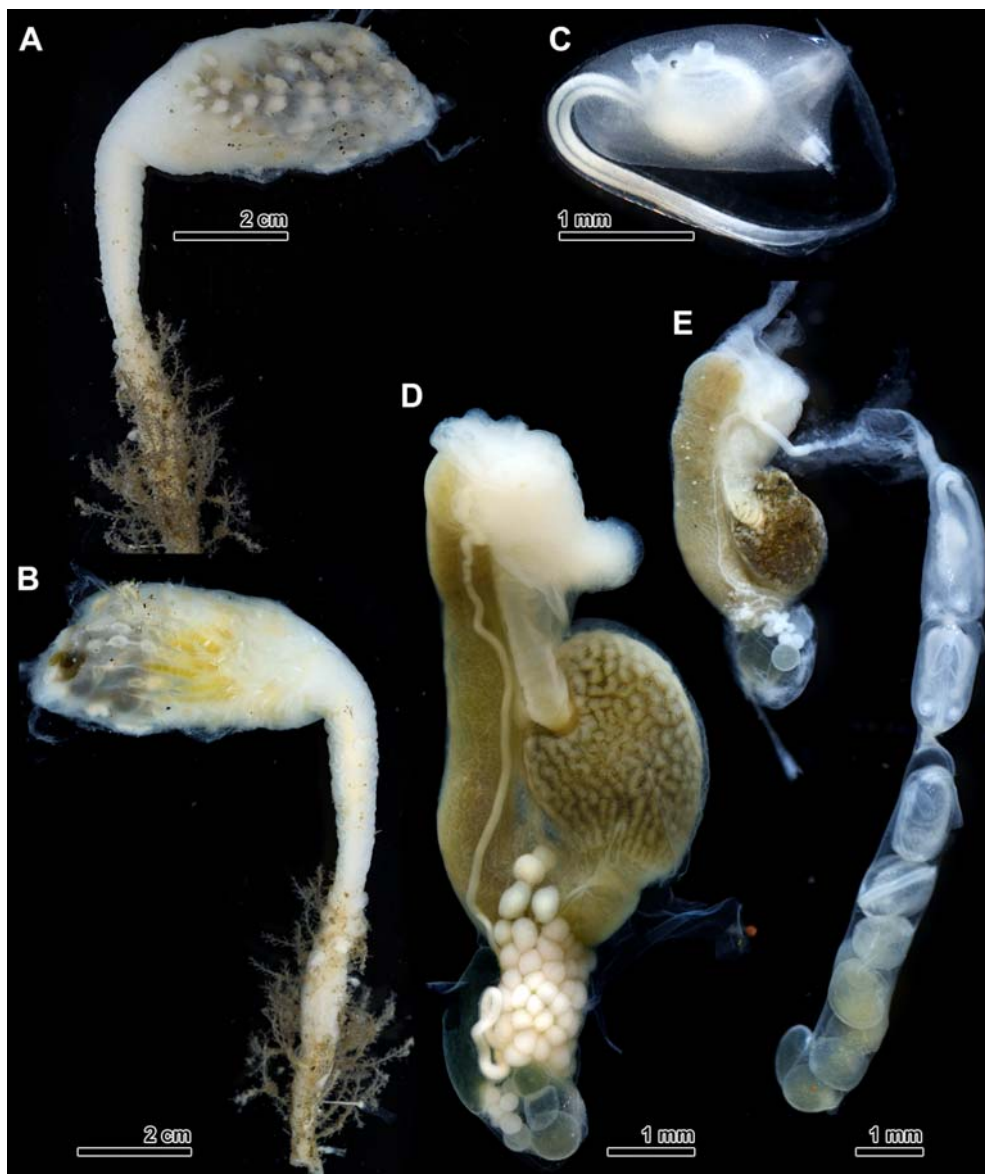


Fig. 36. *Holozoa alaidi*. A — colony, note arrangement of zooids; B — the same colony from opposite side, note long yellow brood pouches; C — larva; D — zooid with well-developed gonad; E — zooid with attached brood-pouch.

Рис. 36. *Holozoa alaidi*. А — колония, видно расположение зооидов в колонии; В — та же колония с противоположной стороны, видны желтые выводковые сумки; С — личинка; D — зооид с хорошо развитой гонадой; E — зооид с прикрепленной выводковой сумкой.

work with fig. 12E in Sanamyan & Sanamyan (2017a)) that I believe the present specimen is just a larger, better developed colony of *Holozoa alaidi*. Although the arrangement of zooids in double rows is not evident in the previously recorded preserved

material, in living fully expanded colonies the branchial openings of individual zooids are arranged into short vertical rows on the lateral surface of the colony head (see Sanamyan & Sanamyan (2017a, fig. 12B, D)). The double rows, are, however, not

discernible. The arrangement of the zooids into double rows in the present colony suggests that it should have *Sycozoa*-like cloacal systems with either long longitudinal canals running between the rows of zooids, or, less likely, individual zooids opening directly into a common central cloacal cavity. The condition of the present material does not allow to clarify the structure of the cloacal system and a common central cavity is not discernible. In smaller live colonies, described by Sanamyan & Sanamyan (2017a), the thoraces of zooids were directly exposed into one common cloacal cavity.

Discovery of a larger colony with double rows of zooids suggests that a relationship of *Holozoa alaidi* with *H. smithi* (Abbott et Trason, 1968) is closer than was suggested by Sanamyan (1993a). The latter species, known from the Pacific coast of North America (Abbott, Trason, 1968; Abbott, Newberry, 1980; Lambert, 2019) has significantly more prolific colonies composed of numerous heads, smaller zooids with a smaller number of stigmata per row (15–23 according to the original description) and smaller number of embryos (one to five) in detached brood pouches. In *H. alaidi* the brood pouches remain attached to the zooids.

Holozoa alaidi is currently known only from Atlasova Island (north group of Kuril Islands, the type locality) and Matua and Shishkotan Islands (central group of Kuril Islands).

Holozoa matua (Sanamyan et Sanamyan, 2017)

Distaplia matua Sanamyan, Sanamyan, 2017a: 318; 2020: 305.

MATERIAL EXAMINED. None.

DESCRIPTION. Sanamyan & Sanamyan (2017a) recently provided a very detailed description of this species accompanied with photographic images of live and preserved colonies and zooids, and therefore will not be repeated here. In brief, *Holozoa matua* is characterized by the following features: The colonies are flat crusts about 10 mm in thickness attached by a whole lower surface. They are reddish in life but become dark brown in preservative (formalin). Large cloacal openings are on rather long siphons in live colonies but not discernible in preserved material. The zooids are 3.5 mm long, brown. About 14–17 stigmata per half-row in the middle rows (up to 19 in the first row). The four rows of stigmata are grouped by two and not crossed by parastigmatic vessels. The stomach has low but quite well-defined numerous regular longitudinal folds. The gonad is in the abdomen on the right side of the gut loop (not in a sac attached to thorax).

REMARKS. *Holozoa matua* is most closely related to *H. shimushirensis* sp.n. (see below). It is

known only from the original description based on three colonies from Matua Island (central group of Kuril Islands).

Holozoa okhotensis sp.n.

Fig. 37.

? *Distaplia* sp. Sanamyan, Sanamyan 2017b: 129.

MATERIAL EXAMINED. Syntypes MIMB 43165: Sea of Okhotsk, Feklistova Island, (~54°55'N, 136°46'E), 19 m, 28.07.1995, coll. Panchenko, several fragments (of one colony?). Other specimens: Sea of Okhotsk, Feklistova Island, Sukhotina Island, 8–25 m, rock, stones, 23.12.1998, coll. Jakovlev, Panchenko, may fragments.

DESCRIPTION. The examined sample consists of numerous small, 3–6 mm in diameter and height, inverted cone shaped cormidia attached to calcareous branches of a bryozoan. Some cormidia are joined by basal ribbons of the test but whether they all belong to a single or to several colonies is not possible to determine. The cormidia are flat-topped, each contains a single system with a central common cloacal opening with about 10–15 (or possibly sometimes more) zooids arranged around it. In preservative the test is translucent and colorless with no attached debris; the zooids are clearly visible through it. The zooids are very small, 1.5–2 mm, and very contracted. The branchial aperture is on a short indistinctly lobed siphon; the atrial aperture in a few less contracted zooids is wide, but slit-like in more contracted ones. In life probably all four rows of stigmata, crossed by parastigmatic vessels, are exposed. The atrial lip is rather long and wide, often with a three-lobed margin. There are 12–14 stigmata per half row. The thoracic muscles are oblique, regularly spaced, almost unbranched, about 15 on each side but too poorly visible (even after staining) to count precisely. The oesophagus is short, with conspicuous transverse folds probably caused by contraction, suggesting that in life and with better relaxation it may be significantly longer. It is curved at a right angle to enter the obliquely or horizontally lying stomach. The stomach is slightly asymmetric, its dorsal side is slightly shorter than the outer ventral side but the pyloric and cardiac ends are of about the same diameter. The stomach wall has well-marked areolation or swellings (Fig. 37B) which occasionally are united into irregular longitudinal ridges. The post-pyloric subdivision of the intestine is not evident on contracted zooids. The gastric reservoir was not detected.

The gonad is on the right side of the gut loop in the abdomen (not in a sac posterior to it). Male follicles are relatively large, about 20 in number, and form a compact cluster with a straight thin sperm

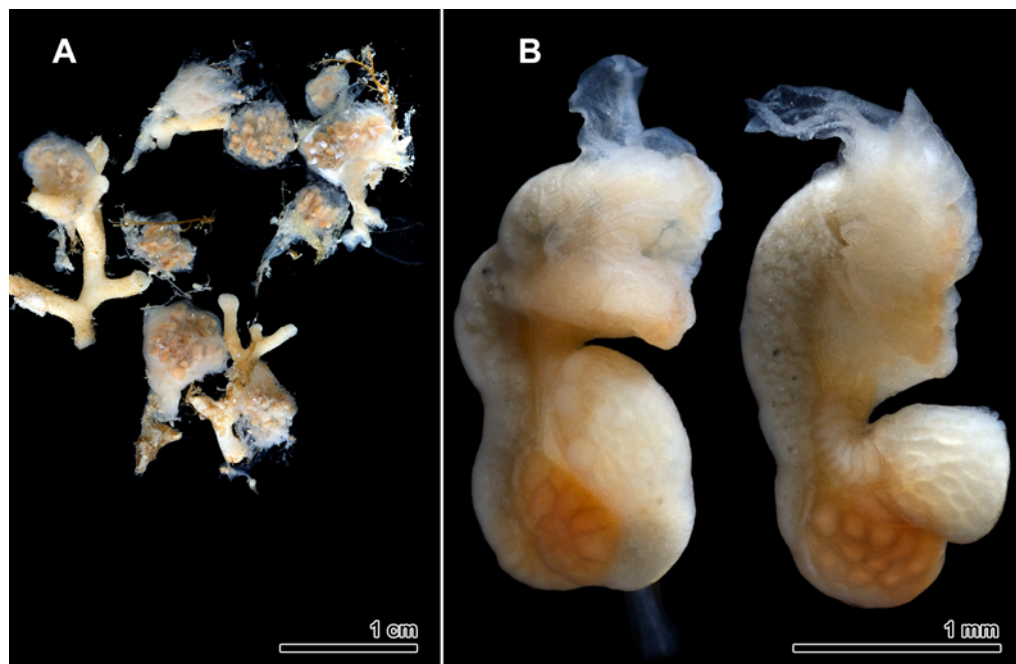


Fig. 37. *Holozoa okhotensis* sp.n. A — colonies (syntypes); B — zooids.
 Рис. 37. *Holozoa okhotensis* sp.n. A — колонии (синтипы); B — зоиды.

duct originating in its centre. The ovary was not detected. The colony contains no larvae.

REMARKS. The species is characterized by a small colony composed of separate cormidia, each with a single system of zooids. The zooids are significantly smaller than in all other *Holozoa* species known from the Sea of Okhotsk. Such colonies are not known for northern cold-water members of this genus, although colonies of several Japanese species, including *H. corona* (Tokioka, 1955), *H. systematica* (Tokioka, 1958), *H. miyose* (Tokioka, 1962) and some specimens of *H. dubia* are similar (Nishikawa, 1990; Tokioka, 1955, 1958, 1962).

Holozoa corona and *H. miyose* are known from the original descriptions only. Both differ from the present species by their elongated male follicles arranged in a rosette and stomach wall with mostly longitudinal plications.

Holozoa systematica, in contrast to the present species, has a smooth-walled stomach.

Holozoa dubia is more often recorded species with a very wide reported range of distribution and it is clear that some records are misidentifications (e.g. a record from Australia, see Kott, 1990). According to a description published by Tokioka (1953), who examined the type material, *H. dubia* has a stomach with 15–20 faint longitudinal plications and up to 14 testicular follicles (fewer than in the

present species). Male follicles, according to his figure (Tokioka, 1953, plate 11, fig. 3), are arranged in a single rosette. The variation in the number of testis follicles may not be very important while the difference in the stomach wall structure most probably is. More significant is that this Japanese species inhabits much warmer water than the cold-water part of the Sea of Okhotsk (water temperature around Feklistova Island varies from around zero at winter and to +4–8°C at summer).

The only other species known from adjacent regions is *H. unigermis* (Ivanova-Kazas, 1965), described from the vicinity of Vladivostok (Sea of Japan). Ivanova-Kazas (1965), who examined numerous specimens, especially stressed the fact that *H. unigermis* always forms flat colonies, the systems of zooids do not tend to form separate cormidia as in some specimens of *H. dubia*. The male gonad contains no more than 10 follicles (half the number in *H. okhotensis* sp.n.) and the stomach is described as smooth although actually may be slightly wrinkled.

Holozoa okhotensis sp.n. currently is known from the most western part of the Sea of Okhotsk (Feklistova Island) but probably has a wider distribution — small inconspicuous colonies are easy to overlook and small “featureless” zooids are difficult to identify. Small colonies, each with a single ring of zooids, reported from Matua Island (middle group of

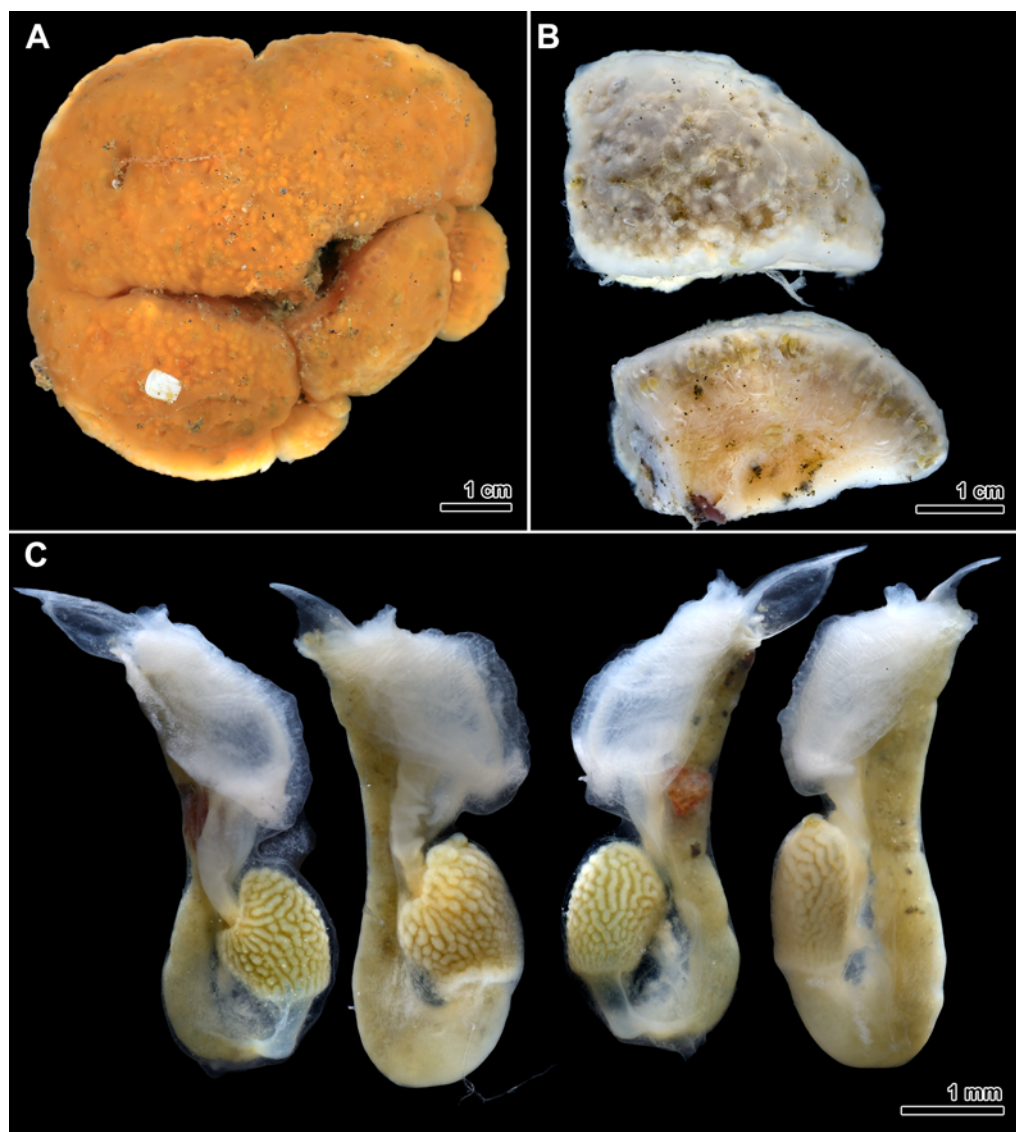


Fig. 38. *Holozoa rzhavskii*. A — freshly collected live colony (photo of A.S. Maiorova, NSCBM FEB RAS); B — the same colony in formalin; C — zooids.

Рис. 38. *Holozoa rzhavskii*. А — колония сразу после сбора (фото А.С. Майоровой, НИЦМБ ДВО РАН); В — эта же колония в формалине; С — зоиды.

Kuril Islands) as *Distaplia* sp. by Sanamyan & Sanamyan (2017b) and photographed underwater probably belong to this species.

Holozoa rzhavskii (Sanamyan, 1993)

Fig. 38.

Distaplia rzhavskii Sanamyan, 1993a: 169.

? *Distaplia* sp. aff. *clavata* Sanamyan, 1993a: 168.

MATERIAL EXAMINED. *Ac. Oparin-56*, St.67, Paramushir Island (Sea of Okhotsk side), 50°17.93'N, 155°18.09'E, 7–13 m, 11.08.2019, one colony.

