CIRRIPEDIA OF ADRIATIC

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ABSTRACT

-CIRRIPEDIA OF ADRIATIC-

The study of all species Cirripedia that live in the Adriatic sea has been done, because of special ecological and economical importance (Thoracica, in total species -25, illustrations -131; Rhizocephala, in total species 5, illustrations -12), one was wrongly determined, and the other could be potential settler. The work comprises several chapters as introduction, history of investigations, methods, results, literature cited, table, appendices.

In introduction it is described the importance of Cirripedia as fouling group especially emphasize their ecological and economical importance. In the history of investigations there were quoted the eminent works and monographs about Cirripedia all over the world.

For Cirripedia Adriatic had been made clear table with authors which had mentioned all species, synonyms, wrongly determined species, forms, varieties (in total 62).

The methods classical and contemporary were described using for conservations of materials. Also there were described relevant systematic characters using for determination of species.

There were described in the results general characteristic for genera and supragenera taxa (subclass, order, suborder, superfamily, family, subfamily), terminology, taxonomy description (given annexes with suprageneric taxa). On the level of species there were taken into the consideration synonym, morphology, reproduction, size, color, ecology (habitation, substratum, vertical stratification, relation towards the factors of environment), for some species ecophisiological, genetics etc., while for some species Adriatic sea there were given description also the locus tipicus.

PREFACE

The cirripedes, sessile crustaceans have a central position in fouling problematic and represent the "tripping stone" for everything in the sea that humans use. Cirripedes are represented in the fouling complex with 86%, and yearly damage is estimated to be $2x10^8$ US dollars (Christie & Dalley 1987). The damage is mostly due to weight of their heavy layers made by epibioses (organisms settle on each other to make layers several decimeters thick). The increasing of weight of navigable objects caused by barnacle fouling changes their hydrodynamics. This fact has direct and indirect consequences for mentioned objects. The weight of cirripedes also reduces functions of host organisms and their commercial value – of eatable species, especially.

The importance of these organisms reflects on greater ecological and physiological features. Some species show greater flexibility of substrate, time and space distribution, so they can be treated as cosmopolites, and anthropogenous cosmopolitism is prominent.

Organization for Economic Cooperation and Development (OECD), favoring the principle that economic progress depends on industrial development, being supported by scientific research of various profiles, with a group of experts for fouling and corrosion of ships, have started cooperative research. The goal of this research was creating a program resulting in one of cooperative projects, making a catalogue. Several catalogues were made representing the most important fouling groups, including *Cirripedia* (Southward & Crisp 1963). The same catalogue includes a smaller number of species important for fouling communities throughout the world. The species description includes partial description of morphology, vertical and horizontal distribution, while the taxonomy is not presented.

Due to data scarcity, it was inevitable to describe this animal group in detail. This work includes the description of outer and inner morphology, reproduction, ecology, partly ecophysiology and batimetric and geographic distribution. Systematics and nomenclature with an immense synonym listing was given, especially for species residing in Adriatic. The "potential" species were also represented. They do not dwell in Adriatic now, but their immigration and existence is possible there, especially in some suitable microlocations (for example tropical species around thermal power plants).

This study gives a better documentation on species biology, on their easier and more precise identification, on better knowledge of their habitat (if they live on coast, open waters, lagoons, mouths, harbors etc.). It gives the knowledge about the important role of crustaceans cirripedes as bioindicators of the environment, too. Furthermore, the precise relationship toward the substrate (physical looks, contours, color, geometry, chemical content), time, batimetric and horizontal distribution is given.

The handbook is a great contribution for science, giving insight in presence of representatives of classis *Cirripedia* living in Adriatic, and so supplementing the incomplete information present on this group. This study is important for all marine researchers that meet these organisms, especially in fouling problematic but also in biocenology. The same handbook is also useful to students as an educational tool.

Finally, this handbook is very applicable for estimating damage caused by cirripedes crustaceans in all objects and organisms in human use. It also gives opportunity for faster and more effective “fight” for invention of adequate protection and damage protection, especially.

INTRODUCTION

Cirripedes (*Crustacea*, *Cirripedia*) are a dominant component of animal fouling species on artificial and natural substrates, as they are best adapted to sessile way of life. For this great degree of adaptation, the principal cause is the cypris larvae. Crisp (1984) states that they are "the top of evolution of sessile organisms". According to long-term research in Oceanographic institute Woods Hole (1952) cirripedes are in 50% of cases present in fouling complexes. These data are for the period 1853-1946. on 153 test substrates (ships, floating and fixated structures). Newer analyses of 600 ships colored with international antivegetative colors in period 1980-1981 also point that cirripedes are present in 86% of fouling communities (*Polychaeta* 12.75%; *Hydrozoa* 0.25%; *Bryozoa* 0.50%; *Balanomorpha* 84%, *Lepadomorpha* 2.5%) (Christie & Dalley 1987). Of the cirripedes, the group *Balanomorpha* is dominant as fouling species on artificial and natural substrate (rocks, stones, shells of shellfish, snails, crayfish etc.), especially in mediolittoral and sublittoral. The deep-sea cirripedes, for example *Scalpellum* and *Megalasma*, are rare in fouling complex, except on transoceanic cables. Other species from genus *Acasta* live only inside the sponges of genera *Spongia*, *Casospongia*, *Ircinia* etc., or on various organisms as epibionts, such as *Chelonibia testudinaria*, *Chelonibia caretta*, *Platylapas hexastilos* and *Stomatolepas elegans*, which live only on sea turtles, separately distributed. The first two species live on carapace, and the rest on neck and wrists of turtles. There are species, such as *Xenobalanus globicit*, that live on dolphin fins, and *Alepas parasitica* settles on jellyfish. There are also obligatory intestine parasites, such as representatives of genera *Ascothoracica* and *Rhizocephala* that spend their lives mostly inside other crustaceans' bodies. On different other organisms live almost all cirripedes as the species from genus *Lepas* and *Conchoderma*. It is also characteristic for them that they live on floating surfaces, platforms, etc. As the cirripedes are the major fouling component, species characteristic for certain geographical areas can be recognized on the fouled ships. It is particulary important that some species may immigrate to new teritories. The examples of anthropogenous cosmopolitism are numerous. The species *Elminius modestus* from Australia and New Zealand was transported to northern Europe (especially England). It is assumed that it immigrated in 1946 (Boschma 1948). The same species is also very common in Netherlands (Frisone, 1951) and France (Den Hartog 1956). Some species which are not typical for Mediterranean, such as *Balanus* (*Megabalanus*) *tintinnabulum*, for example, were found in the Ligurian sea and in the Adriatic

(Relini 1969; Relini et al., 1972 a, b; Kolosváry 1947), in convenient microhabitats near by thermoelectric power-stations with higher temperature of the sea-water. The larvae most likely descended from adults on ships coming from tropical areas (Relini & Montanari 1973). The authors cite that this is not a proper introduction of a species, but it can also become a starting point for invasion of other tropical species, which will gradually adapt to cooler waters. That happened with species *Balanus amphitrite* in Great Britain and northern France, where the species was found in cooling capacities in thermal power plants (Southward & Crisp 1965), so the anthropogenous cosmopolitism is actual for almost all cirripedes . It may be concluded that ships are potential "importers" of foreign species. However, transfers can be done also through various living organisms, most often shellfish. It is assumed that species *Balanus improvisus* came into Italian waters through shellfish (Relini & Montanari 1973) and also to Japan (Kawahara 1963). For that reason it is usefull to investigate species which are not settler in some seas. So, we maybe can intervene before some species becomes regular settler – with all ecological consequences for the environment.

Besides the adaptation on existing abiotical and biotical habitat factors, the individual species are adapted to human-influenced urban industrial areas, and as such are great bioindicators of habitat and water pollution (especially by organic means). The larvae of barnacle *Balanus amphitrite amphitrite* Darwin are recently used in laboratory research of antivegetative technology, that is, poisonous substrate and mixture (Rittschof et al., 1992). They are very much resistant on antivegetative poisonous paint applied on ships and other marine artificial objects. Therefore the barnacles (for example species *Balanus eburneus*) foul stationed ships up to 20-30 kg/m^3 per year (Zevina 1957). Fouling intensity is especially important for harbour habitats, where some species such as *Balanus amphitrite amphitrite* have a high ecological capacity, enabling them to exist in polluted, eutrophied areas (Cecere & Matarrese 1983).

Considering humans, the economic importance of cirripedes is double sided: positive and negative. The negative aspect is connected with fouling. The great damage by *Balanomorpha* is mostly due to increase of ship weight, plugging pipes and increase of fuel consumption and decrease of ship speed due to changed hydrodynamic shape of ship. Furthermore, barnacles can, due to their special way of securing to the ship, remove the protective layer of paint and increase corrosion by enabling sea water to reach the metal. If they are connected to the metal that is resistant on seawater, they can also cause corrosion through differential radiance (Ralph et al., 1981; Cecere & Matarrese 1983).

Barnacles can also be detrimental to platforms and oceanographical instruments and some fishing devices (nets, traps). According to relatively fresh data from 1980-ties, damage due to barnacle fouling is estimated to $2x10^8$ US dollars per year (Christie & Dalley 1987). As epibionts on shells of edible shellfish, barnacles are unwanted settlers, as they decrease host growth rate, damage its esthetic looks and therefore decrease the market value. Besides, shellfish in farms fall off the ropes they are attached on due to great weight of attached barnacles (Sacchi & Renzoni 1962). Such shellfish are then not usable for the market.

The positive effects of cirripedes are visible throughout their using for fertilization of ground (Japan) and for nutrition of young fishes in culture parks. Their larvae are one of the main sources of food for a lot of benthic and nektonic organisms (Christie & Dalley, 1987). Adult barnacles eat some fish species as a food (Bleniidae). Simultaneously, they are the main food of sea-urchins, *Stilochus mediterraneus*, for example (Relini, 1980).

According to the given facts, it is possible to conclude that cirripedes are more important than other fouling groups, and that they are important not only for biologists but also for technologists of protective paints. Therefore, better knowledge of this fouling group is very important, especially from economic standpoint. This work tries to incorporate all cirripedes cited for Adriatic, although several species are never yet found there. Those are *Balanus inexpectatus*, described by Kolosváry (1947) and *Chthamalus stellatus stellatus* with forms *typica*, *depressa* and *cirrata*. Another described species is *Megabalanus tintinnabulum*, which can maybe acclimatize in warmer microlocations at power plants. For these rare species, presented data would lead to better knowledge of ecological and geographical distribution. For species that live in Adriatic, descriptive and iconographic documentation is presented as well as it was possible. Analytical keys and iconography with distribution, ecology and morphology lead to more complete knowledge and as easy as possible recognition of species. The species of order *Thoracica* are mostly found on coastal area and are very interesting as bioindicators of habitat, as damage making organisms in fouling or as useful organisms due to use of their larvae in aquaculture.

HISTORY OF RESEARCH

The barnacles are known from ancient times. Αριςτοτελες describes them as animals similar to primitive ostracodes. At later times Linnaeus (1758) describes order *Thoracica* as "Vermes testacea" and Lamarck (1818) as "Crustaces conchyliferes". Cuvier (1830) considers *Thoracica* to be modified mollusks due to hard shells and calls them "*Cirrhopoda-Mollusca*". However, based on larval stadiums, Strausse (1810) and Burmeister (1834) identify *Cirripedia* as crustaceans.

First more complete knowledge on cirripedes and especially their basic classification date from Darwin, who continued classification system research from Leach (1817, 1825) and Gray (1825). Darwin wrote 4 monographs (1851a, b, 1854a, b) and two short papers (1863, 1873). His work was based on dissection of soft parts and shells, with additional use of literature. He presented anatomic descriptions of certain systematic characters, giving precise diagnoses of species and natural relationships. However, his works were later revised several times, mostly concerning *Balanomorpha* group. Withers (1924) was among the first person suggesting diphyletic* origin of *Balanomorpha*, and they were also partially revised by Pilsbry (1907, 1916). Much later, an extensive revision of systematic status of *Balanomorpha* was done by Norman & Ross (1976). Their catalogue shows evolution and systematics of *Balanomorpha*. For each species geographic and batimetrical distribution was given. Most of described species do not dwell in Adriatic. One of the recent works on systematics and evolution of cirripedes is a study of Newman (1987), who gave a classification of supragenetical taxa above family (Annex 2). The author held an opinion that parasitic groups *Ascothoracica* and *Rhizocephala* are not cirripedes in strict sense. Newman also studied *Thoracica* and made some minor changes on superfamily level. During the analysis of Darwin's monographs, he found badly defined statements on distribution, anatomy, reproduction, geological sequence and age, and tried to present the freshest systematic and morphological standards. Cirripedes catalogues such as the one from OECD (Southward & Crisp, 1963) include barnacles especially important for worldwide fouling complexes. The same catalogue presents morphology, geographical and partially space distribution, but without synonyms. Same aspects were covered by Luther (1987) for 7 most important barnacle species from western Baltic and North Sea. For northwestern Australia, Jones (1990)

* origin from two different evolution branches (phylum)

presents *Lepadomorpha* and *Balanomorpha* with families and genera, and for each taxon gives synonyms, type locality, geographical distribution, range size and remarks. It is also important to note the catalogue of Mediterranean fauna and flora, where some barnacles were described (Riedl 1983, 1991). Besides the already mentioned catalogues, there are monographs on barnacles, for example on systematics and structure of fossil barnacles of Europe and Africa (Davadie, 1963) or on barnacles belonging to the complex *Balanus amphitrite* (Henry & Mc Laughlin 1975), as one of the most variable species. This complex has been described several times (Nillson-Cantell, 1921; Hiro, 1938; Utinomi, 1956, 1960; Stubbings 1961, 1967; Harding, 1962). There are also many extensive biological studies on cirripedes (Hiro, 1937; Pyefinch, 1948), and monographs of for example species of *Megabalanus* (especially *M. tintinnabulum*) (Henry & Mc Laughlin, 1986), but also other species of *Balanomorpha* that do not live in our waters (Kim I. L. H. & Kim, H.S., 1980; Karande & Paleker, 1966). Although the order *Thoracica* is best represented in literature, there are also numerous studies on *Rhizocephala*, and especially *Acrothoracica*, which are described by Zarenkov (1982). By the way, Rainbow (1984) made the most detailed study on orders *Thoracica* and *Rhizocephala*, describing following features: morphology, cement system of adult stadiums, behavior of parasites, epizoits, larval stadiums, their development, spreading, diet etc. Huwae (1985) besides *Thoracica* also included *Rhizocephala* and *Acrothoracica*, giving identification key and additional information on structure, development and distribution. There are several works on cosmopolite parasitic species *Sacculina carcini*, where the major one is paper by Lutzen (1984) who completely describes biology of this species.

As cirripedes are the most important fouling organisms, besides the taxonomic research there are numerous ecological, biochemical and ecophysiological works that are important in finding adequate and long-lasting protection in fight for their extermination. The present cirripedes are often mentioned in analyses of fouling communities, or autecological studies are done on test organisms as bioindicators of habitat quality, as well as various genetic and biochemical research. Such research is usually done in laboratory conditions on larval stadiums, where various abiotical (for example light, currents, substrate) and biotical (food) conditions are analyzed as factors for settling and growth (Pomerat & Reiner 1942; Gregg 1945; Weiss 1947; Sabbateev 1952; Crisp & Barnes 1954; Barnes 1958, 1963; Barnes & Crisp 1956; Crisp & Ritz 1974; Sommer 1978; Wethey 1984; Geraci & Romairone 1986; Korn 1988; Quian & Liu 1990 etc). Lab biochemical research is also done on adults (Southward 1955; Walley 1964; Dando & Southward 1980; Yule & Crisp 1983; Yule & Walker 1984; Waite & Walker 1988). Important studies on antivegetative paint influence on barnacles were done by Clarke (1947), Harris

(1946), Londen (1963), Kühl (1968), Guillén et al., (1968), Saroyon (1968), Relini et al., (1972), Gurevic & Dolgopoljskaja (1975) etc. Especially important is the monograph done by scientific team from Woods Hole Institute (1952), where all mentioned aspects were covered. Besides, there are many autecological researches, for example on species *Balanus eburneus*: development and settling of larvae (Landau 1976; Landau et al., 1979) and the relationship of adults and various salinity levels (Bacon 1971; Mook 1980). The species *Balanus amphitrite* is much used as a bioindicator of habitat quality, organic pollution, various heavy metals etc. (Elliott et al., 1985; Rainbow & White 1989). There is also interesting genetic research on *Balanus improvisus*, dealing with species identification (Flowerdew 1985) and similarities between populations of a same species (Furman 1990). All mentioned research was done on various artificial substrates, and there are also studies on barnacles and other foulers on substrates that are extremely important for humans, such as ships (Wisscher 1927; Relini & Montanari 1973), platforms (Foster & Willan 1979) or edible organisms, such as snails (Wilkinson & Burrows 1972), crustaceans (Williams & Porter 1964), shellfish (Loosanoff 1960, 1965; Sacchi & Renzoni 1962 etc).

Considering cirripedes of Adriatic Sea, there is in a certain sense a chaos, as some species are wrongly determined, some are only possible potential inhabitants of Adriatic, and some species that never lived in our sea are still mentioned. In order to give a structure to content of cirripedes fauna of Adriatic, table 1 is constructed. It shows altogether 68 cirripedes species together with synonyms, varieties and forms, while only 23 species of order *Thoracica* and 9 species of order *Rhizocephala* are real inhabitants of Adriatic.

Of all the mentioned authors (Table 1), the first proper cirripediologist was Kolosváry, considering the immense work on this group of crustaceans. In one of most complex taxonomic-ecological monographs (1947) this author cites the species living in Adriatic, among which some that are not inhabiting our sea (*Balanus inexpectatus*) or are only potential inhabitants (*Balanus tintinnabulum*). This author is so far the only cirripediologist to divide species *Chthamalus stellatus* into three forms. Other taxonomic works are revision of certain species of species complex *Balanus amphitrite*. Kolosváry (1940, 1942) gives a discussion on it and connects for example species *B. regalis* with species *B. concavus*, considering it a subspecies. By the way, Kolosváry in numerous publications (1939, a, b; 1940, a; 1941, a; 1942, a; 1943; 1944; 1947; 1951; 1955; 1961; 1967) describes individual species mostly from the ecological aspects. He considers relationship of biotope and their vertical and horizontal distribution, population density, he cites them as epibionts or on various artificial substrates etc. Besides Kolosváry, the first more complete list of cirripedes is given by Rigo (1942) for Venice lagoons. Rigo discusses if these are forms like previous authors said, or phenotypes inside each species, as he said. Furthermore, the same author cites horizontal and vertical distribution in north Adriatic for each mentioned species. Until the Second World War, important researcher was Neu (1932) who points to barnacles' importance in fouling communities on ships in mid Adriatic. There are actual continuous researches after 1960-ties, mostly regarding fouling communities, done from ecological aspect in *in situ* research (Relini & Relini-Orsi 1971, 1984; Relini et al., 1972, a, b; Specchi et al., 1976; Igić 1968, a; 1981, a; 1982, a; 1983, 1984, 1986, 1991, 1994, a). Especially important are works on introducing new cirripedes species into Adriatic as an example of anthropogenous cosmopolitism (*Balanus trigonus*, *Stomatolepas elegans*) (Relini 1968), species distribution in Italian seas (Relini 1969) and cirripedes catalogue for Italian seas (Relini 1980, a) where not only morphology was given, but also distribution and short ecology data. Synonyms are poorly represented, with old classification and nomenclature with zoological common names. In the same catalogue, the ecological importance of species (especially some very rare) is given, as they might once show in greater numbers (for example *Megabalanus tintinnabulum*). In this way, the author enlarges general knowledge of their ecological niche and geographic distribution, in case that the species becomes a regular resident in our sea.

The newer research on Adriatic cirripedes includes autecological studies on species *Balanus amphitrite* as an indicator of thermal and chemical pollution in Venice waters (Patarnello et al., 1991). Also important is autecological work on parasitic lepadomorph cirripedes *Octolasmis lowei* that lives on gills of decapod crustaceans. It was found in Adriatic for the first time by Števčić (1965) and determined by Broch (1963). The other important work is of Boschma (1961), who described parasitic crustaceans of family *Sacculinidae*, which were unknown for Adriatic excepting for the species *Sacculina carcini*.

Riedl (1963, 1970) in his catalogues of fauna and flora of Adriatic has very concisely described subclass *Cirripedia*. These catalogues were later abridged with data for all Mediterranean (1983, 1991).

Table l . List of all the Cirripedia species that are mentioned in Adriatic with different interpretations of their presence.

Species which live in Adriatic (+); species do not live in Adriatic (-); synonym of species (1); wrongly determination of species, correspond other species (2); species do not lives in Adriatic, but is possible potential_settler (3).

THORACICA		
Alepas squalicola	-	Karl 1873
Lepas laevis	-	Karl 1873
Lepas striata	-	Karl 1873
Lepas hilli	+	Weltner 1897, Relini 1980
Lepas anatifera	+	Olivi 1792; Contarini 1847, Heller 1866, Stossich 1880, Carus 1885, Weltner 1897, Graeffe 1900, Brusina 1907, Nilsson-Cantell 1921, Vatova 1928, Kolosváry 1947, Relini 1969, 1980a, Riedl 1963, 1970,1983, 1991.
Lepas anserifera	+	Olivi 1792, Graeffe 1900, Brusina 1907, Kolosváry 1947, Riedl 1963, 1970, 1983, Relini 1969, 1980
Lepas pectinata	+	Broch 1953, Relini 1980
Lepas balanus	-	Olivi 1792
Lepas fascicularis		Nilsson-Cantell 1921
Lepas balanus = Balanus porcatus	-, 2	Carus 1885, Gruvel 1905
Lepas Balanus = Balanus perforatus[*]	-,2	Rigo 1942
Lepas balanoides = Balanus balanoides	-, 2	Gruvel 1905 .
Lepas balanoides= Balanus amphitrite[*]	-,2	Poli 1791

[*]species lives in Adriatic

Octolasmis lowei	+	Broch 1963, Števčić 1965, Relini 1978, 1980, Riedl 1983
Conchoderma gracile	-	Heller 1866, Weltner 1897, Stossich 1880, Carus 1885, Graeffe 1900
Conchoderma auritum	+	Graeffe 1900, Brusina 1907, Vatova 1928, Nilsson-Cantell 1932a, Kolosváry 1942a,Relini 1969, 1980b, Riedl 1963, 1970,1983, 1991
Conchoderma virgatum	+	Weltner 1897, Graeffe 1900, 1991 Brusina 1907, Kolosváry 1942a, Relini 1969, 1980a, Riedl 1963, 1970, 1983, 1991
Scalpellum scalpellum	+	Olivi 1792, Brusina 1907, Va tova 1928, Kolosváry 1942a, Broch 1953, Relini 1969, 1980, Riedl 1963, 1970, 1983, 1991
Scalpellum vulgare	+	Olivi 1792, Carus 1885, Stossich 1880, Graeffe 1900, Relini 1969, 1980, Riedl 1970, 1983, 1991
Dichelaspis Darwinii	-	Heller 1866, Graeffe 1900, Gruvel 1903
Chelonibia testudinaria	+	Olivi 1792, Contarini 1847, Carus 1885, Stossich 1880, Graeffe 1900, Vatova 1928, Kolosváry 1939a, 1940a, 1940a, Relini 1969, 1980a, Riedl 1970, 1983, 1991, Igić, 1981a
Chelonobia testudinaria = Chelonibia testudinaria	+, 1	Stossich 1880, Carus 1865, Brusina 1907
Coronula testudinaria = Chelonibia testudinaria	+, 2	Karl 1873
Chelonibia patula	+	Relini 1980 b
Coronula testudinaria — Chelonibia patula	+, 2	Karl 1873
Stomatolepas elegans	+	Relini 1969, 1980a
Platylepas hexastylos	+	Relini 1980a, Zavodnik 1997

Verruca stroemia	+	Graeffe 1900, Brusina 1907, Vatova 1928, Kolosváry 1942a, 1947, Relini 1969, 1980b, Riedl 1963, 1970, 1983, 1991
Acasta spongites	+	Contarini 1847, Weltner 1897, Brusina 1907, Relini 1969, 1980°, Riedl 1963, 1970, 1983, 1991
Acasta spongites spongites= Acasta spongites	+, 1	Kolosváry 1939, 1947
Chthamalus stellatus	+	Contarini 1847, Lorenz 1863, Stossich 1880, Carus 1885, Graeffe 1900, Brusina 1907, Vatova 1928, Nilsson-Cantell 1932, Roch 1957-1960, Klepal, 1971, Relini 1969, 1980a, Gamulin-Brida 1974, Zavodnik & Igić, 1968., Zavodnik & Zavodnik 1978, Zavodnik & Zavodnik 1982, Zavodnik D. & Vidaković, 1982, Zavodnik et al., 198l, Igić 1982a , Riedl 1970, 1983, 1991, Kolosváry, 1939a
Chthamalus stellatus var. stellatus= Chthamalus stellatus	+, 1	Riedl 1903
Chthamalus stellatus stellatus= Chthamalus stellatus		Kolosváry 1939c, 1947
Chtamalus stellatus angustitergum		Kolosváry 1939b
Chthamalus stellatus bisinuatus		Kolosváry 1939b
Chthamalus stellatus fragilis		Kolosváry 1939b
Chthamalus stellatus communis		Kolosváry 1939b
Chthamalus stellatus depressus		Kolosváry 1939b
Chthamalus stellatus punctatus		Kolosváry l939b
Chthamalus stellatus forma *typica*		Kolosváry 1947
Chthamalus stellatus forma *depressa*		Kolosváry 1947
Chthamalus stellatus forma *cirrata*		Kolosváry 1947

Chthamalus montagui	+	Dando et al., 1979, Candela et al. 1983, Relini 1980a, 1981, Zavodnik 1997
Euraphia depressa	+	Relini 1981a, 1983
Chthamalus depressus = Euraphia depressa	+, 1	Rigo 1942, Relini 1969, 1980a, Riedl 1970, 1983, Klepal 1971, Relini et al. 1972
Chtamalus stellatus var. *depressa = Euraphia depressa*	+, 1	Riedl 1963
Balanus amphitrite amphitrite	+	Relini 1969, 1980, Relini et al., 1972
Balanus amphitrite = Balanus amphitrite amphitrite	+, 1	Poli 1791, Olivi 1792, Martens 1821, Contarini 1847, Seguenza 1876, Graeffe 1900, Brusina 1907, Neu 1932, Brian 1938, Kolosváry 1939b, Rigo 1942, Franko 1954, Riedl 1963, 1970, 1983, 1991, Specchi et al., 1976, Igić 1968a, 1972, 198la, 1982a, 1983, 1984, 1991, 1994a , Zavodnik & Igić 1968, Barbaro & Francescon 1976,
Balanus eburneus	+	Seguenza 1876, Weltner 1897, Brusina 1907, Neu 1932, Kolosváry 1940, 1947, 1951, Rigo 1942, Numann & Beth 1955, Roch 1957-1960, Riedl 1963, 1970, 1983,1991, Relini 1969, 1980, Relini et al 1972, Specchi et al., 1976a, Igić ,1968a, 1972, 1981a, 1982, 1983, 1984, 1991, 1994a, Zavodnk & Igić 1968, Barbaro & Francescon 1976

Balanus perforatus	+	Carus 1885, Brusina 1907, Pax 1937, Kolosváry 1939a, 1947, Relini 1969, 1980, Relini et al. 1972, Specchi et al. 1976, Riedl 1963, 1970, 1983, 1991, Igić 1981, 1982a, 1986, 1991, 1994, Vrišer 1986
Balanus perforatus angustus = Balanus perforatus	+, 1	Carus 1885, Kolosvary 1940a, Roch 1957-1960
Balanus trigonus	+	Kolosváry 1941b, 1943, 1947, Relini 1968, 1969, 1980b, Relini et al. 1972a, Specchi et al., 1976, Igić 198l, 1982 a, 1991, 1994, Vrišer 1986
Balanus improvisus	+	Relini, 1969, 1980b, Relini et al. 1972a, Relini et al., 1983-1984, Barbaro & Francescon 1976, Candela et al., (1982)1983, Vaccarella et al., 1977, Specchi et al., 1976, Igić 1986, 1991, Barbaro & Franceskon 1976
Balanus tintinnabulum = Megabalanus tintinnabulum	-, 3	Contanari 1847, Stossich 1880, Graeffe 1900, Brusina 1907, Kolosváry 1939a, 1942, Rigo 1942, Vrišer-1978
Balanus tintinnabulum = Balanus trigonus	-, 2	Igić 1968a
Balanus (Megabalanus) tintinnabulum tintinnabulum	1, 3	Relini 1979
Megabalanus tintinnabulum tintinnabulum = Megabalanus tintinnabulum	1, 3	Relini 1980a
Balanus tintibbabulum = Megabalanus tintinnabulum	1, 3	Kolosváry 1947, 1951, 1967
Balanus tintinnabulum = Balanus tulipa	- ,2	Nilsson-Cantell 1921
Balanus balanoides	-	Stammer 1932
Balanus crenatus	-	Graeffe 1900, Vatova 1928
Balanus inexpectatus	-, 3	Koch 1957, Kolosváry 1947

Balanus amphitrite inexpectatus= Balanus inexpectatus	-, 3	Nilsson-Cantell 1933, 1939, Kolosváry 1943, 1951, 1955, 1967
Balanus minutus	-	Leidenfrost 1908
RIZOCEPHALA		
Sacculina carcini	+	Stossich 1880, Vatova 1928, Boschma 1961, Riedl 1963, 1970, 1983, 1991
Sacculina eriphiae	+	Boschma 1961
Sacculina gerbei	+	Boschma 1961
Sacculina gonoplaxae	+	Boschma 1961
Drepanarchis neglecta	+	Boschma 1961
Peltogaster paguri	+	Vatova 1928
Peltogaster eurvatus	+	Stossich 1880
Peltogaster longissimus	+	Stossich 1880
Parthenopea subterranea	+	Stossich 1880

METHODS OF WORK

The cirripedes material is collected from available places (supralittoral, mediolittoral) and substrates (buoys, ships, docks, shells of various organisms, etc.) or through diving, trawling nets, bulldozers, from platforms etc. After that, it is conserved in 70% of alcohol or 5% of neutralized formalin filtrated over magnesium carbonate, or it is left for some time in contact with calcium carbonate (that is, shell) fragments. In order to preserve large specimens, a solution of 10% formalin is usually used. After one week, they are placed in 5% solution of formalin. The specimen container should contain few pieces of marble and text on parchment paper (written in durable ink and covered with nail polish). If only stiff parts are used in an analysis, plates can be dried on the air. In order to detach calcified parts from the surrounding membrane, the specimens are placed in a container with slowly heated NaOH of small concentration (Relini 1980, a). However, according to I. L. H. Kim and H. S. Kim (1980), specimens are being cooked in 10% solution of NaOH for few minutes and then washed in clean water. The calcified parts, like shell and cover plates, as well as mouthparts and cirrus legs, can be observed under the binocular lens.

When determining species, cirripediologists are mostly using classical systematics, based on morphological description of shell, operculum plates, color of all plates and muscular part around the operculum, kind of base with which they are attached to the substrate, base diameter, shell height etc. In recent times, classical systematics is combined with biometric methodology, and many characters are utilized. This methodology is most completely presented by Henry & McLaughlin (1975). For example, asymmetry and allometric growth are determined through variance analysis. The same authors present the opercular plates (scuta and terga) in detail, analyze the structure of shell plates (especially rostrum), that is, tubes and ridges that are integral part of these plates. When describing the opercular plates, characters such as spur (tergal appendage) are used (that is the narrow part of tergum toward the length of basal edge). These authors consider important characters to be: width and length of tergal appendage, the articular ridge on the scutum that borders tergum and together with so-called tergal edge (the lengthened part of this scutal side toward tergum) compose tergal segment, that is also used as a systematic character (Fig. 6); the number of teeth on upper lip-labrum, their average number on both sides of the labrum, either on pointed crest or the sides of the notch; the number of spines on the first jaw – maxilla, the average number of spines between the upper and the lower pair, the number of teeth on the upper jaw -mandible (Fig. 5). Especially important is the detailed analysis of six pair of cirrus legs (Fig. 7).

When describing cirripedes characteristics, terminology of Henry & McLaughlin (1975) was used. These authors are especially well described characters of the scutum, shell plates, tergum and cirrus legs, and the common description used by most cirripedologists for shell and opercular plates (tergum and scutum) is accepted by Pilsbry (1916) and Newman & Ross (1971).

GENERAL CHARACTERISTICS AND NOMENCLATURE

Cirripedia are very much changed crustaceans regarding the other groups. In an adult stage they are attached (sessile) or parasitic. Their body plan includes shell (Fig. 1, 2), which is coalesced to the body only on the head. The whole animal is attached to the substrate with its head, through sticky secretes of a gland that opens to the surface of the widened subfinal joint of first pair of antennae. There are some weakly visible rings on the body. The ventral side of the body is turned upward and bears six pairs of threadlike legs (cirri), which are thickly overgrown with setae and can stretch through the orifice of the shell. Their movement causes water current that brings food to the mouth. They have no paired eyes, only a single nauplius eye. They also lack a heart (Fig. 3, 4). On the head there are upper (labrum) and lower lip (labium), upper jaws (mandibulae) and lower jaws (maxillae). The upper labrum bears two appendages called palpi. The breast is composed of 6 rings with legs. The abdomen is small, lacks legs and bears a fork (furca). In non-parasitic cirripedes there is a shorter digestive tract with large sacks on middle gut, while the parasites lack a digestive system. The cirripedes lack circulatory system. Some have gills on legs, and the excretory organ is a gland on lower jaw. Contrary to most crustaceans, cirripedes are hermaphrodites. The testicles are on the sides of the gut, and their parts intrude into basic parts of the legs. The seminal duct opens into a long copulatory organ (penis). The ovaries are in *Lepadomorpha* in the upper part of the stalk (Fig. 3), and in *Balanomorpha* in the body cavity (Fig. 4). The eggs are collected between the shell and the body. In some specimens of group *Lepadomorpha*, besides the hermaphrodite animals there are some dwarfish additional males, which are attached on the hermaphrodites. However, some cirripedes are gonochorists. The males are tiny, without the digestive tract and legs, so mostly two or more of them hang on the females. Somewhere males are on developmental level of cypris larva. From the egg the larva nauplius develops, which after few skin changes turns into the cypris larva, similar to crustaceans of genus *Cypris*. The larval stadiums live freely, swimming. With a sticky gland, the cypris larva settles on a substrate and starts the sessile life. It connects to the substrate with a first antenna and cement gland. The attached head turns bigger, in *Lepadomorpha* it becomes a stalk and in *Balanomorpha* a wide basal plate. The torso folds, under the shell the calcified plates accumulate, and then some organs degenerate, resulting in an adult animal. The parasites settle in larval stage on a young crustacean, mostly at the leg joint. Then torso falls off, and the head enters the host body as a small irregularly shaped sack. The animal feeds on host body fluids and gradually shifts to the gut channel of crustacean at the abdomen. When the parasite gets bigger, it rips the gentle body shell of the crab, and grows out in a form of sack, sexually mature animal (*Sacculina*) (Fig. 45, 46).

