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## Bryozoa of the Caspian Sea

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**Abstract**—Five bryozoan species of the class Gymnolaemata and a single *Plumatella emarginata* species of the class Phylactolaemata are found in the Caspian Sea. The class Gymnolaemata is represented by bryozoans of the orders Ctenostomatida (*Amathia caspia*, *Paludicella articulata*, and *Victorella pavidata*) and Cheilostomatida (*Conopeum grimmi* and *Lapidosella ostroumovi*). Two species (*Conopeum grimmi* and *Amathia caspia*) are Caspian endemics. *Lapidosella ostroumovi* was identified in the Caspian Sea for the first time. The systematic position, illustrated morphological descriptions, and features of ecology of the species identified are presented.

**Keywords:** Caspian Sea, Bryozoa, endemic fauna, first record

**DOI:** 10.1134/S199508292001006X

### INTRODUCTION

Brackish-water bryozoans of the Caspian Sea are unique. Species from the most abundant infraorder Ascophora (order Cheilostomatida), which are common in the world's oceans, are completely absent from the Caspian Sea fauna.

Kovalevskii (1870) published the first reliable report on the Caspian Sea bryozoans, and the Baku Gulf and the southern part of the sea were studied by Grimm (1874). According to the most recent review (Abrikosov, 1969) based on the illustrations from (Prenant and Bobin, 1966), two of the four bryozoan species found in the brackish waters of the Caspian Sea (*Bowerbankia imbricata* auct. and *B. gracilis* auct., which are probably species of the presently recognized *Amathia caspia*) were conventionally regarded as Holocene invaders, whereas *V. pavidata* auct. was considered an autochthonous species. According to Abrikosov (1959b), the brackish-water genus *Victorella* originates from water bodies of the Tertiary period. These data are largely illustrative of the insufficiency of research data on Caspian Sea bryozoans rather than of invasion intensity. Comprehensive descriptions of bryozoan species of the Caspian Sea with illustrations that would reflect the modern data in the sea fauna are currently unavailable.

The aim of the present study was to perform an inventory of the bryozoan fauna of the Caspian Sea with the modern research method and report it using the modern nomenclature.

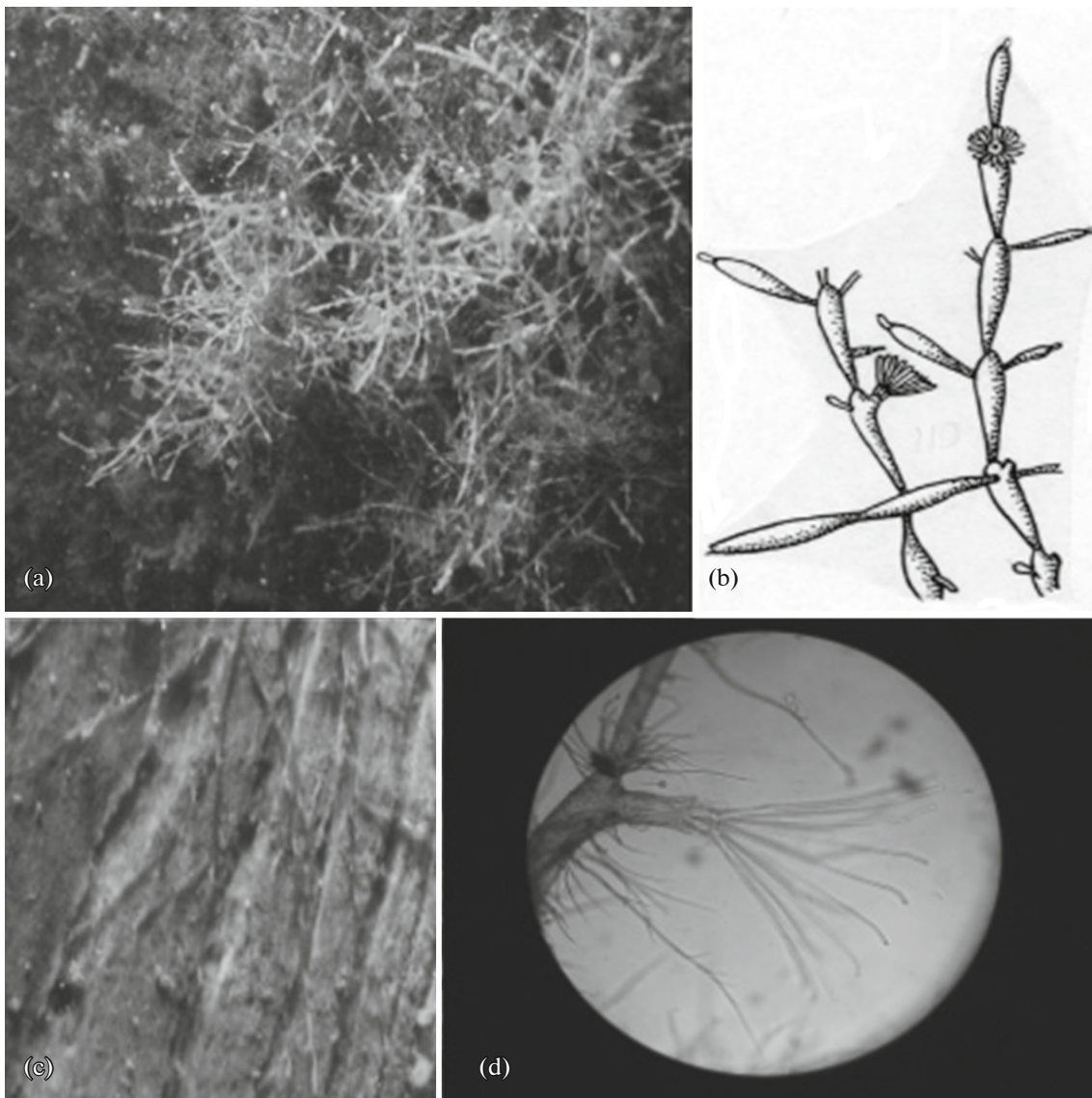
### MATERIALS AND METHODS

This study is based on an analysis of published data and materials that were mostly collected in the northern part of the Caspian Sea (>2500 samples) in 1981–1988 (Tarasov, 1998, 1999), except for the 533 samples collected by G.M. Pyatakova in the middle and southern part of the sea in 1960–1974. Collections of Caspian Sea bryozoans assembled by researchers from the Institute of Zoology, RAS (St Petersburg), T.G. Tarasov (TEK Ecology Center, Moscow, Russia), and N.Sh. Shamionova (Institute of Zoology, National Academy of Sciences of Azerbaijan, Baku) were analyzed.

Bryozoan samples were analyzed by light microscopy and scanning electron microscopy at the Institute of Zoology, RAS. Original illustrations are provided for all species encountered. The samples used for analyzing the colony and autozoid morphology were treated with Javel water (a solution of potassium hypochlorite and chloride,  $KOCl + KCl$ ), washed with water, and air-dried. A colony fragment was coated with platinum (to a 30-nm-thick layer) and analyzed in a FEI Quanta 250 electron microscope (Balashov and Leonovich, 1984). The type material is preserved at the Institute of Zoology, RAS (St Petersburg).

### RESULTS AND DISCUSSION

According to our results and published data (Abrikosov and Zevina, 1968; Gontar' et al. 2009; Kasaei et al., 2017), the Caspian Sea is inhabited by brackish-water species of the order Cheilostomatida (*Conopeum grimmi* Gontar et Tarasov and *Lapidosella*



**Fig. 1.** *Paludicella articulata*: (a, c) colonies of different shapes, (b) autozoid shape, and (d) tentacles and a septum between daughter and parent autozooids.

*ostroumovi* Gontar first identified in 2016) and order Ctenostomatida (*Amatia caspia* (Abrikosov), the widespread *Victorella pavidata* S. Kent, and freshwater *Paludicella articulata* (Ehrenberg)). The freshwater bryozoan *Plumatella emarginata* Allman is found in the northern Caspian Sea. The systematic position, morphological descriptions, distribution, and features of ecology of the species identified are presented below.

Class Gymnolaemata Allman, 1856

Order Ctenostomatida Busk, 1952

Family Paludicellidae Allman, 1885.

Genus *Paludicella* Gervais, 1836.