DESCRIPTION. The colony, 7.5 cm in diameter and up to 2 cm high in its thickest part, consists of several low cushion-like lobes closely adherent to each other and joined by a rather thick common basal layer of the test. The upper surface of each lobe is smooth and slightly convex, the margins sharply

defined. In life it was ochre-colored which faded quickly in preservative (Fig. 38A, B). Surface is smooth and free from attached matter. The test is opaque, spongy, its surface layer (where the zooids are located) of a typical for the genus soft consistency but below the layer of zooids the test is very firm and hard. The zooids open on the upper surface of each lobe (but not on their sides) and are arranged into numerous small oval or circular systems. Common cloacal openings are hardly discernible on preserved material, probably one opening is in each system.

The zooids, with contracted thoraces, are 3.5–5 mm long. The branchial siphon is small, six-lobed. The atrial siphon in most zooids is well formed, sometimes rather long, with a simple plain-edged lip produced from its upper rim. The thoracic muscles are thin and numerous (about 25 per side were counted in several zooids). They run in oblique or transverse direction and often cross each other. The four rows of stigmata are crossed by parastigmatic vessels. The stigmata are very long, 18–21 in the middle rows. The oesophagus is not especially long, and curved to enter the obliquely oriented stomach dorsally. The stomach is large, with the cardiac end distinctly wider than the pyloric end and with the dorsal side being significantly shorter than the outer ventral side. Its wall is coarsely areolated and presents a characteristic pattern (Fig. 38C). The post-pyloric differentiation of the intestine is discernible in some zooids but may be obscured in others, especially if the intestine is densely filled by fecal pellets. The gastric reservoir is on the right side in the gut loop. The voluminous heart is on the left side of the gut loop. Gonads are poorly developed; only male gonads were detected in some zooids and are represented by three or four small poorly discernible male follicles located in the gut loop beside the gastric reservoir. The colony contains no larvae.

REMARKS. The species was known previously only from the original description based on two specimens from East Kamchatka collected by divers at 16–32 m. *Holozoa rzhavskii* is characterized by colonies composed of several lobes closely adherent to each other. Such colonies are present in many *Holozoa* species but none are known in the region covered by the present paper. Very similar colonies (in shape, size, colour and, possibly, in the structure of the systems) has *Aplidium dissectum* Sanamyan et Sanamyan, 2011 known from East Kamchatka. Sanamyan (1993a) used transverse orientation of thoracic muscles as an important feature separating this species from the others. A value of this feature in *Holozoa* was discussed previously by Tokioka (1958), Nishikawa (1990) and Kott (1981). Kott (1981) suggested that the variations in the orientation of thoracic muscles may be apparent and a result from differences in contraction, while Nishikawa (1990:

131) considered the transverse or longitudinal orientation of thoracic muscles to be “*intrinsic features, rather than an artifact*”. Now, after examining numerous specimens of *Holozoa* belonging to many different species, I am inclined to agree with Kott (1981) — this may be (but not necessarily is) an artifact. In most cases in *Holozoa* these muscles run more or less obliquely, from the endostyle to the dorsal, postero-dorsal and posterior side of the thorax causing a characteristic oblique contraction of the thorax (quite different from that seen, for example, in the genera having longitudinal thoracic muscles, e.g. in *Aplidium*, etc.). Depending on the state of contraction these muscles may appear as oblique, transverse, or more or less longitudinal. Certain differences in the orientation of the body muscles between the species probably may exist, but this feature is hard to use in practice unless perfectly narcotized and fully expanded zooids are available.

The specimens from East Kamchatka identified and described by Sanamyan (1993a) as *Distaplia* sp. aff. *clavata* have more massive and entire (not divided into lobes) colonies, longitudinal or oblique thoracic muscles and apparently more numerous embryos in brood-pouches (six or seven in *Distaplia* sp. aff. *clavata* but only two in the type material of *H. rzhavskii*). Other features, including the position of the gonad in the gut loop, coarsely areolated stomach, and number of stigmata per row are similar. At present I cannot conclude whether these massive colonies belong to *H. rzhavskii* but such a probability exists.

The species is currently known only from the shallow waters of East Kamchatka (Sanamyan, 1993a) and North Kuril Islands (present work).

Holozoa shimushirensis sp.n.

Fig. 39.

MATERIAL EXAMINED. Holotype MIMB 43166. *Ac. Oparin-56*, St.23, Shimushir Island (Sea of Okhotsk side), 47°07.38'N, 152°09.58'E, 1–6 m, 3.07.2019, one colony.

DESCRIPTION. The preserved colony is a flat mass 4.5 × 2.5 cm in extent and about 8 mm thick. It was attached to the substratum (probably a stone) by the entire lower part. The test is soft, spongy (as in many *Holozoa* species), almost opaque, dirty grayish-brown in formalin. The upper surface is smooth, without foreign matter apart from a few attached sand grains. Several small common cloacal openings are discernible, randomly distributed over the colony surface. The zooids are visible through the surface of the colony as pale spots, grouped into rather unclear circles around the common cloacal openings, and also form indistinct rows in other places of the colony.

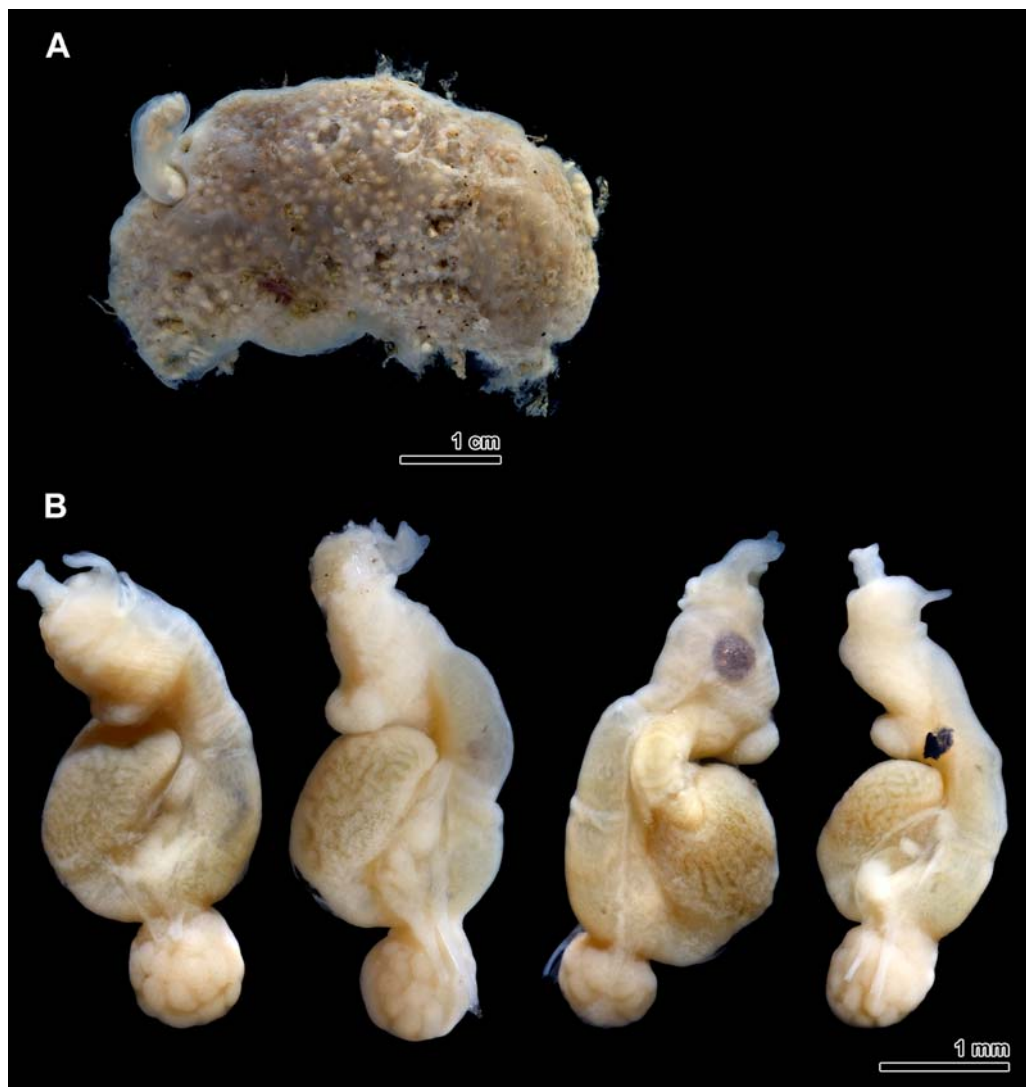


Fig. 39. *Holozoa shimushirensis* sp.n. A — colony (holotype); B — zooids.

Рис. 39. *Holozoa shimushirensis* sp.n. A — колония (голотип); B — зоиды.

The zooids, with strongly contracted thoraces, are 3.5–4 mm long, light-brown in formalin. The branchial aperture on a prominent siphon has six indistinct lobes. The atrial aperture in preserved zooids is small and slit-like, with a small and in most cases simple atrial languet. Thoracic muscles are poorly discernible, numerous, 15 or more per side, longitudinal or oblique, running from the endostyle to the bottom of the thorax. The branchial sac has four rows of about 15–17 stigmata. The rows are not grouped by two. The parastigmatic vessels are thick and well discernible.

The oesophagus is rather long, curved at right angle to enter the obliquely oriented stomach. The stomach is slightly wider at its cardiac end, shorter along the inner mesial side than along its outer curved surface. The stomach wall is finely reticulated, sometimes with faint longitudinal ridges, but in most cases they are not discernible. Only male gonads are present; numerous, oval, rather large male follicles are in a globular sac attached to the posterior end of the abdomen and demarcated from it by a constriction. Male follicles are not present in the gut loop or on either side of it. Two thick vascular

stolons issue from the left side of the posterior part of the abdomen. The colony contains no larvae.

REMARKS. The shape and structure of the preserved colony strongly resembles the colonies of *Holozoa matua*, the only other *Holozoa* species forming compact flat colonies known from cold waters of the NW Pacific. Judging from the distribution of zooids in the preserved colony, in life they were probably distributed as shown in the photographs of *Holozoa matua* (Sanamyan, Sanamyan, 2017a, fig. 13A, B). The consistency of colonies is described as different (spongy in *H. shimushirens* sp.n. and “cartilaginous, not spongy” in *H. matua*, see Sanamyan, Sanamyan, 2017a: 318), but this may not be a real difference. The zooids, however, differ significantly. In *H. matua*, the gonad, containing several ova and up to ten testis follicles, is in the abdomen on the right side of the gut loop, not in the protruding sac. In contrast, in *H. shimushirens* sp.n. the gonad, at least its male part, is located completely in the posterior sac separated from the abdomen by a constriction. Parastigmatic vessels are not present in *H. matua*, but very distinct in *H. shimushirens* sp.n. The rows of stigmata are grouped by two (as in *Sycozoa*) in *H. matua*, but not in *H. shimushirens* sp.n. The structure of the stomach wall also differs: in *H. matua* there are numerous rather regular but faint longitudinal folds. Although the latter feature may not always be reliable (in *Holozoa* the structure of the stomach wall sometimes may be variable), the position of the gonad and the presence of robust parastigmatic vessels are certainly good distinguishing features separating *H. shimushirens* sp.n. from *H. matua*.

Another similar species is *H. confusa* (Ritter, 1901). It has a thin encrusting colony 3 or 4 mm thick and zooids have a finely reticulated stomach as in *H. shimushirens* sp.n. (see Ritter, 1901, fig. 26). However, Ritter (1901) never reported parastigmatic vessels in *H. confusa*, and it is highly improbable that he overlooked them because he was able to count stigmata (16 per row as in *H. shimushirens* sp.n.); his figure is quite clear in this respect. In addition, *H. confusa* differs from *H. shimushirens* sp.n. by a longer oesophagus and zooids about two times larger, but the reliability of these features is not clear since the range of variation of both species is not known. Ritter's species is based on one colony described from NE Pacific (Kodiak Island). It has not been reported again since the original description. Van Name (1945) synonymized it with *H. occidentalis* but *H. confusa*, with its thin, flat and encrusting colony is obviously distinct. Ritter (1901) compared his species with *H. livida*, a poorly known species from Norway.

Holozoa shimushirens sp.n. is currently known only from Shimushir Island (central group of Kuril Islands).

Holozoa unigermis (Ivanova-Kazas, 1965)
Fig. 40.

Distaplia unigermis Ivanova-Kazas, 1965: 44.

Distaplia dubia: Sanamyan, 1993a: 169.

Not *Leptobotrylloides dubium* Oka, 1927: 607

MATERIAL EXAMINED. None.

DESCRIPTION (after Ivanova-Kazas, 1965).

The species forms flat crust-like colonies. Ivanova-Kazas (1965) stated that although very large number of colonies were collected, none had clavate or mushroom shaped form. The largest colonies were 3–4 cm in extent. Young colonies are colorless or have a pinkish tint, older ones are dirty-greyish. Zooids are tiny, 1.4–1.7 mm long, grouped by 6–14 in rounded or slightly elongated systems with a common cloacal opening in the center. About 30–40 longitudinal thoracic muscles are present on each side. Twelve branchial tentacles of unequal length; one dorsal and one ventral tentacle are the longest. The stomach is described as smooth but on total preparations stained with hemalum it is slightly wrinkled. No more than 12 stigmata were counted in each row. Parastigmatic vessels are present. The male gonad consists of no more than ten follicles. Larvae are incubated in a brood-pouch which is detached from the zooid. Each brood-pouch contains only one larva. According to the original figure the larva has an almost round trunk about 1 mm in length and three triradially arranged adhesive organs; ampullae or swellings at their bases were not figured.

REMARKS. According to Ivanova-Kazas (1965) this species is very abundant on marine plants in the vicinity of Vladivostok (Sea of Japan). Sanamyan (1993a) examined numerous colonies from several neighboring localities which were probably also collected from marine plants, and identified them as *Distaplia dubia* mostly based on the presence of fine longitudinal stomach folds in his specimens and on the fact that in several colonies the surface was depressed markedly between systems exactly as it was shown by Nishikawa (1990: 130, fig. 9) for *Holozoa dubia*. Most probably, however, only one species exists on marine plants in the vicinity of Vladivostok and the material examined by Ivanova-Kazas (1965) and by Sanamyan (1993a) belong to the same species. It may be conspecific with some specimens reported previously as *D. dubia*, but at least some existing records of *Holozoa dubia* are certainly misidentified and this species needs a revision. According to Tokioka (1953, plate XI) *H. dubia* has at least three larvae in the brood-pouch, while Ivanova-Kazas (1965) especially stressed that always only one larva is in each brood-pouch. Unfortunately, no new material from the Sea of Japan is available while old specimens are not in good condi-

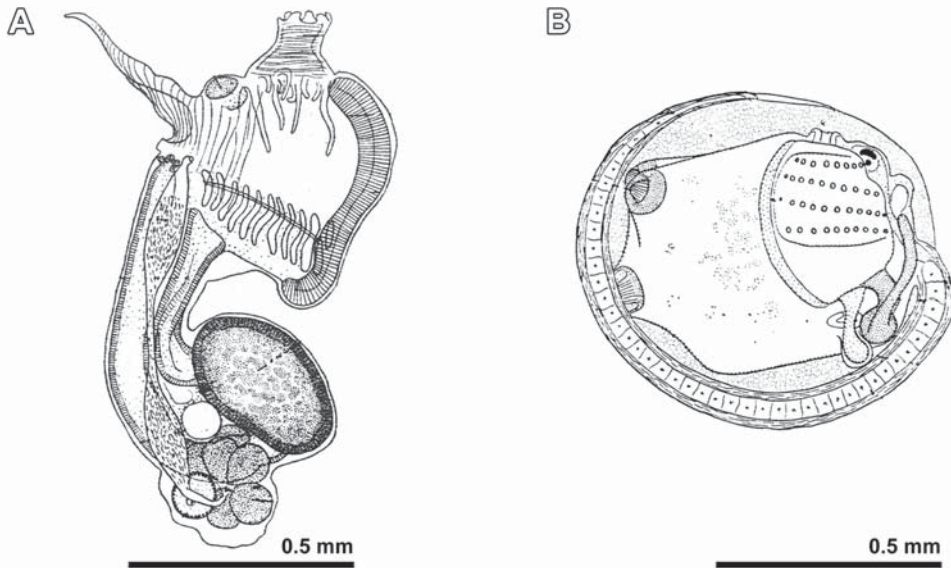


Fig. 40. *Holozoa unigermis*. A — zooid; B — larva. After Ivanova-Kazas, 1965.

Рис. 40. *Holozoa unigermis*. А — зооид; В — личинка. По: Ivanova-Kazas, 1965.

tion now. Pending further work on this species I prefer to treat *H. unigermis* as a valid species distinct from *H. dubia* and identify all flat colonies of *Holozoa* collected on marine plants near Vladivostok city as *H. unigermis*.

Holozoa urupensis sp.n.

Fig. 41.

MATERIAL EXAMINED. Holotype MIMB 43167. *Ac. Oparin-56*, St.5, Urup Island (Sea of Okhotsk side), 46°17.1'N, 150°17.4'E, 215–205 m, 28.06.2019, one colony; Paratypes MIMB 43168, St.7, Urup Island (Sea of Okhotsk side), 45°52.2'N, 149°37.0'E, 142 m, 28.06.2019, three colonies; MIMB 43169, St.24, Urup Island (Sea of Okhotsk side), 46°15.9'N, 150°15.4'E, 450–460 m, 5.07.2019, one colony (poor fixation).

DESCRIPTION. Colonies consist of separate short cylindrical or conical upright heads 2.5–3 cm in height and in diameter with slightly narrower and short stalks. The holotype (Fig. 41A) is attached by a wide base to a sponge; one of the paratypes has a narrow slit at the base of the colony (Fig. 41B), in life it was probably attached to a thin elongated object like a gorgonian stem. The stalks are filled by crowded thin vascular stolons rising from the base of the colony. The test is soft, spongy, and almost opaque in formalin. On the photograph of the freshly collected holotype, submitted by the collector, the test is translucent and has a distinct greenish tint with

zooids of the same color; this specimen was labeled as a “green colonial ascidian”. The same specimen in formalin shows no trace of greenish tint and is of flesh color. The paratypes retained a slight greenish tint in preservative and the fluid is pale green. The zooids are in the expanded head of the colony and open on both the top and sides of its surface. The condition of the material does not allow to recognize the shape of the systems. No common cloacal openings are distinguishable. There are some hints that the zooids are arranged into longitudinal rows, and I assume that the cloacal system either is represented by longitudinal canals converging to the top of the head, or there are several elongated (but not circular), longitudinally arranged systems.