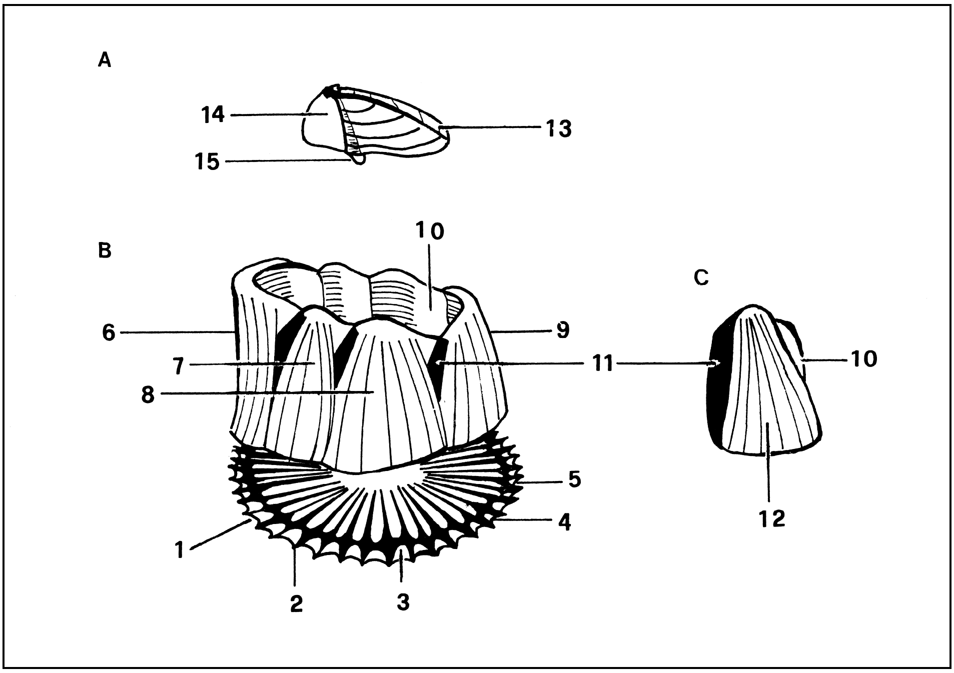

Figure 1. Sketch of shell of barnacles

A. operculum
B. parietal of shell raised from basal plate
C. separated parietal plate (paries), middle part of skeleton plate with along furrowes; alae-white, radii and basal plate-black
1. basal plate
2. along septum
3. cutting of tube (canal)
4. external lamina
5. inner lamina
6. carina
7. carino-lateral plate
8. lateral plate
9. rostrum
10. alae
11. radii
12. paries
13. scutum
14. tergum
15. spur

according to: G. Luther, 1987

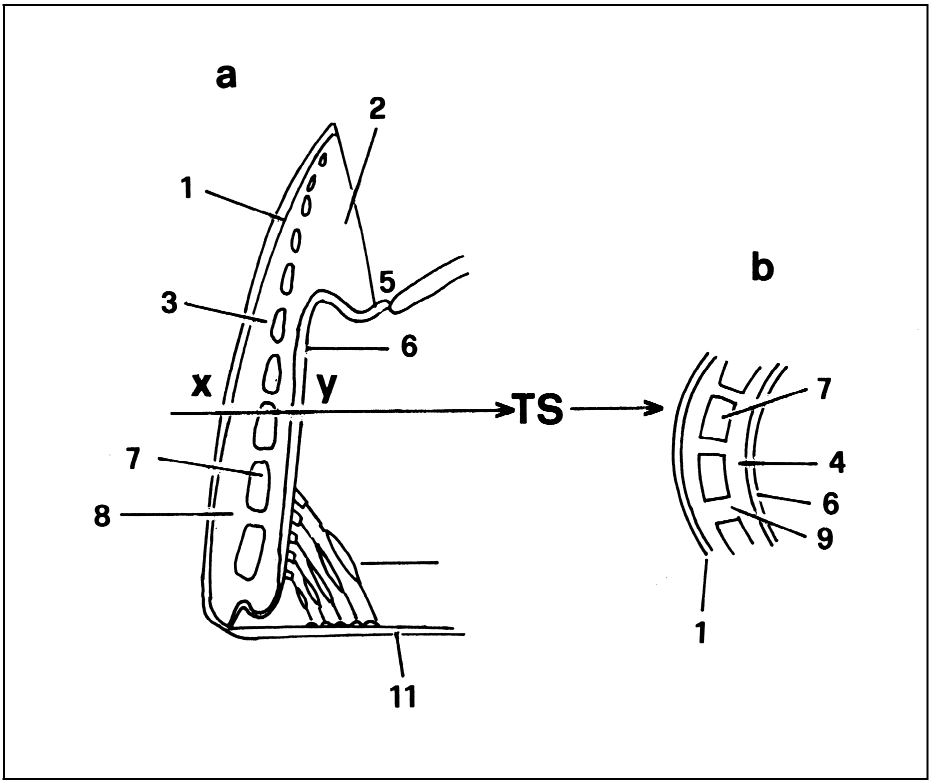

Figure 2. The structure of shell plates (Balanomorpha)

a. vertical section
b. cross section across XY line
1. epicuticle
2. sheath
3. outer lamina
4. inner lamina
5. opercular membrane
6. hypodermis
7. longitudinal canal
8. transverse septum
9. longitudinal septum
10. fixation fibres
11. base

According to: E. Borget, 1977

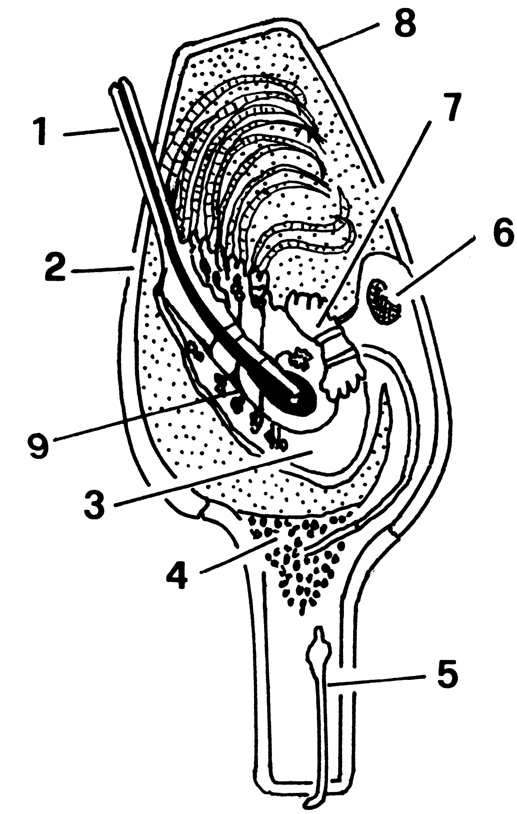

Figure 3. The anatomy of Lepadomorpha sessile *Lepas*

1. penis
2. carina
3. gut
4. ovary
5. cement gland
6. scutum adductor muscle
7. pancreatic gland
8. oral organs
9. testis

According to: I. Matoničkin, 1981

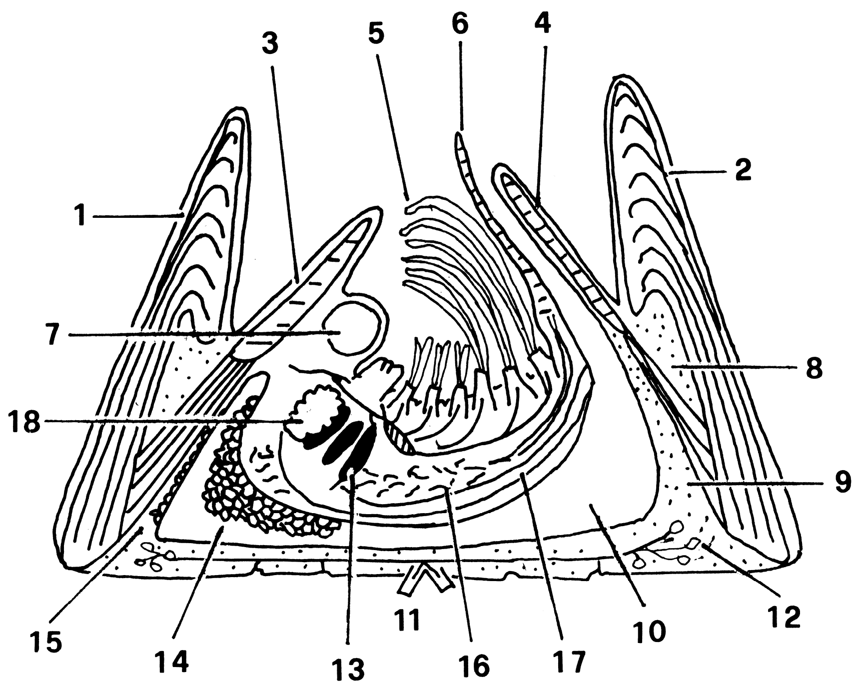

Figure 4. The anatomy of Balanomorpha, sessile barnacle

1. rostrum
2. carina
3. scutum
4. tergum
5. cirri
6. penis
7. scutum adductor muscle
8. depressor muscle
9. mantle
10 mantle cavity
11. antennules
12. cement gland
13. filaments
14. egg mass
15. ovary
16. testis
17. mid gut
18. pancreatic gland

According to: P.S. Rainbow, 1984

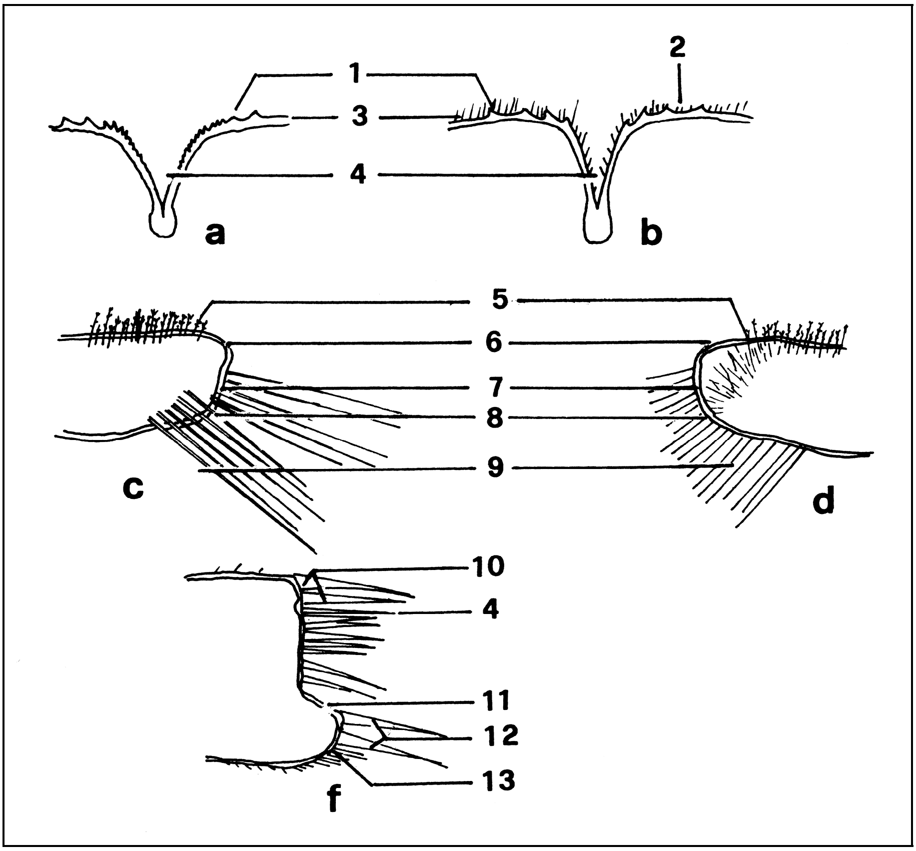

Figure 5, a, b, c, d, f. Mouth parts of Balanomorpha - labrum (upper lip)

a. multidenticulate
b. simple
c. palpus, outside
d. palpus, inside
f. maxilla (lower jaw) I.
1. teeth
2. setulae
3. crest
4. notch
5. upper margin
6. superodistal angle
7. distal margin
8. inferodistal angle
9. lower margin
10. upper pair of spines
11. prominence
12. lower pair of spines
13. inferior angle

According to: D.P. Henry & P.A. McLaughlin,1975

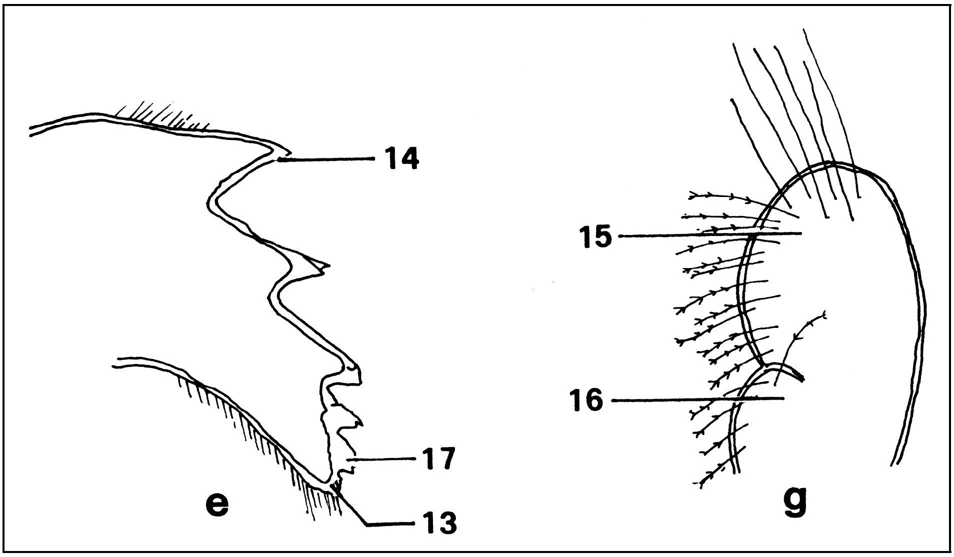

Figure 5, e, g. Mouth parts of Balanomorpha - labrum (upper lip)

e. mandible (upper jaw)
g. maxilla (lower jaw) II.
13. inferior angle
14. 1st tooth
15. distal lobe
16. proximal lobe
17. 5th tooth

According to: D.P. Henry & P.A. McLaughlin,1975

Description of additional terms used in species description

Shell - the parietal or wall tubes are lined in one, two or several rows between the inner and outer wall (the thin plate like layer). Primarily, the tubes are concentrated toward the inner wall (lamina, Fig. 2) if there is more than one row of tubes. The additional tubes are in one or several rows, that is, between the primary rows and outer lamina.

Vesicular sheath: sheath composed irregular, thin – walled calcareous vesicles, elongated into furrow under overhanging lower margin of sheath.

Scutum, pl. scuta - the opercular plate (Fig. 1).

Tergal segment - the narrowest inflected part of scutum at the tergal margin (Henry & Mc Laughlin 1975), or the tergal part of scutum detached from the hypothetical line from the top to the point on basal margin from where the angle slowly rises to the basitergal edge (Mc Laughlin 1980) (Fig. 6).

Tergum, pl. terga - the opercular plate (Fig. 1).

Carinal segment - part alongside the carinal edge of tergum that is made out of a ridge turned upwards. The ridges can rarely be recognized and may be absent (Fig. 1).

Cirri - threadlike legs (Fig. 7).

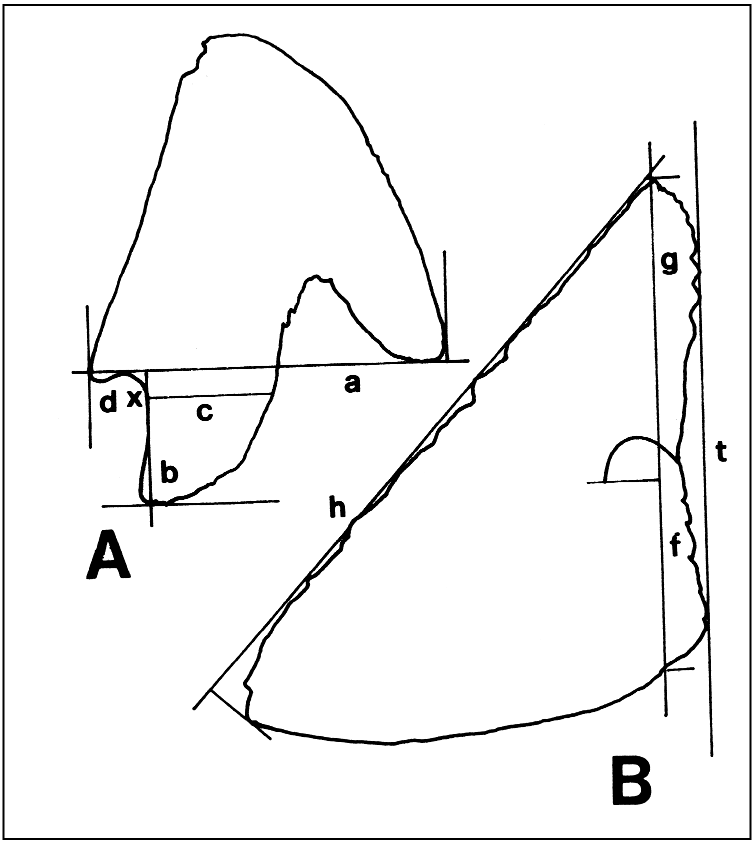

Figure 6. Diagrams showing lines and points established for measurements in statistical analyses

A. tergum
a. length of basal margin
x. point farthest from basiscutal angle on proximal half of scutal margin of spur
b. spur length
c. spur width
d. distance from basiscutal angle to spur
B. scutum:
t. initial line tangent to tergal margin
f. length of tergal margin
g. Length of articular ridge
h. length of occludent margin

According to: D.P. Henry & P.A. McLaughlin,1975

Types of cirral setae

Simple: setae lacking lateral processes.

Feathered: setae somewhat oblique processes (setulae) on each side of shaft approximately equal in thichness to simple setae. Pinnate: with short processes, usually restricted to apical third, or less, of shaft. The setae with somewhat perpendicular position from both sides of a major axis, which is equally thick, while setae are very simple, short, usually bordered toward the top (apical) third. They rarely stretch above the top half (Fig. 7a). Plumose: with somewhat longer setae that strech close to the proximal part that are closer to the middle part axis (shaft) (Fig. 7b).

Complex cirral setae of Cirrus III: setae usually shorter and wider (broader) than in previous two setae types, with single or double row of processes, usually thickened, on one side of shaft; or with apical branches. Pectinate: with a simple row of short , usually fine appendages, the shafts of similar size to simple and feathered setae (Fig. 7c). Denticulate: with a simple formation line, finely toothed with small teeth (Fig. 7d). Bidenticulate: with a double row of toothed appendages that vary in size and number (Fig. 7e). Bifurcate: with two equal or almost equal apical branches (Fig. 7f). Multifurcate: with one long branch on apical and 3 or 4 lateral branches (Fig. 7g).

Characters of cirri

The structure of cirrus legs is an important systematic character in determining species:

First pair of legs – cirrus I: number of segments. The average number of segments by which the anterior rami exceed, or fail to exceed the posterior rami in length.

Second pair of legs - cirrus II: number of segments. Same criterion as cirrus I.

Third pair of legs - cirrus III: number of segments. Same criterion as cirrus I.

Sixth pair of legs - cirrus VI: number of paired setae. The average number of paired setae on the median segment of the rami, i.e. where the maximal number of paired setae occurs.

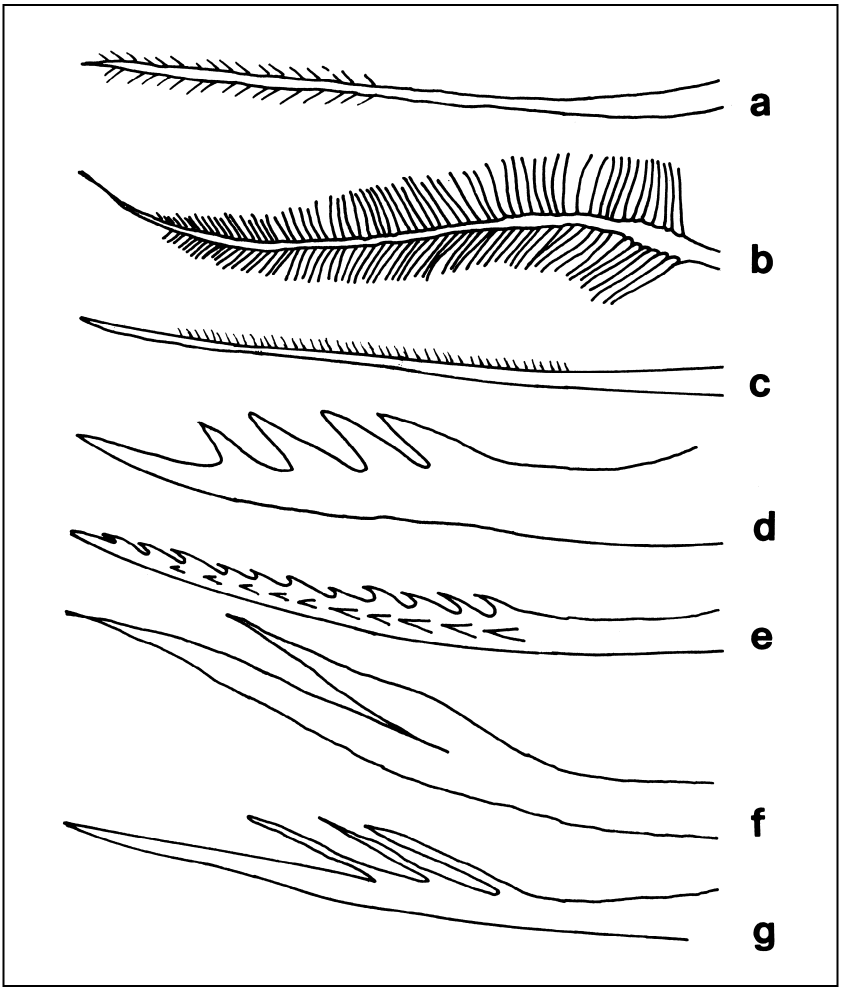

Figure 7. Types of cirral setae

a. pinnate	d. denticulate
b. plumose	e. bidenticulate
c. pectinate (only one row of setulae illustrated)	f. bifurcate
	g. multifurcate

according to: D.P. Henry & P.A. McLaughlin, 1975

SYSTEMATICS AND SYSTEMATIC CATEGORIES

There are various opinions on systematic divisions of this subclass and its lower categories. In last thirty years or so, the subclass *Cirripedia* was treated as an order and orders *Acrothoracica*, *Rhizocephala* and *Thoracica* as suborders (Zarenkov 1982). Zevina & Dolgopoljskaja (1969) consider groups *Lepadomorpha*, *Balanomorpha* and *Verrucomorpha* to be superfamilies, while they have been treated as suborders by most cirripedologists (Newman & Ross 1976; Newman 1987 etc). Classification for suprageneric categories such as orders was given by Waterman (1960), Kaestner (1967), Huwae (1985) and Newman (1987), Annex 1, while the division of *Balanomorpha* on lower categories from order to subfamilies is given by Newman & Ross (1976).

As the most modern systematics of orders, suborders and superfamilies is the one given by Newman (1987), it is accepted in this work and shown in Annex 2, while the categories of order *Balanomorpha* (superfamilies, families, subfamilies) were named according to Newman & Ross (1976) and shown in Annex 3.

SUBCLASS *CIRRIPEDIA*

ORDER *THORACICA*

The shell is mostly calcified, but may be chitinous. The order includes Silurian fossils, and maybe some from Cambrium (Foster 1978; Buckeridge 1983).

The body is composed of head and thorax and the rudimentary abdomen, covered with mantle. On the surface there is the exoskeleton made of chitin or calcified plates forming a shell. The shape and number of plates is an important systematic character in representatives of this order. The plates forming the shell are either solitary (carina and rostrum) or paired (carino-lateral), which are coalesced and connected with thin threads, inner appendages that are called ”wings” (alae). The outer are called radii and are not properly outer, but only look that way (Fig. 1). From the upper side, the shell covers the opening (operculum) composed of two pairs of movable valves. The front pair of valves is scuta and the rear part is terga. When the valves are opened toward the outer world, the legs stick out. They are used to transfer food particles and to remove the hatched larvae nauplius. On the head part, the shell is much stretched (*Lepadomorpha*, Fig. 8) or very shortened (other *Thoracica*, Fig. 1). Inside the shell there is a rudimentary first pair of antennas (antenullae), where cement glands open, and with secretions of these glands the larvae stick to the surface. In the rear part of the head there are appendages of the oral cone - the single upper lip (labrum) with a pair of mandibles and two pairs of maxillae on lower lip (labium). The thoracic part is composed of 6 segments. On the reduced abdomen there are an anal opening and a penis, and in some species there are also segmented tail threads (filaments) (Fig. 4). The digestive tract has a shape of upturned horseshoe, and is divided into a front and a rear part of the gut. The esophagus and the end gut are covered with chitin. The front part of the gut is on the inside covered with an endodermic cylindrical epitel. They feed on detritus and small plankton organisms (phytoplanktophages, filter-feeding organisms). The excretory organs are maxillary glands, opening at the second pair of maxillae. The circulatory system is lacunar. They breathe through body surface and through the slits of circulatory lacunas (lacunae). It is also possible that the oxygen passes through the surface of thread like appendages that are found in some representatives of group *Lepadomorpha*. The greater role in breathing and feeding is played by rhythmical beating of legs, pushing water through the body cavity. The nervous system in *Lepadomorpha* is very primitive and threadlike, while in *Balanomorpha* is more concentrated and composed of two pairs of head ganglia (one above the head and one below), connected with comisurae. Considering the senses, the adults have a pair of simple eyes, while the nauplius larva has a single eye. The cypris larvae have a pair of composed eyes. The *Thoracica* are hermaphrodites, and they usually inseminate each other. In certain families, for example *Scalpellidae*, there are also some very well developed females. The males are always dwarfish, undeveloped and there are several of them in the female body cavity, where eggs are fertilized. The first part of development, up to nauplius stage, is spent inside the egg. Then larvae enter the outside environment - water, and turn into metanauplius, and it turns into a cypris larva. Cypris larva settles on the substrate and metamorphoses into a sessile adult animal.

This group lives in all, even estuarine habitats, including many symbiotic associations. Their distribution covers various depths, from supralittoral to over 7000 m (Zevina & Dolgopoljskaja 1969). They mostly settle on hard, stiff substrates (rock, mollusk and crustacean shells etc). The representatives of this order are the main component of fouling communities on ships and various structures and constructions, both floating and stationary. Some species from genera *Lepas* and *Conchoderma* lead only a passive pelagic way of life, while the genera *Temnaspis* and *Octolasmis* live in gills, mouthparts and carapace of decapode crustaceans and *Alepas* on jellyfish. This order is richest in species (about 620), while in the fouling communities they cover 50-80% in regard to other foulers (Korn 1988).

The order *Thoracica* includes three suborders:
With a stalk and a plate-covered head......................... *Lepadomorpha*
The shell is composed of symmetrical plates..............*Balanomorpha*
The shell is composed of asymmetrical plates........... *Verrucomorpha*

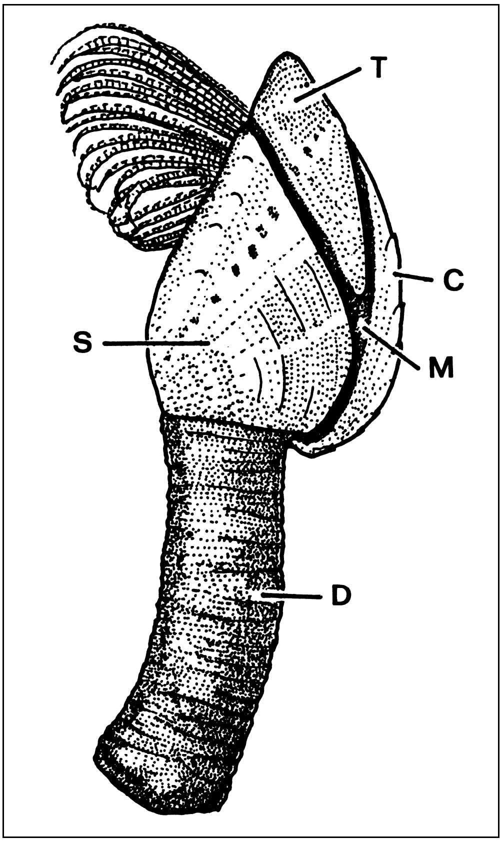

Figure 8. Typical pedunculate cirripedes

C. carina, add narrow plate
D. stalk
M. hornlike membrane
S, T Lateral broad plates; front-scuta (S); back- terga (T)

according to: R. Riedl, 1991

Key* to the some suborders and families of the cirripedes which live in the Adriatic and other world seas.

1. Peduncle and capitulum present, latter with or without calcified valves (Lepadomorpha)....................2
Peduncle absent, calcified valves attached directly to substrate (Balanomorpha)....................7

2.(1) Capitulum with four (two pairs) weakly calcified valves, capitulum not distinct from peduncle, latter thickly clothed with long, blunt, chitinous spines.................... *Iblidae*
Capitulum with 13 calcified valves, five or two calcified or weakly calcified valves, or without calcareous valves; peduncle distinct from capitulum, naked, smooth or annulated, or with short, blunt cuticular spines....................3

3.(2) Capitulum with 13 calcified valves.................... Scalpellidae
Capitulum with five or two calcified or weakly calcified valves, or without calcareous valves....................4

4.(3) Capitulum without calcareous valves; attachment sites of scutal adductor muscles marked by small, chitinous areas on each side below orifice....................Heteralepadidae
Capitulum with five or two calcified or ewakly calcified valves..........5

5. (4) Five capitular valves, calcified, caudal appendages absent; attached to antipatharians....................Oxynaspidae
Five or two capitular valves, calcified or weakly calcified or reduced; caudal-appendages usually present; not attached to antipatharians......6

6.(5) Five or two valves, calcified or weakly calcified or reduced; pelagic on floating objects and nekton, or forming own float; caudal appendages without long setae....................Lepadidae

7.(1) Opercular valves reduced, not occluding orifice; scutum and tergum (if present) not articulating;
attached to marine mammals....................Coronulidae
Opercular valves complete, occluding orifice; scutum and tergum present, articulating; attached to hard substrata and sponges...............8

8. (7) Walls solid, not porose or tubiferous....................Archaeobalanidae
Walls porose or tubiferous....................9

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* according to Jones (1990)

9. (8) Walls solid or multiporose; penis without basidorsal point .... Tetraclitidae
Walls tubiferous, tubes in single uniform row; penis with basidorsal point ....Balanidae

Suborder *Lepadomorpha* Pilsbry 1916

These are cirripedes with elongated body, differentiated into a head and a stalk (pedunculum) that they are attached with. The head is flattened and mostly protected with special calcified plates, which may be reduced or totally absent. The shell around the head is mostly composed of 5 calcified plates. The single narrow plate on the dorsal side is carina, and the two wider plates on the sides are front scuta and rear terga. The stalk is, similarly to other crustaceans, covered with exoskeleton, which can be of various thickness and sclerotinization degree, that is, may have calcified plates or they may be lacking. When the stalk is covered with large plates, they are distributed in rings under the head plates of the shell (for example *Scalpellum*). The stalk is mostly flexible, with muscles that allow changes in orientation. The thin shell (cuticle, membrane) presents a barrier for water loss, being important during the very low tides (Rainbow 1984). As these animals are usually hermaphrodites, the stalk contains testicles and ovaries, and in gonochorists they are separated (Fig. 3).

Stalked or pedunculate barnacles are considered to be primitive cirripedes, being similar to ancient cirripedes with 8 corresponding homologous wall plates with movable scuta and terga (Rainbow 1984).

These cirripedes are characteristic for open waters. They settle on buoys, ships, whales etc (Bassindale 1964; Zullo 1979; Dalley & Crisp 1981).

The horizontal distribution is especially important for warmer waters, such as Sargassum Sea and corresponding parts of Atlantic Ocean (Butler et al., 1983). As these cirripedes develop in open ocean waters, their reproduction and distribution is poorly documented. Considering the vertical distribution, they stretch from upper narrow shore zone between high tides and dry ground (supralittoral) to big depths. In supralittoral and big depths they are rarer, while their most favorable living zone is between high and low tides (mediolittoral). In supralittoral there are species of genus *Pollicipes*, with short stiff stalk, some of which dwell in crevices (Ibla) or the hollows in their «cousins» (for example *Lithotrya*) with humid microclimate (Rainbow 1984). There are other species specialized for greater depths, such as *Lepas pectinata*, that lives in depths between 300 and 500 m in Sargassum sea, in temperature gradient of 11-15^{o}C and salinity between 35.5 and 36.3x10^{-3} (Conway et al., 1990). According to the interpretation of same authors, distribution to greater depths is possible due to lower metabolism and larger amount of oxygen, although this species can migrate to shallower water.

Superfamily *Lepadidea* Darwin 1854 (nom. Trans. Zevina 1978)

Family *Lepadidae* Darwin 1851

The representatives of this family have 5 head plates or their rudiments, including carina and pairs of scuta and terga. The stalk lacks plates. The mandible bears 5 teeth and the lowest tooth is on the lowest corner. Maxilla is stair-like and has a sharp edge. The caudal appendages, if present, lack bristles and are never bearing several joints. Hermaphrodites, they are usually pelagic animals on floating objects and in nekton.

Genus *Lepas* Linnaeus 1758

The shell has 5 plates. There are two each of scuta and terga, as well as a single carina, ending in the upper part between the two terga. The basal part of carina is forked or finishing in a single disk (Fig. 8). Scuta are half-circular with an appendage, navel (umbo), on a spot where the basal edge of scuta closes the head plates. The head plates are usually white or gray in color, small in width, and between them there is a horn membrane, colored pink, dark rosy, orange or yellow. The peduncle is without the calcified plates or spines. There are 5-6 threadlike appendages in the lower part, and these are often called "caudal appendages".

The representatives of this genus live mostly in warmer seas, principally near the surface, although they can also be found up to 950 m of depth (Conway et al., 1990) on buoy chains. In the fouling complex, they are usually settled on buoys, other floating objects, marine animals, and more rarely on fixed objects. On all these substrates the representatives of this genus are usually found in open waters, few miles from the shore.

Lepas anatifera Linnaeus 1767

Anatifera dentata Bruguière 1789-1832: 158, text.

Darwin (1851) has described two forms of this species: the spotted form with one or more diagonal lines on valves and the toothed form with well-developed warty carina.

This species has 5 well-developed plates, which are slightly striped on the outside or smooth. Carina is forked at the base and is not pushed by other plates. Terga and scuta have slight furrows. Scuta have very curved edges, which can be almost straight: the navel right appendage is variable in form and size. In some specimens scuta (and sometimes also terga) bear along the radial axis one to three small square hollows dark green in color. Terga are convex and trapezoid. Carina is convex, smooth with ridges or teeth, with more or less pointed peak, while the forks of two branches diverge under the 90^{o} angle (Fig. 9). The top of the carina is between terga on 3/4 of their length. The peduncle and valves are smooth although plates may be also slightly furrowed. The threads are leading from the inner shell wall to the shell base, and there are never more than two of them on each side.

Maxillae in this species have a deep notch, with several large spines above it. Somewhat under the notch on each maxilla, there is a row of double spines. The mandible bears five teeth, while the lower corner is comb like. The caudal appendages are tender, circular, placed at approximately half height of axis basal segment of sixth pair of cirrus legs. The penis is long, ringed and distally pointed.

Color: Valves are white, more or less transversally shiny, rusty or cream-colored and may bear brown spots. The edge of the opercular opening is vividly reddish-orange, while the membrane on the base of scuta and sometimes all plates are deep orange. The space between plates is dark orange. The stalk is dark purple with often darker upper part. Eggs are intensively blue in color, and become yellow after fixating in alcohol.

Size: This is one of the largest species of stalked barnacles, as the capitulum may reach 50 mm in height, 25 mm in width, and the stalk is up to 200 mm long. The specimen with the maximal head height reached 52 mm (Foster & Willan 1979).

Habitat and ecology: They live on floating objects of any kind, including oil platforms, ships and floating algae (*Sargassum*). On oil platforms this species settles together with *Lepas anserifera* in such large numbers that the fouling biomass of these two species may reach up to 1000 kg/14000m^2 of submersed surface, while the average density of these two species was 248 specimens on 1 m^2, and the average weight of a single specimen was 0.29 g (Foster & Willan 1979). This species can be met in open waters (it is an offshore species), although in Gulf of Mexico it was found up to 96 m of depth. As a species of warm waters, in laboratory conditions it produces nauplius larvae at 19-25^{o}C (Patel & Crisp 1960). However, this species is also considered cosmopolitan, as it reaches colder waters (Foster & Willan 1979) and is not known up from 60^{o}S (Newman & Rose 1971).

Diet: This species usually feeds on Radiolaria 75%, then Calanoida 10%, snail larvae 5%, cypris larvae 4%, Foraminifera 4%, shrimps 2% (Tabačnik 1986).

Distribution: Besides the warm seas and the Mediterranean, it is also met with in the Adriatic, and is mentioned by Brusina (1907) and other authors, cited in table 1.

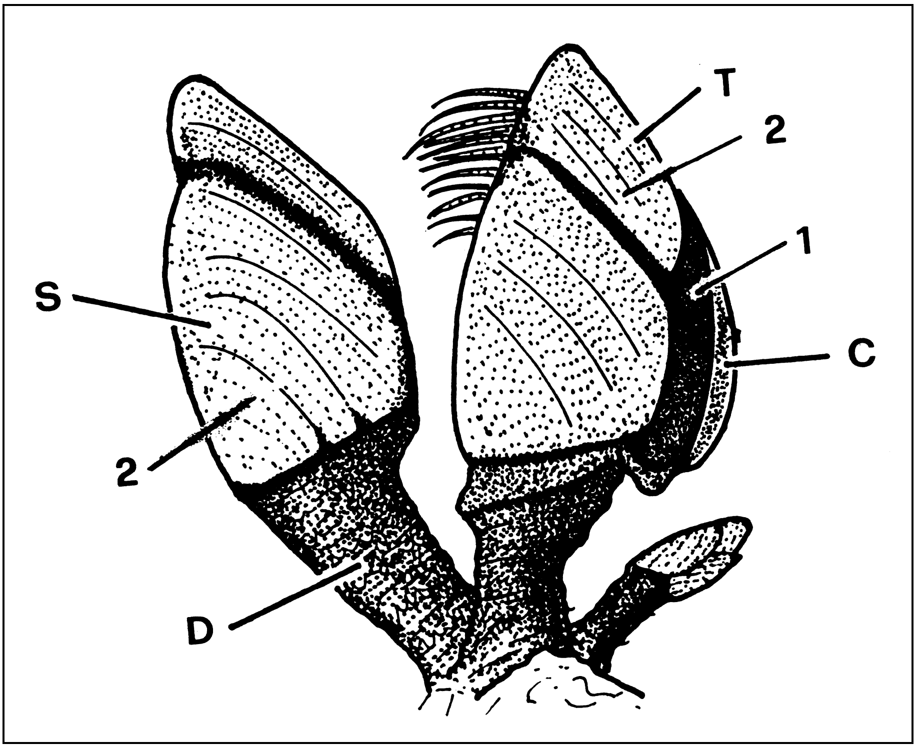

Figure 9. *Lepas anatifera* (Linnaeus 1767)

C. carina	T. tergum
D. stalk	1. hornlike membrane
S. scutum	2. distinct lines of the increase

according to: P. H. M. Huwae, 1985

Lepas anserifera **Linnaeus 1767**

Anatifera striata Bruguière 1789-1832: 158, text

Pentalasmis dilata Leach 1818: 168, text

They have five head plates, which are without interspaces, very thick and slightly furrowed. Opercular plates are more or less furrowed. Scuta are large, triangular, radially furrowed and wavy, smoother in the navel zone. The edge surrounding the scuta is wing like (Fig. 10), more or less pointed, and the umbonal right tooth is more developed than left. Terga are trapezoid and sometimes convex, and the waves are more prominent than on scuta, while the tops of these valves are blunt. Carina is from the inner side very concave. The outer part is finely ridged and mostly toothed, while the base is forked and the branches diverge in an angle somewhat bigger than 90^{o}. The carina is shield like, as the other part is small and slightly narrowed above the fork (Fig. 10b). The stalk is usually either as long as the head or shorter than the head, cylindrical. There are mostly 5 threadlike appendages, sometimes 6 on every side, while the caudal appendages are short, smooth, curved and claw like. Maxillae are deeply furrowed, with several thick spines above the notch and one longer spine few steps down. Every maxilla has a row of double spines. The mandible has 5 teeth, and the lower angle is comb like. The upper lip in this and previous species (*L. anatifera*) is convex on one side and concave on the other, and looks wrinkled. Penis is long but shorter than the sixth pair of cirrus legs, slightly ringed, thin, pointed, with stiff setae on the top. The first pair of cirrus legs has unequal ramus. The rear ramus is shorter and thicker than the front one. The second pair of cirrus legs has thicker front ramus, and the third pair is elongated toward the sixth, while the segments bear 3-6 pairs of long stiff setae on the front side.

Color: Opercular valves are white with an orange edge, while the stalk is dark purple with an intensive orange upper edge (which is connected with capitulum).

Size: Capitulum height is mostly up to 40 mm or 38 mm in height and 26 mm in width. The stalk height is up to 21 mm (Foster & Willan 1979).

Habitat and ecology: They live like the previous species : on vessels, platforms, floating objects, algae etc. This is also a cosmopolitan and offshore species that lives mostly in clean waters and the horizontal distribution is mostly like in the previous species.

