SOME SPECIES OF *BRYOZOA* FROM THE ADRIATIC SEA AND FROM FRESHWATERS, WHICH ARE OF SPECIAL IMPORTANCE FOR FOULING COMPLEX

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ABSTRACT

- SOME SPECIES OF *BRYOZOA* FROM THE ADRIATIC SEA AND FROM FRESHWATERS, WHICH ARE OF SPECIAL IMPORTANCE FOR FOULING COMPLEX-

In consideration of absence of handbook for bryozoa from Adriatic Sea especially for species of fouling communities (which are contemporary species of benthic communities), the handbook is written in the form of catalogue and partial as monograph for 21 species and with 56 illustrations. Also, three the most important fresh water bryozoans species are treated, because according to the harmful effect for water systems, they are not backwards in regard to the bryozoans from sea.

For bryozoan phylum and higher systematic categories (classes) the morphology, reproduction, geographical and stratigraphycal distribution , habitat and some ecological properties are described. For orders, families and genera, the morphology is described; but, for species, synonymies, the morphology, reproduction, seasonal settlement , habitat, geographical and stratigraphical distribution is prepared.

Such handbook should primary be made to enable easer identification of species bryozoans, and better knowledge of this animal group in relation to ecological, eventually ecophysiological characteristics, stratigraphycal distribution, systematical revision of species etc.

FOREWORD

As we are aware that the economic growth is significantly correlated with industrial growth (which is in turn dependant on use of results of scientific research), there are an ever-growing need and importance of narrowly specialized research as the fouling problematic, for example. Especially important research is on animal colonies on vessels, as there is a great cost of redoing damage (lesser speed, increased fuel consumption, corrosion), totalling almost one billion dollars in all world countries (Houghton, 1970; Evans & Smith, 1975). This is the reason to know better the ecology and morphology of organisms that jeopardize boats, and bryozoans are among the most common such animals.

Until now there were no such available taxonomical or ecological studies, including detailed description of species important for fouling complexes on underwater surfaces and vessels.

From this reason, the idea and goal of this work were, primarily from taxonomical and ecological aspects, and using other biologically available data, to treat and well illustrate the most frequent species of fouling communities, which are however always present in benthic communities. Considering the multitude of bryozoan species, the treated species are representatives of certain more common taxonomic categories. Usually only one or two species were shown, and these are the species of special ecological importance due to abundance, cover, frequency etc.

The following species identification will lead to better understanding of fouling problems, especially in harbours, and development of effective protection measurements, which are nowadays on a very low development level in our country.

INTRODUCTION

Bryozoans are usually marine, rarely freshwater organisms, very attractive and interesting for most biologists. Their colonial growth and sessile way of life caused confusion as they were identified as corals (Linnaeus, 1758; Pallas, 1766), hydroids, or zoophytes and marine plants (Rondelet, 1558; Imperato, 1599).

According to the latest information, there are about 5000 recent and more than 1500 fossil species of bryozoans (Kubanin, 1980); while more than 300 species are known from the Mediterranean (Zabala & Malaquer, 1988). This large number of species seems to be the enough good reputation for this taxonomically different animal group.

The modular nature of bryozoans and tendencies towards extreme polymorphism of auto zooids causes the more complex interest, especially in geneticists and taxonomists. Further, their almost obligatory presence in fouling complexes, especially on artificial substrates, is of extreme ecological and economical value.

This animal group is one of the most important fouling components in coastal waters (Swami & Karande, 1987), that is, in many Mediterranean (Relini, 1980) and worldwide harbours (Ghobach et al., 1980; Grovhoug & Rastetter; Ehrler & Lyke, 1980; Lichtschein de Bastida & Bastida R., 1980), although the intensity of their settlement is not imposing – between 100 and 2500 grams, in extreme cases 5000 g/m^2 (Partali, 1979). However, the bryozoans are important in fouling complexes in other ways. They are especially important on vessels, where they are often the only or most abundant foulers. They are very resistant to copper poisonous protective covers of middle intensity (Ketchum, 1952). The colonies of fouling organisms are also important in cooling capacities of thermo-electric power-stations (Relini & Romairone, 1976; Relini et al., 1974, 1980) or in sea aquifers, which can be completely blocked (Dobson, 1946). Besides, these animals together with other species stick to platforms in open waters, which is negative for constructions of such objects (Relini et al., 1976).

It is especially interesting to point out that the bryozoan associations can play important ecological roles in the sequence of fouling process development. They are often space competitors in fouling communities and they may “biologically exclude” other present organisms. Further, due to protective mechanisms, living bryozoans disable access to larvae and spores of other organisms to the substrate. This is one of the reasons why they are often prevalent on the submersed surfaces in fouling communities. But the dead bryozoans together with sulphur-reducing bacteria enable easier colonization of larvae and spores of other fouling organisms on poisonous substrates (Deshmukh et al., 1986).

HISTORY OF RESEARCH

Although the interest in bryozoan animals is very old, dating from Imperato (1599), the research of this group is especially active in last 150 years. Until then, the works usually included only the species list. However, the systematic, complex research achieved the monograph level with the publication of Thomas Hincks "British Marine Polyzoa" (1880). Besides this regional study on bryozoans, important works include Busk's catalogues (1852, 1854, 1875), the "Challenger" expedition (Busk, 1884) and the cruising of "Hirondelle" (Jullien & Calvet, 1903) when bryozoan material was collected. Throughout following years the research become ever more complex and includes morphology, ecology, reproductive biology (Prouho, 1892; Calvet, 1902). In XX Century, the more important systematic research on bryozoans is done especially on fossil material from European seas (Canu, 1916) and American waters (Canu & Bassler, 1917; Bassler, 1935). Works of Harmer also marks these as well as later years, among which collecting and treatment of material collected on "Siboga" expedition is most important (1915, 1926, 1957). Marcus investigated chiefly the shore of South America (Brazil) (1937, 1938). In later years, numerous works of Hayward stand out in areas of British bryozoan fauna (1979, 1983, 1985) and deep waters of Spain and Portugal shores (1979a). For the same author are important bryozoan studies, for example in collecting material in African waters (Hayward & Cook, 1983), or synopses on British bryozoans (Hayward & Ryland, 1979 – *Ascophora*, 1985 – *Cyclostomata*) and systematic of *Cyclostomata* (Hayward & Ryland, 1985a). Another famous bryozoologist is Ryland, who researched this animal group from different aspects in several seas, for example Norwegian (1963), British (1970) etc. The same author also works on problems of bryozoan terminology (1968) and performs the revision of nomenclature done by Hincks (1969), the catalogue of bryozoans important for fouling problems (1965) and other studies, such as *Anasca* of Britain (Ryland & Hayward, 1977).

Although numerous researches were done in many seas, the Mediterranean remains the central area of research on bryozoans, regarding research tradition, scope of work and especially the source of bryozoan material. So, the first publication on bryozoans "Natura history" (Imperato, 1599) was connected with Mediterranean basin. The same author introduced several bryozoan genera (*Retepora*, *Frandipora*), and the work of this author is a sure source of references for later authors, for example for Donati (1750) who has also described several number of bryozoans. During the mid and late XIX

Century, almost all European specialists have worked for some time on the rich bryozoan fauna of Mediterranean. This tradition continues in the XX Century. For example, the Spanish bryozoologists like Barroso (1921, 1922, 1923, 1924, 1927, 1935) have treated all the Spanish coasts. Further studies of bryozoans are known of western Mediterranean in two-volume work "Fauna de France" (Prenant & Bobin, 1956, 1966). Another French bryozoologist is Gautier, who in 1962 made a capital work, a monograph of bryozoan species in northwest Mediterranean. However, most other works of this author are primarily based on ecology and reproductive cycle and less on taxonomy so there is a slight identification of keys. The author does regional works on coast of France (1952), Corsica (1953), Sicily (1958), Ligurian sea (1958b), Genoa Bay (1958b) and communities on marine flowering plant *Posidonia oceanica* (1954) etc. Also, from the meadows of marine flowering plant (*P. oceanica*) and from the artificial substrates Bryozoa were investigated in the important work from Geraci (1973). Harmelin made research on Mediterranean bryozoan fauna (1968, 1969, 1973), as well as on the Atlantic shore around the Canary Islands (1977) and further (1978). This author did a deep research on suborder *Tubulipoda* (1976), certain bryozoan species of genus *Cribrilaria* (1970) etc.

Among the last bryozoologists of the past century, the Spanish researchers are in the top, again. Zabala (1986) presents a very concise monograph with the review of morphology, ecology, biology, together with systematic for Catalania fauna. Finally, Zabala & Maluquier (1988) broaden the preceding research for all Mediterranean species, and this work is a starting point to the future studies of Mediterranean bryozoans, as the keys are very carefully structured, matching species characters with their illustrations.

Considering the Adriatic Sea, the best-known works are by Friedl (1917, 1918), citing 19 families, 49 genera, 98 species and 29 varieties. The author gives detailed account on 10 bryozoan species with synonyms, citing former researchers such as Olivi (1792), Lorenz (1863), Heller (1864, 1867) and Graeffe (1905) who presented distribution of these species in Adriatic, from Trieste to Izola, Umag, Rovinj, Kvarneri, Dubrovnik, Otrant and certain islands (Hvar, Vis, Lastovo, Korčula). Also, the paper from Brusina (1907) must be mentioned giving a contribution to bryozoan fauna of Dalmatia, mostly about Zadar area (Veli rat). Neviani (1937, 1939) has studied bryozoans in Venice Lagoon. Unfortunately this literature was unavailable while writing this work. Nümann & Beth (1955) studied bryozoans as a component of fouling community in Venice Lagoon, Lim channel and about Rovinj. On the north-eastern coast of Adriatic, this group is described as a part of fouling community of Piran Bay (Vrišer 1978, 1986). By the way, the bryozoans are continuously researched as a part of fouling complexes on the artificial substrates on coasts of Istra Peninsula around Rovinj (Igić, 1968, 1969, 1972, 1982a, 1994; Zavodnik

& Igić, 1968 a), in the Lim channel (Igić 1982, 1984), in Ras Bay (Igić, 1986), Pula harbour (Igić, 1982), Verudian Bay in Pula (Igić, 1999), Plom harbour (Igić, 1991), Rijeka Bay (Igić, 1998) and southern Adriatic in Boka Kotorska Bay (Igić, 1983). While investigating epibionts on different organisms the bryozoans were also followed on a *Pinna nobilis* clam (Zavodnik, 1967) and on edible shellfish in culture parks in Lim channel, at Pomer and at Rovinj (Igić, 1975).

The studies of epizootic bryozoans were also done on same hosts such as mussels (*Mytilus galloprovincialis*) and oysters (*Ostrea edulis*) in Raski Bay (Igić 1986) and mid Adriatic in culture park at Mali Ston on mussels (Igić 1981). Besides the shellfish, bryozoans are noted in epibioses on other hosts, such as on a sponge (*Gedonia cydonium*) (Santucci 1922), on bryozoan cormus (*Hipodipplosia foliacea*) (Nikolić 1959), and on the talus of a green alga (*Acetabularia mediterranea*) (Zavodnik 1969). Along the western Adriatic coast, very important are ecological investigations of the fouling communities with the special review to bryozoans as an integral component (Relini et al., 1972; Gherardi et al., 1974; Barbaro & Francescon 1976; Relini et al., 1976; Matricardi et al., 1980; Candela et al., 1982/83; Relini et al., 1983/84) or only dealing with the bryozoan group (Occhipinti & Ambrogi 1980). All these research are phenological, including ecological and partly ecophysiological aspects, studying the relationship between the organisms and environment quality, substrate (kind, size, position, physical contours, protective anti-vegetative spreads etc). However, it is also important to mention the autecological study on our coast at Rovinj, on the species *Schizoporella violacea – Sch. errata* (Nikolić 1959a).

METHODOLOGY

This work includes data on morphology and horizontal and vertical distribution for higher taxonomic categories - classes. On the species level, data include synonyms, morphology, geographic distribution, stratification, habitat, and certain ecological and ecophysiological characteristics, as much the working experience and literature could help.

Taxonomic criteria in determining basic species characteristics are taken from the literature on marine bryozoans (*Gymnolaemata*, *Stenolaemata*) according to Ryland & Hayward (1977) for Anasca; Harmer (1957), Gautier (1962), Hayward & Ryland (1979) for Ascophora; Harmelin (1968, 1976) and Hayward & Ryland (1985a) for *Cyclostomata*. For the species level data from recent literature Lichtschein de Bastida & Bastida, R. (1980), Zabala & Malauer (1988) and Riedl (1983, 1991) were used. The classic literature for species includes Hinck (1880), and synonyms were taken from Jelly (1889). Especially for description of bryozoan species as fouling ones, with morphology, geographical distribution and habitat character, catalogue of Ryland (1965) was used. However, on the genus level, only Hincks (1880) was used of the older authors, and the rest is newer literature of Zabala & Maluquer (1988). According to the Zabala & Maluquer (1988) classification was used from phylum up to species level (Annex 1), and it matches the classification for higher taxonomic categories, from phyla to suborders, given by Hyman (1959). The difference is that this author does not recognize classis *Stenolaemata*, so the order *Cyclostomata* that belongs to this classis is included in classis *Gymnolaemata*. The division into three classes given by Zabala & Maluquer (1988) (Annex 1) is supported by Boardman (1984) and Boardman et al., (1983). As the same authors deal with bryozoan evolution, and therefore start with the classis containing most fossil and least recent species, that is, classis *Stenolaemata*, I have accepted this order, and not the one given in Annex 1. By the way, the freshwater bryozoans (*Phylactolaemata*) are treated according to Hegner (1946), Hyman (1959) and Rogick (1962).

As the special accent was put here on bryozoans as a fouling component, the most used data are on most important species of fouling communities, and several species typical for benthos biocenoses. Those are especially studies from Mediterranean, Black and Red Sea due to coincidence of the species, that is, similarity of habitat to that of Adriatic Sea. The most available and most adequate is the literature on bryozoan species from ecological and ecophysiological point of view, on the artificial substrate of coastal waters of Mediterranean (Arias & Morales 1963; Taramelli-Rivosecchi & Chimenz – Gusso 1965, 1968a, b; Relini 1966, 1980; Relini & Romairone 1976; Relini & Pisano 1977, 1979; Relini & Wurtz, 1977; Relini et al., 1972, 1973, 1974, 1976, 1980, 1983-84; Sara 1971; Geraci 1973, 1974; Geraci & Relini 1970 a, b, c; Gherardi, 1973; Gherardi & Lepore 1974; Gherardi et al., 1974; Chimenz Gusso & Taramelli Rivosecchi 1973; Chimenz Gusso et al, 1981; Agius et al., 1977; Tursi et al., 1977; Pisano & Relini 1978; Pisano 1979 a, b; Riggio 1979; Galluzzo 1980; Balduzzi & Deandreis 1980; Cantone et al., 1981; Candela et al., 1982/83; Montanaro & Tursi 1983; Pisano & Boyer 1985; Gravina et al., 1989) and less from open waters of Mediterranean (Simon Papyn, 1965; Sentz Braconnot, 1966; Morales & Arias, 1979). Besides the data from Mediterranean seas, literature was also used that covers the Black Sea basin (Dolgopoljskaja, 1954; Turpaeva, 1967, 1977; Zevina, 1972; Zevina et al., 1963; Kubanin, 1980) and Red Sea (Ghobashy et al, 1980). Each of these works includes some of the species treated in this study.

The mentioned works usually include the following aspects: seasonal distribution, spatial (vertical and horizontal) distribution, rate of growth, succession, analytical species characters (frequenting, abundance), size of fouling (cover), relationship to the substrate (sort, shape, quality, position etc). As well as on the artificial substrates, bryozoans were treated also as epibionts on natural substrates, that is, organisms, especially those of economic importance, for example oysters (*Ostrea edulis* L.) (Korringa, 1951), snails (*Murex brandaris*, *Murex trunculus*) (Pourbaix, 1931) and very uneven surfaces of microcosmus (*Microcosmus sabatieri*) (Monniot, 1964). The association mussel - flattened bryozoans - *Pomatoceros* is the climax (Nair, 1962). Although the bryozoans are extremely rare epizoonts on sea turtles, they have been recorded on turtle *Caretta caretta* (Caine, 1986; Frazier et al, 1992). Sometime the bryozoan corms are themselves centres of association of different organisms, even other bryozoans, for example on the bryozoan *Hippodiplosia foliacea* (Nikolić, 1959a) or on the same host with synonym name *Flustra foliacea* (Stebbing, 1971; Ryland & Stebbing, 1971). Besides the settlement on animals, bryozoans can settle on plant organisms also. Usually these are brown algae, for example *Laminaria digitata* (Stebbing, 1972), *L. digitata* and *L. saccharina*, *L. hyperborea* (Ryland & Stebbing, 1971), *Sargassum muticum* (Friedrich, 1969; Withers et al. 1975), *Fucus serratus* (Ryland & Stebbing, 1971; Hayward & Harvey, 1974). Besides settling on algae, bryozoans sometimes settle also on different body parts of marine flowering plant *Posidonia oceanica* (Casola et al, 1987).

Besides the numerous works on bryozoans on species level, it is important to mention the primarily laboratory research on larval stage. These studies are dealing with the process of colonizing and succession (after colonizing) periods (Walters, 1991, 1992a) as well as choosing of location on solid substrate by larvae (Walters, 1992b). Similar studies are on effect of microbiological film on settlement of bryozoan larvae (Brancoto & Woollacott, 1982). The fouling primary film contains molecular organic and microbial components (Mihm & Banta, 1981). Also important are the studies on impact of certain physical factors (sea currents) on the feeding process (Mc Kinney et al, 1986).

Regarding the afore-mentioned studies, monographs and textbooks, only Ryland (1965) has covered some bryozoan species interesting from fouling aspect, while the other larger works do not present the species of fouling complexes.

MATERIAL COLLECTING AND WORKING TECHNICS

Bryozoan material can be collected from biocenoses or from fouling communities from various artificial substrates and epibioses on marine organisms (most often, shellfish).

For collecting fresh material from benthos, Gautier (1962) cites several kinds of equipment, especially stating that trailing net “CHARCOT” is suitable, as it can collect bryozoan material on pre-coral and coral bottoms. The same author cites this net to be suitable for sea bottoms with various ”herbaria”, that is, strewn gravel and sand and a lesser quantity of silt on depths approximately between 10 and 1000 meters. Furthermore, Gauthier (1962) states that “PETERSON” catcher is suitable for quantitative analysis. Applicable is also a method of diving to app. 50 meters of depth, however, it is suitable only for lesser areas of investigation (Gautier, 1962).

When researching fouling species material is collected most often by “raft” method. Several different test surfaces are put out, and this initiates colonization of fouling organisms, that is, bryozoans. It is possible to determine how much data will be collected, in which area and when. When using this method, the most commonly used substrate is glass, as most researchers consider it pretty inert to the organisms (Harris 1946, Dolgopoljskaja 1954, Allem 1957, Nikolić 1959, Igić 1972). In order to prevent pollution of surrounding environment by poisonous protective coating, the rafts are made of natural uncoated wood material, and instead of metal floating devices, styrofoam is built into the construction. The passive movement of the test plates enables intensive settlement of larvae and spores, that is, stronger fouling process. These plates are afterwards analyzed in the laboratories, where following attributes are determined: quality, quantity, growth, regeneration process, interaction of bryozoans and other settled organisms, dying with mortality and weight. These aspects are followed on so called ”year plates”, exposed one month up to a year. The seasonal distribution is followed in shorter periods (7, 14, 30 days), most often on so called “month plates” (Igić, 1972). Besides the already mentioned aspects, following of processes of growth and life span of colonies of certain species can best be done on marked hosts, for example, shellfish. So on one colony from settlement to dying out of last zooecium in cormus, all the aspects can be observed in function of time, mostly in one-month periods in situ (Igić, 1975). The research on larval level is done in laboratory conditions. For example, Nikolić (1959a) has followed the fototaxism of species *Schizoporella violacea* (*S. errata*), by placing several corms with live zooids in glass basin containing 30-40 l seawater. Immediately under water surface by the basin wall, uncoloured glass 10x10 cm plates were placed. They were utilized for larval settlement and following relationship to light. The plates were turned toward the light and this position was suitable for swimming larvae moving toward light.

When observing material, binocular lens with movable micrometer is used, and for the finer analyses of microstructure microscope is also used, usually enlarging 100x. If material should be treated for collections, the simplest way is to dry it, and this method is used for flattened, bark-like species. In other cases, material is put into 70% alcohol in order to preserve colour of the colonies, and it is put together with the substrate, as the live flattened colonies are difficult to detach from the substrate. For the detailed study of the skeleton, live organic parts are to be burned out, according to Nikolić (1959a). As the author does not cite the temperature, it is to be assumed that these temperatures are low enough not to ruin $CaCO_3$ the skeleton is made of. By the way, both this author and Gautier (1962) cite that the organic matter is to be removed by soaking bryozoans into ”Eau de Javelle”, used to wash dishes and remove stains.

In order to make fixated preparates it is necessary to perform cuts. It is necessary for those species with polymorphous growth and where vertical parts of colonies are brittle. Nikolić (1959a), dealing with the species *Schizoporella violacea*, first made slices 2-3 mm thick, and then glued them to soaked Canada balsam put on object glass. Then he grinded them till they were 0.4-0.8 mm thick, and soaked it into several drops of Canada balsam. Afterwards, the preparate was put into exicator in order to remove all air and fill all holes with Canada balsam. This process with Canada balsam is faster when xilole was added.

Remark:

In the literature cited, the same species is often mentioned with different names. This problem is especially acute in species *Scrupocellaria bertholettii*, presented in different publications by following names:

-*S. bertholetti* - Gautier (1962)

-*S. bertholettii* - Ryland (1965)

-*S. bertholletii* - Candela et al., (1981)

-*S. bertholleti* - Zabala & Maluque (1988)

In this work, term given by Ryland (1965) was used, as his catalogue is an important work on fouling aspect, and as he is a very well known bryozoologist.

GENERAL CHARACTERISTICS AND TERMINOLOGY OF PHYLLUM

Marine bryozoans are sessile colonies of modulate units - zooids. Colony called zooarium is made by budding. There are many different shapes of colonies: branchy (Fig. 1), leaf-like, bark-like (Fig. 2), lace-like, moss-like etc. The size of the colony is from several millimetres to several decimetres. The shape and function of the colony is influenced by the number of present modules (zooids) and their way of gregariousness.

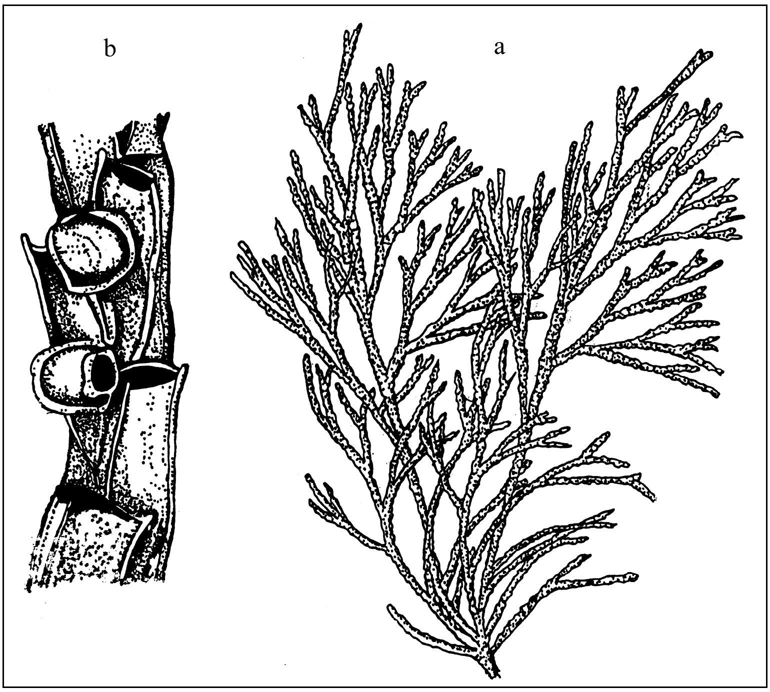

Figure 1. View of colony (*Bugula neritina*)

a. colony bushy tuft, b. zooecia; according to: J.S. Ryland , 1965

Zooids are morphologically detached functional units with diverse internal dependence regarding function and surviving of the whole bryozoan organism. Zooids are small, usually less than 1mm^3, and the longest reach diameter of about 2 mm.

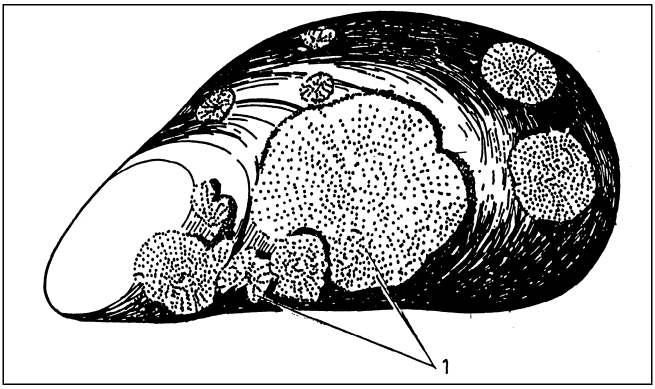

Figure 2. View of colony (*Cryptosula pallasiana*); Flat colony on bivalve shell according to: H. Hyman, 1959

In some species at sexual old age, colony contains only 2 or 3 zooids, while this number is usually much higher and is measured in tens of thousands or even tens of millions. The basic module, autozooid, is the feeding unit polypide, which has polipoid growths - tentacles, pointing out into the water and collecting food. The rear end of immobile polypide is called cystid. It is covered with a thickened membrane secreted by epithelium. Usually calcium carbonate is excreted into this layer, so many marine species have a thick, zooidal skeleton, that is, the protective "house", called zooecium (Fig. 3). On the front part of the body there are a mouth and a line of tentacles, so this part of the animal does not have the hard membrane, is soft and when touched hides into the zooecium. The most important part of the polypide is the narrow tentacles placed on a holder named lophophore in the shape of circle or horseshoe (figs. 7 and 8). The mouth is placed in the middle of the tentacle circle, and the anal opening is placed above it. The tentacles are equipped with little cilia, making water movement important to bring water into the mouth. There are no nephridia (excretory organs) or circulatory system. At some zooecia decomposed polypides can be seen as brown remains in shape of semi-circle. Zooecia that survive polypide death for the longest time show most species-specific features and are important for determining species. The opening of the zooecium usually has a closing mechanism, for example, ruffled membrane, or, more often, a hard, horn covering (operculum). In many species the lower edge of the opening is not smooth but contains a hollow (sinus), which is filled with the part of the operculum. The primary opening of the zooecium may be surrounded by a high edge - peristome. When the zooecium is observed, the part with the opening is considered the frontal part, and the opposite side as a base. The species containing calcium carbonate have base part turned toward the substrate.