The contracted zooids are 7–8 mm long in the holotype and up to 9 mm in paratypes. They are transparent and not colored (with the exception of the stomach). The thorax is most often contracted in dorso-ventral direction. The branchial aperture is sessile, irregularly lobed. The atrial opening is not large, often slit-like. The atrial languet is short and simple but highly contracted. Thoracic muscles in most zooids, especially in the holotype, run mainly in transverse direction, but this is less evident in zooids extracted from the paratypes. There are about 15 muscle fibers originating from the endostyle area and several from the branchial siphon and intersiphonal area. Six or seven large branchial tentacles are present. Four rows of very long stigmata are not grouped by two. On the right side in the middle rows

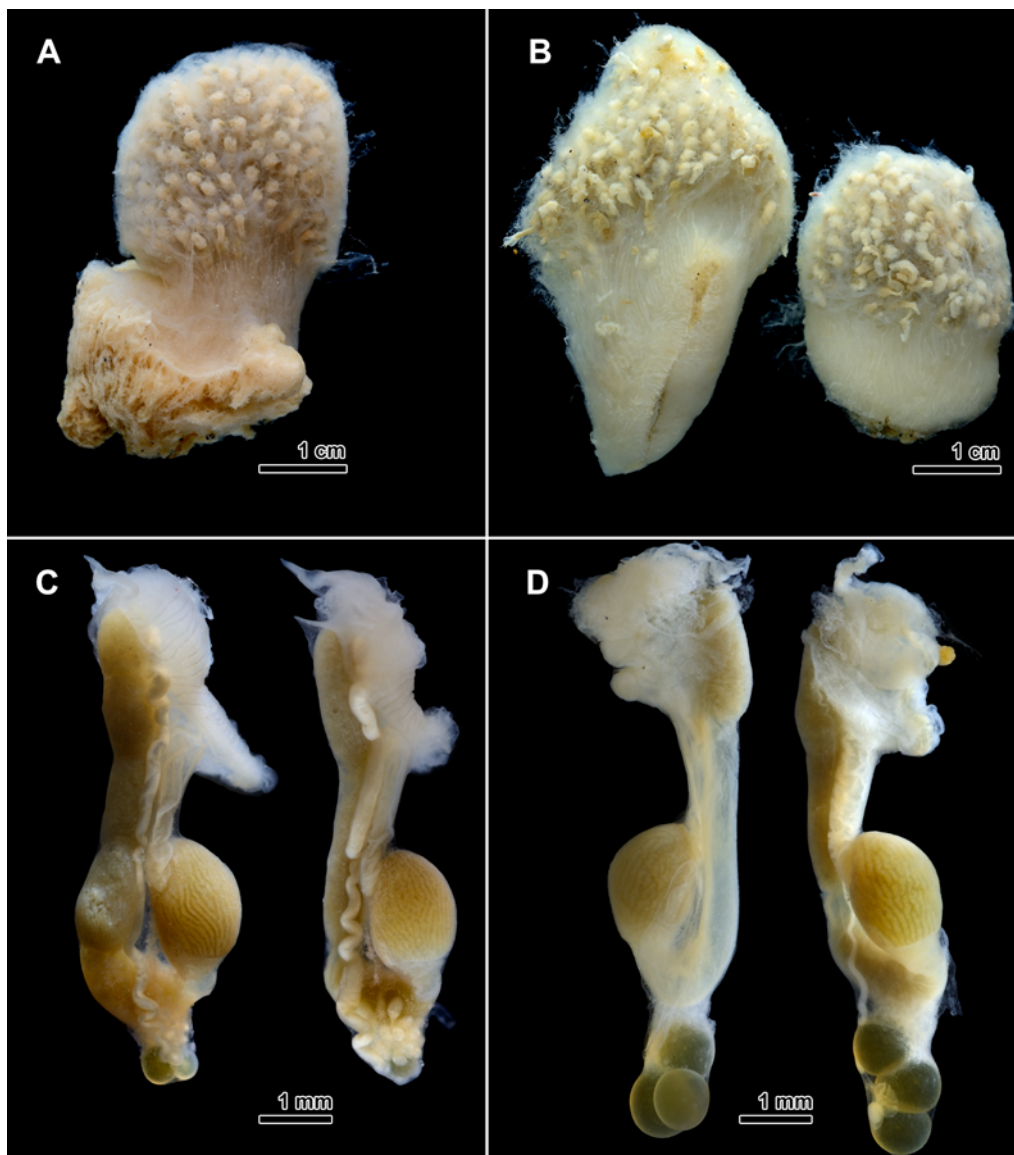


Fig. 41. *Holozoa urupensis* sp.n. A — colony (holotype); B — colonies (paratypes); C — zooids from holotype; D — zooids from paratype.

Рис. 41. *Holozoa urupensis* sp.n. A — колония (голотип); B — колонии (паратипы); C — зооиды из голотипа; D — зооиды из паратипа.

I counted 30–32 stigmata and 26–28 on the left side. The parastigmatic vessels are well developed but not robust, weaker than the transverse vessels separating the rows of stigmata. Three long dorsal languets are significantly displaced to the left.

The oesophagus is long and straight. The gut loop is almost straight and vertical. The stomach is oval, shorter along inner mesial side than along its outer

curved surface, located in the posterior half of the abdomen and almost vertically oriented. Its cardiac and pyloric ends are of about the same diameter, with a wider central part. The stomach wall is finely striated in a distinct and characteristic pattern composed of mostly longitudinal occasionally branched lines (Fig. 41C, D). The duodenal region and mid-intestine are well defined, with a gastric reservoir in the gut loop.

The gonads are located below the pole of the gut loop in a sac-like extension protruding from the posterior-right side of the abdomen which is not separated from the abdomen by a constriction (compare with *H. shimushirensis* sp.n. Fig. 39B which has a constriction). They consist of a compact cluster of small numerous pyriform male follicles and several large ova located posteriorly. The sperm duct is very thick, usually sinuously curved along its course and opens near the anus at the top of the thorax. The colonies contain no larvae or brood-pouches.

REMARKS. The present species most closely resembles *Holozoa rzhavskii* originally described from East Kamchatka, especially in the reported presence of only transverse thoracic muscles in contracted preserved zooids (but see comments on this feature in Remarks under *H. rzhavskii* above). *Holozoa urupensis* sp.n. differs from *H. rzhavskii* in about two times larger zooids, more numerous stigmata per row (18–20 in *H. rzhavskii*, 26–32 in *H. urupensis* sp.n.) and in the structure of the stomach wall. The differences in zooid size are not caused by contraction (in type specimens of both species the abdomens are not contracted), therefore size differences are considered real. The stomach wall is coarsely areolated in *H. rzhavskii* but finely striated in *H. urupensis* sp.n.

The species is currently known only from Urup Island (south group of Kuril Islands).

Family Polycitoridae Michaelsen, 1904

The family Polycitoridae comprises colonial ascidians (except monotypic *Millarus*) characterized by the following features: zooids divided into thorax and abdomen; branchial and atrial siphons six-lobed and open directly to the exterior; gonads in abdomen; gut loop vertical and long, oesophagus usually long (except *Brevicollus*, *Cystodytes* and *Eucoelium*), stomach in posterior part of abdomen. Most genera, except *Archidistoma* Garstang, 1891 and *Millarus* C. Monniot et F. Monniot, 1988 have completely embedded zooids.

The family includes eight genera: *Archidistoma*, *Brevicollus* Kott, 1990, *Cystodytes* Drasche, 1884, *Eucoelium* Savigny, 1816, *Eudistoma* Caullery, 1909, *Polycitor* Renier, 1804, *Salix* Kott, 2005 (a replacement name for *Exostoma* Kott, 1990) and *Millarus*. Most species are concentrated in *Eudistoma* and also in *Polycitor* and *Cystodytes*. *Eudistoma* and *Archidistoma* have only three rows of stigmata and are easily distinguishable basing on this feature alone. These two genera are distinguished only on the basis of the structure of the colony: *Eudistoma* has completely embedded zooids while in *Archidistoma* they are at least partially free. They were considered synonyms by some authors (and *Archidistoma* has a

priority) but now a consensus exists in considering them as separate genera (see very detailed discussion in Abbott *et al.*, 1997: 17). *Cystodytes* has four rows of stigmata and disc-shaped calcareous spicules forming a capsule around the abdomen of zooids. *Eucoelium* Savigny, 1816 (a senior synonym of *Polycitorella* Michaelsen, 1924) also has calcareous spicules, but they are stellate, not disc-shaped, and zooids have more than four rows of stigmata. *Polycitor* has embedded zooids with more than three rows of stigmata and lacks calcareous spicules. Three remaining genera are monotypic: *Millarus* is a deep-water genus with solitary zooids and was recorded only once; *Salix* has three rows of stigmata and a long atrial siphon issued from the posterior (basal) part of the thorax and opening into a common cloacal cavity (unique feature in Polycitoridae); *Brevicollus* has five rows of stigmata crossed by parastigmatic vessels, its position in Polycitoridae is problematic (see Kott, 2003: 1625).

Only one genus, *Eudistoma*, is recorded in the region covered by the present work.

Nomenclatural notes on family Polycitoridae, Distomidae and several included genera

The family Polycitoridae was created by Michaelsen (1904: 2) for a group of genera previously included in Distomidae Giard, 1872. Giard (1872) indicated type genus of Distomidae as *Distoma* with the reference to Savigny (1816) in the text. *Distoma* Savigny, 1816 is an incorrect spelling of *Distomum* Gaertner (in Pallas, 1774: 40), a species currently in Styelidae, therefore Distomidae Giard, 1872 and Polycitoridae Michaelsen, 1904 are not synonyms. Moreover, as incorrect spelling *Distoma* Savigny, 1816 is not an available name (see Article 33.3 and Opinion 1865, ICZN, 1997). The family name Distomidae is therefore not available.

The generic name *Polycitor* first appeared in a work of Renier commonly attributed to 1804. This work has been rejected for nomenclatural purposes as being not duly published within the meaning of the relevant articles of the Code (Opinion 316 and 427, ICZN, 1954, 1956). However, subsequently the generic name *Polycitor* was validated under plenary powers and placed on the Official List of Generic Names in Zoology (Opinion 478, ICZN, 1957b). Thus, *Polycitor* and Polycitoridae are available names and both are currently considered valid.

Salix is a replacement name for *Exostoma* Kott, 1990 which is a junior homonym of *Exostoma* Blyth, 1860 (Pisces). The work of Kott (2005) where the name *Salix* was suggested is a CD-ROM-only publication which is disallowed now (ICZN, 2012) but was allowed under Article 8.6 for a short period of time (2000–2011). The name is thus available and considered valid.

A genus *Rhombifera* Pérès, 1956, created for a colonial ascidian with *Holozoa*-like zooids and assigned to Polycitoridae by its author, is a primary junior homonym of *Rhombifera* Barrande, 1867 (a fossil echinoderm) and, therefore, is invalid.

Genus *Eudistoma* Caullery, 1909

Type species: *Distoma rubrum* Savigny, 1816 by subsequent designation by Michaelsen (1930).

The genus is homogeneous and characterized by embedded and usually small zooids divided into thorax and abdomen; both siphons six-lobed, open directly to the exterior; three rows of stigmata; longitudinal muscles run along thorax and abdomen; usually transverse muscles on thorax also present; oesophagus long; stomach smooth, usually globular, in posterior part of abdomen; gonads and heart in abdomen.

Paessleria Michaelsen, 1907 is a senior synonym of *Eudistoma* Caullery, 1909 suppressed in favor of *Eudistoma* (Opinion 1865, ICZN, 1997).

Eudistoma is a large genus, with more than 130 species currently considered valid. The genus is especially diverse in the tropics, while the number of cold-water species is small. Only three species of *Eudistoma* were recorded previously in the NW Pacific north of Japan and along Russian coasts of the Sea of Japan: *E. kurilense* Sanamyan, 1993, *E. vitreum* (Sars, 1851) and a species briefly reported as *Eudistoma parvum* (Oka, 1927) by Sanamyan (1993a). The first species, *E. kurilense*, may be easily identified by just the shape of the colony and is distinguished from all other *Eudistoma* species by the large number of stigmata in each row.

KEY TO SPECIES OF THE GENUS *EUDISTOMA* KNOWN FROM FAR EAST SEAS OF RUSSIA

- 1 Large colonies composed of thick upright lobes of characteristic shape (Fig. 42A); about 40 stigmata per row *Eudistoma kurilense*
 – Colonies small, often sandy; 10–13 stigmata per row *Eudistoma vitreum*

Eudistoma kurilense Sanamyan, 1993

Fig. 42.

Eudistoma kurilense Sanamyan, 1993a: 164.

MATERIAL EXAMINED. *Ac. Oparin-56*, St. 71, Shishkotan Island (Sea of Okhotsk side), 48°48.3'N, 154°17.7'E, 285–304 m, 12 August 2019, one colony.

DESCRIPTION. The colony is composed of two massive upright conical lobes attached to a stone. The lobes are 10 and 12 cm in height and about 5 cm in diameter. The distal, zooid-bearing part of each

lobe is slightly conical in shape and blunt. There is no constriction, or other demarcation, separating zooid-bearing parts from the basal stalk. In general, the surface is quite clean with only very sparse minute sand grains are attached to the test surface and also sometimes present in the inner layers. The test is dirty-white, almost opaque, the surface hard in touch and firmer than the inner matrix. The zooids are probably in a resting (non-feeding) state; the thoraxes are strongly contracted and their interior is disintegrated. Two short, closely set, six-lobed siphons are distinguishable only in a few zooids. The abdomens are also contracted and filled with parenchyma. Longitudinal muscles run along each side of the abdomen as a wide band. At the posterior third of the abdomen these muscles form two separate ribbons one on each side. They end abruptly at the base of the abdomen and do not continue into the vascular stolon. The V-shaped heart located just below the gut loop is well visible in several zooids. The only other structure recognizable is a rather large male gonad in the middle part of the abdomen, composed of numerous small pyriform testis follicles forming a compact, usually almost globular mass. The follicles are joined by individual straight and apparently not branched thin ducts which converge at the proximal end of the robust and straight common vas deferens. Almost all zooids have a rather long thin vascular stolon with a mesodermal septum.

Several zooids from the holotype colony were also reexamined (Fig. 42B, C). Their structure corresponds to the original description and to the zooids described above, but they lack gonads and the vascular stolon was not detected.

REMARKS. Although the zooids in the present material are in a resting state I have no doubt in the identification — the shape, the consistency and large size of the colony are unique characters for this *Eudistoma*. Another colony, consisting of a single head, was collected in the vicinity of Shishkotan Island, from deeper waters (516–498 m), during the same cruise (St. 76), but was not available for study to confirm identification. The species was known previously from the original description only, based on two colonies, one from Shishkotan Island and another from neighboring Onekotan Island, 150–250 m. Thus, currently it is known only from a limited area in the vicinity of two northern Kuril Islands.

The zooids in the specimens described by Sanamyan (1993a) were in a much better condition than those of the present material but they lack gonads, described here for the first time, and Sanamyan (1993a) did not mention a long posterior vascular process. The latter feature is unusual for *Eudistoma* and for other polycitorid genera, which usually have a short inconspicuous posterior vascular stolon and

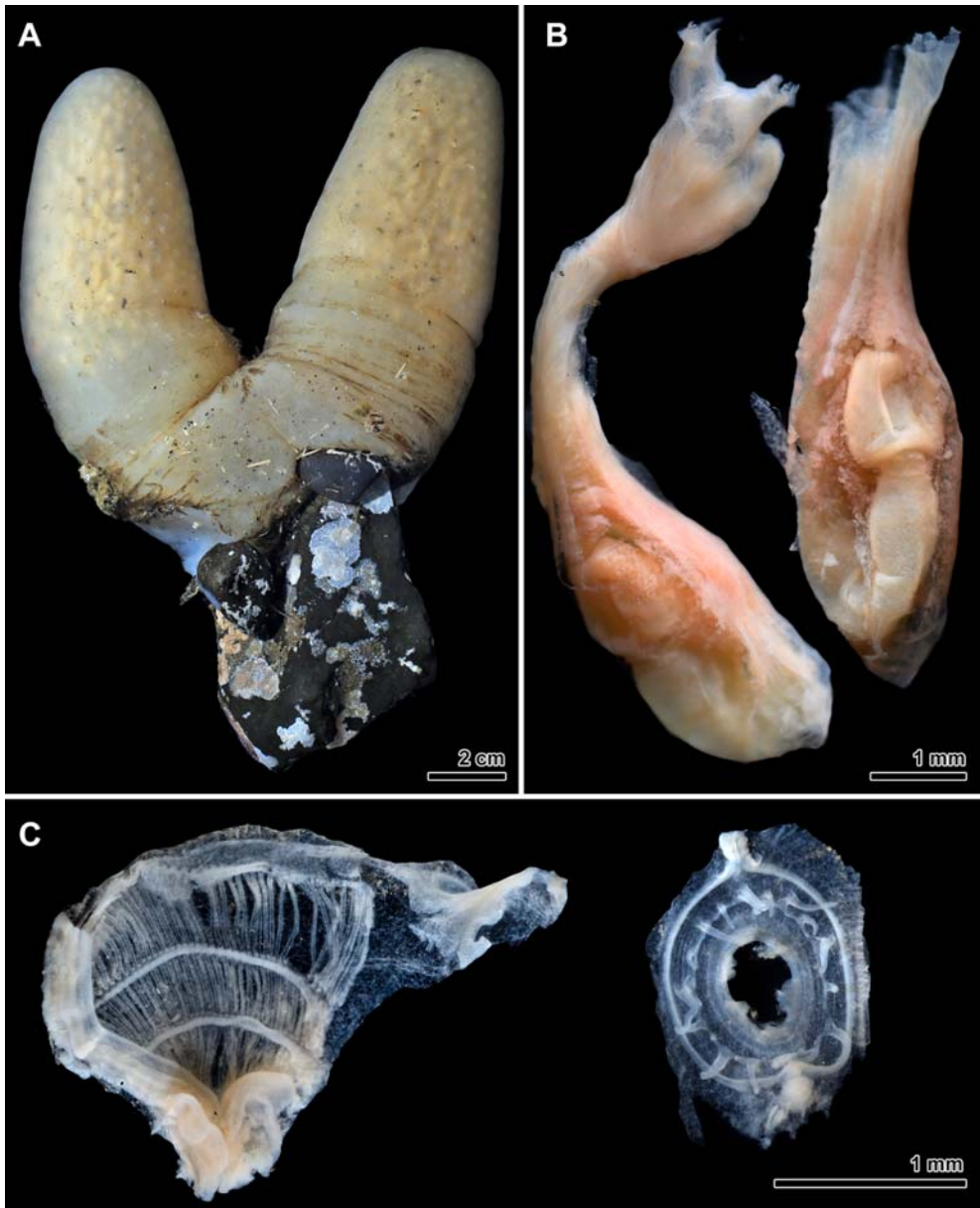


Fig. 42. *Eudistoma kurilense*. A — colony; B — zooids; C — sections of thorax to show three rows of numerous stigmata (left) and branchial tentacles (right). B, C, from the holotype.