Diet: It feeds mostly on Calanoids (65%), detritus 20%, threadlike algae 4%, bivalve larvae 5%, Gastropoda larvae 3%, Harpactoida 1%, Foraminifers 1% and Hydroidea 1% (Tabacnik 1986) (Fig.. 10).

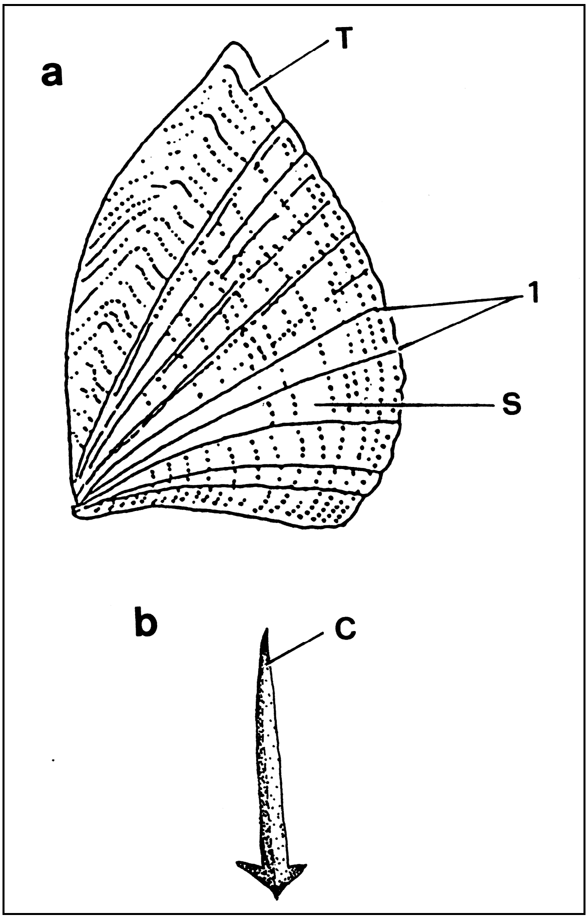

Figure 10. *Lepas anserifera* Linnaeus 1767

a. capitulum
T. tergum
S. external the margin drawed out in the shape of wing - scutum
b. C.carina- lower part furked, some more under the angle of 90°
1. strong furrow

according to: R. Riedl, 1991 (a); Relini(1980b)

Lepas hilli (Leach) 1818

Pentalasmis hilli Leach 1818: 168, text

The major characteristic of this species is lack of umbonal teeth on the scuta, three filaments, and the wide space between scutum and carina and tergum. The shell is smooth, although sometimes growth increase may be visible. The distance on the upper part of scuta is very large. Terga are flattened and more triangular. Carina is separated from the other plates with an empty space, is of various shape, and the carinal edge (fork) with a point on the top stretches between terga to the half of their length (Fig. 11). Maxillae are deeply dented, and there are several thick spines above the notch. Each has a double row of large stiff spines. The mandible has 5 teeth and the lower edge is pectinate. The upper lip is from one side convex and on the other concave and looks wrinkled, the same as in former species. The caudal appendages are small, almost half a length of basal ring of sixth pair of cirrus legs. The penis is elongated, slightly ringed and pointed at the top. Below the first pair of cirrus legs there is a threadlike product on the side of prosoma and two similar appendages at the base of the first pair of cirrus. The first pair of cirrus legs is close to the second. The branches are unequal, the front branch is somewhat longer and thinner than the rear branch. The second pair of cirrus legs has almost equal branches and the front branch is somewhat thicker than the rear one. The third pair of cirrus legs is elongated almost to the sixth, and the rings bear 4-6 pairs of longer setae on their front sides.

Color: The shell is white and the stalk is yellowish orange with a clear transfer to deep red. The wide border zone toward the capitulum is sometimes orange in adults, and in juveniles is almost always orange. The space between carina, scutum and tergum is orange in fresh material.

Size: Capitulum and stalk height is about 200 mm, or the capitulum height is 27.5 mm and capitulum width 22.0 mm, while the stalk length is 14.8 mm and diameter 6.0 mm (Jones 1990).

Habitat and ecology: It lives in groups with L. anatifera, L. pectinata, L. anserifera and Conchoderma virgatum. Together with C. virgatum, this species settles on turtle carapaces, ships and ropes. In contrast to most Lepas species, this species and C. virgatum more prefer settling in subsurface layer than on floating objects (Reskell 1969).

Diet: According to Tabačnik (1986), this stalked barnacle feeds on Calanoida 52%, Polychaeta 10%, Radiolaria 10%, cypris larvae 5%, Foraminifera 8%.

Distribution: Cosmopolite species, living in all seas of Atlantic, Pacific, Australia and Mediterranean. Considering the Adriatic, Relini (1969) has cited this species in all Italian seas except Adriatic, while the same author later (1980a) mentions it also for this sea as a very rare stalked barnacle (Fig. 11).

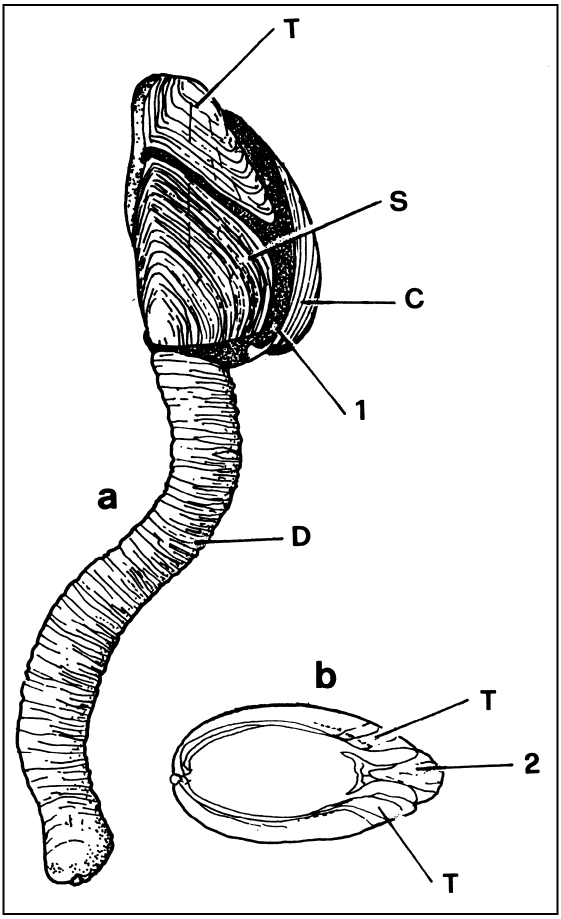

Figure 11. *Lepas hillii* Leach, 1818

a. capitulum and stalk
C. carina
T. tergum
S. skutum
D. stalk

1. hornlike membrane
b. carina
2. point of carina spread to half length of terga

according to: P.H.M. Huwae, 1985

***Lepas pectinata* Spengler 1793**

Lepas miricata Poli 1791: 1, text

Pentalasmis sulcata Leach 1824: 1, text

This species lacks umbonal teeth on scuta in the inner part, and to the sides of the body there are filamentous appendages 0-2. There is a single tooth on the carina, while all the plates are furrowed.

Capitulum is larger than the stalk, while the 5 plates are thin, radially furrowed and sometimes even spiny (Fig. 12a). Valves may be connected with spine like teeth (Fig. 12c). Scuta are triangular, with the pointed part, and are placed near the lateral edge surrounding all plates. Terga are triangular with a single burrow into which enters the top of scuta (Fig. 12c). Carina is large, much hollowed inside. The upper part is narrow, while on the lower part there is a fork with two branches under the angle of 135-180^o, and these spines diverge under umbers (Fig. 12b). The stalk is short, smooth and with thin walls. Maxillae are slightly stair like, with stiff setae at the upper angle, and on the lower angle are short spines. Mandible bears 5 teeth. The upper lip bears thick wrinkles and stiff hairs. Penis is long, slightly ringed, pointed on the top. Filamentous appendages are usually lacking, and if they are present there is only 1 or 2, on the sides under the first pair of legs. First pair of cirrus legs is short with almost equal rami, the front ramus is longer and somewhat thinner than the rear one. Second pair of cirrus legs is longer than first, with almost equal rami. The rear one is longer and thinner than the front one. Third pair of cirrus legs is long, ringed and stretches to the sixth pair, carrying 6 pairs of long strong setae on the front edges.

Color: Valves are white or slightly gray, while the stalk is brownish and varies from pink to purple depending on matureness.

Size: This species is the smallest in the family *Lepadidae*. In our area maximal height of capitulum is 5 mm, while the 3 mm specimens are already fertile (Broch 1953). In other seas capitulum width can reach 15 mm, width 11 mm, stalk length 7.5 mm and diameter 4.0 mm (Jones 1990).

Habitat and ecology: It settles on floating thick wooden objects, is often seen on shores and rarely on ships, bottoms.

Diet: It feeds on microplankton and tiny macroplankton. Tabacnik (1986) cites that the diet includes *Harpactioida* 54%, *Calanoida* 40%, skeleton parts of cirripedes 5% and Radiolaria 1%.

Distribution: According to Darwin (1854), this is a Mediterranean and Atlantic species, spreading to Ireland, but is however a cosmopolite, more common in subtropical and tropical seas. It is rare in Adriatic as well as the previous species, especially in north Adriatic (Relini 1980a) (Fig. 12a, b, c). In vertical space this species is due to its settling objects most common in upper and middle mediolittoral, or as Anderson (1980a) cites, near the water surface.

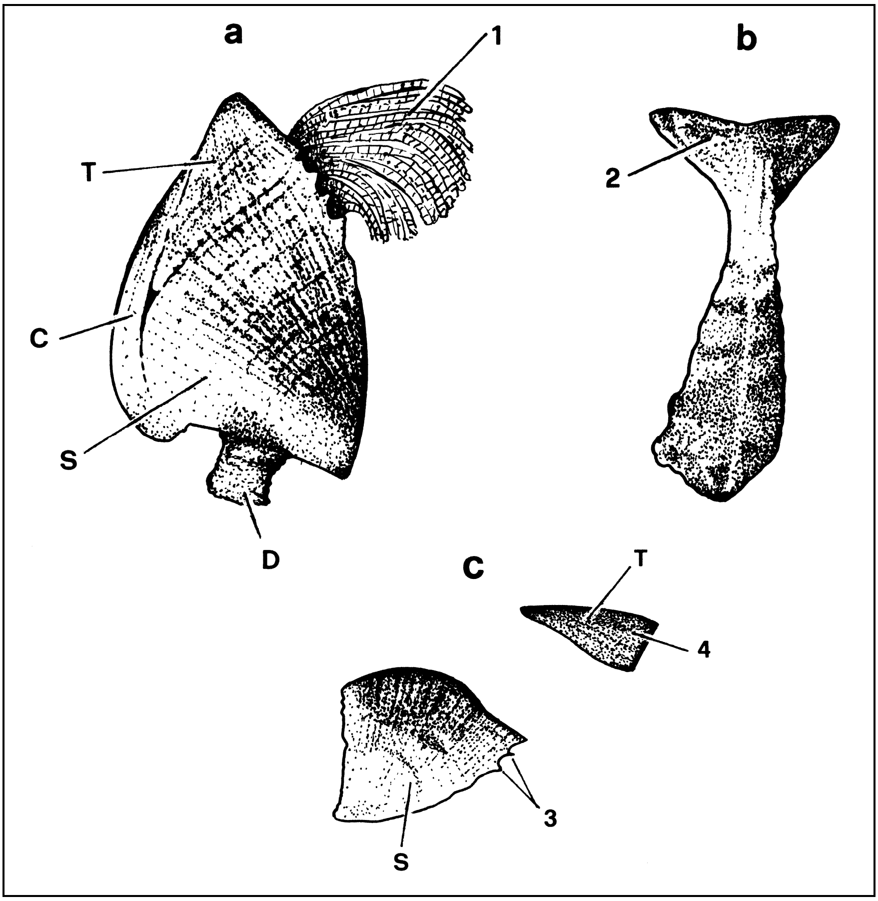

Figure 12. *Lepas pectinata* Spengler 1851

a. capitulum and stalk
C. carina
T. tergum
S. scutum
D. stalk
1. cirri

b. carina
2. fork with two branches
c. scutum (S)
3. teeth
tergum (T)
4. furrow

according to: G. Relini, 1980b

.

Genus *Conchoderma* Olfers 1814

Capitulum is composed of one smooth membrane that closes 2-5 tiny plates. The remaining part of capitulum is membranous and connected with a stalk.

The connection between stalk and capitulum is poorly developed, while the umbonal teeth used for better connection are placed more toward the middle part. Terga and carina are often reduced or lacking. Scuta and terga are not plate like, and are covered with a layer of thick meaty material stretching into the stalk. The stalk is almost as thick as the capitulum, of medium length, smooth. From stalk emerges two hyphens for attach, usually pointed . Umbonal teeth are between scuta and stalk and between terga and carina. The plates on the capitulum are thin and partially calcified.

Color: The connection between the capitulum and the stalk is usually striped dark purple on the lower white part of the capitulum, while the capitulum and the stalk have identical color.

Remark: Our species vary greatly. *Conchoderma auritum* has two bumps on the capitulum like ears and is large (10 or more cm), while *C. virgatum* is smaller and wrinkled lengthwise. Both species are broadly distributed.

Conchoderma auritum (Linnaeus 1767)

Lepas aurita Linnaeus 1767: 533, text

Capitulum has 2 rudimentary (often lacking) plates and 2 tubes that resemble ears. In large specimens there are 2 rudimentary plates, while in small ones there are 5. Carina and terga are often lacking. In greater specimens scuta have two lobes. The stalk is clearly detached from the capitulum, long, cylindrical and smooth. Maxillae are deeply dented, with two large stiff spine above the notch, about four stairs lower. The mandible is 5-toothed. Every tooth is finely pectinate toward the base on both sides. The lower angle is rudimentary and often looks like a spina. The upper lip is wrinkled and similar to those of previous species. The caudal appendages are absent. Penis is medium long, not elongated, ringed. All the legs are short and wide. First pair of cirrus legs has equal rami. Segments on both rami are bumped from the front side, thickly overgrown with setae, and the spines are toothed. Third to sixth pair of cirrus legs are relatively short and wide, with long and medium setae on slightly pointed edge on the front part. On the rear part there are groups of large spines (Fig. 13).

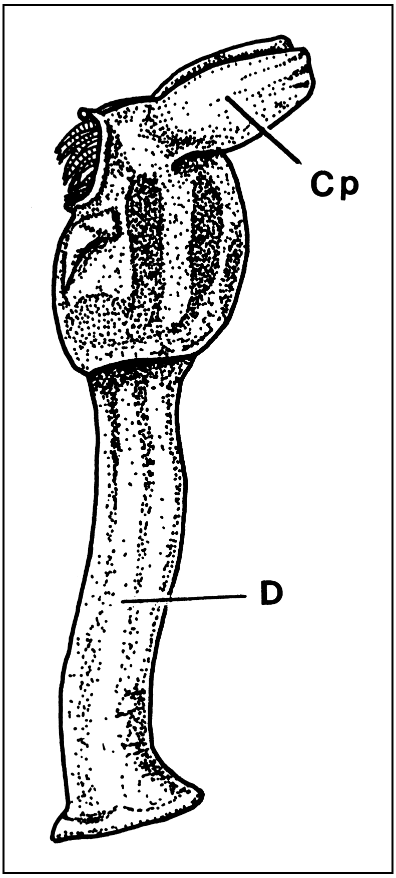

Figure 13. *Conhoderma auritum* (Linnaeus 1767)
Cp. capitulum with the protuberances in the shape of ears
D. stalk
according to: R. Riedl, 1991

Color: Scuta and terga have a dark brownish hue.

Size: This is one of smaller stalked barnacles. Capitulum is about 25 mm long in average, and the whole animal is about 130 mm.

Habitat and ecology: Together with the species *Conchoderma virgatum* it lives on whales, turtles, fish, ships and buoys. It is common on sea bottom and large ships, often with species of genus *Lepas*.

Diet: Tabačnik (1986) cites stomach contents to be: detritus 79%, Calanoida 20%, Foraminifera 1%.

Distribution: Together with the species *Conchoderma virgatum* this is a widely distributed cosmopolite species in warm and temperate seas.

***Conchoderma virgatum* (Spengler, 1790)**

Lepas virgata Spengler 1790: 158, text

Conchoderma virgata Darwin 1851: 1, text

This species is characterized by triangular scuta. The capitulum is composed of 5 plates that are much reduced and built into a thin membrane. Carina lacks basal bumps and forks and is placed near the subcentral umbal appendage. Tergum is long and narrow, and the top is curved inwards. Scutum is thin and lobed. The stalk gradually passes into head. Maxillae are with 2 thick stiff hairs above the wide notch, four poorly developed steps below. The mandible is with 5 strong teeth, the lower edge is poorly developed. The upper lip is like in previous species, wrinkled, that is, convex from one side and concave from the other side. The caudal appendages are shorter than half a length of basal ring of stem cirrus. Penis is long with unequal rings, pointed at the top. First pair of cirrus legs has almost equal rami, short and wide. The rings of the front side are bumped from the front and thickly overgrown with stiff hairs resembling spines. Second pair of cirrus legs is longer than the first pair. The rami are unequal and the intermediary rings of the front ramus are slightly bumped and thickly overgrown with stiff hairs. From third to the sixth pair of cirrus there are 4-5 pairs of stiff hairs with slightly raised front free edges. On the free rear parts of these cirri there is a group of large spines (Fig. 14).

Color: Capitulum and stalk are grey-blue or blue with six black or reddish-black stripes.

Size: this species grows very quickly, as Darwin (1851a) has described that it fouled greatly in 33 days. Broch (1931) describes that the representatives of this species can in five weeks grow 18 mm in capitulum and 7 mm in stem, while according to Newman & Abbott (1980) after 17 days of fouling on buoys the capitulum height of 20 mm in average is reached. The new data are: capitulum height 18 mm, width 13 mm, stalk length 28 mm, stalk diameter 8.9 mm (Jones 1990).

Habitat and ecology: It settles in pelagic and benthos on various objects, mostly ships, and rarely on carapace of older crabs. It is usually found together with the species of *Lepas* and *Conchoderma*.

Diet: The stomach contents are: *Calanoida* 55%, *Harpactocoida* 15%, *Polychaeta* 10%, Foraminifera 10%, fish eggs 5%, larvae of cirripedes 1%, snail larvae 1% (Tabacnik 1986).

Distribution: This is a cosmopolite species, in all temperate and warm seas, and is known from New Zealand, South America and south Africa, but not Antarctica (Newman & Ross 1971).

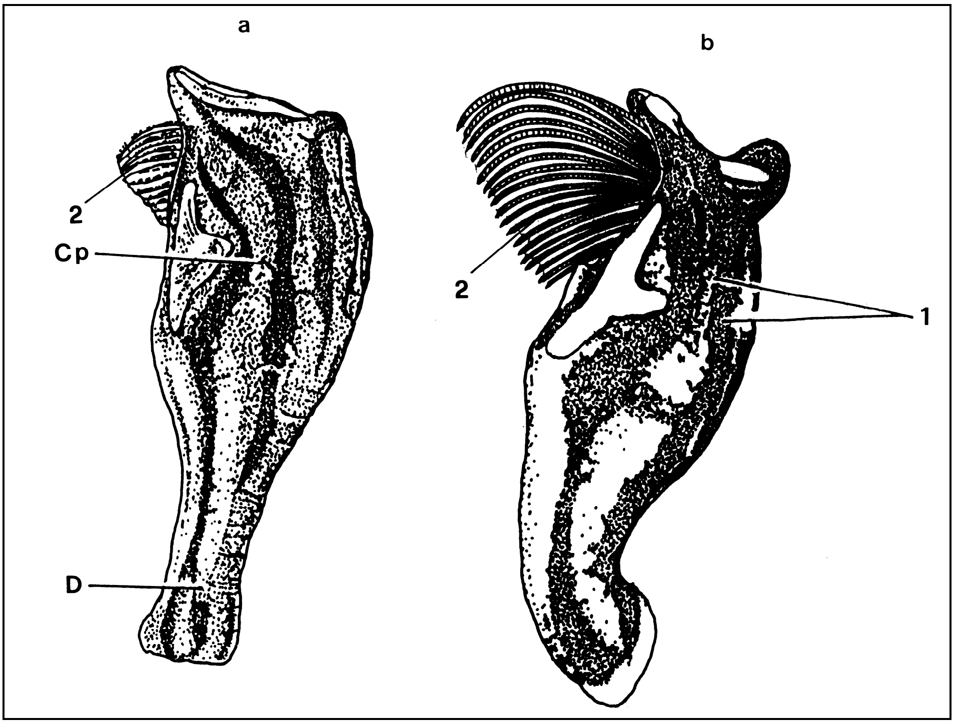

Figure 14. *Conchoderma virgatum* (Spengler, 1790)

a.	b.
Cp. Capitulum	1. along darknedred-brown to violet stripes
D. stalk	2. cirri

according to: R. Riedl, 1991 (a); A.J. Sothward & D.J. Crisp, 1963 (b)

Family *Poecilasmatidae* Annandale 1910

The body with 5 and more capitulum plates, including carina and one pair of scuta and terga each. In some species scuta have two detached parts. Some capitulum plates can be degenerated or absent. Umbo of terga is on the top, while it is placed basally on carina and scuta. The stalk is not calcified. Maxillae are not stair like. Mandible has an irregular furrowed edge. The caudal appendages are not spiny. They are divided in joints. First pair of cirrus legs is much shorter and much detached from other legs.

Genus *Octolasmis* Gray 1825

This order includes small stalked barnacles, with 2-5 incompletely calcified plates. Scuta are usually divided into 2-3 segments. Terga may be not calcified. Species of this genus are cosmopolites, usually settling on gill walls of crustaceans.

Octolasmis lowei (Darwin 1851)

In this species, capitulum and stalk are together having 2-5 incompletely calcified plates. Scuta are usually divided into 2-3 segments. Terga are not calcified, one part is hooked and the rest of the plate is reduced and makes a curved edge. Carina is reduced and connected under the scuta. The stalk is forked at the end (Fig. 15).

Color: Light reddish or pink.

Size: Very small stalked barnacle, up to 1 cm long.

Habitat: The epizootic animal, living in gill holes or at their entrance in decapode crustaceans, mostly crabs *Maja squinado* and *Maja verrucosa* (Broch 1963; Števčić 1965; Riedl 1970, 1983, 1991; Relini 1980a) as well as on species of genus *Neptunus* (Hiro 1936). In tropical seas this epizooide can develop both on marine and freshwater crustaceans (Hiro 1936).

There are few opinions on the relationship between the host and the parasite, and they vary. According to Broch (1963), this species lives on the host's cost, while Relini (1980a) considers it to be commensal. However, the physiological research on other species of the same genus (*Octolasmis myelleri*) on gills of crustacean *Callinectes sapidus*, shows that there is decrease in oxygen consumption (Gannon & Wheatly 1992). The same authors cite that the ventilation volume is increasing due to faster and stronger heart beats, being the compensation for maximal use of oxygen in the tissues, so there is no anaerobic breathing. However, if the invasion of this parasites on crabs (more than 50 individuals), the experimental hosts can not survive this stress. However, the authors support the opinion that in natural condition the influence on host population is not significant. This relationship between the host and the parasite is treated by the authors as ectocomensal, as it does not settle in inner hollows.

Distribution: Indian Ocean, Malay Archipelago, Australia, Japan, Formosa, around the Hawaii (Nillson & Cantell 1938), while Darwin (1851a) cites that this species is rare in Atlantic. Mediterranean seems to be edge zone of this species' range and it is assumed that this species came there through the Suez Channel or Gibraltar (Broch 1963).

In the Adriatic *O. lowei* was for the first time found by Stevcic (1965) at Rovinj, and determined by Broch (1963), while Relini (1978) in the survey of Italian cirripedes has cited this species only for Genoa Bay.

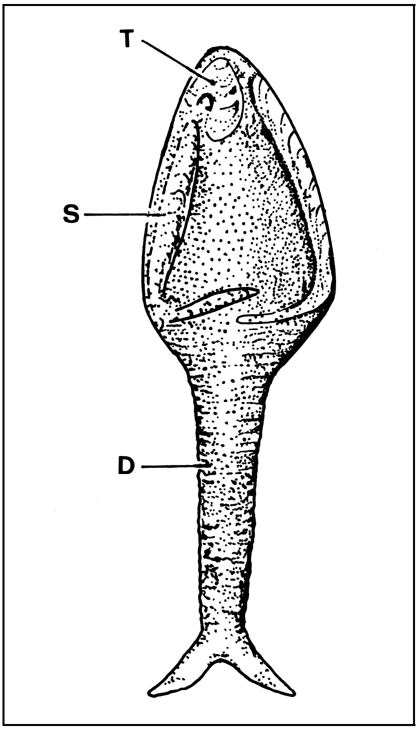

Figure 15. *Octolasmis lowei* (Darwin, 1851)

T. tergum - hooked part not sclerotinised
S. scutum
D. stalk - forked

according to: R. Riedl, 1991

Superfamily *Scalpelloidea* Pilsbry 1916

Family *Scalpellidae*

Capitulum is covered with more than 5 calcified plates, and more plates are on the stem. These are gonochorists.

Genus *Scalpellum* Leach 1818

The capitulum shell is composed of 12-15 plates that are not coalesced, but are connected with the similar material the stalk is made of. In female individuals, the head bears 14 plates, which are completely or partially calcified. Carina is usually curved in the umbal area. Terga are normal or forked, while scuta bear the pointed umbonal appendage. The additional males are saclike without developed stalk and capitulum, with or without 4 calcified plates. The stalk is short and very stiff, with spines or plates. This genus has over 150 species, and is widely distributed both in geographic and batimetric sense. 25 species have been found on telegraph cables and ship wrecks.

Scalpellum scalpellum Linnaeus 1767

Lepas scalpellum Linnaeus 1767: 533, text

The species has 14 capitulum plates and hairy surface. The umbonal part of the scutum and the curved carina are deeply placed. These are hermaphrodites with dwarf or additional males.

Capitulum is somewhat flattened and with pointed top, that is, 4 calcified plates (Fig. 16) which are well detached from each other. The whole capitulum is covered with membrane bearing fine hairs resembling down. On scutum the umbonal part is on the edge that surrounds all the capitulum plates. In the inner part of scutum towards the edge is a furrow that is often used to accommodate the additional males. The beginning part of curved carina is placed on one third of whole length of lateral plates. The beginning parts of plates are near the base, and they join under the carina. The stalk is as long as the capitulum or is somewhat longer. It bears the series of parallel small shells, and is covered with the membrane bearing downy hairs, same as the capitulum (Fig. 16). For this species is characteristic large variability of capitulum plates, which can be thin, tiny, brittle or very well calcified. The space between plates varies greatly, as well as the color.

Color: There are many hues, from yellow to gray, sometimes with reddish purple hues.

Size: Capitulum height may exceed 30 mm, and width 16 mm.

Habitat: Often an epibiont on hydrozoans, bryozoans and polychaete tubes on rocky ground.

Distribution: It is vertically distributed from 30 to 100 m. In the Italian waters it is found between 50 and 400 m and between 600 and 700 m (Relini 1980a). At the greater depths on immersed structures this species is the counterpart of barnacles, as they do not reach great depths.

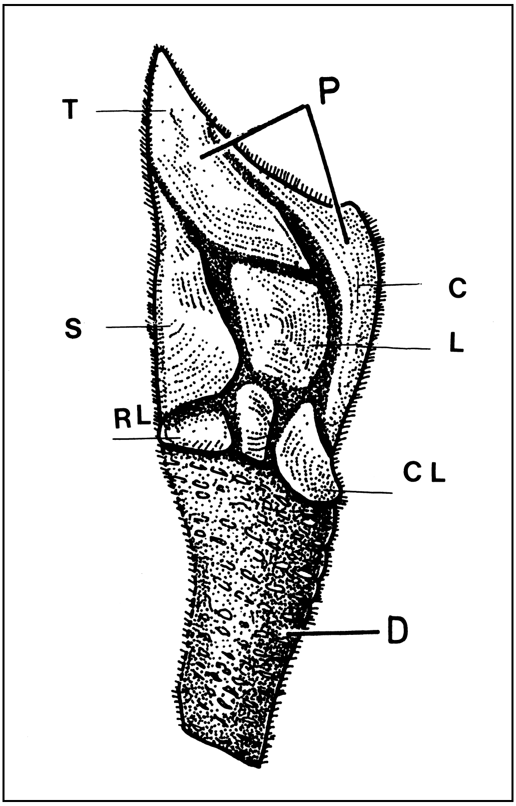

Figure 16. *Scalpellum scalpellum* Linnaeus 1767

P. half of plates on part of the capitulum with haired surface
T. tergum
S. scutum
C. carina
CL. carino - lateral plate
RL. rostro - lateral plate
L. lateral plate
D. stalk, short and stiff

according to: R. Riedl, 1991

In the Adriatic, this species is found in biocenoses of deeper littoral in channels of mid Adriatic, from 30 to 50 m – the lower zone of sea flowering plants and photophilous algae. In "Malo more" in deeper littoral at Maslinice, this species was found on 99 m of depth (Gamulin-Brida 1962a). The same stalk barnacle was found in biocenoses of circalittoral and in upper part of batial; 200-500m (Gamulin-Brida, 1947). It is also found in biocenoses of circumlittoral at depths of 26-100 m, or in open waters at about 200 m of depth in parts of mid Adriatic; in Vis Channel near Maslinice, Sholta island (Gamulin-Brida, 1962). It is very common between 150 and 200 m from Šibenik to Mljet, and very rare between 100 and 200 m between Dubrovnik and Vlora (Broch 1953). The same species is mentioned for north Adriatic, at Piran and Rovinj (Brusina 1907).

Suborder *Verrucomorpha* Pilsbry 1916

Thoracica without a stalk and with asymmetrical shell. The orifice closes with movable plates, i.e. with scuta and terga. They are hermaphrodites. This group has descended from *Lepidomorpha*, losing the stalk during evolution (Rainbow 1984).

Family *Verrucidae* Darwin 1854

The species are asymmetrical. The valves are movable on one side, while on the other side they are connected with rostrum and carina. The plates are along and across furrowed. The base is membranous. The upper lip has a concave edge. Caudal appendages are present.

Genus *Verruca* Schumacher 1817

This is the only living genus of family *Verrucidae* and is easily recognizable by an asymmetrical shell, with equally distributed plates on each side of middle line. The shell is flattened with 4 unequal valves. The movable valves are parallel with the base. On the shell plates there are well developed growth lines, similar to necklace. Carina has an umbo on its top, while the top of carina in shield like, being the top of rostrum in the same time. Two valves (scuta, terga) are movable, and the other two are immobile. On the other side these are coalesced with carina and rostrum into an asymmetrical shell. The movable tergum has a strong diagonal rib, and the movable scutum 3 slightly jointed (articulatus) ribs on the tergal edge. The immobile tergum has on the scutal edge the inner ridge (crista), while the immobile scutum has one raised part connected with a muscle. The movable scutum is always smaller than the responding tergum. The outer side is trapezoidal, mostly flattened or slightly indented, while the inner side of scutum is indented with upraised edges. The immobile scutum and tergum are incorporated into the shell wall together with rostrum and carina, leaving the other scutum and tergum in a form of movable lid or door. By the way, the fixed scutum and tergum represent the structure analogous to the wall plates of barnacles. The suture zones are variously shaped and are similar to barnacle radii. The base is membranous. The upper lip has hollowed edge.

Verruca stroemia (O. F. Müller) 1776

Lepas ströemia O.F. Müller: 1776.: 1, text

Lepas stroemia O.F. Müller: 1776.: 1, text

Lepas verruca Spengler, 1790: 158, text

Ochtosia stroemia Ranzani 1818: 63, text

Verruca strömia Darwin 1854: 1, text

Verruca strömia (O. F. Müller), Pilsbry 1916: 1, text

Verruca strömia (O. F. Müller), Kolosváry 1947: 1, text

Verruca strömia (O. F. Müller), Riedl 1983: 450, text; 1991: 415, text

The shell is often flattened. The opening is almost parallel to the surface. The shell plates are bearing various bumps in the shape of rays or ribs, with furrows between (Fig. 17a). The carina has an apical umbo, and the rostrum has a margino-apical umbo (Fig. 17d). The immobile tergum has a pronounced ridge. The immobile scutum also has a ridge for attaching muscles (Fig. 17b). The movable tergum has a pronounced diagonal rib, while the narrow movable scutum has 3 slightly jointed ribs on the tergal edge (Fig. 17c). There are abdominal appendages. The mandible bears 3 large teeth, while the maxilla has 2 spines above and a membranous base. The first pair of cirrus legs has short unequal rami, covered with thick setae. The second pair of cirrus legs has a short and thick front ramus, shorter than the rear one by a half. The third pair of cirrus legs is similar to second. The remaining fourth, fifth and sixth pair are similar to each other, being much longer than the first two pairs.

Color: the shell plates are whitish or light brown, often with lengthwise ribs. The tergoscutal flap is pink or reddish.

Size: The average diameter is 5 mm, and it may reach 8-9 mm in Atlantic.

Reproduction: larvae are intensively released into the water medium in the time of phytoplankton «flowering». This happens in English waters in February and beginning of March (Barnes & Stone 1973), continuing into summer but in lesser numbers, while in autumn and early winter due to insufficient food supply the larvae release is lacking (Barnes & Barnes 1975). The isolated individuals of the species may self-reproduce. With normal fertilization in early January and early February, settling is usually starting in early April and last till September in British waters (Bassindale 1964). In the

Adriatic around Split and Rovinj, the larvae are found in plankton, and fixated individuals of 1 mm diameter only in July (Kolosváry 1947).

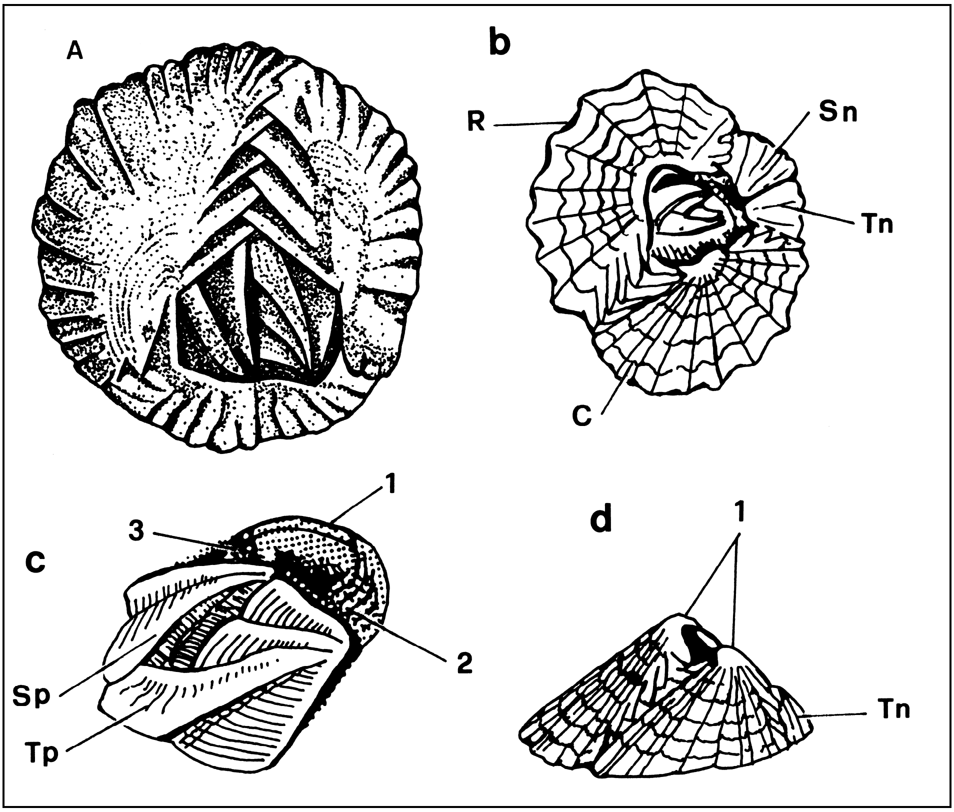

Figure 17. *Verruca stroemia* (OFP. Müller) 1776

A. view of shell in the region of orifice
b. shell above (sketch)
c. carina
r. rostrum
Sn. non mobile left scutum
Tn. non mobile left tergum
c. mobile half of operculum
Sp. mobile right scutum
Tp. mobile right tergum
1. mantle edge
2. carcinal velum
3. rostral velum
d. shell from side (skech)
Tn. non mobile left tergum
1. umbo

according to: R. Riedi, 1991; (A); G. Lutherr, 1987 (b,c,d)

Habitat and ecology: It settles on hard surfaces, and sometimes is an epibiont on shellfish, ascidians and *Posidonia* rhizomes. It can also be found under rocks (Stone & Barnes 1973). This species is sciaphile, that is, shuns light, so it is commonly found in underwater caves. It is also eurihaline (tolerates a wide range of salinity), so it can be found in lagoons and fjords, and laboratory specimens of adults have proven this feature.

Diet: Tabačnik (1986) cites the following components in this species' diet: detritus 93%, Harpacticoida 4%, sand 2%, Diatoms less than 1%.

Distribution: In the vertical space it lives from mediolittoral to 300 m of depth, while the geographic distribution is from Norway, Heligoland and Great Britain to Mediterranean and Red Sea. Considering the Adriatic, this species is found in biocenoses of «deeper littoral» in channels of mid Adriatic , in «Malo more» and «Neretva» up to 99 m, and in zone of photophilous algae on 30-50 m, as well as in circumlittoral (to the lower zone of marine flowering plants) (Gamulin-Brida 1962a). This species is besides infralittoral and circumlittoral also found in the upper step of batial (200-500 m) (Gamulin-Brida 1974), and it is a common epibiont in circumlittoral on depths of 26-100 m. In mid Adriatic the species *V. stroemia* was noted in open waters at the depth of 200 m, near Maslinica, Sholta, in Nin Channel (Gamulin-Brida 1962). The same species is mentioned in other places: it is very abundant in oil harbour of Rijeka, and less so around Zadar (Brusina 1907) or Split and Rovinj (Kolosváry 1947) and Trieste Bay (Vatova 1928, Kolosváry 1955).