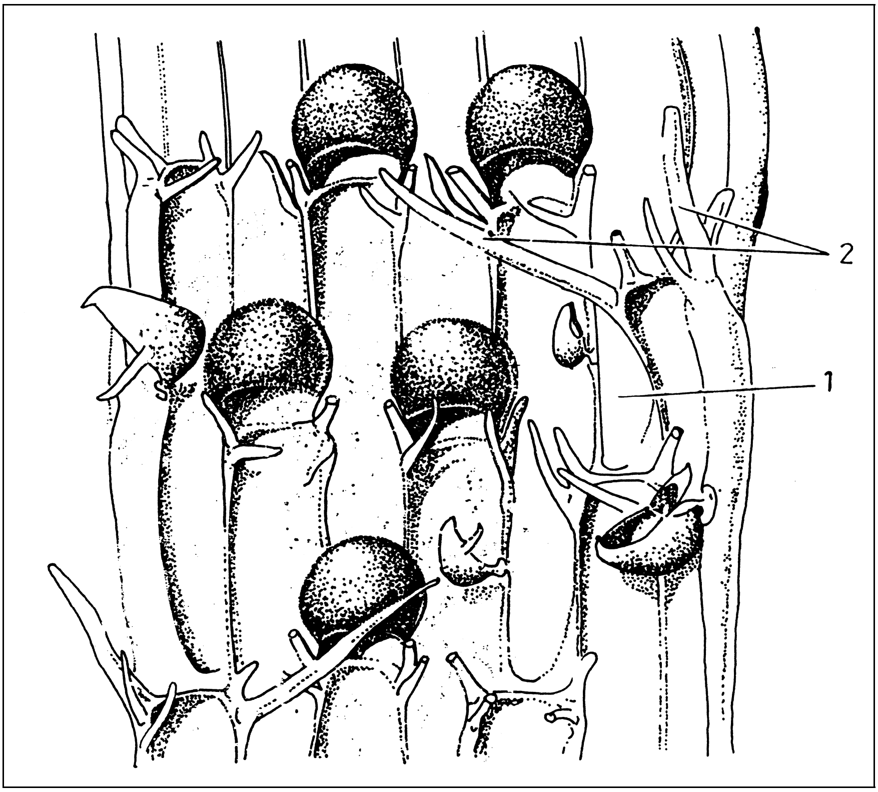

Figure 3. View of zooecia; Zooecia with spinae
1. zooecium, 2. spina; according to: J.S. Ryland, 1965

At the polymorphous colonies, there are various morphologies and various other specialized modules. All zooids except autozooids are called heterozooids. They have no function in feeding and are present at many species as one or more specialized types in the colony. The heterozooids' functions include protection, reproduction, locomotion, maturing, structure support, etc. Function of many heterozooids is yet unknown. Those who are used for reproduction and keeping and developing of ovum (ovicell) are localized toward the proximal part of next zooid. They are shaped like hollow globes (Fig. 4A, B). The other heterozooids, avicularia, are various in shape and abundant (Fig. 5). They are localized on the modified operculum of the zooecium. The opening below the operculum is elongated, and narrowed on the distal (free) part. Such an operculum represents a mandible in the shape of the jaws. The distal part is curved backwards like a hook and it covers the inside high edge of the opening. Avicularia vary in position and size. Most of them are vicarious, occupying the position of autozooids. Others are inter-zooidal, that is, placed, between the autozooids. There are many hypotheses about the function of avicularia. They may be used for protection or frightening predators (for example small annelids, amphipods etc.) and they may hold body parts 0.05 mm or smaller (Kaufmann, 1971). Vibracula (vibraculae) (Fig.6) are like “bodyguards” in the colony. Their opercula are hypertrophied into a long thread similar to a rough hair, so they can reach alongside the frontal membrane. They wipe above the zooecia in the colony and in some *Cheilostomata* help in locomotion (Cook & Chimonidas, 1978).

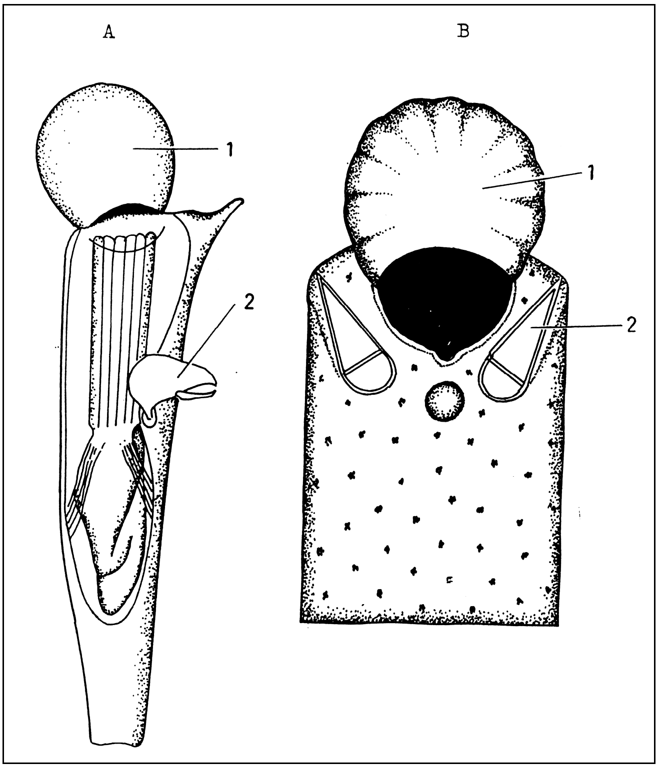

Figure 4. View of heterozooids at ANASCA (A) and ASCOPHORA (B)

1. Ovicellate zooecium, 2. Avicularian zooecium; according to: J.S. Ryland , 1965

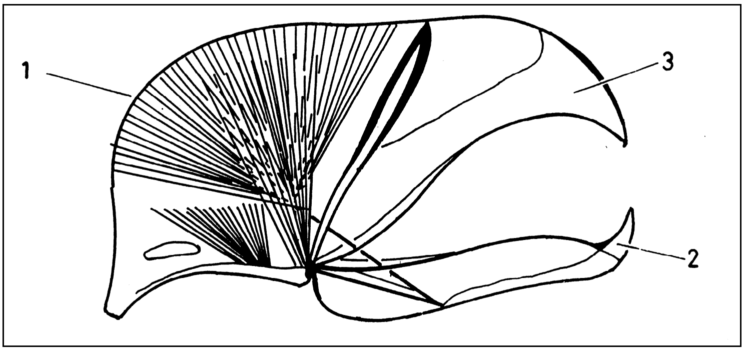

Figure 5. Structure of avicularium
1. head; 2. mandible; 3. beak; according to: J.S. Ryland , 1965

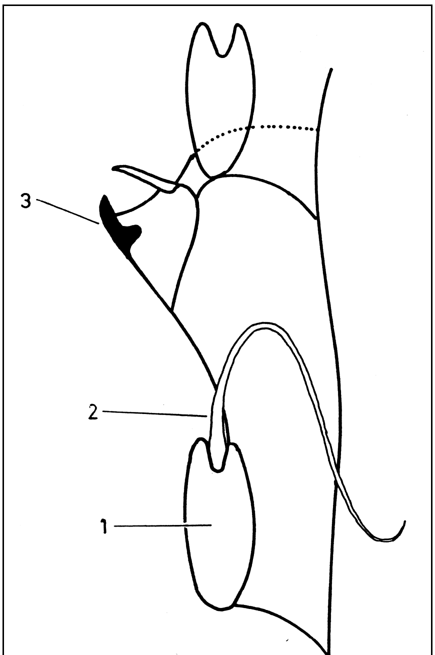

Figure 6. Structure of vibraculum
1. vibraculum, 2. seta, 3. lateral, avicularium,
according to: J.S. Ryland , 1965

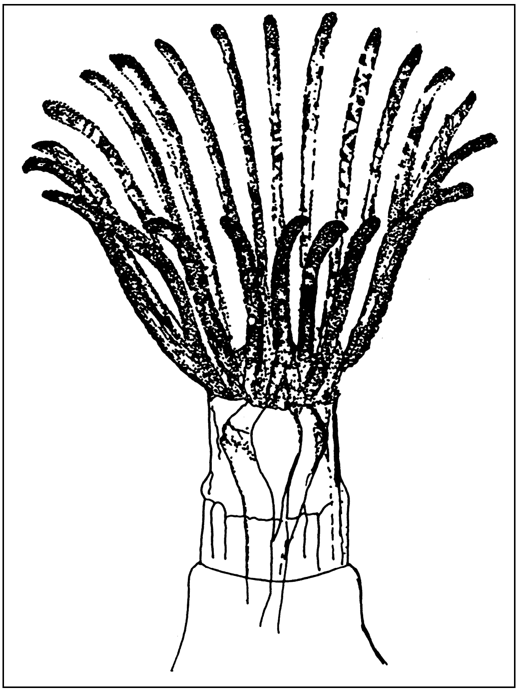

Figure 7. Lophophore - the ring of hollow, ciliated tentacles surrounding the mouth of the zooid

according to: H. Prouho, 1892

Nanozooids are tiny zooids with small simple tentacular polypides. They are developed in some recent *Cheilostomata*. But in other marine bryozoans (*Gymnolaemata*, *Stenolaemata*), many zooids are developed as kenozooids. They develop between other zooids, along the edges of the colonies or fill a larger area. It is assumed that kenozooids have different functions in the colony, for example they may enforce or help collecting larvae in order to start a future colony.

Spines are placed on the frontal part of zooid of *Cheilostomata* (Fig.3). However, in some colonies there are areas that do not belong either to autozooids or heterozooids. Such parts of the colony are marked as extrazooidal, representing a thick skeleton or series of skeleton products (cysts), which fill up the places or strengthening the surface of the colony.

In the bryozoan colonies there is an integration of the modules and increased cooperation between the zooids. It may happen due to coordinated feeding, rapid growth, suitable distribution of polymorphous zooids etc. Boardman & Cheetham (1973) cite 6 ways of integration in bryozoans, such as degree of polymorphism, position of heterozooids, type of zooidal walls etc. The colonial form is correlated with integration of modules.

The flattened, bark-like bryozoans generally show poor structural integration and vary from poor to better functioning integrations. The opposite is true in upright, free-living forms, where there is a large level of functional and structural integration.

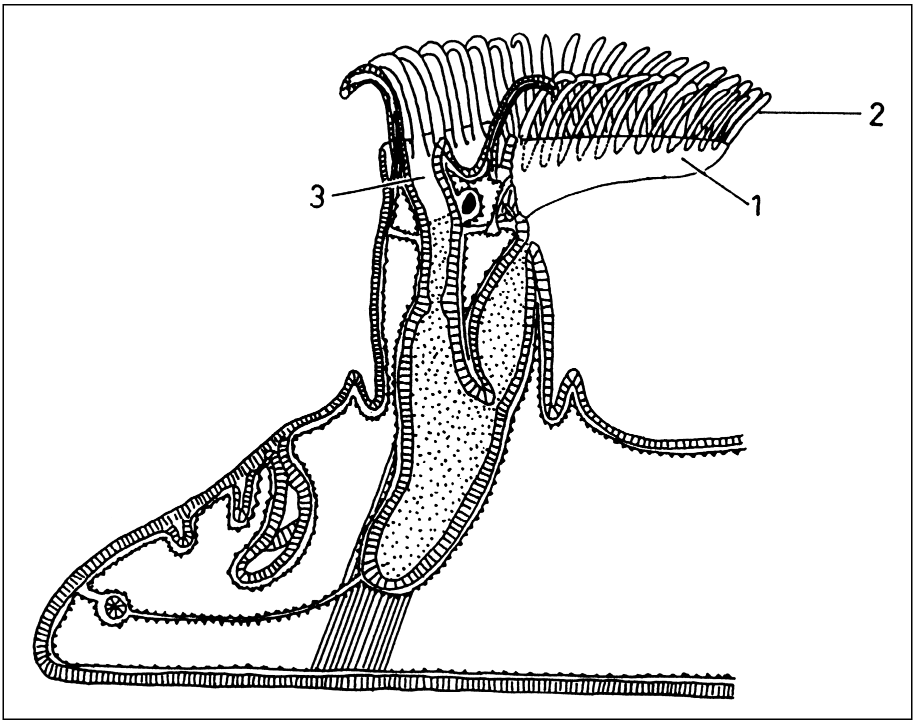

Figure 8 .Lophophore is crescentic or shaped like a horseshoe
1. lophophore, 2. tentacles, 3. mouth; according to: R.W. Hegner, 1946

Bryozoans reproduce sexually and asexually. Sexual products fall into the body hollow, where fertilization occurs. The fertilized egg develops by metamorphosis through the swimming stadium (larva), which settles on some substrate and there changes into a future source individual or ancestrula (Fig.32b). During the further process, ancestrula buds into a whole colony.

Budding is the asexual way of reproduction. The outside budding makes growths called stolones (Fig.13), while the inside budding makes so-called statoblasts (Fig. 9 A, B).

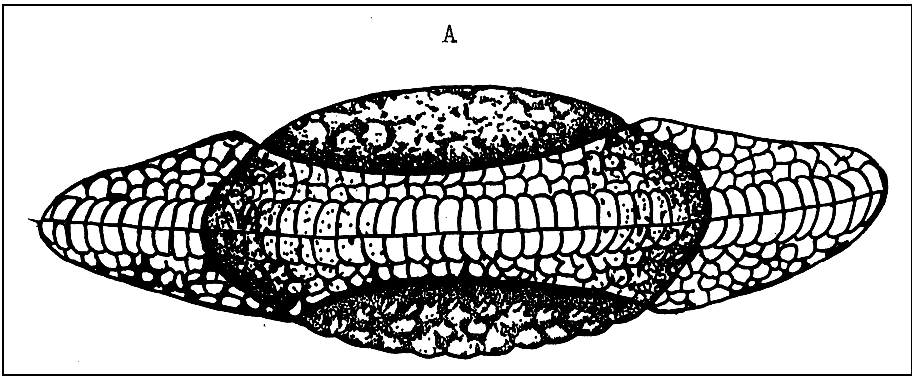

Figure 9A. View of statoblast; Statoblast elliptic (*Plumatella*)
according to: M.D. Rogick, 1962

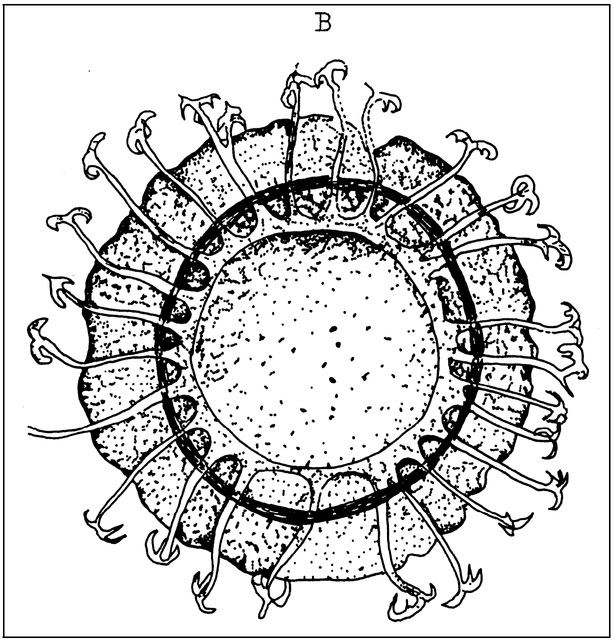

Figure 9B. View of statoblast; Statoblast; spherical (*Cristatella*)
according to: R.W. Hegner, 1946

The marine bryozoans differ from freshwater ones greatly in tentacle holder. It is rounded in marine bryozoans (Fig.7), while tentacles are free from the base and do not make statoblasts. During the winter they make special winter buds. Zooids in a colony are clearly detached from each other with a wall.

In freshwater bryozoans, the tentacle holder is shaped like a horseshoe (Fig.8), egg-shaped or rounded. They live in colonies that are not encrusted with minerals. Zooids are not clearly detached from each other. The tentacles are connected with each other with a membrane up to one third of their length. They make statoblasts (Fig.9A-elyptical, B-rounded).

SYSTEMATICS AND SYSTEMATIC CATEGORIES

MARINE BRYOZOANS

Classis: *Stenolaemata* - calcified zooids are tubular or sack like. Tentacles are attached at the base of the lophophor, where there is also a membranous sack surrounding the tentacular crust where gut is attached. The presence of membranous sack around each polypide represents the tissue organization between *Stenolaemata* and *Gymnolaemata*. As the inside portion of the zooecium is thin due to relatively rapid growth, and the outside portion relatively thicker, zooecium is twisted on the place where inside and outside part meet. In tubular zooecia, the opening has almost the same diameter as is the width of the zooecium, while in sack like zooecia; the opening is smaller than the diameter of the tube, which is relatively narrow, seems like a tube.

This classis includes 5 orders, which vary in polymorphism, colonial geometry, skeletal structure etc. Only the order *Cyclostomata* is recent, while the rest are fossil, long ago extinct bryozoans.

Classis *Gymnolaemata* - with rounded lophophor. Number of tentacles 8-30. The body wall is cuticular or with a coelom (secondary hollow) communication between the zooids. Zooecia are connected and the vertical walls are porous. Autozooids are shaped like a box, sack or short cylinders. The main axis is mostly equal with main direction of colony growth. The direction of growth is defined as distal, and it comes from the proximal. The frontal part is detached from the base and contains an opening. The vertical walls of zooecia are usually uniformly built from basal to frontal sides. The growth of the walls finishes quickly in the ontogenetic development and the resulting polypide holds an approximately permanent position with coelom chamber. The lophophore is circular with 8-30 tentacles. Further, for this class an important characteristic is polymorphism, consisting of zooids developing in linear series (Ryland, 1970, Cheetham & Cook, 1983). Another characteristic is lack of epistome.

Gymnolaemata are the most numerous classis of *Bryozoa* and is divided into two orders: *Ctenolaemata* and *Cheilostomata*. These bryozoans are very tolerant to the environment factors and substrate. They settle mostly on solid substrate of various characteristics (rocks, shells, logs, algae, sea plants etc), while in some of them there is a selection of substrate. For example, Gautier (1954) cites a very selective relationship between the bryozoan *Electra* and sea plant *Posidonia*, and therefore creates a new species *Electra posidoniae*. Some other families of *Ctenostomata* (for example *Penetrantinae*) chisel shells of dead molluscs or barnacles (Marcus, 1938; Soule, 1950, a). Regarding distribution as a function of depth, they can be found from drying zone (supralitoral) to abyssal (down to 6000 m of depth). The abundance decreases significantly with depth, especially below 3000 m, where the only present are *Chaeliostomata* (Marcus, 1921). *Cheliostomata* are also widely horizontally distributed, in all world seas, while there is smaller number of species in polar zone. They tolerate high salinity ($38\text{-}40 \times 10^{-3}$) very well (Marcus, 1926; Duncan, 1957), and therefore differ from *Ctenostomata*, who prefer more brackish waters ($1\text{-}27 \times 10^{-3}$) (Marcus, 1926a). The horizontal distribution is very much influenced by anthropogenous cosmopolitism due to floating objects such as ships, which transfer these organisms easily into very far places. By the way, European boreal species spread to Mediterranean and along western African coast, while there is a great resemblance between eastern Atlantic, Mediterranean and West Indian region (Osburn, 1940).

As fouling organisms, *Gymnolaemata* often cause death of other sessile invertebrates by growing over them and preventing their feeding, while in the opposite case, bryozoan larvae are consumed by oysters and other filter-feeding organisms.

FRESHWATER BRYOZOANS

Classis: *Phylactolaemata* - monomorphous bryozoans with chitinous or gelatinous zooecia. The lophophore is horseshoe-shaped and in genus *Fredericella* it moves toward the circular shape. The digestive system is usually V-shaped, with the anus opening dorsally, near the mouth. Colonies show basic structure types: plumatelid and lophopodid. At the plumatelid type, the colonies are branched and spread over the substrate more or less above the surface as branched tubes or pillars. They are composed of a line of more of less different zooids. Lophophodid type colonies are completely within the gelatinous mass, there are about fifty or more zooids and they are all turned in the same direction. There is a cristatela form, wormlike in shape, crawling, up to several cm in length, with flattened gelatinous lower surface. In this lophophodid type, the upper surface is convex with 2 or 3 lines of zooids, while on the sides there are no zooids and that is the place where statoblasts are.

All *Phylactolaemata* except for *Cristatella* type lives permanently attached to submersed objects, water plants, rocks, roots and different parts of freshwater habitats. They usually live in alkaline, fresh waters. They usually dwell in shallow waters, up to three feet in depth, rarely to the depth of 20 or

170 m. Some prefer still waters (the gelatinous types), where the substrate is shadowed. The special feature of some bryozoans is their ability to move. It happens with a genus *Cristatella* and some young colonies of other species. They move in the direction of longer axis, 1-15 mm per day (Marcus, 1926) or 19 mm in three days (Harmer, 1911).

Lately the freshwater bryozoans start to get economic attention as very dangerous organisms in city water systems (aquifers), as they make large masses (”pipe mass”) that can destroy even whole instruments in water.

MARINE BRYOZOANS

Classis *Stenolaemata*

Order *Cyclostomata*

Colonies are flattened or erect. Autozooids are long, some of them with basal diaphragms and other structures, many are porous. Extrazooidal skeleton can be present in ways of kenozooids and nanozooids. The opening of the zooecium is on the top and is completely covered with an elastic membrane. There are no avicularia and vibracula, but there are ovicells.

Suborder *Rentanguloidea*

At the beginning, the colony is fanlike in shape, then circular or oval, and it can form cylindrical shapes about the circular erect substratum. The reproducing chamber is in the centre of the colony. There is no polymorphism.

Family *Lichenoporidae*

Zooarium is disk-shaped, simple or complex, partially free. Zooecia are tubular, erect or semi-erect spaced in more or less different series that start ray shaped from the free central area. The surface between them is reticular or porous.

Genus *Lichenopora* Defrance, 1823

Zooecia are detached or coalesced into simple lines that go ray shapely in several rows. Autozooids are arranged in radial series in pentagonal shape or without any rule. The space in between (alveoles) is detached by calcified screen, open on the top, or in the late staid can be closed with porous plates. The colony is discoid, detached from the substrate, simple or complex with many parts that coalesce, disks, or is partially free, developed on a thin plate that usually forms the edge. Tubes with peristome are arranged into radial series, or in rare cases they may form net, but they are always detached from the alveolar parts (series), making their distribution unrecognizable. The embryo-raising chambers are bordered with fuzzy borders that are actually widened calcified edges. The disks are collected into cylindrical pillars. Alveoles (hollows) are hexangular, with always the same proportions, more or less closed from the circular diaphragm. They are toothed. Peristomes are radial, non-serial, always high; they spread from the centre toward the periphery. There is only this one genus in Adriatic.

***Lichenopora radiata* (Audouin, 1826)**

Melobesia radiata Savigny 1812: 1, text pls. 1-14.

Tubulipora patina, Milne-Edwards 1836: 321, text fig.1, pl. 13.

Unicavea radiata, Orbigny 1951-54: 1, text.

Discoporella floschulus Hincks 1862: 1, text fig.3, pl. 16.

Discosparsa patina Heller 1867: 77, text.

Discoporella radiata Busk 1852: 1, text fig.2, pl. 34.

The colony is completely rounded, covered with a thin plate that sticks to the substrate, convex; the centre of the circle is usually larger, flattened, and reticular. Near the central area there are tubular openings (openings of ovicells). Zooecia are much raised, coalesced, arranged in ray rows. The opening is usually lower. Long and short "houses" (zooecia) are spaced alternately (Fig. 10). This species is very beautiful and differs from the rest due to its ray shape of long and short rows of zooecia. The most hidden tubes inside the colony are the longest ones and the length of the tubes diminishes toward the edge. When the colony is attached to algae, it is often distorted in shape and loses the principal characters of the species. The autozooids are in series that are strictly coalesced into pipe-organs, with only distal projections of free peristomes.

Reproduction: larva ancestrula was observed in Mediterranean water in July (Riedl, 1991).

Habitat: This species is extremely rare on artificial test surfaces as a fouling species, so its significance is only a qualitative one on calcite and sandstone plates (Vriser, 1978) although in other researches on the same substrates this species, together with polychaete *Pomatoceros triqueter*, was the dominant fouling species on 5 m of depth on the unlighted side of the plates (Vriser, 1986). The same species was also recorded on artificial ridges with small covered area (Relini & Würtz, 1977). However, as an epibiont, *L. radiata* is somewhat commoner. So, it is known to live in epibiosis with algae, especially brown algae of the genus *Sargassum* (Mawatari, 1963). Besides this, *L. radiata* was recorded as a member of epibiosis on a shellfish *Pinna nobilis*, on the preadult hosts (22-50 mm in length) with frequency of 6%. These hosts live in coastal area but when they grow up, they move to depth of 5-15 m onto the sand bottom covered with grown seaweed (Zavodnik, 1967). The further proof that this species prefers meadows of flowering plants is its presence in meadows of *Posidonia* in biocenoses, and in the zone of corals up to 50 m (Riedl, 1991). The bryozoan *L. radiata* is also member of a community of coastal terrigenous mud at depths of 10-15 m (Zavodnik, D & Zavodnik, N., 1982). It is also observed in benthic communities in infralittoral in phytal, where is very sciaphile (Gamulin-Brida, 1974).

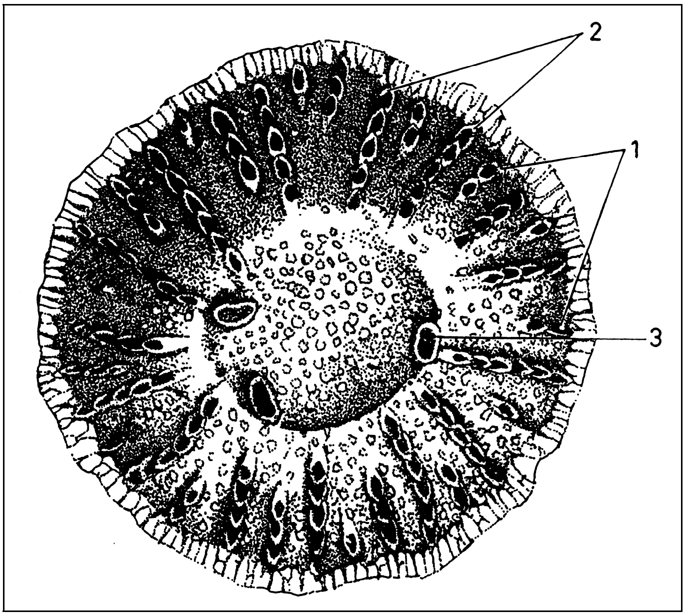

Figure 10. *Lichenopora radiata* (Audouin, 1826); View of colony

1. series of shorter-zooecia, 2. series of longer zooecia, 3. orifice of ovicell; according to: T. Hincks, 1880 Vol. II, pl. LXVIII, fig. 9

Distribution: Mediterranean (Riedl, 1983, 1991), as well as in Japanese waters (Mawatari, 1963). As this species is rare in fouling communities and is characteristic for biocenoses, especially of middle and lower littoral, it is not well represented in the available literature of fouling communities. There are no other data, and it shall not be told that this species is not distributed in wider area.

For the Adriatic, this species is first mentioned as *Discosparsa patina* by Heller (1867) from Hvar, Vis and Korčula, while Grube (1861) cites it for Lošinj and Graeffe (1905) for Trieste and Rovinj. But in later years, the only person mentioning it for the Piran Bay is Vriser (1978, 1986), and all the others in biocenoses. In benthic communities *L. radiata* was found at Krk coast in Omišaljska uvala (Zavodnik et al., 1981), at Osor island in the meadows of *Posidonia oceanica* (Zavodnik, D. & Zavodnik, N., 1982), while in the corresponding meadows in the infralittoral of northern Adriatic this species is mentioned by Gamulin-Brida (1974). In biocenoses at Istra coast, *L. radiata* is also present in Rabac area (Zavodnik & Vidaković, 1982).

Classis *Gymnolaemata*

Order *Ctenostomata*

Zooecia are flattened, cylindrical or sack like. The walls are not calcified, but they are membranous or gelatinous with a terminal opening, which is closed by ruffled collar. Only one other suborder has stolones that are actually kenozooids. They do not have ovicells or avicularia. They form massive colonies, mostly bark-like and rarely erect. Stoloniformous bryozoans are reticular or thickly crowded, like upright tufts. Zooecia are usually half-transparent, the opening is terminal or frontal in bark like species, without the opercular cover. Chitinous quills (spines) may be present. The representatives of this order mostly grow like a miniature tree or a massive flattened form. Several of them have structures of skeleton suitable for piercing shells of other organisms, mostly in molluscs, and in primeval times (Palaeozoic) mostly in *Brachiopoda*, the oligomerous animals similar to *Bryozoa* and *Pheronidea* (Mc Kinney & Jackson, 1989).