Рис. 42. *Eudistoma kurilense*. А — колония; В — зоиды; С — вскрытый тораке, три ряда многочисленных стигм (слева) и жаберные щупальца (справа). В, С, из голотипа.

only rarely it may be well developed (e.g. as in *Eudistoma superlatum* Kott, 1990). A long posterior vascular stolon is characteristic for *Sigillina* (Pseudodistomidae), a genus which also has three rows of stigmata and resembles *Eudistoma* in other features. However, *Sigillina* has short oesophagus, its vascu-

lar process, in contrast with the present species, usually contains longitudinal muscles (see discussion in Kott, 1990: 192) and the present species cannot be assigned to it. Another feature separating the present species from other *Eudistoma* species is a very wide branchial sac: Sanamyan (1993a) report-

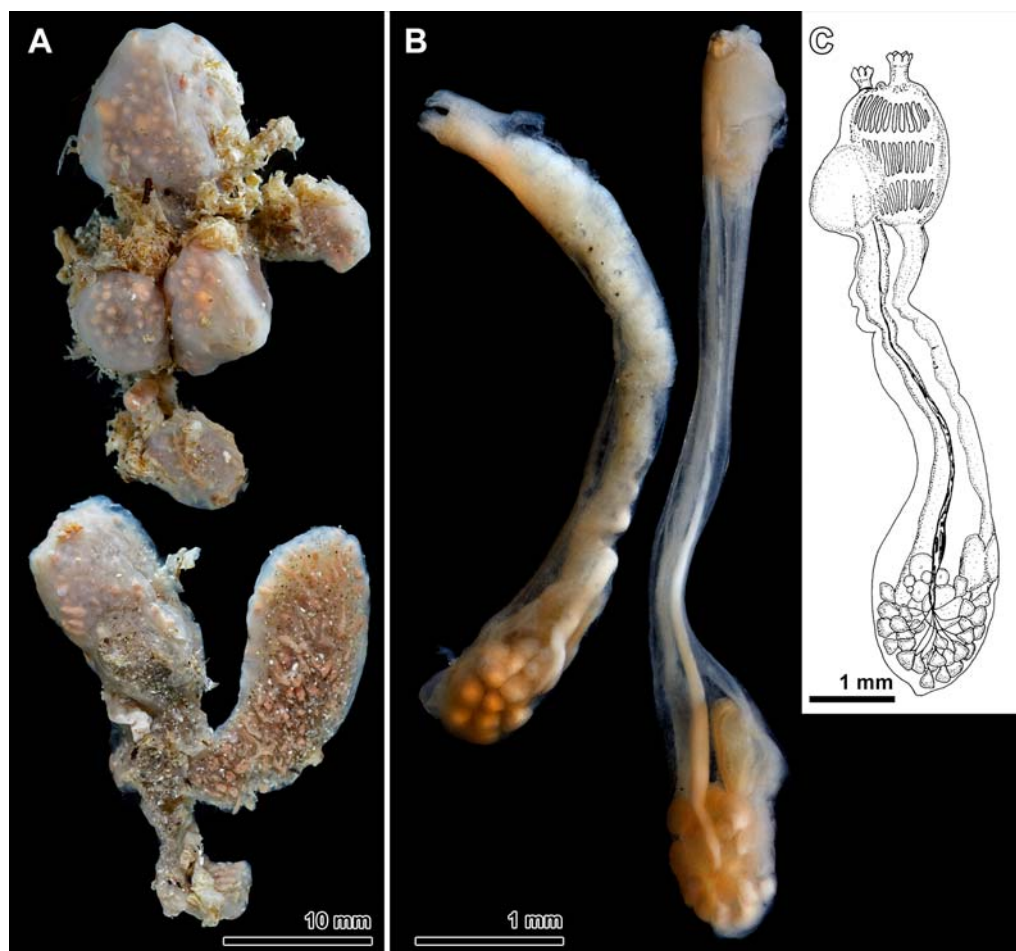


Fig. 43. *Eudistoma vitreum*. A — colonies; B, C — zooids (C, after Sanamyan, 1993a).
Рис. 43. *Eudistoma vitreum*. A — колонии; B, C — зооиды (C, по Sanamyan, 1993a).

ed 39–42 stigmata per row on each side of the branchial sac while usually species of *Eudistoma* have no more than 25 stigmata per row. Other features are quite characteristic for the genus and the assignment of this species to *Eudistoma* seems to be correct. However, *E. kurilense* is apparently distantly related to other members of this genus.

Eudistoma vitreum (Sars, 1851)
Fig. 43.

Distomum vitreum Sars, 1851: 154.

Polycitor vitreus: Van Name, 1945: 130.

Eudistoma vitreum: Millar, 1966: 14. Sanamyan, 1993a: 166.

MATERIAL EXAMINED. Commander Islands, Bering Island, 5–7 m, 12.07.1991, several colonies and fragments.

DESCRIPTION. The specimens consist of numerous small (1–2 cm) fragments composed of small cushions or upright lobes. The surface is free from sand except for the basal parts, and often some sand is present in the inner layers (Fig. 43A). The zooids are remarkably featureless, typical for the genus, with two prominent six-lobed terminal siphons, three rows of stigmata and 10–13 stigmata per row. Zooids are slender but long, up to 6 mm in length. Longitudinal muscles extend as a wide band on each side of the thorax to the posterior end of the abdomen where they terminate abruptly. The oesophagus is very long and its length varies considerably in different zooids. The asymmetrical stomach is more or less rectangular in transverse section, located in the posterior part of the abdomen. Large male follicles form a rosette-shaped cluster beside the pole of the gut loop around the proximal end of the thick sperm duct (Fig. 43B, C).

REMARKS. *Eudistoma vitreum* is known mainly from north European and Arctic waters; the original description is based on specimens from Lofoten and is the only *Eudistoma* species occurring there. In the Pacific it was reported from the Commander Islands by Sanamyan (1993a). Identification should not constitute a problem since no other similar species occur in cold waters of the NW Pacific.

Eudistoma sp.

Eudistoma parvum: Sanamyan, 1993a: 167.

Not *Distoma parvum* Oka, 1927: 497.

MATERIAL EXAMINED. None.

REMARKS. The taxonomic affinity of the small colony from Peter The Great Bay (Sea of Japan) identified as *E. parvum* by Sanamyan (1993a) cannot be clarified from available information. The colony was too small (possibly a fragment) and composed of only four short upright lobes, each with several zooids. The lobes form short cylinders, rather than the mushroom-shaped as figured by Tokioka (1954b, plate IV G) and the zooids have somewhat more numerous stigmata (12–14 instead of 8–10). These differences, together with the fact that *E. parvum* has not been previously reported from the Sea of Japan (see Nishikawa, 1990) suggest that the specimen from Peter The Great Bay is not conspecific with Japanese species and therefore I prefer to exclude *E. parvum* from the ascidians known from Russian waters. *Eudistoma parvum* was originally described as *Distoma parvum* Oka, 1927. The latter binomen is a primary junior homonym of *Distoma parva* Sluiter, 1900 and, according to Article 57.2 is permanently invalid. Accordingly, *Eudistoma okai* **nom.n.** is suggested here for *Eudistoma parvum* (Oka, 1927).

Family Didemnidae Milne-Edwards, 1842

The family comprises colonial ascidians with usually very small zooids completely embedded in a common test and arranged in cloacal systems; zooids divided into thorax and abdomen; branchial siphon six-lobed, atrial siphon sometimes present but usually atrial aperture is sessile; branchial sac with three or four rows of stigmata; abdomen contains short gut loop and gonad composed of one or several male follicles with often but not always spirally coiled sperm duct and small ovary. Most species have characteristic stellate calcareous spicules in the test. Zooids replicate by oesophageal budding, a feature distinguishing this family from other Aplousobranchia.

The family includes nine genera: *Atriolum* Kott, 1983, *Clitella* Kott, 2001, *Coelocormus* Herdman, 1886, *Didemnum* Savigny, 1816, *Diplosoma* Macdonald, 1859, *Leptoclinides* Bjerkan, 1905, *Lisso-*

clinum Verrill, 1871, *Polysyncraton* Nott, 1892 and *Trididemnum* Della Valle, 1881. *Clitella* and *Coelocormus* are monotypic (the latter may be a synonym of *Leptoclinides*, see Kott, 2001: 20); the other genera contain numerous to very numerous species.

Members of this family are easily recognizable as belonging to Didemnidae — stellate calcareous spicules present in most species and very small zooids are characteristic features. Zooids of large fleshy colonies lacking spicules (e.g. some *Diplosoma* spp.) bear some (rather superficial) resemblance with zooids of *Holozoa* but differ in details. Identification to a species level is, however, very difficult (and probably not possible for a wide range of biologists not specialized in ascidian taxonomy).

Didemnid ascidians of Russian waters, including species from the NW Pacific, were summarized in a monograph of Romanov (1989), who reported 35 nominal species from Far East Seas of Russia. A significant number of these species appear to be incorrectly identified (e.g. four of his new species described from Commander Islands were synonymized by Sanamyan (1999)). Unfortunately, now I have no possibility to reexamine the material collected by Romanov, and there are surprisingly few didemnid ascidians in the available material collected by recent expeditions. Also, the specimens collected in the Sea of Okhotsk and Kuril Islands during cruise 56 of RV *Academic Oparin* (material on which a significant part of the present work is based) were fixed in improperly neutralized (i.e. slightly acid) formalin and the spicules either were eroded or completely dissolved. Therefore, I prefer not to complicate the already much confused taxonomy of NW Pacific species of Didemnidae and provide here only a list of all known species without detailed descriptions and without identification keys to species. For description of species and identification keys see Romanov (1989) and Sanamyan (1999).

Nomenclature and authorship of Didemnidae

Van Name (1945) and Romanov (1989) credited authorship of Didemnidae to Verrill (1871) while Kott (1998, 2001, 2009) ascribes it to Giard (1872), a work published a year later than the work of Verrill (if accepted date of publication of Verrill's work is correct). Indeed, both papers use this family name. Giard (1872: 608) spelled it as Didemnidæ and used it for a group of three genera (*Didemnum*, *Eucoelium* and *Leptoclinum*). He also created the family Diplosomidae (spelled as Diplosomidæ) for *Diplosoma* and two other genera. Verrill (1871) used "Family Didemnidæ" in a header in his text. However, there are earlier appearances of this family rank name, and both Verrill (1871) and Giard (1872) refer to some of these earlier works. Verrill (1871: 443) mentioned a

work of Gill (1871) which obviously was published before Verrill's work. Gill (1871) used the family name Didemnidae with a reference to Bronn (1862). Bronn (1862: 217) created a group named "Didemmina" coded by two preceding dots (a subfamily level in his coding system). However, Milne-Edwards (1842) was probably the first who comprised several ascidians under the name "Didemniien". As it appears from his text his "Didemniien" was used "as a scientific name to denote a suprageneric taxon and not merely as a plural noun or adjective referring to the members of a genus" (Article 11.7.1.2.), (e.g. treated as "tribe", see Milne-Edwards 1842: 230). This fact makes family rank name "Didemniien" introduced by Milne-Edwards (1842) validly established and, according to Article 11.7.1.3, "available with its original authorship and date, but with a corrected suffix", i.e. as Didemnidae Milne-Edwards, 1842.

KEY TO GENERA OF THE FAMILY DIDEMNIDAE
KNOWN FROM FAR EAST SEAS OF RUSSIA

- 1 Three rows of stigmata *Trididemnum*
– Four rows of stigmata 2
2 Atrial siphon present *Leptoclinides*
– Atrial siphon not present 3
3 Vas deferens straight 4
– Vas deferens coiled 5
4 Spicules not present, atrial languet not present, one
or two male follicles *Diplosoma*
– Spicules usually present but may be sparse, atrial
languet present, sometimes more than two male
follicles *Lissoclinum*
5 One or two testis follicles *Didemnum*
– More than two testis follicles *Polysyncraton*

Genus *Didemnum* Savigny, 1816

Type species: *Didemnum candidum* Savigny, 1816 by subsequent designation of Hartmeyer (1909).

Didemnum is characterized by the following features: vas deferens coiled; one or two male follicles; four rows of stigmata; atrial aperture sessile (atrial siphon not developed); spicules present in most species. *Didemnum* is a very large genus comprising about 250 species.

The following 16 species of *Didemnum* are known from Far East Seas of Russia:

Didemnum caudiculatum Romanov, 1989. Iturup and Kunashir Island (South Kuril Islands), Moneron Island (Sea of Japan), West Sakhalin. Known only from the original description.

Didemnum extensum Romanov, 1989. Iturup Island (South Kurile Islands). Known only from the type material.

Didemnum filiforme Romanov, 1989. Kunashir Island (South Kurile Islands). Known only from the type material.

Didemnum grande: Romanov, 1989 (not Herdman, 1886). Romanov (1989) reported this species from North Kurile Islands, west coast of Sakhalin and Moneron Island (Sea of Japan). The identification is incorrect. Herdman (1886) described it from Philippines and its presence in cold waters of North Pacific is excluded.

Didemnum immundum Romanov, 1974. Iturup Island (South Kurile Islands). Known only from the type material.

Didemnum kurilense Romanov, 1989. Makanrushi Islands (North Kurile Islands). Known only from the type material.

Didemnum megaductus Romanov, 1974. Iturup Island (South Kurile Islands). Known only from the type material.

Didemnum minispirale Romanov, 1989. West Sakhalin and Moneron Island (N of Japan Sea). Known only from the original description.

Didemnum moseleyi: Romanov, 1989 (not Herdman, 1886). Romanov (1989) reported this species from Peter the Great Bay (Sea of Japan). Nishikawa (1990) treated this record as doubtful, an opinion with which I agree.

Didemnum papillatum Romanov, 1974. Anadir Bay (NW of Bering Sea), Commander Islands, Kamchatka, North Kurile Islands and West Sakhalin. Common. *Didemnum beringense* Romanov, 1977, *D. gemmiparum* Romanov, 1977 and *D. transparentum* Romanov, 1977 are synonyms.

Didemnum pseudobiglans Romanov, 1989. From Commander Islands to South Sakhalin. Common.

Didemnum risirense Nishikawa, 1990. Described from Rishiri Island, Hokkaido by Nishikawa (1990); Sanamyan (1999) reported it from Peter the Great Bay (Sea of Japan).

Didemnum sachalinense Romanov, 1989. SW of Sakhalin Island (Sea of Japan). Known only from the original description.

Didemnum translucidum Tokioka, 1953. Romanov (1989) reported it from Peter the Great Bay. Nishikawa (1990) commented that his description agrees in general with *D. translucidum* but differs slightly in the number of coils of the vas deferens.

Didemnum trispirale Romanov, 1989. Iturup Island (South Kurile Islands). Known only from the type material.

Didemnum vermiforme Romanov, 1989. Kunashir Island (South Kurile Islands) and Peter the Great Bay (Sea of Japan).

Genus *Diplosoma* MacDonald, 1859

Type species: *Diplosoma rayneri* MacDonald, 1859 by monotypy.

Diplosoma is characterized by the following features: vas deferens straight; one or two male

follicles; four rows of stigmata; atrial aperture sessile and usually very wide; spicules not present.

The following three species of *Diplosoma* are known from Far East Seas of Russia:

Diplosoma listerianum (Milne-Edwards, 1842). Romanov (1989) and Sanamyan (1999) reported many colonies of this species from Russian coasts of the Sea of Japan. This species has a worldwide distribution but many records are possibly misidentified.

Diplosoma lukini Romanov, 1989. Published records include only the original description based on one colony from the north part of the Japan Sea. Another colony was identified in material from Kamchatka (Sanamyan, unpublished data).

Diplosoma siphonale Romanov, 1989. Makarunshi Island (North Kuril Islands). Known only from the type material (one colony).

Genus *Leptoclinides* Bjerkan, 1905

Type species: *Leptoclinides faeroensis* Bjerkan, 1905 by monotypy.

Leptoclinides is characterized by the following features: vas deferens coiled; one or several male follicles; four rows of stigmata; atrial siphon present; spicules present.

The following three species of *Leptoclinides* are known from Far East Seas of Russia:

Leptoclinides aspiculatum Romanov, 1989. Known only from type material (several colonies) from Moneron Island (Sea of Japan).

Leptoclinides faeroensis Bjerkan, 1905. The distribution includes northern Atlantic and European waters. Romanov (1989) reported it from Kunashir Island (South Kurile Islands) and this is the single Pacific record. Most probably the identification is not correct.

Leptoclinides macrottestis Romanov, 1977. Known only from the type material (several colonies) from Medny Island (Commander Islands).

Genus *Lissoclinum* Verrill, 1871

Type species: *Lissoclinum aureum* Verrill, 1871 by subsequent designation by Van Name (1910).

Lissoclinum is characterized by the following features: vas deferens straight; one or several male follicles; four rows of stigmata; atrial aperture sessile (no atrial siphon); spicules present in most species. Only one species, *Lissoclinum aureum* Verrill, 1871, is known from Far East Seas of Russia. It is widely distributed in North Atlantic and Arctic waters. In the Pacific it was reported by Romanov (1989) from Iturup Island (South Kuril Islands).

Genus *Polysyncrator* Nott, 1892

Type species: *Polysyncrator paradoxum* Nott, 1892 by subsequent designation by Hartmeyer (1924).

NOMENCLATORIAL NOTE. Nott (1892) originally included two species in *Polysyncrator*, *P. paradoxum* and *P. fuscum* Nott, 1892. Hartmeyer (1912: 325) stated that both constitute the type of *Polysyncrator*, but this is disallowed by the Code. Romanov (1989) stated that *Polysyncrator paradoxum* is the type of *Polysyncrator* by monotypy and this statement is also not correct because more than one species was originally included. Kott (1998) stated that *P. paradoxum* is the type by original designation but I failed to find such a statement in a work of Nott (1892). The type species of this genus has been fixed by Hartmeyer (1924) (providing that no earlier type fixation exists which I failed to find).

Polysyncrator is characterized by the following features: vas deferens coiled; more than two male follicles; four rows of stigmata; atrial aperture sessile (no atrial siphon); spicules present in most species.

The following species of *Polysyncrator* are known from Far East Seas of Russia:

Polysyncrator adenale Romanov, 1977. Originally described from two colonies from Raschua Island (Middle Kuril Islands). Sanamyan (1999) reported another colony from Sanak Island (NE Pacific). No other specimens are known.