Origin: The way of movement of cirrus legs can help in determining origin of this suborder from the suborder *Lepadomorpha*. Rainbow (1984) describes the movement of these legs as strong beating with rhythmic movements, causing water flow. The same movement is present in more primitive *Lepadomorpha* as a mechanism of catching prey (Anderson 1980). Besides this carnivorous feeding, *Verruca* can also feed in microphagous way, using the first three pairs of cirrus legs (Anderson 1980). *V. stroemia* is obviously a verruciformous barnacle, able to make cirral rhythm movements due to possible life in deep waters. As the rhythmic movements are based on different mechanisms than in barnacle groups, this species had an independent evolution, maybe as an adaptation for shallow biotopes (Anderson 1980).

Suborder *Balanomorpha* Pilsbry 1916

These are *Thoracica* with no stalk, and with bilaterally symmetrical shell, composed of carina, rostrum and 1-3 pairs of lateral plates, which can be coalesced in various ways. The opercular valves are connected with joints or are coalesced. The terminology is derived from the terminology of mollusks. Pairs of scuta and terga are the active covering, which can open and close through muscle action. The other wall plates (6 in species of *Chthamalus*, *Semibalanus*, *Balanus*) are around the body mantle and its cavity, and can be easily recognized in freshly metamorphosed barnacles (Fig. 18 a, b).

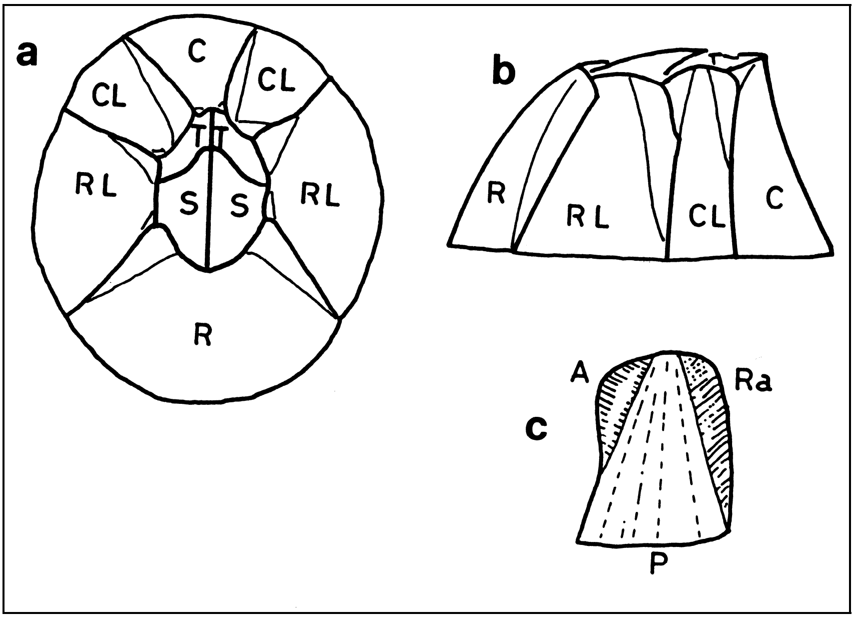

Figure 18. Balanomorpha; structure of shell

a. structure of shell (the arrangement of the shell plates), top and sides view of a typical acorn barnacles, without of stalk (sketch)
C. carina
Cl. two carino - lateral plates
R. rostrum
Rl. two rostro-lateral plates
S. scutum, the pair of scuta
T. tergum, the pair of terga
b. side view of barnacle
c. on single plate
P. central part (paries)
A. ala (side piece)
Ra. radius (side piece)

according to: A. J. Southward & D.J. Crisp, 1963

The shell is composed of calcified plates that are variously placed in the evolutionary line of development Each of wall plates is composed of central part and sides with a wedge-shaped appendage. If it is overlapping another plate, it is called radius, and if it is overlapped by it, it is called ala (Fig. 18c). However, in certain genera shells are made by coalescing of two or more plates. On the outside the plates are wrapped in a membrane that is not falling out when changing, so the thickness of the shell is increasing during growth. On the inner side of the shell is hypodermis. Toward the top of the plate the shell walls are thickened into a calcified crust, which is connected with opercular membrane surrounding terga and scuta. The structure of shell walls varies among the species, and can contain the greater amount of calcium carbonate ($CaCO_3$), or be porous with empty channels that stretch lengthwise between the inner and outer thin tubular plate. Such shells are called tubiferous. Sometimes there may be walls between tubes (Fig. 2) (Bourget 1977), or the channels are filled with calcified material. The shell plates are furrow by lengthwise (longitudinal) stripes, having a microstructure of many light and dark connections. They are formed in high tides when the growth is evident, in contrast to the period of low tides, when the growth stops (Bourget 1977). In some genera, for example *Chthamalus*, the growth is evident in whole inner shell surface and is a one-layered object, while in genus *Semibalanus* growth happens in specific regions – at the basal edge, resulting in increase of shell plate height and width, so along the upper half goes the thickened layer of shell wall (Bourget 1977). The representatives of this suborder are «cemented» at the substrate with whole base that may be calcified. When the barnacles are removed from the surface, the calcified base is clearly showing as a white circular furrow. In some species the furrow is darkish-white without the lines (thick), but in others there are radial ribs or channels (porous) that look like sticks of a wheel (Fig. 19).

The opening of the house is from the above (Fig. 20a) closed by a mobile cover (operculum) made out of scuta and terga, and moved by a muscle (adductor scutorum). The opercular plates are connected to each other and the shell wall with a membrane. The valves open along the middle line at the end of a shell. In most species valves are a pair of triangular plates (scuta) and a pair of hammer like plates (terga). The shape of terga may vary. The end may be pointed like a beak, but doesn't have to (Fig. 20 a, b, c). The tergoscutal flaps like a skin tissue become clearly visible on the inner side of the opening. In certain barnacles they are brightly colored with a combination of stripes etc. The color of that part of the flap is by the way an important systematic character, as it varies from one species to the other.

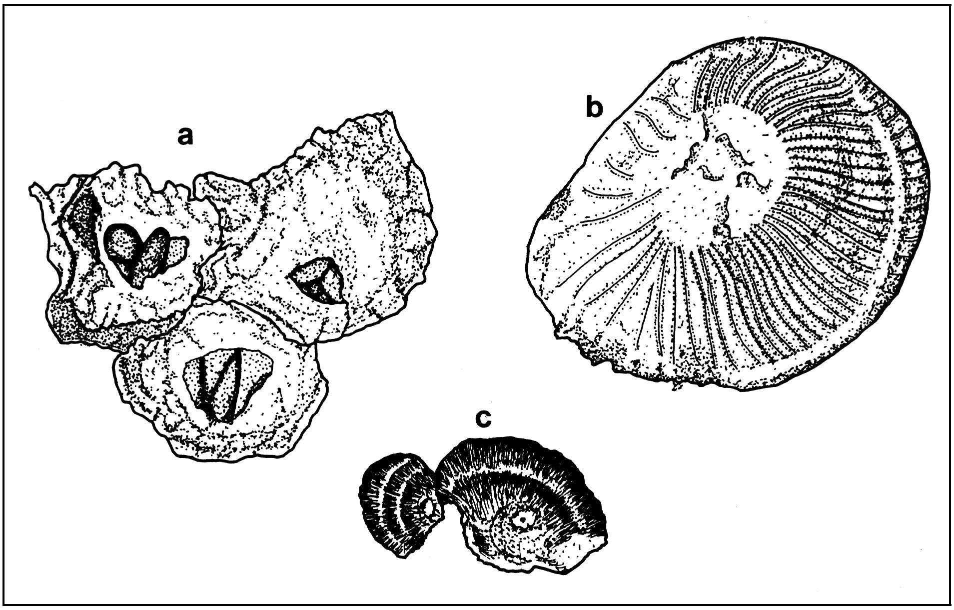

Figure 19. Balanomorpha - basis of body (sketch)

a. membranous bases, the membranes partly torn; showing part of body inside
b. barnacles with porose basis seen from underside after removal from substratum
c. appearance of solid bases when the rest of the barnacle is removed from the substratum

according to: A.J. Southward & D. J. Crisp, 1963

Superfamily *Chthamaloidea* Darwin 1854 (nom. trans. Newman & Ross, 1976)

The shell wall is composed of rostrum and 1-3 pairs of lateral plates. These plates are rarely supplemented with one or more additional plates shaped as appendages, placed one above the other around the basal edge. The rostrum is rarely connected with the other plates, while the wall plates are thick. The inner wall lacks ribs, and radii are thick also. The jointedness of opercular plates (scuta, terga) is usually lacking, and they are rarely jointly calcified. The base is mostly membranous, always calcified, and thick and does not make a complex between the rings and the wall. The upper lip is wrinkled. The ridge is almost flattened or slightly inserted, but without the notch in the middle. The mandible has 3 or 4 teeth, the lower joint is ridge like or saw like. The pair of cirrus legs resembles the fourth pair more than the second. The second pair often bears special terminal setulae. All the cirri lack specialized spines and hooks. The upper fork of the third pair of cirrus legs resembles an antenna.

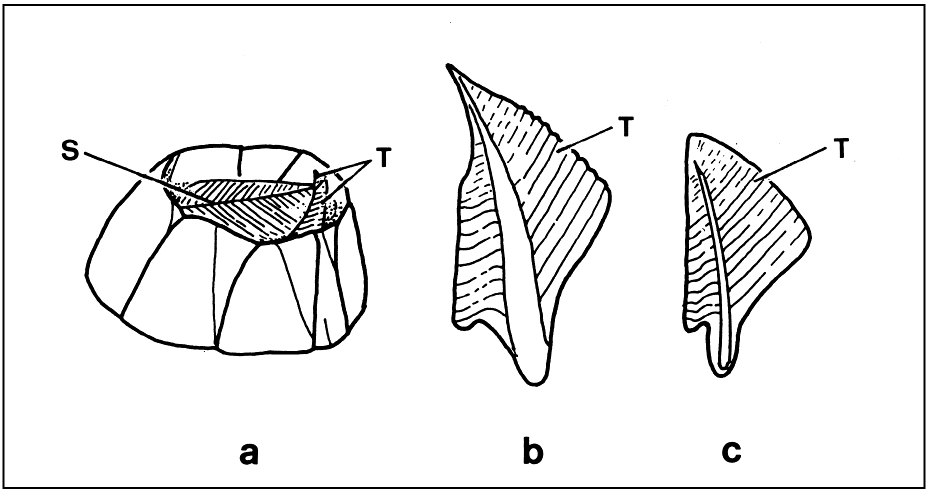

Figure 20. Balanomorpha - opercular valves (sketch)

a. barnacle with sharply pointed terga

b. one of the terga

c. tergum with blunt point from another species

according to: A.J. Southward & D. J. Crisp, 1963

Family *Chthamalidae* Darwin (1854a)

The shell is composed of 8, 6 or 4 plates. The shell wall is without channels or additional basal appendages or plates. The rostrum is with alae. The mandible has 3-4 teeth and ridged lower angle. The caudal appendages, when present, are multijointed (Newman & Ross 1976). The upper lip is round, hollowed, often raised. The third pair of cirrus legs is more similar to the fourth than to the second pair. There are only about 50 species.

Subfamily *Chthamalinae* Darwin (1854a)

The shell wall is composed out of 4 or 6 plates, which are connected with sutures, usually finely toothed, and the shell is flattened. The rostrum has well developed alae. The scuta are wider than they are long. The mandible has 4 teeth, 2 of which have 4 additional tops each. The caudal appendages are generally lacking. The base is membranous.

Genus *Chthamalus* Ranzani (1818)

The shell is composed of 6 immobile plates. Rostrum and carina have alae. In most species there are lateral and rostrolateral plates, which are arranged as on the Fig. 21. The narrow rostrum is not coalesced with rostrolateral plates, in contrast to genera *Balanus* and *Semibalanus*, where it is. In adults all plates may coalesce together. Rostrum and carina are very similar as both have alae, while the plates lateral to carina are more or less triangular and without alae. These features can be used to differentiate the genus *Chthamalus* from other genera with 6 lateral plates of Chthamalids. The base is always membranous, sometimes partially calcified due to curving of wall plates, which grow outward toward the middle of the base (Fig. 19 a, b, c). The shell is dark whitish, gray or brown. The tergoscutal flap is blue, brown or discreetly white. It may be a mixture of all these colors. The mandible is quadrodentriodal. The scutum is usually low. The plates on the lid are thick or porous. The first and the second pair of cirrus legs differ from other (rear) pairs, and are not included in gathering and processing food, due to passive extension in the areas of strong currents (Crisp & Southward 1961).

This genus is distributed almost worldwide, mostly in supralittoral and mediolittoral. This is a group of cirripedes that is furthest detached from the sea, that is, they tolerate emersion the best (Relini 1969, 1980a). They tolerate drying due to low half permeability of shell plates and the increase of osmotic pressure of body liquid. Such physiological adjustments are not known in other barnacles. However, *Chthamalus* can be relatively easily killed by toxic metabolites accumulated in body hollow, as a result of anaerobic conditions after closing, due to diminished aerobic respiration (Barnes et al., 1963; Barnes & Barnes 1964). However, Foster (1971) cites that death as a result of desiccation does not happen in genus *Chthamalus*, but it can happen in other species of genus *Semibalanus* or *Elminius*. *Chthamalus* is also very tolerant to high temperature, same as *Elminius modestus* or *Balanus perforatus*. That is the reason why this genus and other mentioned species are mostly found in warmer seas. For example, in experimental conditions 50% of genus *Chthamalus* population survives on the temperatures of 52.5°C and 49.7°C, while in the species *B. perforatus* it is 45.5°C and it is the upper lethal temperature for these barnacles (Foster 1969).

Of family *Chthamalidae* there are 4 species in the Mediterranean. The species *Pachylasma giganteus* is found only between 100 and 200 m of depth near Mesina, while the species *Chthamalus montagui* and *C. stellatus* live in middle and lower levels of supralittoral, and *C. depressus* on intertidal zone (Relini 1981). However, the last species is lately known under the other name – *Euraphia depressa* (Newman & Ross 1976; Crisp et al., 1981; Relini 1983) or both names are mentioned in the same time (*C. depressus*, *E. depressa*) (Relini 1981) or differentiating the species *C. depressus* into two varieties a and b. (Kensler et al., 1965). For the species *C. montagui*, it was assumed till 1979 that it is not a Mediterranean species (Southward 1976), but the biochemical electrophoretic analyses (Dando et al., 1979) have proven that this species lives in Mediterranean and Adriatic. It was proven on the base of material from Venice. It is very interesting that material collected by Heller (1866) and held in British Museum of Natural History was not considered to be from Mediterranean at all, and that therefore the species *C. montagui* did not live in Mediterranean (Southward 1976). However, Dando et al., (1979) have with electrophoretic analysis proven that species *C. montagui* was present, as the specimens were very similar to those from Venice and Split on which the analyses were also done in that way to refute a claim that *C. montagui* is not recent species in Mediterranean and Adriatic (Crisp et al., 1981). The same authors consider this species to be well distributed in Adriatic and Greek bay Saros, so it could be more present in Aegean sea. Further, Crisp et al., (1981) point that the species *C. montagui* is derived from circum-boreal group of Chthamalids, and *C. stellatus* from tropical-subtropical Atlantic stock.

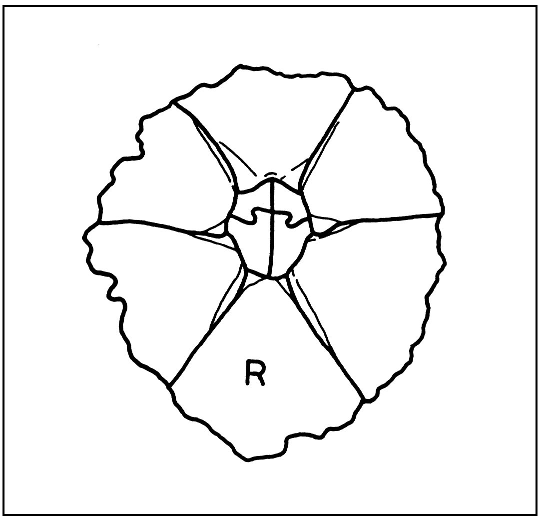

Figure 21. *Chthamalus sp*. Ranzani (1818); arrangement of shell plates

R. rostrum - narrow, overlapped by plates on each side (sketch)
according to: A.J. Southward & D. J. Crisp, 1963

There are certain differences between these two species in body structure, larva representation in plankton, behavior and physiology, so there is a convergent adaptation of two genetically different forms to similar habitats and climatic conditions. According to before-mentioned authors (Southward 1976; Dando et al., 1979; Crisp et al., 1981) the species *C. montagui* and *C. stellatus* are distributed along the Atlantic coast from Great Britain to northern Africa, in whole Mediterranean, and the species *C. stellatus* also more to the south along the west coast of Africa. *C. montagui* is more common in higher waters, mostly in secluded places, and *C. stellatus* in deeper waters on open places.

The third species *Euraphia depressa* is characterized by more restricted vertical distribution, so it is distributed in the high tide level on the wave-beaten places, but also in more secluded habitats. According to Relini (1981), this species dwells in higher levels of supralittoral, and the former two species in mid and lower levels of supralittoral and throughout the tidal zone. However in Ligurian sea research in situ on various levels (5 cm, 40 cm, 100 cm, 200 cm), all three species settle mostly on 100 and 200 cm (Relini 1983).

Besides the different vertical distribution, Southward (1976) describes structural differences of *C. montagui* and *C. stellatus* in detail. In *C. montagui* the operculum is deltoid in shape, very angled, and the cross joint between scutum and tergum passes through the central line with less than one third of distance toward the rostrum. The major curve of the joint between the opercular plates toward the rostrum is concave (Fig. 22B), while the soft tissue of the flap is usually blue light to blue with brown and black spots. In *C. stellatus*, operculum is oval, semicircle; crossed connection between scuta and terga is on more than one third on the distance from the rostrum. The main curve between scuta and terga toward the rostrum is convex (Fig. 22A). The soft tissue of the flap around operculum is usually light blue with the orange and black spots.

These two species also differ in reproduction: although the breeding period in North Sea (Plymouth) is from May to the end of September for both species, *C. stellatus* is more common on exposed places in the mid tidal area, and produces more offspring than *C. montagui*. The embryo develops after 3 months and that is same in both species. The embryo-carrying eggs in *C. stellatus* are bigger than in *C. montagui*. In both species most offspring was produced in shady and poorly exposed places, while the egg production relative to body mass is greatest in medium-shaded places (Burrows et al, 1992). Both species are able to bear offspring in the first year after settling, with the difference that *C. montagui* has one or two broods per year, and *C. stellatus* one to three during the summer. In the second year both species produce two broods in a summer season (O' Riordan et al, 1991). Finally, Burrows et al., (1992) conclude that *C. stellatus* and *C. montagui* are similar in ways of reproduction.

In the similar periods of the year they produce similar number of broods with the similar number of larvae. According to authors this similarity includes the convergent adaptation of these species, which are very different morphologically, and after Dando & Southward (1980) also in biochemical genetic.

***Chthamalus montagui* Southward 1976**

Balanus punctatus Montagu 1803: 8, text fig. 5, pl. 1

Lepas punctatus Maton & Racket 1807: 17, text; Wood 1825:1007, text

Chthamalus stellatus Darwin 1854: 1, text fig 1e, pl. 18; Gruvel 1905: 1, text; Zevina and Tarasov 1957: 1, text; Southward 1964: 241, text

Chthamalus stellatus stellatus f. *punctatus* Pilsbry 1916: 1, text; Kolosváry 1939b: 159, text; Bassindale 1964: 1, text

nec. *Lepas cornubiensis* Ellis 1758: 845, text; Pennant 1784.

nec. *Balanus punctatus* Martini & Chemnitz 1788; Pulteney 1799: 1, text

The shell is angular and bucket like, conical or lowly conical, but often elongated like a pillar, especially when individuals are grouped. The shell surface (Fig. 23) is almost always "corroded", often spotted on the outside and porous on the inside, often barely visible connected with sutures. Inside, towards the sutures, there are small holes that are much smaller than the corresponding holes in *C. stellatus*. The connection of opercular plates (scuta and terga) crosses the central line on the distance smaller than one third of the distance toward the rostrum. The main curve between scuta and terga toward the rostrum is concave, while the connection between scuta and terga is somewhat smaller angle than 90^{o}, reaching that figure in extreme circumstances. The articular ridge is shorter than in *C. stellatus*, and the basal angle with the ridge of a depressor muscle is relatively higher than in *C. stellatus*, while the insert of the lateral depressor muscle is longer and narrower than in *C. stellatus*. The adductor muscle hole is deep like in *C. stellatus*, but is always narrower and closed toward the surrounding edge (Fig. 22). Terga are short and wide and have various angle of basal edge, possibly as a consequence of depressor muscle crest that are very prominent. The scutal edge of terga is also inserted. The further spur of terga is very weak, almost as a remaining, and the same is true for a shallow furrow that crosses the inner part of terga toward its undeveloped appendage. Maxilla is similar to the maxilla of *C. stellatus*. It carries 2 large and 2-5 smaller spines above the notch, and under the notch there are 6-11 large and 7-23 smaller hairs, as well as (usually) a tuft of hair under the lower angle. The mandible could hardly be distinguishable from the mandible of

C. stellatus. There are 4 large teeth. The second and the third are split and the fourth is double. There are also many small comb-like teeth (24-44, average 31), even in juveniles. The lower margin carries 2-3 spines and a tuft of hair. The labrum is concave and almost always hairy (they may be lacking, however). The notch bears a row of small knob-like teeth, generally less than in *C. stellatus*. There are mostly 12-18 teeth, but sometimes only 7. The first pair of cirrus legs has a longer front ramus with 6-10 segments, and the rear ramus has 5-7 segments. On the anterior ramus of that cirrus there is no spine on the basal segment as in the species *C. stellatus*, but hairs are much more developed. The rough simple hairs are on both sides of cirrus. Second pair of cirrus legs has a somewhat longer anterior ramus, composed of 6-7 segments, while the posterior ramus has 5-6 segments. On the joints of lowest segments there are tiny spines, but they are less obvious than spines of *C. stellatus*. Both rami bear plumose setae, but the stiff hairs are however less rough, and they are placed very close to each other. The anterior ramus has 7-15 pectinate setae on the distal segment and sometimes there are such setae (up to 6) on the next segment. The posterior ramus has 6-15 plumose hairs (setae) on the distal segment and 3-13 on next segment. The first segment is often shaped like an antennula, without the pectinate setae, but there may be 1 or 2 such setae. The third pair of cirrus legs is shaped like an antenna, with up to 19 segments on the rear branch. There are usually 12-15 segments on a ramus. Segments bear 5 spines that grow larger progressively, like in species *C. stellatus*. The fourth, the fifth and the sixth pair of cirrus legs are similar to each other, having 14-20 segments. The branches of each segment are mostly equal in length, although there are insignificant variations in number of segments. There are 5 spines, whose size increases in every successive segment.

Color: The shell is brownish or grayish. The soft tissue of the flap is around the operculum in living specimens darker in average than in *C. stellatus*. The basic color of this tissue is blue with light brown or dark brown spots in the center and at rostral edge, while the edge spots are somewhat darker brown or blue.

Reproduction: In western Mediterranean, settling lasts from March to August, and more intensively from September to February. The fertilized eggs are present throughout the year except in November and December, and the later embryonic stages develop from February to September (Relini 1983). The number of generations varies with habitat and sea level in this species as well as in *C. stellatus* (O' Riordan et al., 1991). If water level is high and there are many waves, the production of nauplius larvae starts earlier with more intervals than in individuals in sheltered places (Crisp 1950). In the high tidal level this species has 1-2 generations, in mid level 2-3, and in low levels 3-4 (Burrows

1988). In the Marseille Bay, this species and *C. stellatus* can have up to 5 generations in a season (Le Reste 1965).

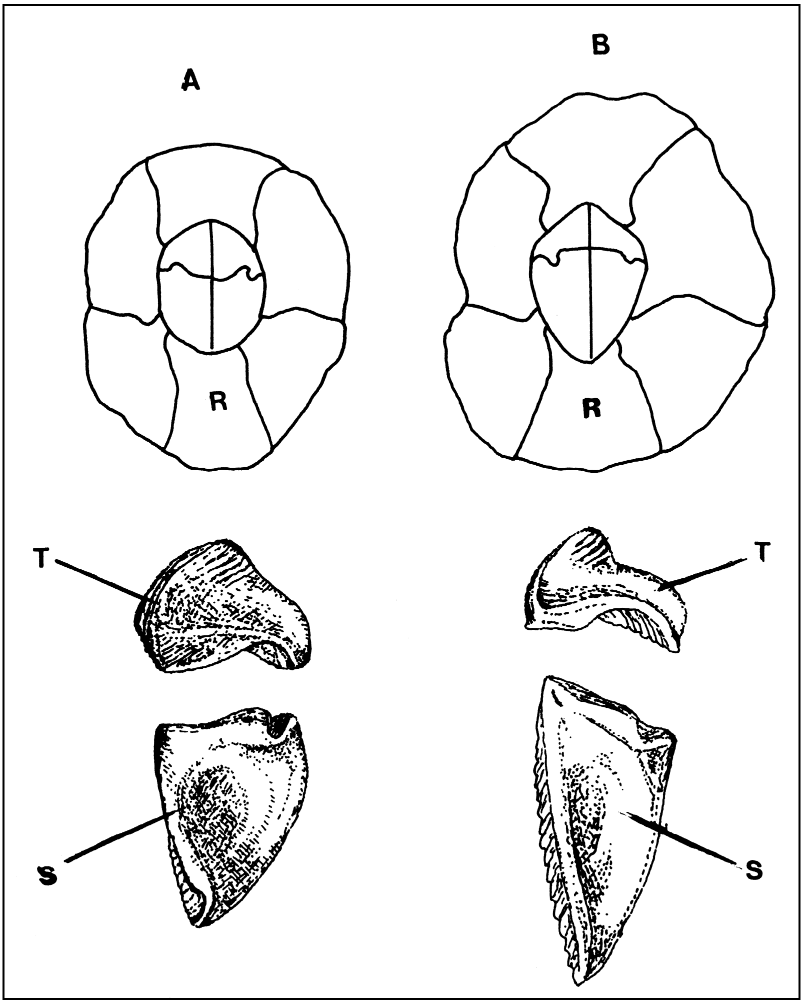

Figure 22. A. *Chthamalus stellatus* (Poli 1791); B. *Chthamalus montagui* Southward, 1976; arrangement of shell plates

a. curve in the direction rostrum is convex
B. curve in the direction rostrum is concave
R. rostrum below - internal view of opercular valves
T. tergum
S. scutum (sketch)

according to: A.J. Southward, 1976

According to Southward & Crisp (1954), production in both species (*C. montagui* and *C. stellatus*) around Great Britain starts in the first summer, that is, 9-10 months after settling. In Irish waters in first year of settling in summer season, *C. montagui* produces 3 and *C. stellatus* 2 generations (O' Riordan et al., 1992).

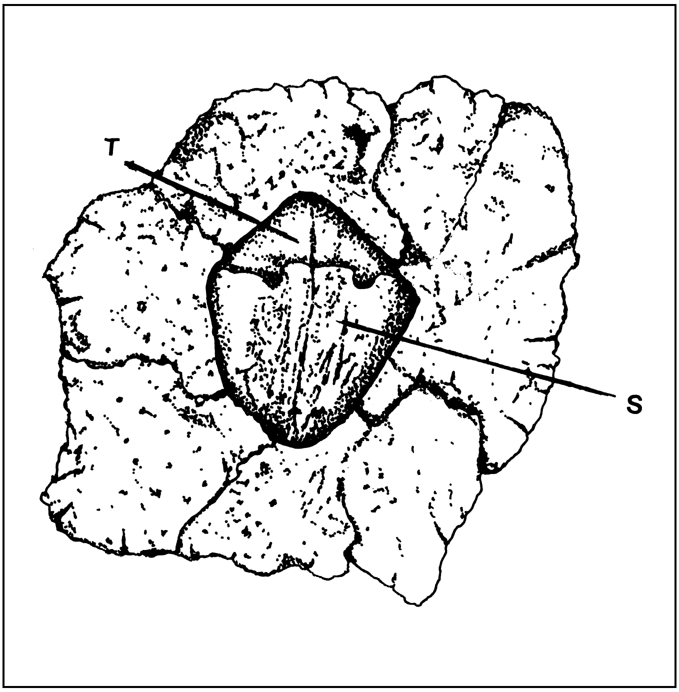

Figure 23. *Chthamalus montagui* Southward, 1976; apical view of shell
T. tergum S. scutum
according to: D.J. Crisp, A.J. Southward, E.C. Southward, 1981

Size: in the first year basal diameter is 2-5 mm, in the second year 5-6 mm although it could reach 8 mm, while the maximal basal and opercular diameter is described for Ligurian sea, being 11 and 4.6 mm (Relini 1983). According to the same author, this diameter is reached in more than three years. In the eastern coast of Adriatic the carinorostral diameter is maximally 8-9 mm (Zavodnik 1997).

Ecophysiological characteristics: All chthamalids species including this that live in Mediterranean could live in natural ambient for more than 10 years (Relini 1983).

Habitat: This species is prevalent in the zone between the mid and high water level, high tide (MHWS) (second and fourth lunar quartile) and lowest tide (MHWN) (first and third lunar quartile) (Southward 1976; Crisp et al., 1981; Relini 1981). According to the experiments done by Relini (1981), this species settles mostly on depths of 5 cm and 2 m, and rarely on 40 cm and 1m. Crisp et al., (1981) point out that this chthamalid is most common in shallow waters and that it was not found deeper than MHWN. It is especially present in sheltered places of half-estuary waters, polluted and with more mud. In such a polluted rich ambient according to these authors this species grows better, produces more larvae but lives shorter than *C. stellatus*. On our Adriatic shore it is found in mediolittoral on carbonate rocks. Mostly it settles in upper level of tidal zone. It is not found on free rocks, large gravel or as epizootic on *Patella* and *Monodonta* shells. Populations of this species are always mixed with species *C. stellatus* (Zavodnik 1997).

Distribution: This chthamalide has more or less continuous distribution from northern Scotland, coasts of England, Ireland, France, and Spain to northern Africa around Morocco in estuaries and on open coasts near Cape Tafelney (31^{o}N). Stubbings (1961, 1964, 1967) considers this species and *C. stellatus* to have southern border at Cape Verde, only the population of *C. montagui* is scattered.

In Mediterranean this species is very abundant near Barcelona, Marseille, in Ligurian Sea, and less so around Majorca island (Relini 1979), in Tyrrhenian Sea, especially near Naples. It is absent near Sicily and Sardinia (Relini 1981). In the Adriatic on the west coast this species was identified for the first time in the material from vicinity of Venice (Dando et al., 1979), and later on it was found on artificial substrate in that area (Candela et al., 1983). Relini (1981) cites this chthamalide for Trieste with distribution to Bar, and as accidental species near Rijeka. However, Zavodnik (1997) gives a further comment on this species' distribution in Adriatic. Before the revision done by Southward (1976) in Mediterranean and Adriatic, *C. montagui* was treated as a subspecies in *C. stellatus* group (Pilsbry 1916; Kolosváry 1939,a, 1941, 1947). It is cited as a characteristic species of Mediterranean communities in rocky shores (Peres & Picard 1964). The same term was used in our regional coast research until the spring of 1991, when in Makarska harbour several specimens were identified as *C. montagui*, and it seems that this species has a wider distribution in eastern Adriatic in communities of mediolittoral rocks and that it is often cohabiting with *Chthamalus stellatus* (Zavodnik 1997). The same author has collected more than 300 specimen in situ at Kopar, Rovinj, eastern coast of Istra, Brestovo, Zadar, Split, Makarska, Dubrovnik and at stations on islands Krk (Omišalj, Malinska, Punat), Cres (Porozina, Cres), Silba, Grebeni, Ugljan (Frnaza), Dugi otok (Lucina), Zut (Bizikovica), Sholta (Nečujam), Hvar and Mljet (Veliko jezero, Soline, Tojsti, Stit, Pomena).

***Chthamalus stellatus* (Poli 1791)**

Lepas stellatus (Poli 1791)

Chthamalus stellatus Pilsbry 1916: 1, text; Nilsson-Cantell 1921: 75, text; Kolosváry 1939b: 159, text.

The shell is flattened or conical, widely oval or half circular, usually corroded, often spotted on the outside and hollowed on the inside (Fig. 24). The shell plates are often coalesced, without any traces of outer sutures, and on the inside there are very deep holes. The connection between the scutum and the tergum crosses the central line at one third on somewhat larger distance toward the rostrum, while the main curvature between scuta and terga is convex toward the rostrum (Fig. 22). The connection between scuta and terga is under the angle of 90^0 to the middle line when the plates are closed. The operculum is wide and deltoid in juvenile specimens, and in adults is almost circular. Scuta are short and wide, sometimes equal on both sides. The articular ridge is steep at the articulary furrow, while the extension of tergal edge after the furrow is lowered, so the appendage of depressor muscle at the basal angle is relatively lower than in species *C. montagui*. The hollow for the abductor muscle (Fig. 22) is wide, deep and rounded, and its basal edge is covering about a half of valves' width from the distal edges. Some specimens have a weekly developed adductor ridge, almost as an invisible trace. Terga are very deep relative to their width. Sometimes the lateral sides are almost equally developed, and the edge toward the carina is especially bow shaped. The depressor muscle crest is well developed, while there is no trace of tergal appendage (spur). The base is membranous.

Mouth parts: Maxilla is reduced. It bears two large spines and 3-7 smaller above the notch, while below the notch there are 4-8 larger spines and 9-14 smaller, together with hair tufts at the lower angle. The mandible has 4 large teeth. The second and the third are bifid and the fourth is double. Under the fourth tooth there is a row of small comb like (pectinate) teeth, 25-39 in average, while the lower edge carries 2-4 teeth with a hair tuft at the lower edge. The upper lip (labrum) is typical chthamalid, with a concave edge, always hairy. There is a row of small convex teeth along the concave edge, usually 25-26, rarely only 13.

The first pair of cirrus legs has a longer upper ramus composed of 6 segments. The lower ramus is shorter with 4-7 segments. Both rami carry simple and feathered (plumose) stiff hairs, while there are less hairs of pectinate type. Along the outer and rear edge of anterior branch, there is a row of short conical hairs, which stretch along the lower edges of second or third segment. Second pair of cirrus legs has a ramus composed of 5-7 segments. There are several spines that point out at the rear edge of the anterior ramus and the upper edges of segments. Both rami bear toothed stiff hairs (setae). The anterior ramus on the distal segment bears 3-14 stiff hairs (setae), 0-10 on the next segment and 1-4 on the segment to him. The posterior ramus has 4-12 stiff hairs on the distal segment, and 0-10 on the next. All these hairs are biodenticulates (Fig. 7e), according to Henry (1974) and Henry & McLaughlin (1975). There are two rows of rough stiff hairs that get larger gradually and are well separated at the proximal part, while on the distal part they are fine and comb like. In some specimens the lowest pair of stiff hairs is more separated from the others, although they are not bigger, and their function is similar to guardians, so they are called "basal guards" (Southward 1976). The third pair of cirrus legs happens to be antenniform like in barnacles (Ross 1969). The posterior ramus is composed of 23-28 segments with uniformly distributed hairs. There are usually 13-15 segments in the anterior ramus and 14-16 in the posterior ramus, while each segment bears 4-5 spines of increasing size. The fourth, the fifth and the sixth pair of cirrus legs are similar to each other, and are composed of 14-16 (IV), 14-18 (V) and 15-19 (VI) segments. Each segment bears 4-5 spines of increasing size. The rami are usually equal in length, but there may be more segments in the posterior ramus.

Color: The shell is light gray but often discolored by epibionts. The soft tissues of the opercular flap on the inside from the entrance toward the cavity around mantle are lighter in color than in species *Chthamalus montagui*, especially in juveniles. In specimens from Great Britain, the soft tissues of the flap are steel-gray with large orange fields in the middle and near the rostral edge, while the edge is black or brown in juvenile individuals, and in older ones the steel color is lighter and immersed with white. The specimens from Mediterranean are less blue and more orange and reddish brown. In the middle there is an orange spot, and there are brown areas on each side. These brown and orange areas are equal in size to a blue area, although the orange area can stretch on each side and join the brown one. The blue color may sometimes be very pale (Fig. 24b).

Reproduction: In warmer seas this species reproduces in the spring and summer, and settling throughout the year. In waters around Great Britain the egg mass is visible in July and August (Crisp et al., 1981). In laboratory conditions after 2-3 weeks the egg cells develop under the temperature of 15-16^{o}C (Patel & Crisp 1960). In west Mediterranean this chthamalide reproduces from February to April (Crisp et al., 1981), or from March to May, mostly from September to January. The fertilization is present throughout the year except

October and November, and the later embryonal stages develop from February to September, same as in *C. montagui* (Relini 1983).

Size: Relini (1983) cites size and growth intensity and gives estimates for life span. According to this author, the basal diameter is same as in species *C. montagui*, in first year 2-2.5 mm, and in second year 5.1-6 mm. The maximal values of basal diameter are 10.2 mm, and of opercular diameter 4 mm. In order to reach these high values it takes more than 3 years. Sometimes the shell is decreasing due to abrasion. These chthamalids live more than 10 years.

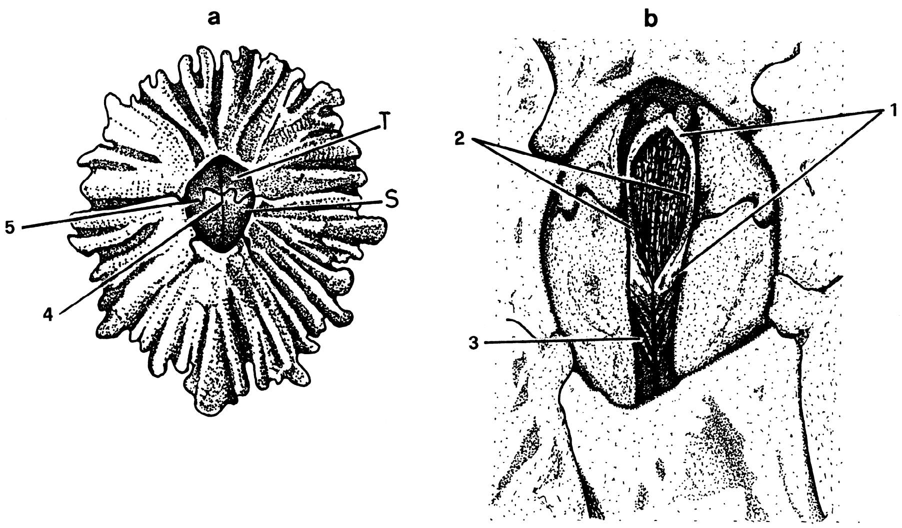

Figure 24. *Chthamalus stellatus* (Poli 1791)

a. apical view of shell; the joint between tergum is wavy or sinnous, and its whole length usually stands under angle 90° to the midline when the valves are closed.
T. tergum
S. scutum
4. roidline
5. the joint wavy
b. tergoscutal flap, blue
1. blue color
2. central orange spot at the groove and brown parches at each end
3. brown parches

according to: R. Riedl,1991 (a); A.J. Southward & D.J. Crisp, 1963 (b)

Diet: This species feeds on 69% of detritus, 10% of Calanoida, 10% of snail and seashell larvae, 3% of threadlike algae, under 1% of *Harpacticoida* and less than 1% of metatrochophores (Tabacnik 1986).