Suborder *Carnosa*

In these bryozoans zooids are detached or touching, usually bulbous. Ancestrula produces colonies of budding zooids.

Family *Flustrellidae*

Colonies are made out of chitin, flexible, expansion is erect, multiserial, the zooecia touch each other. Avicularia are usually simple.

Genus *Pherusella* Soule, 1951

The colony is chitinous, bark like or upright, made of simple layer of large zooecia, connected at the base and separated at the top. The opening is square, lined with a thickened chitinous edge.

Pherusella tubulosa (Prenant & Bobin, 1986)

Pherusa tubulosa Ellis J & Solander 1786: 1, text.; Heller 1867: 77, text.

The colonies are upright, chitinous, look skinny. When young, colonies are flattened, while in adult stage are upright and branched. Zooids are together, coalesced with lower parts. The opening of the zooecium is square, closed with a membranous cover (Fig. 11 a, b).

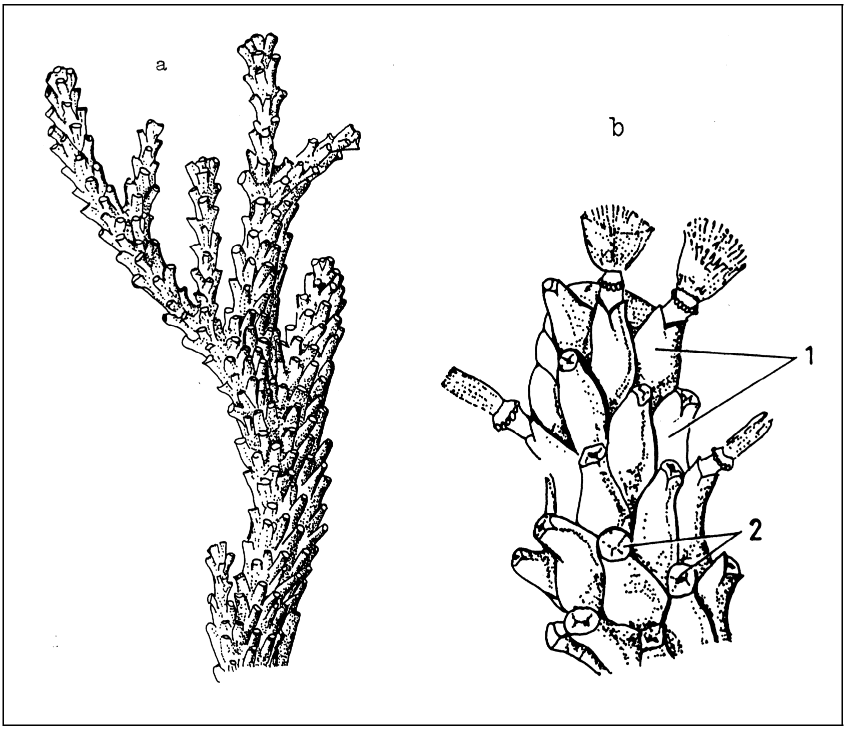

Figure 11. *Pherusella tubulosa* (Prenant & Bobin, 1956)
a. Colony erect and branching when adult, b. zooecia
1. zooecia (fused by their lower half), 2. quadrangular orifice of zoecia
according to: R. Riedl, 1983

Colour: Cormus of this species is light beige, horn-colored or light buff.

Habitat: This species is usually observed on rhizomes of *Posidonia oceanica* and taluses of brown algae of genus *Cystoseira* (Riedl, 1983, 1991). It is also found in harbours, even as a dominant species, for example, as a fouling species on eternite plates on coast of Sicily (Catania) (Cantone et al., 1981).

Distribution: This species is present in Mediterranean (Riedl, 1983, 1991). In the Adriatic, the same species is described under the synonym *Pherusa tubulosa* and found near Hvar and at Dubrovnik (Heller, 1867), while in the mid Adriatic this species was observed in vicinity of Zadar at Veli rat (Brusina, 1907).

Suborder *Stolonifera*

In this group of bryozoans, the stoloniform colony is composed of special vase-like zooids, which start from branched stolones detached from the zooids by transversal septe.

Family *Vesiculariidae*

Colonies are upright or curved, branched irregularly. Zooecia curved downward, cylindrical to elongated oval, in groups or rows.

Genus *Amathia* Lamouroux, 1812

The colony branches dichotomously and is composed of crawling tubular stolone (stem) and upright growths in columns by one spout. Zooecia are distributed in groups, either on one or both sides of stolone, and the looks of the groups is wavy-circular, spiral. The zooecia are semi cylindrical, distributed in two parallel rows.

Amathia semiconvoluta Lamouroux, 1824.

Autozooids are distributed along the branches between the bifurcations. There are 2-6 groups on a stolone, each group having many autozooids (18-25).

Colour: Light beige or horn-colored, Fig. 12.

Habitat: Like *L. radiata*, this bryozoan is relatively rarer in fouling, and in a way also in benthos life communities. This species is mentioned in north Adriatic in a biocenosis about Kvarner (Heller, 1864), more often in littoral, for example on the coast of Krk (Omišaljska uvala) (Zavodnik et al., 1981), at Osor island (Zavodnik, D. & Zavodnik, N., 1982), on the coast of Istra on the eastern side at Raski Bay (Zavodnik, D & Zavodnik, N., 1986) and on the west coast in Rovinj area ("Two sisters" island) at depth of 28-31 m (Gamulin et al., 1968). In mid Adriatic Heller (1867) mentions the species *A. semiconvoluta* in the surroundings of Primošten, while in the deeper waters of mid Adriatic it was found by Gamulin-Brida (1962, 1974), as well as in benthic communities in circumlittoral of Southern Adriatic (Karaman & Gamulin-Brida, 1970). By the way, this species is present in the Mediterranean usually as an epibiont and more often on taluses of algae or bryozoan cormus up to 25 m of depth (Riedl, 1983, 1991).

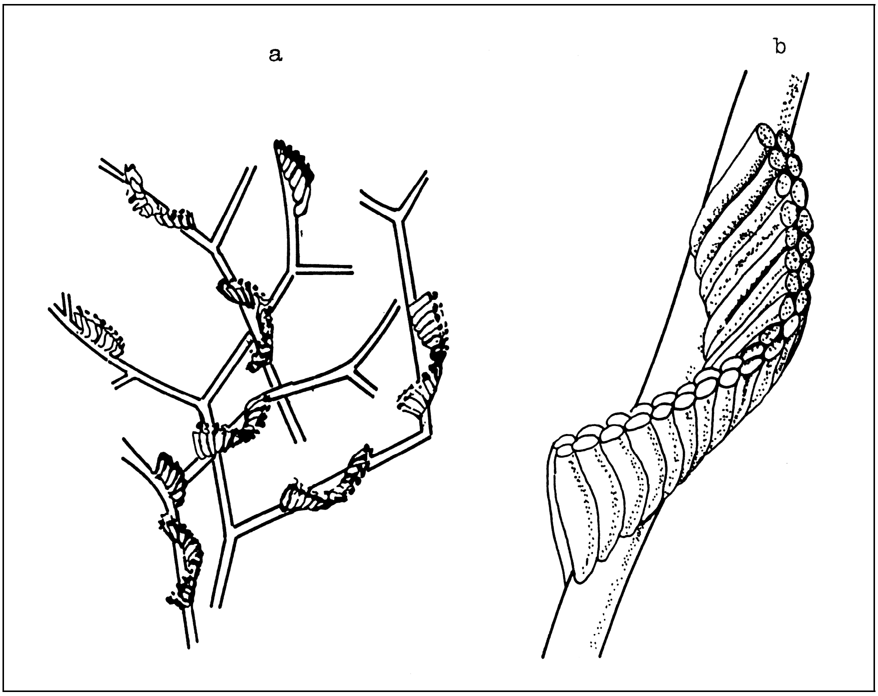

Figure 12. *Amathia semiconvoluta* (Lamouroux, 1824)

a. View of colony (autozooids placed along the branches between two bifurcations)
b. Double series of zooecia which occupy one side of branch, in spiral
according to: R. Riedl, 1983

Genus *Bowerbankia*, Farre, 1837

Colony is not dichotomous. It is curved or upright, composed of crawling or free-branched very tender stems along which zooecia are spaced. Zooecia are oval or cylindrical in adult colonies, while in young ones they are transparent or half transparent. Zooids are variously arranged, depending on the species, but when they are in a series, they are not connected regularly or helicoidally as in *Amathia*, but grouped and sometimes arranged as a chain or a line along the stolone (stem).

Bowerbankia gracilis **Leidy, 1855.**

Valkeria caudata Hinck 1861: 1, text; ; 1862: 22-30, 200-207, 303-310, 467-475.

Bowerbankia caudata Hincks 1880: 1, text; Marcus 1937: 5, text; ; 1938: 1, text.

Vesicularia stationis Ostroumov 1886*.

Stolones are very tender, much narrower than zooecia, less than 0.1 mm in diameter, always adhering to substrate, branching irregularly. Zooecium is elongated, semi cylindrical, biserial, blunt on the top, slightly narrowed below and elongated at the base into a short pointed part curved outwards, about 0.1-0.2 mm in diameter and 0.6-1.5 mm in length. Zooecia are normally distributed in groups along the stolones, across each other very precisely, or they are grouped together in such fashion that they look like a compact mass. On some zooids, smaller tailer sprouts are protuberant. Opercular opening in square with no operculum. Polypide has 8 tentacles (Fig. 13).

Colour: Zooecia of this species are white with yellow shine, thin and transparent, so the internal structure is seen through the body wall. Ancestrulas are bright red, resulting in pale red shine of colonies in reproduction period.

Reproduction: Length of planktonic life of larva is short, from 24 hours to just a few hours. The species reproduces in summer. The colonies reach sexual maturity during summer, while most of the colony dies at winter. However, several living specimens can be seen in dead colonies during summer. According to Brajko (1960), it is probable that special specimens can form winter buds. In warmer water, species can reproduce throughout the year except in the winter, while in colder water reproduction time is shortened from July to September, for example in British waters. In Mediterranean waters, such as Ligurian Sea, species *B. gracilis* is found as a fouling species on PVC and wood

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* not pages, cit. in: Brajko, V.D.: Mšanki Černogo morja – Trudy Sevastop. Biol. Stancii.13, 129-154

test plates on depth 1-4 m from April to January. However, it was not found (in this research) in August and November, as a species, but only as a genus *Bowerbakia* (Chimenz-Gusso & Taramelli-Rivosecchi, 1973). In the fouling communities in Adriatic its distribution is discontinuous, for example, from April to December, but lacking in August, near Rovinj (Igić, 1994). In Rijeka area it was found in the fouling complex in June, August and November, with greatest abundance in August, when it fouls glass test plates up to 25% on 30 m of depth (Sepen cove). It covers 17.5% on same substrates on 2m of depth in Omišalj Bay. In the same area in June it fouls only 2.5% and 3.5% in November (Igić, 1998).

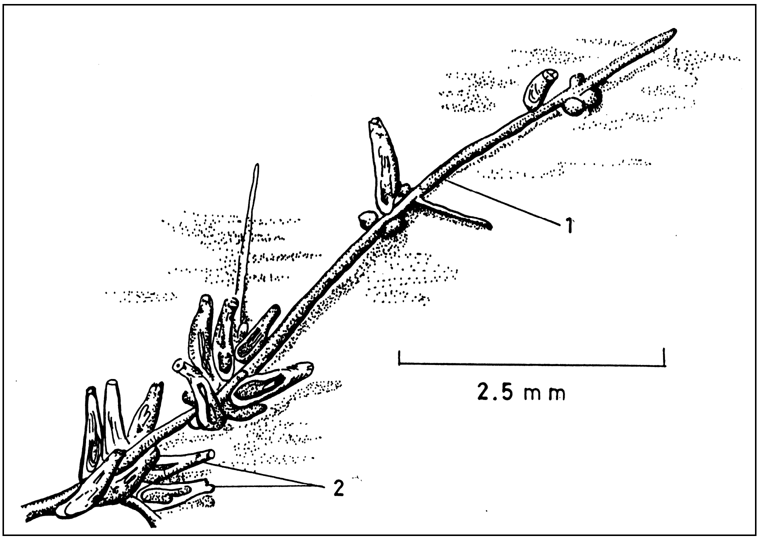

Figure 13. *Bowerbankia gracilis* (Leidy, 1855); Colony

1. stolon, 2. zooecia
according to: J.S. Ryland , 1965

Habitat: this species is together with bryozoan *Zoobotryon verticillatum* most resistant on conditions in harbours. For example in Genoa harbour it is resistant to increased concentration of nutrients and detergents (Geraci & Relini, 1970, a). It is one of the relatively few bryozoan species in Italian harbours (Relini, 1980). In Po delta, *B. gracilis* was observed as a fouling species after half a year of exposition of an asbestos plate in a small channel where water is periodically present; being pumped from the dry ground, so the habitat is sheltered and especially rich in nutrients (Matricardi et al., 1980). This species was also found in several investigated lagoons in central Italy, in Fondi region, where due to tectonic disturbances the surface layer of water has a salinity of 2-26x10^{-3}, and deeper layers 13-33 x10^{-3} (Ardizzone, 1984; Gravina, 1985). The species is also present in fouling communities in Venice lagoons (Candela et al, 1982/83) and Obetello lagoon (Relini & Pisano, 1977). As a fouling species on artificial substrates (asbestos-cement, wood) it is important in Catania harbour, where physical and chemical parameters are very variable (Salinity 17-35 x 10^{-3}, oxygen 9.05-16.80 mg/l, nitrates 3.30-23.50 mg/l, phosphates 0.01-3.10 mg/l, detergents from traces to 0.20 mg/l etc.). However in this habitat an especially frequent species is *Bugula neritina* and somewhat *Cryptosula pallasiana* (Cantone et al, 1981). The species *B. gracilis* is differently distributed in our waters in fouling communities. At the place where wastewaters are spilled into the sea (Ploma harbour), frequency on glass plates on 1.5 m is 25.0%, with enormous abundance, but in the same harbour on the cleaner place presence increased progressively from 0.10 m to 10 m. So, at the surface, the frequency is F=15,4%, at the depth of 1.5m F=16.7%, and at the depth of 10m F=46.2%. The highest abundance (Am=CC) is found at 10m depth, while at the surface and at 1.5m depth, abundance was doubly smaller. In Rijeka Bay it was also found that abundance of this species increases with depth gradient. On 0.10 m it is only qualitatively important. On 2 m of depth, on three localities, frequency is different (F=7.2%, 10.5%, 18.6%), while covering rate is from 8 to 12%. On 30 m presence is in traces (3%) but cover is 30% of surface (Igić, 1998). In Bakar Bay as a fouling species on glass test plates on two depths, presence is greater in upper infralittoral (1.5 m) (F=26.30% in harbour for spilled cargo, 36.8% on bay entrance) when compared to upper mediolittoral (0.10 m) (F= 5.2% in harbour). The harbour has most abundant population with greatest cover (20%) (Zavodnik et al, 1978). In many other spots on our coast this species is only of secondary importance dependless on habitat quality as the frequency is small and almost the same (F=5.9% - Raski Bay) (Igić, 1986) (F=5.1% factory for fish products Mirna Rovinj, F= 6.7% - Crveni otok Rovinj) (Igić, 1994), while abundance is almost non-existent.

Distribution: Species *B. gracilis* is known to be cosmopolitic. It is not found only in polar areas (Hyman, 1959), while it is found both from Arctic through all eastern Atlantic, Mediterranean, Black Sea, Sea of Marmara. It is also found on Suez Canal (from Port Said to Devresoir) (Ghobashy et al., 1980), and on Pacific coasts in ecosystems of Hawaii shores and their harbours on asbestos test plates (Grovhoug & Restetter, 1980), on acrilate plates in California harbours (Ehrler & Lyke, 1980). In the fouling complex of Argentine harbours it is variously present, from insignificant (Mar del Plai) (Bastida et al, 1980) to relatively common (Puerto Quequen, Puerto Belgrano) (Lichtschein de Bastida & Bastida, R., 1980).

In benthic communities in Adriatic this species is rarely mentioned. In Raski Bay it was found in biocenoses where is totally insignificant by its presence (Zavodnik, D. & Zavodnik, N., 1986).

Order *Cheilostomata*

These bryozoans have upright, flattened and crawling colonies. Walls of zooecia are calcified, shaped like flat boxes, sacks and rarely cylinders. The opening of zooecia is on the frontal part on the top or under the top. In most species, frontal and basal walls have greater surfaces than vertical walls. Heterozooids are generally abundant, especially avicularia and heterozooidal structure where the embryo is developing. There are three known zooid types used for development and placement of embryo. This order is richest in species, very diverse concerning way of growing, presence of stolones etc.

This order contains two suborders:

1 - suborder *Anasca*, without a compensing sac that would eject tentacles through muscle contraction -

2 - suborder *Ascophora*, with compensing sac

Suborder *Anasca*

Representatives of this suborder have zooecia with front part covered with large mobile non-calcified membrane. Part of this membrane is the covering of zooecium (Fig. 14a, b).

Suborder *Ascophora*

In these bryozoans complete zooecium is calcified, smooth, whole or on margins perforated with numerous pores. Colonies are flattened; bark like or upright and then they are mostly stiff and hard. The compensing sac for ejecting tentacles is present, and it can be enlarged by flexing of parietal muscles. While water is getting in, the space in zooecium is decreasing and the tentacles are being ejected outside of zooecium (Fig. 15a, b). Tentacles are taken inside again by retractor muscles.

Both suborders contain flattened, upright crawling non-stoloniform and stoloniform colonies.

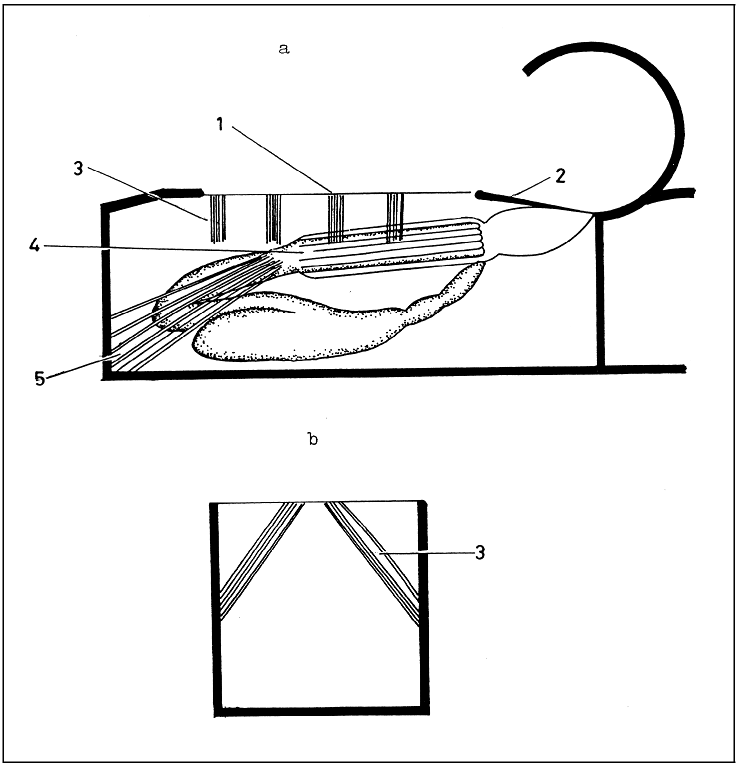

Figure 14. Characteristic of suborder ANASCA - structure of zooid (drawing)
a. Longitudinal section through zooecium, b. Transverse section through zooecium
1. frontal membrane, 2. operculum, 3. parietal muscles, 4. tentacle sheath, 5. retractor muscles
according to: J.S. Ryland , 1965

Non-stoloniform erect *Cheilostomata* - the colony is erect-upright. Most autozooids are not directly connected to the substrate, but they are connected to tiny zooids that form basic colony. Colonies have stiff non-mobile or mobile calcified skeleton, with or without attached rhizoid.

Non-stoloniform flattened *Cheilostomata* - the colony is flattened, composed of zooids thickly placed in one plane. If there is space between, they still compose a single reticular object. Every zooid is connected with three of more others.

Stoloniform *Cheilostomata*. The colony is flattened, stoloniform, crawling, formed from non-serial lines of zooids. Zooids are bifurcate and make discontinuous, flabby, reticular objects. Every zooid is connected with two, rarely three others. There are no avicularia and vibracula, and often there are no ovicells either.

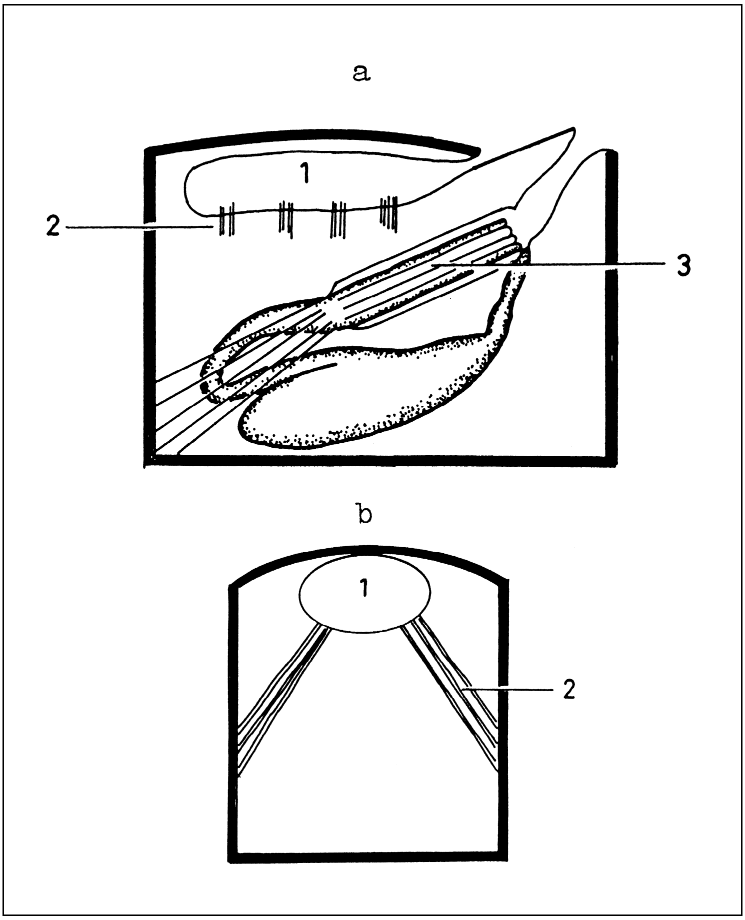

Figure 15. Characteristics of suborder ASCOPHORA- structure of zooid (drawing)

a. Longitudinal section through zooecium,

b. Transverse section through zooecium; frontal wall

1. compensation sack, 2. parietal muscles, 3. tentacle sheath

according to: J.S. Ryland , 1965

Suborder *Anasca* - erect non-stoloniform *Cheilostomata*

Family *Scrupocellariidae*

Bryozoans of this family have zooecia in two or more series. Over the front side of zooecia is a complex spine. Avicularia and vibracula are present, rarely only avicularia. Colony is upright, dichotomously branched and made out of zooecia distributed in lines, which are thickly connected in the same plane. The structure is compact and there is no tendency for flabby habitus. Zooecium is square or with a complex lower part. The opening is usually equipped with a spine and often protected by an opercular plate (modified spine). It is elliptic or oval in shape and usually completely covered with a membrane (in some cases with a calcified plate).

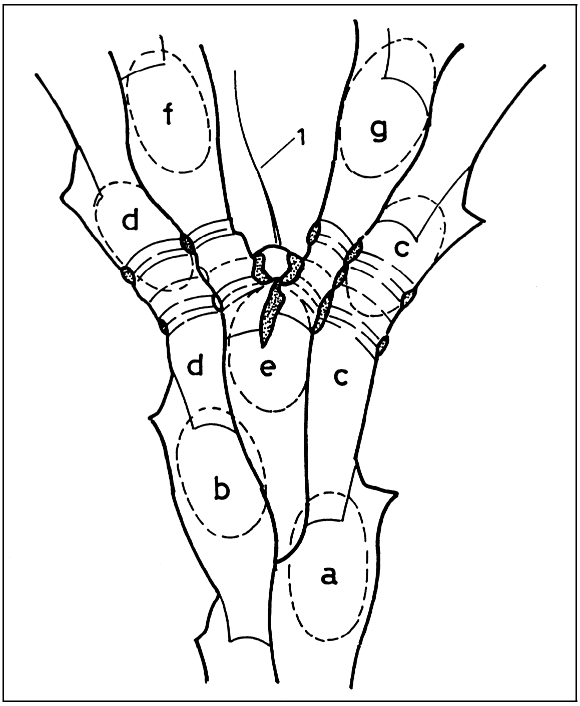

Figure 16. Plan of branch bifurcation in basal view (drawing)

Leters: a, b, c, d, e, f, -described on Fig. 19

1. frontal avicularium situated proximal portion of bifurcation branches

according to: J.S. Ryland , 1965

Genus *Scrupocellaria* Van Beneden 1845

Colony is branched and looks more like it is creeping along the ground. The branches are connected at every bifurcation and contain zooecia in two lines. The fashion of bifurcation is an important systematic character. Looking from the base, the zooecium is completely closed, while the bifurcation is just above it. The joint of four zooecia is clearly visible at the place where the lower parts f and g are crossing. The middle and upper parts cross immediately beside c and d (Fig. 16). There are 1 or 2 vibracula, which are rarely absent in some species, in the sinus on the frontal part of the zooecium. The vibracula are smaller, oriented parallel or perpendicularly to the longer axis of zooid, occupying only a small lateral part of basal surface. Avicularia are sitting, placed on the sides at the upper and outer angle. Lateral avicularia are sometimes almost gigantic, rarely atrophied and looks like the only one formed. Zooecia are rhomboidal with the oval frontal part. The opening is permanently circular, with or without the covering. There are mostly four spines on the upper edge of zooecia. There is a special spine called scutum in many species, reaching to the middle of inner wall of zooecium. This genus is very rich in species. There are over 20 known and widely distributed, whose number increases more toward the southern latitudes.

Scrupocellaria reptans Linnaeus 1758

Creeping coraliline Ellis 1755: 1, text fig. b, pl.20.

Sertularia reptans Linnaeus 1758: 1, text.

Cellularia reptans Pallas 1766: 1, text; ; Johnston 1847: 1, text figs. 3-4 ed. pl.58; Dalyell 1847: 1, text; Smitt 1867: 284, text figs. 37-40, pl.31; Ellis & Solander 1786: 1, text pl.63; Lamarck 1835-38: 1, text.

Scrupharia reptans Oken 1815: 1, text.

Crisia reptans Lamouroux 1816: 1, text.

Acamarchis geoffroyi Audouin 1826: 225, text fig. 4.

Bicellaria reptans De Blainville 1834: 1, text.

Canda reptans Busk 1852: 1, text figs. 3-4, pl.21.

Colonies are branched so they form somewhat circular brushes, crawling, but looking like bushes. The appendages are on the end of circular threads or in some other curve. The branches are dichotomously divided into numerous septae and with at most 5-6 zooids between bifurcations. Zooecia are biserial, alternative, oval and elongated so that the proximal part is the narrowest, while the opening is oval and covers app. 2/3 of front part. There are usually 3 spines on the external distal angle. They may be smaller on the ovicellate zooecia. Generally there is one spine on the internal angle. There is a well-developed scutum in a branched form covering the opening. Vibracula are present on the basal surface, one at the base of every bifurcation. Lateral avicularia are small and usually hidden behind the spines, large frontal avicularia are present on most zooecia, with a mandible in proximal position. Ovicells are sub-globular, spotted, and at the base of the branches are square. Polypides have 14-16 tentacles.