Polysyncrator asperum Romanov, 1989. West Sakhalin. Known only from the type material (two colonies).

Polysyncrator crassum Redikorzev, 1913. Alaska Gulf, Sea of Okhotsk, from North to South Kuril Islands. *Polysyncrator fadeevi* Romanov, 1989 is a synonym. Not rare.

Polysyncrator kashenkoi Romanov, 1989. Reported from Commander Islands (type material) and Moneron Island (Sea of Japan) (one colony). Romanov (1989) says that in the Commander Islands this yellow species forms large settlements together with the red species *Didemnum immundum*. I worked on several expeditions to the Commander Islands, large colonies of yellow and red didemnids were found to be *Didemnum papillatum* (yellow) and *D. pseudobiglans* (red). It is possibly that Romanov (1989) misinterpreted generic features and his *P. kashenkoi* is a synonym of *D. papillatum*.

Polysyncrator krylatkae Romanov, 1974. Reported from Medny Island (Commander Islands) and from Iturup and Kunashir islands (South Kuril Islands); The holotype is from Iturup Island. It is doubtful if a colony from Medny Island is conspecific with a colony from Iturup Island.

Polysyncrator paramushiri Romanov, 1989. Paramushir Island (North Kurile Islands). Known only from type material (two colonies).

Polysyncraton tokiokai Romanov, 1989. Paramushir Island (North Kurile Islands). Known only from type material (two colonies).

Genus *Trididemnum* Della Valle, 1881

Type species: *Lissoclinum tenerum* Verrill, 1871 by subsequent designation by Hartmeyer (1924).

Trididemnum is unique in the Didemnidae in the presence of three rows of stigmata. Spicules present in most species.

The following two species of *Trididemnum* are known from Far East Seas of Russia:

Trididemnum aff. *tenerum*: Sanamyan, 1999 (not *T. tenerum* (Verrill, 1871)). East Kamchatka, rather deep-water (330–560m). Probably not conspecific with *T. tenerum* (Verrill, 1871).

Trididemnum vostoki Romanov, 1989. Peter the Great Bay (Sea of Japan). Known only from type material (several colonies).

Family Cionidae Lahille, 1888

The family comprises solitary ascidians characterized by horizontal gut loop located below the branchial sac, large entire epicardial sacs with persistent openings into the pharynx, large branchial sac with straight stigmata and longitudinal vessels supported on papillae.

I follow Kott (1990) in accepting *Ciona* as a sole genus of the family. Abyssal genera *Araneum* C. Monniot et F. Monniot, 1973 (two species) and *Tantillulum* C. Monniot et F. Monniot, 1984 (monotypic) were provisionally included in this family by their authors (Monniot C., Monniot F. 1973; Monniot C., Monniot F., 1984). The true taxonomic position of these simplified aberrant genera is hard to determine (as mentioned in the original descriptions of these genera), but they have no apparent characters of Cionidae *sensu* Kott (1990). According to Kott (1990) *Araneum* may be related to Ascidiidae (although it lacks renal vesicles). Another abyssal monotypic genus, *Mysterascidia* C. Monniot et F. Monniot, 1982 was suggested as a possible member of Cionidae, although its authors acknowledge that “*the taxonomic position of this species is still difficult to fix*” (Monniot C., Monniot F., 1982: 106). According to C. Monniot, F. Monniot (1982) *Mysterascidia* seems to be nearer to *Ciallusia* Van Name, 1918 and *Pterygascidia* Sluiter, 1904. These two genera were subsequently synonymized by Kott (2008b) and placed in a reinstated family Ciallusiidae Huus, 1937, characterized, among other features, by the absence of the epicardial sacs and a more or less straight gut. *Mysterascidia* should probably be assigned to this family, rather than to Cionidae. None of above mentioned abyssal genera occur in the North Pacific.

Genus *Ciona* Fleming, 1822

Type species: *Ascidia intestinalis* Linnaeus, 1767 by monotypy.

Ciona is probably the most well-known ascidian genus. It has a complicated history (see Hoshino, Nishikawa, 1985) and at least 24 specific epithets have been associated with this generic name. Many were synonymized with *C. intestinalis*, which was thought previously to be the only shallow-water member of the genus, but several authors proved that the specimens formerly known under this name belong to several distinct species (Hoshino, Tokioka, 1967; Copello *et al.*, 1981; Hoshino, Nishikawa, 1985; Brunetti *et al.*, 2015; Mastrototaro *et al.*, 2020). Brunetti *et al.* (2015) listed six shallow-water and five deep-water species of the genus. Currently I recognize 13 putatively valid species of *Ciona* which may be divided into the groups listed below. This list differs slightly from the list published by Brunetti *et al.* (2015), in particular *C. roulii* Lahille, 1890 is conspecific with *C. intestinalis* (see Nydam, Harrison, 2010) and a small abyssal *C. imperfecta* C. Monniot et F. Monniot, 1977 should be better assigned to another (possibly new) genus rather than placed with *Ciona*. Also, three species were added, tropical *C. hoshinoi* C. Monniot, 1991, which is obviously valid, *C. gefesti* Sanamyan, 1998b and recently described *C. intermedia* Mastrototaro in Mastrototaro *et al.*, 2020.

(A) Shallow water species with endostylar appendage:

- C. intestinalis* (Linnaeus, 1767)
- C. robusta* Hoshino et Tokioka, 1967
- C. edwardsi* Roule, 1884
- C. intermedia* Mastrototaro in Mastrototaro *et al.*, 2020

(B) Shallow water species without endostylar appendage:

- C. savignyi* Herdman, 1882
- C. hoshinoi* C. Monniot, 1991
- C. sheikoi* Sanamyan, 1998

(C) The species with posterior abdominal extension:

- C. longissima* Hartmeyer, 1899
- C. gelatinosa* Bonnevie, 1896

(D) Deep water species without posterior abdominal extension:

- C. mollis* Ritter, 1907
- C. pomponiae* C. Monniot et F. Monniot, 1989
- C. gefesti* Sanamyan, 1998

(E) Antarctic species:

- C. antarctica* Hartmeyer, 1911

Three species of the genus are currently known from Far Eastern Seas of Russia: *C. savignyi*, *C. sheikoi* and deep-water *C. gefesti* and they all are rare in the cold waters north off Japan.

In addition, Redikorzev (1941) recorded *C. intestinalis* from Vladivostok (Sea of Japan) but at that time he never recognized other species of the genus and the specific identity of this material is not known. There are no confirmed records of *C. intestinalis* in the region covered by the present paper.

KEY TO SPECIES OF THE GENUS *CIONA* KNOWN FROM FAR EASTERN SEAS OF RUSSIA

- 1 Four thin longitudinal muscle bands on each side in posterior half of the body, deep-water species *C. gefesti*
- More than four muscle bands in posterior half of the body 2
- 2 Pharyngo-epicardiac openings close to endostyle; longitudinal muscle bands very strong, fused together (at least in preserved specimens) *C. sheikoi*
- Pharyngo-epicardiac openings close to oesophagus 3
- 3 Genital apertures far anterior to anus *C. savignyi*
- Genital apertures slightly anterior to anus *C. cf. savignyi*

Ciona gefesti Sanamyan, 1998

Fig. 44.

Ciona gefesti Sanamyan, 1998b: 98.

Ciona pomponiae: Sanamyan, Sanamyan, 2007: 56.
Not *Ciona pomponiae* Monniot C., Monniot F., 1989:

17.

MATERIAL EXAMINED. Bering Sea, in vicinity of Karaginsky Island, 58°56.3'N, 164°55.9'E – 58°59.3'N, 165°01.5'E, 400–408 m, 10.07.1994, one specimen (Holotype KBPGI 1/673); RV Keldysh, cruise 22, St. 2328, Kamchatka, Kronotsky Bay, 53°26.59'N, 160°21.00'E – 53°25.76'N, 160°21.40'E, 1814–1920 m, 14.08.1990, one specimen.

DESCRIPTION. Many specimens obviously belonging to this species were photographed underwater (but not collected) by ROV *Comanche 18* NSCMB FEB RAS (A.V. Zhirmunsky National Scientific Center for Marine Biology) during the cruise 75 of RV *Ac. Lavrentyev* in 2016 at lower bathyal depths (from about 2000 to 3000 m) on the slope of underwater Piip Volcano (north off Commander Islands, 55°27.6'N, 167°16.2'E). The specimens are oval in outline (not elongated as some other *Ciona* species, e.g. *C. intestinalis*), slightly wider at the proximal half of the body. Branchial siphon terminal, atrial significantly displaced down along the dorsal side. Siphons face in opposite directions (Fig. 44D). The specimens are colorless, including no obvious pigment spots on the siphons. Longitudinal muscle bands, two of which originate on the atrial

siphon and three or four on the branchial on each side are well visible on the underwater photographs. Some specimens on the photographs appear to have an almost vertical simple gut loop (Fig. 44C), a position and shape not characteristic for shallow-water *Ciona* species, however examined preserved specimens have horizontal gut loop under the branchial sac (see Sanamyan, 1998b; Sanamyan, Sanamyan, 2007). The branchial sac, as in many deep-water species, is thin-walled and lacks an endostylar appendage. Pharyngo-epicardiac openings in the retropharyngeal groove are halfway between the endostyle and the oesophageal opening. The anal margin is lobed, but the lobes are not prominent. The C-shaped oviductal opening is just above the anus.

REMARKS. *Ciona gefesti* is known from the original description based on a single specimen collected in the vicinity of the Commander Islands and a detailed redescription (Sanamyan, Sanamyan, 2007) based on a much deeper record of another specimen from Kamchatka. In the latter paper it was synonymized with *C. pomponiae* known only from the Galapagos Islands, but now I consider the species to be valid. According to Sanamyan & Sanamyan (2007) the only difference between *C. gefesti* and *C. pomponiae* is the shape of the anus, smooth in the latter species and lobed in both known specimens of *C. gefesti*, and possibly the structure of the stomach wall. The more important difference, overlooked by Sanamyan & Sanamyan (2007), is the length of the gonoducts and the position of the genital apertures, they are situated near the anus in *C. gefesti* but far anterior to it in *C. pomponiae* (see C. Monniot, F. Monniot, 1989). Also, C. Monniot & F. Monniot (1989: 19) described a well-developed pyloric gland encircling the posterior intestine, a feature not detected in *C. gefesti* but its taxonomic value is not known.

Ciona cf. savignyi Herdman, 1882c

Fig. 45.

MATERIAL EXAMINED. *Ac. Oparin-56*, St.3, Urup Island (Pacific side), 45°35.5'N, 149°47.7'E, 145–142 m, 27.06.2019, two specimens; St.69, Onokotan Island (Sea of Okhotsk side), 49°24.0'N, 154°16.1'E, 146–147 m, 12.08.2019, two specimens.

DESCRIPTION. All specimens are small; the test of the largest is 3 cm in height but the mantle body, which was not attached to the test in preservative, is strongly contracted and half the size of the empty test (Fig. 45A). The test is gelatinous, very soft, transparent, without any color markings. Both siphons are terminal, the branchial with eight and the atrial with six lobes each marked by a bright yellow spot. Three longitudinal muscle bands originate from

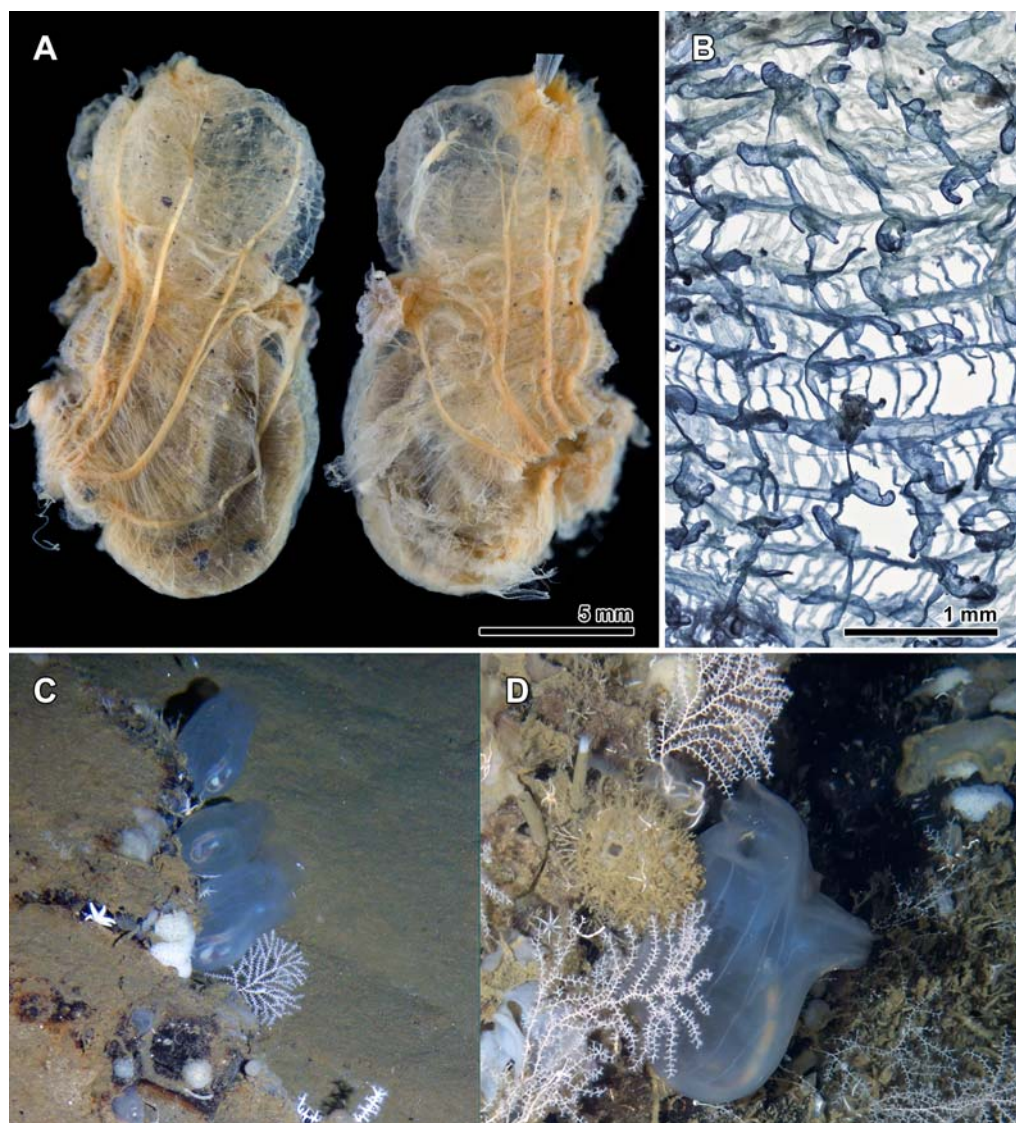


Fig. 44. *Ciona gefesti*. A — body with test removed, left and right side; B — branchial sac; C, D — underwater photographs of several specimens at the slope of underwater Piip Volcano, 2000–2990 m (taken by ROV *Comanche 18* NSCMB FEB RAS (A.V. Zhirmunsky National Scientific Center for Marine Biology) during cruise 75 of RV *Ac. Lavrentyev*).

Рис. 44. *Ciona gefesti*. А — тело с удаленной туникой, вид слева и вид справа; В — жаберный мешок; С, D — подводные фотографии нескольких экземпляров на склоне подводного вулкана Пийпа, 2000–2990 м (фото ROV *Comanche 18* ННЦМБ ДВО РАН (Национальный научный центр морской биологии им. А.В. Жирмунского), сделанные в ходе 75-го рейса НИС «Академик Лаврентьев»).

the atrial and four from the branchial siphon on each side of the body; some of them fuse together to form only five muscle bands along most of the body. Each band is composed of several parallel muscles. In preservative the longitudinal muscles are slightly

tinted red but pure white on a photograph of freshly collected specimens. The branchial sac is not plicated (apart from plications caused by contraction of the body, Fig. 45D). There is no endostylar appendage. Pharyngeo-epicardiac openings are close to the

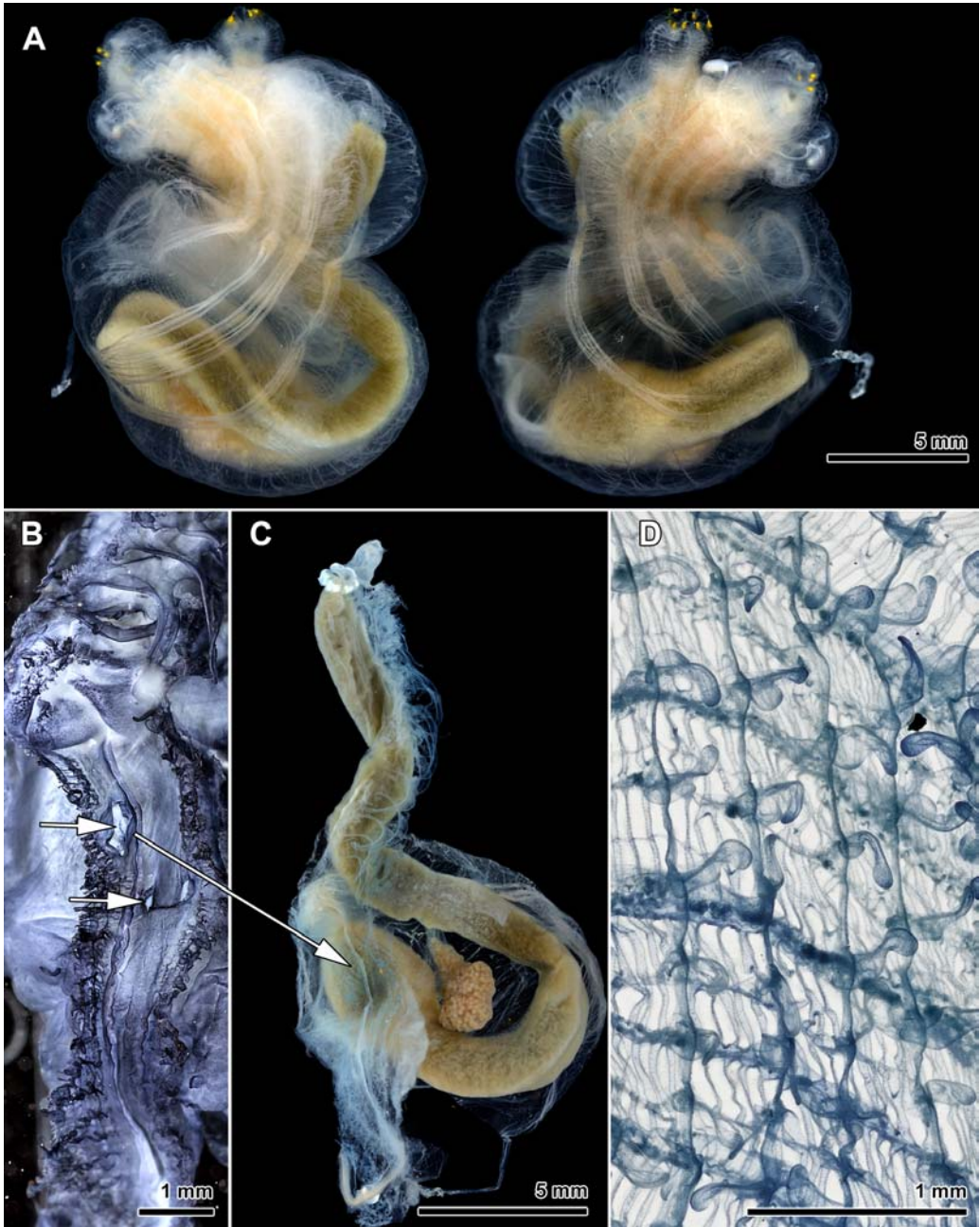


Fig. 45. *Ciona* cf. *savignyi*, A — body without tunic, left and right side; B — retropharyngeal groove, arrows point to pharyngo-epicardiac openings; C — visceral mass; D — branchial sac.