***Paludicella articulata*** (Ehrenberg, 1810) (Fig. 1)

Abrikosov, 1959b: 698.

**Diagnosis.** Colonies brownish or yellowish-brownish, strongly branched, up to 10 cm in size. Partly attached to the substrate, partly forming vertical or hanging branches. Autozooids very thin, transparent, of 250–450  $\mu\text{m}$  in size. The autozoid cystid is spindle-shaped, and the orifice is tetragonal. The tubelike autozooids can be creeping or erect, and they are separated by internal septa. The zooids can branch from each other at an acute or nearly straight angle (Fig. 1b). Stolons not found. Autozoid cuticle chitinized. Calcareous particles sometimes found on the cystids. Epistome not found. The tentacles form a ring; tentacle number ranges from 10 to 23. New autozooids bud from parent autozooids, and incomplete transverse septa are formed between them (Fig. 1d). Lateral buds can be formed on the opposite sides of each autozoid;

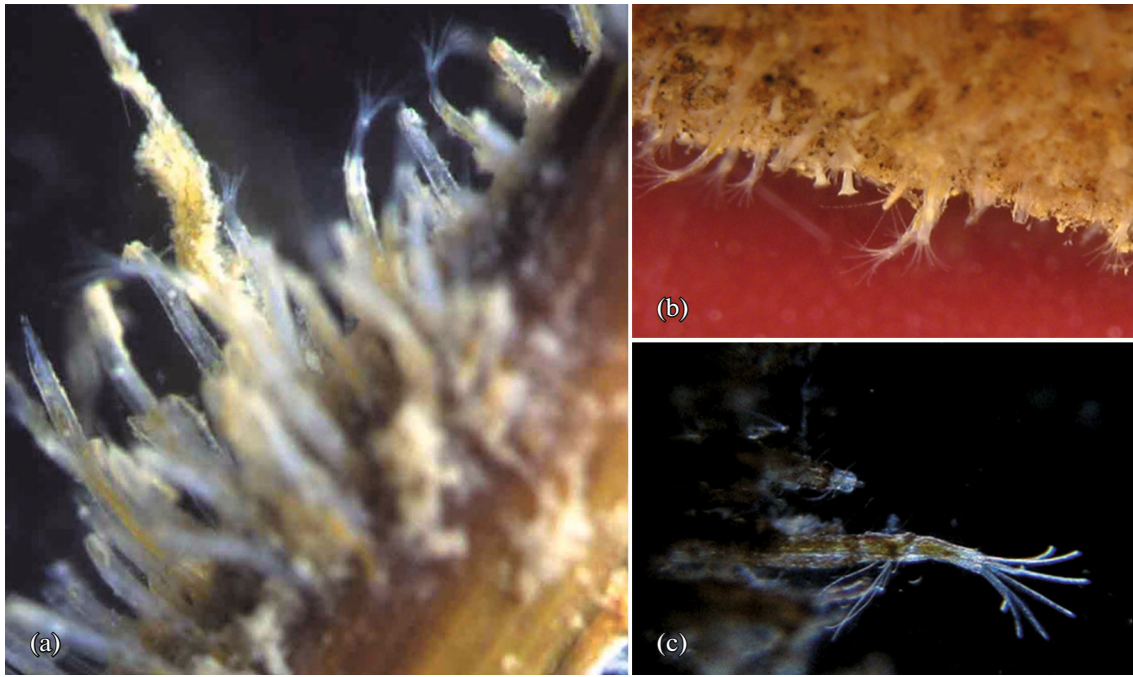


Fig. 2. *Victorella pavidus*. (a) colony, (b) vertical zooids, and (c) zooid with eight tentacles.

the angle between these buds and the main axis is nearly straight. The species forms chitinaceous hibernacula of a brownish color and irregular shape, which persist after the death of a colony.

**Distribution.** The species was found in the sea crust of ships in the Volga River and the northern part of the Caspian Sea within the basin analyzed (Abrikosov, 1959b).

**Ecology.** As reported by Abrikosov (1959b), *P. articulata* was found on rocks and wood debris in clear water at depths of <20 m (usually at sites with linear or vortex flow) in the northern part of the Caspian Sea. The colony grows in areas devoid of silt. The freshwater species can tolerate salinity of up to  $\leq 5\%$ .

Family Victorellidae Hincks, 1880

Genus *Victorella* S. Kent, 1870

*Victorella pavidus* S. Kent, 1870 (Fig. 2).

*Farella repens* Kovalevskii, 1870; Prenant et Bobin, 1966; *Laguncula repens* Grimm, 1875, 1876: 118, table IV, fig. 5–5b; Derzhavin, 1951; Abrikosov, 1959b: 695–698 (Fig. 1).

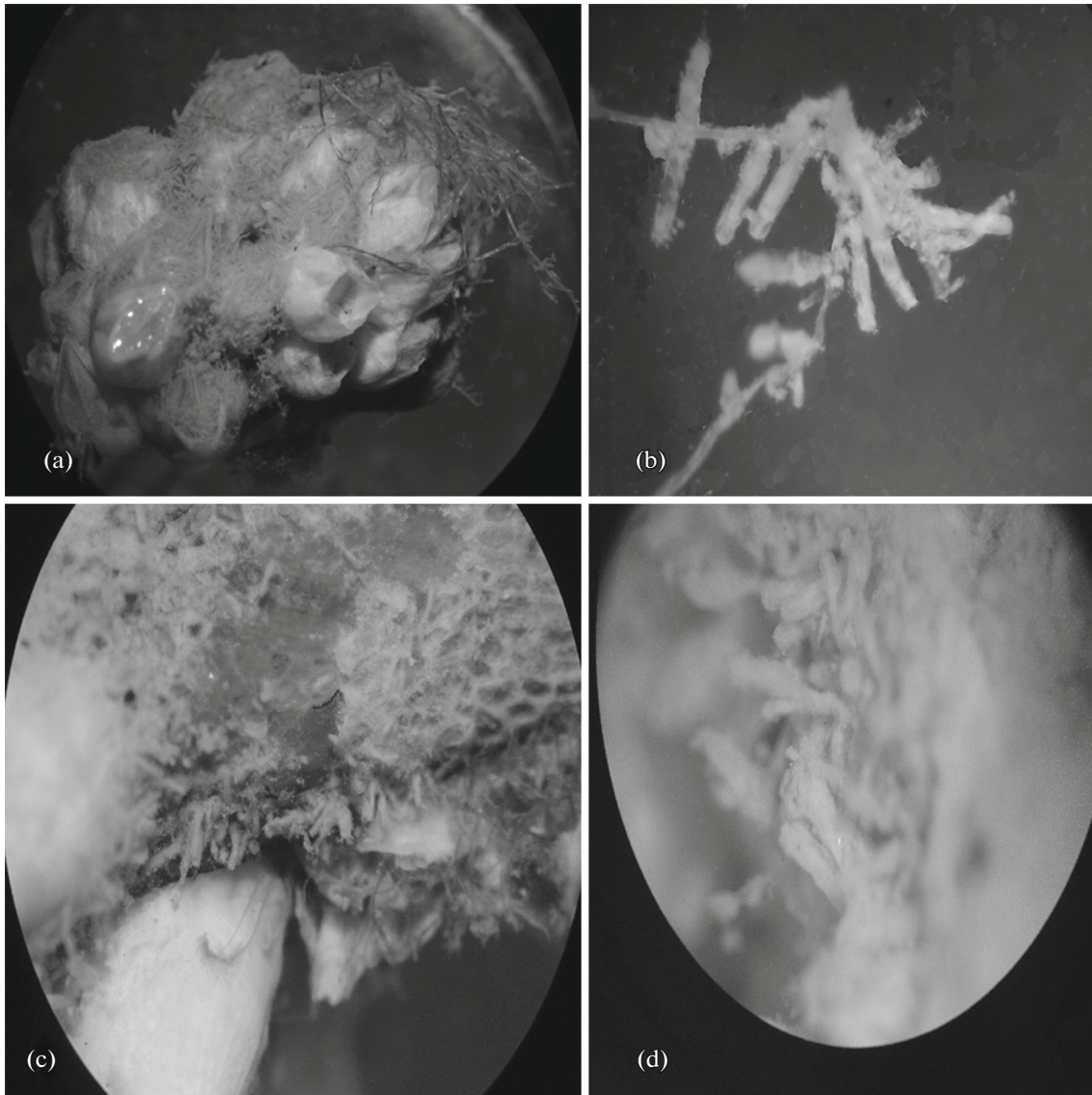
**Diagnosis.** Colonies yellowish or white, forming chains of small gracile autozooids connected by creeping tubes similar to stolons. The presence of these stolons creeping along the substrate is a characteristic feature of *V. pavidus*. Colony morphology is very simple in the young bryozoans, but the autozooids become longer as the colony develops and new stolons and autozooids bud from them to form a robust network. The autozooids are initially shaped as somewhat flattened elongated cylinders of up to  $\sim 0.15 \times 0.60$  mm

in size; autozooid size in the old colonies can amount to 2–3 mm. The annular lophophore of 0.37 mm in diameter carries eight tentacles (Fig. 2c). Zooids 2 to 3 mm in size fulfil various functions within the colony. The net of autozooids forming the colony becomes more robust as the colony ages. *V. pavidus* embryos develop in the coelome prior to hatching.