Color: embryos in this species are dark-pink (coral). Polypides are light orange (figs 17a, b, c).

Reproduction: In Mediterranean this bryozoan can be found throughout the year, while the embryos develop in February, June and November. In our area, settling on newly put substrates is observed from July to October. By the way, in all seasons except winter it is possible to observe settlement of this species on various immersed substrates.

Ecophysiological characteristics: Monthly increase of growth of the cormus *Scr. reptans* is 3-8 mm (8 mm in August). The weight is undetectable, as the height of colony is 3-3.5 cm and abundance small (at average 1.28 g/80 cm^2 on an oyster *Ostrea edulis* (Igić, 1975).

Habitat: it lives to the depth of 50 and more meters, on the littoral of the shores. In biocenoses it is found from infralittoral to circalittoral, and more often in biocenoses of phytal on a detritus bottom (Gamulin-Brida, 1974). This species is however rarely found in shallow waters such as lagoons (Orbetello) (Relini & Pisano, 1977). This bryozoan prefers clean waters. Its presence in fouling communities is not imposing in our conditions and is only qualitative on glass test plates, for example in Rovinj area (Zavodnik & Igić, 1968). In the same area only few reach presence of up to 27.2 %, and cover of 12% (Igić, 1972, 1982).

However, this species is more often as an epibiont on various hosts. It often settles on algae, mostly brown algae, for example *Laminaria digitata* (Stebbing, 1972), species of *Sargassum* or *Cystoseira* (Riedl, 1991). It is interesting that this was the only bryozoan species present as an epibiont in a very rich epibiosis (47 algal and 139 animal species) on the talus of a very tender green alga *Acetabularia mediterranea* (Zavodnik, 1969). Also it is often settling on a marine flowering plant *Posidonia oceanica* (Riedl, 1991), and on bryozoan corms, for example on *Hippodiplosisa foliacea* (Nikolić, 1959). Among the hosts are also edible shellfish. The research showed presence of 2.8-17.6% of *Sor. reptans* on oyster (*Ostrea edulis*) (Igić, 1975). The frequency (F %) on mussels (*Mytilus galloprovincialis*) is lower, F=0.89-1.70% in north Adriatic (Igić, 1975) and F=2.70% (Igić, 1981) in mid Adriatic. When settling on organisms, very important are orientation and choice of location.

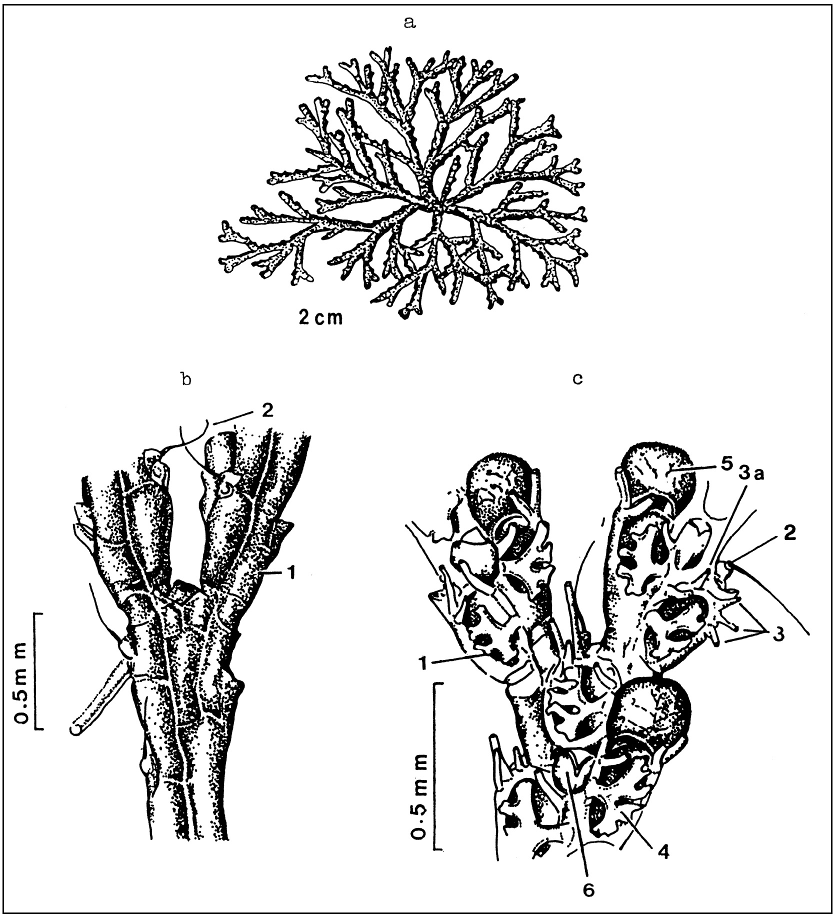

Figure 17. *Scrupocellaria reptans* Linnaeus, 1758

a. Dichotomously branch colony
b. Zooecia at a bifurcation in basal view (zooecia biserial, alternate, ovate, narrowed below
c. Zooecia at a branch bifurcation in frontal view
1. zooecium
2. vibraculum
3. three spinae present on the outer distal angle of the zooecium
3a. one spina on the inner angle of the zooecium
4. scutum branched in form and covering the orifice of zooecium
5. ovicell - subglobular, punctured
6. avicularium

according to: R. Riedl, 1983 (a);. J.S. Ryland, 1965 (b, c)

On the cormus of *Flustra foliacea* (*Hyppodiplosia foliacea*) the orientation is pointed toward the distal part, perhaps due to positive phototaxism, and seemingly due to reduction of competition (Ryland & Stebbing, 1971).

However on the talus of algae *Laminaria hyperborea* orientation toward light is lacking, when it settles more on younger parts due to lessened competition, and less on older parts of the talus, possibly due to effect of sea currents (Ryland & Stebbing, 1971). However, the opposite is observation for the talus of brown alga *Fucus serratus*. There ancestrula longs for the basal part, probably due to direction of movement of sea water (Ryland & Stebbing, 1971).

Distribution: in the European waters it spreads from Norway and Iceland to Madeira, Mediterranean (French, Italian and Spanish coast) and Adriatic (Riedl, 1983). It the earlier research this species is mentioned for mid Adriatic (Olivi, 1792), around the islands Hvar, Korčula, Lastovo near Dubrovnik (Heller, 1867), in Zadar area (Brusina, 1907), and on the north in the Trieste Bay (Graeffe, 1905). In later research, *Scrupocellaria reptans* as a fouling species was found near Rovinj, in Bakar Bay (F=3.5%, P=6.2% as a covering rate) (Igić, 1982) and very rarely in Rijeka Bay (F=0.3%, P=2.7%) (Igić, 1982). However, in contrast to the species *Scrupocellaria bertholettii*, this species is more common in biocenoses of north and mid Adriatic (Gamulin-Brida, 1974) and south Adriatic (Boka Kotorska Bay) (Karaman & Gamulin-Brida, 1970).

Scrupocellaria bertholettii Audouin 1826

Acamarchis bertholettii Savigny 1812: 1, text fig. 2, pl.11.

Scrupocellaria capreolus Heller 1867: 77, text.

Scrupocellaria reptans var *bertholetti* Waters 1896-1897: 43, text; Hincks 1887: 150, text.

Cellularia (Scrupocellaria) Berthollettii var. *carpeolus* Ostroumov 1886*; Perejaslavceva 1890-1891*; Zernov 1913*; Borcea 1931*

Colonies of this species are bushy and much branched. The branches have at most 5-7 zooecia between bifurcations. Zooecia are narrowest in the proximal part. The opening (opesia) is elongated and covers approximately two thirds of front side. Zooecia carry up to six spines, 4 on the top from the outside, and two laterally from inside. Ovicells carry spines, one and sometimes two on the inside angle. Scutum is present in most zooecia. It is simple, bifurcated at the top, and sometimes divided into two parts. It never covers the edges of the membranous area, is reduced and then looks like a little thread or fork, and

* not pages, cit. in: Brajko, V.D. (1960): Mšanki Černogo morja – Trudy Sevastop. Biol. Stancii.13, 129-154

sometimes is lacking altogether. In this species vibracula are on the basal part, one at the base of each bifurcation. Lateral and frontal avicularia are not equally distributed. The lateral avicularia are sparser, while the frontal are present in most zooecia. They are well developed with lower jaw directed at proximally. On the inside angle the avicularia are very sparse, one or sometimes two. Ovicells are in shape of sub-globular, punctured and square to the branch axis (Fig. 18).

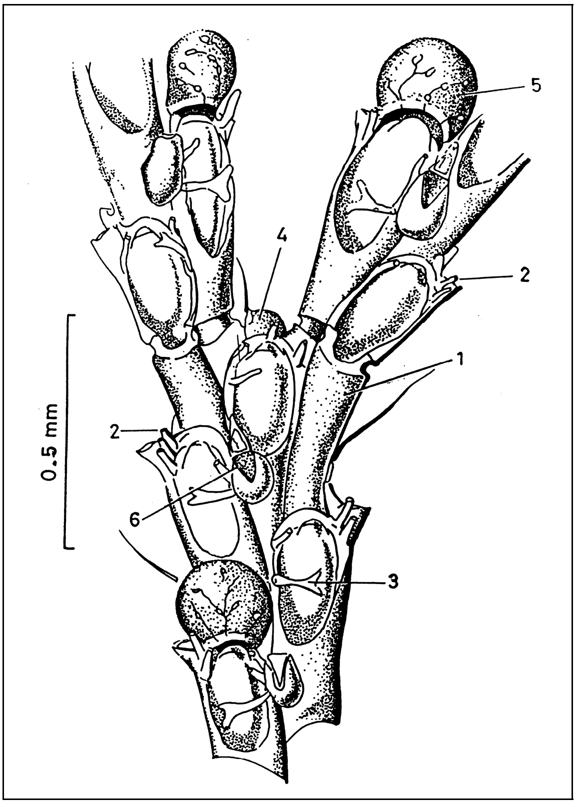

Figure 18. *Scrupocellaria bertholettii* Audouin 1826; View and structure of the heterozooids; Zooecia at a branch bifurcation in frontal view

1. zooecium
2. three spinae present on the outer distal angle of the zooecium
3. scutum branches at the tip
4. vibraculum
5. ovicells subglobular, punctured
6. avicularium

According to: J.S. Ryland, 1965

Color: Colonies are white with yellow shine, but due to red ancestrulae they turn orange in reproductive period.

Size: adult colonies usually attain size between 15 and 25 mm, sometimes 40-50 mm. Zooecia are about 0.4 mm long (Ryland, 1965).

Reproduction: In some seas (for example Black Sea) this species is found throughout the year. In the cold season colonies were observed orange in colour, as the ancestrulae were immensely present in ooecia (Brajko 1960). However, in Venice lagoons, embryos were found in July and August (Ryland, 1965), or even in September. Ovicells are present in these waters already in April, although they are mostly seen from July to October (Candela et al, 1982/83). By the way, in that area there are small colonies seen sporadically in spring and summer period. The very variable salinity in this area has influence on decreased number of bryozoans, and also on shortened season (Candela et al, 1982/83). In our conditions settlement of this species on short exposed test surfaces was found in Rijeka region in August, September and October, with insignificant abundance and cover of substrate (cover - 1.5% in October, 2% in August and 3.3% in September) (Igić, 1998).

Habitat: Due to eurihaline this species tolerates oscillations of salinity in lagoons (Relini & Pisano, 1977; Candela et al., 1982/83). This bryozoan spread vertically from the surface through all infralittoral. For example, in the Rijeka area, *Scrupocellaria bertholettii* is present in fouling complex with greater frequency on 30 m (F=4.8%) than on the surface (0.10m) (F=1.4%), while the abundance was very small on both depths (Igić, 1998). The same species also spreads horizontally, as it is found both on the shore and in open water on platforms, 6 km from shore on depths up to 14 and 20 m (Relini et al., 1976). This bryozoan is also adapted to conditions within the thermal power plants (Relini & Romairone, 1976), and is one of the leading fouling species, for example, in a channel with slow flux of seawater and relatively more light (Torvaldaliga power plant) (Relini et al., 1980). Although this species is found in deeper clear waters it is very tolerant to pollution, so it is more common in polluted sites, especially in harbours. It can be found in smaller coves and larger bays and in sites of large wave action (Agius et al., 1977). The species *Scrupocellaria bertholettii* can thrive in harbours with combined pollutants, like urban sewage waters and heavy metals from protective antivegetative paint against fouling on vessels (Igić, 1999). It also thrives in special lagoon habitat with enormous quantity of mud (30-60 cm) with small water circulation, that is, weak direct connection with the sea, where on the bottom the decomposing process has already begun (Gravina et al., 1989). In relation to substrate composition, it settles on various artificial objects (glass, cement-asbestos, wood etc), plastic boxes, chests, but also as an epibiont on algae, shells, sponges etc.

Distribution: this species is characteristic for warmer waters, so it is mostly a circumtropic species. The greatest distribution is in warmer waters of

Atlantic and Pacific. It is not found in Western Europe (Ryland, 1965). It is however present in the Mediterranean (Napoli, Capri, Rapollo, Malta, Monaco etc) (Ryland, 1965), Red Sea, Black Sea (on the south coast of Crimea, the northwestern part of Black Sea) (Brajko, 1960). In the Adriatic it is well known, especially in lagoons of Venice, where it is together with genera *Cryptosula*, *Bowerbankia* and *Conopeum* among the most important bryozoan species (Occhipinti & Ambrogi, 1980). Of the earlier data on Adriatic bryozoans, Graeffe (1905) mentions this species for the Trieste Bay. Our research shows that *Scrupocellaria bertholettii* is rare as a fouling species and only qualitatively important. For example, at Rovinj F=0.2%, cover 5% (Igić, 1982), and it is somewhat more present in Omiš Bay (F=13.4%, cover 8%) (Igić, 1998). In the harbour in Verudo Bay (Pula), frequency was 2.63% and dominance 0.03% in a fouling community (Igić, 1999). In the benthos cenoses it is also very rarely found, for example in Raski Bay (eastern coast of Istra) (Zavodnik D. & Zavodnik N., 1986).

Family *Bugulidae*

Genus *Bugula* Oken 1815

Colony is erect, bushy (Fig.1), leaf like with not jointed and bifurcated branches that may be shaped in spirals. Bifurcation of branches with zooecia is a systematic character for species. The first zooecium is signed as a, and the second with b. From all the zooecia the outward zooecia are c and d, and the inside ones are e and f. Zooecium g without the double bifurcation is not systematically important (Fig. 19). Developed branches of the colony are made out of a single layer of zooecia. Zooecium is boat-shaped, in two or more lines. The upper part of zooecium is not rounded and looks like it is cut. The surface is whole or partially membranous. The lower part of zooecium is wider at the base, the walls are calcified at the sides. An operculum is not clearly differentiated. There may exist some spines (usually 4 or 5) on the upper free angles of zooecia, short, stiff. Avicularia are often present. They are shaped like a bird's head and are placed on the lateral edge of all or many zooecia, usually one on every zooecium. The bill, when looked from the side, is usually curved downwards (Fig. 20A) or looks like a hook (Fig. 20B). This genus is richest in cosmopolite species due to great space distribution.

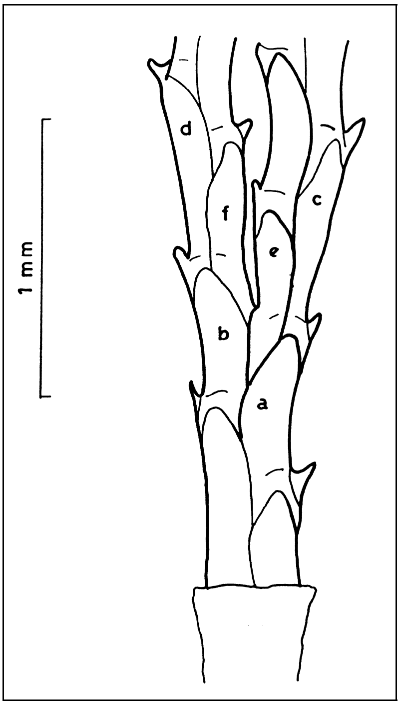

Figure 19. Plan of branches bifurcation in basal view (*Bugula*)
a. First zooecium from which two zooecia are budded in preparation for the bifurcation,
b. the one beside it; c. d. the outer zooecia above a, b; e. f. the inner zooecia
according to: J.S. Ryland , 1965

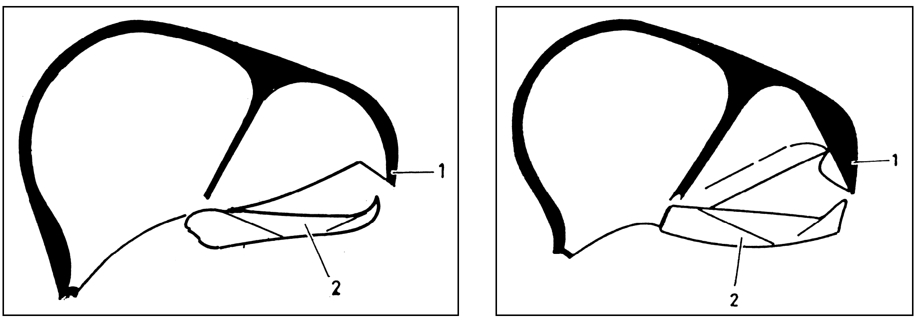

Figure 20. Avicularia of species of genus *Bugula*, seen in profile (drawing)
A. Avicularium - beak down bended (*Bugula* spp.)
B. Avicularium - beak hooked (*Bugula* spp.)
1. beak, 2. mandible
accaccording to: J.S. Ryland , 1965

Bugula neritina (Linnaeus) 1758

Corallina cellifera Ellis 1755: 1, text.

Sertularia neritina Linnaeus 1758: 1, text; Linnaeus 1767: 533, text; Linnaeus 1791: 3021, text; Olivi 1792; Chiaje 1823-1825: 1, text;

Cellularia neritina Pallas 1766: 1, text; Fleming 1828: 1, text; Busk 1858: 124, text fig. 5, pl.8; Landsborough 1852; 1, text; Lamarck 1836: 1, text

Acamarchis neritina Lamouroux 1810; Lamouroux 1816: 1, text; Lamouroux 1821: 1, text; Risso 1826: 1, text; De Blainville 1830: 1, text; De Blainville, 1834: 1, text, fig. 3.; Orbigny 1839: 1, text; Orbigny 1851-54: 1, text.

Alive colonies look like bushes (Fig.1). Tops of the branches (but not colonies) show slight spiral growth. Branches are composed of ”houses” in two lines. In zooecia bifurcation is small (Fig.21). Zooecia are biserial, alternative, large, elongated, narrowest in proximal part and widening toward the distal part. There is no spine, or very rarely there is a small one in the upper outward corner. The free upper angle of zooecia makes a slight outward edge. The opening is oval, sometimes greatly scratched and narrowed from below, covering about two thirds of the space. There are also no avicularia. Ovicells are connected to the inner upper part of zooecia and under a right angle to the branch axis. Polypides have 23-24 tentacles (Fig.21).

Color: Live colonies are reddish brown, while the dead ones are either very transparent or half transparent, even brown. Alive embryos are yellow, while dead ones are brown.

Size: If abundance is great, colony height is between 25 and 30 mm, while they can in extreme cases reach 80 mm. The zooecia are 0.6-0.8 mm long and 0.2-0.3 mm wide.

Reproduction: This species reaches sexual maturity at about 6 weeks from the moment of settlement of a larva (Agius et al., 1977). The larvae settle preferentially around the base of small surfaces (Walters 1991, 1992, Walters & Wethey, 1991). This is very evident in experiments with ascidian *Styela plicata*, as larvae most often found shelter around the base of knots on the body of this tunicate (Walters, 1992a). The survival of larvae is also greater in the first week if they settle in the crannies than in extended surfaces (Walters, 1991). Considering the time of settlement, it may vary a lot, in correlation with many factors, the most important being geographic areas. In colder waters (for example Great Britain) the seasonal distribution is shorter and lasts from May to October. In Mediterranean waters it lasts throughout the year except in cold months (January in Tarant Sea) with largest rate of settlement in June, July and extremely September (F=100%). The smallest rate of settlement is in February and April (F=20 and 25%) (Montanari & Tursi, 1983). On the shores of Sicily (Palermo) the species was not found in fouling complex in December and January, but it fouls very intensively in July (cover 120%), August and June (110%), and somewhat lesser in May (98%) (Riggio, 1979). In Genoa harbour the settlement of this species is shorter, from March to December, with a peak in spring-summer season (Geraci & Relini, 1970,a). In Civitavecchia harbour it can be found year-round (Chimenz Gusso & Taramelli Rivosecchi, 1973). There is an interesting situation in lagoons for bryozoans in general and therefore also for species *B. neritina*, when especially in sites with fresh water influx, season is shortened to summer and beginning of autumn and then this species is most developed (Candela et al., 1982/83). In lagoons of Orbetello the species *B. neritina* settles from spring to autumn, maximally in July (Pisano & Relini, 1978), while in lagoons of Venice, settling begins in May on artificial cement-asbestos plates (Relini et al., 1972; Barbaro & Franceskon, 1976) and lasts to June and July, with peak in June (Barbaro & Francescon, 1976). However, on our coast this species is not determined on substrates exposed for shorter time, so there is no precise data of seasonal distribution. It is also extremely rare in fouling communities on glass plates (F=0.1% - Pomer, 1.9% Rovinj, Pula) (Igić, 1982).

Ecophysiological characteristics: This species is found mostly in developed fouling communities on artificial substrates that remained in the water until one year (Tursi et al., 1979). However, there is an opposite opinion that this species is a pioneer species that settles on the clean substrate and as such is not concurrent to already colonized species (Bellan - Santini, 1970). There are experimental data that presence of primary film had no influence on settlement intensity of larvae, but only on dispersion. The larvae group at one spot instead of being randomly distributed on the surface (Mihm & Banta, 1981). Especially important is settlement of these larvae on ships with differently exposed parts toward sea currents, cavitations etc. On iron ships frequency total is 5.5% and average values of the surface occupied by the species are: 5.0% on the stern, 7% on the bow, 15% on stern-post, middle of the hull and keel, while propulsive system and rudder are not fouled. However on wooden ships for this species total frequency is 11.1% and only propulsive system fouled with 1% (Igić, 1968).

Especially interesting is relationship of *B. neritina* larvae and speed of sea water flux, as it is especially important for feeding regime. Zooids are more active in an ambient where water flows less than 0.04 m/s than in swifter-flowing water (McKinney et al., 1986). According to these authors, it is assumed that this bryozoan reacts to water movements as they bring food particles.

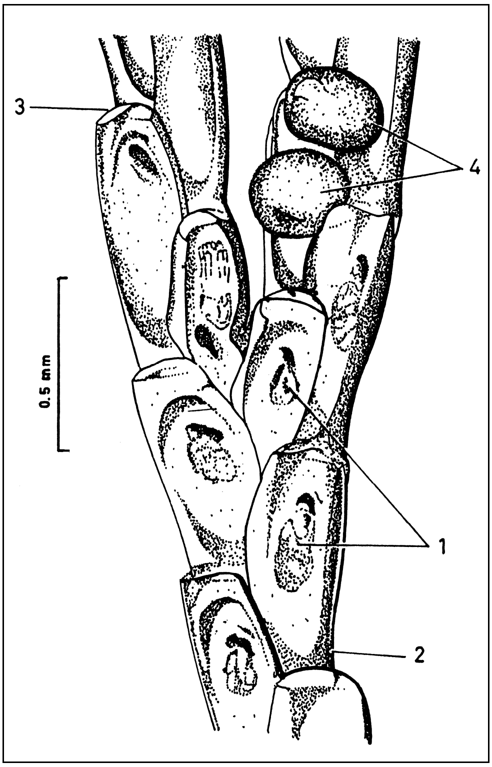

Figure 21. *Bugula neritina* (Linnaeus, 1758); Structure of zooecia
1. zooecia, 2. narrowest proximally part of zooecium, 3. zooecium no spinae, 4. ovicells
according to: J.S. Ryland , 1965

Habitat: This species is one of the most abundant members of fouling communities, especially in harbours (Ryland & Hayward, 1977; Winston, 1977) in tidal zone, upper infralitoral (Hughes, 1974; Caine, 1986) where it settles on piers, buoys, ships, logs and other submersed objects. The same species is found in inside tubes of the ships, intake ventiles (Igić, 1968), cooling facilities of thermal power plants (Relini & Romairone, 1976; Relini et al.,1974, 1980). It is often seen on natural substrates, for example rocks and shells. This species is most abundant in the first meter below the surface. On 0.20 m there are 308 colonies, on 1m - 172, on 5 m - 11, on 9 m - 12, on 14 m - 4, on 16m 0-3 colonies. These numbers are for the test surface of 1 dm^2 (Geraci & Relini, 1970b). Therefore, on the basis of this very picturesque data, this species can be treated as one of coastal surface species of up to first 10 m of depth, not entering submarine caves (Marcus, 1937). Regarding the quality of the habitat, the species *B. neritina* and the species *B. stolonifera* are highly ecologically adapted to organic pollution, especially the later species (Montanari & Tursi, 1983), so these two species are characteristic for harbour waters in Mediterranean (Relini 1980). Due to its adaptation on urban pollution, the species *B. neritina* in harbours of Palermo (Ardizzoni et al., 1977), Catania (Galluzzo 1980; Cantone et al., 1981) and Marseille (Leung Tack Kit, 1972), represents one of the characteristic species of incrustated fauna. This species is adapted to various degrees of eutrophication, small circulation of water, low oxygen level, high temperature, high content of silt (Riggio, 1979), and ambient with beginning of process of anoxia (Gravina et al., 1989). The same species is adjusted to special conditions in thermal power plants, in the places where there is great speed of moving water and turbulence, temperature up to 10^o higher than at the openings of channels, and where illumination is reduced (Relini & Romairone, 1976 - Vado Ligure; Relini et al., Genoa, 1980- Totvaldaliga).

This species also tolerates diverse kind and quality of substrate, some of which are already mentioned. It can also be an epibiont on various organisms, for example ascidian *Styela plicata* (Walters, 1992a) or a sea turtle *Caretta caretta* (Caine, 1986; Frazier et al., 1992). Rarely there is settlement on edible shellfish on culture parks in north Adriatic - oysters *Ostrea edulis* and mussels *Mytilus galloprovinciallis* (Igić, 1975, 1986), as well on mussels in mid Adriatic (Igić, 1981). In culture parks of shellfish *Crassostrea gigas* on coast of Malta, this species does not settle on the shellfish itself but on the plastic boxes and chests present (Agius et al., 1977). On Japanese shores it accepts various objects, such as logs, pillars, ropes, test plates etc. Species *B. neretina* is one of principal epizootics on *Pecten* shells (Mawatari, 1963).