Рис. 45. *Ciona* cf. *savignyi*, A — тело с удаленной туникой, вид слева и вид справа; B — ретрофарингеальная борозда, стрелки показывают на фаринксо-эпикардные отверстия; C — петля кишечника и гонады; D — жаберный мешок.

oesophagus: examined specimen had one large right opening and two smaller openings on the left side of the retropharyngeal groove (Fig. 45B). The pear-shaped ovary is in the gut loop; male follicles were not seen. The genital apertures are situated slightly anterior to the anus, with no trace of pigment spots. The anal border is lobed (Fig. 45C).

REMARKS. *Ciona savignyi* is common around Japan (Nishikawa, 1991) and is abundant from southern British Columbia to southern California (Lambert, 2019). It has been recorded on Russian coast of the Sea of Japan (in Peter the Great Bay, Zvyagintsev *et al.*, 2007) but was not known previously in more northern regions along the east coast of Russia. This species was originally described from the east (Pacific) coast of Japan (34°35' N, 135°10' E, 18 and 90 m) and redescribed by Hoshino & Nishikawa (1985). These authors listed several distinguishing features of this species, the most important are: endostylar appendage is absent; pharyngo-epicardiac openings are close to the endostyle; genital apertures are usually situated far anterior to anus; distal end of the vas deferens never pigmented orange or red. In most of these features the specimens from Kuril Islands described here are similar to *C. savignyi* but the genital apertures are only slightly anterior to the anus. I reexamined available specimens of *C. savignyi* from the Sea of Japan (the material reported by Zvyagintsev *et al.*, 2007, see below) and from the Pacific coast of USA (Washington, the specimens collected and identified by G. Lambert in 1999). They all have genital apertures situated far anterior to the anus (Fig. 46B). This feature may be taxonomically significant, but having only four specimens, only one of which is in more or less good condition, it is not possible to decide whether the specimens with shorter ducts should be treated as a distinct species and I prefer to identify them provisionally as *C. cf. savignyi*.

In the absence of the endostylar appendix, the position of the pharyngo-epicardiac openings close to the oesophagus and in the position of male and female openings close to the anus the present specimens resemble *C. gefesti*, a deep-water species known from Kamchatka and vicinity of Commander Islands. However, *C. gefesti* has widely spaced longitudinal muscle bands on each side and they are significantly thinner and weaker than in the present species (Fig. 44). Also, the wall of the branchial sac of *C. gefesti* is much thinner than in *C. savignyi*.

Ciona savignyi Herdman, 1882
Fig. 46.

Ciona savignyi Herdman, 1882c: 236; Hoshino, Nishikawa, 1985: 69 (and synonymy); Lambert, 2003: 675; 2019: 420.

MATERIAL EXAMINED. Sea of Japan, Nakhodka Bay, 17.08.2004, collector A. Zvyagintsev, six specimens.

DESCRIPTION. Available specimens from the Sea of Japan are very small (about 1 cm in height without the test) and strongly contracted. They correspond in all details to *C. savignyi* as it was described by Hoshino & Nishikawa (1985). Most features are as in *C. aff. savignyi* described above but the genital apertures (large C-shaped sessile female opening and a group of about ten crowded sessile male apertures) are situated far anterior to the anus (Fig. 46B).

REMARKS. See Remarks under *C. aff. savignyi* above.

Ciona sheikoi Sanamyan, 1998
Fig. 47.

Ciona sheikoi Sanamyan, 1998b: 100.

MATERIAL EXAMINED. Atlasov Island, Lava Point, 18 m, 22.07.1989, one specimen.

DESCRIPTION. The specimen is strongly damaged, about 10 cm in length and 2.5 in diameter. The test is soft and very thick (up to 1 cm in thickness), colorless and transparent. The body removed from the tunic is only 4 cm in length. Longitudinal muscle bands are very strong. In the contracted specimen they all are fused together and form a continuous solid muscle layer over the whole body except the most posterior part of the body. About six such ribbons are present on each side of the body but since they are merged it is not possible to count them precisely. The branchial sac is thin-walled and horizontally pleated (Fig. 47C). The alimentary tract and gonad are completely destroyed, but numerous long finger-like lobes characteristic for the species are still recognizable on the margin of the anus (Fig. 47B). The position of the genital openings cannot be determined.

REMARKS. Although all internal organs are strongly damaged and several important features cannot be examined, there is no doubt that the present specimen is conspecific with *C. sheikoi*. This species is based on 12 specimens collected at the vicinity of neighboring Shumshu Island (50°38.1'N, 156°50.5'E) at 90 m. Type specimens described by Sanamyan (1998b) are smaller but have similar strong and wide deep-red longitudinal muscle ribbons (Fig. 47D). According to Sanamyan (1998b), in the type specimens the pharyngo-epicardiac openings are close to the endostyle but the endostylar appendage is not present. This combination was reported only for *C. gelatinosa* (see Sanamyan & Sanamyan (2007)) and tropical *C. hoshinoi* (see *C. Monniot*, 1991). In other *Ciona* species without an endostylar appendage (*C. savignyi* and *C. gefesti*)

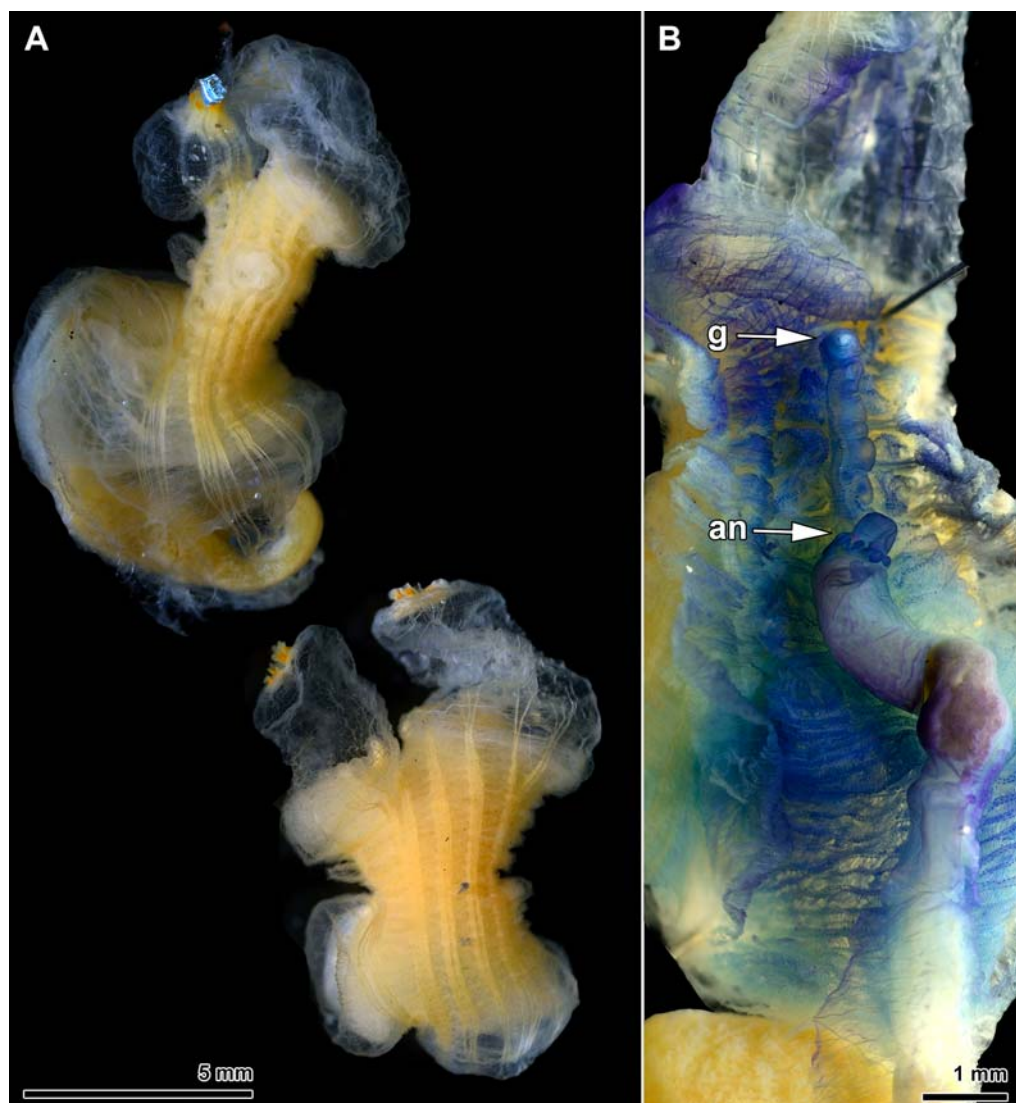


Fig. 46. *Ciona savignyi*. A — two specimens removed from test; B — specimen opened dorsally to show relative position of anus (an) and genital apertures (g).

Рис. 46. *Ciona savignyi*. А — два экземпляра с удаленной туникой; В — вскрытый экземпляр, показано относительное положение ануса (an) и генитальной апертуры (g).

the pharyngo-epicardiac openings are located far from the endostyle (either closer to the oesophagus or in the middle of the retropharyngeal groove), and the species in which they are close to the endostyle (*C. intestinalis*, *C. edwardsi* and *C. robusta*) have an endostylar appendage. *Ciona gelatinosa* does not occur in the Pacific and is morphologically distinct from *C. sheikoi*. Despite the above mentioned similarity it does not appear to be closely related. The pleated wall of the branchial sac, reported here for *C.*

sheikoi, is also characteristic for *C. intestinalis* (see Copello *et al.*, 1981 and Brunetti *et al.*, 2015) and *C. robusta* (my data based on the specimens collected along the coasts of Peru and Chile). In their description of *C. intestinalis* (which in part is based on the specimens of *C. robusta*) Hoshino & Nishikawa (1985: 66) wrote “the endostylar appendage is usually very distinct, though rarely not so”. Both species usually have a distinct red spot at the end of the sperm duct while in *C. sheikoi* the gonoducts are not

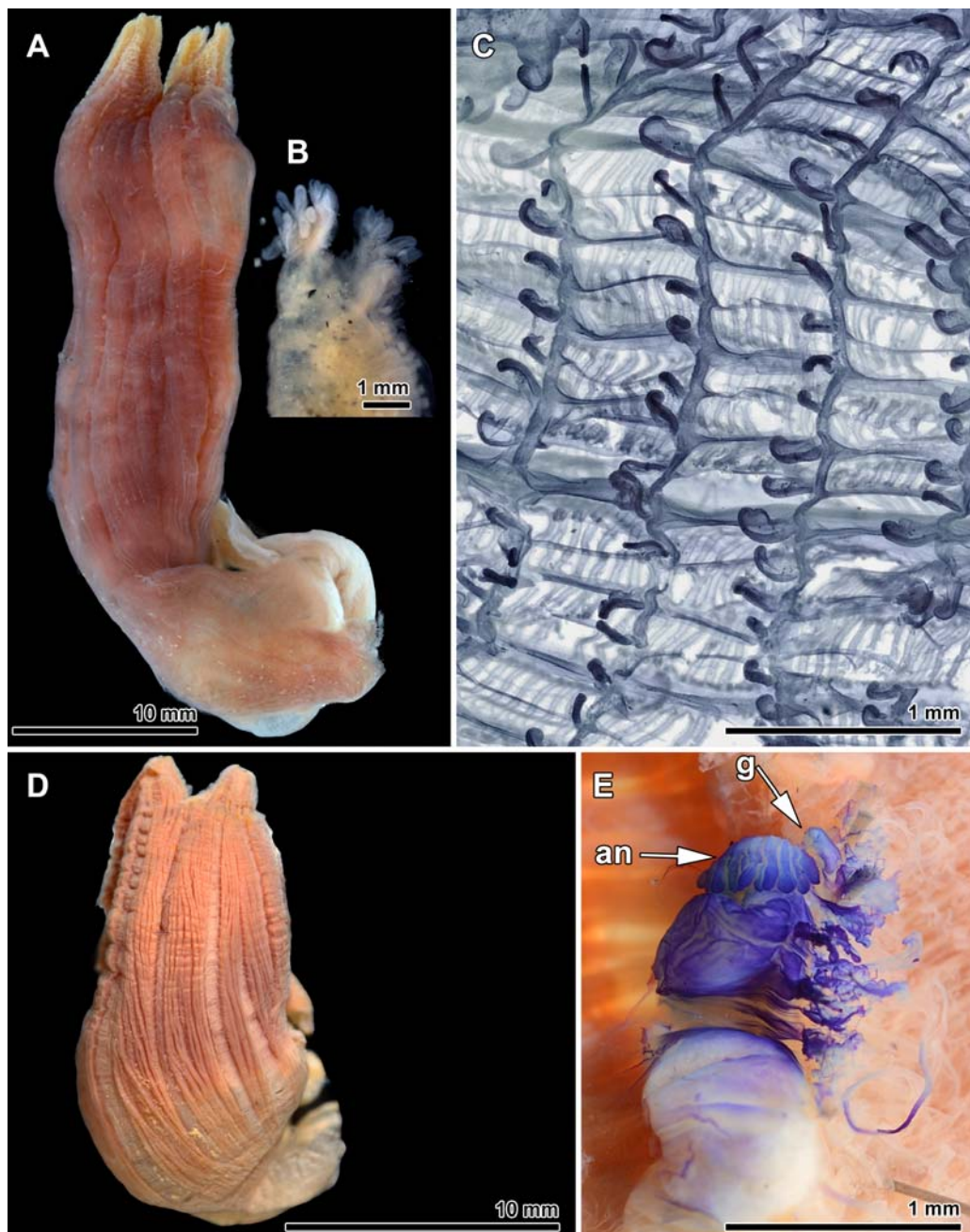


Fig. 47. *Ciona sheikoi*. A — body with test removed; B — finger-shaped lobes around the anal margin; C — branchial sac; D — holotype, test removed; E — dissection showing relative position of anus (an) and genital apertures (g), paratype.

Рис. 47. *Ciona sheikoi*. А — тело с удаленной туникой; В — пальцевидные лопасти вокруг края ануса; С — жаберный мешок; D — голотип, туника удалена; E — вскрытие, показывающее относительное положение ануса (an) и генитального отверстия (g), паратип.

pigmented. Long finger-shaped lobes of the anus may constitute another character distinguishing *C. sheikoi*. According to Hoshino, Tokioka (1967: 285) the anus in *C. robusta* “is plainly margined in a fully extended condition, but in a more or less contracted state the margin is cut into a number of lobules”. It is hard to imagine that finger-like lobes in *C. sheikoi*, which are very distinct in the type material (Fig. 47E and see also Sanamyan, 1998b: Fig. 1F) and recognizable in the present specimen (Fig. 47B), appeared as a result of contraction. Thus, I conclude that *C. sheikoi* is a distinct species. Currently it is known only from a limited area around North Kuril Islands.

Acknowledgments

First of all, I must thank Dr. Vladimir Mordukhovich and Dr. Anastaiia Maiorova (Zhirmunsky National Scientific Center for Marine Biology, Vladivostok) who collected ascidians during cruise 56 of RV *Academic Oparin* in the summer of 2019 and sent me this carefully documented material. There was an unusually large number of species, a fact that prompted me to write this monograph. I also must thank very much Gretchen Lambert who helped a lot with English language in this work and also for some specimens of ascidians which she collected many years ago on the American side of the North Pacific and made these specimens available for me—some were used in the present work as material for comparisons. Finally, all our scientific work would have been impossible without the support of Dr. Alexey Tokranov, the former (unfortunately) director of the Kamchatka Branch of Pacific Geographical Institute. During his directorship he created very good conditions for us (Karen and Nadya Sanamyan) that allowed us to concentrate on our scientific work without any restrictions in selecting the subject for our studies or other limitations and unnecessary duties. This work has not been supported by any grants.