**Comparison and general remarks.** The species is broadly distributed in the Caspian Sea. *V. pavidus* colonies are reminiscent of bryozoans of the genus *Amathia*.

**Distribution.** The precise origin and time of collection of the Caspian Sea material are not indicated in the research publications. The species was probably found in the west of northern or middle Caspian Sea between the Volga avandelta and the border of Dagestan and Azerbaijan (Abrikosov, 1959b) after 1932. The species was found near the coast of Iran in 2016 (Kasaei et al., 2017). The species is included in the Red Book of Great Britain ([www.marlin.ac.uk/species/detail/1302](http://www.marlin.ac.uk/species/detail/1302)).

**Ecology.** *Victorella pavidus* colonies inhabit on different substrates. They are found on rocks, on piers, and on other solid surfaces (including shells) in harbors, as well as on algae, sea grass, and reeds. The species was found in shallow waters at depths of  $\leq 2$  m, often in estuaries, flood-gates, or other objects with shallow water. Even though it is considered (Hayward, 1985) a brackish-water species, *V. pavidus* can survive in a very broad salinity range (1–27‰). The species was proposed (Hayward, 1985) for use as an indicator of the boundary between freshwater masses and the lower



**Fig. 3.** *Amathia caspia*: (a) colony on balanus valves; (b) *A. caspia* at a higher magnification ( $\times 14$ ), photo taken by N.Sh. Shamionova; (c) *A. caspia* and *Conopeum grimmeri* colonies, and (d) *A. caspia* under a binocular microscope ( $\times 20$ ).

boundary of brackish water in the coastal zones, where different water masses contact each other. The species tolerates polluted and cloudy waters.

Family Vesiculariidae Hincks, 1880

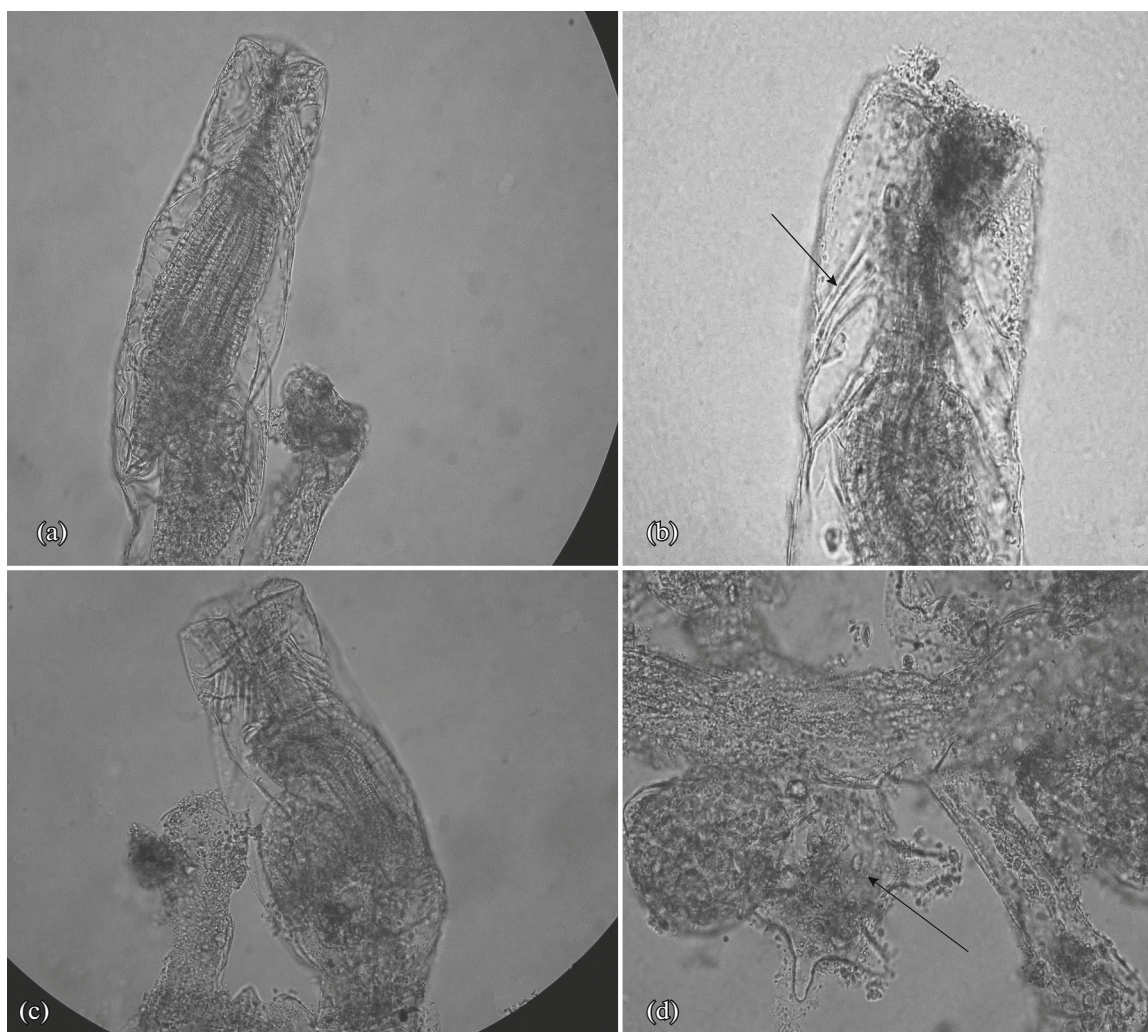
Genus *Amathia* Lamouroux, 1812

*Amathia caspia* (Abrikosov, 1959b) (Figs. 3, 4).

*Bowerbankia densa* Grimm, 1876: 117b, table IV, Fig. 4; table VI, fig. 17; *Bowerbankia imbricata caspia* Abrikosov, 1959b: 698; *B. imbricata* Prenant et Bobin, 1966; Abrikosov and Zevina, 1969: 392 non fig. 375; *B. caudata* Ostroumov, 1905; Zevina, 1957; Zevina, 1959; *B. gracilis* Abrikosov and Zevina, 1968: 393, non fig. 376.

**D i a g n o s i s.** Zoarium composed of creeping and freely growing stolons covered by groups of autozooids

usually located at a certain distance from each other (Fig. 3a). The stolon is branched and separated into internodes of varying length by transverse septa (Fig. 3b). Zooids bud directly from the rather thick stolon and are not connected to each other (Fig. 3b). Zooids transparent, cylindrical,  $< 1.00$  mm, usually arranged in groups of pairs in front of the diaphragm, sometimes single (Fig. 3b). The opening at the distal end of the autozooid (cystid) is quadrangular (Fig. 4). The masticatory stomach is entirely lined by tall cells keratinized at the distal end. The length of the cone-shaped “teeth” (as by Grimm) is  $\sim 0.018$  mm, and the base of each tooth has an irregular quadrangular outline and a diameter of  $0.006\text{--}0.008$  mm. The teeth are hollow, with a domelike concavity at the base (Abrikosov, 1959a).



**Fig. 4.** *Amathia caspia* at a higher magnification ( $\times 70$ ) (photo taken by N.Sh. Shamionova): (a) autozooid with the tentacles retracted; (b) upper part of a cystid, retractor muscles visible (arrow); (c) quadrangular cystid opening; and (d) growth on a stolon (arrow).