Distribution: Marcus (1937) cites that distribution is not cosmopolite in strict sense, but that the species is confined to temperate and warm zones of all oceans, being transferred by ships. In spread that way to several harbours of Great Britain, from Milford Haven to Shorcham (Ryland, 1965). In Europe it is characteristic for the whole Mediterranean - Spain, Italy, France, both on shores and around islands in lagoons, and on the north coast of Africa (Cartagena) (Ryland, 1965). Riedl (1983, 1991) also cites this species as a Mediterranean one. Outside Europe *B. neritina* is found in fouling state all over the world, and in some places it is the most important fouling species, for example in almost all harbours of Suez Canal (Ghobachy et al., 1980), or on the coast of Japan (Kawahara 1965, 1969), in harbours of Hawaii (Grovhoug & Rastetter 1980) and California (Ehrler & Luke, 1980). On the southern part of the globe, it is found in Atlantic at the coast of Argentina (Lichtschien de Bastida & Bastida, R. 1980; Bastida et al., 1980) and in Pacific on the coast of Chile (Viviani & Di Salvo, 1980). In the Adriatic it is mentioned on the west coast in lagoons of Venice (Relini et al., 1972; Barbaro & Francescon 1976; Candela et al., 1982/83) and in middle part (Manfredonia) (Gherardi et al., 1974). On the eastern shore of Adriatic, this species is not prevalent after all in fouling communities on artificial substrates (glass plates), as the frequency is only 1-1.9%, rarely up to 5% about Rovinj area. Individual fishermen ships can be fouled up to 10-15% with this species (Igić, 1982). In Pula harbour, the species is only qualitatively significant (F=1.9%, cover 5%) (Igić, 1982), same as in Veruda Bay (F=4.55%, D=0.05%) (Igić, 1999). Similar situation is in Rijeka Bay, where this species is secondary in fouling communities, as the frequency is less than 0.5%, but the settlement can be very intensive in some moments, so cover can reach 13.3% (Igić, 1982). In North Adriatic, species *B. neritina* is mentioned by Heller (1867) and Lorenz (1863) in Kvarner, and in Trieste Bay it is mentioned by Graeffe (1905). By the way, in mid Adriatic, Brusina (1907) mentions this species for Zadar harbour as very abundant.

Bugula simplex **Hincks 1886**

Bugula sabatieri Calvet 1900: 1, text; Gautier 1952: 1, text.

Bugula flabellata Osburn 1912: 205, text pls.18-21; Rogick and Croasdale 1949: 31, text.

This species' colonies are cone, brush or fan shaped. Zooecia are narrowest on the proximal part, while on the distal part there are spines on a corner of that part of zooecium. The branches of the colony are narrow on the proximal and wider on the distal part. They are usually composed of 3-6 rows of zooecia. Avicularia are present only on zooecia of edge rows, they are directional about 1/4 on the lower outer edge and together with a hooked beak they are pointed downwards. Ovicells are sub-globular. Ancestrula has 5 spines and 3 short flattened stolones that point in ray shape.

Color: Colonies of this species are orange-brown, and sometimes they are straw colored. Embryos are yellow (Fig. 22).

Size: Colonies are 1-3 cm high. Zooecia are 0.5-0.8 mm long and 0.1-0.3 mm wide.

Reproduction: Ovicells are found in April, May, November, December, and embryos in April, May and December. The seasonal distribution of this species varies. In Mediterranean it settles to the substrate usually from April to December. In some places (harbour Civitavecchia) it settles throughout the year (Chimenz Gusso & Taramelli Rivosecchi, 1973). In the colder waters (Great Britain), though, seasonal settlements are from July to November, most intensive in August-September (Ryland, 1965). In northern Adriatic the species *B. simplex* is found on substrates from May to December, in greater numbers in July-September (Igić, 1975).

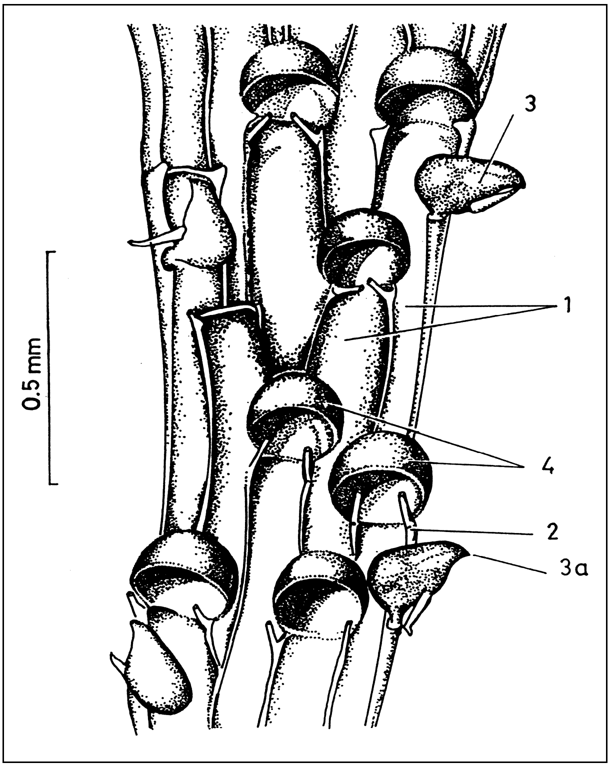

Figure 22. *Bugula simplex* (Hincks, 1886); Portion of branch in frontal view
1. zooecium, 2. spinae, 3. avicularia,
3a. the beak of avicularium down curved, 4. ovicells
according to: J.S. Ryland , 1965

Ecophisiological characteristics: As an epizootic on oysters (*Ostrea edulis*) and mussels (*Mytilus galloprovincialis*) in culture parks of northern Adriatic (coast of Istra), the monthly increase of growth is in June 3-4 mm and in July 5-8 mm. Life span of this epibiont on oyster and mussel shells on Istra coast (Pomer, Lim channel) is usually one month, maximally two months, and minimally it lives only about fifteen days. The frequency in the function of time, space and substrate varies greatly. Analysis of continuous settlement of *B. simplex* on oysters in Pomer culture park (south-south-east of Istra Peninsula) shows that in first and second year it was present only in 3.70% cases, and in third year in 75.90%. In the same time in Lim channel it was found in first year in 1.80% and in second year in 8.30%, which is the same figure (F=8.30%) as for the first year at Rovinj. In the second year it did not settle near Rovinj at all, while on the mussels it was secondary, as the frequency was 0.89-5.30%. The extreme case was first year at Pomer, when *B. simplex* was present on 14.30% of mussels, pointing that the third year was very suitable for settlement of this species especially on oysters.

By the way, the abundance of this species was in all cases small, showing cover of 10-25% on microhabitats such as shells of oyster and mussels (Igić, 1975). In Maloston Bay on mussel (*Mytilus galloprovincialis*) culture park, *B. simplex* had secondary importance for epibioses, as it was present 4 and 9.3% and covering 11 and 13.1% of shell (Igić, 1981).

There is some interesting research of settlement of this species on the horizontal substrate, where it was settling only on the lower side. It is assumed that it is more geotropism than sciaphile moment, as on the perforated substrate it also settles only on the lower but relatively more lightened side (Igić, 1984). Considering the relationship of *B. simplex* larvae to the primary film (periphyton) at the time of settling on the substrate, it was shown experimentally in laboratories that larvae significantly prefer filmed substrates, that is, those with a layer of microorganisms (Brancato & Woollacott, 1982).

Habitat: this species lives in shallow waters and according to some authors (Ryland, 1965; Chimenz Gusso & Taramelli Rivosecchi, 1973) in polluted harbours, so often with *B. neritina* and *B. stolonifera*. However, it can be said that this species is eurivalent on environment character, as it can often be found as a fouling species in clean water of culture parks (like in Pomer). It settles on submersed objects such as logs, rafts and other structures including ships. It also settles on artificial test substrates such as glass, sternite, plastic, wood etc. Of natural substrates, organisms are most prominent (for example edible shellfish).

Distribution: This species dwells in temperate-boreal waters of Atlantic. It is mentioned for eastern and western coast of Great Britain, Atlantic coast of USA, from Maine to Florida, while it is more abundant in Mediterranean and Adriatic (Ryland, 1965). This species is also found on the coasts of Argentine (Puerto Belgrano) (Lichtschie de Bastida & Bastida, R., 1980). Of early researchers of Adriatic, it is mentioned only by Brusina (1907) in Zadar harbour together with *B. neretina*, but is said to be rarer than the latter. In mid Adriatic, research of fouling complex in Maloston Bay in culture park proved the hypothesis that *B. simplex* is of secondary importance (Igić, 1981). In north Adriatic, excepting for culture park at Pomer (F=75%), it may be said that status of this species is similar in fouling community on glass test plates in Pula harbour (F=0.3%, cover 0.7%) or Bakarski Bay (F=4.4%, cover 3%) (Igić, 1982). In Raski Bay on oysters it is almost insignificant, analogous to Pula harbour with frequency of 0.8%. But in same site on plastic collectors for oyster breeding, its presence was more significant (F=25%), while the abundance in Raski Bay is insignificant as in all other sites. Settlement is usually 0.5-3.8

colonies on a test substrate (length of oyster shell, 57 mm, average abundance 0.2; plastic collectors, 4000 cm^2, average abundance 1.8) (Igić, 1986).

Family *Aeteidae*

Colonies are white, thin, crawling on the surface, usually tiny.

Genus *Aetea* Lamouroux, 1812

The colony is composed of tubular walls, so every zooecium has a crawling part on the surface and an upright free distal part. Stolones form on the place of contact and can be leaf like or like a necklace of pearls with thin tender sections. There are non serial zooids on the stolone and it is a sum of proximal parts of autozooids, which are treated as kenozooids which can sometimes be inserted between autozooids. The stolone is branched. Branches start from parts that are near the substrate. The middle part of autozooid is a stolone in shape of a cylindrical stem. There are neither avicularia nor ovicells.

Aetea truncata (Landsborough) 1852

Fistularia multicornis Müller 1776: 1, text.

Anguinaria truncata Landsborough 1852: 1, text, fig. 57, pl.16.

Cercariopora truncata Fischer 1866: 293, text.

This species differs in certain development stages. In its simplest form the colony contains rows of attached (sessile) zooecia, separated along the delicate threads. Zooecia are short, flattened, narrowed on the lower part. The upper part is not rounded. The erect parts of zooecia are in an upright plane, which is shorter than in, for example, species *A. sica*. The stem is spotted not striped. The top region that includes 1/3 or 1/2 of upright part of zooecium has no curved on the upper part. The surface of zooecium is large, insignificantly spotted and often equipped with tubular structures in shape of tail, which often grows out of the middle of upper surface. This part is pointed upward and its length can vary. In some cases this ”tail” can be extremely elongated and supported by neighbouring zooecia and so on (Fig. 23).

Size: The erect part of zooecium is 0.6-0.8 mm high.

Reproduction: The seasonal distribution of this species is different, correlated with climate. In colder waters, for example on the western coast of Norway, settlement is short, from July to November (Nair, 1962). In the Mediterranean waters, colonization is longer, and for example in harbour

Civitavecchia is from May to February, while it is more common from June to October, with a peak in August (Chimenz Gusso & Taramelli & Rivosecchi, 1973). There is a similar situation in other parts of Italian seas, that is, settlement last almost throughout the year, while the most intensive colonization is like in most fouling species, during the summer season (Relini et al., 1980). However, in Adriatic in Piran Bay, the settlement of species *A. truncata* is found in June, July, August and October (Vriser, 1986).

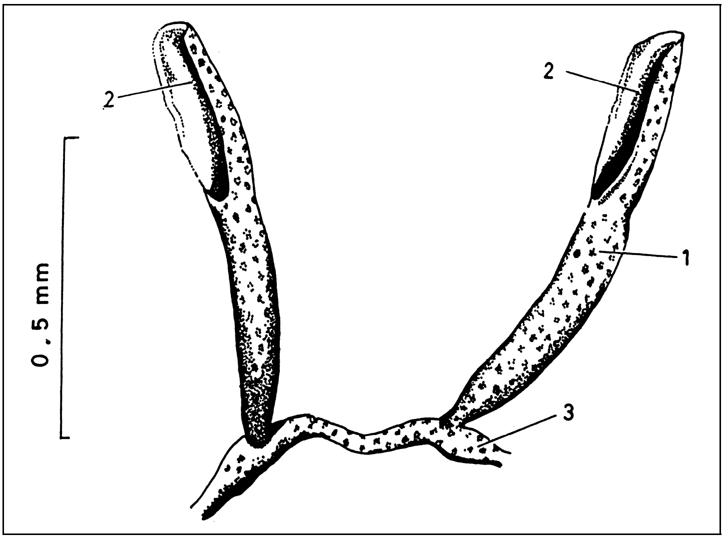

Figure 23. *Aetea truncata* (Landsborough, 1852); Portion of colony with two zooecia

1. zooecium, 2. orifice of zooecium, 3. stem (stolon)
according to: J.S. Ryland , 1965

Habitat: species *A. truncata* spreads from the middle tide line downward. It is most abundant in waters up to 50 m deep, and it reaches 150m. In the horizontal direction along the coast it comes to the open waters, settling on platform constructions on 14, 20 and 65 m (at Crotona in Ionean Sea) (Relini et all, 1976). It also settles in cooling equipment of thermal power plants, choosing microlocations on the end of the channel where speed of water movement is smaller and illumination relatively more intense (Relini et al., 1980). This species can be found both in clean waters and harbours, for example on the Sicily (Catania) (Galluzzo, 1980; Cantone et al., 1981), in harbour Civitavecchia (Chimenz Gusso & Taramelli Rivosecchi, 1973), on the coast of

Malta (Rinella Creek) (Agius et al., 1977), and in the inner part of Piran Bay (Vriser, 1986).

Regarding the substrate, this species is very tolerant, and can use many test surfaces, such as, glass, wood, sternite, PVC, cement-asbestos, limestone etc. It can also settle on ships, chests, cages in shellfish culture park, etc. As an epibiont it is known on talus of brown alga *Sargassum* (Mawatari, 1963) but also on the marine flowering plant *Posidonia oceanica*. On *Posidonia* it can settle on the rhizomes (Riedl, 1983), but also on leaves. Casola et al., (1987) found this species on top of leaves, and explain such distribution by microclimatic changes due to leaf maturity. Pisano & Boyer (1985) explain this phenomenon, which every species, including *A. truncata*, has a special way of reacting on host condition and habitat factors.

Distribution: Cosmopolitic species, living in all seas except for the polar ones (Ryland, 1965). As a fouling species it is known in Mediterranean, Suez Canal (Ghobashy et al, 1980), in the Pacific (Hawaii) (Grovhoug & Rastetter, 1980), Japan (Mawatari 1963), while there is no literature citing it for South American fouling communities. In Adriatic it is extremely rare fouling species. It is mentioned for Piran Bay with a very small abundance on limestone test blocks (Vriser, 1986), while on glass plates at Rovinj was determined only once in many years of investigations (F=0.2%, cover 0.3 %) (Igić 1982). Friedl (1817) is mentioning it as an Adriatic species.

Family *Membraniporidae*

Representatives of this family have large, crawling, calcified colonies. Zooecia are dispersed with no order on in linear series. The front part is membranous with raised edges entering the membranous part. There is a terminal opening on the zooecium. It is pretty large, closed with a membrane and usually surrounded with numerous spines. If there are avicularia, they are very specialized.

Genus *Membranipora* De Blainville, 1830

Colonies are calcified, bark like. Zooecia are square, simple. Angles are equipped with tiny growths. The front part is completely or partially concave. They are rarely in linear series. The opening of zooecium is in membranous area, covered with opercular cover, while the edges are raised. In most species the inner part of zooecium is covered with uniformly thin membrane, lying little below the edge. In some species this membrane is calcified, more or less, forming a solid plate that protects the portion (part of the wall surrounded with raised edges) of zooecium. But in species with even more intensive process of calcification, almost all front part of zooecium is hard. The position of zooecium shows a way of growth where a membranoporous structure is visible. The genus *Membranipora* is very present in space and time, it shows many variations.

Membranipora membranacea **(Linnaeus 1767)**

Flustra membranacea Linnaeus 1767: 533, text.

Flustra telacea Lamarck 1836: 1, text.

Reptoflustra telacea Orbigny 1851-1854: 1, text.

Colonies of this species are arranged in fine knots, which usually form harmonious shapes (Fig. 24a), Zooecia are elongated, distributed in rows, alternatively, with a hollow spine on every upper angle (Fig. 24b). The whole front part of zooecium is covered with a membrane, which is from the inside little under the smooth edge. There are no avicularia. Closed tubular appendages often develop from the front wall of zooecia (Fig. 24c). It is assumed that these appendages are ovicells, irregularly distributed over the colony. They often present in large numbers and in groups. Polypides have about 20 high tentacles.

Size: in tropics, they can, in somewhat more that a month, reach 4 cm in diameter (Ganapati et al, 1958; Menon & Nair, 1974). In cold Norwegian waters it takes three or four months to reach that size (4 cm) in August (Nair, 1962). Larvae of this species are relatively bigger (750µm) than in other bryozoans, for example *B. neritina* (200 µm) (Reed 1987).

Reproduction: Data from various parts of the world are in correlation with life conditions there. In Nordic countries (west Norway), the seasonal distribution of this species lasts from April to November with most intensive settlement in August (Nair, 1962). On the coast of Great Britain colonies settled on talus of brown alga *Laminaria hyperborea* survive the winter and some of them can live for more than a year, although the host life span is mostly up to a year (Ryland & Stebbing, 1971). Gametogenesis in this species starts in late winter, and sometimes colony starts to grow again in March (Lutaud, 1961), so the great colonies can develop in September (Ryland & Stebbing, 1971). However, in some research of this species' settlement, as in other species, there is discontinuity in colonization. For example, in San Francisco Bay (California) on monthly exposed test substrates (acrilite) the species *M.* m*embranipora* settles from February to July and again in November, while on bimonthly exposed plates settlement is observed throughout the year except in January (Ehrler & Luke, 1980). Considering settlement in Adriatic, in Venice lagoons the seasonal distribution is much shorter, as this species begins to settle in May and is present further in June and July, according to the research of Relini et al., (1972) and Barbaro & Francescon (1976) on same stations, so on three researched sites (S.Giogio, S.Basilio, Piazzale Roma) it was found only in June.

Habitat: Considering habitat quality, this species tolerates urban pollution in Venice Lagoon, as during the three months of settlement it was found on the most polluted site (Piazzale Roma) and only once at the entrance of the lagoon (S.Giorgio) (Barbaro & Francescon, 1976). At Piazzale Roma there is a low concentration of oxygen (O_2 - 63%) and high concentration of nutrients, especially phosphates ($P\text{-}PO_4$- 13 μg-at/l). As it thrives in eutrophied environment and estuaries, this species together with *Bugula* and *Schizoporella* species is one of the leading ones in fouling of ships in harbours (Edmonson & Ingram, 1939). Besides the harbours, this species also tolerates microclimate of cooling capacities in power centrals, for example in Russian seas (Barentz and White Sea) (Kuznjecova & Zevina, 1967).

Considering the substrate, as most other fouling species it settles on various artificial test substrates, several kinds of plastic (eternite, acrilite, polystyrene), cement-asbestos, fibrous-cement plates etc. Besides, it is an epibiont, mostly on brown algae of genus *Laminaria*, whose growth it may inhibit when abundant (Osburn, 1944). On species *Laminaria hyperborea*, bryozoan *M. membranacea* if abundant can cover intercalary meristeme, and cause the stem like part of the host to grow downwards. Covering of leaf like structures of *Laminaria* can also lead to death of host (Ryland & Stebbing, 1971). The same authors cited orientation of *Membranipora* colonies on taluses of *Laminaria* and brown alga *Fucus serratus*. Orientation of growth on these two hosts is different. On *Laminaria*, colonies grow toward the narrower parts of talus (stem), that is, in the direction of water current and toward the youngest part of talus ”leaf”. The purpose of such orientation is reducing of competition for space. On *Fucus*, colonies also grow in the direction of water currents, but this time from the youngest widest parts of host’s talus. It this case orientation is mainly consequence of water currents, but also of photopositive reaction of *Membranipora* and age of *Fucus* talus (Ryland & Stebbing, 1971). Besides the plant hosts there are also animal organisms on which M. *membranipora* settles. Most of them are shellfish, especially *Pinna nobilis* in Rovinj vicinity. The bryozoan often settles on this shellfish (F=58%), when it is 19-60 cm long. The range of shellfish host size also represents vertical distribution, as younger shellfish dwell in shallow water, while adults move to depth of 5-15 m (Zavodnik, 1967). Especially interesting is settlement of this species on sea turtles, as bryozoans are rarely epibionts of turtles.

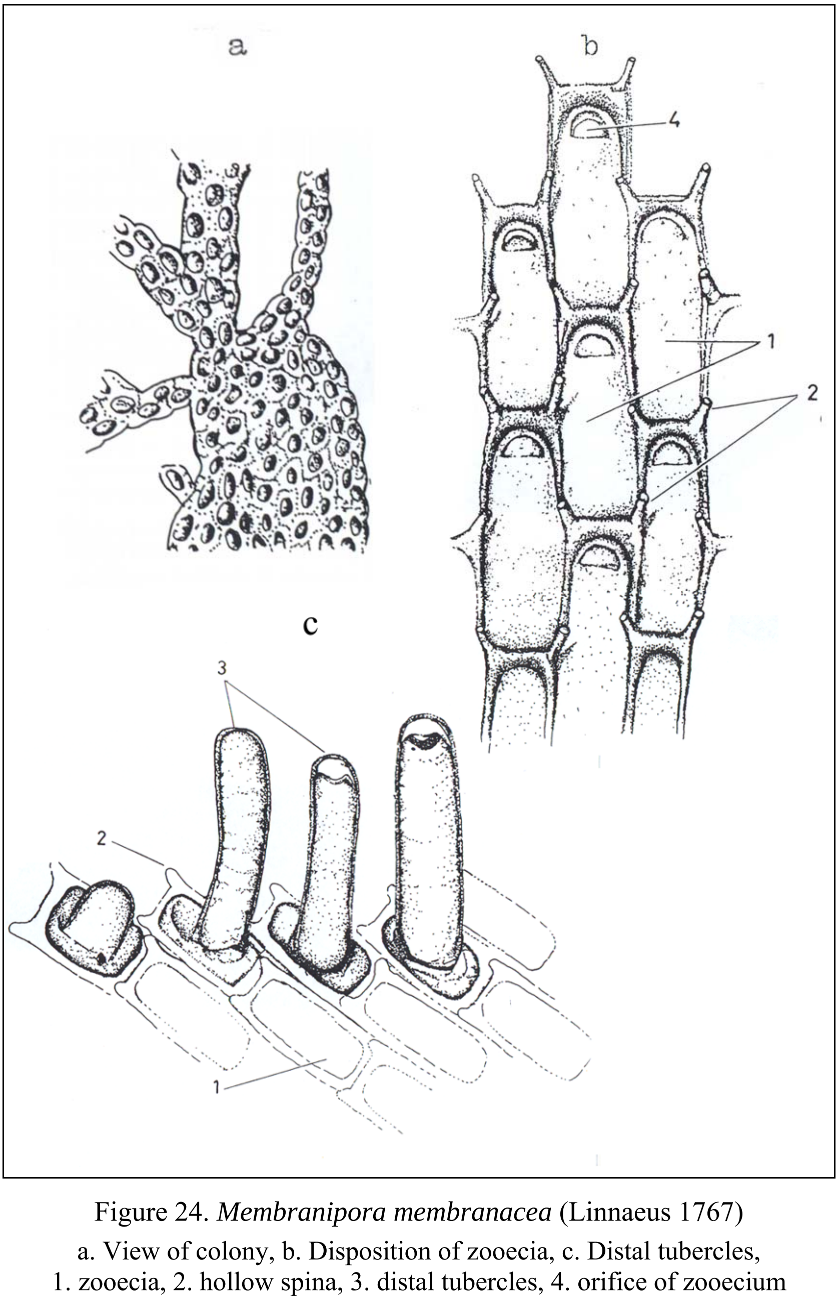

Figure 24. *Membranipora membranacea* (Linnaeus 1767)

a. View of colony, b. Disposition of zooecia, c. Distal tubercles,
1. zooecia, 2. hollow spina, 3. distal tubercles, 4. orifice of zooecium
according to: R. Riedl, 1983 (a); T. Hincks, 1880 (b, c), Vol. II, pl. XVIII, fig. 5

Hughes (1974) cites species *Membranipora membranacea* on undetermined turtle (probably *Caretta caretta*) in South Africa. For this information, Hughes (1974) and Frazier et al., (1992) cite that it is the first precise report of bryozoan epizootic on a sea turtle. However, this species is extremely rare in benthos. According to one piece of information it was found in middle tidal level on a natural substrate of peat plates or on the surfaces covered with mixed peat and sand (Jocque & Van Damme, 1971).

Distribution: As a cosmopolite species it is distributed throughout the world. In Europe from Norwegian fjords (Nair, 1962), Barentz, White Sea (Kuznjecova & Zevina, 1967), coasts of England (Ryland & Stebbing, 1971), Belgium (Jocque & Van Damme, 1971), in Mediterranean (Riedl, 1983, 1991). Outside Europe it is present in Suez Canal (Ghobashy et al., 1980), on coasts of North America (Ehrler & Lyke, 1980; Walters & Wethey, 1991), South Africa (Hughes, 1974) etc. First researcher who mentions this species for Adriatic is Heller (1867). It was mentioned also by Condorelli Francaviglia (1899) at Ortrant and Graeffe (1905) in Trieste and Piran Bay. Much later, information on species *M. membranacea* is mentioned for Venice Lagoon (Relini et al., 1972; Barbaro & Francescon, 1976), and the vicinity of Rovinj (Zavodnik, 1967).

Family *Flustridae*

Colonies are erect and composed of one or two layers. If the colony has two layers, they are connected with upper side. Colonies are branched in a manner of leaves, horny and bendable. Zooecia are distributed in several series. Avicularia are mostly very simple.

Genus *Securiflustra* Silén, 1941

Colonies of this genus are erect, bilaminar (having two layers of thin plates) and resemble a fern. Zooecia are distributed in one or two layers, which are coalesced with their upper surfaces, more or less square or tongue-like, with up curved edges, without spines. Opening of a zooecium is large and covered with membranous covering. Avicularia are small, square, inside a linear series of zooids, but not at forks. Ovicells are almost completely immersed and distally high over the opening of zooecia.

***Securiflostra securifrons* Pallas 1766**

Eschara foliacea Linnaeus 1758: 1, text.

Eschara securifrons Pallas 1766: 1, text.

Flustra truncata Linnaeus 1767: 533, text; Lamarck 1835-38: 1, text; Johnston 1847: 1, text; Busk 1852: 1, text figs. 1-2, pl. 56, figs. 1-2, pl.58.

Flustra papyracea Dalyell 1847; 1, text.

Chartella securifrons Gray 1848: 1, text.

Flustra securifrons Smitt 1866: 279, text; 1868: 279, text; Hincks 1887: 150, text.