References

- Abbott D.P., Newberry A.T. 1980. Urochordata: the Tunicates // R.H. Morris, D.P. Abbott, E.C. Haderlie (eds.). Intertidal invertebrates of California. Stanford University Press. P.127–226.
- Abbott D.P., Newberry A.T., Morris K.M. 1997. Ascidians (Urochordata) // G. Lambert (ed.). Reef and Shore Fauna of Hawaii. Honolulu: Bishop Museum Press. P.1–64.
- Abbott D.P., Trason W.B. 1968. *Ritterella rubra* and *Distaplia smithi*: two new colonial ascidians from the west coast of North America // Bulletin of the Southern California Academy of Sciences. Vol.67. No.3. P.143–154.
- Apstein C. 1915. Nomina conservanda // Sitzungsbericht der Gesellschaft naturforschender Freunde zu Berlin. Bd.5. S.119–201.
- Bancroft F.W. 1899. Ovogenesis in *Distaplia occidentalis* Ritter (M.S.), with remarks on other species // Bulletin of the Museum of Comparative Zoology. Vol.35. P.59–112.
- Barrande J. 1867. Classe des Mollusques, Ordre des Ptéropodes // Système Silurien des Centre de la Bohême, Part I: Recherches Paléontologiques. Vol.3. P.1–179.
- Benjaminson T.S. 1974. [Ascidians (Asciacea) from the intertidal zone of the Kuril Islands] // Zhirmunsky A.V. (ed.). Rastitel'nyi i zhivotnyi mir litorali Kuril'skikh ostrovov. Novosibirsk: Nauka. P.318–331 [in Russian].
- Benjaminson T.S. 1975a. [Morphology and systematic position of genus *Syncarpa* Redikorzew with description of *Syncarpa corticiformis* sp.n. (Asciacea)] // Biologiya morya. Vol.3. P.29–36 [in Russian].
- Benjaminson T.S. 1975b. [New species of colonial ascidians of the Kuril Islands] // Biologiya morya. Vol.5. P.71–73 [in Russian].
- Berrill N.J. 1950. The Tunicata with an account of the British species. London: Ray Society. 354 p.
- Bjerkan P. 1905. Ascidien von dem norwegischen Fischereidampfer „Michael Sars“ in den Jahren 1900–1904 gesammelt // Bergens Museums Aarbog. Bd.5. S.1–29.
- Blyth E. 1860. Report on some fishes received chiefly from the Sitang River and its tributary streams, Tenasserim Provinces // Journal and Proceedings of the Asiatic Society of Bengal. Vol.29. No.2. P.138–174.
- Bonnevie K. 1896. Ascidiae Simplicis and Ascidiae Compositae. From the North Atlantic-Expedition // The Norwegian North-Atlantic Expedition 1876–1878. Vol.7. No.23. P.1–16.
- Brewin B.J. 1950. Ascidians of New Zealand. Part 5. Ascidians from the East Coast of Great Barrier Island // Transactions of the Royal Society of New Zealand. Vol.78. No.2–3. P.354–362.
- Brewin B.J. 1952. Ascidians of New Zealand, Part 7. Ascidians from Otago coastal waters, Part 2 // Transactions of the Royal Society of New Zealand. Vol.79. No.3/4. P.452–458.
- Brewin B.J. 1953. Australian ascidians of the sub-family Holozoinae and a review of the sub-family // Transactions of the Royal Society of New Zealand. Vol.81. No.1. P.53–64.
- Bronn H.G. 1862. Die Klassen und Ordnungen der Weichthiere (Malacozoa), wissenschaftlich dargestellt in Wort und Bild. C.F. Winter'sche Verlagshandlung. Leipzig und Heidelberg. 518 S.
- Brunetti R. 2007. Nomenclatural Acts: homonymy in the Asciacea (Tunicata) and proposed nomina nova // Zootaxa. Vol.1613. P.67–68.
- Brunetti R., Gissi C., Pennati R., Caicci F., Gasparini F., Manni L. 2015. Morphological evidence that the molecularly determined *Ciona intestinalis* type A and type B are different species: *Ciona robusta* and *Ciona intestinalis* // Journal of Zoological Systematics and Evolutionary Research. Vol.53. No.3. P.186–193.
- Caullery M. 1909. Recherches sur les synascidien du genre *Colella* et considérations sur la famille des Distomidae // Bulletin Biologique de la France et de la Belgique. Vol.42. P.1–59.
- Coldstream J. 1830. Addition to the Natural History of British Animals // Edinburgh Philosophical Journal. Vol.9. P.234–241.

- Copello M., Devos L., Lafargue F. 1981. *Ciona edwardsi* (Roule, 1884) espèce littorale de Méditerranée distincte de *Ciona intestinalis* Linné, 1767 // *Vie Milieu*. Vol.31. No.3–4. P.243–254.
- Cretella M. 2010. The complete collation and dating of the section Zoologie of the Coquille voyage // *Bollettino Malacologico*. Vol.46. P.83–103.
- Della Valle A. 1881. Nuove contribuzioni alla storia naturale delle ascidie composte del Golfo di Napoli // *Atti della Reale Accademia dei Lincei*. Series 3. Vol.10. P.431–498.
- Drasche R. 1884. Über einige neue und weniger bekannte aussereuropäische einfache Ascidien // *Denkschriften der Kaiserlichen Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Classe*. Bd.48. S.369–386.
- Dubois A. 2011. The International Code of Zoological Nomenclature must be drastically improved before it is too late // *Bionomia*. Vol.2. P.1–104.
- Fleming J. 1822. *The Philosophy of Zoology; or a general view of the Structure, Functions, and Classification of Animals*. Vol.2. Edinburgh and London: Archibald Constable & Co., Hurst, Robinson & Co. 618 pp.
- Garstang W. 1891. Note on a new and primitive type of compound ascidian // *The Annals and Magazine of Natural History*. Ser.6. Vol.8. P.265–268.
- Giard A. 1872. Recherches sur les ascidies composées ou synascidies // *Archives de Zoologie Expérimentale et générale*. Vol.1. P.501–704.
- Gill T. 1871. Arrangement of the families of Mollusks // *Smithsonian Miscellaneous Collection*. Vol.227. P.1–49.
- Hancock A. 1870. On the larval state of *Molgula*; with descriptions of several new species of simple ascidians // *The Annals and Magazine of Natural History*. Ser.4 Vol.6. No.35. P.353–368.
- Harant H. 1931. Contributions à l'histoire naturelle des ascidies et de leurs parasites // *Annales de l'Institut Océanographique*. Vol.8. No.4. P.229–389.
- Hartmeyer R. 1899. Die Monascidien der Bremer Expedition nach Ostspitzbergen // *Zoologische Jahrbücher*. Bd.12. S.453–511.
- Hartmeyer R. 1903. Die Ascidien der Arktis // F. Romer, F. Schaudin (Hrsg.). *Fauna arctica. Eine Zusammenstellung der arktischen Tierformen, mit besonderer Berücksichtigung des Spitzbergen-Gebietes auf Grund der Ergebnisse der Deutschen Expedition in das Nördliche Eismeer im Jahre 1898*. Bd.3. No.2. Jena: Gustav Fischer. S.93–412.
- Hartmeyer R. 1909. Zur terminologie der Didemnidae // *Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin*. S.575–581.
- Hartmeyer, R. 1911. Die Ascidien der deutschen Sudpolar-Expedition, 1901–1903 // E. Drygalski (Hrsg.). *Deutsche Südpolar-Expedition 1901–1903*. Vol.12. Zoologie. Berlin: Georg Reiner, S.403–606.
- Hartmeyer R. 1912. Die Ascidien der Deutschen Tiefsee-Expedition // C. Chun (Hrsg.). *Wissenschaftliche Ergebnisse der deutschen Tiefsee-Expedition "Valdivia" 1898–1899*. Bd.16. Jena: Gustav Fischer. S.225–392.
- Hartmeyer R. 1915. *Ascidium nomia conservanda* // *Sitzungsbericht der Gesellschaft naturforschender Freunde zu Berlin*. Bd.6. S.247–258.
- Hartmeyer R. 1924. Ascidiacea. Part 2 // *The Danish Ingolf-Expedition*. Vol.2. No.7. Copenhagen: Bianco Luno. P.1–278.
- Herdman W.A. 1880a. Preliminary Report on the Tunicata of the "Challenger" Expedition. 1. Ascidiadae // *Proceedings of Royal Society of Edinburgh*. Vol.10. No.106. P.458–472.
- Herdman W.A. 1880b. Preliminary Report on the Tunicata of the "Challenger" Expedition. Part 2 // *Proceedings of Royal Society of Edinburgh*. Vol.10. No.107. 714–726.
- Herdman W.A. 1882a. Preliminary Report on the Tunicata of the "Challenger" Expedition. Part 3. Cynthiidae // *Proceedings of Royal Society of Edinburgh*. Vol.11. No.108. P.52–88.
- Herdman W.A. 1882b. Preliminary Report on the Tunicata of the "Challenger" Expedition. Part 4. Molgulidae // *Proceedings of Royal Society of Edinburgh*. Vol.11. No.109. P.233–240.
- Herdman W.A. 1882c. Report on the Tunicata collected during the voyage of H.M.S. Challenger during the years 1873–1876, part 1, Ascidiadae simplices // *Report on the Scientific Results of the Voyage of H.M.S. "Challenger", 1873–1876*. Zoology. Vol.6. No.17. P.1–296.
- Herdman W.A. 1886. Report on the Tunicata collected during the years 1873–1876. Part 2, Ascidiadae compositae // *Report on the Scientific Results of the Voyage of H.M.S. "Challenger", 1873–1876*. Zoology. Vol.14. No.38. P.1–425.
- Herdman W.A. 1891. A revised classification of the Tunicata, with definition of the orders, suborders, families, subfamilies, and genera, and analytical keys to the species // *Zoological Journal of the Linnean Society*. Vol.23. No.148. P.558–652.
- Hoshino Z., Nishikawa T. 1985. Taxonomic studies of *Ciona intestinalis* (L.) and its allies // *Publications of the Seto Marine Biological Laboratory*. Vol.30. P.61–79.
- Hoshino Z., Tokioka T. 1967. An unusually robust *Ciona* from the northeastern coast of Honsyu Island, Japan // *Publications of the Seto Marine Biological Laboratory*. Vol.15. No.4. P.275–290.
- Huntsman A.G. 1912a. Ascidiadae from the coasts of Canada // *Transactions of the Canadian Institute*. 1911. P.111–148. [31 May 1912]
- Huntsman A.G. 1912b. Holosomatous ascidians from the coast of western Canada // *Contributions to Canadian Biology*. 1906–1910. P.103–185. [31 December 1912]
- Huntsman A.G. 1922. The ascidian family Caesiridae // *Proceedings and transactions of the Royal Society of Canada*. Vol.16. P.211–234.
- Huus J. 1937. Ascidiaceae Tethyodeae Seescheiden // W. Kukenthal, T. Krumbach (Hrsg.). *Handbuch der Zoologie*. Bd.5. No.2(6). Berlin, Leipzig: Walter de Gruyter. S.545–672.
- ICZN [International Commission on Zoological Nomenclature]. 1922. Opinion 74. Apstein's (1915) List of Nomina Conservanda // *Smithsonian Miscellaneous Collection*. Vol.73. No.1. 32–34.
- ICZN [International Commission on Zoological Nomenclature]. 1926. Opinion 94. Twenty-two Mollusk and Tunicate names placed in the Official List of Generic Names // *Smithsonian Miscellaneous Collection*. Vol.73. No.4. P.12–13.

- ICZN [International Commission on Zoological Nomenclature]. 1954. Opinion 316. Rejection for nomenclatorial purposes of the Tavola alfabetica delle Conchiglie Adriatiche and Prospetto della Classe dei Vermi of S. A. Renier commonly attributed to the year 1804 // Opinions and Declarations rendered by the International Commission on Zoological Nomenclature. Vol.9. No.5. P.91–106.
- ICZN [International Commission on Zoological Nomenclature]. 1956. Opinion 427. Rejection for nomenclatorial purposes of the work by Renier (S.A.) known as *Tavole per servire alle classificazione e conoscenza degli animali* and commonly attributed to the year 1807 and addition to the *Official Indexes of Rejected and Invalid Names in Zoology* of certain names first used in the foregoing work or in two earlier works by the same author commonly known as the *Tavola alfabetica* and the *Prospetto* respectively and both commonly attributed to the year 1804 // Opinions and Declarations rendered by the International Commission on Zoological Nomenclature. Vol.14. No.11. P.281–310.
- ICZN [International Commission on Zoological Nomenclature]. 1957a. Direction 72. Completion and in certain cases correction of entries relating to the names of genera of the Phyla Mollusca, Brachiopoda, Echinodermata and Chordata made of the Official List of Generic Names in Zoology by Rulings given in Opinions rendered in the period up to the end of 1936 // Opinions and Declarations rendered by the International Commission on Zoological Nomenclature. Vol.1. No.E12. P.163–192.
- ICZN [International Commission on Zoological Nomenclature]. 1957b. Opinion 478. Validation under the plenary powers of the generic name *Polycitor* [Renier], [1804], and of the specific name *crystallinus* [Renier], [1804], as used by the foregoing author in the combination *Polycitor crystallinus* (class Urochorda) (Opinion supplementary to Opinion 427) // Opinions and Declarations rendered by the International Commission on Zoological Nomenclature. Vol.16. No.21. P.353–364.
- ICZN [International Commission on Zoological Nomenclature]. 1978. Tethyidae in Gastropods, Sponges and Ascidians: proposals to remove the homonymy. Z.N.(S.) 1780 // Bulletin of Zoological Nomenclature. Vol.34. No.4. P.247–251.
- ICZN [International Commission on Zoological Nomenclature]. 1997. Opinion 1865. *Eudistoma* Caullery, 1909 (Tunicata): given precedence over *Paessleria* Michaelsen, 1907 // Bulletin of Zoological Nomenclature. Vol.54. No.1. P.70–71.
- ICZN [International Commission on Zoological Nomenclature]. 1999 // International code of zoological nomenclature. Fourth edition. London: International trust for zoological nomenclature. 306 pp.
- ICZN [International Commission on Zoological Nomenclature]. 2012. Amendment of Articles 8, 9, 10, 21 and 78 of the International Code of Zoological Nomenclature to expand and refine methods of publication // ZooKeys Vol.219. P.1–10.
- Ivanova-Kazas O.M. 1965. [Asexual reproduction of ascidian *Distaplia unigermis*] // Vestnik Leningradskogo Universiteta. Vol.15. P.44–59 [in Russian].
- Kesteven H.L. 1909. Studies on Tunicata no. 1 // Proceedings of the Linnean Society of New South Wales. Vol.34. P.276–295.
- Kott P. 1957. The ascidians of Australia. 2. Aplousobranchiata Lahille: Clavelinidae Forbes & Hanley and Polyclinidae Verrill // Australian Journal of Marine and Freshwater Research. Vol.8. No.1. P.64–110.
- Kott P. 1963. The ascidians of Australia. 4. Aplousobranchiata Lahille: Polyclinidae Verrill (continued) // Australian Journal of Marine and Freshwater Research. Vol.14. No.1. P.70–118.
- Kott P. 1969. Antarctic ascidiacea // Antarctic Research Series. Vol.13. P.1–239.
- Kott P. 1981. The ascidians of the Reef Flats of Fiji // Proceedings of the Linnean Society of New South Wales. Vol.105. No.3. P.147–212.
- Kott P. 1983. Two new genera of didemnid Ascidians from tropical Australian waters // The BEAGIE Occasional Papers of the Northern Territory Museum of Arts and Sciences. Vol.1. No.2. P.13–19.
- Kott P. 1985. The Australian Ascidiacea part 1, Phlebobranchia and Stolidobranchia // Memoirs of the Queensland Museum. Vol.23. P.1–440.
- Kott P. 1990. The Australian Ascidiacea, part 2, Aplousobranchia (1) // Memoirs of the Queensland Museum. Vol.29. No.1. P.1–226.
- Kott P. 1992. The Australian Ascidiacea part 3, Aplousobranchia (2) // Memoirs of the Queensland Museum. Vol.32. No.2. P.375–620.
- Kott P. 1998. Tunicata // A. Wells, W.W.K. Houston (eds.). Zoological Catalogue of Australia. Vol.34. Hemichordata, Tunicata, Cephalochordata. Melbourne: CSIRO Publishing. P.51–252.
- Kott P. 2001. The Australian Ascidiacea Part 4, Aplousobranchia (3), Didemnidae // Memoirs of the Queensland Museum. Vol.47. No.1. P.1–407.
- Kott P. 2003. New syntheses and new species in Australian Ascidiacea // Journal of Natural History. Vol.37. No.13. P.1611–1653.
- Kott P. 2005. Catalogue of Tunicata in Australian waters // Brisbane: Australian Biological Resources Study. 306 pp. [CD-ROM publication, available from Australian Biological Resources Study].
- Kott P. 2007. Taxonomic affinities of three stalked colonial species of the Ascidiacea (Tunicata) from the central coast of New South Wales and indication of trans-Tasman connection // Journal of Natural History. Vol.41. No.9–12. P.633–645.
- Kott P. 2008a. Ascidiacea (Tunicata) from deep waters of the continental shelf of Western Australia // Journal of Natural History. Vol.42. No.15–16. P.1103–1217.
- Kott P. 2008b. Ciallusiidae (Ascidacea, Tunicata), a monotypic family from deeper waters of the tropical Indo-West Pacific // Zootaxa. Vol.1742. P.47–52.
- Kott P. 2009. Taxonomic revision of Ascidiacea (Tunicata) from the upper continental slope off north-western Australia // Journal of Natural History. Vol.43. No.31–32. P.1947–1986.
- Lahille M.F. 1886. Sur la classification des tuniciers // Comptes rendus hebdomadaires des séances de l'Académie des Sciences. T.102. P.1573–1575.
- Lahille M.F. 1887. Faune ascidiologique de Banyuls // Bull. Société d'Histoire Naturelle de Toulouse. T.21. P.LVII–LXII.