**Comparison and general remarks.** *A. caspia* is distinguished from *A. imbricata* by a smaller zooid size ( $\leq 1.0$  mm and 1.2–1.5 mm, respectively). The shape of individual *A. caspia* zooids is closer to ovoid than the shape of *A. imbricata* zooids. A constant number of tentacles is characteristic of the species (Abrikosov, 1959b).

**Distribution and ecology.** The species was found in meso- and oligohaline waters with a salinity of  $\sim 13$  to  $\sim 3\text{‰}$  (at depths up to 15 m (Zevina, 1957)). The species was found at a salinity of  $< 8\text{‰}$  and depths of  $> 10$  m in the northern part of the Caspian Sea. Found in the town of Enzeli (Iran) in a semifreshwater basin of  $\leq 3$  m in depth inhabited by freshwater forms (Grimm, 1876), in Kyzyl-Agach Bay (southwestern part of the Caspian Sea), and in the Gulf of Baku (middle Caspian Sea) at depths of 1.3 m and less; large communities on cane stems were found near the coast of Kulaly Island (northern part of the Caspian

Sea) and near Ogurchinskii Island (southern part of the Caspian Sea). The species was found on bulrush and cane stems, the sea crust of ships, and hydrotechnical constructions in the southern and central parts of the Caspian Sea (Grimm, 1876; Zevina, 1957). The species was found near the Mardakany settlement situated on the coast of Apsheron Peninsula in 2014 (Fig. 4c), as individual colonies near the settlements of Bil'gya and Shuvelyan in 2015. (Shamionova, personal communication), and in the coastal waters of Iran in 2016 (Kasaei et al., 2017).

Order Cheilostomatida Busk, 1852

Family Electridae d'Orbigny, 1851

Genus *Conopeum* Gray, 1848.

Only one species of the genus *Conopeum* is found in the Caspian Sea. Electron microscopic analysis of the colonies and comparison to other species of the

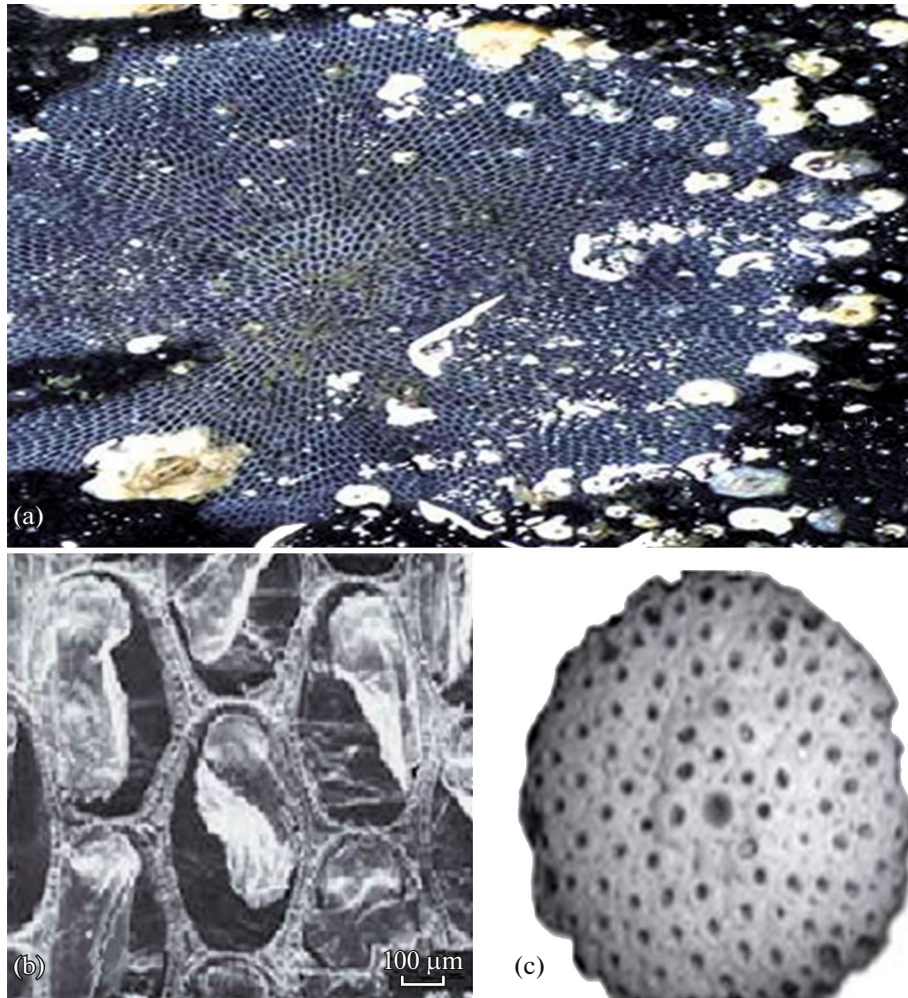


Fig. 5. *Conopeum grimmi*: (a) *Conopeum reticulum* colony, (b) fragment of a *Conopeum seurati* colony, and (c) *Stichoporina* sp.

genus *Conopeum* laid the foundations for the identification of a new species: *Conopeum grimmi*.

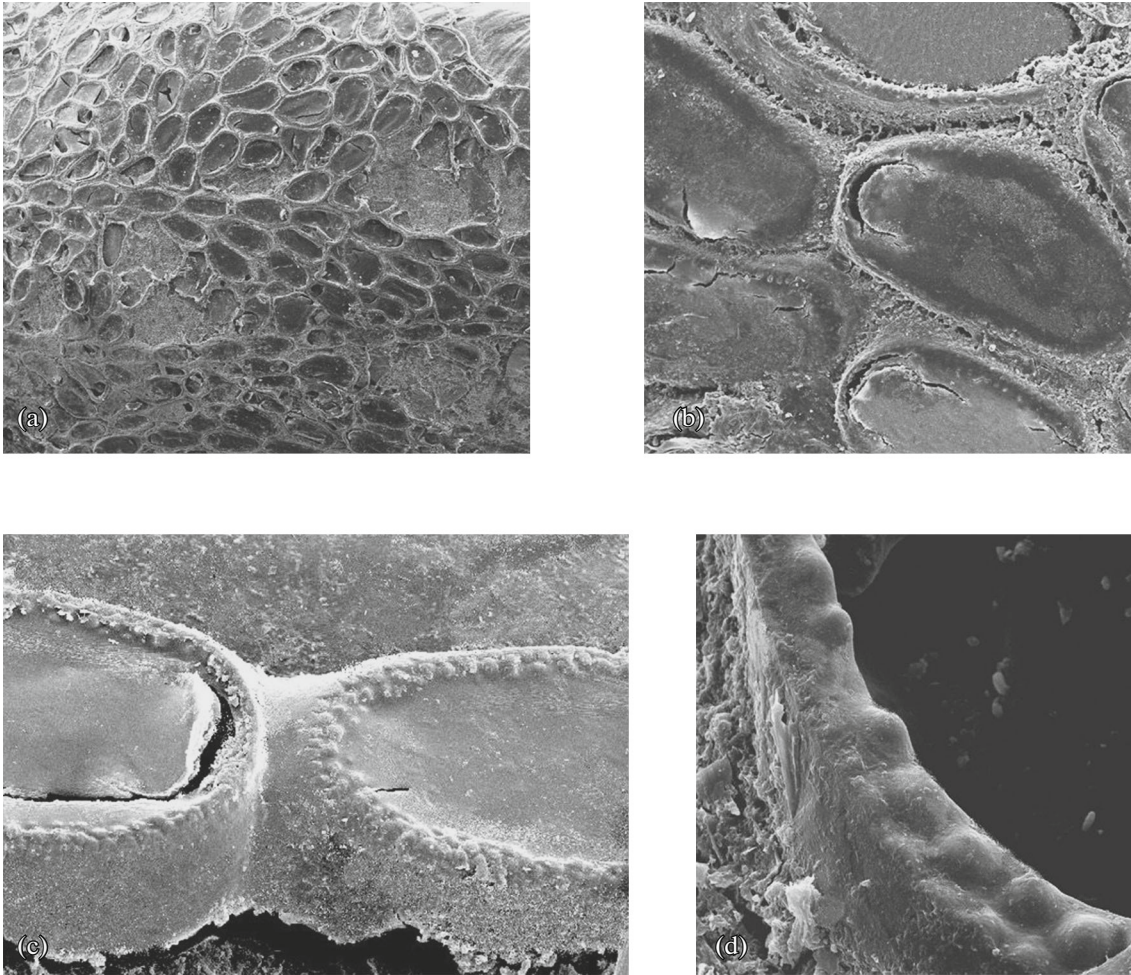
***Conopeum grimmi*** Gontar et Tarasov, 2009 (Figs. 5–7).