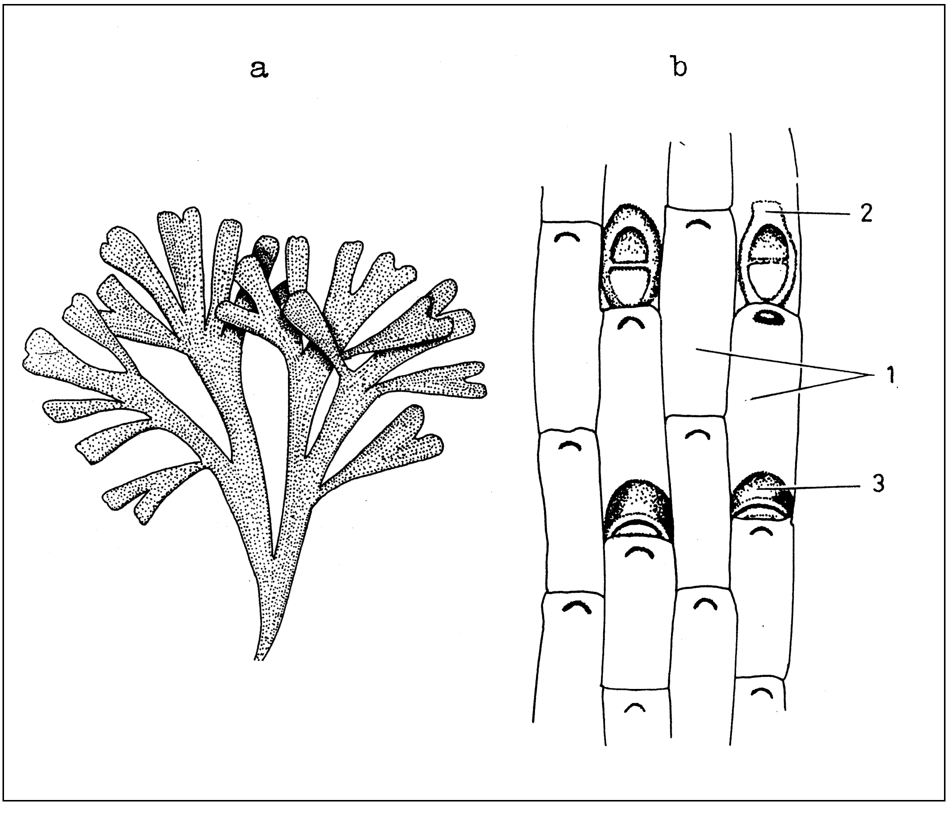

Figure 25. *Securiflustra securifrons* (Pallas, 1766)

a. Colony, zooarium, b. Disposition of zooecia,
1. zooecium, 2. avicularium, 3. ovicell
according to: T. Hincks, 1880, Vol.II, pl. XVI, fig. 3, 3a

Colonies are divided into parts and subparts of linear looks. Tops are not rounded and colony is attached with numerous tubular threads. Zooecia are linearly spaced, square with unprotected edges. Avicularia are strewn around, elliptical or lens-shaped, with thickened mandibles. Ovicells are globe-like with slightly thickened edges. The opening is closed with two rib-like objects, situated in front part somewhat lower than the opening.

Color: Colonies are light yellow or straw colored.

Size: Height of the colonies is 10-13 cm (Fig. 25a, b).

Habitat: This bryozoan is not typical for fouling complexes but to benthos (biocenoses). It settles on coraligenous sea bottoms. In our conditions, this species is very rare in littoral, where bryozoans are never important members of biocenoses. This species is found in littoral on the western side of Krk island, while in the littoral benthic communities of Kvarner Bay or on the western coast of Istra our bryozoans are yet important to benthos littoral (Zavodnik et al., 1981). The species settles on objects immersed on sea bottom among which are shells of molluscs.

Distribution: This species is primarily characteristic for cold areas, so it is considered to be Atlantic cold temperate and boreal species, although it is also found in Mediterranean, on coasts of Spain, France, Italy. This bryozoan is rare in our surrounding and is not well represented in literature.

Suborder *Ascophora*

Family *Hippoporinidae*

In this family zooecia are oval or rhomboidal. The two upper layers of zooecia coalesce with their upper sides.

Genus *Pentapora* Fischer 1807

Colonies are flattened or leaf like, erect, stiff. Frontal wall is uniformly porous, tends to be very thick and calcified. The primary opening is long more than it is wide, semi-square with clear bumps on the opposite side of the opening where there are wedge-shaped parts of operculum. Vertical walls of zooecia have a spacious, wide, very porous part. There is a hyperstomial ovicell which partly enters the upper, distal zooid and is free above the operculum of parent zooid. Avicularia is suboral (under the opening), adventitious, having a position on the outer wall of autozooid (vicarious) *.

Hippodiplosia foliacea **(Ellis & Solander) 1786**

Millepora foliacea Ellis 1755: 1, text; Ellis & Solander 1786: 1, text.

Eschara fascialis (vars. *lamelosa* & *fascialis*) Pallas 1766: 1, text; Moll 1803: 1, text figs. 1-2, pl. 1; Milne - Edwards 1836: 321, text.

Eschara bidentata Milne-Edwards 1838: 193, text.

Eschara foliacea Lamarck 1836: 1, text; Couch 1844: 1, text; Johnston 1849: 1, text, pl.67; Busk 1854 55, text figs. 4-7, pl. 106; Heller 1867: 77, text; Manzoni 1870: 323, text fig. 4, pl.1, fig.24., pl. 4.

Lepralia foliacea Hincks 1880: 1, text figs. 4-7, pl. 106; Calvet 1902: 1, text fig. 5, pl. 1.

Hippoporina foliacea Brusina 1907: 42, text.

Colonies of this species are large, leaflike, composed of thin elongated plates, variously curved and hemed with a border, which is often anastomosed, while the hollows between them are various in shape and size. Colonies (corms) grow vertically from the substratum. Their dichotomous branches are calcified, flattened, 5-15 mm wide (sometimes more) and 0.8-1.2 mm thick. Due to closeness of branches the two neighbouring parts coalesce so they make one thick calcified body. This is the origin of ”windows”, hollows of various shape and size, which give strength to the cormus. Zooecia are distributed in two, rarely one layer. They are elongated, egg-shaped, slightly convex, rhomboid, detached by lines, perforated. Pores are often bordered by a membranous ridge. The opening reaches the upper part of zooecium and is somewhat narrowed below the middle where there is a tiny tooth on each side. The lower edge is almost a straight line or is slightly upward in the centre. Just under that is an avicularia with a rounded mandible, pointed downward, and sometimes is of spade-like shape. Ooecium is large, often semi-globular, slightly flattened on the front side, smooth and shiny. In fertile zooids the peristom is on the front part of the ovicell (Fig. 26 a - corm; 26 b - zooecium).

Color: A live colony is flesh colored, often orange, while the dead colony turns brownish.

Size: Corms grow normally vertically from the substrate. The height reaches up to 20 cm, with total 0.1 m^2 of surface. In the vicinity of Rovinj was found a cormus of 30 cm in height and width (Nikolić, 1959a), while in

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* performs analogous function

Scotland was noted that this species may reach 7 feet 4 inches (about 223.36 cm) (Couch, 1844).

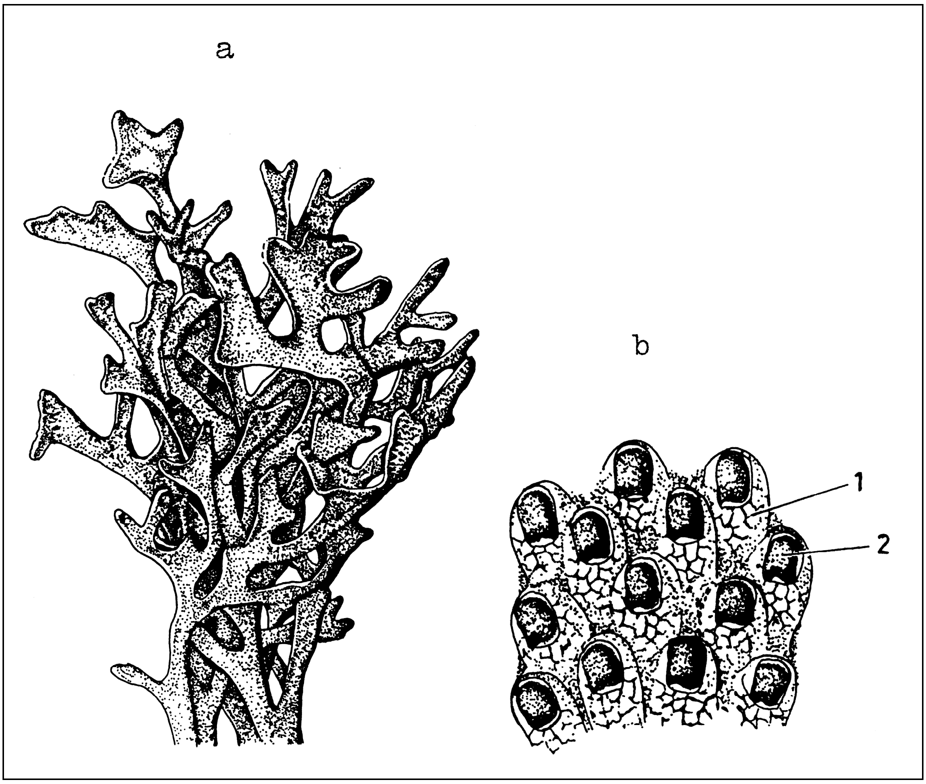

Figure 26. *Hippodiplosia foliacea* (Ellis & Solander) 1786

a. Colony, zooarium, b. View of zooecia,
1. zooecium oval, 2. orifice of zooecium
accoridng to: R. Riedl, 1983

Reproduction: Ovicells are found in January, February, May, September, November, and ancestrula in February (Gautier, 1962).

Habitat: This species is a member of bentos (biocenoses) and is rare in fouling complexes. It is found on hard bottoms - the pre-coralogenous, coralogenous, on various kinds of detritus bottom with organic matter, but also on clay on depths 111-113 m. With other bryozoan species (*Porella cervicornis*, *Retepora beaniana*, *Myriozoum truncatum*) it is included in making of hard substratum. The bryozoan that incrustrates shows the existence of hard substratum in the zone of low light. It can be found in greater quantities in open part of islands (Pakleni otoci ”Maslice”) where there is an intensive process of organogenous hardening of the substrate, then on muddy ground where there are less bryozoans (*Postulosa sp*, *Cellaria fistulosa*) (Gamulin-Brida, 1962). As the same bryozoan is often found on slightly muddy detritus bottoms in coastal communities, this bryozoan is making special facies. It may be an epibiont, for example on shellfish, but vagile organisms can also settle on this bryozoan. Therefore this species is considered to be a special centre of association (Nikolić, 1959. According to the same author, this bryozoan is vertically distributed between 32 and 41 meters (for example at Rovinj), while it can reach 100 or even 200 m of depth (Gautier, 1962).

Distribution: It is relatively small in horizontal space. It is found in eastern Atlantic from boreo-arctic zone to Marocco. It can be assumed that the species *H. foliacea* is more important for southern areas where it is more abundant and more frequent (Mediterranean coast of France, Italy, Tunis). On the coast of Sweden this species is in several years of research on natural and artificial substrate found to be only qualitatively important (Svane, 1988).

In the Adriatic, besides the already mentioned species, it is mentioned in biocenoses on clay bottom of open mid Adriatic from north-western border of Jabuka area (150 m isobate) toward the muddier and deeper bottom of Jabuka valley (Gamulin-Brida, 1965). In mid Adriatic circalittoral this species is characteristic for coralogenous biocenoses (Gamulin-Brida, 1974). Also in mid Adriatic and Kornati archipelago on several research stations, the species *H. foliacea* is present in biocenoses on the depth of 35 and 42 m with frequency of only 0.58% (Zavodnik, unpublished).

Suborder *Ascophora*

Family *Sertellidae*

Colonies of this family are erect, reticular, cone-like and rough surfaced.

Genus *Sertella* Julien & Calvet (1903)

Colonies are erect, reteporiform, branches are usually tightly entwined and make reticular widenings. The basal surface starts from the thickest joints. The frontal part of zooecium has a visible pore on the edge - border. The primary opening lacks sinus, is semi-circular or transversally elliptical. peristome is with a cut or pore (pseudosinus). Avicularia is variously shaped and places on both sides of the colony. Oral spina is present or absent. Ovicell is prominent and has medial frontal fissure. There is one small but very porous septula, as well as a rostrum carrying an avicularia.

***Sertella beaniana* King (1846)**

Millepora cellulosa Jameson 1811: 556, text.

Retepora cellulosa Thompson 1830: 89, text; Johnston 1838: 1, text; 1847: 1, text; Lorenz 1863: 1, text; Grube 1861: 1, text; Heller 1867: 77, text; Sars 1863: 1, text; Danielssen 1868: 24, text; Koren & Danielssen 1877: 1, text; Brusina 1907: 42, text.

Retepora cellulosa form *beaniana*, var *borealis*, Smitt 1867: 284, text.

Cellepora reticulata Smitt 1873: 1, text.

Eschara beaniana Smitt 1878.

This species is one of the most beautiful bryozoans. French call it ”Manchette de Neptune”. Colonies are mostly budlike, wavelike, with curled edges and holes. Due to enormous number of holes all over the colonies, the cormus looks like a wonderful lace. Colony is attached to the substrate with a very short underdeveloped stem that sprouts out of the base with mineral matter (Fig. 27a). Zooecia are cylindrical, smooth, slightly bumped, raised toward the upper part. The opening of the zooecium has bow shaped upper edge, while the lower edge sports on its middle a short rostrum with an avicularia. So avicularia has a semi-circular mandible directed downward. From the inner part of avicularia 2-3 teeth sprout (Fig. 27b). In juvenile colonies zooecia have six, and in older corms four spines, which are high and sharp on the tops. Two spines are placed little over the lower part and they are visible on the front part of zooecia. The upper surface of zooecia is halved by a white line. Besides the avicularia on rostrum, on the frontal part with elongated avicularia (beaked or pointed), close by there is one more oval avicularia. Nannies can be elongated, smooth, often slightly inversed and look like narrow fissure on the front part.

Color: Alive colonies are red (coral colour) and dead ones are ivory colored.

Size: Height of the colony is usually 3.5-4 cm, and it can reach 10 cm.

Habitat: It lives in darker areas and does not form dense populations. It can be found on cave walls, shells, corals, rocks etc. So this bryozoan is considered more of a bentos species. Together with the species *Hyppodiplosia foliacea* and other bryozoans it makes incrustrations in open island areas of mid Adriatic and so has impact on organogenous thickening of the substrate (Gamulin-Brida, 1962). Considering the kind of sea bottom, there are indications that species *Sertella beaniana* is a member of coralogenous biocenoses, rarely found on detritus bottoms (Karaman & Gammulin-Brida, 1970).

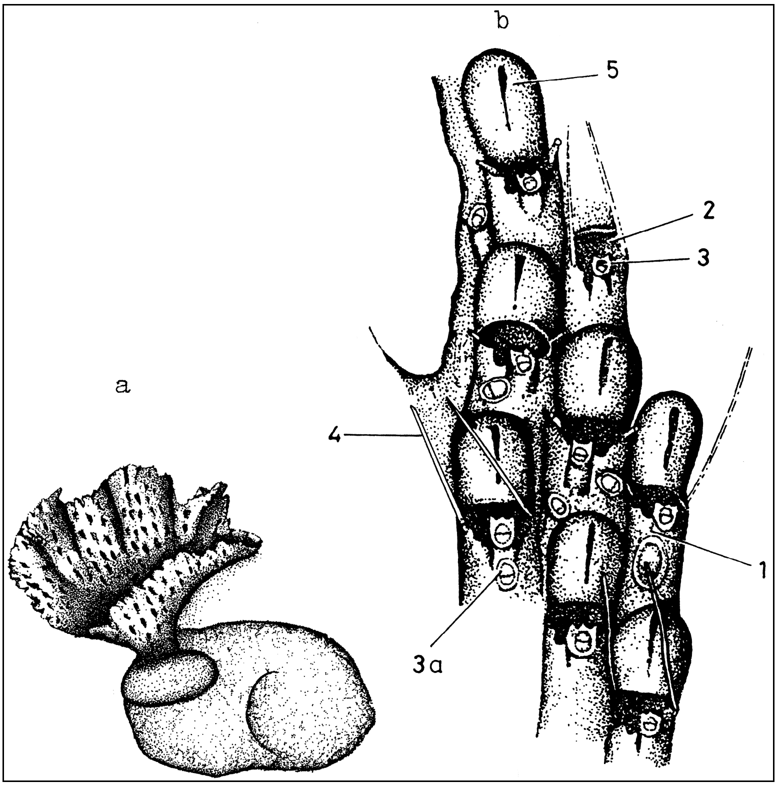

Figure 27. *Sertella beaniana* King (1846)

a. Colony lace-like,
b. Disposition of zooecia, in frontal view
1. zooecium,
2. orifice of zooecium,
3. avicularia on rostrum,
3a. avicularium in the vicinity,
4. spinae,
5. touch line on the distal part of the zooecium

according to: T. Hincks, 1880, Vol. II, pl. LII , Fig. 3,4

In the vertical space distribution of this species is very wide, as it is found in biocenoses between 10 and 30 m and 42 m. Of 68 searched spots in Kornati Islands, this bryozoan was found only in 0.29% (Zavodnik, unpublished). On similar depths in North Adriatic this species was found in Lim channel on depth between 30 and 35 m with insignificant abundance. At Rovinj (Valdibora Bay, island Dvije Sestrice) it is more abundant and common in biocenoses (Gamulin-

Brida et al., 1968). In somewhat deeper biocenoses this species was present on depth of 59-104 m in mid Adriatic (Gamulin-Brida, 1962), and in circalittoral in coralogenous biocenoses as a sciophile species in north and mid Adriatic (Gamulin-Brida, 1974) and in Boka Kotorska Bay in South Adriatic (Karaman & Gamulin-Brida, 1970).

Distribution: In Mediterranean (Riedl, 1983, 1991). There are no data for other areas. Among the first authors mentioning this species for Adriatic was Condorelli-Francaviglia (1899) under the name *Retepora cellulosa*. Lorenz (1863) and Grube (1861) cite it for Kvarneri and Graeffe (1905) for Rovinj area. Heller (1867) finds this species at Hvar, Vis, Lastovo and Dubrovnik, and Brusina (1907) in Zadar area. In biocenology research of Adriatic it is found in north Adriatic at west side of Istra Peninsula (Lim channel, Rovinj) (Gamulin-Brida et al., 1968), Rabac area (Zavodnik & Vidaković, 1982), Raski Bay (Zavodnik, D. & Zavodnik, N., 1986), Rijeka Bay (Omišalj coast - Krk) (Zavodnik et al., 1981), at Kvarneri (Osor Bay) on meadows of *Posidonia oceanica* together with *H. foliacea* and *Schizoporella* spp. (Zavodnik, D & Zavodnik, N., 1982), in mid and northern Adriatic (Gamulin-Brida, 1962, 1974), and in south Adriatic (Boka Kotorska Bay) (Karaman & Gamulin-Brida, 1970). However, in unpublished data of large biocenology research of Kornati area, Zavodnik mentions rare occurrence in communities, as well in biocenoses on coast of Krk. The same author with associates (1981) however states that this species is more abundant in Kvarner Bay and on west coast of Istra.

Family *Smittinidae* Levinsen 1909

Colony is incrustrated with a lot of calcium carbonate, bumpy. The frontal wall is porous. Avicularia is usually medially placed and is suborally closed toward the proximal border of the opening. Ovicell is hyperstomial and perforated by numerous tiny pores.

Genus *Porella* Gray 1848

Colonies are bark like or erect, leaf shaped, irregularly branched. The frontal wall of zooecia is smooth but with only edge pores. Avicularia is sub oral (under the mouth), vicarious avicularia are absent. Ovicell is free, spherical in shape, is not perforated or has a simple central pore, and is not closed with zooidal operculum. Zooecium is with a primary semi-circular opening, which is long in adult colonies, while in young colonies and zooecia it can be semi triangle or horse shoe like in shape.

***Porella cervicornis* Gray, 1848**

Millepora cervicornis Pallas 1849: 1, text.

Celepora cervicornis Johnston 1849: 1, text.

Eschara cervicornis Milne-Edwards 1836: 321, text fig. 19 pl. 12.

Smittina cervicornis Grube 1861: 1, text; Lorenz 1863: 1, text; Heller 1867: 77, text; Calvet 1903; 1, text; Graeffe 1905: 317, text; Brusina 1907: 42, text.

Colonies are erect, tender, irregularly branched. The branches are more or less pushed together, and may finish without globes. Zooecia are irregularly distributed on both sides of the colony, except on tops of the branches that are still growing, where they are regular. Zooecia are oval in shape, the surface is rough with large holes around the edge. In young colonies zooecia bear ribs, which are distributed in ray like fashion toward the centre. The opening is bow-like in older colonies. It continues upward and is pushed from the sides and downward. It is somewhat narrowed above the upper edge, making a sinus bearing an avicularia. Ovicell is round, more or less inserted, the surface is smooth (Fig. 28a- colony, Fig. 28b - zooecia).

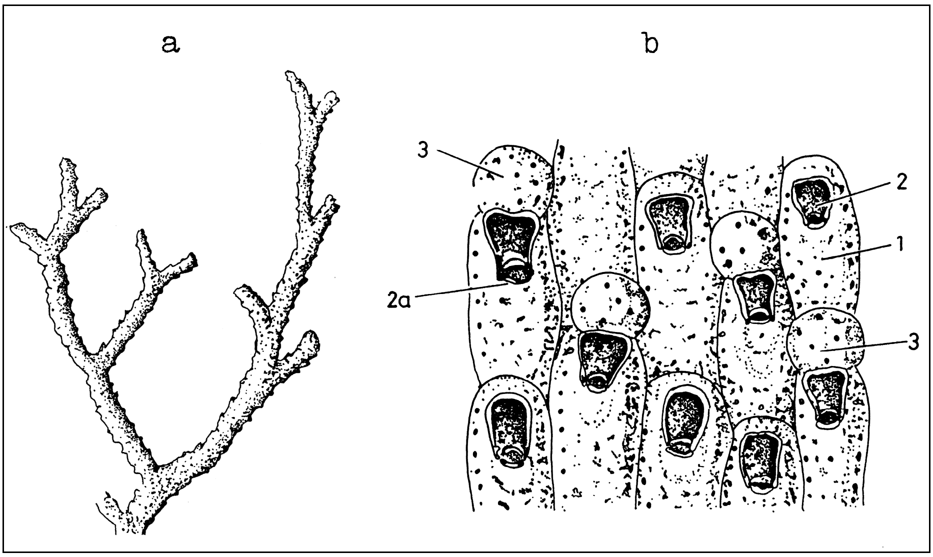

Figure 28. *Porella cervicornis* Gray, 1848

a. View of colony, b. View and structure of zooecium
1. zooecium roughly, full of holes, 2. orifice of zooecium, 2a. sinus, 3. ovicell
according to: R. Riedl, 1983

Color: Live colonies are flesh-colored, and the surface of zooecia is pink.

Size: Colony is up to 8 cm high.

Reproduction: Reproduction and settling is in all seasons except the winter.

Habitat: Peres & Picard (1958) consider the species *P. cervicornis* to be among the principal species of coralline biocenoses on shell bottom of open sea. By the way, this species is mostly found in undersea caves on rocky ground and in biocenoses of precoralogenous or typical coralogenous type and on detritus bottoms. On detritus bottoms it settles on organic objects, parts of molluscs and calcified algae. It can sometimes also be found as an epibiont on other bryozoans, for example on species of genus *Hippodiplosia* species. It is especially interesting to see this species as fouling on artificial substrates. It is found extremely rare on asbestos test plates in Genoa Bay near the coraligenous bottom at 35 m of depth and on meadows of flowering plant *Posidonia oceanica* on 28 m of depth, as a dominant species (Relini et al., 1973). From the biocenose research on our coast, this species was also found in mid Adriatic in coralogenous biocenoses in phytal as a characteristic species (Gamulin-Brida, 1974) and in communities of deep littoral in channels of mid Adriatic, on depths of 38-104 m (Gamulin-Brida, 1962). This bryozoan is present in coraligenous biocenoses on 20 m of depth in Kotor Bay with very variable salinity (8.44×10^{-3} at surface, 36.6×10^{-3} at the bottom) (Karaman & Gamulin-Brida, 1970). In North Adriatic, the same species is distributed on several kinds of sea bottom: on coastal detritus bottom, sand bottom, bottom with coastal terrigenous silt, in communities of photophile algae (Bakar Bay) (Zavodnik et al., 1978). On mentioned kinds of sea bottom *P. cervicornis* was also found on coast of Istra (Rovinj, Lim channel) on depths of 20-38 m (Gamulin-Brida et al., 1968). It can be generally said that this species is in our conditions very rare in biocenoses of various depths, bottom and area. It is more common at Rovinj (Valdibora Bay, island ”Dvije sestrice”, island ”Banjole”) together with the species *Sertella beaniana* and *Schizoporella sanguinea*, and rarer in Lim channel on various depths (from 2, 3 m to 32 m) (Gamulin-Brida et al., 1968). In earlier research Vatova (1935) cites this species in biocenoses of *Schizaster*, together with the species *Myriazoum truncatum*.

Distribution: this species is known for Atlantic, from Bay of Biscay and coast of Portugal (Galopim De Carvalho, 1971) to Marocco. Besides, it is found in the Mediterranean (Riedl, 1983, 1991), that is, on the coast of France, Italy, in Aegean Sea, on the coast of Tunis, Alexandria, and it reaches Dardanelles.

In earlier research in Adriatic it was known as *Smittina cervicornis* and cited by Grube (1861) for Lošinj, Lorenz (1863) for Kvarneri, Heller (1867) for mid Adriatic islands (Hvar, Vis, Lastovo) and Dubrovnik, Graeffe (1905) for

Rovinj and Brusina (1907) for Zadar Area (Veli rat, Zirie). In new biocenose research, species *P. cervicornis* is found in bentos life communities in north Adriatic on the coast of Istra (Rovinj, Lim channel) (Gamulin et al., 1968), in Raski Bay (Zavodnik D. & Zavodnik N., 1986), in Rijeka area (Omišalj Bay - Krk) (Zavodnik et al., 1981), Bakar Bay (Zavodnik et al, 1978). In mid Adriatic it is found by Gamulin-Brida (1962, 1974) and on Kornati islands on depth of 12-45 m it has frequency of only 0.58% (Zavodnik, unpublished). For south Adriatic there is only information of Karaman & Gamulin-Brida (1970) from Boka Kotorska Bay.

Family *Myriaporidae*

Colony is calcified, tree-like, on the substrate or raised into a leaflike expansion. Calcified zooecia are having reduced membranous area and lack raised edges. The opening with a sinus is on the lower, mouth side. The oral sinus is characterized by the medial pore.

Genus *Myriapora* Donati 1750

The colony is large, erect, cylindrical with a small bark like base, irregularly branched and without suturae. The border between the zooecia is invisible, and the frontal wall of zooecia is strong with tubular pores. The zooecium has only the opening, and all the other characteristics are lacking, even avicularia. There are some additional avicularia with a beak like spike, which may be absent. The ovicell is concave and inserted into the distal zooid.

*Myriapora truncata (*Pallas 1766)

Millepora truncata Pallas 1766: 1, text.

Myriozoum truncatum Grube 1861: 1, text; Lorenz 1863: 1, text; Heller 1867: 77, text; Graeffe 1905: 317, text; Brusina 1907: 42, text; Canu & Bassler, 1930: 1, text; Vatova 1935: 1, text; Neviani 1939; Gamulin-Brida 1962: 1, text; 1965: 1, text; Karaman & Gamulin-Brida 1970: 3, text.

Myriozoum punctatum Manzoni 1877: 59, text.

Due to its beauty, this bryozoan achieved its name ”false coral” and is without doubt the most popular bryozoan in Mediterranean (Zabala & Maluquer, 1988). Borders between zooecia are invisible. The front walls of zooecia are porous, while the opening is inserted and its cover partially calcified, so the membranous area is lacking (Fig. 29a, 29b). Ovicells are big, globular. The frontal wall is slightly porous, while there are two openings of ovicell zooid, one small and one large, which is treated as a normal opening.