Habitat and ecology: This species settles in supralittoral and mediolittoral on the rocky ground, especially in mid supralittoral. Together with *C. montagui* it is found in cooling capacities of power plants in supralittoral (Relini 1981), and it is often dominant in the mid level in tidal zone and lower (Southward 1976). In the research of Relini (1983) on depths of 5cm, 40cm, 1m and 2m, this chthamalid settles mostly on 1 m depth and least on 40 cm. In contrast to previous species that prefers sheltered, muddy, dirty places, this species is also dominant in wave-influenced places, where the water is cleaner (Crisp et al., 1981). Sometimes this species is an epibiont on snails (*Patella* sp) or the individuals of the same species settle on each other. The species is eurivalent and especially resistant on great draughts and high temperatures, but is less tolerant of variations in salinity, although sometimes it may be found in lagoon harbour waters (Relini 1980). As it prefers the wave-influenced zones, it may also settles in parts of open sea.

Distribution: This is an Atlantic-Mediterranean species, although it is also found in Black and Red Sea. The upper border of distribution is from the British isles along the Atlantic coast of Europe and west Africa, to the south to Cape Verde Islands. The species is treated as tropical and subtropical (Crisp et al., 1981), and it penetrates in Indo-Pacific (Newman & Ross 1976).

In the Adriatic it is distributed along the whole coast. It used to be mentioned for the benthic communities, but until 1976 the species *C. montagui* was not mentioned in Mediterranean and Adriatic. As the two species are very similar, probably there was often a wrongful determination. The species *C. stellatus* is found in benthic communities on rocky ground with endolitic green algae (Cyanophyceae) in supralittoral and mediolittoral in Rijeka Bay (Zavodnik D & Zavodnik N 1978). In supralittoral and mediolittoral on Krk coast, this species was dominant in the benthos, covering up to 70%, and extremely up to 80% of rocky and stony substrate. On ten places, the abundance was on average 100-500 specimens (Zavodnik et al., 1981). In Osor Bay this species was also very abundant in open places in benthic communities of mediolittoral (Zavodnik D & Zavodnik N 1982), while in Raski Bay its cover is also enormous, 75-100% (Zavodnik D & Zavodnik N 1986). Also in Istra area, at Rabac, this species in benthic communities in supralitoral were marked as inclined species (+0.1-1.2). Toward mediolittoral the specimens used to be thickly distributed, over 500 per $1dm^2$. Such abundance was cited to be present +0.1-3.4 by Zavodnik D & Vidaković (1982) in benthic communities. Klepal (1971) also cites this species for Istra (Rovinj, Lim channel). At Kornati islands, *C. stellatus* was present in 30 out of 68 places (frequency F=44.10%) in littoral, usually up to 80 cm of depth with small abundance (Zavodnik, unpublished). In biocenoses of mid Adriatic in upper mediolittoral step this species is cited to be characteristic (Gamulin-Brida 1974).

This species is extremely rarely found in fouling communities. In many years of research at Rovinj area, it was found only twice on glass plates, on depth of 5-15 cm (Igić 1982) and 10-30 cm (Zavodnik D & Igić 1968). Frequency was 1.70%, abundance 2 specimens at average, and cover 5%, maximally 10% (Igić 1982). Also on artificial substrates in Venice lagoon in supralittoral, this species is mentioned for fouling complex together with the species *C. montagui* (Candela et al., 1983).

*****Chthamalus stellatus stellatus* (Poli) 1791**

Lepas stellatus Poli 1791: figs. 18-20, tab. 5.

Lepas depressa Poli 1791-1795: figs. 12-13, tab. 5.

Lepas punctatus Montagu1803: 8, text fig 5, tab. 1.

Chthamalus stellatus Ranzani 1818: 63, text figs. 21-24.; 1820: 24, text fig. 2, tab. 3.; (Poli), Darwin 1854: 1, text.

Chthamalus stellatus stellatus (Poli), Pilsbry 1916: 1, text; Kolosváry 1947: 1, text

Chthamalus vitreus Costa 1839: 1, text.

Chthamalus stellatus stellatus forma typica Kolosváry 1947

The shell is thick, conical, smooth or knob-like. The basal edge is cloth-like. Although the shell is conical, it may also be flattened, corroded, or ribbed, star-shaped or wavy. The radii on the rostrum are not developed. The opercular opening is wide and oval. The scutum is under 90^o angle between apical articulation sides. Tergum is large and triangular (Fig. 25 a, b).

Habitat: It lives on hard substrate in the tidal zone, but also from 0-7 m.

Distribution: It lives throughout Mediterranean and Adriatic. In Adriatic, this species was found by Kolosváry (1947) from Venice over Trieste, Rovinj, Fazane, Briones, Rijeka and Karlobag up to Kotor and in the paper from 1955, the same author mentions it also for Split, Brac, Branjac, Duin and Chioggia.

***Chthamalus stellatus stellatus* forma *depressa* Kolosváry 1947**

The shell is flattened, smooth, and thin, almost like a pergament. It is slightly corroded. Although it is mainly smooth it may be circularly furrowed.

* Kolosváry (1947) describes it under this name as a species, but in text mentions that it is also a subspecies with following characteristics: the shell is thick, conical, smooth or knob-like. The basal edge is cloth-like. It lives in tidal zones. However the same author later describes three following subspecies of this species.

The alae are wide, and the rostrum radii are lacking. The opercular opening is half-hexagonal. The top of the scutum is often completely pointed. Tergum is long with a large false spur (Fig. 26 a, b).

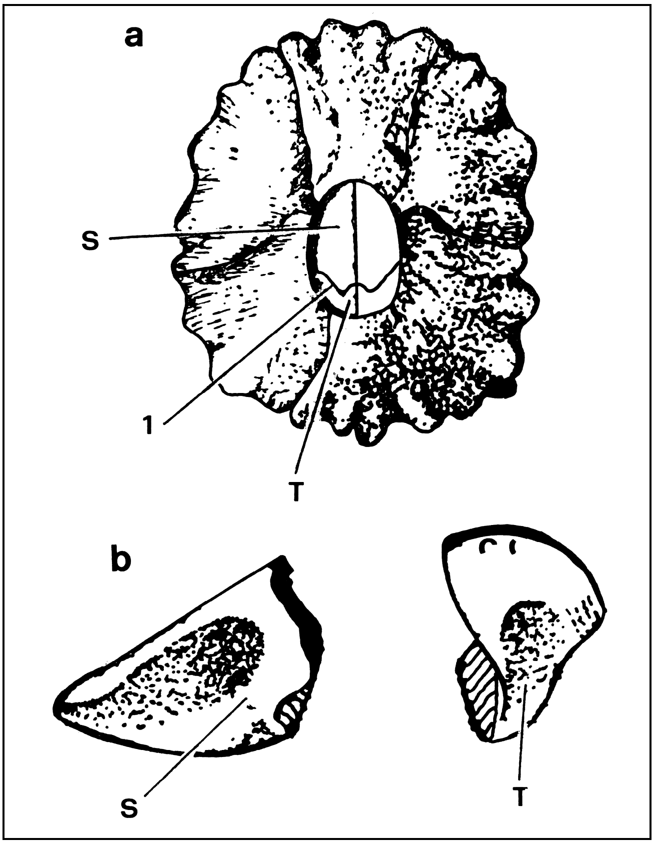

Figure 25. *Chthamalus stellatus stellataus* forma *typica*, Kolosváry, 1947

a. apical view of shell; shell conic or flatten, wavy or ribbed
1. joint between scutum and tergum is under angle 90°

b. internal view of opercular valves
S. scutum
T. tergum, triangular, broad

according to: G. Kolosváry, 1947

Color: Shell is greenish-yellow.

Habitat: It is mostly attached on the lower sides of the rocks in the tidal zone.

Distribution: It lives in western Mediterranean, about Gibraltar, Naples, Sicily and whole Adriatic. Kolosváry (1947-1955) found this form about Trieste, Vrsar, Rovinj and Briones.

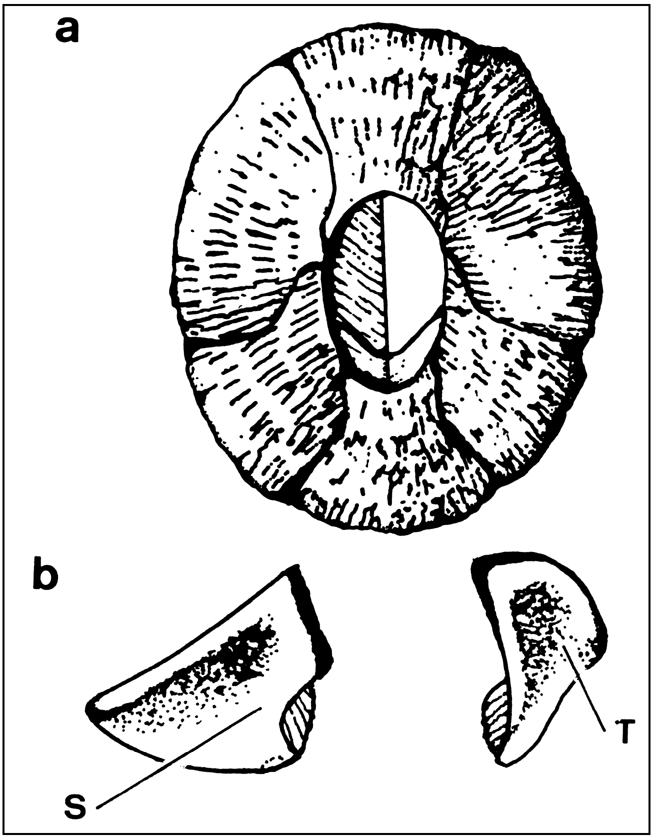

Figure 26. *Chthamalus stellatus stellatus* forma *depressa*, Kolosváry, 1947

a. apical view of shell, shell strong flatten, thin, mostly smooth

b. internal view of opercular valves
S. scutum
T. tergum

according to: G. Kolosváry, 1947

Chthamalus stellatus stellatus forma *cirrata* Kolosváry 1947

The shell is mostly flattened, exceptionally conical, large and very wide. The opercular opening is much larger and wider than in previous two forms. Scuta and terga are similar to those of *depressa* form (Fig. 27a, b).

Color: The shell is gray like ash, with one white stripe as the hem on base habitus.

Habitat: It lives in topmost parts of surf zone, mostly on smooth rocks and in their crevices.

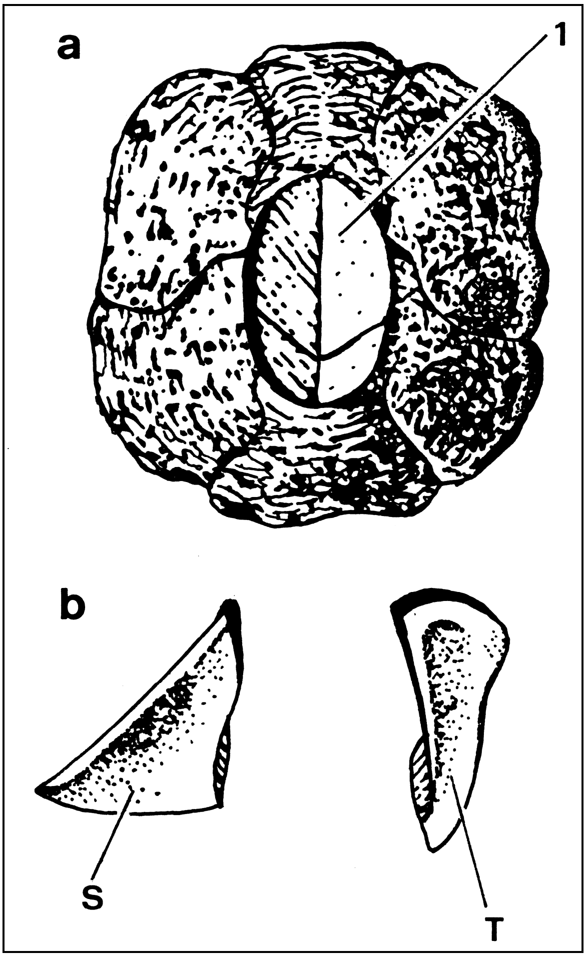

Figure 27. *Chthamalus stellatus stellatus*; forma *cirrata*, Kolosváry, 1947

a. apical view of shell, shell flatten, broad
1. oriffice large , broad

B internal view of opercular valves
S. scutum
T. tergum, S.T. like to forma *depressa*

according to: G. Kolosváry, 1947

Distribution: In Adriatic Kolosváry (1955) cites this form for Trieste, Rovinj, Split and Hvar.

Considering the described forms, Kolosváry (1947) considers the subspecies *Chtamalus stellatus stellatus* to be very dynamic and in process of developing new species. Besides, the same author had considered this species to be Adriatic endemic on localities of Trieste, Rovinj, Split and Hvar (1942a, 1947), but later contradicts this opinion, as he found the same subspecies in material from other world seas (1951).

Besides this subspecies, Kolosváry (1939b) discuss some other chthamalids that according to him and Pilsbry (1916) are subspecies (*Chthamalus stellatus depressus*, *Ch. st. fragilis*, *Ch. st. angustitergum*, *Ch. st. bisinuatus*), and some of these (*fragilis* and *depressus*) as well as *Chthamalus stellatus communis* are according to Darwin (1854) varieties. However Kolosváry (1939b) considers *C. stellatus* f. *punctatus* to be species *C. montagui*.

***Euraphia depressa* (Poli) 1791**

Chthamalus depressus (Poli) 1791

Lepas depressa (Poli) 1791

Darwin (1854) has described several varieties of *Chthamalus stellatus*. One of these was *C. stellatus* var. *depressus*. Southward (1964) has reduced the variety stage and set up the new species *Chthamalus depressus* (Fig. 28). This is the dominant name in the literature, although Newman & Ross (1976) have placed it into genus *Euraphia*, so there is another name *Euraphia depressa* (Southward 1976; Crisp et al., 1981; Relini 1981, 1983). However, there are numerous discussions on difference between this species and *C. stellatus*, the way of life in surf zones and sheltered places, and some morphological and anatomical differences. Therefore this species was described as two varieties a and b (Fig. 29, 31) by Kensler et al., (1965). The variety from the surf zone was described as variety a, and the sheltered form as variety b (the hypobiotical variety). However, Utinomi (1959, a) has also described a different form from shaded, sheltered places of low water level, that he marked as form of *C. stellatus* modified from hypobiotical habitus, corresponding *C. stellatus* var. *depressus* described by Darwin (1854). In order to point out the difference between species *C. stellatus* and *C. depressus*, Kensler et al., (1965) takes characteristics of variety b of *C. depressus* as a hypobiotic form. According to same authors difference between species are following:

The species *C. depressus* is slightly flattened with less eroded shell (due to sheltered habitat). Terga are more elongated with smaller articular ridge and similar furrow. Scuta have a low basitergal angle and relatively more elongated surrounding edge, much shallower hole for adductor muscle and much smaller articular furrow. Especially important is the presence of shell thickening at the base of alae. The mouth parts of a hypobiotical variety of *C. depressus* are different from the corresponding parts of *C. stellatus*. The mandible in hypobiotic variety b of *C. depressus* has three large teeth and a relatively shorter but more pectinate lower angle. In *C. stellatus* there are on average 4 teeth and a relatively longer lower corner, strewn with many little spines. The hypobiotic form is often larger and more flattened than the typical form of *C. stellatus*.

The mentioned authors completely agree that the hypobiotic form of *C. depressus* is identical to Darwin's (1854) form *C. stellatus* var. *depressus*. The description of this variety b and the variety a according to Kensler et al., (1965) is the following:

C. depressus **var. a from the splash zone**

This is the species *Euraphia depressa* or *Chthamalus depressus*. It is a chthamalid from surf zone, with an eroded valve surface (Fig. 29a). The shell is very low and flattened. The plates are not coalesced. When the opercular plates are moved, the opening is large and rhomboidal, or hexagonal (Fig. 28b). The connection between scuta and terga is under the angle of 50-75^0 to a middle line when the plates are closed. The base is membranous (Fig. 19a). Scutum has a low basitergal angle, the hole for adductor muscle is shallow, and the articular base of scuta is poorly developed, while tergum is elongated (Fig. 29 b, c). The carriers for shell support at the angles are better defined than in variety b (Fig. 30), while the alae are well developed.

Color: Shell plates are light brown or gray. The tergoscutal flap is dark brown or light brown, without any spots or flecks (Fig. 28b).

Size: This species for example in Ligurian sea in first year reaches the growth of 2-6 mm of base diameter, while after the third year the maximum growth of base diameter (13.2 mm) and opercular diameter (6 mm) is reached (Relini 1983). In extreme conditions the species can reach base diameter of 15-20 mm, and shell height of 2 or 3 mm.

Reproduction: The fertilized eggs and late embryonal stages are found from June to September. The settlement is from March to May, usually from September to January (Ligurian sea) (Relini 1983).

Habitat and ecology: The important difference between this variety and variety b is in habitat. This variety lives in the surf zone, so it common in supralittoral and much more detached from the sea than other chthamalids species. The variety b settles in hollow, secluded places. In experiments done by Relini (1983) on four depths (5 cm, 40 cm, 1 m and 2 m) the species *C. depressus* or *Euraphia depressa* settles in February and March mostly on 1 m of depth, and almost the same on 40 cm and 2 m. On 5 cm it didn't settle at all in march, while a single specimen was registered in February. As the author did not cite any varieties, it is not certain which chthamalid was observed, but it is assumed that those were both varieties, considering depths, present in approximately same density. Kensler et al., (1965) cites that these are both varieties, considering the various habitats. The influx of enough food particles is small and the common rapid growth of these varieties was not possible. However, the same authors and associates cite that *C. depressus* is adapted to more intensive fasting and immobility, so it can survive such mishaps. This species is also adapted to a higher temperature regime, so the upper average lethal value is 54^0C, and for species *C. stellatus* 52.5^0C. For the reproduction of *C. depressus* the needed temperature level is approximately $14\text{-}32^0$C (Patel & Crisp 1960). The species *C. depressus* tolerates estuarine waters less than *C. stellatus* (Relini 1980).

Distribution: Kensler et al., (1965) are the only one who strictly gives the distribution for both varieties. The variety a is dominant in Mediterranean, but stretches across the Straits of Gibraltar to Cabo Trafalgar on European side and Benzori on African. This species was never found in fouling communities. However, it can be found in benthic communities of Adriatic, but less often than *C. stellatus*, and almost always in lower zones and with smaller densities than *C. stellatus*. In the northern Adriatic (Osor area), this species is one of the most characteristic organisms in supralittoral zone, and lower down there is another species, *C. stellatus*, present (Zavodnik D& Zavodnik N 1980). Also in benthic communities of Rijeka Bay, this species is found in the mediolittoral (Zavodnik D & Zavodnik N 1978). On the coast of Krk this species is more abundant in benthos of mediolittoral, although it lags quantitavely behind the species *C. stellatus* (Zavodnik et al., 1981). On the eastern coast of Istra (Rabac), in benthos community this chthamalid is in similar quantitative status as on the previously mentioned locality, on the depth 0-180 cm, with analytical marks of +0.1-1.2 (Zavodnik D & Vidaković 1982). In mid Adriatic this species is commonly present in biocenoses of rocks of lower mediolittoral, while the species C. stellatus has the same status in upper mediolittoral (Gamulin-Brida, 1974). Around Kornati Islands, the distribution of this chthamalid is until 120 cm, and its presence is rare (Zavodnik D, unpublished).

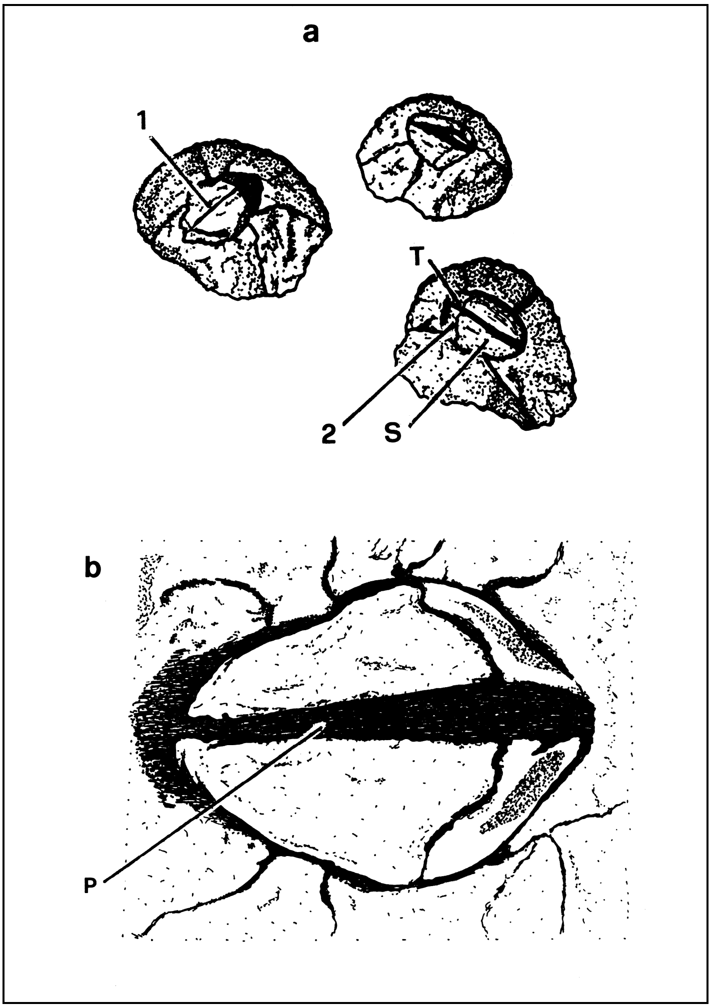

Figure 28. *Chthamalus depressus* (Poli 1791)

apical view of shell
1. midline
2. joint between terga and scuta forming an angle of 50°-75° with midline when valves are closed

T. tergum
S. scutum
b. tergoscutal flap, flat, dull-brown or chocolate colour, devai of pattern
P. flap

according to: R. Riedl, 1991(a), A.J. Southward and D.J. Crisp, 1963 (b)

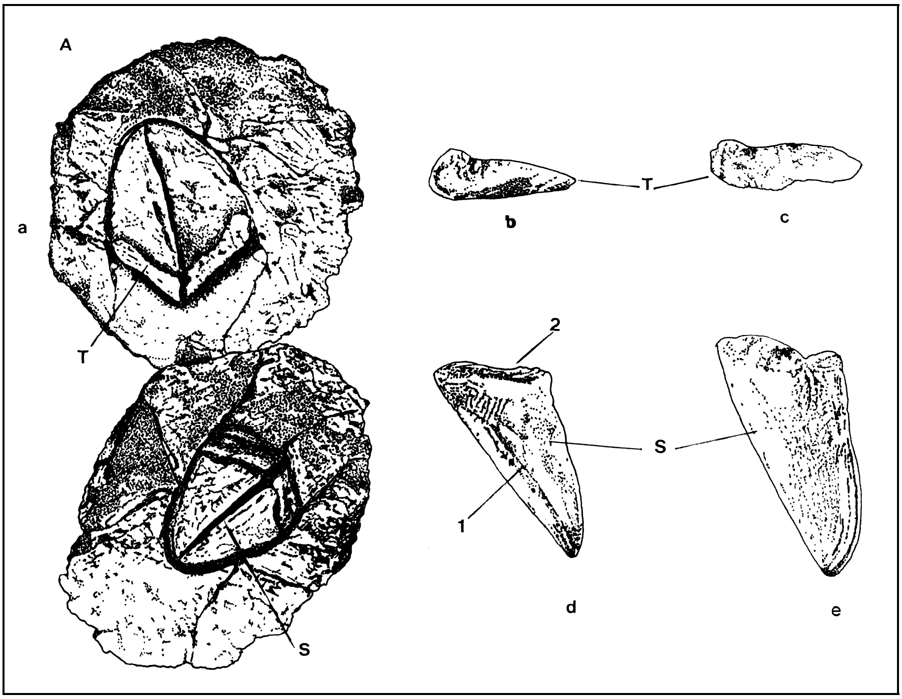

Figure 29. *Euraphia depressa* (*C. depressus*)

A. variety - from the splash zone
a. apical view of shell
b. internal view of tergum
c. external view of tergum
d. internal view of scutum
e. external view of scutum

T, S, opercular valves -eroded surface of valves
T. elongate tergum
S. scutum
1. weak articular furrow of scutum
2. shallow adductor pit

according to: C. B. Kensler, K. M. Bratnagar, D. J. Crisp, 1965

C. depressus var b, hypobiotic from the crevices

As it was already told, this is actually a form of *C. stellatus* var. *depressus*, which is determined by Darwin (1854), and the variety rank reduced by Southward (1964). This variety differs greatly from the variety a, due to habitat in lower (hypobiotic) coast level (Kensler et al., 1965). As this variety lives in the lower tidal zone, in sheltered spots like crevices and hollows, it differs from variety a from upper supralittoral in following: the shell is less calcified, less abraded, thin, little flattened. The line between scuta and terga is straight. Terga are elongated as in variety a (Fig. 31 b, c), while scuta have large ridges (Fig. 31e). The alae are well built, the carrier pillars of the shell are less precisely arranged than in variety a (Fig. 30). The other characteristics are already defined when comparing with the species *C. stellatus*. Kensler et al., (1965) who were the only ones describing this variety, cite that in greater depths there are specimens with intermediate characteristics similar to *C. stellatus*, so they suggest that the most important determination criteria are scuta, terga and mouth parts. The other characteristics, such as color, size and reproduction, are very similar to those of variety a.

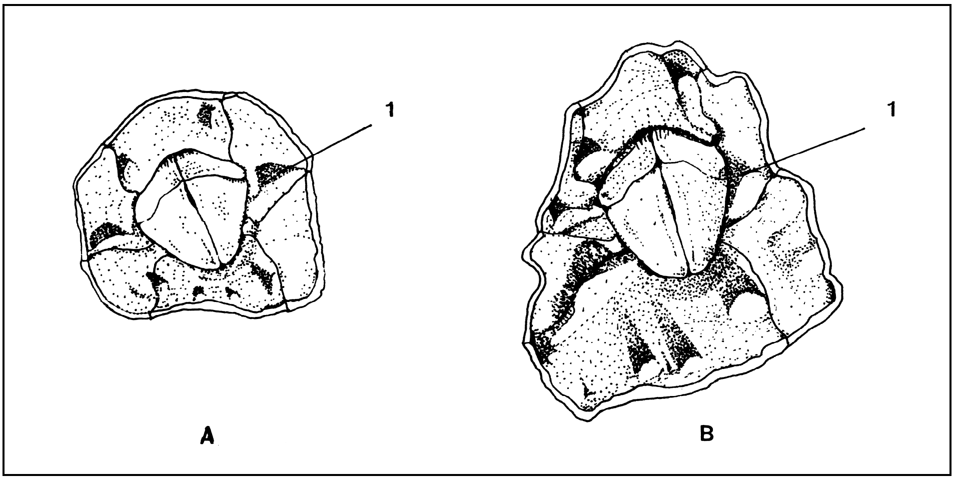

Figure 30. Drawings from photographs taken with oblique illumination, of the underside of intact cleaned specimens note of pillar for support of shell at angles

A. variety from splash zone
1. well developed descending pillar

B. hypobiotic variety from crevices
1. pillar similar variety A, but more irregular structure

according to: G. B. Kensler, K. M. Bratnagar, D. J. Crisp, 1965

Distribution: It is similar as in variety a, but the spreading to west is smaller. It does not reach Straits of Gibraltar and northwestern Morocco coast. When it is present in same localities as variety a, it is less abundant. Crisp et al., (1981) have described chthamalids from the tidal zone, and the description of species *Euraphia depressa* could fit the variety b, that is, hypobiotic form. According to these authors, this species lives only in Mediterranean and its distribution is much smaller than that of other two chthamalid species from Mediterranean. The same species is found in Black Sea and Suez Channel (Achituv & Safriel, 1980). However, this species is found neither in Red Sea or Indian Ocean, although there are present other species from the same genus, but it is found from Tarife to Cape Trafalgar on Atlantic coast of Spain. The first authors that have placed species *C. depressus* into the other genus *Euraphia depressa* (Newman & Ross 1976) also have described presence of this species in Mediterranean from Gibraltar to Israel, in Black Sea. In Adriatic this species lives together with variety a, whose distribution is mentioned by Riedl (1963, 1970), Relini (1980, a) and our researchers of benthic communities.

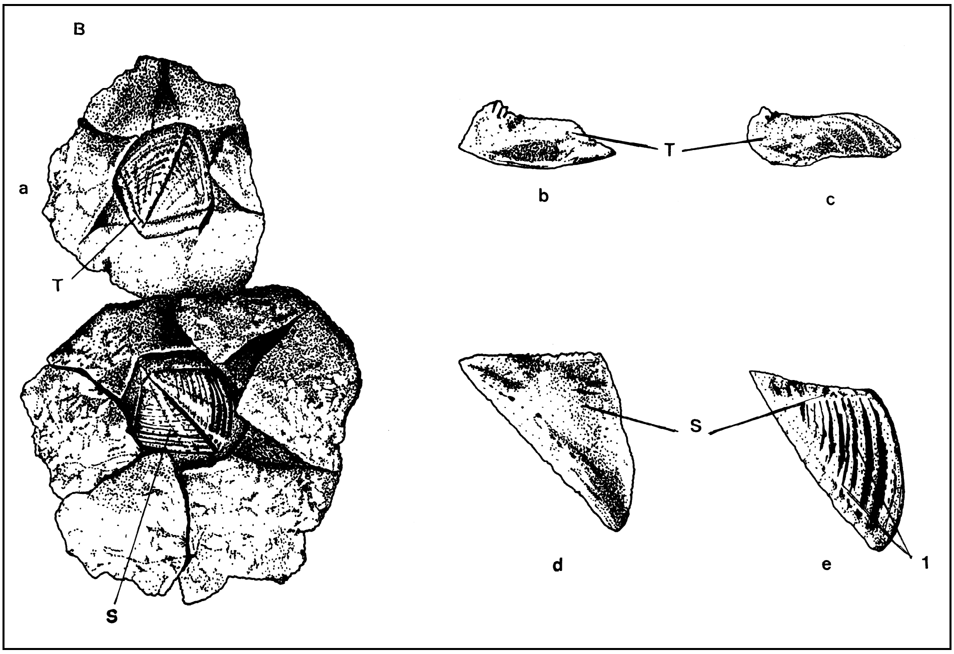

Figure 31. *Euraphia depressa (C. depressus)*

B. hypobiotic variety from crevices
a. apical view of shell
T,S, opercular valves; strong resemblance to valves of variety A, except for the marked growth ridges on scuta
b. internal view of tergum
c. external view of tergum
d. internal view of scutum
e. external view of scutum
T. tergum
S. scutum
1. ridges on outlier surface of scutum

according to: G. B. Kensler, K. M. Bratnagar, D. J. Crisp, 1965

Superfamily *Coronuloidea* Leach 1817 (nom. Trans. Newman & Ross 1976)

Family *Coronulidae* Leach 1825

The shell is composed of 8 plates (rostrum has three parts) or 6 plates with medial outer lengthwise furrows, and they may lack the furrow. The shell plates are tubular, that is, there are tubes between the outer and the inner wall. The tubes support only the inner wall, although they may be placed also between the outer ribs. Radii are stiff. The base is membranous. The opercular plates, when present, are reduced, lack joints and do not close the opening.

Subfamily *Coronulinae* Leach 1817

The shell wall is composed of 6 plates, including the rostral plate without fissures, 2 lateral, 2 carino-lateral and 1 carina. The wall plates are either stiff or porous and form the shell. The outer lamina of the wall is curved toward the host's epidermal tissue. There is also an inner parietal lamina. The opercular plates, when present, lack joints and do not close the opening. The base is membranous. All species are epizootics on sea vertebrates, attached on the surface of the body.

Genus *Chelonibia* Leach 1817

The shell wall is composed of 6 plates, very thick and stiff, while the inner side of rostrum has three rudimentary parts connected together. Along the wall there are longitudinal hollows with many pillars. Sometimes these hollows are filled with solid material almost to the base, while the base is membranous. The opercular parts are narrow and surrounded with wide membrane, as the opening is larger then the opercular apparatus. The scuta are narrow and connected with terga by a joint with ligament of hardened epitel. The first two pairs of cirrus legs are shorter and thicker than the remaining 4 pairs, and the latter are somewhat longer due to bigger number of segments or the size of the animal.

Ecology: They mostly live as epibionts, especially on sea turtles. In our area the most common is *Chelonibia testudinaria*, and the rare species is *Ch. patula*. Relini (1980) cites also the species *Chelonibia caretta*, which is very similar to *Ch. testudinaria*, also lives on turtles and is sometimes confused with that species. According to the same author, *Ch. caretta* does not live in Adriatic but in other Italian seas. In *Ch. caretta* radii are poorly developed, the hollow between pillars is filled with solid material almost to the base, while the shell is massive and heavy. In *Ch. testudinaria*, radii are mostly well developed, while radii and wings are toothed.

The hollows between the parts of the shell are very deep. The operculum covers only a small part of the opening. Rostrum is composed of 3 rudimentary parts.

***Chelonibia testudinaria* (Linnaeus) 1758**

Verruca testudinaria Gualtierius 1752; Ellis 1758: 845, text fig. 12, tab. 34.; 1758: 845, text figs. 12-13.; (?) Schroeter 1784: 1, text

Lepas testudinaria Poli 1791: figs. 8-11, tab. 5.; Linnaeus 1758: 1, text

Balanus polythalamicus Bock 1778: 1, text fig. 9a, b, tab. 4.

Coronula testudinaria Linnaeus, Lamarck 1818, 375, text; Ranzani 1820: 13, text; De Blainwille 1824: 1, text fig. 2, tab. 117.; (?) Leach 1824: 1, text; Linnaeus, Lamarck 1825: 1, text fig. 2., tab. 2.; Philippi 1853: 421, text.

Astrolepas rotundarius Gray 1825: 97, text

In juvenile individuals, the shell is composed of 8, and in adults of 6 plates. The shell has well developed radii, whose surface is smooth, but the upper part of the shell is almost always corroded, so plates are furrowed. The rostrum is coalesced with rostrolateral plates. The operculum plates are elongated, jointed (2 joints) and connected with a strong opercular membrane. Radii with an oral opening form a six-sided star, with toothed edges. This systematic character is very important and is enough to positively identify the species. Sometimes the teeth are lacking and radii are very narrow, and then walls on the basal side should be considered. On the inner side of walls there are ridges separated with deep burrows. Radii and alae are toothed. Scuta and terga (Fig. 32b) are somewhat shorter than in other species, while terga are very variable in shape. The shell is conical and inserted. The opening is oval with a major axis in size of 1/3 of basal diameter of rostro-carina (Fig. 32a). The base is oval or rounded. First and second pair of cirrus legs has almost equal length of rami, medium large and thickly set with stiff hairs. Third pair of cirrus legs is longer than the first and the second, but shorter than fourth, fifth and sixth pair, set with rough hairs (setae). Fourth, fifth and sixth pair of cirrus legs have long segments and carry 2 pairs of long spines on the front edges. The maxilla lacks the notch, but has two large spines on the upper corner and a row of shorter spines under a right angle. The mandible has 5 teeth. The lower edge is cut short and comb like (pectinate). The labrum is double notched and polydont. Penis is longer than the sixth pair of cirrus legs, usually ringed and pointed at the top.

Color: the shell plates are white or ivory colored.

Size: the carino-rostral diameter is usually 50 mm, and height up to 18 mm, and extremely it can reach the length of 78.0 mm and 21.0 mm of height (Jones 1990).

Reproduction: Nauplius larvae are found in Adriatic (at Split and Rovinj) in plankton in March and April, and cypris larvae in May and June. The larvae 1 mm long can settle on the substrate and were found in July (Kolosváry 1947).

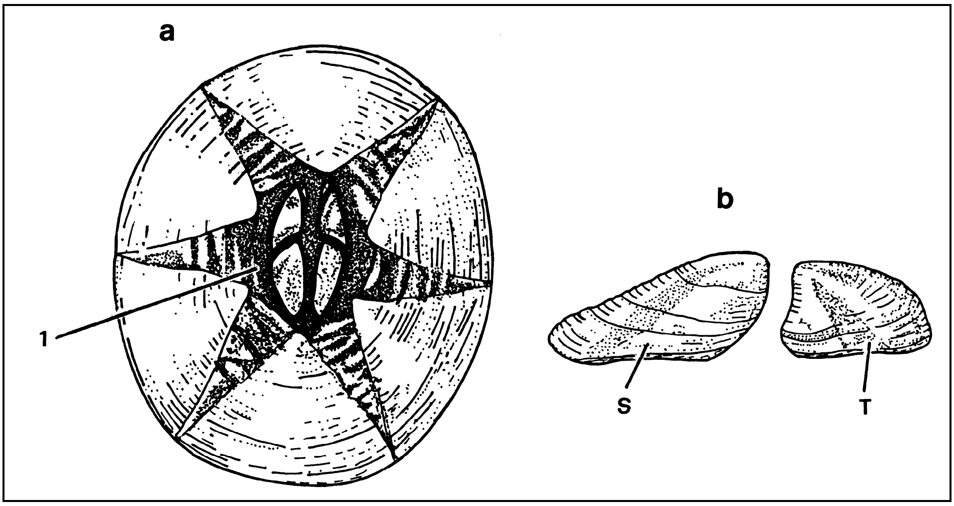

Figure 32. *Chelonibia testudinaria* (Linnaeus) 1758

a. radii with oval; the orifice form the star with six-legs; radial relief (important taxonomic character)

1. radial relief

b. opercular valves, thickset and smaller from orifice of the shell

T. tergum

S. scutum

according to: R. Riedl, 1991

Habitat: It lives on the plastron and carapace of sea turtles, extremely on floating objects. The specimens are not covered with host’s tissue and fall off when it is molting, approximately once a year (Monroe 1981). The structure and the form of the shell are specially designed to help adhesion and reduce turbulence (Monroe 1981). When turtles are put into the aquarium, *Chelonibia testudinaria* can live up to 8 months (Relini 1980a).