*Membranipora crustulenta* Abrikosov, 1959a: 1754–1755; 1959b: 694–701; *Electra crustulenta* Zevina, 1959: 80; *Conopeum seurati* Zevina and Kuznetsova, 1965 (part.) non fig. 1; Abrikosov and Zevina, 1968: 390 (part.) non fig. 374; *Stichoporina?* Grimm, 1876: 120.

**Diagnosis.** The zoarium is white. A colony consists of numerous autozooids arranged in rather dense oblique lines budding from the first initial chain of autozooids (Figs. 5a, 6a). This autozooid arrangement is determined by the distolateral budding of autozooids. A colony can use the so-called running strategy, so the arrangement of zooids is often disordered. Autozooids in the initial chain of zooids, from which the oblique or radial autozooid series create, often possess a strongly chitinized frontal membrane, similarly to the autozooids that appear later during ontogeny. Autozooids are arranged loosely (Fig. 6b)

and only share a distal-proximal wall (Fig. 6c). Abortive zooids are sometimes found between the autozooids (Figs. 7a, 7b). Autozooids are of moderate size (length 0.45–0.65 mm, width 0.2–0.25 mm), elongated oval or irregular elongated shape, with rounded distal corners. Lateral walls strongly calcified. Basal wall visible through the transparent frontal membrane and represented by the basal membrane. The calcified hymnecyst, weakly conspicuous and somewhat thickened, surrounding the aperture as a fringe of constant width and extends near the proximal edge of the autozooid. The aperture occupies nearly the entire frontal surface and is covered by the slightly convex transparent frontal membrane, through which the retracted polypid can be well seen. The cryptocyst has the appearance of a very narrow ridge, so that the opesium size does not differ much from the aperture size. The cryptocyst forms a low fold covered by tubercles of a nearly semispherical shape (Fig. 6d).

Operculum noncalcified, transparent, with a rounded distal edge extending over the sclerite and a



**Fig. 6.** *Conopeum grimmi*: (a) colony fragment ( $\times 40$ ), (b) autozooid arrangement in a colony with no common lateral walls and no contact between the lateral walls of the neighboring autozooids ( $\times 283$ ), (c) distal and proximal autozooid common wall ( $\times 400$ ), and (d) cryptocyst (in an aperture) ( $\times 2000$ ).

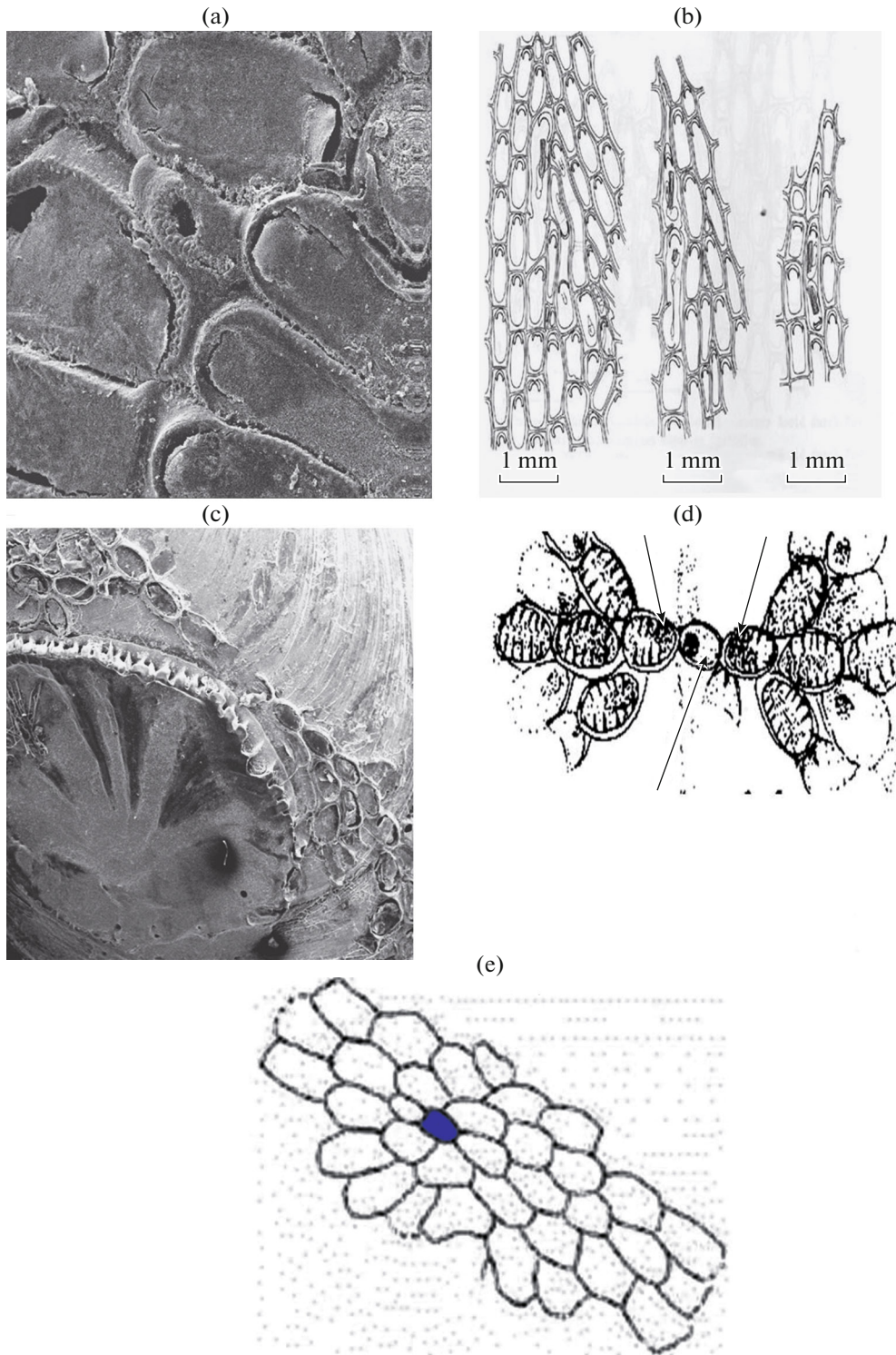
straight proximal edge, 80–110  $\mu\text{m}$  wide (Fig. 6a), with a chitinized fibrous membrane formed along the edge in some autozooids during later development. Individual autozooids in colonies located in the folds of balanus shells carry slightly bent thin long side spines (up to three pairs). No spines are found in the proximal part, and those in the distal part are arranged in pairs and almost perpendicular to the autozooid's frontal surface (Fig. 5a). In contrast to other species of the genus *Conopeum*, *C. grimmi*, budding starts from the distal and proximal ends of the ancestrula (Fig. 7c). Regardless of ancestrula destruction, budding in two opposite directions is conspicuous.

**Notes on morphology.** The colonies found in the northern part of the Caspian Sea are often multilayer. The colonies on *Mytilaster lineatus* shells are arborescent, and those on *Zostera* sp. leaves are linear. *C. grimmi* is distinguished from a closely related *C. seurati* (Canu) species by autozooid and ancestrule

size. The *C. seurati* ancestrule is 340- $\mu\text{m}$ -long and 300- $\mu\text{m}$ -wide, with a pair of spines, whereas the one in *C. grimmi* is 140- $\mu\text{m}$ -long and without spines. Autozooid length and width in *C. seurati* are 360–650  $\mu\text{m}$  and 215–370  $\mu\text{m}$ , respectively, and *C. grimmi* autozooids are 450–650  $\mu\text{m}$  long and 200–250  $\mu\text{m}$  wide. Operculum shape and structure also differs between the two species. The *C. grimmi* cryptocyst has the appearance of rounded protrusions, and that of *C. seurati* has the appearance of serrations which extend into the operisium and vary in shape from spinules scallops to very sharp small spinules, which are sometimes arranged in several rows in certain planes.