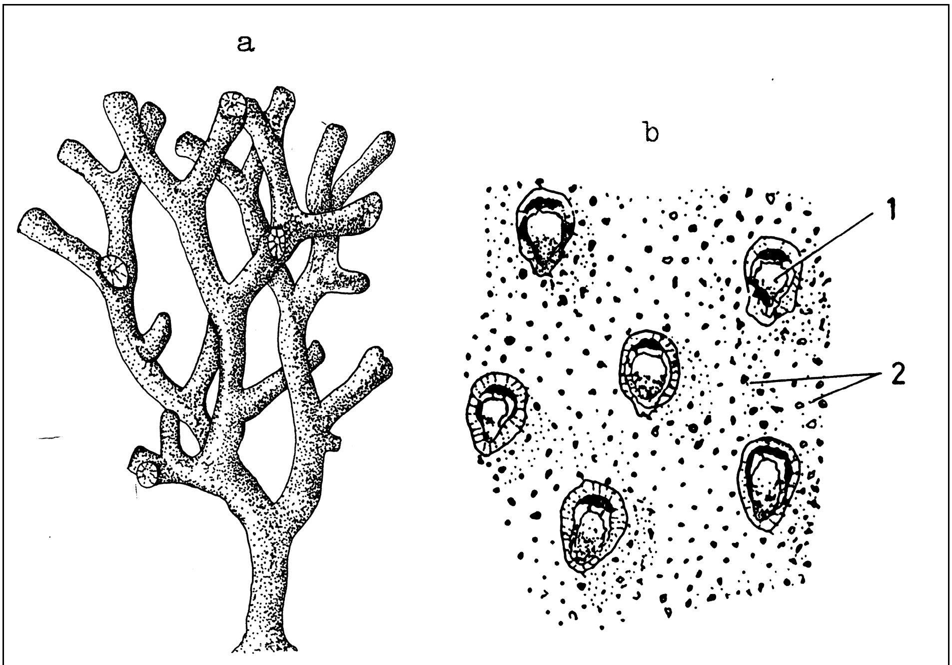

Figure 29. *Myriapora truncata* (Pallas 1766)

a. Colony dichotomously ramified, b. Zooecia without visible confines; frontal wall stout, with tubular pores, 1. orifice of zooecium, 2. pores
according to: R. Riedl 1983

Color: Live colonies are red, while the dead ones are yellowish-red or even paper-colored.

Size: colony is up to 12 cm high.

Reproduction: Ovicells are present throughout the year, and embryos and larvae are found in March on the French coast (Gautier, 1962).

Habitat: This is not a fouling species and lives usually on somewhat greater depths on various kinds of sea bottom. According to Peres & Picard (1958) this species is considered a basic element of coralline biocenosis, while Gautier (1962) cites it as especially abundant species on coraligenous bottoms between 30 and 60 m. This is the case in bentos (biocenoses) of Adriatic. This species is in mid Adriatic characteristic for coralogenous biocenoses in circalittoral (Gamulin-Brida, 1974), and in channels in deep littoral it was found mostly on depths of 29-104 m, most abundant at ”Maslinica” (104 m) (Gamulin-Brida, 1962). However, the same species is also found in Jabucka valley on muddy-sand bottom, on depth of 111-130 m, with average number of colonies between 10 and 100 (Gamulin-Brida, 1965). Similar to this, in northern Adriatic at Kvarneri (Osor Bay), the species lives in sand-muddy bottom, and in bottom communities making shift toward the coastal terrigenous mud, on 10-152 m of depth (Zavodnik, D & Zavodnik, N, 1982). In Istra area, this species is not significant quantitatively, as there are 1-2 colonies on 1-3 sites in same locality (Rovinj, Lim channel) (Gamulin-Brida et al, 1968), similar to the situation in Rabac area (Zavodnik & Vidaković, 1982). However, Vatova (1935) connects this species together with bryozoan *Porella cervicornis* to the biocenosis of species *Schizaster chiajei* (*Echinoidea*).

Distribution: Canu & Bassler (1925) mention that species *M. truncata* is rare in Atlantic, mostly individually with small populations. However, in the Mediterranean, it is distributed on the shores of France, Italy, Tunis, and Dardanelles (Gautier, 1962). This species was cited (as *Myriozoum truncatum*) by Grube (1861) and Lorenz (1863) for biocenoses of Kvarner, Graeffe (1905) in Piran and Fazane area, Neviani (1939) for Venice region and Vatova (1935) for Rovinj area. In mid Adriatic Heller (1867) cites this species for vicinity of island Hvar, Vis and Lastovo, Brusina (1907) for Zadar, and much later it is described in works of Gamulin-Brida (1962, 1965, 1974) as said in the last chapter. In the south Adriatic this bryozoan is mentioned only for one site in Boka Kotorska Bay on depth of 20-52 m, on the same place as *P. cervicornis*, where salinity very greatly (8.49×10^{-3} at the surface and 36.62×10^{-3} at the bottom) (Karaman & Gamulin-Brida, 1970).

Family *Schizoporellidae* Bassler 1935

Colonies are calcified, erect, branched or flattened, bark like. The opening on zooecium is horse shoe like, subellyptic or semi-circular. If it is horse shoe like it may also be toothed on the lower edge. In some species the lower edge is rising around the opening.

Subfamily *Schizoporellinae* Bassler 1935

Genus *Schizobrachiella* Canu & Bassler 1920

The frontal wall of zooecium is symmetrical and completely perforated. The primary opening is with the sinus. On side there are wedge-shaped appendages on which the opening prolongs. The oral spine is lacking. The adventitious secondary avicularium is lacking or rarely present in vicinity of the opening. It is tiny. The ovicell is prominent, is perforated and closed with a zooidal operculum. In vertical walls there are septa with a pore.

***Schizobrachiella sanguinea* Norman 1868**

Hemeschara sanguinea Norman 1868: 212, text.

Lepralia pertusa Manzoni 1871: 73, text; Heller 1867: 77, text; Grube 1861: 1, text; Graeffe 1905: 317, text.

Escharella sanguinea Smitt 1873: 1, text.

[*]*Schizoporella sanguinea* Hincks 1880: 1, text; Harmer 1902: 263, text fig. 45, pl. 17; Barroso 1923: 119, text.

Colonies of this species are flattened, bark like, and can be rising into a lace like object. The erect part forms a series of simple or multi platal cells or a tube. The degree of calcification varies. Most often it grows like a bark and then rises upward (free expansion), being composed of one layer of cells, zooecia. Zooecia are square, mostly in regular linear series in shape of radial rays, flattened or slightly convex, detached by a weak raised suturae. The frontal wall is closed, perforated by numerous large round pores with calcification between. Primary opening (orifice) above is arched. The central sinus is on the lower edge and having two small dentate indentations on each side. The primary opening is semi globular with two blunt appendages, pointing out (Fig. 30a). The peristome is low and very much thickened with one or more rows of proximal protuberances. One or two tiny avicularia may be present near the opening (Fig. 30b). The mandible is pointed and in disto-medial plane. In one linear series of zooecia there are septa with a pore in distal lateral walls. Polypides are with 15 tentacles (Calvet, 1900). The ovicell is pointing out. It is globular and very porous. The periphery series of pores are the most prominent. Besides, the ovicells have many tiny bumps, which later develop into ridges (Fig. 30 c).

[*] Under this name the species was known up to 1988, when in their catalogue, authors Zabala & Maluquer have stated that that is one the same species, so *Schizoporella sanguinea* is a synonym. The Spanish authors (Zabala & Maluquer, 1988) have treated *Schizobrachiella sanguinea* and *Schizoporella sanguinea* as two separate species.

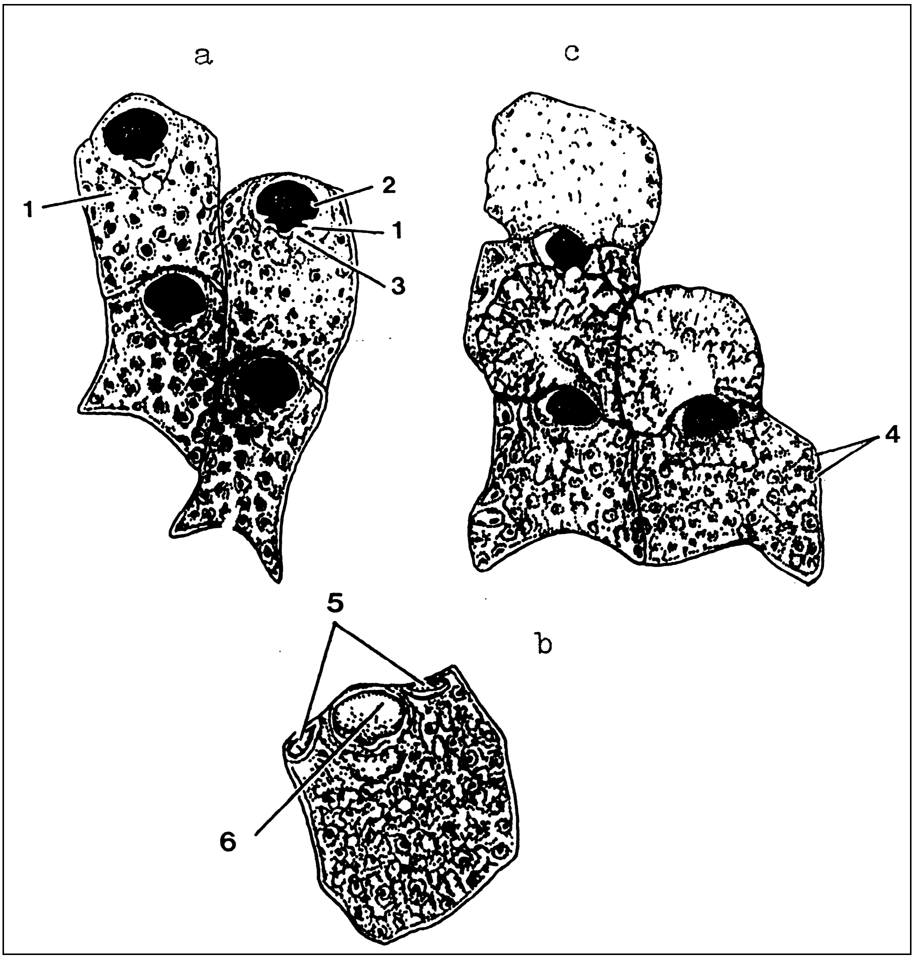

Figure 30. *Schizobrachiella sanguinea* Norman 1868

a. four typical zooids,
b. zooids with operculum, and minute lateral oral avicularia,
c. ovicellate zooids,
1. view of zooecium,
2. orifice of zooecium,
3. sinus,
4. perforations on zooecium,
5. avicularia,
6. operculum of zooecium

according to: P.J. Hayward; J.S. Ryland, 1979

Color: Live colony is dark red, and dead one is brown.

Size: the monthly growth is about 1-1.5 cm, and in four months it can reach diameter of 11-11.5 cm in a season and extremely 22.5 cm in a half-year period (Northern Adriatic at Rovinj) (Igić, 1972). Zooecia are 0.4-0.5 cm large.

Reproduction: Ovicells, embryos and larvae (ancestrula) are present throughout the year (Gautier, 1962; Riedl, 1983, 1991). Considering the seasonal distribution, it varies with space, time etc. For example in northeastern Adriatic it is present from June or more often July and up to December (Igić, 1969, Vriser, 1986) or the settling period is shorter and starts for example in August and lasts till November (Igić, 1972). The maximal settling is mostly in August (3385-4064 colonies per square meter of test substrate) (Igić, 1969, 1972).

Ecophysiological characteristics: In our area, frequency of this species is correlated with numerous factors, such as exposition time of test substrates, degree of community development and available space, season, weather etc. On the western coast of Istra, presence is usually between 9 and 10%, abundance at average only 1.6 colonies and cover of test substrate (290cm^2) at average 50.1% (Igić, 1982). These data are based on numerous researches in different areas. However, on one location (Rovinj), when glass test plates were submersed in April, on month test plates frequency was 25%, while on year plates, frequency was 90.9%. When the same plates were submersed in November, on monthly plates frequency was the same (25%) but on year plates it was only 45.4% (Igić, 1972). Here is evident the effect of development degree of fouling community, as at the beginning and most intensive settling of this species, space competition has limited the greater abundance of *Schizoporella*. As to the fouling of test substrates, the average is 25% while the range is 1-100%. The life span of this species is 15 days - 3 months, extremely up to 4-5 months including the dying off period, manifested by loosing colour and peeling off colony with substrate. The rate of growth is determined by substrate. If a larva settles on the talus of alga (for example *Cistoseira*), growth is tubular, positively tigmotropical in orientation, and flattened on the surface. Zooaria of this species grow dichotomely and are not so well developed as in species *Sch. errata*, as *Cystoseira* dies at winter. Therefore it keeps at the bottom of alga's talus (Nikolić, 1959). The other authors such as Friedl (1925) cite that growth of this species stops when space is decreasing, while Hinck (1880), Carus (1893) and Gautier (1953) cite that larvae expand in tubular form.

Habitat: This species is however rarer in fouling communities than *Schizoporella errata*, especially if vertical distribution is accessed. In contrast to *Sch. errata*, this species prefers deeper water. As an epibiont on *Pinna nobilis*, together with *Sch. errata* it settles on hosts 22-70 mm long. These are older shellfish, living deeper than 5-15 m, in contrast to younger shellfish that live in shallower water (Zavodnik, 1967). The same species is known as an epibiont on edible shellfish, such as mussels (*Mytilus galloprovincialis*) and oysters (*Ostrea edulis*) on culture parks on coast of Istra. In Lim channel this bryozoan is present on shellfish in 54.2% of cases and covers them at average 20.4%, while at Pomer the frequency is 48.6% and cover 43.5% (Igić, 1982). This points out that this species prefers cleaner water. In harbours it is rare, and when it is present its significance as a fouling species is secondary, for example in Pula harbour F=11.4%, cover 10% (Igić, 1982).

It is found in various artificial substrates mostly in upper and middle infralittoral zone, for example on 5 m of depth on limestone and sandstone plates (Piran Bay) (Vriser 1978, 1986), as well as on asbestos-cement test plates in underwater parts of thermal power plants. In such ambient, this species settles in places where water flow is slow and there is less light. It is not settling in places with high turbulency and swift flow, where bryozoans are not chief fouling species anyway (Relini & Romairone, 1976; Relini et al., 1974, 1980). It was found on wooden fishery ships on west coast of Istra (Rovinj), where fouling was 16.6% of the ship. It was found together with the species *Sch. errata* and their distribution is different on different parts of the ship. *Sch. sanguinea* settles mostly on the statical part of propulsive system (20.9%), then on keel of the ship (13%), middle of the hull (5.0%), stern-post 6.0% and bow 3.0% (Igić, 1968). Besides the mentioned substrates, Nikolić (1959) cites this species for sheltered spots of upper infralittoral, settling mostly on brown algae *Cystoseira* sp. However, in bentos communities this species is mentioned in infralittoral in phytal and upper part of batial step (Gamulin-Brida, 1974) and in coraligenous biocenoses on 7 m, and even lower on 20 m (Karaman & Gamulin-Brida, 1970). It must be mentioned that in literature only genus *Schizoporella* is mentioned, especially if material was already dead and decaying, so it was not possible to determine it on the species level.

Distribution: It is treated as Atlantic temperate boreal species, absent in polar seas. However it is primarily typical for temperate-warm zones and reaches northward to southwestern part of Great Britain. It is very well developed in west coast of Mediterranean, and diffusely on Italian coast, for example around Sicily and Corsica. The similar situation holds for Tunis and Adriatic (Geraci & Relini, 1970). On our coast it is found as a fouling species in Piran Bay (Vriser 1978, 1986), in vicinity of Rovinj (Igić 1968, 1969, 1972, 1982; Zavodnik 1967; Zavodnik & Igić, 1968a), in Lim channel (Igić, 1982) at Pomer, southeast of Istra Peninsula, at Pula, in Bakar Bay (Igić, 1982). In north Adriatic it is mentioned in biocenose research in bentos at Rabac (eastern coast of Istra) (Zavodnik & Vidaković, 1982). It is cited for mid Adriatic by Gamulin-Brida (1974) and for south Adriatic (Boka Kotorska Bay) by Karaman & Gamulin-Brida (1970). The ancient researchers mention this species for Adriatic (Hinck, 1880), Kvarneri (Grube, 1861), Trieste (Graeffe, 1905) and Rovinj (Heller, 1867). So, Heller (1867) describes this species as epibionts on shellfish *Pina* sp.

Genus *Schizoporella* Hincks 1877

The colony is bark like. The frontal wall of zooecia is regularly perforated. The primary opening is semiellyptical, semi-circular or of horse shoe shape with a sinus on the proximal part. The adventitious avicularium is single or there are two. They are placed laterally from the opening or they may develop on another part of frontal wall. There may be three of them, and rarely none. Spines are lacking or present only on periphery zooids. Ovicell is typically globular and prominent. It lays on the next zooid, is strewn with pores and is often furrowed or with prominences.

Schizoporella errata (Waters) 1878

Lepralia errata Waters 1878: 20, text fig. 9, pl. 1.

Lepralia errata stadium *hemeschara* Waters 1879: 27–43, 114–126, 192–202, 267-284; 1896-1897: 43, text.

Schizoporella unicornis var. errata Calvet 1927: 1, text; Marcus 1940: 1, text.

Schizoporella violacea Canu & Bassler 1930: 1, text; Nikolić 1959a: 1, text.

Schizoporella errata Canu & Bassler 1929: 1, text; Barroso 1935: 373, text.

The colony is flattened and stretch on the substrate like a bark. It is made of two layers and may rise in tubes. When the colony is young, the zooecium is hexangular, and later on it is mostly square or rhomboid. The front wall of zooecium is not transparent. It is much calcified, flattened and with many hollows in which are pores. The opening is semi-circular with a wide shallow sinus in shape of U. Avicularium is simple and placed left or right of the opening. The mandible is triangular, placed at an angle to a frontal plan and is placed laterally, either disto-laterally or proximal-laterally. The ovicell is round with small holes; the opening is half circular and larger than in normal zooecium. The ancestrula is oval, smooth and not perforated. Its opening (orifice) is semi-circular, larger then in normal zooecia, surrounded by four pairs of spines (Fig. 31a - zooecia in adult colonies, b - zooecia in juvenile colonies).

Color: Zooecia are mostly milk - colored, transparent, but they can also be light orange, orange, violet-grey, dark rusty, brick red. All this hue can develop while dying off, so age of zooecia can be distinguished by colour. Rusty - violet - grey colour keeps up when the zooecia dry up on the air and when the frontal wall is getting calcified (Nikolić, 1959a).

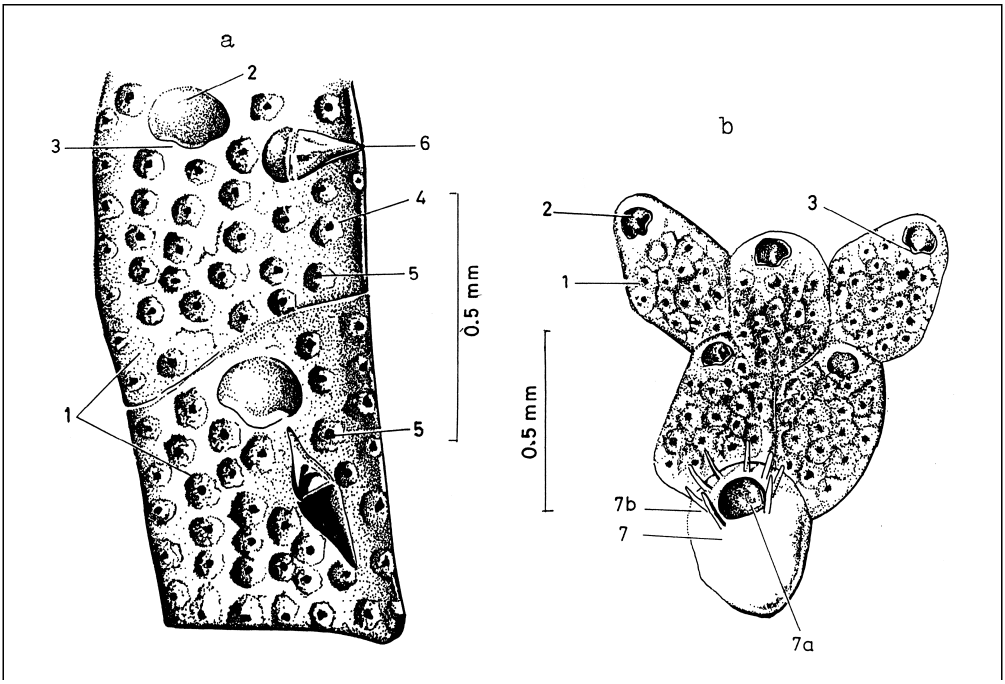

Figure 31. *Schizoporella errata* (Waters) 1878

a. zooecia quadrangular at old colonies,
b. zooecia hexagonal at young colonies,
1. zooecium,
2. orifice of zooecium,
3. sinus,
4. recess in zooecium,
5. recesses containing a large round pores,
6. avicularium,
7. ancestrula,
7a. orifice semicircular,
7b. four pairs of spinae

according to: J.S. Ryland , 1965

Size: The polymorphous zooecia grow 1 cm in two months, and 5 cm in width and 4 cm in height in four months (Nikolić, 1959a). It the fouling communities many factors can limit growth, such as spatial competition, length of exposition of test substrate and settling of this species, etage of the sea etc. For example, at the same station in upper mediolittoral (0.10 m) in three month period of colonization, the average growth in diameter is 11.5 mm, and in upper infralittoral (2 m) in five months the colonies grow at average 54.0 mm (Igić, 1998). The length of zooecia is 0.4-0.6 mm, and width 0.3-0.6 mm (Ryland, 1965).

Reproduction: In the Mediterranean waters, this species settles throughout the year except in winter, but with various length of colonization.

On the coast of Sicily (Palermo) settlement lasts from March to November with the greatest intensity in June, July and August (Riggio, 1979), while in Tyrrhenian Bay it is from August to November with a peak in August (Chimenz Gusso & Rivosecchi - Taramelli, 1973). In Taranto Bay (Ionian Sea) colonization lasts from June to December (Gherardi & Lepore, 1974) what is the most similar to our areas (habitats). Geraci & Relini (1970, b) state that the characteristic temperature for this species in Mediterranean is 14-22°C, when the settlement is more intensive, while the peak of settling is on 22.5°C. In our waters, settling of this bryozoan is the same as in species *Sch. sanguinea*, together with peak in August (Igić 1969, 1972), and in some areas (Omišalj Bay - Krk) and in July (Igić 1998).

Ecophysiological characteristics: on the larval stage there is a lot of information from laboratory research of Nikolić (1959a). Larvae show up in all months and are only limited by temperature of 6-10°C, while the salinity has no influence this developmental stage. According to the same author, larvae show positive phototaxism. Besides, they need aerate water. They need much light in the water, and they are not able to resist water flow. Besides, they have a small action radius, while sometimes they manage to swim 50-100 m away of the mother (source) colony. Otherwise, the larvae settle in immediate vicinity of source cormus (colony) on the area of $1m^2$, with a tigmotaxic orientation (by touch). Tigmotaxism is positive at the beginning of growth, while when space is lacking, colony grows upward and makes tubular formations, showing a negative tigmotropism (Nikolić, 1959a).

Biomass: Although weight is not interesting in fouling bryozoans, it may be imposing. In north Adriatic (Pula) the average weight on pillars was 7860g and 8340g per $1m^2$. The precise abundance is not known, as this was dead and partially broken material (Igić, 1999).

Diet: The digestive tract of this species contained nanoplancton and bentos diatomea (*Pennatae*) (Nikolić, 1959a).

Habitat: It hides from breaker waves in crevices. This species is especially sensitive to course and speed of sea currents, which not only influence fixation, but also growth intensity (Nikolić, 1959a). The most useful current direction is northwards, and the least westwards (Geraci & Relini, 1970b), so it can tolerate speed of 5 cm/sec (Vučak et al., 1981). This bryozoan is also influenced by oxygen in sea water, so in aerated water it lives 48h at the temperature between 17 and 20°C, while in unaerated water at 20°C it lives only 24 hours (Nikolić, 1959a). Regarding the environment factors, the same species is more sensitive on higher salinity variations and in lagoons of Venice where there is a large influx of fresh water this species is lacking (Candela et al., 1982/83). According to Nikolić (1959b) this bryozoan is sensitive on oscillations of salinity greater than 5×10^{-3}. In lagoons, this species is present at the places where aeration is larger (90-110% O_2), concentration of nutrients is smaller and salinity is relatively larger (31.5 - 33.5 x 10^{-3}) (Barbaro & Francescon, 1976). If presence of this species on various habitats is analyzed, it is evident that this species is more eurivalent than species *Sch.sanguinea*. As *Sch. errata* dwells in surface waters with high content of organic compounds, it is common in fouling communities (Gautier, 1962). It lives in harbours (Ryland, 1965) and in some of them (inner harbour of Vado Ligure) it is the most important species, more numerous than other bryozoans (Geraci & Relini, 1970a). Although the larvae are looking for the shelter when settling, there are some researches showing that this species tolerates areas with strong hydrodynamics (Taramelli & Chimenz, 1965; Geraci & Relini, 1970a). Riggio (1979) cites that in several different sites in Palermo harbour this species was relatively similarly representing at the stations with 1 m of depth with strong eutrophication and weak circulation, and in the relatively cleaner site with intensive influx of warm water from power plant, the settling time was somewhat shorter (July, August), while cover is the same (110-120%). On the site with intensive pollution and quick replacing of water, the settling is longer (June - November) and fouling of the substrate is smaller, 83% for whole period of colonization, with maximums in July and August (100%). According to the research by Riggio (1979) on vertical distribution of the species, on the same species presence is successively decreasing with depth: on 1m - colonization is from May to August, cover 100-110%; on 3 m - colonization is from March to October, cover 60-110%, on 6 m - colonization from July to September, cover 40-80%. Smaller presence, that is, size of fouling, is in spring and autumn period, and it also decreases as a function of depth (Riggio, 1979). Except for such characteristics of harbour habitats, especially interesting is presence of species *Sch. errata* in various sites in smaller bays with marinas. In Verudo Bay (Pula), this species is mostly settling at the bay entrance (F=54.55%, D=7.38%[*]), less in marina spot with middle intensity of organic pollution and poisonous ship paint (F=31.60%, D=1.08%), and the least in inner part (F=8.34%, D=0.06%). In the latter part of the cove, due to small water circulation and municipal pollution, with a start of anoxic process, the colonies were decolorized into dark grey to black colour. This process went on old biological material on beton pillars, while on the other substrates (glass, plastic collectors) recent colonies 3-4 months old were not influenced by decomposition, only dying off (Igić 1999). In such ambient with the beginning of reduction process, at the bottom of one Italian lagoon (Caprolace), where there is a relatively larger amount of silt on sea bottom (30-60 cm) and low

[*] D=dominance – is number of colonies of given species divided with total number of individuals of all species times 100

communication with the sea, this species is one of ten present bryozoans, while *Polychaeta* and *Crustacea* are most abundant (Gravina et al., 1989). In the relatively specialized ambient such as cooling devices of thermal power plants, this bryozoan is present in all three research stations on the coast of Italy : at Genoa (Relini et al., 1974), Vado Ligure (Relini & Romairone 1976) and Torvaldaliga (Relini et al., 1980). It shuns places with large flux of water, high turbulence and relatively illumination.

Regarding the substrate, there are data on various artificial substrates such as test plates of glass, asbestos - cement, plastic collectors, beton pillars etc. This species settles variously on ships. On iron ships frequency is 5.5% of whole ship, while average values of the surface occupied by this species are: 7% middle of the hull, 1.7% on propeller, 1% on keel, and 0% on other parts of the ship. In wooden ships frequency is only 2.22% of whole ship, but covering rate are 11.5% on rudder, 8.7% on the propeller. The metal part of the rudder, covered with anticorrosive colour without antivegetative spread is fouled 22.5% (Igić, 1968). According to Nikolić (1959a) on the anticorrosive paint (minium) larvae settle only after a month, and on antivegetative poisonous spread after 3-6 months, but the spread has to be covered with microorganisms first. Of natural substrates, it settles on shellfish, for example on *Pinna nobilis*, together with *Sch. sanguinea* with frequency of 62% on the same size of host (22-70 mm) (Zavodnik, 1967). However, numerous analyses of fouling communities on various artificial substrates, natural communities as epibiosis and in bentos communities, often cite only the genus, so there are no precise data either for this or for previous species in our or other seas. Although both species can be found on the same site, it must be aware that this species prefers shallow waters and tolerates polluted habitats, especially with organic matter, and various degrees of eutrophication up to reductive process.