Diet: The digestive tract contained: detritus 59-99%, *Calanoida* 15%, snail larvae 15%, *Ostracoda* 1-5%, algae 5%, *Radiolaria* 1% (Tabačnik 1986).

Distribution: It lives in all temperate and warm seas. In the Adriatic it was found at Venice, Trieste, Rovinj, Rijeka, Hvar, Orebic (Kolosváry 1947) and in Zadar archipelago (Brusina 1907).

Chelonibia patula **(Ranzani) 1818**

Coronula patula Ranzani 1818: 63, text; Lamarck 1818: 1, text; Southward & Crisp 1963: 1, text

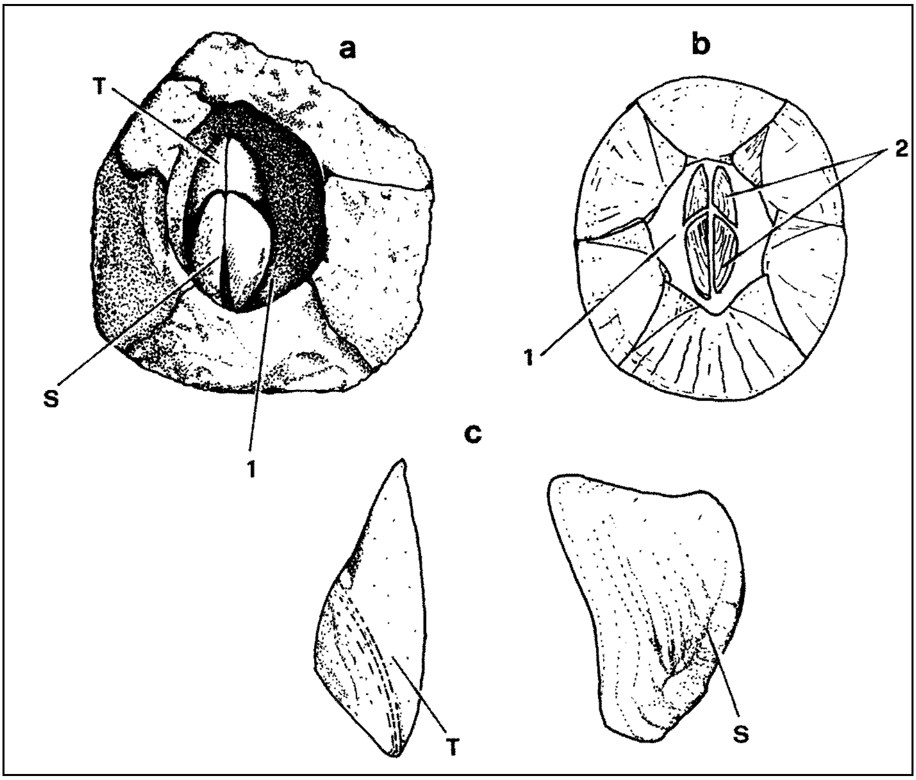

Figure 33. *Chelonibia patula* (Ranzani) 1818

a. shell oval, flattened, the plates smooth, very thick
b. sketch - apical view of shell
1. opening large, hexagonal
2. two small elongate pairs of valves
c. outer surface of opercular valves
T. tergum
S. scutum

according to: G. Relini, 1980a (a,c); A.J. Southward & D.J. Crisp, 1963 (b)

The shell is oval or cylindrically-conical, flattened. The plates are smooth, very thick, with slightly curved tops (Fig. 33a). Radii are wide and smooth with oblique, inclined ends. The thickness of the plates is more pronounced than in other species. That is best seen from inner side, where the hollow is visible, containing the animal's body. The hollow is longer than half of diameter of complete shell base. On the inner side of the shell, the lamina of the plate that resembles a thin membrane, forms an oval, hexagonal or polygonal formation that is larger than half of diameter of complete shell base. On the opercular membrane the plates are placed close, and more elongated than in other species (Fig. 33b). Tergum has a rudimentary beak and is coalesced with the furrows. Across the scuta there is no separated line of growth, and that is the main difference between the opercular plates. The tergoscutal flap is transparent, without pigments (Fig. 33c).

Color: Very similar to the previous species *Ch. testudinaria*.

Size: It reaches 20-25 mm in base diameter.

Reproduction: In the temperate zones during summer, and in subtropical and tropical throughout the year.

Habitat: It settles on crustacea shells, rarely on snails, buoys, floating objects (plastic bottles, chests etc) and especially ships.

Distribution: Mediterranean, tropical and subtropical Atlantic toward the western Indo-Pacific. Relini (1980a) cites that this species was found in all Italian seas, including Adriatic, but cites that it was not found as constant settler in Tyrrenian Sea. However, it is assumed that this species is rare in the Adriatic, as Relini (1969) does not cite it for Adriatic, but only to Ionian sea and other zones of Mediterranean.

Subfamily *Platylepadinae* Newman & Ross 1976

Genus *Stomatolepas* Pilsbry 1910

Stomatolepas elegans (Costa) 1838

The shell is shaped like topless cone, and its base diameter is double the diameter of oral region (Fig. 34a). The outer side of the shell is covered with many plates in a triangular zone, whose base covers the shell base. Every part of shell has a slightly defined stripe on the outer side in the middle zone. The base is leveled and membranous. The basal part when detached from the substrate is shown on figure 34b. The mandible is composed of 6 teeth, 4 of which are well developed, and the fifth and the sixth are different from the others, as they bear two small appendages on the distal part (Fig. 34c). Labrum has a central wide notch (furrow), as well as a tuft of very fine hairs. The opercular plates are thin, smooth and detached from each other, and they cover less than a half of opercular plate.

Color: The outer side of the shell is dirty white, while the opercular plates are white.

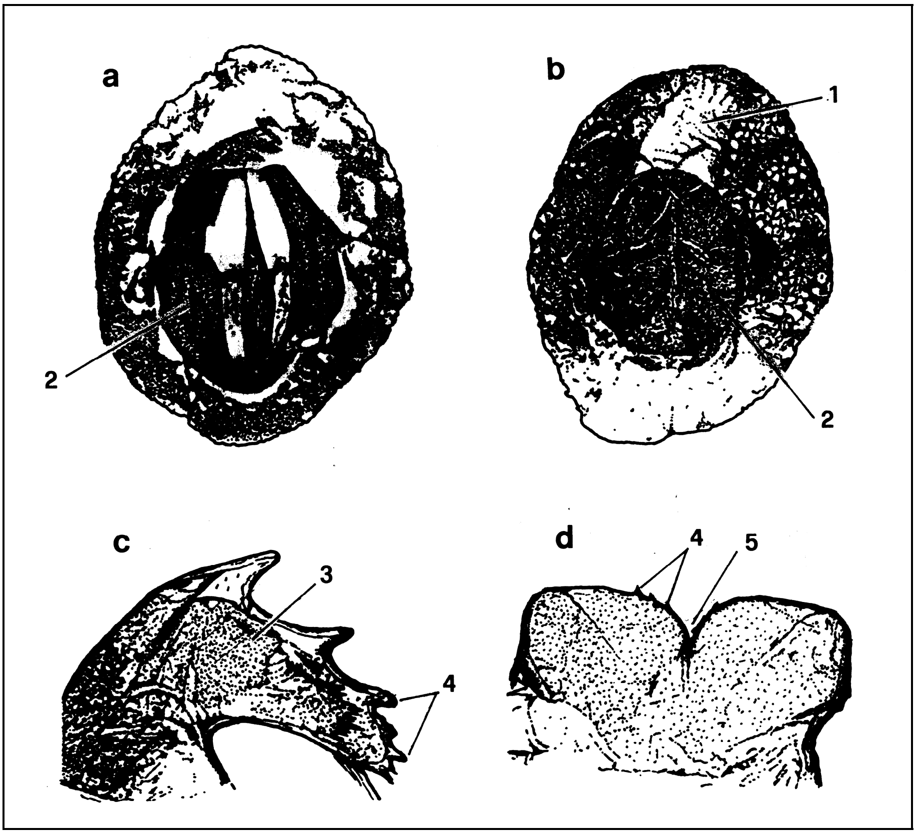

Figure 34. *Stomatolepas elegans* (Costa) 1838

a. the shape of shell is truncated conic of a cup
2. opercular part valves cover smaller from half opercular orifice
b.
l. basal part of the shell
c. mandible
3. distal part
4. teeth
d. labrum
5. central fissure (notch)

according to: G. Relini, 1968 (c,d), 1980b (a,b)

Size: The minimal length of rostro-carinal part is 4-5 mm, the width is 3.5 mm and height 2.8 mm, while the maximal length is 11.1 mm, width 8 mm and height 4.4 mm (Relini 1968).

Habitat: This species most often settles as an epibiont on marine turtles, such as *Caretta caretta* and *Caretta olivacea*.

Distribution: This is a cosmopolitan species, usually characteristic for subtropical and tropical seas. It seems that the final border of distribution is Nova Scotia, as this species was found together with *Chelonibia*, so it is assumed that this is a final border not only for *Stomatolepas* but also for Platylepadinae (Zullo & Bleakney 1966). *S. elegans* was also cited for Antilles, Malay Archipelago, west Africa, Mediterranean (Stubbings 1965) and Adriatic (Relini 1969, 1980a).

***Platylepas hexastylos* (Fabricius 1798)**

Platylepas pulchra Gray 1825: 97, text

Platylepas bisexlobata Darwin 1854: 1, text; Pilsbry 1916: 1, text.

The shell is flattened, oval or circular, with six plates that are bi-lobed (forked), and on the outer side horizontally divided into parts, as equally spaced concentric edges parallel with the base (Fig. 35).

Color: ivory color predominates.

Size: The shell length is 7.5-18.5 mm, width 6.9-13.0 mm, and height 1.8-4.8 mm, extremely in the half-circular specimens the diameter of 14.6 mm and height of 2.0 mm (D: H=7.3) is noted (Zavodnik 1997).

Habitat: It lives as an epizootic on sea turtles, on the soft parts such as skin of the neck, fins, and tail (Newman & Ross 1976). It is mostly associated with *Stomatolepas elegans* (Relini 1980a), while Zavodnik (1997) found this species only on the carapace of the turtle.

Distribution: In the North Sea (Netherlands) on the turtle *C. caretta* (Holthuis 1952), and also as an epizootic on turtles in West Mediterranean (Pilsbry 1916, Utinomi 1959). In the Adriatic, Relini (1980a) cites the shell of this species on the plastic buoy in the area of River Po. However, Zavodnik (1997) has found this species twice, in 1993 and 1996, near Rovinj, together with cirripede *Chelonibia testudinaria*. The population *Ch. testudinaria* was absolutely predominating over *Platylepas*: 160:11 and 49:2. Therefore it is assumed that this cirripede is very rare in Adriatic Sea (Fig. 35).

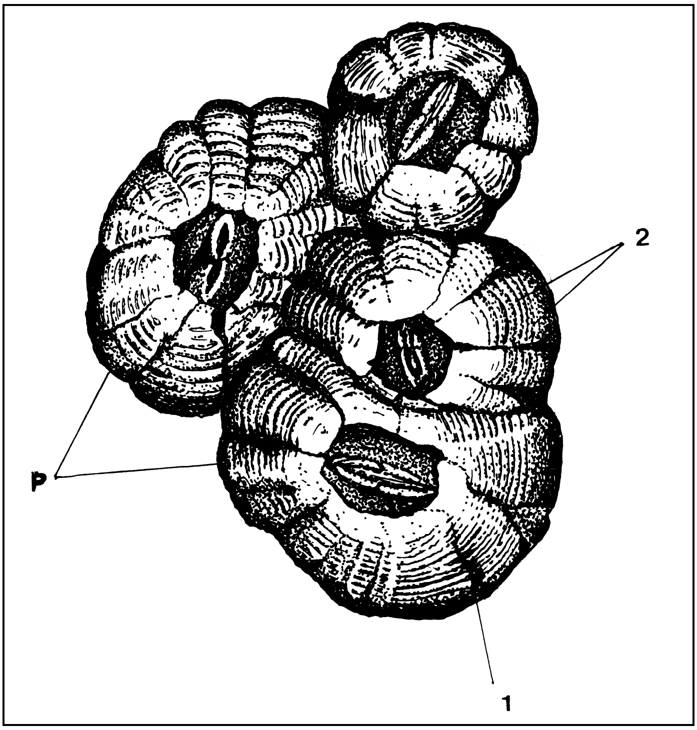

Figure 35. *Platylepas hexastylos* (Fabricius, 1798); apical view of shell

P. shell plates with outher surface
1. bilobated (vertical cleft) plates
2. shell horizontally divided on uniform concentric edges parallel with basis.

according to: P. H. M. Huwae, 1985.

Family *Archaeobalanidae* Newman & Ross 1976

The shell is composed from 6 or 4 plates that are thick and sometimes tubular. If they are tubular, they may be precisely arranged or in disorder. The tubular plates develop between the inner and the outer lamina, and when they are linearly arranged, the interlaminar ridges are simple and straight. The radii are stiff, and the labrum is thin with well-developed middle furrow. The base is mostly calcified but may be tubular.

Subfamily *Archaeobalaninae* Newman & Ross 1976

The shell wall is composed of 6 or 4 plates that may be tubular, and then they are arranged in a simple line. The base is membranous or calcified. When it is membranous, one wall of the shell is thick.

Genus *Acasta* Leach 1817

The shell is composed of 6 plates, without tubes. The plates are thin and slightly attached at the base. They are so arranged that on the basal edge they form a round or slightly oval ring. This cirripede is round or acorn-like. The basal form is round or oval and is not formed in the carino-rostral axis. All the wall plates of the shell, except carina, have radii. The calcified base is flattened or convex. The cover and the mouth parts are similar as in the genus *Balanus*. The fourth pair of cirrus legs has strong short spines, upright or curved teeth. The species of this genus have a relatively various diet. Detritus predominates with 64-84%, followed by sand 5-30% and spicula 3-5%. Foraminifera, *Diatomeae*, *Infusoria* and eggs of pelagic mollusks constitute less than 1%. Rarely there are *Radiolaria*, fewer than 1%, and crustaceans can reach 3% (Tabačnik 1986). Specimens of this genus live inside sponges and cephalopods.

Acasta spongites (Poli) 1791

Lepas spongites Poli 1791: figs. 3-6, tab. 6.

Lepas spongiosa Wood 1815: 1, text

Balanus spongeosus Montagu 1808: 81, text

Balanus montagui Brown 1844: 1, text figs. 24-26, tab. 53

Acasta montagui Leach, in Lamarck 1824: 1, text, tab. 57; Gray 1825: 97, text

The carino-lateral plates cover about 1/6 of width of parietal shell plates (Fig. 36a). The inner surface of the plates is usually slightly furrowed. Scuta have an articular angle that is broken at the lower side. Terga have a broken appendage that is long about 1/3 of valve width. The edge of terga is slightly toothed, and it is hollowed with tiny holes (Fig. 36b). The shape of the shell is usually peg-like, and the opening is mostly large and deeply furrowed due to large curve of tops of radii and alae. The upper part of the shell is composed of 6 wall plates that are slightly furrowed inside. The ribs may stretch toward the membrane of the shell, or the inner membrane of the shell can rarely be smooth. On the outer side shell plates have pronounced calcareous ridges. Radii are narrow, that is, they are never as wide as plates. Their upper surface is furrowed with wavy lines, which are almost parallel at the base. Scuta have lengthwise placed hairs, and in variable forms is smooth. The valve as a whole is flattened, thin and elongated with a poorly developed adductor ridge (the short joint pointed out, downwards). Terga are triangular, sometimes small as compared with scuta. The beak is poorly developed, while the spur on lower side is cut short but curved especially on the carinal side. Its length is more than 1/3 of valve width. On the terga, the inner ridge for the depressor muscle is poorly developed. The joint ridge is high, while the inner adductor and joint ridge are turned out. The base is slightly deep, conical and resembling an acorn cap. Sometimes it is so deep that it resembles the horn, and often it is perforated with small irregularly round holes. The first pair of cirrus legs has on the upper part a segment longer than the last. The second pair of cirrus legs is much smaller with longer third and fourth segment than second, while the top segments are blunt. The third pair of cirrus legs is about 1/3 longer than the second pair. The fourth pair of cirrus legs is different than the rest, as there are hairs on the segments. On the upper parts of segments the hairs are grouped in tufts, while on the other parts they are strewn around irregularly, and the space between these tiny spines and tufts is larger than in the fifth and the sixth pair of legs. In the sixth pair of cirrus legs there are 4 pairs of hairs on every segment. There are spines on every cirrus. They are short, but very pointed at the tops. Maxilla is without notch. Two large spines are at the upper corner, with 10 smaller spines on the blade under one large and one small spine. The mandible has 4 major teeth. The lower angle is curved and resembles a tooth. Labrum has 1-2 teeth on each side of the deep middle cleft. The penis is long, ringed, with large hairs, while the basidorsal spot is absent.

Color: In the lower part, the shell is yellow, whitish or pinkish.

Size: the average diameter of the base is 8 mm, although specimens up to 3 inches (7.62 cm) were recorded in British waters (Darwin 1854). The depth of lower part is about 2/3 of the height of upper part. The carinorostral diameter is 8.3 mm, and the total height of the specimen is 11.0 mm.

Reproduction: In Adriatic (at Rovinj and Split) the nauplius larvae were found in February, March, August and September, and the cypris stage in April, May, October and December. The larvae 1 mm long can fix to the substrate in June (Kolosváry 1947).

Habitat: This species lives as an epibiont or endobiont on sponges with horny skeleton. While the specimens grow, they are getting more incorporated into the body of the sponge, and dead specimens can be found totally overgrown with the host. Usually it lives in large species *Demospongia*, such as *Ircina variabilis*, and in species of genera *Cacospongia* and *Spongia* (Pax 1937).

Distribution: On British islands (southern coast of England and southern Wales), France, Portugal, Mediterranean, Red Sea, south Africa, Australia, Japan. In our area it is mentioned for the first time near Zadar (Brusina 1907).

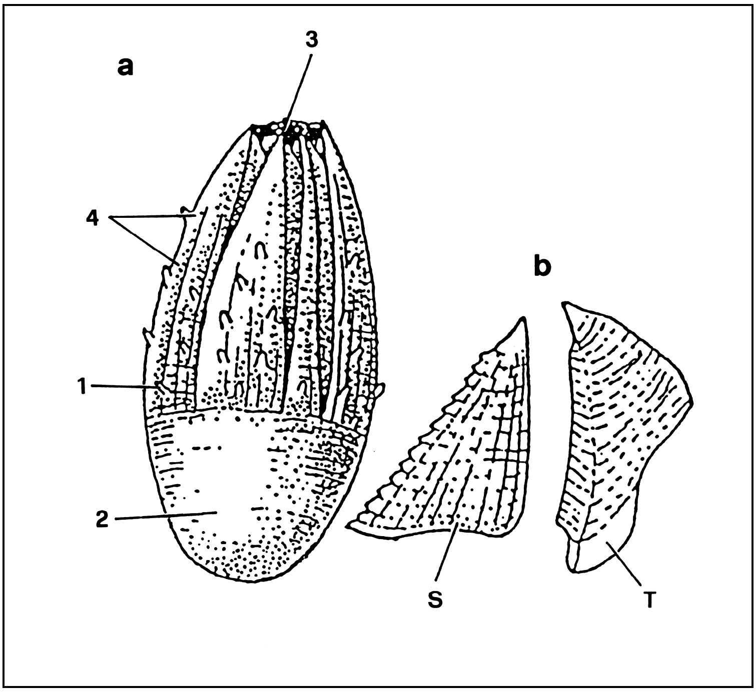

Figure 36. *Acasta spongites* (Poli) 1791

a. the shape of shell is usuall; that of a cup; composed by upper part (1) and of basis (2)
1. upper part of the shell composed by only one sixth or one seventh of plates, which are generally smooth, but furnished with sharp
2. lower part of the shell-basis, is moderately deep, cup - like form; the edge is feebly crenated and rarely quite smooth; it is often penetrated by small rounded irregular holes.
3. orifice is large, and deeply notched calcareous projections (4)
b. T. tergum slightly beaked; the spur is truncated, but rounded more especially on the carinal side
S. cutum is striated longitudinally flat, thin, and rather elongated

according to: R. Riedl, 1991

Superfamily *Balanoidea* (1817)

Thoracica without the peduncle, with bilaterally symmetrical shell on both sides of rostro-carinal axis. The primary shell wall is made of many wall plates, including carina, rostrum and 1-3 pairs of lateral plates. Plates are either separated from each other, or coalesced in various ways. Two genera have additional outside plates of the primary shell wall. On the top, the shell is closed with opercular plates, pair of terga and pair of scuta, whose segments may be separated, jointed, coalesced or reduced. The shell may also be tubular, and then tubes may be filled like pillars. The radii are stiff or tubular when the base is calcified (it can also be membranous). The inner surface of the segments usually has uniform ribs. The opening of the operculum is closed by valves, which are slightly toothed or with straight edge. Labrum is thin with well developed medial furrow. The mandible bears four or five teeth. The fifth tooth resembles the second more than the fourth. Cirri usually lack specialized setae, but usually bear specialized hooks and spines. The rami on the second and the third pairs of cirrus legs are never antenna-like. The rami in the first pair of cirrus legs can either be almost the same, thick, or very different. The caudal appendages are lacking (Fig. 6). These cirripedes are hermaphrodites, and some species of *Archaeobalaninae* have additional males.

Family *Balanidae* Leach (1817)

The body is without the stalk and closed within the shell. The shell plates are symmetrical. There are two pairs of mobile plates, one of scuta and one of terga. The number of immobile plates differs among the genera. There are often a single rostrum and a single carina, and one or two pairs of lateral plates. The immobile plates bear protuberances. The radii somewhat cover the neighboring plates, while the alae are below the neighboring plates (Fig. 1). The shell is composed of 4 or 6 plates. The paired plates are tubular, and the tubes stretch in a single line between the inner and the outer lamina (Fig. 2), like membranous plates. The additional tubes may form basically between lamina, so a branched complex may develop. Radii are solid or tubular, as well as the base. The rostrum has radii, while the labrum has a deep notch in the middle (Fig. 5). This family is one of the richest in species (it has about 100 species).

Genus *Balanus* Da Costa 1778

The shell is composed of 6 immobile plates: rostrum, carina, rostrolateral and carinolateral plates. Rostrum has radii and carina has alae. In lateral plates radii are on carinal and alae are on rostral sides. The shell plates are shown on Fig. 37. Rostrum is wide and overlaps the plates on both sides. The inner part of the plates is lengthwise ribbed, and is getting successively smaller near the base. On the inner side, the membrane is well defined from the other inner wall of the plates. The shell color is white, cream, pink, dark purple or a combination of these colors. The tergascutal flap is yellow, orange, red, dark purple, white or multicolored. This is the largest genus among cirripedes . In our waters there are five species, which are very important for fouling communities.

Key* to the acorn barnacles (some genera and species) which live in the Adriatic and other European seas.

1. (2) Shell with the same arrangement of plates and valves on either side of the mid line 3

2. (1) Shell plates not arranged symmetrically on either side of the midline, the single valve hinged at one side of the opening like a trap door ....*Verruca stroemia*

3. (4) Shell of four plates only, having a sinuous octoradiate outline when viewed from above. Tergoscutal flaps white, with an orange or brown spot in the middle and a grey band at one end ....*Eliminus modestus*

4. (3) Shell of more than four plates, or apparently fused into one piece. Outline smooth or irregularly folded 5

5. (6) When the valves are closed they fill the opening to the shell.....................7

6. (5) Valves small, covering only a small part of the opening to the shell, the rest being covered by a leathery membrane.............*Chelonobia patula*

7. (8) The rostral plate is overlapped by the plates on either side, but in old specimens all the plates may by fused together. Shell dull white, grey or brown. Tergoscutal flaps blue, brown or rarely white, or a mixture of these colours .... genus *Chthamalus* 29

8. (7) The rostral plate is wide and overlaps those on either side.........................9

9. (10) Rostral plate with radii overlapping the plates on either side. Shell white, cream, pink, purple or a mixture of these colours. Tergoscutal flaps yellow, orange, red, purple, white or variegated.. genus *Balanus* 11

* after Southward & Crisp 1963

10. (9) Rostral plate (and other plates) without radii; shell white, tergoscutal flaps white ....genus *Hexelasma*

11. (12) Shell obviously coloured or striped pink, red purple or purple brown .13

12. (11) Shell white or cream 19

13. (14) Shell white with groups of pink or purple or purple – grey stripes. Walls fairly thin, opening relatively large. Tergum not beaked, tergoscutal flaps white, crossed by three black or purple transverse bands ....*Balanus amphitrite*

14. (13) Shell wholly or partly coloured, never striped.....................................15

15. (16) Shell coloured bright orange to red; tergoscutal flaps yellow crossed by three black bands...*Balanus tulipiformis*

16. (15) Shell pink or purple, without orange colours. Tergoscutal flaps coloured orange as well as yellow, or variegated blue, white pink and purple shades...17

17. (18) Shell wholly pink or purple, very massive, with a small opening, and the valves sunk well inside the rim. Tergum beaked, tergoscutal flaps with patches of blue and white, sometimes pink, on a dark purple or chocolated ground colour.......................................*Balanus perforatus*

18. (17) One half shell (rostral half) pale pink or nearly white, the other half deep pink or purple. Tergoscutal flaps transversely banded yellow or cream on brown, with an orange line round the rim ....*Balanus spongicola*

19. (20) Tergum sharply pointed...21

20. (19) Tegum blunt...23

21. (22) Shell strongly ribbed, opening relatively small. Tergoscutal flaps with stripes along their length, yellow brown and yellow (or white)..*Balanus balanus*

22. (21) Walls smooth, aperture very large. Tergoscutal flaps white, sometimes with faint pink markings .... *Balanus hameri*

23. (24) Tegoscutal flaps mottled or with 3 or more dark bands across.............25

24. (23) Tergoscutal flaps white, or uniformly striped along their length without dark bands across 27

25. (26) Opening an elongated diamond shape, scuta striated in one direction only. Tergoscutal flaps speckled white and pink or purple the dark

pigment usually grouped into three transverse bands especially in young individuals. Alae nearly horizontal, radii narrow, very oblique, with smooth margin .... *Balanus improvisus*

26. (25) Opening triangular rather than diamond shaped. Scuta striated in two directions. Tergoscutal flaps banded rich brown on a cream or white ground; three bands in young individuals and more continuous banding in old specimens. Alae oblique, radii wide, oblique, with crenulated margin... *Balanus eburneus*

27. (28) Tergoscutal flaps white with central spot of orange or brown. Base membraneous, not calcareous .... *Balanus balanoides*

28. (27) Tergoscutal flaps striped along their length, with yellow or cream line (more rarely pinkish or white) on dark purple.
Base calcareous, solid .... *Balanus crenatus*

29. (30) Opening large, diamond shaped, the joint between the terga and scuta at an angle. Shell plates always distinct. Tergoscutal flaps brown, verging to chocolate... *Chthamalus depressus*

30. (29) Opening kite-shaped or rounded, usually small. Joint between terga and scuta normally at a 90^0 angle to the mid-line. In old specimens the shell plates may be fused together. Tergoscutal flaps varying from deep electric blue to bluish white, with orange and brown patches of varying size at centre and ends .... *Chthamalus stellatus*

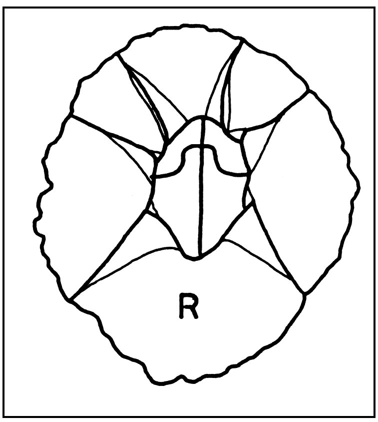

Figure 37. *Balanus sp*. Da Costa 1778; sketch; arrangement of shell plates

R. the wide rostrum overlapping the plates on either side
according to: A. J. Southward & D.J. Crisp, 1963

***Balanus amphitrite amphitrite* Darwin 1854a**

Lepas purpurea Spengler 1790: 158, text

Lepas balanoides Linnaeus, Poli 1791-1795: figs. 2-7, tab. 5

Lepas radiata Wood 1815: 1, text fig. 7, tab. 7

Lepas minor Wood 1815: 1, text fig. 6, tab. 7

Balanus radiatus Bruguière 1789: 158, text

Balanus balanoides Risso 1826: 379, text

Balanus amphitrite var. *communis* Darwin 1854: 1 text; Oliveira 1941: 1 text fig. 3, pl 1, figs. 5, 6, pl. 2, fig. 1, pl. 3, fig. 7, pl. 8, figs. 5, 6, pl. 9; Pope 1945: 351, text fig. 5, pl. 28; Karande & Palekar 1966: 139, text figs. 4-6, pl. 1

Balanus amphitrite communis Pilsbry 1916: 1, text figs. 1-9, pls. 1-76; Nilsson-Cantell 1921: 75, text figs. 1-89, pls. 1-3; 1932: 103, text figs. 1-8, pl.2; 1938: 1, text figs.1-28, pls. 1-3; Kolosváry 1947: 1, text; Zevina & Tarasov 1954: 341, text figs. 1-8; Daniel 1956: 1, text figs. 15-21, pl. 4; Tarasov & Zevina 1957: 1, text figs. 62a-g, 63a-d

Balanus amphitrite forma *hawaiiensis* Broch 1922: 215, text figs. 1-77

Balanus amphitrite var. *denticulata* Broch 1927: 133 text fig. 14; Bishop 1950: 409 text; Millard 1950: 256 text figs. 1, 2, pl. 11; Stubbings 1961: 7, text figs. 1-3

Balanus amphitrite cochinensis Nilsson-Cantell 1938: 1, text figs. 1-28, pls. 1-13

Balanus amphitrite var. *fluminensis* Oliveira 1941: 1, text fig. 4, pl. 5, figs. 1, 2, pl. 8

Balanus amphitrite var. *aeratus* Oliveira 1941: 1 text fig. 5, pl. 4, figs. 1-4, pl. 9

Balanus amphitrite herzi Rogers 1949: 3, text figs. 6, 12-15, pl. 1

Balanus amphitrite franciscanus Rogers 1949: 3 text figs. 5, 6, pl. 1

Balanus amphitrite var. *columnarius* Tarasov & Zevina 1957: 1, text figs. 1-106, pls. 1-4

Balanus amphitrite denticulata Henry 1959; 1, text fig. 5, pl. 1, fig. 7, pl. 3

Balanus amphitrite var. *hawaiiensis* Stubbings 1963: 1, text figs. 1-11; Karande & Palekar 1966: 139 text figs. 8, 9, pl. 1, fig. 5, pl. 4.

Balanus amphitrite Southward & Crisp 1963: 1, text fig. ; Riedl 1983: 1, text; 1991: 1, text.

The shell is usually canoe-like or half-cylindrical, sometimes cylindrical. The shell surface is smooth, often corroded (Fig. 38a). Epicuticule (outer membrane) is thin and often absent. The top of the outer part of the shell is thick, and the inner part is furrowed, especially toward the basal part, and sometimes also toward the top. In the parietal wall plates the tubes are arranged into a simple row, and are of various sizes. In the rostrum, the tubes are often without the transversal septae, and are filled to 1/5 – 1/2. They may also be filled to the top, or not filled at all but containing the fine transversal septae in the 1/4 -1/3 of upper part. The base has radial tubes and fine transversal septae, usually 6-7. There may be some stiff ribs between the septae, which are basally toothed. The radial tubes are so arranged that they include the primary point of attachment, and the basal edge is straight of slightly concave. Radii and alae are parallel or near so. Radii are wide, sometimes very wide. Stiff hairs are usually transversal, the tops are under a small angle and often thickened. The alae are usually with medium oblique tops. The opening is smooth-edged or slightly toothed, about ½ of width of carinorostral diameter. Considering the opercular plates, scuta are flattened or concave between the top and the basal edge. The top may be slightly covered and the growth increase is reflected through ridges, which are often wedge-like, while the fine lengthwise arranged stiff hairs are hard to determine. Terga are not beak-like. They are raised with a carinal edge in the upper 1/3-1/2, with a thread-like appendage on the lower side that is long about 9/10 of the width of this part. The protuberance is often so large and raised that may look separate from the rest of the valves, while the increase of growth is furrow-like (Fig. 38b). Tergoscutal opening is flattened, the basic color is white, but it may be pink or yellowish on the carinal side. The labrum is many-toothed, with 8-25 teeth, and there may be hairs on each side of the deep notch. The mandible has 4-6 teeth and a spiny inner angle. The second tooth is split, and from third to the sixth there are additional teeth. The first maxillae lack notches under the upper pair of spines. There are 3-17 spines between the upper and lower pair of spines and somewhat shorter spines on the inner angle. The lower part of spines is usually poorly developed, sometimes of normal size, and very rarely well developed. The second pair of maxillae lacks pronounced systematic characters. The adductor ridge, to which the adductor muscle is connected, is medium long and clearly detached from the joint hollow. The first pair of cirrus legs has unequal rami. The anterior one is longer than the posterior one, and the latter has basal segments pointed backwards. The second and the third pair of cirrus legs have almost equal rami. The second pair of cirrus legs is shorter than the third, and the segments are pointed forward. The third pair of cirrus legs has tooth-like spines on the outer anterior distal surfaces of the segments. They are more pronounced in the anterior ramus, while the basal segments of both rami carry spines on the posterior distal part. The fourth, the fifth and the sixth pairs of cirrus legs carry 7-8 pairs of long stiff hairs (setae) on the front edges of intersegmental spaces. The penis is as long as the sixth pair of cirrus legs, differently ringed and distally pointed.

Color: the shell is white or bluish-white with lavender or pink stripes, which vary in intensity and width. Usually one stripe is wide, while the middle ones and the lateral ones are narrower. The radii are usually white with brownish-red, pink or reddish patches, rarely completely white. Rostrum may be white. Scuta are most often purple or violet on the outside, with a narrow or wide white thread near the tergal border. Terga are usually white with a purple thread toward scuta and carina. They may be colored inside or outside, but this is rare. The tergo-scutal flap has three transverse tapes, black or scarlet. The central stripe is at the furrow and its color is same as that of spots.

Size: It is generally cited that the base diameter is fewer than 10 mm (Henry & Mc Laughlin 1975). In the Australian waters, specimens of this species are maximally 12.2 mm high with a base diameter of 12.8 mm. In the suitable situation, for example in estuaries or on ships, the base may grow up to 30 mm (Jones 1990). In our part of northeastern Adriatic, on spots with longest research time on fouling problem, this species size is usually corresponding with general constatation of Henry and McLaughlin (1975). In epibiosis on oysters, the basal growth of this species is on average 5.5 mm, extremely 8 mm, and on mussels at average 6 mm, maximally 10 and 11.2 mm (Igić, 1981a). These are data from Lim Channel and Rovinj area. In these epibioses, in a month the newly settled individuals attain growth of 2.25 mm in October and maximum of 5.65 mm in August. On mussels the minimal basal growth is in July (2.99 mm), while in September it is maximal (6.50 mm) (Igić 1981a).

Ecophysiological characteristics: The intensity of growth is closely correlated with the season. On oysters in Lim channel the maximal growth increase is in August, when the base diameter is 3.10-3.53 mm. On mussels it is 6 mm then, while in September it is only 3.05 mm. In winter season the growth increase is minimal, so it is smallest in January, only 0.90 mm on oysters and 0.95 mm on mussels (Igić 1981a). Life span in epibioses is relatively short, being in average 3 months on mussels and oysters. Rarely on oysters it may be 4 months and on mussels 6 months. The specimens begin to die already between 10 and 30 days (Igić 1981a).

Reproduction: This species and *B. eburneus* can reproduce on 15^0C (Crisp & Patel 1961; Crisp & Costlow 1963; Iwaki 1981). In Japanese waters larvae of *B. amphitrite* are being produced from November to January (Anil et al., 1990), but the successful metamorphosis into the cypris larvae is lacking at temperatures of 15 and 20^0C (Anil et al., 1989). However, the larvae produced in summer months develop into cypris larvae on such temperatures (Anil et al, 1990). This barnacle may reproduce once a week (Holm 1990) and in laboratory conditions throughout the year (Rittschof et al., 1984). In Adriatic (at Split and

Rovinj) the nauplius stages are found in the plankton in March, April, August and September, and the cypris stage in June and July (Kolosváry 1947). They are settling on the substrate from June to January, most abundantly from July to October (Igić 1981a).