*C. seurati* hymnocytes can bear large protrusions in varying numbers, but such protrusions were not observed in *C. grimmi*. There are also some differences in the character of zoarium growth, which can start from budding in the proximal and distal parts of the ancestrula, continue along the radii, and then become

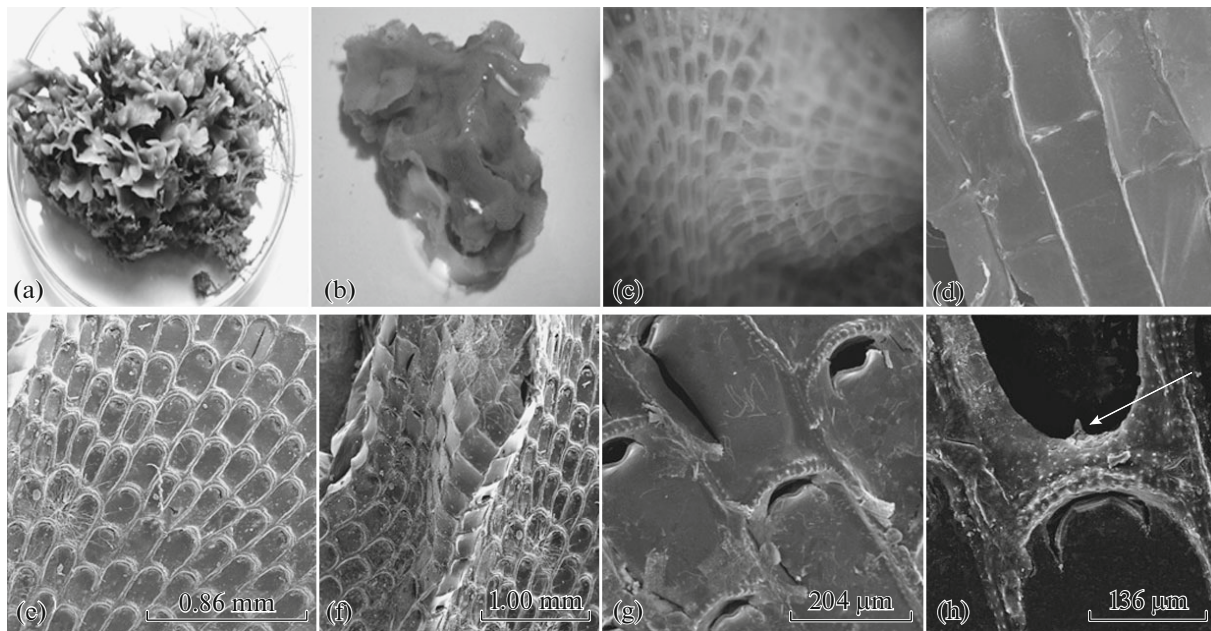




**Fig. 7.** *Conopeum grimmii* and the initial stage of colony formation in other species of the genus *Conopeum*: (a) abortive zooid with a cryptocyst, autozooids in the neighboring series arranged in opposite directions ( $\times 260$ ); (b) abortive zooids (Jebram, Voigt, 1977); (c) *C. grimmii* ( $\times 40$ ); (d) *C. tenuissimum* (arrows indicate an ancestrula individual and two budding individuals); and (e) *C. seurati*.

rather irregular in *C. grimmii*. Triangular areas between the zooids and distal protrusions near the zooids are not found in *C. grimmii*, but are characteristic of *C. reticulum*. If spines are present in *C. grimmii*, they

only slightly decline from a perpendicular orientation relatively to the autozooid aperture surface; there are no spines in most autozooids, but small sharp spines in various numbers are sometimes found in *C. reticulum*.



**Fig. 8.** *Lapidosella ostroumovi*: (a) ( $\times 70$ ), (b) general appearance of a colony, (c) a colony layer growing over the other layer ( $\times 5.5$ ), (d) colony margin with the emerging lateral and transverse walls, (e) colony fragment ( $\times 220$ ), (f) broad autozooids at the margin of a colony, (g) open opercula, and (h) small spike on the internal opesia proximal edge of the cryptocyst.

They are arranged around the aperture in a regular pattern and sometimes bent in an arch shape over the frontal membrane.

We analyzed the 18S mitochondrial DNA, as the most conservative and least liable to change, in order to prove that *Conopeum grimmii* we collected from the Caspian Sea is a true species. The nucleotide sequence of the 18S mitochondrial DNA from *C. grimmii* differed significantly from those from *C. reticulum* and *C. seurati*, which were erroneously considered identical to the former (Gontar et al., 2009).

**Distribution and biotope association.** *C. grimmii* was found over the entire southern and central parts of the Caspian Sea in 1874, mostly on *Theodoxus* gr. *pallasi* and *Dreissena caspia* Eichwald, 1855 mollusks (depths of  $\leq 80$  m), less often on *Cerastoderma* shell valves (Grimm, 1876). Finds on hydrotechnical constructions, navigation buoys, and in the sea crust of ships in 1958–1961 were also limited to the central and southern Caspian Sea sublittoral (Zevina and Kuznetsova, 1965). The species was more often found on the shells of the *Mytilaster lineatus* (Gmelin) mollusk and live *Zostera* sp. leaves in the northern part of the Caspian Sea. The finds in the southern part of the Caspian Sea were registered near the Sal'yan estuary at a depth of 17 m on a silt substrate with coquina. The species was found near the Mardakany settlement situated on the coast of Apsheron Peninsula in 2014 (Shamionova, personal communication).

The species was not found at a salinity of  $< 5.5\text{‰}$  in the northern part of the Caspian Sea. The frequency of occurrence in waters with a salinity of  $5.5\text{--}8.5\text{‰}$  was  $\sim 3\%$ ; it increased to  $18\text{--}24\%$  at a salinity of  $8.5\text{--}13.1\text{‰}$  only. Colony number decreased sharply at depths of  $> 20$  m. The species was met in the fouling of ships in the Krasnovodsk Bay with a salinity of  $> 13\text{‰}$  (Abrikosov, 1959a). Based on the above mentioned the upper limit of salinity resistance for *C. grimmii* is likely  $\leq 15\text{‰}$ .

Nasrolahi (Kasaei et al., 2017) reported that the species was collected along the entire Iranian coast in 2016 and salinity was  $\sim 10\text{‰}$  at all stations.

**Stratigraphic distribution.** Fragments of *C. grimmii* colonies were found on decomposed *Zostera* sp. leaves in Turkmenian Bay necrocenoses. Basal and lateral wall fragments of individual zooids were found in the folds of the upper parts of *Didacna* sp. shells from the Khvalynskian profile near the settlement of Svetlyi Yar (Volgograd oblast). Distribution of *Didacna trigonoides* (Pallas, 1771) is restricted by a  $5\text{‰}$  salinity level, so one may conclude that only the autochthonous species of the genus *Conopeum* inhabited the Caspian Sea before 1988.

***Lapidosella ostroumovi*** Gontar, 2010 (Fig. 8).

*Membranipora reticulum* Ostroumov, 1892: 8–11, 18; Zevina, 1967: 32–34; *Lapidosella ostroumovi* Gontar, 2010: 274–282.

**Diagnosis.** Zoarium white, up to several centimeters long and wide, first adherent to the substrate, then freely growing bilayer, calcified, and hard (Fig. 8a, 8b).

The colony can form numerous festoons oriented in different planes and directions. Composed of multiple autozooids arranged in series, often in a chess order pattern (Fig. 8c).

The pattern of autozoid arrangement is determined by the distal budding of autozooids. One or two daughter autozooids can bud distally from each autozoid. If two daughter autozooids are formed, additional rows of autozooids appear in a colony. A single colony can form a second layer of autozooids by spreading along the basal surface of a colony already formed (Fig. 8c). Thus, a bilayer fan-shaped colony, which is often similar to a partly opened fan in shape, is formed. The lobes can then approach each other at different angles to form structures reminiscent of lace gathers. The edge of a bilayer colony is formed by large irregularly shaped autozooids (Fig. 8f), which can join both layers of a colony, on one side. Since the basal walls of the autozooids are nearly transparent, the opposite layer of autozooids in a colony, which can have different orientations, can be seen through them.