Distribution: it is considered to be warm-temperate species, or subtropics. It is found on east coast of America, from North Carolina through Caribbean to Brazil, on the Pacific coast of North America, on coast of southern Africa, Australia, in Mediterranean, Red Sea, Persian gulf. The distribution around the islands of Great Britain is considered to be an example of anthropogenous cosmopolitism, that is, it was transferred by ships, as it is not characteristic for that area. The center of distribution of *Sch. errata* remains Mediterranean (Ryland 1965). It is present in Italian seas, in Ligurian Sea (Geraci & Relini, 1970,a,b; Relini & Romairone, 1976; Relini et al., 1974), Tyrrhenian Sea (Chimenz-Gusso & Taramelli-Rivosecchi 1973), around Sicily (Riggio 1979, Galuzzo 1980, Cantone et al.,1980), around Malta (Agius et al, 1977), in Ionian Sea (Tarant Bay) (Montanaro & Tursi 1983), in Suez Canal (Ghobashy et al., 1980).

Information for this species as fouling in Adriatic is sparse. On the west coast it is mentioned for Venice Lagoon (Barbaro & Francescon, 1976) in harbour Manfredonia (Gherardi et al., 1974), and on the east coast around Rovinj (Nikolić 1959a; Zavodnik 1967), in Verudo Bay (Pula) (Igić 1999), in Rijeka area (Omišalj Bay, Krk) (Igić 1998). In bentos communities usually only the genus is mentioned, but as species *Sch. violacea* is mentioned by Zavodnik & Vidaković (1982) in marine communities at Rabac (eastern coast of Istra).

Family *Cryptosulidae*

Genus *Cryptosula* Canu & Bassler 1925

Colonies are flattened. The frontal wall of zooecium is thick, non-transparent and covered with regularly spaced pores. There are no ovicells. The embryo develops in the distal part of zooecium. There are no spines around the opening (orifice). There is one tiny avicularium, but not obligatory. The opening of zooecium is square or bell shaped, usually with a spacious peristome. The vertical walls of zooecia have many pores.

Cryptosula pallasiana (Moll) 1803

Eschara pallasiana Moll 1803: 1, text fig. 13. pl. 3.

Celepora pallasiana Lamoroux 1816: 1, text.

Lepralia pediliostoma Hassall 1841: 363, text pl. 9.

Lepralia pediostoma Johnston 1849: 1, text.

Lepralia pallasiana Hincks 1862: 22-30, 200-207, 303-310, 467-475; 1880: 1, text; Smitt 1866: 1, text; Busk 1852: 1, text; 1858; 124, text; 1859: 65, text; Ostroumov 1894*; Sovinskij 1904*; Osburn 1912: 205, text; Zernov 1913*; Marcus 1926: 1, text; Calvet 1927: 1, text; Borcea 1931*; Prokudina 1952*; Valkanov 1957; 1, text; Brajko 1960: 129, text.

Colony of this species is flattened. When young it is circular in shape, and older colonies may stretch. There are no spines around the opening or ovicells, while the embryos develop in the distal part of the zooid. The primary

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* not pages, cit. in: Brajko, V. D.: Mšanki Černogo morja. – Trudy Sevastop. Biol. Stancii. 13, 129-154.

* not pages, cit. in: Brajko, V. D.: Mšanki Černogo morja. – Trudy Sevastop. Biol. Stancii. 13, 129-154.

opening is as long as it is wide, that is, it is very much square, slightly narrowed on the middle, slightly widened in the lower part. Zooecia are hexangular, sometimes oval, egg shaped, almost square, with thick convex frontal wall and many frontal pores, each of them in a little hollow. The peristome is wide, raised, unprotected, forming a prominent edge around the mouth. Sometimes it is raised a lot. Considering avicula, it is very rare, and when it is present it is immediately under the opening and closed with a mandible. The ancestrula looks like a regular zooecium. The polypide has 16 tentacles (Fig. 32 - colony, Fig. 32a - Zooecium, 32b - ancestrula).

Color: Alive colonies may be very pale pink (almost white) or intensive pink, while dead ones are discoloured or white.

Size: in colder areas (for example west Norway), it reaches maximal size of diameter (46 mm) from May to December. In April - September size is 22 mm, and in June - October 17 mm (Nair 1962). Our data are similar, due to small available space (perforated plastic cup) and size of colonies in six months was between 25x13 - 48x15 mm (Igić, 1983).

Reproduction: seasonal distribution of this species was cited for colder seas. It starts very early and last till winter. In southern parts (Azov Sea) reproduction last throughout the year except in January and February, while larvae remain in the plankton only 24 hours (Brajko, 1960). So in Palermo harbour (Sicily coast) it settles in all months except for July, August, September and October (Riggio 1979) or in March-July and November-December in Ionian Sea (Tarant Bay) (Montanaro & Tursi 1983). In Vado Ligure colonization lasts from May to September (Geraci & Relini, 1970b), same as around Rovinj (Igić 1968), in Marseille harbour (Bellan - Santini 1968, a; Leung Tack Kit 1971-72) or on wooden ships in Palermo harbour (Ardizzone et al., 1977). In the function of time and geographic distribution, the presence of this species varies. In colder seas it is present in warmer months, July, August and September in Norway (Nair 1962) and in Great Britain still and in October (Ryland 1965). In warmer Mediterranean areas, this species is seen mostly intensive during spring. In Mar Piccilo (Taranto), frequency was 100% in May and only 20% in June. In other months (August, September, October) it was below 10% (Montanaro & Tursi 1983). In Palermo harbour it covers 100% of substrate in April and only 5% in December. Values for other months on asbestos test plates are 10-65% (Riggio 1979). This variability in presence is mostly caused by temperature. According to Montanaro & Tursi (1983) adequate temperature for settling is 13.5^{o}C-23^{o}C, because higher temperature facilitates fixation of calcium carbonate in incustrated organisms such as bryozoans. In our climate in Rijeka area (Omišalj Bay, Krk) settlement of this species corresponds this temperature regime, as it settled in June, July, August and September, when average minimal temperatures were 8.60^{o}C, and average maximal temperatures 25.80^{o}C (average for whole year 15.96^{o}C) (Igić 1998).

Ecophysiological characteristics: This species is in Adriatic characterized by great frequency but small abundance and growth. For example in Plomin harbour, on glass test plates in 2-12 months, without significant differences between 0.10 and 1.50 m of depth, frequency was 66.7%, average abundance 9.0, and colony size 3-33 mm (Igić 1991). On other sites (Kotor Bay) on substrate with small space (perforated cover for oyster farming), species *C. pallasiana* grew in half-year period 34 mm (upper side) and 24.5 mm (lower side), with influence on different fouling size (9.34% on upper side, 5% - lower side) or biomass (43.16 g/m^2 on upper side and 8.55 g/m^2 on lower side), when F=56.25% (Igić, 1983). From these data it is obvious that this species is not a sciaphile as most fouling bryozoans.

Habitat: Species *C. pallasiana* is important for harbour habitats both on artificial and natural substrate (Ryland 1962; Hayward & Ryland 1975; Gautier 1962). In many harbours of Mediterranean, this bryozoan is a characteristic member of incrustrating fauna, for example in Marseille harbour (Bellan-Santini 1969; Leung Tack Kit 1971-72) and Palermo harbour on wooden ships (Ardizzoni et al., 1977). As harbour species, it is tolerant on many natural and anthropogenous influences, such as large quantities of organic and inorganic matter (silt) coming from terrestrial ecosystems. Such a case is for example in Plomin harbour, where this species was most frequent in sites with much additive matter, while it was lacking in the cleaner parts. In same conditions on one of the central Italian lagoons (Caprolace) *C. pallasiana* can be found together with *Schizoporella errata* (Gravina et al., 1989). As this species tolerates lagoon ambient, it is eurychaline and can live in areas with lower salinity, for example in Venice Lagoon and on sites with high concentrations of nutrients (Barbaro & Francescon 1976; Candela et al., 1982/83). It is also found in lagoons throughout the world (in Argentina - Bastida & Brankevich 1980) in estuaries where a harbour is located (San Francisco Bay) (Ehrler & Lyke 1980). Besides the lagoon waters, this species tolerates high oscillations of salinity in other habitats, mostly bays. Examples are Plomin Bay (26.33-37.61 x 10^{-3}) (Igić 1991), Omišalj Bay (Krk) (30.60-38.69 x 10^{-3}) (Igić 1998) and Kotor Bay (12.45-35.79 x 10^{-3}) (Igić 1983). Also considering the temperature factor, *C. pallasiana* tolerates a wide range of oscillations, for example up to 30^{o}C (Riggio 1979), so it can be found on spots under the influence of thermal power plants (Riggio 1979) and inner underwater parts of such plants (Relini & Romairone 1976; Relini et al., 1974, 1980). It also tolerates a wide range of oxygen concentration in sea water (114.20, 120.40 % O_2 in Omišalj Bay; 101.4, 133.5 % O_2 - Plomin harbour, 110 % O_2 - Venice Lagoon) (Barbaro & Francesco 1976) up to beginning of reduction, that is anoxic state. That was the case in Verudo Bay at Pula in inner very shallow part (about 2.5 m of depth) with slight circulation. On that site, F=2.27%, D=0.01, abundance average eight colonies per square meter, but more at the station of double pollution (urban and toxic spread on ships) in a harbour, where F=16.21% and D=0.16%. However, at the bay entrance at the cleanest part this species was absent (Igić, 1999). The sea current flow was 40 cm/s at the bay entrance and only 10cm/s in the inner part (Brana, unpublished data). Similar situation is in Bakar Bay, where species *C. pallasiana* is not present at the entrance, but on the oil polluted site (INA) on 1.5 m of depth frequency is 10.5% and in harbour for scatter cargo (mineral rich with metal oxides) frequency is 15.7% (Igić 1982; Zavodnik et al., 1978).

The presence of species *C. pallasiana* decreases in vertical space with depth, so it is most prominent in upper infralittoral. Frequency on the surface (0.10 m) was 7.4%, on 2 m 28.4%, on 30 m only 1.6% (Igić, 1998).

There are no significant differences according settling on various artificial substrates (glass, plastics, asbestos-cement plates, acrilite, wood), limestone blocks, beton construction along the shore etc. However, there is difference between settling on wooden and metal-covered ships. The iron ships frequency total is 33.3%. The zone of 100-130 cm from the water line is fouled, and distribution varies. On these ships *C. pallasiana* mostly fouls stern (21.5%), and leastly the propeller (5.3%), while on the wooden ships frequency total is 66.6% in the zone of 50-70 cm from the water line. This species mostly fouls the metal part of rudder which is protected only with anticorrosive spread, without antivegetative one (cover 32%), while the wooden part of rudder is fouled only 1%. Of the other ship parts, the mostly fouled are stern-post and propulsive system (20.2%), and the least fouled are stern itself (3.0%), bow and ship keel (5%) (Igić, 1968). However, it seems that this species is less tolerant to toxic spreads, as on experimental metal and wooden plates, protected and unprotected, it was found only on unprotected wood in Rovinj harbour (Igić, 1982a). It is obvious that the species *C. pallasiana* is intolerant on toxic metals, primarily copper. Considering the more common settlement on metal parts of rudder at wooden ships, there was no in enquiry settling on anticorrosive spread containing toxic aluminium pigment. This part of rudder was covered with antivegetative colour for wood, which was mostly peeling off. On the natural substrate it is rare as an epibiont. It was found on shells of oyster (*Ostrea edulis*) in vicinity of Rovinj (Zavodnik & Igić 1968a). The same species was recorded on *Pecten* shells in water of Japan (Mawatari 1963) and talus of brown alga *Sargassum muticum* in waters of Great Britain (Withers et al., 1975). However, as a bentos species it is relatively less known in Adriatic biocenoses, although Borcea (1931) cites it as a bentos species in Black Sea, which is also conformed later by Brajko (1960). In Norwegian fjords there is a climax in association, where this species is dominant (*Mytilus edulis - Cryptosula pallasiana - Pomatoceros triqueter*) (Nair 1962).

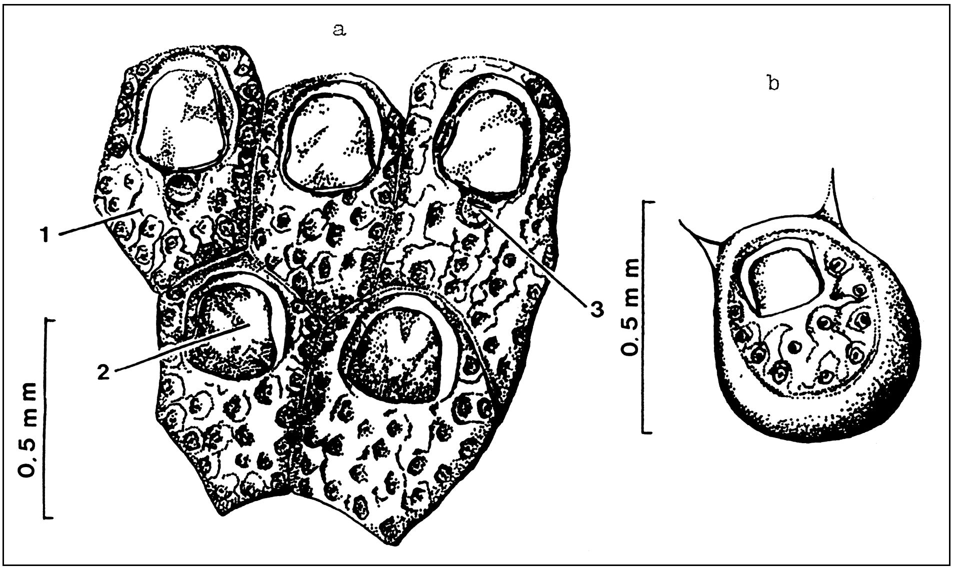

Figure 32. *Cryptosula pallasiana* Canu & Bassler 1925, View of colony incrusting demonstrative on Fig. 2

a. Group of hexagonal zooecia, b. Ancestrula, present in young colony,
1. zooecium, 2. orifice of zooecium, 3. avicularium
according to: J.S. Ryland , 1965

Distribution: species *C. pallasiana* is represented in Atlantic shores of Europe, from western Norway through Mediterranean toward the Black Sea. It was found in Norway (Nair 1962), Great Britain (Withers et al., 1975), in French harbours, Italian seas, lagoons, and especially on the coast of Sicily in the Palermo harbour (Riggio 1979; Ardizzone et al., 1977) and coast of Catania (Galluzzo 1980; Cantone et al., 1981). In Black Sea it is found in Sevastopolj Bay, on the southern coast of Krimea, at Caucasian coast and on northwest of Black Sea (Brajko 1960). The same authors cite it in Azov Sea under the name *Lepralia pallasiana*. Outside Europe this species was found in Suez Canal (Ghobashy 1980), at California (Ehrler & Lyke 1980), in Japanese waters (Mawatari 1963), in Argentine harbours (Lichtschien de Bastida & Bastida; Bastida et al., 1980) and lagoons (Bastida & Brankevich 1980).

For Adriatic, it is known as a fouling species in Piran Bay (Vriser 1978) and already mentioned harbours as well on western coast in Italian lagoons.

However this species is important in the fouling complex of Ionian Sea, in "Mar Piccolo" (Tarantno) (Montanaro & Tursi 1983) but also in open waters (Crotone) on platforms 6 km from shore and on depth of 14 and 20 m (Relini et al., 1976).

FRESHWATER BRYOZOANS

For these bryozoans classification is on the levels of class, families and genera, while the orders are not mentioned in available literature. Types of colonial forms are mentioned. The two principal types are the lophopodide and the plumatellide, according to Hyman (1959), the most important researcher of their biology.

Family *Plumatellidae*

Colony is branched like a bush, mushroom like or like mycelia. It is creeping about the surface or is erect. Zooecia are glued throughout their length.

Genus *Plumatella* Allman 1856

Colonies are branched and creeping, composed of tender, long cylindrical individuals. Sometimes colonies are in contact with substrate and be 30 cm long, and 2.5-5 cm high. They have a thick chitinous cuticula. This genus is the most numerous of all freshwater bryozoans, and is counterpart of marine *Bugula*. The lophophore carries 40-60 cilliate tentacles. The individuals have an outer layer (ectocyst) and an inner layer (endocyst). The outer layer is dark, mostly brown, with inserted sand grains, and it can be quite transparent. The inner layer is the soft membrane of the body. There are primarily two polypides forming from an embryo. Statoblast are lens-shaped and flattened (Fig. 9A).

Plumatella repens **Linnaeus 1758**

Colony is composed of cylindrical, tubular, stiff chitinous branches, longer than 20 cm. It settles on the lower side of leaves, rocks, shells etc. It is mostly found in fishponds and ponds. Its common name is "water feather" (Fig. 33).

Plumatella fungosa **Pallas 1766**

Colony is mushroom-like, individuals are crowded in parallel groups. Colonies mostly settle on trees, rocks, pillars, bridges, and many animals such as hydroids, planaria, nematodes, copepods, gastrotrichs, insect larvae etc (Marcus 1926). This species is characteristic for still waters (Fig. 34).

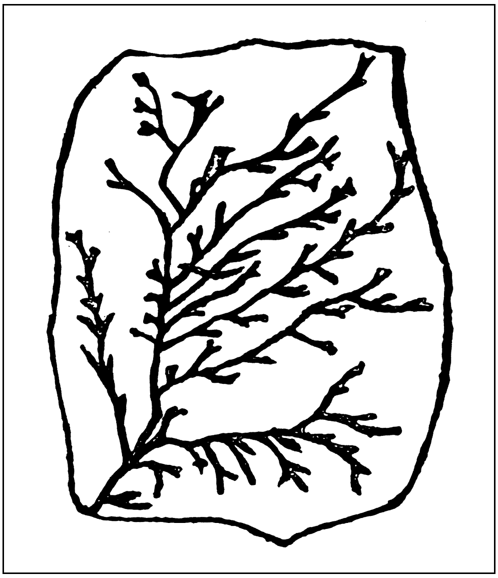

Figure 33. *Plumatella repens* Linnaeus 1758 ("watery feater"); Colony adopted on leaf
according to: V.A. Dogelj, 1948

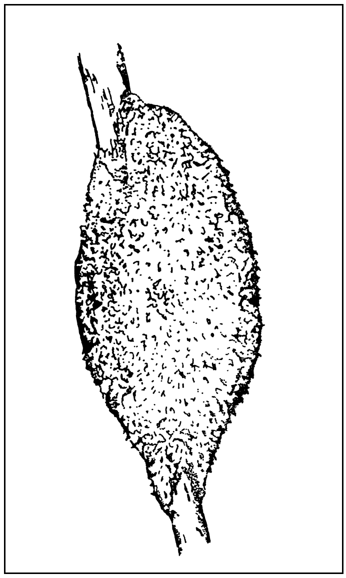

Figure 34. *Plumatella fungosa* Pallas 1766
accoridng to: V.A. Dogelj, 1948

Family *Cristatellidae*

Colonies are slug like, with broad flattened bottom and thick gelatinous walls. Zooids in a colony are not separated by a cystid wall but with a tape that is remain of cystid.

Genus *Cristatella* Cuvier 1800

Wormlike creeping colonies, 3-5 cm long (although they may reach 30 cm). The upper side is convex and the lower is flattened, with a thick gelatinous cuticula. There are also polypide bodies form from an embryo. The individuals are on the upper side of a colony, which leads the movement. Statoblasts are round (Fig. 9B).

***Cristatella mucedo* Cuvier 1800**

The colony resembles a jelly plate or sausage, whose upper side carries individuals, while the lower side is an elongated mucous product not connected with the substrate, so the colony can move slowly. It is mostly 2.5 cm long, sometimes up to 9 cm, and 1 cm thick. This species is known as "slimy uhoracha". It is especially common in fishponds, ponds and very clear waters. It is very sparsely distributed, but is very abundant where present (Fig. 35).

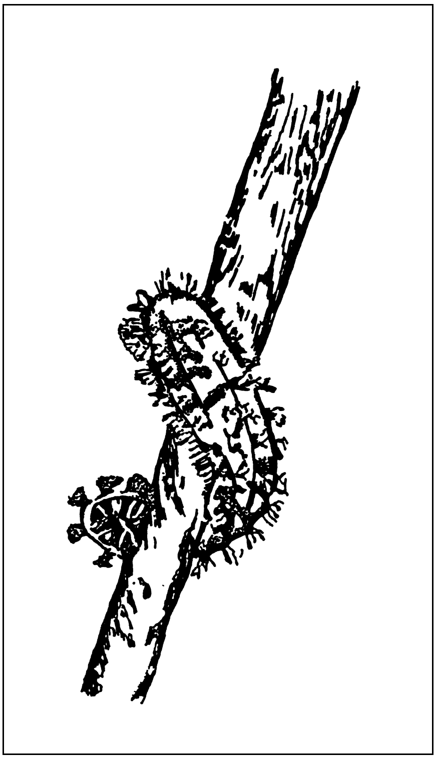

Figure 35. *Cristatella mucedo* Cuvier 1800
according to: V.A. Dogelj, 1948

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ANEX 1
- MARINE BRYOZOA -

Classsification of BRYOZOA from phylum to species according to Zabala & Maluquer (1988)

Phylum BRYOZOA
- Classis GYMNOLAEMATA
  - Order CTENOSTOMATA
    - Suborder Carnosa
      - Family Flustrellidae
        - Genus *Pherusella* Soule, 1951
          - Species *Pherusella tubulosa* (Prenant & Bobin, 1956)
    - Suborder Stolonifera
      - Family Vesiculariidae
        - Genus *Amathia* Lamouroux, 1812
          - Species *Amathia semiconvoluta* Lamouroux, 1824
        - Genus *Bowerbankia* Farre 1837
          - Species Bowerbankia gracilis Leidy
  - Order CHEILOSTOMATA
    - Suborder Anasca
      - Family Scrupocellariidae
        - Genus *Scrupocellaria* Van Beneden 1845
          - Species *Scrupocellaria reptans* Linnaeus 1758
          - Species Scrupocellaria bertholeti Audouin 1826
      - Family Bugulidae
        - Genus *Bugula* Oken, 1815
          - Species *Bugula neritina* (Linnaeus 1758)
          - Species *Bugula simplex* Hincks 1886
      - Family Aeteidae
        - Genus *Aetea* Lamouroux, 1812
          - Species *Aetea truncata* (Landsborough) 1852
      - Family Membraniporidae
        - Genus *Membranipora* De Blainville, 1830

Species *Membranipora membranacea* (Linnaeus 1767)

Family Flustridae

Genus *Securiflustra* Silén 1941

Species Securiflustra securifrons Pallas 1766

Suborder Ascophora

Family Hippoporinidae

Genus *Pentapora* Fischer 1807

Species *Hippodiplosia foliacea* (Ellis & Solander 1786)

Family Sertellidae

Genus *Sertella* Jullien & Calvet (1903)

Species *Sertella beaniana* King 1846

Family Smittinidae Levinsen 1909

Genus *Porella* Gray, 1848

Species *Porella cervicornis* Gray, 1848

Family Myriapridae

Genus *Myriapora* Donati 1750

Species *Myriapora truncata* (Pallas 1866)

Family Schizoporellidae

Subfamily Schizoporellinae Bassler 1935

Genus *Schizobrachiella* Canu & Bassler 1920

Species Schizobrachiella sanguinea Norman 1868

Genus *Schizoporella* Hincks 1877

Species *Schizoporella errata* (Waters) 1878

Family Cryptosulidae

Genus *Cryptosula* Canu & Bassler 1925

Species Cryptosula pallasiana (Moll) 1803

Classis STENOLAEMATA

Order CYCLOSTOMATA

Suborder Rectanguloidea

Family Lichenoporidae

Genus *Lichenopora* Defrance, 1823

Species *Lichenopora radiata* (Audouin, 1826)

SUMMARY
- SOME SPECIES OF *BRYOZOA* FROM THE ADRIATIC SEA AND FROM FRESHWATERS, WHICH ARE OF SPECIAL IMPORTANCE FOR FOULING COMPLEX -

Fouling, particularly for its applicability for everything that is submerged in water environment but is can be used by human being, (water systems, edible organisms), imposes the necessity for higher specialised investigations of that process. Because, as complexness and better knowledge of species, so it will make easier the way for finding out the effective protection and the prevention of harmful consequence from fouling.

From those reasons it was aimed to be perform an handbook in the form of catalogue and partial as monograph, which will primarily made easier the identification of bryozoan species which are attractive in fouling complex, and which are contemporary species of benthic communities.

The work has consisted some economic importance of bryozoan for fouling problem, specially for navigable objects, which can be completelly fouled by bryozoans, because they are toleranted towards the copper in the antifouling paints (Ketchum, 1952). Than, is emphasizes the economical importance of bryozoans in fouling communities, as one of the main spatial competitors and in the succession of fouling process. Very often, because of the defensive mechanisms, bryozoans disible the settlement of other foulers, but when the colonies are dead, enable better settlement of foulers because of the rougness of substratum.

It was done on species which live in Adriatic sea and continental waters taking only the representative from some taxonomic categories, which are very often presented, limited only on one or eventually on two species.

The collecting of material and its conserving have been described, as making of slides, too.

Besides the methods of working “in situ” for initiation of colonization of fouling organisms i. e. the settlement of bryozoans in space and time were also described.

I such a way it is made possible to see of the process from settlement to mortality, including a few aspects: composition and quantity, growth, regenaration, process of dying, weight and so on.

The method on marked hosts which enables following of growth dynamics of the fouling community –i.e interactive relation of the fouling species was mentioned, also. The working method on larval level was described, too.

In the same chapter were cited authors important for determination from classis to species. A few species important for fouling complex were worked out (their frequency, abundance, covering), as a few species typical for benthos. Also, a few the most frequent and more important freshwater bryozoan species were described.

In the chapter RESULTS for bryozoan phylum and classes some general characteristics have been described; morphology, reproduction, stratification, geographic distribution and some ecological properties. Especially the influence of salinity on the number and distribution of species have been emphasized, because the low salinity has the influence on the reduction of species and it is the best tolerable by *Ctenostomata* (Gautier, 1962), while *Cheilostomata* are stenovalent towards the salinity, they prefer to higher salinity (Duncan, 1957). In relation to stratification the wide-spreadness is described; from supralittoral to about 6000m depth, although most abundant in the littoral zone to a dept of 200 to 300m. But with deeper environment the number of species considerable reduces, so after 3000m only *Cheilostomata* are presented (Marcus, 1921). According substratum, the hard bottoms have the best preferies. Their wide-spreadness in geographical meaning is in all seas but not only in polar zones. On such wied distribution of bryozoans the anthropogenic cosmopolitism is partly influenced, thanks to navigational objects, which are used as the transfers from one to sometimes very far away located seas. Besides, it was established the connection and similarity between Eastern-Atlantic, Mediterranean and West Indian region (Osburn, 1940).

For fresh-water bryozoans the morphology has being described, than reproduction, stratification (to 20m, extremely 170m depth) and specification for bryozoans anyway in general; the movement at type *Cristatella*.

In Taxononomic part the morphology for orders, families and generia has been described.. On the level of species it was included the synonymies, morphology, reproduction with seasonal distribution, geographical distribution, habitat - including relation to substratum, environmental conditions, and stratification. In addition, for some relatively lesser number of species,ecophysiological data are mentioned.