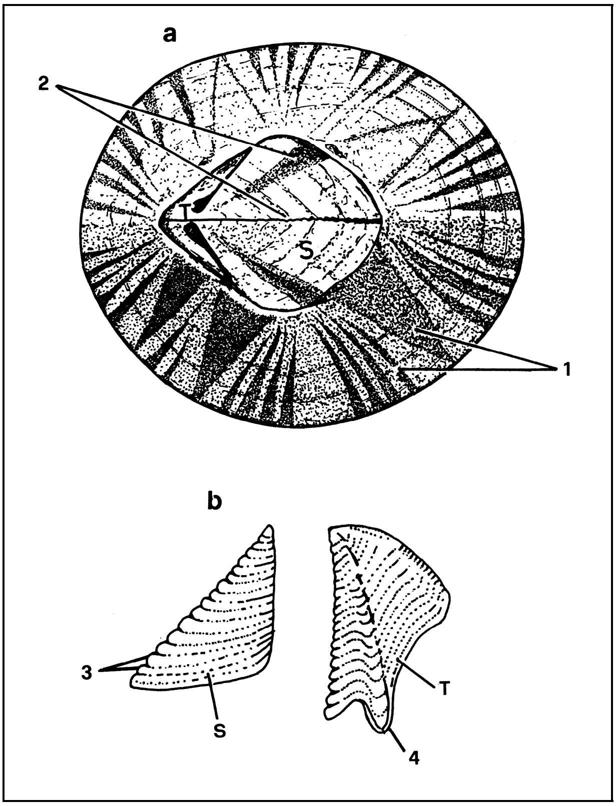

Figure 38. *Balanus amphitrite amphitrite* Darwin 1854

a. apical view of shell plates of shell usually thin, smooth, white, with groups of pink, purple or grey-brown stripes
1. stripes on the plates
2. romboid operculum with coloured stripes on the scuta
b. external view of opercular valves

S. scutum with growth ridges; occasionally with fine longitudinal striae
3. scutum often crenulated
T. tergum with carinal margin protuberant in upper third to half , which are sometimes separated from rest of valve by narrow groove
4. spur fasciole

according to: A.J. Sothward & D.J. Crisp, 1963 (a); D.P. Henry & P.A. McLaughlin, 1975 (b)

Habitat: this species is most often found in tidal zone up to 10 m, and it can reach 65-70 m. Extremely it was found up to 1000 m on rock, shellfish and crustacean shells, on mangroves, docks and ships etc. This is the most common fouling species, especially tolerant on organic pollution, so it is a common dweller of harbour waters. It prefers bays (Yamaguchi 1977, a). In such sheltered zones and harbour systems, the primary production is higher (Anil et al., 1990), so the larval stock is concentrated here (Foster 1987; Martin & Foster 1986). In such ambient, the presence of nauplius larvae is longer than in open waters, and the weight of the fouling complex is significantly higher (Anil et al., 1990; Igić, 1994, a, 1999). Besides, this species is tolerant on high temperatures, larger concentration of Fe, $N\text{-}NH_4$ and lower concentration of O_2 (Relini & Relini-Orsi 1971), while it is however sensitive on some heavy metals (Cd, Mn, Ni, Cr, Co, Zn, Pb, Hg) (Patarnello et al., 1991). This barnacle is especially important as a model organism for studies of anti-fouling components. It has a rapid larval development, easy achieves synchronous mass culture, and settles in predictable way in statical conditions (Branscomb & Rittschof 1984; Rittschof et al., 1984, 1986, 1992; Roberts et al., 1991).

Diet: larvae in a culture feed well on diatoms *Skeletonema costatum* (Rittschof et al., 1992).

Distribution: This is the temperate-tropical cosmopolitan species. In Europe it stretches from England to the south coast of Africa, in southeastern Africa toward India and Eastern Asia, from Vladivostok to China, Japan, Australia, eastern coast of America, Bermudas, and to the south to Brazil, from central California to southwestern Mexico and Hawaii. In Europe it is also present throughout Mediterranean, Black Sea and partially Red Sea. In England or Netherlands it can however succeed only on microlocations that are under warm influence of power plants, and where sea temperature is 6-7^{0}C higher than in other areas (Borghouts – Biersteker, 1969). Such habitats are mostly in harbour waters, estuaries or channels that never freeze.

In Adriatic, this species is well distributed, especially in harbors or places with much organic waste, relatively protected from strong currents and large concentration of detergents. On the west coast of Adriatic in lagoons such as on mouth of River Po, where salinity on the surface is 4.1-9 x 10^{-3} and on the bottom 6.5-34 x 10^{-3}, this barnacle is not especially abundant (Relini et al., 1983-1984). However, in the Venice lagoon, this species tolerates organic pollution, salinity of 26-34 x 10^{-3} (Candela et al., 1982, 1983) or 30.5 - 33.5 x 10^{-3}, oxygen levels of 60-110% and pH of 7.8-8.4 (Barbaro & Francescon 1976). The populations are densest in places where there is no extreme concentration of nutrients. In this area settlement starts earlier (end of May) and finishes earlier (end of August, rarely September) (Franco, 1964), and maximums are in June and August (Relini et al., 1972a). In Manfredonia harbour, on yearly exposed plates, this barnacle is found throughout the year (Gherardi et al., 1974), in Lake Acquatina, which is connected with Adriatic via channel in October (Prato et al., 1995), in Bari harbour from June to December (Vaccarella et al., 1977). In Trieste harbour, this barnacle settles from June to November, most intensively in August (Specchi et al., 1976). In Piran Bay on 5 m of depth this species was not found (Vriser 1986), as well as in south Adriatic on depths of 25, 5, 27, 7, 31 m (Karaman & Gamulin-Brida 1970), or 22-72 m (Stjepcevic & Parenzan 1980). This barnacle is rarely mentioned in benthos of mid Adriatic, for example at Split, Vranjace (Kolosváry 1955). Zavodnik (unpublished) from 68 stations in littoral (supralittoral, mediolittoral, infralittoral), found species *B. amphitrite* only on one station at 0-1.5 m of depth (Vela Pamtula). Similar situation was in benthic communities of north Adriatic, where species *B. amphitrite* is not found in Rijeka Bay (Zavodnik D & Zavodnik N, 1982), on the coast of Krk Is. (Zavodnik et al., 1981), at Osor (Zavodnik D & Zavodnik N, 1982) or in Istra area at Rabac (Zavodnik & Vidaković 1982), as well as in Raski Bay (Zavodnik D & Zavodnik N, 1986), Lim Channel, at Rovinj (Gamulin-Brida et al., 1968). However in fouling communities this species is much more common. In north Adriatic in many years of study, this barnacle was found on various artificial substrates (inert test substrates, floating objects) in vicinity of Rovinj (Zavodnik & Igić 1968; Igić 1968 a, 1982 a, 1984, 1994), Umag (Igić 1994a), Lim channel (Igić 1982), Pula (Igić 1984), in Raski Bay on eastern coast of Istra (Igić 1986), in Plomin harbour (Igić 1991). This species is also found in epibioses on edible organisms (mussels, oysters) in Lim channel and at Rovinj (Igić 1981) and on oysters in Lim channel (Kolosváry 1940). In mid Adriatic, species *B. amphitrite* is rarely found in mussel farm at Maloston Bay(Igić 1981a), while Kolosváry (1939-40) found this species on mussels and snails in vicinity of Split and in Boka Kotorska. Besides, in south Adriatic, this cirripede is found in Kotor Bay on lids of cages for settling young oysters (Igić 1983).

Remark: Among all the species of barnacles, this is the one with most varieties, which were first described by Darwin (1854), and later by Harding (1962), who has described variation of *B. a. amphitrite* in shell color, radii tops and width of lower tergal appendage. Of the more modern works, it is especially important to cite the study by Henry & Mc Laughlin (1975), who especially point out the number of tubes (11-19), especially in rostrum. The same authors also consider finess of radii as a systematic character, and together with Utinomi (1960), place more importance on tergal characteristics.

***Balanus eburneus* Gould 1841**

B. (alanus) democraticus Dekay 1843: 1, text pls. 1-40

Balanus amphitrite var. *niveus* Oliveira 1941: 1, text fig. 1, pls. 1-11.

The shell is conical and steep, except when individuals are grouped together, when body gets a cylindrical shape (Fig. 39 a, b). The shell wall is not completely filled and is usually composed of holes and vesicles. The vesicles may be filled and calcified, and then the wall is solid. The parietal wall plates are composed of tubes in a simple line, usually medium large, 11-12 in the rostrum, with septes almost to the base. The inner surface of outside lamina usually bears 2-4 fine ribs between the longitudinal septes. The opening of the operculum is wide, toothed, and usually smaller than ½ of carinorostral diameter. In conical and cylindrical specimens, it is more than ½ of carinorostral diameter, and in half cylindrical and cylindrical specimens the surface is smooth. Carina is usually higher than the rostrum, the epicuticle is thin and present on all parts except on radii. Radii and alae have oblique tops under small angles (about 45^0), and are finely toothed or waved at the edges. Radii are usually narrow, middle wide or very wide in cylindrical specimens. They have transversal stripes and are thick, rough surfaced and rarely toothed. Alae are placed under the angle, but are rarely half-horizontal. Terga are blunt, scuta have fine radial stripes that start at the angle between the tergal edge and middle line. Terga are wide (Fig. 39c). The basal part is pushed inside on the carinal side, while the inner side of the valve is covered with a soft appendage like a knob. On the scutal side, tergum points upwards. The edge toward the scuta is toothed. The carinal side is usually medially concave, while the edge is very convex from the lower third to the half. Scuta have well developed growth lines (Fig. 39c). On the inner side the adductor ridge is visible, and it is not elongated, but placed in the middle part of the valve and covered with a soft appendage like a knob. Labrum has 6-32 teeth on each side of the deep notch. On the distal part of labrum, there are very fine feathery hairs (pinnate), whose number gradually decreases toward the proximal part, where there are only 3-4 rows. On the lower half of the distal edge, there is a row of long hairs that are parallel with the distal edge. The mandible bears 5-7 teeth. The second tooth is split, 3rd-5th (sometimes also 6^{th}) teeth have extra teeth on them, while the first tooth is coalesced with the inner angle that may bear spines. First maxilla is without notches under the upper pair of spines. 5-14 spines are built out of pectin and placed on the dull-edged inner angle. The upper and under pairs of spines are longer, and between them there are somewhat shorter spines. The long spines are most prominent due to their thickness, not length. Second maxilla has no important systematic characters. On all 6 pairs of cirrus legs there are hairs, 7-9 pairs on the front side of every segment, while on the rear side of the segment there are small spines.

Color: Shell is white, and in juvenile and small adult specimens the transparent longitudinal lines may be absent. Radii, alae and opercular valves are white. The tergoscutal flap is painted with clear brown patches on the light surface (Fig. 39d).

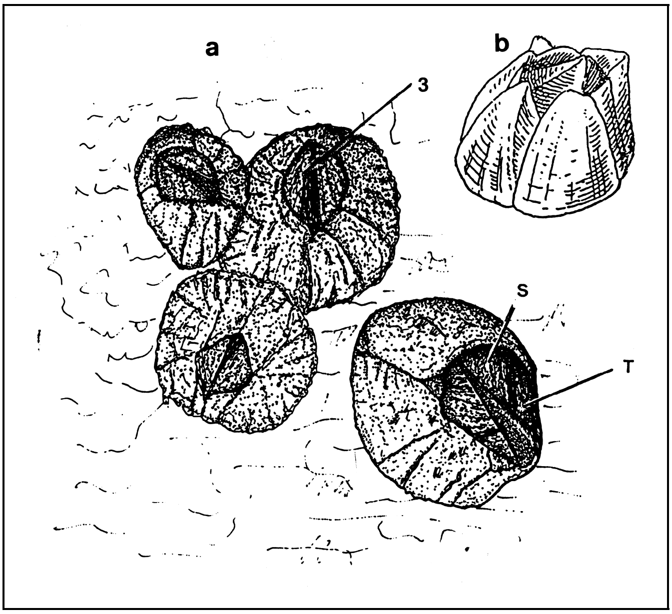

Figure 39 a, b. *Balanus eburneus* Gould 1814

a. shell conic to cylindroc, surface smooth
3. orifice toothed, width, usually less than 1/2 carino-rostral diameter
b. lateral view of shell; shell steeply
T. tergum, blund, with carinal margin protuberant in upper 1/3 to 1/2 (4); with spur fasciole (5)
S. scutum with growth ridges strongly crenulate; longitudinal striae strong

Institution, 1952 (b) D.P. Henry & P.A. McLaughlin, 1975 (c)

Size: The average base diameter is 10 mm, height 8 mm, while the maximal base diameter reaches 40 mm, and height 30 mm (Henry & Mc Laughlin 1975). In our part of northeastern Adriatic, base diameter is 8 mm, extremely 15.5 mm (oysters) and 11 mm (mussels) (Igić, 1981a). In the south Adriatic (Boka Kotorska), the minimal base diameter is 7 mm, average 20 mm, and extremely an individual may reach basal diameter of 22.63 mm and height of 6.87 mm (Igić 1983). In the northeastern Adriatic (Rovinj, Lim channel), the newly settled individuals reach monthly growth on oysters maximally in August, differently between the two reproductive years. In the first year the largest average growth was 3.11 mm, and in the second year on the same spot 6.37 mm. On mussels in first year, the base growth was in average in first year 2.73 mm in June and in second year 4.58 mm in September (Igić 1981a).

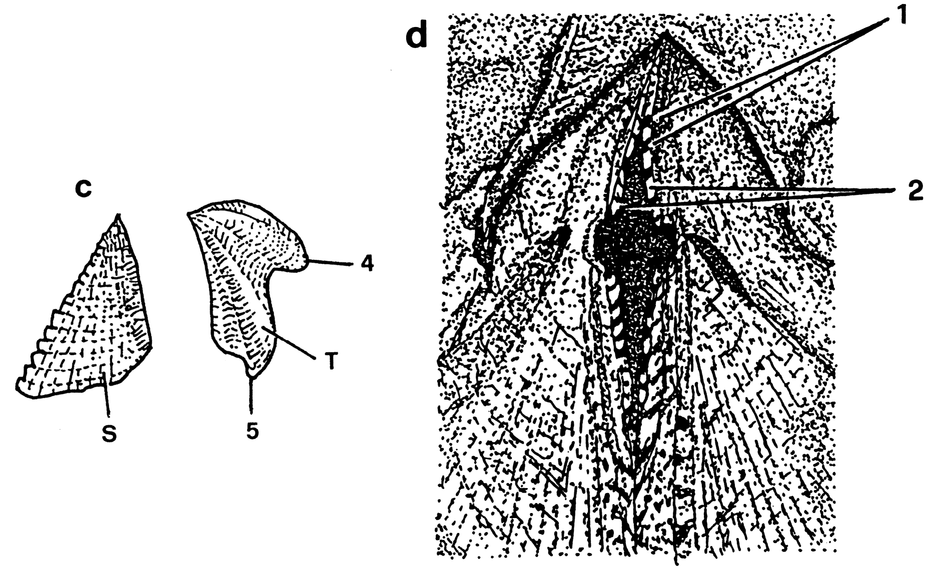

Figure 39 c, d. *Balanus eburneus* Gould 1814

c. external view of opercular valves
4. tergoscutal fleps speckled and banded rich brown colour on a white or cream ground
1. brown band
2. white, cream ground

T. tergum, blund, with carinal margin protuberant in upper 1/3 to 1/2 (4); with spur fasciole (5)
S. scutum with growth ridges strongly crenulate; longitudinal striae strong

according to: A.J. Southward & D.J. Crisp, 1963 (a,d); Woods Hole Oceanographic Institution, 1952 (b) D.P. Henry & P.A. McLaughlin, 1975 (c)

Ecophysiological characteristics: The intensity of month growth increase was in northeastern Adriatic 5 mm (Lim channel) and 5.23 mm (Rovinj) on mussels, while on oysters it could not be precisely determined, but was similar (slightly smaller) to the one on mussels, and was reached in August. The vitality of individuals was relatively low. In Lim channel on oysters, the individuals lived maximally 5 months, but at average 3 months. The shortest life span was 30 days. On mussels the longest life span was 8 months and average 4 months, although some individuals have died after larva fixation. At Rovinj area, on both hosts the individuals lived maximally 6 months, at average 5 months (oysters) and 4 months (mussels), and in both hosts mortality started almost immediately after settling (Igić 1981a).

Reproduction: in tropical areas throughout the year, and in temperate zones in all seasons except winter. In Adriatic, the nauplius larvae were found in plankton in all months except September and October (Kolosváry 1947) and 1 mm long larvae settle from June to December, with a peak in July-September (Igić, 1981a). The sexual cells are maturing throughout the year, and the egg fertilization happens in mantle cavity for a various amount of time (Lepore et al., 1979).

Ecophysiological characteristics: In Adriatic this cirripede lives on average as long as *B. amphitrite*, 1-3 months, while the mortality starts in newly settled individuals with a base diameter of 1 mm. Extremely this species may live up to 6.5 months, at average 3.5 months, and several specimens were 8 months old (Igić 1981a). The frequency, abundance, cover and biomass in fouling communities is correlated with numerous factors. In cleaner localities with a higher salinity, this species is relatively rarer, 16-25%, the number of specimens is 1-17, and weight is below 0 g on 100 cm^2 of test substrate (Igić 1981a). However in less urbanized ambient with brackish water, *B. eburneus* is a dominant barnacle on various substrates, fouling them with 50-100%, and with enormous biomass up to 3758 g/m^2 (plastic collectors for settling of young oysters) (Igić 1983).

Habitat: It lives on rocks, stones, ships, hydro centrals, seashell shells etc., in depths up to 40 m, more frequently in sheltered places with weak water flow. It mostly lives in polluted waters of low salinity, so it is a common inhabitant of river mouths (Mook 1980; Relini et al., 1983-84). For example, in the delta of River Po, this species predominates below 15 cm in one zone and toward the bottom in the intertidal zone, but less than *B. improvisus*. Salinities there are 0.1-9.2 x 10^{-3}(surface) and 6.5-34 x 10^{-3} (near the bottom), and on the other spots 7.3-25.6 x 10^{-3} (Relini et al., 1983-84). Besides, the population density of this species is also correlated with temperature regime and phytoplankton concentration. According to the laboratory research of Scheltema & Williams (1982), the temperature values where nauplius larvae develop are between 20 and 30°C. Between 20 and 25°C, larvae survive 63.5% and 66% at the algal concentration of $1x10^5$ cells per ml, while at the double concentration ($2x10^5$), the larval survival rises to 92.5 and 96.5%. At 30°C, the larval survival is 90%. It does not prefer some special depth and is usually distributed from the surface to 14 m of depth (Lepore et al., 1979).

Diet: In the algal culture of diatom *Skeletonema costatum*, this species lives well (West & Costlow 1988).

Distribution: This is a tropical and subtropical species, especially distributed between the northeastern America and South America. This species was later introduced into other parts of the world, such as Mediterranean, Black and Caspian Sea, India, Japan to Hawaii, California to Panama. Considering the presence of this species in waters of Great Britain, Stubbing (1967) cites that this species was brought by ships from western coast of Africa, spreading toward the southwestern Europe.

In the Adriatic, this species has similar distribution to *B. amphitrite*, although there are differences considering habitat quality. The previous species is more abundant in polluted waters, and this one in polluted areas of lower salinity. On the west coast of Adriatic, in Venice lagoons, this species is less common at salinities of $31.5\text{-}33.5 \times 10^{-3}$, while in other places where there are more nutrients and oxygen level is 60-110%, pH 7.3-8.3, this species is more common (Barbaro & Francescon 1976). In the same area, *B. eburneus* was present at the salinity of $26\text{-}34 \times 10^{-3}$ (Candela et al., 1983) and settles in June-August period (Relini 1981b) with maximum in August (Relini et al., 1972a), while in the delta of the river Po settling is very rare, only in June, July and August (Relini, 1981a). In Manfredonia harbour, settling on the depth of 1.5 m is continuous throughout the year except the February (Gherardi et al., 1974). To the contrary, in south Adriatic in Bari harbour, settling was visible only in July and September (Vaccarella et al., 1977). In Trieste Bay, settlement period is the same as in other barnacles, that is, it starts in June-July, reaches the maximum in August and finishes in October-November (Specchi et al., 1976). In the Piran Bay this species was not found in benthos, same as *B. amphitrite* (Vriser 1986), and the same was true for other benthic communities in northern, mid and south Adriatic. It is important to note that wherever *B. amphitrite* shows up in fouling communities of eastern Adriatic coast, this species always follows.

***Balanus improvisus* Darwin 1854a**

Balanus improvisus var. *assimilis* Darwin 1854: 1, text figs. 1, 2, pls. 1-39; Müller 1867: 329 text pls. 1-3; 1868: 392 text pl. 20

Balanus improvisus var *gryphicus* Münter 1869: 1 text pls. 1, 2

Balanus amphitrite pallidus Nilsson-Cantell 1932: 103 text figs. 1-8, pl. 2

Balanus amphitrite var. *denticulata* Stubbings 1961: 7 text figs. 1-3 (fig. 4c, d)

Balanus amphitrite var. *pallidus* Stubbings 1961: 7 text fig. 6a, b

Balanus amphitrite Zullo 1963: 1, text pls. 1, 2.

Balanus amphitrite amphitrite Stubbings, 1967: 227 text figs. 1-28, pl.1 (figs. 14a-f)

Balanus pallidus Stubbings 1967: 227 text fig. 16a

The shell is conical (Fig. 40a), and in dense settlements it is cylindrical or tulip-like. The surface of the shell is smooth, excepting for the inner part that is turned toward the substrate. The epicuticle is thin and often present only on radii. The shell wall is thick with fine, basally toothed ribs. The wall tubes are arranged in a simple row. There are 14-24 (average 19.9) tubes on the rostrum, with a transversal upper ridge that is placed in the upper two thirds, and sometimes toward the base of the plates. The inner surface of the outer lamina may bear 1 or 2 fine ribs between the longitudinal ridges. The opercular opening is usually narrow, rhomboidal (Fig. 40b), slightly toothed, and may be the same width as a carino-rostral diameter. Scuta have well developed growth lines, especially longitudinal. Furrows may be present. The edge that touches the other plates is toothed. The knee ridge is well developed and long. The adductor is almost straight, while the muscle hollow is very shallow (Fig. 40d). Tergum has an edge toward scuta (scutal edge) that is not toothed. The carinal edge is convex. The longitudinal furrows are absent. The lower appendage is placed upside down on the length of the basal edge. It has interrupted furrows, which are however of the normal depth. The lower part of the appendage is flattened only on the scutal side (Fig. 40d). By the way, this appendage is almost 1/5 of the touching surface from the basal edge. The length of this appendage is about 3/5 of its width, while the distance from basiscutal angle toward that part of terga is about 9/10 of its width and 1/2 of its length. The end of the appendage is broken, blunt or rounded, very narrow, and the lateral sides are straight. The radii are narrow and thin, with the transversal furrows. The tops are rounded and under an angle. If radii are observed from the top, they have a pointed top like a sharp chisel. The angles are suture-like. The upper angles of radii are smooth. One alae is placed over the other, missing the top of radii and reaching to the back and over from the radii. Radii are covered with thin epidermis.

The base is calcified and filled with radial tubes and transversal ridges. The first pair of cirrus legs has almost straight segments. In the third pair, the front part of the segment is covered with straight spines, and in the fifth and sixth pair of cirri the segments have on the front side longer hairs, and between them many short hairs. The labrum is toothed in the lower part, and there is a row of tiny teeth on the top (7-23, at average 15.1) on each side of the crest. Along the upper edge there are numerous hairs, especially at the upper distal angle, while near the inner edge setae are somewhat longer. The mandible bears 5-6 (at average 5.9) teeth. The inner angle is not spiny. The second tooth is split, the third has extra tiny teeth, and the sixth is small and may be split. The lowest tooth usually touches the inner lower angle. Maxilla is without notches under the upper pair of spines. It has 3-15 (at average 6.3) spines between the upper and lower pair. They are somewhat shorter on the inner angle. The second maxilla lacks any important visible characters.

Color: The shell is white, sometimes with the regular longitudinal lines. Radii, alae, carina and opercular valves are white. Epicuticle is light yellow. The tergoscutal flap in older individuals has white, pink or purple spots, which are grouped in 3 transversal lines that look pink or purple. In juvenile individuals, there are 3 such stripes on white surface, so they resemble *B. amphitrite*. The middle line is different from one in that barnacle, and is under the furrow of the flap, not responding to the middle colored line of other species (Fig. 40c).

Size: the length of the carino-rostral diameter is on average 13-15 mm. The maximal length is 17 mm and height 9 mm.

Reproduction: In the brackish waters of River Po delta, the mature gametes are present throughout the year, but the reproduction and settling are present only from May to December. In places where the influence of River Po is less prominent, species *B. improvisus* is able to settle, grow and produce new larvae in just one month (this period would be at least three months in places with fresh water influx) (Relini & Fasciana 1982). In such environment and lagoons it takes the longest time for this barnacle to settle. It is present in all lagoon areas in Po River delta as a dominant species (1044 individuals per square decimeter) on *B. eburneus* that settles only in summer with smaller population density (115 individuals per square decimeter) (Relini et al., 1982). In certain areas, for example in British estuaries, the larvae are found from June to mid August and again in the second part of September and October. The maximum settling is from mid June till the end of July (Jones & Crisp 1954). This species settles on solid substrate in the same time that the larvae show up in the plankton (Bassindale 1964).

Habitat: It lives in tidal zone to 46 (and even 120) meters of depth. The nauplius larvae are usually concentrated near the surface, while there are on average 50% of them on the depth of 190 cm or 11.3-12% on depth of 240 cm (Bousfield 1955). This is the most tolerant cirripede to low salinity, and is distributed in estuaries throughout the world. The peak of settling in Chesapeake Bay (USA) is on 10-15 x10^{-3}(Dineen et al., 1992). It tolerates salinity of 0-12x 10^{-3}, and is very common in brackish waters, especially estuaries, and it may permanently live in fresh water (Cawthorne 1979). The minimal salinity tolerated by all stages in ontogenetic development is 8-16 x 10^{-3}, although salinity of 0-12 x 10^{-3} may be tolerated (Bousfield 1955). Due to such tolerance, this cirripede closes the opercular plates only if fluctuations of salinity are falling to the level of 0x10^{-3}. It is most active at the salinities of 10-20 x 10^{-3} (Foster 1970; Davenport 1976). The larvae can survive temperatures between 10 and 30^0C. During the vertical migration they are also tolerant of diffuse light of low optimal intensity (Weiss, 1947; Smith 1948).

Distribution: This species has a wide, but uneven distribution throughout the world. Its origins are in cold-temperate northern hemisphere, and later it was transferred by ships to America and Indo-Pacific, so it is now distributed from Scotland and Baltic Sea to west Africa (to the Cape of Good Hope), Mediterranean, Red, Black and Caspian sea, from Nova Scotia to Patagonia, from Oregon to Peru, from Japan to Australia, on the coast of USA (Carlton & Zullo, 1969). In the Adriatic, especially in the northern part, this species is distributed on all immersed surfaces in the fouling complex, especially at the river mouths (Relini et al., 1983-84) and in lagoons (Barbaro & Francescon 1976; Candela et al., 1982-83). It is also found in places of lower salinity, but in small numbers, for example in the Manfredonia harbour (Gherardi et al., 1974), at Bari (Vaccarella et al., 1977) and Rimini (Kolosváry 1955). On the eastern coast of Adriatic, this species was found in the fouling community, although not in imposing numbers, of the Trieste Bay (Specchi et al., 1976) (max. 6.83 individuals per square decimeter), or Raski Bay (0.2 individuals per 390 square centimeters) (Igić 1986). Somewhat better abundance was observed in Plomin harbour (12 individuals per 390 square centimeters) (Igić 1991). It is also common in fouling complex in Lim channel, on places with intensive influence of fresh waters, as well as on other similar microlocations along the Adriatic coast.

Variations: The individuals decomposing after death are totally different from the typical forms. The shell is often brown or gray, and radii may be destroyed. The upper parts of opercular valves are usually eroded. The specimens growing close together are cylindrical or peg-like with extremely wide openings. The base may be elongated, stretched, and the shell walls are very thin. The thickness of the opercular valves differs in grouped and solitary specimens. When they are relatively thin, the scutal edge toward the terga has rough inner surface. The carinal edges toward the narrow part of the terga are curved in an arch-like fashion and toward the lower part – appendage of the terga are concave. Carina may be also brown.

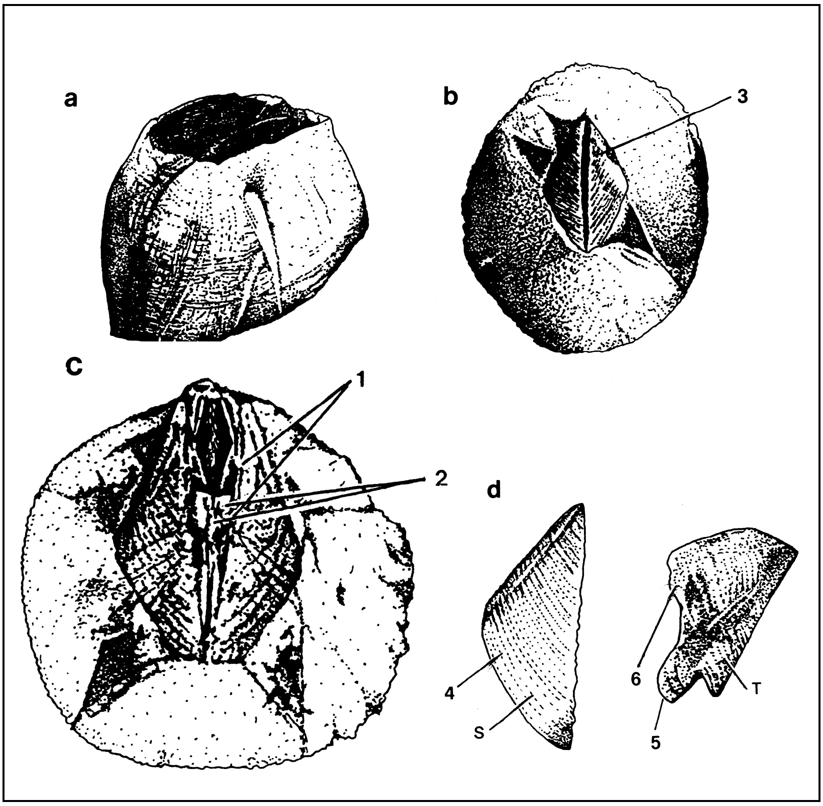

Figure 40. *Balanus improvisus* Darwin 1854

a. lateral view of shell; conical shell, plates smooth, white or cream of colour
b. apical view of shell
3. orifice rhomboid, usually slightly toothed
c. tergo scutal fleps in younger specimens
1. three distinct pink or purple bands on a white ground, resembling *B. amphitrite*, but unlike the latter the middle band is below the groove of the flap, and does not correspond to the central coloured spot of other species.
2. white ground
d. external view of scutum and tergum
S. scutum with growth ridges finely crenulate; longitudinal striae occasionally present (4)
T. tergum with carinal margine convex (6); spur length greater than width, furrow (5)

according to: G. Relini, 1980b (a,b); A.J. Sothward & D.J. Crisp, 1963 (c); D.P. Henry & P.A. McLaughlin, 1975 (d)

Remark: Among the species of the complex *Balanus amphitrite*, this species is most related to the species *B. eburneus*, from which it is best distinguished by narrow radii and narrow curved arch-like tergal appendages.

Balanus perforatus **Bruguiére 1789**

Balanus cornubiensis Ellis 1758: 845 text fig.16, tab. 34

Lepas angustus Gmelin 1790: 3021, text

Lepas Balanus et *fistulosus* Poli 1791-1795: fig. 1, tab. 6

Balanus communis Pulteney 1799

Lepas angusta Wood 1815: 1, text fig. 5 tab. 6

Balanus Crancil leach (in tab. De Blainville) 1824: 1, text fig. 9 tab. 7; 1827: 1, text figs. 9-12, tab. 53.

The shell is very thick and solid. The walls are steeply descending into the edge, while the opening is very small. The shell surface is strongly furrowed and may be smooth only in juvenile individuals (Fig. 41a). The shell plates are tubular, although the channels may be filled later. The rostral plate is connected with the rostrolateral, and this plate connection covers the neighboring lateral plates. Terga are topped with a beak, which is very pointed out (Fig. 41 c). The base is calcified. The isolated individuals are shaped like a volcano.

Color: the shell color varies from ash gray to violet, pink or nearly white. The furrows are darker than the rest of shell. The tergoscutal flap is usually edged with dark violet or chocolate base and blue and white patches, and there may be some pink, too (Fig. 41 b).

Size: The base diameter reaches 15-30 mm. The height may be smaller, but is usually larger, 20 and even 30 mm (Bassindale 1964). In the Adriatic, the average size is usually between 8 and 13 mm, extremely up to 18 mm in base diameter and up to 17 mm of height (Igić, 1981 a).

Reproduction: in the colder areas (Great Britain), the settling of cypris larvae is from late July to September, although the egg cells can be found in plankton from June to August, while in laboratory conditions the larvae develop 2-3 weeks on the temperature of 15-16^{o}C (Patel & Crisp 1960). In the warmer areas (for example Ionian sea), this species is sexually mature 12 months in year, but fertilization and larval emission happen only during the summer. The settling is very intensive, starting in March and lasting till November (Lepore et al., 1979).

For the Adriatic, Kolosváry (1947) cites presence of egg cells in March and June. It is somewhat different from the other cirripedes (in our part of Adriatic) that mostly settle in July, as its settling starts in August and lasts till January. Very rarely the colonization may start in July (Igić 1981a). However in

Trieste Bay it may rarely settle from June to November, with a peak in September (Specchi et al., 1976), and in our conditions there is intensive settling in October and November (Igić, 1981 a).

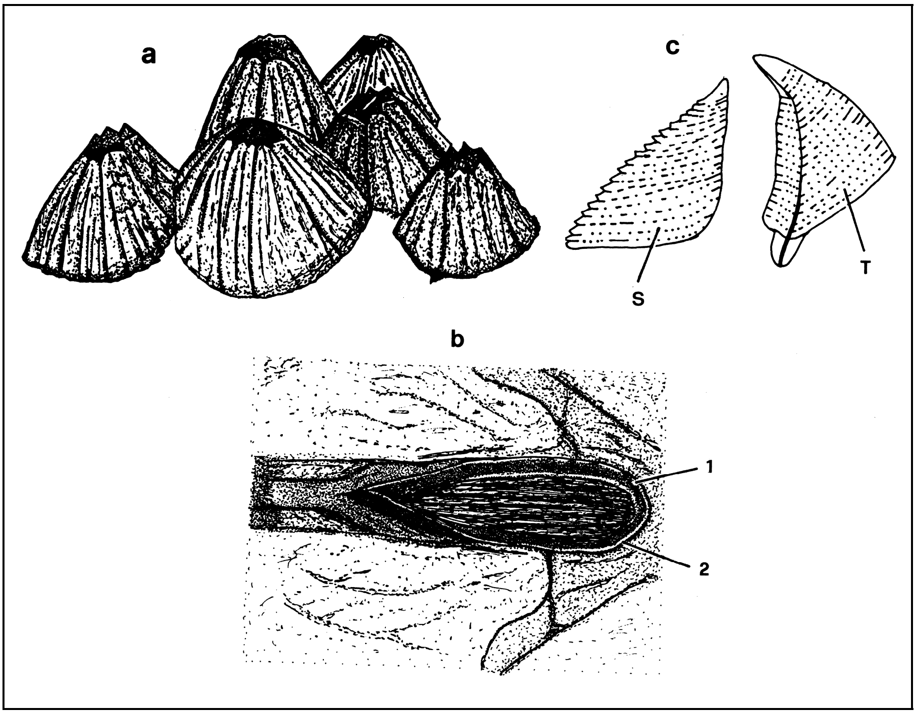

Figure 41. *Balanus perforatus* Bruguiére 1789

a. shell very strong and thick, steeply conical with a very small opening; looking like a miniature volcano
b. tergoscutal flap with a dark-purpl or chocolate ground with blue and white patches .
1. dark- purple ground
2. blue and white patches
c. opercular valvae; external view
T. tergum, prominently beaked, with a dark purple tip.
S. scutum

according to: A. J. Southward & D.J. Crisp, 1963 (a,b); G.Relini, 1980b (c)

Ecophysiological characteristics: This is the longest-living species of barnacles. In our part of Adriatic it lives at average about 8 months, extremely up to 10 months in fouling communities (Igić 1981 a). Besides, for this species the growth process is very slow. In one month individuals reach the base diameter of only 1.7-2.0 mm, while in *B. amphitrite* it is 2.26-5.26 and in *B. eburneus* 4.12-6.37 mm (Igić 1981a).

Habitat: This species is most often found in benthic communities on natural surfaces, that is, rocks. It is common on docks, shellfish, crustaceans and artificial substrates that are submersed for several months at the infralittoral edge. Considering the depth, there are relatively various comments. Relini (1980a) cites that this species is distributed from the upper level of infralittoral to about 40 m of depth, most often about 10 m of depth and on entrances of underwater caves. Cecero & Matarrese (1983) assume it to be the species of surface waters, and this view is supported by Relini & Giordano (1969). Vaccarella et al., (1977) cite that this barnacle has no depth preferences. Considering the habitat quality, this species is very sensitive on pollution with Fe, $N\text{-}NH_4$ and various oils. In such places mortality is high, up to 86%, while in the cleaner waters mortality is under 24% (Relini & Relini-Orsi 1971). Although this barnacle is present in harbour waters, it is however a species that prefers cleaner waters and there predominates over all other animals. When this species is dominant over *B. amphitrite*, the waters are relatively clean, flowing and not desalinized (Relini 1980a).

Diet: This species has a very interesting method of feeding. The rhythmical movements by three pairs of cirrus legs push the water toward the filtration system (Rainbow 1984). These movements are different than those of other species (Crisp & Southward 1961; Anderson 1981). Besides being an eater of phytoplankton, as all the other barnacles are, this species may also feed on zooplankton. The water passes over the mantle cavity, across the gills, and then lingers on the carinal end, where it is filtrated by three pairs of anterior (front) legs (Anderson 1981). Particles up to 1 mm in size may be consumed that way. The most important factor are the numerous hairs on the cirrus legs.

Distribution: the eastern coast of Atlantic, from England through Europe and Africa, and the whole Mediterranean including the Black Sea. Considering the existence at the upper border of distribution, in waters of Great Britain this species is present only in warmer months, while in winter the individuals die and new ones arrive by ships from warmer areas.

In the Adriatic, Kolosváry (1947) cites this species for the northern part (Trieste, Rovinj, Senj, Chioggia) and the middle part (Split), while the same author (Kolosváry, 1955) does not mention it for lagoons and River Po delta. In North Adriatic, this species is present in Trieste Bay in fouling communities together with the former species, but with lesser abundance (Specchi et al., 1976) as well in Piran Bay on limestone plates (Vriser 1986). This species is somewhat more common in fouling complex at Umag (Igić, 1994a) and Raski Bay (Igić 1986), where it was also found in the benthic communities (Zavodnik D & Zavodnik N 1986). Besides, in the north Adriatic it is even more present on the shellfish at Rovinj (F=48.10-73.20%) and rare on oysters in Lim channel (F=0.88%) (Igić 1981b), or on test plates in Pula harbour (F=2.2%) (Igić 1982) and Plomin harbour (F=8.3%) (Igić 1991). However in mid Adriatic in Kornati islands, of 68 investigated spots it was found in 15, that is, 22.05%, on various depths. For example, it was found on depth of 0.5 m at Lucmarinjak island, at 0-1 m at islands Puraro and Laus (another at 5 km depth) and in harbors Ravni Zakon and Lavso. Also, in benthos, this barnacle was found on Grpascak (1.5 m, 2.5 m), on Smokvica island, on Gominjak (at 1-4 m of depth), on infralittoral edge of Kasel is., on Kornati Island in Stinivo Bay (at 2.5 m) and in Lapescin Bay (at 0-2 m). On all these localities, the population density was insignificant except for the greater abundance at Puraro island and Grpascak island (Zavodnik, viva voce).