Several series of newly budding autozooids are located at the distal margin of a colony (Fig. 8e). The lateral walls form first, and the different stages of distal-proximal wall formation between these walls can be observed. Distal-lateral wall formation starts from small protrusions on both sides of the lateral walls, which are subsequently fused. The appearance of an additional lateral wall between the two other lateral walls upon the formation of two daughter autozooids starts from the colony margin, rather than from the distal-proximal wall of a still incompletely formed parent autozoid. Two new zooids are thus formed. Cryptocysts submerge at the proximal edge of an autozoid under its frontal membrane after the formation of vertical autozoid walls. The cryptocyst of a mature autozoid is situated as a very low band along the opesium and expands conspicuously in the proximal part.

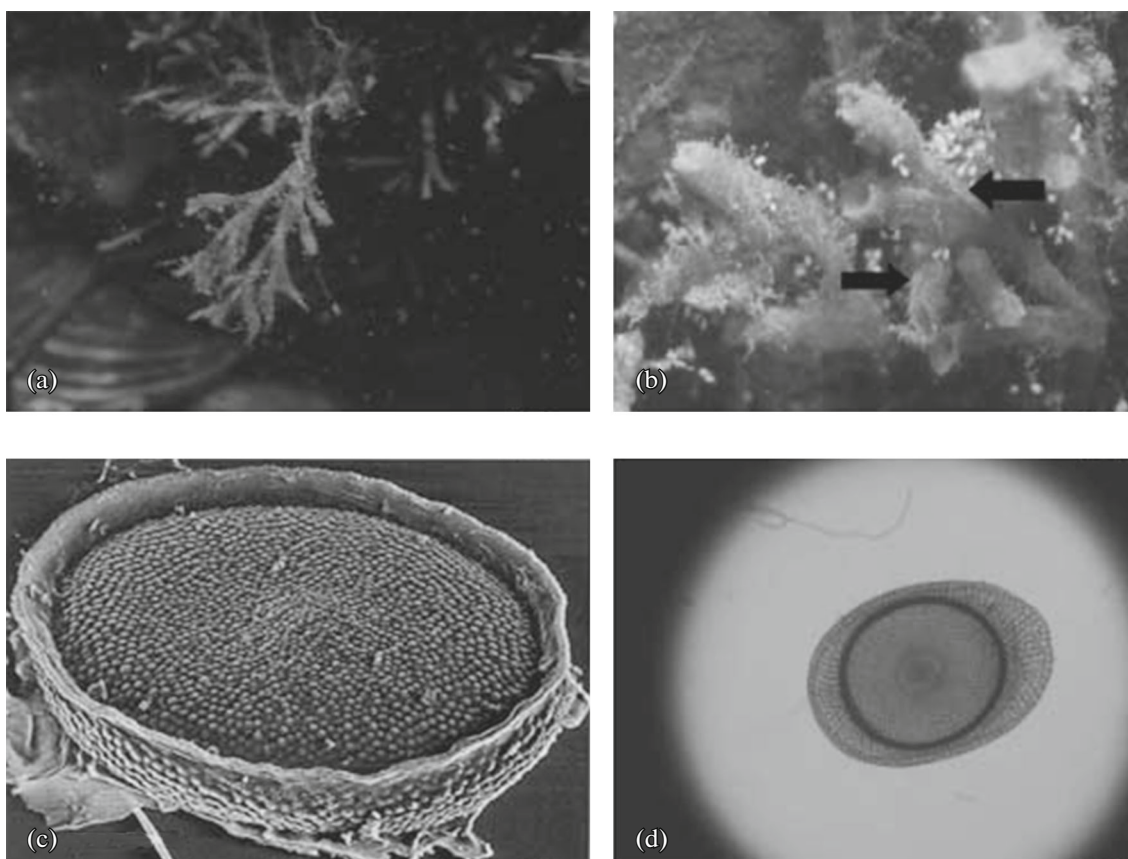
Autozooids have a transparent frontal membrane in ontogeny. Autozooids are closely situated and have separate lateral walls and a common distal-proximal wall (Fig. 8d).

Autozooids are of moderate size (length 0.35–0.57 mm (average 0.43 mm), width 0.22–0.39 mm (average 0.33 mm)), and length-to-width ratio 1.35–1.6 (rarely 2.5)), elongated oval or irregular elongated shape, sometimes slightly broaden at the middle, with rounded distal angles and a somewhat concave proximal edge (Figs. 8g). Autozooids of the colonies from the coastal waters of Iran are 0.43–0.66 mm long and 0.17–0.37 mm wide. Lateral walls more strongly calcified, semitransparent in the young autozooids (Fig. 8d). Basal wall weakly calcified, convex, visible through the transparent frontal membrane. The oval aperture extends over almost the entire frontal surface and is covered by a slightly convex transparent frontal membrane, through which a retracted polypid can be seen. The cryptocyst has the appearance of a very narrow

fringe, so that opesium size deviates only slightly from aperture size. The cryptocyst forms a plane (shelf) covered by nearly semispherical tubercles and somewhat expanded at the proximal edge, where it forms an oval opesium. Several (2–3) series of rounded tubercles are formed on the proximal edge of the cryptocyst plane (Fig. 8h). A small transparent spine that extends into the opesium (Fig. 8h) is found in the center of the internal opesial proximal edge of the cryptocyst. This spike is well visible in fully formed autozooids, but can be absent in the newly formed autozooids on the colony margin. Very broad autozooids on the lateral margin of a colony (or two daughter autozooids budding from them) can have two or three spinules of this type, with one or two located on the internal lateral edges of the cryptocyst. Some very broad autozooids have two opercula. Two rounded porous plates are found in each lateral autozoid wall, with one or two (in a zooid that gives rise to two distal daughter zooids) rounded multiporous plates in the distal wall. Brown bodies are observed in the proximal part of some autozooids.

Operculum noncalcified, transparent, with a rounded distal margin and straight proximal edge, supported by a transparent or thin brown sclerite (average width 150  $\mu\text{m}$ ) on the distal edge. No ovicells or avicularia were found.

**Comparison and remarks.** Colony sizes and shapes vary. Autozoid size, flustra-like colony shape, and the absence of a hymnocyst distinguish the species from *Conopeum seurati* (Canu). *Lapidosella ostroumovi* ancestrula is smaller than the normal autozooids and can bear two spines. The operculum of *L. ostroumovi* is nonchitinized, transparent, sometimes with a narrow brownish edge, with a shape and structure different from those of *Conopeum seurati* operculum, in which the operculum plane is not fringed by a simple marginal sclerite, but rather by a complex, broad, and flexible membranous structure, which extends along the entire free circle (Bobin, 1962). This membrane, supported by two thin arches and marked by numerous fibers, is colorless in young *C. seurati* specimens and brown at later stages, chitinized. *Lapidosella ostroumovi* cryptocyst has the appearance of a narrow plane with rounded tubercles, whereas that of *Conopeum seurati* is formed by serrations. The internal opesial edge of the *Lapidosella ostroumovi* cryptocyst carries one or several spinules that extend into the opesial area. Most *L. ostroumovi* autozooids are, as a rule, devoid of spines. Some *C. grimmi* autozooids in colonies located in balanus shell folds carry long thin slightly arched lateral spines (up to three pairs). Spines not found in the proximal part, and arranged pairwise, almost perpendicular to the frontal autozoid surface in the distal part. Varying numbers of small short spines are sometimes found in *C. reticulum*, and a pair of distal spines is found in *C. seurati*. Autozoid budding pattern distinguishes *L. ostroumovi* from all species mentioned above.



**Fig. 9.** *Plumatella emarginata*: (a) colony; (b) autozooids, with dorsal margin indicated by the arrow (photo by M. Waaij); (c) sessile (photo by Th. Wood and B. Okamura); and (d) flotoblast (photo by L.V. Yanygina).

**Distribution.** Sea of Azov (Gontar, 2010). First finding in the Caspian Sea was made in the coastal waters of Iran in 2016 (Kasaei et al., 2017).