- Lahille M.F. 1888. Etude systématique des Tuniciers // Compte Rendu de la Association Française pour l'Avancement des Sciences. T.1887(2). P.667–677.
- Lahille M.F. 1890. Recherches sur les Tuniciers des côtes de France. Toulouse: Imprimerie Lagarde et Sebillé. 330 p.
- Lambert G. 2003. New records of ascidians from the NE Pacific: a new species of *Trididemnum*, range extension and redescription of *Aplidiopsis pannosum* (Ritter, 1899) including its larva, and several non-indigenous species // *Zoosystema*. Vol.25. No.4. P.665–679.
- Lambert G. 2019. The Ascidiacea collected during the 2017 British Columbia Hakai MarineGEO BioBlitz // *Zootaxa*. Vol.4657. No.3. P.401–436.
- Lambert G., Sanamyan K. 2001. *Distaplia alaskensis* sp.nov. (Asciacea, Aplousobranchia) and other new ascidian records from south-central Alaska, with a redescription of *Ascidia columbiana* (Huntsman, 1912) // *Canadian Journal of Zoology*. Vol.79. P.1766–1781.
- Lesson R.P. 1831. Voyage autour du monde, exécuté par ordre du Roi, sur la corvette La Majesté, La Coquille, pendant les années 1822, 1823, 1824 et 1825. *Zoologie*. Vol. 2(1). Livraison 26. Paris: Arthus Bertrand. P.241–471. [Published 22 December 1831].
- Linnaeus C. 1767. *Systema naturae per regna tria naturae: secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. Tom 1, Pars 2, Ed. 12. Regnum Animale. Holmiae: Laurentii Salvii. 1327 p.
- Mastrototaro F., Montesanto F., Salonna M., Viard F., Chimienti G., Trainito E., Gissi C. 2020. An integrative taxonomic framework for the study of the genus *Ciona* (Asciacea) and description of a new species, *Ciona intermedia* // *Zoological Journal of the Linnean Society*. Vol.20. P.1–24.
- Michaelsen W. 1904. Revision der compositen Styeliden oder Polyzoen // *Zum Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten*. Bd.21. H.2. S.1–124.
- Michaelsen W. 1907. *Tunicaten // Ergebnisse der Hamburger Magalhaensischen Sammelreise, 1892/1893*. Band 1. Allgemeines, Chordonier, Echinodermen und Coelenteraten. Hamburg: L. Friederichsen & Co. S.1–84.
- Michaelsen W. 1921. *Ascidiae Krikobranhiae des Roten Meeres: Clavelinidae und Synoicidae* // *Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenschaftliche Klasse*. Bd.97. H.9. S.1–38.
- Michaelsen W. 1924. *Ascidiae Krikobranhiae von Neuseeland, den Chatham und den Auckland Inseln // Videnskabelige Meddelelser fra Dansk naturhistorisk Forening i København*. Bd.77. S.263–264.
- Michaelsen W. 1930. *Ascidiae Krikobranhiae // Fauna Sudvest-Australiensis*. Vol.5. P.461–558.
- Mikuláš R. 1992. Trace fossils from Early Silurian graptolitic shales of the Prague Basin (Czechoslovakia) // *Casopis pro Mineralogii a Geologii*. Vol.37. No.3. P.219–228.
- Millar R.H. 1960. *Asciacea // Discovery Reports*. No.30. P.1–159.
- Millar R.H. 1963. Australian ascidians in the British Museum (Natural History) // *Proceedings of the Zoological Society of London*. Vol.141. No.4. P.689–746.
- Millar R.H. 1966. *Tunicata Ascidiacea*. Marine invertebrates of Scandinavia. 1. Oslo: Scandinavian University Book. 123 p.
- Millar R.H. 1988. Ascidians collected during the International Indian Ocean Expedition // *Journal of Natural History*. Vol.22. P.823–848.
- Milne-Edwards H. 1842. Observation sur les Ascidies composées des cotes de la Manche // *Mémoires de l'Académie de Sciences de l'Institut de France*. T.18. P.217–326.
- Monniot C. 1991. *Ascidies de Nouvelle-Calédonie*. 8. Phlébobranches (suite) // *Bulletin du Muséum national d'Histoire naturelle*. 4 série. Vol.12. Ser.A. No.3–4. P.491–515.
- Monniot C., Monniot F. 1973. *Ascidies abyssales récoltées au cours de la campagne océanographique Biaçores par le 'Jean Charco'* // *Bulletin du Muséum national d'Histoire naturelle*. 3 série. Vol.93(121). P.389–475.
- Monniot C., Monniot F. 1977. *Tuniciers benthiques profonds du Nord-Est Atlantique. Résultats des campagnes Biogas* // *Bulletin du Muséum national d'Histoire naturelle*. 3 série. Vol.323(466). P.695–719.
- Monniot C., Monniot F. 1982. Some Antarctic deep-sea tunicates in the Smithsonian collections // *Antarctic Research Series*. Vol.32. P.95–130.
- Monniot C., Monniot F. 1984. *Tuniciers benthiques récoltés au cours de la campagne Abyplaine au large de Madère* // *Annales de l'Institut océanographique*. Nouvelle série. Vol.60. No.2. P.129–142.
- Monniot C., Monniot F. 1988. Some bathyal ascidians from the New Zealand area // *New Zealand Journal of Zoology*. Vol.14. No.3. P.399–407.
- Monniot C., Monniot F. 1989. *Ascidians collected around the Galapagos islands using the Johnson-Sea-Link research submersible* // *Proceedings of the Biological Society of Washington*. Vol.102. No.1. P.14–32.
- Monniot F. 1987. *Ascidies de Nouvelle-Calédonie*. 3. Polyclinidae du lagon // *Bulletin du Muséum national d'Histoire naturelle*. 4 série. Vol.A9. No.3. P.499–535.
- Monniot F. 2012. Some ascidians from the southern coast of Madagascar collected during the "AtimoVatae" survey // *Zootaxa*. Vol.3197. P.1–42.
- Monniot F., Monniot C. 2008. Compléments sur la diversité des ascidies (Asciacea, Tunicata) de l'ouest Pacifique tropical // *Zoosystema*. Vol.30. No.4. P.799–872.
- Monniot F., Tatián M. 2020. Questions on the taxonomic status of species of *Protoholozoa* Kott 1969 (Asciacea, Aplousobranchia, Holozoidae) with a description of a new genus // *Zootaxa*. Vol.4718. No.2. P.261–268.
- Neave S.A. 1939. *Nomenclator Zoologicus* Vol.II. London: Zoological Society of London. 1025 p.
- Neave S.A. 1940. *Nomenclator Zoologicus* Vol.IV. London: Zoological Society of London. 758 p.
- 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 // *Proceedings of the Japanese Society of Systematic Zoology*. Vol.29. P.37–56.
- Nishikawa T. 1990. The ascidians of the Japan Sea 1 // *Publications of the Seto Marine Biological Laboratory*. Vol.34. No.4/6. P.73–148.

- Nishikawa T. 1991. The ascidians of the Japan Sea 2 // Publications of the Seto Marine Biological Laboratory. Vol.35. No.1/3. P.25–170.
- Nishikawa T. 1992. The ascidians of the Japan Sea. III // Publications of the Seto Marine Biological Laboratory. Vol.35. No.6. P.303–334.
- Nott J. 1892. On the compositae ascidians of the North Shore Reef // Transaction and Proceedings New Zealand Institute. Vol.24. P.305–332.
- Nydam M.L., Harrison R.G. 2010. Polymorphism and divergence within the ascidian genus *Ciona* // Molecular Phylogenetics and Evolution. Vol.56. P.718–726.
- Oka A. 1926. Sur un genre nouveau d' Ascidies Simple ("*Corelloides*" nov. gen.) // Proceedings of the Imperial Academy Japan. Vol.2. No.2. P.67–68.
- Oka A. 1927. Zur Kenntnis der japanischen Botryllidae (Vorlaufige Mitteilung) // Proceedings of the Imperial Academy Japan. Vol.3. P.607–609.
- Oka A. 1933. Über *Sigillinaria*, eine neue Synascidien Gattung aus Nordpazifik // Proceedings of the Imperial Academy Japan. Vol.9. No.2. 78–81.
- Pallas P.S. 1774. Spicilegia zoologica, quibus novae imprimis et obscurae animalium species iconibus, descriptionibus atque commentariis illustrantur. Fasciculus 9. Berolini: August Lange. 52 p.
- Pallas P.S. 1788. Marina varia nova et rariora // Nova Acta Academiae Scientiarum Imperialis Petropolitanae. Vol.2. P.229–249.
- Pérès J.M. 1956. Etudes sur le seuil Sieulo-Tunisien. 2. Ascidies // Annales de l'Institut océanographique. Vol.32. No.2. P.265–304.
- Phipps C.J. 1774. A Voyage towards the North Pole undertaken by His Majesty's Command. London: Bowyer and Nichols. 253 p.
- Redikorzev V. 1910. [Ascidians of Arctic seas] // Trudy Sankt-Peterburgskogo Obschestva Estestvoispytatelei. Vol.16. No.2. P.87–175 [in Russian].
- Redikorzev V. 1911a. Zwei neue *Zelyosoma*-Arten // Annuaire du Musée Zoologique de l'Académie Impériale des Sciences de St. Pétersbourg. Vol.16. S.143–151.
- Redikorzev V. 1911b. Neue Ascidien // Annuaire du Musée Zoologique de l'Académie Impériale des Sciences de St. Pétersbourg. Vol.16. S.215–218.
- Redikorzev V. 1913. Neue Ascidien // Zoologischer Anzeiger. Bd.43. S.204–213.
- Redikorzev V. 1916a. [Tunicata (Tunicata). Livraison 1] // Fauna Rossii i prolezhshchikh stran. Petrograd: A. Benke. 339 p. [In Russian with Latin diagnoses]
- Redikorzev V. 1916b. A new species of the genus *Dianthrocarpa* // Annuaire du Musée Zoologique de l'Académie Impériale des Sciences de St. Pétersbourg. Vol.21. P.31–33.
- Redikorzev V. 1927a. Zehn neue ascidien aus dem Fernen Osten // Zoologische Jahrbücher. Bd.53. S.373–404.
- Redikorzev V. 1927b. Eine neue Ascidie // Festschrift für Prof. N.M. Knipowitsch 1885–1925. Moscow: Izdatelstvo Narodnogo komissariata zemledelia RSFSR. S.351–353.
- Redikorzev V. 1937. Neue Ascidien aus den Fernen Osten // Festschrift zum 60. Geburtstage von Professor Dr. Embrik Strand. Vol.3. Riga. S.122–127.
- Redikorzev V. 1941. [Ascidien der Meere des Fernen Osten der Ud.S.S.R.] // Issledovaniya Dal'nevostochnyh morei SSSR. Vol.1. P.164–212 [in Russian with German descriptions].
- Renier S.A. 1804. Prospetto della classe dei Vermi pp. XV–XXVII. [Rejected for nomenclatural purposes as being not duly published].
- Ritter W.E. 1899. A contribution to the knowledge of the Tunicata of the Pribilof Islands // D.S. Jordan (ed.). Fur seals and fur-seal islands of the north Pacific ocean. Part 3. Washington: Government Printing Office. P.511–537.
- Ritter W.E. 1901. The ascidians. Papers from Harriman Alaska expedition // Proceedings of the Washington Academy of Sciences. Vol.3. P.225–266.
- Ritter W.E. 1907. The ascidians collected by the United States Fisheries Bureau steamer Albatross on the coast of California during the summer of 1904 // University of California publications in zoology. Vol.4. P.1–52.
- Ritter W.E., Forsyth R.H. 1917. Ascidian of the littoral zone of southern California // University of California publications in zoology. Vol.16. P.439–512.
- Romanov V.N. 1974. [Didemnidae (Ascidiae) of sublittoral zone of Iturup Island (Kuril Islands)] // Zoologicheskyy Zhurnal. Vol.53. No.2. P.237–243 [in Russian].
- Romanov V.N. 1977. [Ascidians Didemnidae from intertidal zone of Kuril and Commander Islands] // Biologia Morya. Vol.2. P.51–62 [in Russian].
- Romanov V.N. 1989. [Colonial ascidians of the family Didemnidae from the seas of the USSR and adjacent waters] // Fauna SSSR. New series. Obolochniki. Vol.1. No.1. Leningrad: Nauka. 226 p. [In Russian with English descriptions]
- Roule M. 1884. Sur deux nouvelles espèces d'Ascidies simples (famille des Phallusiadées) // Comptes rendus hebdomadaire des séances de l'Académie des sciences. T.99. P.613–614.
- Sanamyan K. 1992. Ascidians from the Sea of Okhotsk collected by R.V. "Novoulyanovsk" // Ophelia. Vol.36. No.3. P.187–197.
- Sanamyan K. 1993a. Ascidians from the North-Western Pacific region. 1. Polycitoridae // Ophelia. Vol.37. No.3. P.163–173.
- Sanamyan K. 1993b. *Pseudoplacentela smirnovi* gen. et sp.n. (Tunicata, Ascidiacea), with a discussion of its phylogenetic relationships // Zoologica Scripta. Vol.22. No.3. 305–307.
- Sanamyan K. 1993c. Ascidians from the North-Western Pacific region. 2. Molgulidae // Ophelia. Vol.38. No.2. P.127–135.
- Sanamyan K. 1996. Ascidians from the North-Western Pacific region. 3. Pyuridae // Ophelia. Vol.45. No.3. P.199–209.
- Sanamyan K. 1998a. Ascidians from the North-Western Pacific region. 4. Polyclinidae and Placentelidae // Ophelia. Vol.48. No.2. P.103–135.
- Sanamyan K. 1998b. Ascidians from the North-Western Pacific region. 5. Phlebobranchia // Ophelia. Vol.49. No.2. P.97–116.
- Sanamyan K. 1999. Ascidians from the North-Western Pacific region. 6. Didemnidae // Ophelia. Vol.51. No.2. 143–161.
- Sanamyan K. 2000a. Three related *Aplidium* species from the Southern Kurile Islands (Ascidacea: Polyclin-

- idae // Zoosystematica Rossica. Vol.8 (for 1999). No.2. P.211–216.
- Sanamyan K. 2000b. Ascidians from the North-Western Pacific region. 7. Styelidae // Ophelia. Vol.53. No.1 P.67–78.
- Sanamyan K., Sanamyan N. 2007. Poorly known Ascidiacea collected in the vicinity of the Commander Islands and East Kamchatka, NW Pacific // Zootaxa. Vol.1579. P.55–68.
- Sanamyan K., Sanamyan N. 2010. [Ascidians (Tunicata: Ascidiacea) of the coastal waters of the Starichkov Island] // K. Sanamyan, N. Sanamyan, A. Tokranov, O. Cherniagina (eds). Biota ostrova Starichkov i priliegayushchei k nemu akvatorii Avachinskogo zaliva. Trudy Kamchatskogo filiala Tihookeanskogo instituta geografii DVO RAN. Vypusk 8. Petropavlovsk-Kamchatsky: Kamchatpress. P.241–249 [in Russian].
- Sanamyan K., Sanamyan N. 2011. Shallow-water species of the genus *Aplidium* (Ascidiacea) from Kamchatka and Commander Islands // Zootaxa. Vol.2922. P.41–50.
- Sanamyan K., Sanamyan N. 2017a. Shallow-water Ascidiaceans from Matua Island (central Kuril Islands, NW Pacific) // Zootaxa. Vol.4232. No.3. P.301–321.
- Sanamyan K., Sanamyan N. 2017b. Shallow-water Ascidiaceans from Matua Island (central Kuril Islands, NW Pacific), part 2 // Zootaxa. Vol.4337. No.1. P.121–131.
- Sanamyan K., Sanamyan N. 2020. [Ascidiaceans (tunicates of class Ascidiacea)] // Sanamyan K., Sanamyan N. (ed.). Flora i fauna ostrova Matua (srednie Kuril'skie ostrova): atlas-opredelitel'. Tom 1. More. Cherepovets: OOO "Intron". P.276–315 [in Russian].
- Sanamyan K., Schories D., Sanamyan N. 2010. New records of aplousobranch ascidiaceans from Central Chile // Zootaxa. Vol.2537. P.58–68.
- Sars M. 1851. Beretning om en i Sommeren 1849 foretagen zoologisk Reise i Lofoten og Finmarken // Nyt Magazin for Naturvidenskaberne. Bd.6. S.121–211.
- Savigny J.C. 1816. Mémoires sur les animaux sans vertèbres. Part 2. Paris: G. Dufour. 239 p.
- Seeliger O. 1907. Appendicularien und Ascidien, Tunicata. Manteltiere // H.G. Bronn (Hrsg.). Klassen und Ordnungen des Tier-Reichs. Bd.3. Supplement. Leipzig: C.F. Winter. S.1121–1773.
- Seo S.Y., Rho B.J. 2016. First Record of *Synoicum clavatum* (Ascidiacea: Aplousobranchia: Polyclinidae) from Korea // Animal Systematics, Evolution and Diversity. Vol.32. No.1. P.60–62.
- Skalkin V.A. 1957. [A new species of ascidia of the Pacific – *Syncarpa longicaudata*, sp. n. (fam. Styelidae)] // Zoologicheski Zhurnal. Vol.36. No.2. P.297–299 [in Russian].
- Sluiter C.P. 1895. Tunicaten // R. Semon (Hrsg.). Zoologische Forschungsreisen in Australien und den Malayischen Archipel. Denkschriften der Medicinisch-Naturwissenschaftlichen Gesellschaft zu Jena. Bd.8. Jena: Verlag Von Gustav Fischer. S.163–186.
- Sluiter C.P. 1900. Tunicaten aus dem Stillen Ozean // Zoologische Jahrbücher. Bd.11. S.1–64.
- Sluiter C.P. 1904. Die Tunicaten der Siboga-Expedition. Part 1. Die socialen und holosomen Ascidien // Siboga Expedition. Bd.56a. S.1–126.
- Tokioka T. 1953. Ascidiaceans of Sagami Bay. Tokyo: Iwanami Shoten. 315 p.
- Tokioka T. 1954a. Contribution to Japanese ascidian fauna. 8. Sporadic memorandum (1) // Publications of the Seto Marine Biological Laboratory. Vol.3. No.1. P.67–68.
- Tokioka T. 1954b. Contribution to Japanese ascidian fauna. 9. Re-description of Oka's species found in "Figuraro de Japanaj Bestoj" // Publications of the Seto Marine Biological Laboratory. Vol.4. No.1. 69–74.
- Tokioka T. 1955. Contribution to Japanese ascidian fauna. 11. Sporadic memoranda // Publications of the Seto Marine Biological Laboratory. Vol.4. No.2–3. P.205–218.
- Tokioka T. 1958. Contribution to Japanese ascidian fauna. 12. Sporadic memoranda // Publications of the Seto Marine Biological Laboratory. Vol.6. No.3. P.313–326.
- Tokioka T. 1959. Contribution to Japanese ascidian fauna. 13. Sporadic memoranda (4) // Publications of the Seto Marine Biological Laboratory. Vol.7. No.2. 223–236.
- Tokioka T. 1960. Contribution to Japanese ascidian fauna. 16. On some ascidiaceans from the northern waters of Japan and the neighboring subarctic waters // Publications of the Seto Marine Biological Laboratory. Vol.8. No.1. P.191–204.
- Tokioka T. 1962. Contribution to Japanese ascidian fauna. 19. Addition to Japanese ascidian fauna, with notes on two already known species // Publications of the Seto Marine Biological Laboratory. Vol.10. No.2. P.259–282.
- Tokioka T. 1967. Pacific Tunicata of the United States National Museum // United States National Museum Bulletin. Vol.251. P.1–247.
- Tokioka T. 1968. Contribution to Japanese ascidian fauna. 24. On *Sigillinaria clavata* Oka, 1933 // Publications of the Seto Marine Biological Laboratory. Vol.11. P.131–156.
- Van Name W.G. 1910. Compound ascidiaceans of the coasts of New England and neighboring British provinces // Proceedings of the Boston Society of Natural History. Vol.34. P.339–424.
- Van Name W.G. 1918. Ascidiaceans from the Philippines and adjacent waters // Bulletin United States National Museum. Vol.100. No.1. P.49–174.
- Van Name W.G. 1945. The North and South American ascidiaceans // Bulletin of the American Museum of Natural History. Vol.84. P.1–476.
- Verrill A.E. 1871. Descriptions of some imperfectly known and new ascidiaceans from New England // American Journal of Science and Arts. Series 3. Vol.1. No.1–6, P.54–58, 93–100, 211–212, 288–294, 443–446.
- Zvyagintsev D., Sanamyan K., Kashenko S.D. 2007. On the Introduction of the Ascidian *Ciona savignyi* Herdman, 1882 into Peter the Great Bay, Sea of Japan // Russian Journal of Marine Biology. Vol.33. No.2. P.133–136.

Responsible editor K.G. Mikhailov