Class Phylactolaemata Allman, 1856

Order Plumatellida Pennak, 1953

Family Plumatellidae Allman, 1856

Genus *Plumatella* Lamarck, 1816

***Plumatella emarginata*** (Allman, 1844) (Figs. 9 and 10) Abrikosov, 1959b: 698.

**Diagnosis.** Colonies of very diverse shapes: often branched (Fig. 9a), sometimes fully covering the substrate, compact, or spherical. Colonies can be nearly fully adherent to the substrate (creeping). The size of a single autozooid can reach to 2 mm. Grey pigment is often observed on the body wall, even in young zooids. Polypid with a horseshoe-shaped lophophore, on which the tentacles are arranged in two rows. The oral opening is covered by the epistome. Cystid often with a margin and encrusted with small grains of sand. Cystids partly attached, with the contrast transparent area surrounding the top of the zooid and narrowed at the frontal part at the end of a cystid to form a V-shaped notch. This feature is especially notable in this species, even though it can be present, although less conspic-

uous, in other species. The V-shaped notch can be absent or inconspicuous. Zooids often have a dorsal (frontal) margin (Fig. 9b), the fusion line (on the side opposite to the substrate side), which starts from the tip of the V-shaped notch. Margin usually not found in freely growing branches. Autozooids separated by inner septa perpendicular to the direction of branch growth. Tentacle crown horseshoe-shaped and formed by 30 to 60 tentacles.

All these features can be absent in certain cases, and identification is only possible by statoblast examination in this case. Flotoblast length to width ratio (L/B) is 1.65 (Figs. 9d, 10). Lateral margins of flotoblasts more or less parallel. Annulus silver-colored, with a fine bubble-shaped structure, greatly overlapping with the capsule and extending far beyond the capsule. Statoblasts often flattened at the ends (poles), so that statoblast outlines are almost square. A small round opening (fenestra) is present in the center of a flotoblast dorsal side. The ventral fenestra is smooth, and the dorsal one is tuberculose. The capsule overlap with the annulus is greater on the dorsal side than on the ventral side. Dorsal valve almost flat, ventral highly convex. Ventral valve somewhat larger than the dorsal; its edges overlap the edges of the dorsal valve,

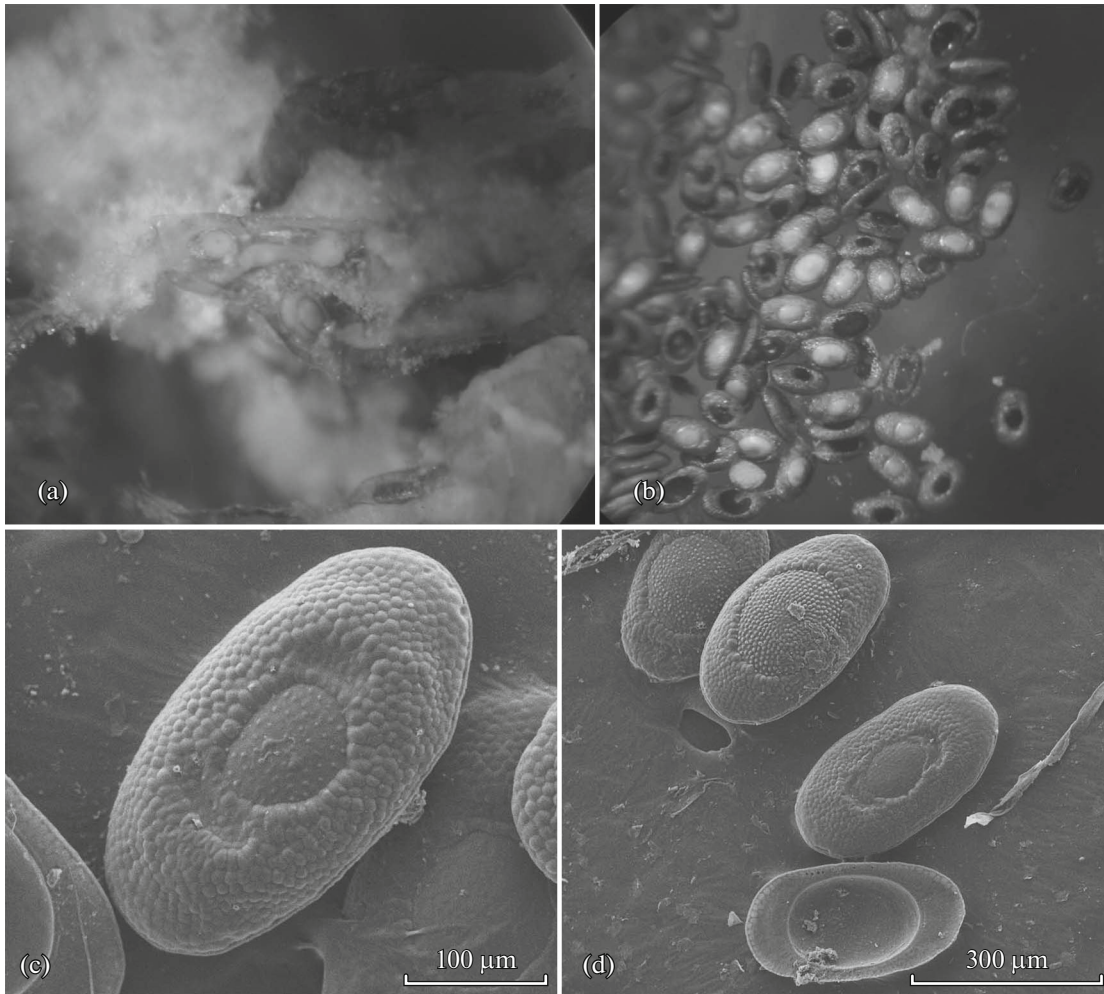


Fig. 10. *Plumatella emarginata*: (a) flotozooids in a colony and (b–d) freely-swimming flotozooids.

so that the suture is visible from the dorsal side. Annulus width constant. Sessoblasts (Fig. 9c) attached to the substrate, of a broad oval shape, rigid, with a rudimentary annulus; lateral walls and the frontal valve tuberculate, but not reticulate. The number of statoblast per autozooid can be numerous.

**Distribution.** According to Abrikosov (1959a), *Paludicella articulata* and *Plumatella emarginata* are the two most common freshwater species in the Caspian Sea, especially in its northern part. *P. emarginata*, which is most common in the northern part of the sea, is often found relatively far from the coast and common on mollusks (*Vivipara* and *Dreissena*). Inhabits in clear (especially flowing) waters, avoids areas with accumulation silt deposition.

### CONCLUSIONS

According to Abrikosov (1959a), “the bryozoan fauna of both Caspian Sea and Aral Sea is still very insufficiently studied.” This give the grounds for him the to describe of several new species and subspecies of

bryozoans of the order Ctenostomatida (Abrikosov, 1959b). The following brackish-water species inhabit the Caspian Sea: the endemic species *Conopeum grimmi* (order Cheilostomatida) and *Amathia caspia* (order Ctenostomatida) and the more widely distributed *Victorella pavidia* species (order Ctenostomatida). The origin of the brackish-water genus *Victorella* can be traced to water bodies of the Tertiary period. According to Abrikosov (1959a), this species should be regarded as typically autochthonous in the Caspian Sea and Aral Sea and historically connected with water bodies of the Tertiary period. The living range of the *Victorella pavidia* species is Ponto–Caspian. Freshwater bryozoans *Paludicella articulata* (Ehrenb.) and *Plumatella emarginata* Allm. are also found in the northern part of the Caspian Sea. The Sea of Azov brackish-water species *Lapidosella ostroumovi* Gontar was found in the southern part of the Caspian Sea for the first time. Freshwater, transitional freshwater–brackish-water, and brackish-water zones are present in the northern part of the Caspian Sea. The distribution of freshwater and brackish-water bryozoan spe-

cies corresponds to the salinity zonation. According to Abrikosov (1959a), a species of the genus *Amathia* should be regarded as a marine invader from the west, which has undergone substantial changes due to the specific environmental conditions, and this shows that the number of marine invaders in the Caspian Sea is larger than previously considered.

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#### COMPLIANCE WITH ETHICAL STANDARDS

*Conflict of interests.* The author declares no conflict of interest.

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