Balanus trigonus Darwin 1854

Balanus armatus Müller 1867: 329 text pls. 1-3.

This species is very simple to recognize, as the shell has longitudinal protuberances. It is composed of 6 parietal plates, and on the inner side is white with a simple row of tubes. The operculum opening is triangular or semi-triangular, and the sharp angle toward the carina is not toothed. On the outside of scuta there are 2-6 longitudinal rows of tiny holes, which make transversal rows (Fig. 42 a, c). Darwin (1854) and Kolosváry (1941) cite that these holes may be hardly present or even lacking. On the inner side of scuta there is an angled ridge that is very long, deep and narrow (Fig. 42 b). Terga are relatively thin, flattened, wide and the upper part looks like a beak without a furrow. The appendage is broken, as wide as the basal edge and as long as 1/3 of the tergal length. On the outer side, the terga are almost completely smooth with hardly visible lines (Fig. 42e), while on the inner side there is a ridge and a hardly visible furrow (Fig. 42d). The mandible has 3 well developed teeth and one irregularly built tooth that is placed somewhat lower. The maxilla has a slight notch, with two long stiff hairs in the upper part, placed at the lower edge. Six to eight shorter hairs are placed at the blade of the angle. The labrum is dented, with three teeth on one side of the notch. Radii are wide, non-porous, with the upper edge parallel to the base. The base is calcified and porous. The first pair of cirrus legs has uneven rami. The anterior ramus is pointed and longer than the posterior ramus. The front edges of the second ramus are convex. On the anterior ramus of cirrus legs from second to fourth pair, the final parts of basal segments are tooth-shaped. The second pair of cirrus legs has even rami, although the posterior ramus is somewhat shorter than the anterior one. The third pair of cirrus legs has somewhat longer rami than the second pair and the front pair is somewhat longer than the rear one. The fourth pair of cirrus legs has rami almost equal in length, much longer than in the third pair. The front edges of segments bear 2-4 long pairs of stiff hairs (setae), while the segments of the anterior ramus have teeth-like spines on the outer side. The fifth and the sixth pair of the cirrus legs are long, with 1-4 pairs of long stiff hairs on the front edges. The penis is longer than the sixth pair of cirrus legs, with a basidorsal spot of sharp angle, and is very much curved toward the carina.

Color: The shell is pink or pinkish-violet. The opercular plates are pink or reddish-white with longitudinal stripes that are mostly white. Radii are somewhat more intensive pink.

Size: The base diameter is 18.0 mm at maximum (Relini 1980 a), while on our shellfish the maximum size is 12 mm (mussels) and 13 mm (oysters). The average size on mussels is 6.5 mm and on oysters 8.5 mm (Igić 1981 a).

Reproduction: The settlement of larvae varies according to the climate and area. In Bari harbour, it settles continuously throughout the year (Vaccarella et al., 1977), in Tarant Bay (Mar Piccolo) from May to November, with a peak in August and September (Cecere & Matarrese 1983), in Genoa harbour from June to October (on the depth of 14-16 m this was a dominant barnacle species, 81.9 % in a four-year period) (Relini & Giordano 1969). In the Adriatic in Trieste harbour it settles from June to December with a most intensive colonization in August (Specchi et al., 1976), while in Piran Bay there is no clear view of seasonal distribution, as on year plates this species and *Ostrea edulis* were dominant and covered over ¾ of the surface (Vriser 1986). However, at Rovinj and in the Lim channel this species settles later, from August to January, extremely somewhat earlier in July (F=2.2%) (Igić 1981a). In the laboratory, under the specific values of temperature, light, dark, the development of six nauplius stages (from first nauplius stage to cypris larva) last for 9-13 days (at average 11 days) (Lee & Kim 1990).

Ecophysiological characteristics: in situ, this species is characterized by relatively slower growth, so the monthly growth is 0.50-1.50 mm, extremely in August 3.25 mm (mussels) and 1.16 mm (oysters). Considering the life span, it is relatively longer, so they usually live 4 months on mussels and 5 months on oysters as epibionts. The maximal life span on mussels is 8 months and on oysters 9 months, although they start to die after a month. Similar to the species *B. perforatus*, this species prefers biologically prepared substrate, and on shortly exposed substrate is rare (Igić 1981 a), so it is dominant on the substrate with longer exposition (Specci et al., 1976; Vriser 1986).

Diet: in the digestive tract of this species the following material was found: detritus 15-90%, crustaceans 75%, sand 5%, Foraminifera 2%, Radiolaria 2%, *Macrophyta* 1%, sponge spicula 1% (Tabacnik 1986). However, in laboratory conditions, larvae of this species thrive very well in sea water with a unicellular alga, diatom *Nitzschia closterium* (Lee & Kim 1990).

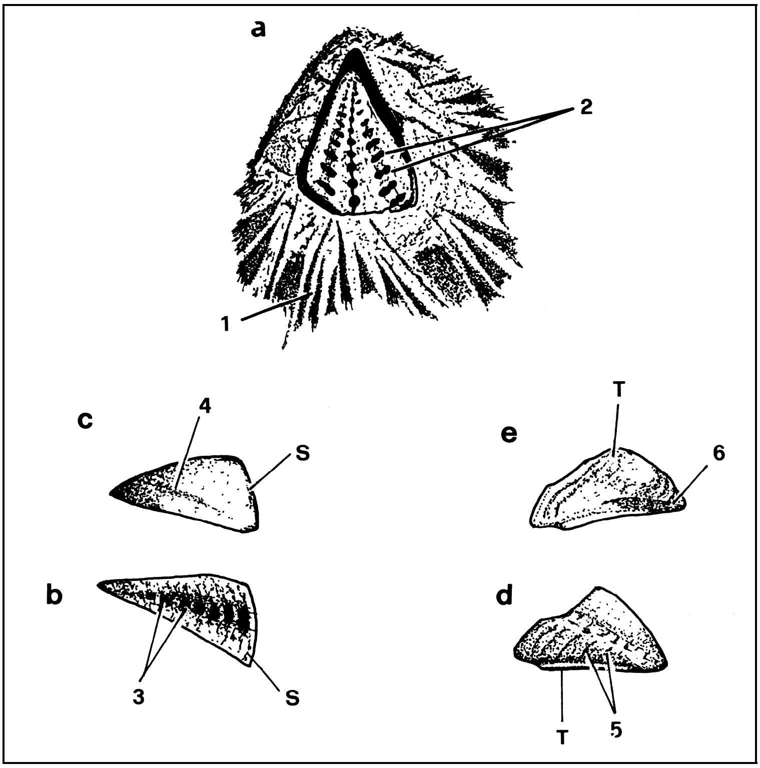

Figure 42. *Balanus trigonus* Darwin 1854

a. apical view of shell shell with longitudinal the prominences; orifice of operculum triangular, and is not tooth	b. outer surface of scutum 3. holes c. inner surface of scutum 4. ridge, long, narrow d. outer surface of tergum
1. prominences on shell	5. striae slimly visible
2. triangular orifice of operculum	e. inner surface of tergum

according to: G. Relini, 1968 (a, b, c, d)

Habitat: this species is mostly distributed on natural substrates, although is known for the fouling communities of piers, ships and various other immersed objects. It is also found on organisms: bryozoans, sponges, sea turtles, shellfish, for example mussels and oysters (Igić 1981 a), *Pinna nobilis*, snails, rhizomes of higher plant *Posidonia* (Relini 1968) and extremely rarely on sea star *Asteroid anthenea flavescens* (Jones 1992). In the vertical space it is present from the lower tide level up to 150 m, 450 m (Nilsson-Cantell 1921; Utinomi 1968) and even 3000 m (Gruvel 1905; Kolosváry 1942 a). This barnacle is found in mussel layer, between 14 and 16 m, with the frequency of 81.9% (Relini & Giordano 1969). It is distributed to 45-50 m of depth and prefers the bottom (Cecere & Matarrese 1983) and greater depths (Vaccarella et al., 1977). In contrast to species *B. amphitrite* and *B. eburneus* as a species characteristic for bays, this barnacle is classified as a species of open waters (Yamaguchi 1977 a; Anil et al., 1990). In the lagoons it is found only in constantly refreshed waters. Considering the quality of the water habitat, it prefers cleaner waters, while in the polluted ones, such as in harbors, only 1% of larvae survive, much as in species *B. perforatus* (Geraci & Romaitone 1982). It is found together with *B. perforatus* on the rocky shores (Relini 1973; Lepore & Gherardi 1977).

Distribution: a cosmopolite species, present mostly in warmer and subtropical seas, of three oceans but also in subtropical coast seas. In the Pacific, it is present from the Tokyo Bay across the eastern part of Indian Ocean to the Sidney and southern part of New Zealand, the west coast of South America to Peru and to the north across the North America to south California. In Atlantic it is present from Madeira to the Cape of Good Hope, with densest population at Senegal and Cape Verde islands. It is also present in Red Sea and Mediterranean. Considering the Adriatic, this is one of the youngest barnacles, discovered for the first time in the Trieste Bay in 1964. It was brought by fishing ships that linger for 7-15 days and come from the northwestern coast of Africa (Relini 1968). In relatively the same time, this species was found in the Genoa Bay (Relini 1964 a) and somewhat earlier in Tarant Bay (Kolosváry 1966). The first time in Mediterranean this species was discovered earlier at Catania (Patane 1927). It was also found in fouling complex of Bari harbour (Vaccarella et al., 1977), and on our side of the Adriatic in Trieste harbour (Specchi et al., 1976) and Piran Bay (Vriser 1986). At Umag in fouling complex this was the most common species of barnacles (F=43.4) in the upper infralittoral (2 m) in the ”open sea”, while in the lagoon area it was totally lacking (Igić 1994 a). This is true in general for other research in lagoon areas of northwestern Adriatic coast, where the well presented barnacle was *B. improvisus*. This species is often found on the shells of oysters (F=29.6%) and mussels (25.45%) at Rovinj, while on the same shellfish in Lim channel, the settling was only qualitatively important (F=1.80%) (Igić 1981 a). In numerous research of fouling communities, only the species *B. trigonus* settled on the glass test plates at Rovinj (F=18.9%) (Igić 1982), and somewhat in the Plomin area too (F=7.7%) (Igić 1991). Besides, on this type of test surface the settling is generally only qualitatively important, for example in Lim channel (F=0.4%), Pula harbour (F=3.8%) and Rijeka Bay (F=0.6%) (Igić 1982). The same barnacle is not mentioned in benthic communities along the Adriatic coast or in the fouling communities of mid and southern part of eastern Adriatic coast, probably due to much rarer research of fouling problematic. For all places in our research it is a common characteristic that the population density is low, and especially in Piran Bay (Vriser 1986).

Balanus inexpectatus Pilsbry 1916

Balanus amphitrite inexpectatus Pilsbry 1916: 1, text figs. 1-99, pls. 1-76; Nilsson-Cantell 1933: 503, text figs. 1,2; Kolosváry 1947: 1, text figs. 1-7, pls. 1-3; Newman and Ross 1976: 1, text; Henry 1943: 367, text figs. 15, 16, pl. 31; 1959: 1, text; 1969: 135, text.

The shell is usually peg-like, conical, rarely cylindrical. The shell surface is smooth. The epicuticle is thin, sometimes present at the base. The inner lamina of shell plates is ribbed usually only on the lower half, and the ribs are basally toothed. The parietal tubes are lined in a single row and vary in size and shape. There are 14-18 (average 16.5) tubes in the rostrum, without the transversal ridge, and they are filled in the upper half or third. The base has radial tubes and transversal septae that do not stretch toward the periphery. The opening's width is less than one half of carinorostral diameter (Fig. 43a). Scuta are usually flattened and may have a narrow tergal segment that is slightly bendable. The inner surface is usually rough in the upper part. The articular ridge is high, barely movable, about 3/4 of length of tergal edge and 1/2 of edge length (hem). The articular furrow is deep, the adductor ridge is high and long with a deep edge below. It rarely may be attached on the tergal side. The adductor muscle of the edge is medium wide and the lateral depressor muscle is small. Terga have raised scutal edge that is often stiff and rarely may be finely toothed. Toward the carina, the edge is slightly convex. The ridge is stronger toward the narrow carinal segment. The longitudinal lines are lacking. The lower tergal part spur (appendage) width about 2/5 length of basal edge; spur length about 2/3 spur width; distance from basiscutal angle to spur about 1/3 spur width, about 1/2 spur length, and about 1/10 length of basal edge. The distal end of the spur is usually cut short or rounded, rarely under an angle. The basal edge is usually straight on both sides and is rarely concave on the scutal side. The inner edge of the terga toward the scuta is high. The articular ridge is very prominent, pointing out, while the articular hollow is medium wide and deep. Crests for the depressor muscle are large and rarely stretch from the carinal edge toward the appendage and under the basal edge. The surface of terga is usually rough on the carinal side. On the basal part it may be finely or more intensively toothed (Fig. 43 b). Labrum has setulae and teeth on the crest on each side of the notch. The first tooth on each side of the notch is usually on the crest and near the notch. 1-4 teeth are on one or both edges and near the crest. The palpus has very fine appendages like feathers. The short setae are on the upper edge and the setulae on the lower one.

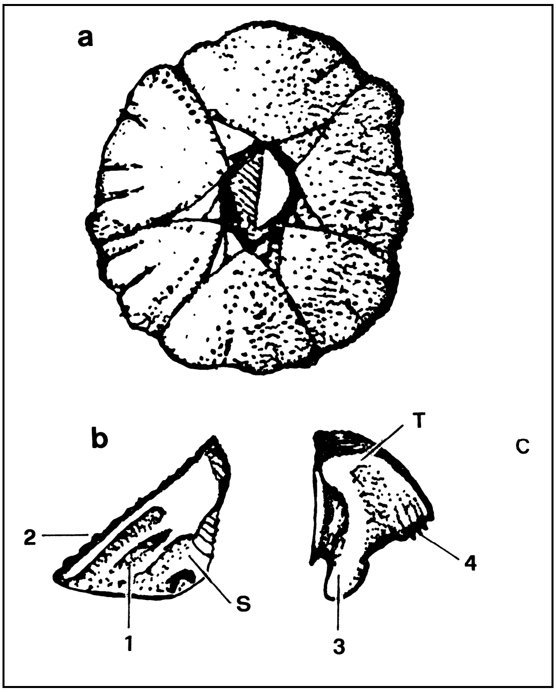

Figure 43. *Balanus inexpectatus* Pilsbry 1916

a. apical view of shell
shell usually conic, occasional cylindric; surface smooth; orifice entire
b. inner surface of scutum (S)
1. inner surface usually in upper part
2. occulent margin of scutum is toothed

c. inner surface of tergum (T)
3. spur width, and usually rounded or truncate, occasionaly obliquely truncate
4. surface of valve usually roughned on carinal side, sometimes finaly to strongly denticulate

according to: D. P: Henry & P.A. McLaughlin, 1975 (a,b,c)

The outer look of the labrum is characterized with several rows of simple short setae near the upper edge. Their density is decreasing proximally. The mandible has 5-7 (5.0) teeth, rarely with spines on the inner angle. The first and the second tooth are bifid; from third to seventh there are special teeth. The lowest tooth is usually attached with the inner angle. First maxilla has no notch under the upper pairs of spines, 2-14 (5.9). Between the upper and under pair of spines there are several fine spines on the inner edge. The lower pair of spines is somewhat longer than the upper pair, but is weekly moved toward the inner angle. The second maxilla has no important systematic characteristic. The first pair of cirrus legs has an anterior ramus composed of 1-10 equal sized pretuberant segments. The anterior ramus of the second pair of cirrus legs has two shorter front segments, while the third segment is longer than the rear one. The third pair of cirrus legs has an anterior ramus composed of 1-5 segments longer than in the posterior one. The fourth pair has 2 longer and 5 or 6 short setae on the distal ends of proximal segment, and there are rarely some on the middle segments. From fourth to the sixth pair of cirrus legs, there are several upright teeth (ridges), sometimes with simpler spinules under the ridges. The front edges of the front segment may have a conical tooth and spinules on certain proximal segments. Rarely there are no teeth and spinulas. The proximal segment is as long as the second. Usually there are no teeth or spinules. The following 3-9 segments have 1 or 2 rows of scarce teeth. The fifth and the sixth pair of cirrus legs have fine simple spinules on the distal spots where the middle segments are attached. The inner part of front segments has scarce strewn teeth. The rear segments have several short setae on the distal ends. The sixth pair of cirrus legs has 4-7 (5.6) pairs of setae on the front edges of middle segments.

Color: the shell is usually dull purplish-blue, with white or light blue longitudinal stripes. Sometimes the upper part is white, and the lower one is purplish, blue or white. There may be reddish-blue spots or stripes in certain parts. Rarely it is grayish blue with light longitudinal stripes; infrequently with indistinct transverse stripes. The radii are white, white with dark blotches, or light like parietal plates of the shell. Alae are usually blurred blue or purplish blue, sometimes white. The epicuticle is yellowish brown. The outer surface of the shell wall usually has some purplish or bluish parts in the middle of each segment. The inner lamina of rostrum and carina may be purple or blue near the edge of sheath, while the outer surface is like the chitinous cover of insect wings. Scuta are usually colored except for the white ring toward the tergal edge. The inner surface is rarely white. The outer side is usually dark purple or reddish, brownish or purple-scarlet, rarely blue. Terga are usually blurred white, rarely clean white. The outer surface usually has colored furrows. Sometimes there is the colored ring around the carinal edge. The inner surface usually has a wide colored ring along the edge. It may be grayish blue, lavender or reddish, brown or bluish-purple.

Size: the length of carinorostral diameter is at average 14 mm, extremely up to 19 mm, the height is at average 12 mm, while in the largest specimens it is 17 m (Henry & Mc Laughlin 1975).

Reproduction: In the Adriatic (vicinity of Split and Rovinj), in the plankton larvae were found up to 1 mm in size, and they were able to settle in July (Kolosváry 1947).

Distribution: This species is found along the California coast, in the Gulf of California and toward southwest to Ecuador. It is also mentioned for the Red Sea and Mediterranean. For the Adriatic Kolosváry (1947) cites this species for Venice, and the same author (1955) cites this species as *Balanus amphitrite inexpectatus* in Palestrina, Chioggia, San Pietro, Volta Canale Barbarigo, and also in Split and Rovinj (1947).

Variation: This species varies greatly in all parameters and features. For example, the upper parts of opercular valves are often corroded. Sometimes they may be bluish with weak longitudinal furrows and not corroded. However, the corroded specimens are most common.

Remark: As is already said, this species is not considered to be Adriatic, as none except Kolosváry (1947) has ever mentioned it. However, the description of this species should enable the quicker and easier identification of this species if it immigrates into the Adriatic.

Subfamily *Megabalaninae* Newman 1979

These barnacles have tubiferous wall plates of the shell. The base is solid, with well developed radii. There are transversal tubes between the toothed ridges. The representatives are found in littoral. There are about 53 species.

Genus *Megabalanus* Hoek 1913

There is much intraspecific variability. This holds mostly for the appendage of terga (the part of terga facing the basal edge). The narrow furrow is usually open in juvenile individuals, and in adults may be either open or closed. Terga usually lack the top part that resembles a beak. Radii have transversal tubes that are placed between the toothed ridges, and these teeth would mark the primary teeth. The edges of radii bear regular secondary teeth on upper and lower sides. the base is usually tubiferous. Labrum usually has well developed teeth on each side of the notch. They were present since Oligocene. About 42 species are known, 23 of which are recent. They live in warm and tropical seas (Henry & McLaughlin 1986).

***Megabalanus tintinnabulum* (Linnaeus 1758)**

Balanus tintinnabuliformis laevis Lang 1722

Balanus cylindraceus unicum thalamum efformans, magis ventricosus Gualtierus 1742: fig. E.H.I., pls. 1-110

Lepas Tintinnabulum Linnaeus 1758: 1, text, pls. 96-100

Lepas calyciformis orientalis Ellis 1758: 845, text, pl. 34

Balanus tintinnabulum Bruguière 1789: 158, text pls. 164-166

Lepas tintinnabulum Wood 1815: 1, text figs 1, 2, pl. 6

Lepas spinosa Wood 1815: 1, text fig. 4, pl.7

Balanus tintinnabulum var. *communis* Darwin 1854: 1, text figs. a, b, f, pl.1, supra pl. 2, figs. 1a, c, d, e, i, k; Hoek 1883: 1, text pls. 12-14; Sundra Ray 1927: 111, text pls. 12-14

Balanus tintinnabulum tintinnabulum Pilsbry 1916: 1, text figs. 1-99, pls. 1-76; Hiro 1939: 245, text figs. 1-16; Daniel 1956a: 1, text pls. 1-10; Davadie 1963: 1, text figs. 1-57, pls. 1-55; Zevina and Tarasov 1963: 76, text figs.1-14; Stubbings 1964: 327, text figs. 1-5; 1967: 229, text figs. 1-28, pl. 1; Karande & Palekar 1966: 139, text figs. 1-22, pls. 1-4; Kolosváry 1947: 1, text figs. 1-7, pls. 1-3

Balanus tintinnabulum antillensis Pilsbry 1916: 1, text figs. 1-99, pls. 1-76; 1953: 13, text figs.1-5, pls. 1,2; Oliveira 1941: 1, text (fig.2, pl.3), pls. 1-11

Balanus tintinnabulum var. *tintinnabulum* Oliveira 1941: 1, text (figs. 1, 2, pl. 4, fig. 1, pl. 4, fig. 3 pl. 5, fig. 6 pl. 8), pls. 1-11

Megabalanus antillensis Newman & Rose 1976: 1, text figs. 1-6

Balanus (Megabalanus) tintinnabulum tintinnabulum Xianqui 1978: 119, text figs. 1-33, pls.1-11

Megabalanus tintinnabulum tintinnabulum Relini 1980a: 1, text figs. 1, 2, 6, 7, tab. 4

The shell is cylindrical, cylindro-conical or conical with 6 parietal plates that are smooth or medium longitudinally ribbed, medium thick, tubular. The base is often elongated. The opening is medium large or small (1/3 – 2/3 of basal diameter), half-circular or half-triangular (Fig. 44 a). Scuta have narrow to medium wide tergal segment. It is usually flattened or slightly curved in cylindrical specimens, bluntly curved in cylindrical and conical individuals. The outer surface rarely has a shallow middle furrow. In young specimens shallow pits may be present. The basal edge is straight or slightly curved. The longitudinal furrows are prominent, but may be lacking (Fig. 44 c). Terga are often wider than scuta. They are triangular with a furrowed spur that may be broad or narrow, of normal length, detached from the basiscutal angle by 1.5-4 times of its own width. The basal edge is erect or slightly steep toward the spur on both sides (Fig. 44 c). Radii have teeth on both sides of the ridge. They are wide and have horizontal upper edges. The alae have tops under angle. The labrum is hirsute with two teeth or one tooth on each side. One of two of them may be reduced or lacking. The mandible bears 5 teeth. The second and the third are split (double), and the fifth is tiny and coalesced with the blunt lower side. The first maxilla has a pair of long spines at the top, another one at the base and 10 smaller spines in between. The second maxilla has a steeply cut angle and numerous medium sized spines, two large spines at the upper edge and other two toward the lower, spiny angle. The first pair of cirrus legs has unequal rami and have front and rear protuberances. The segments have numerous peg like flakes on dorsal areas. The second pair of cirrus legs has short rami. The anterior ramus is somewhat longer than the posterior one, and all segments are very pronounced. The outer side has short spines in a distal row. The third pair has unequal rami (the anterior one is longer than the posterior one). The segments are medium prominent and on the distal part there are erect short spines. Forth, fifth and sixth pair of legs are characterized by a row of upright spines on the distal part. Penis is shorter than the sixth pair of cirrus legs, thin, ringed, pointed on the top.

Color: Shell plates are reddish or bluish, purple to brownish-red, usually with longitudinal striae. Very often, there are also narrow or wide rings, which are darker or lighter than the plates. Radii are white with yellow, crimson or carnation blotches. The tergoscutal flap has 3 transversal brown or reddish brown furrows. The areas between the furrows are light brown or almost transparent, with green fluorescent spots, and the shadows may be yellowish green or bluish green (Fig. 44 b).

Size: This is one of the largest barnacles. The diameter of the base is mostly about 25 mm, and it may be 50, 60 or even 75 mm. The height is up to 50.0 mm (Henry & McLaughlin 1986).

Reproduction: Kolosváry (1947) cites that nauplius larvae are found in plankton in Adriatic (Rovinj, Split) from May to January, while in the warm seas they can be found throughout the year, with greatest intensity in the summer months.

Habitat: In the fouling communities, this species is very important due to its size and therefore huge biomass. It settles from shallow water to 40 m of depth, most often at 5-6 m, on the wave-affected shores. It settles on rocks, buoy sticks, ships, sea algae, mollusk shells (*Mytilus*, *Cypraea* sp., *Patellae*), *Echinodermata* etc.

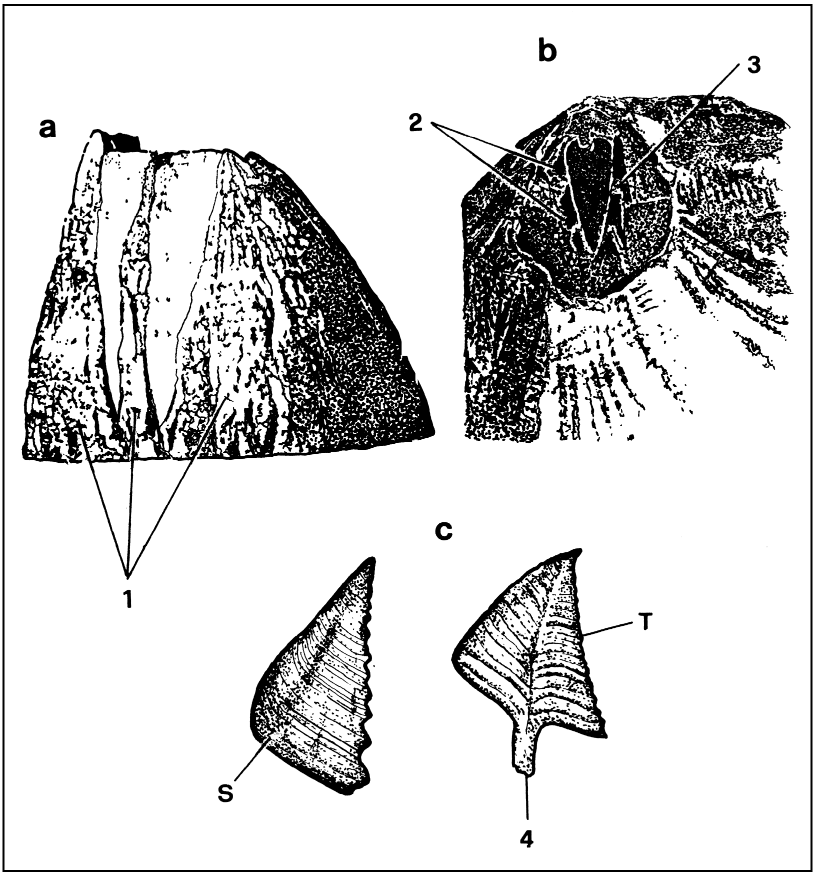

Figure 44. *Megabalanus tintinnabulum* (Linnaeus 1758)

a. lateral view of shell
shell cylindric, cylindro-conic or conic
1. showing typical ridges on the plates and the horizontal upper edges of the radii
b. tergoscutal flap
2. with three transverse brown or purplish-brown bands
3. the spaces between the bands lighter brown or almost transparent, speckled and tinged with bright fluorescent green shads, varying from yellow-green to blue-green.
c. external sides of opercular valves
S. scutum - surface usually flat or slightly inflected (in cylindric specimens), occasionally with shallow median
T. tergum - frequently widen than scutum
4. spur, moderately long, narrow to moderately wide

according to: D. P. Henry & P.A. McLaughlin, 1986 (a,c); A.J. Southward & D.J. Crisp, 1963 (b)

Distribution: in temperate and tropical waters of South hemisphere. As an important example of anthropogenous cosmopolitism, it reaches into the colder waters via ships. It was found in Dutch waters in 1764, and is still present there. It is assumed that it was transported through ships from west Africa (Holthuis & Heerebout 1972). This species is present on the west coast of Africa to the Cape of Good Hope, about Madagascar, Arab Sea, Gulf of Bengal, Thailand, Taiwan, Japan, New Zealand, Australia, Brazil, Peru. In the European waters it is present in Netherlands and in several microlocalities in Mediterranean. Considering the Adriatic, it is mentioned at the entrance of harbour Malamocco, in Coroman channel, at the entrance of Chioggia (Rigo 1942) and in Piran Bay (Vriser 1978). For Trieste, Rovinj, Pula and Rijeka, Kolosváry (1947, 1955) cites this species as *Balanus tintinnabulum tintinnabulum*. Relini (1969, 1980) cites these findings to be wrong and that this barnacle is not present in the Adriatic. However, through ships this barnacle got into the Ligurian Sea and managed to settle in cooling tubes of power plants, where the temperature is higher than in the other parts of the sea (Relini & Montanari 1973). Therefore this species is dealt with here, as there is always a possibility that through fouling complex on ships it may be transferred from warmer waters and settle in some warmer microlocality.

Remark: When citing synonyms in this text, the synonyms and authors considering the Adriatic were not listed as they can be seen in Table 1. Besides, for some authors in synonymia, the first page of the text was not put (for example Poly 1871) or for some species of order Rhizocephala, after author we didn't put the year (for example, *Sacculina gerbei* Bonier). In these cases we had not data.

CONSIDERATION OF TAXONOMIC CATEGORIES ON ORDER LEVEL (SUBCLASSIS CIRRIPEDIA) RELATED TO PARASITICAL REPRESENTATIVES

The division of taxonomic categories on order level (Annex 1) was explained in various ways. Zarenkov (1982) considers the mentioned orders to be suborders, and subclass *Cirripedia* to be an order, while the other authors use the given categories. Newman (1987) comments that the parasitic animals of orders *Ascothoracica* and *Rhizocephala* are not *Cirripedia* in literal sense, and that they should be considered to be "sister groups" of *Cirripedia* in Maxillopoda. The three groups should be placed in the taxon *Thecostraca*. For the orders *Ascothoracica* and *Acrothoracica* the data are extremely scarce, almost lacking. Only Zarenkov (1982) cites that representatives of *Ascothoracica* are gonochorists. The males are unable to feed, and the female bores into the calcified substrate when reproducing. If there is no such substrate when changing skin, females constitute an exoskeleton and an ectodermic cover. The author thinks that this suborder includes the superfamily *Pygophora*, whose representatives have a closed gut. The second pair of cirrus legs is branched and the third is relatively larger from the other pairs of legs. The same suborder should also include superfamily *Apypophora* with a characteristic gut and three pairs of branched legs. Both these groups belong to the recent fauna. However, Huwae (1985) describes the morphology of the species *Trypetesa lampes*, from the same order, that lives in Dutch waters.

Besides, Høeg and Rybakov (1992) divide the order *Rhizocephala* into 7 families, including the *Sacculinidae* and *Peltogastridae* that have representatives in our waters.

ORDER *RHIZOCEPHALA*

Without the studies of their larvae, it would be hard to determine these animals as *Cirripedia*. They have a nauplius larva with a characteristic front antenna. These crustaceans have a shape of broken root. The female is able to suck the liquids from the host. She develops an external sack for the brood, with ovaries and a mantle cavity in which the eggs are incubated (Figs 45 and 46). The commonest and widest distributed, cosmopolitan representative of this order is the species *Sacculina carcini* on the crab *Carcinus maenas* (Fig. 47 a,

b) and *C. aestuarii*. The species *Peltogaster paguri* is found on *Pagurus bernhardus*.

Suborder *Kentrogonida* Delage 1884

This suborder got its name due to characteristic infective state kentrogon in their life cycle. The early researchers were in dilemma if they were parasites or not, and if they were hermaphrodites or not. However, several authors (Ichikawa & Yanagimachi 1958, 1960; Yanagimachi 1961 a; Yanagimachi & Fujimaki 1967; Ritchie & Høeg 1981) cite that these are kentrogonid rhizocephalan barnacles with a modified hyperparasitic larval females. The males and the larval nauplius females differ in size, produced from separate male - or female - bearing females . The larvae develop through several larval stadiums in the plankton. They do not feed, but use own yolk reserves, and after moult in 5 or 6 days develop into cypris larvae, for example in the species *Sacculina carcini* (Day 1935). Three days later, the female cypris larva settles at the hair base on the host crab (Day 1935), and attach by middle sized antennules. She then metamorphoses into the remarkable infective stage – kentrogon. This process in *Sacculina carcini* takes 24 hours in *S. carcini* (Delage 1884). These parasitic crustaceans are castrators (Reinhard 1956). The male crabs attacked by rhizocephalan develop secondary sexual characters, including shape of abdomen, pleopodes and hooks, while the testicles become more or less atrophied. The abdomen in sacculized male crabs becomes wider with more hairs about the edge. The third, the fourth and the fifth segment coalesce, while the number and shape of pleopods is changed (Reinhard 1956). The sacculinized females are hyperfeminized. The mechanisms changing the sexual characteristics of hosts are not explained yet. However, it is assumed that the attacked host makes a metabolite-rich matter similar to yolk, which is then used for development of eggs. The fertilized egg mass and morphological modifications of host rear abdomen probably helps the parasite to aerate better, which is necessary for incubation of egg mass. The settled parasite either directly inhibits the growth of any further parasite by selection toxins (Levy 1923; Rainbow et al., 1979), or the immune reaction on further parasites happens in the host (Reinhard 1956).

Family *Sacculinidae*

Laterally flattened. Narrow moesenterium. The opening of the cover is more or less opposite to the stem. The segment glands are branched.

Genus *Sacculina* Thompson 1830

The kentrogon contains a sack of undifferentiated cells together with the antennules. The new cuticle is secreted around the sack and the kentrogon is detached from the old cypris cuticle. In that way a flabby reduced body develops (Delage 1884). The hollow saclike bump (kentrolog) develops at the base of antennules, and all this is imprinted into the base of crab setae. The mass of undifferentiated cells migrates from there into the crab through the hyperdermic sprincler (tube) (Fig. 45, 46).

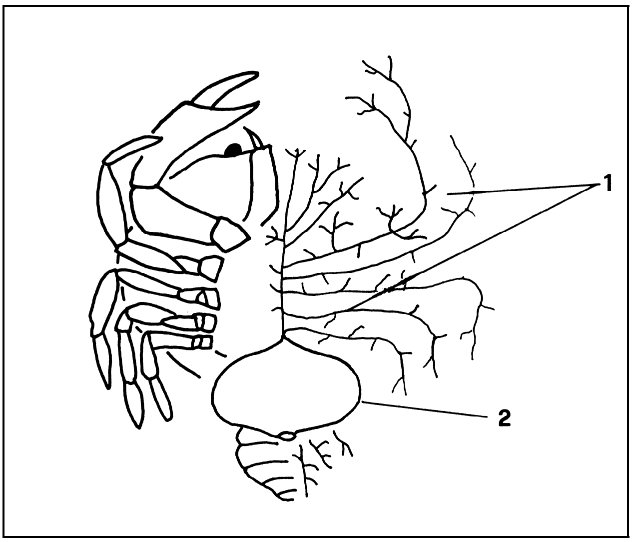

Figure 45. Rhizocephala - *Sacculina* sp.

a. parasite on crabs, exists as a network (interna) penetrating the body of the crab, with an externa emerging at the base of the crab's abdomen

1. internal view of parasite (network)
2. external view of parasite

according to: P. S. Rainbow, 1984

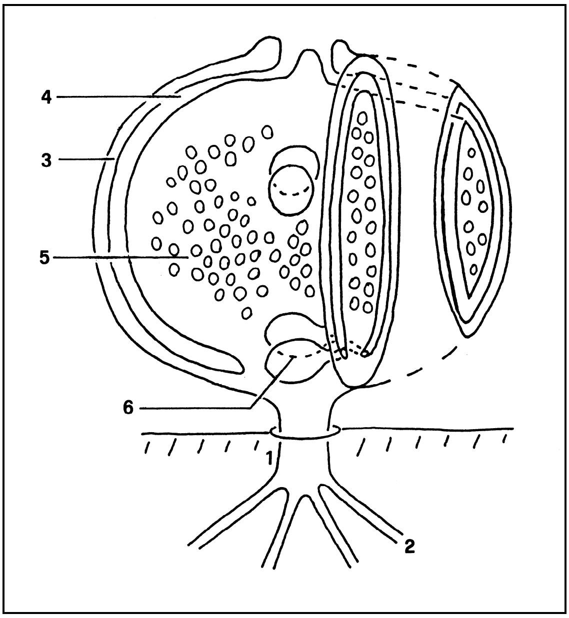

Fig. 46. *Sacculina* sp. Thompson 1830

The structure of the externa of genus Sacculina

1. host	4. mantle cavity
2. roots	5. eggs
3. mantle	6. male cypris cells

according to: Ichikawa & R. Yanagimachi, 1960

Sacculina carcini Thompson 1830

This species is more or less triangular, and the front part is much wider than the rear one. One of front angles is elongated like a horn and the other one is uniformly rounded. The opening is placed under the top of well developed papilla on a distance from the front edge. The opening has no radial furrow like in other species of this genus (*S. gonoplaxae*, *S. gerbei*) (Fig. 47 a, b; 48 d).

Color: the body and the roots are yellowish, while the mature larvae are usually red.

Size: The dorso-ventral diameter is 10 mm, the anterio-posterior diameter is 7.5 mm and thickness 4 mm on a host *Pisa nodipes* (Leach). These are average values, while in the northern Adriatic (at Rovinj) on host species *Pachygrapsus marmoratus*, the larger individuals are found (15.5 mm), and near Pula was found the largest specimen that had a diameter of 18 mm. At Split harbour the largest specimens were 17, 14, 18 and 11 mm. All of these were found on depth up to 1 m. However, on the same host in the open waters of Rovinj, where depth was about 20 m, the largest parasite diameter was 10 mm. There was no positive correlation between carapace size and parasite size (Boschma 1961).

Reproduction: about 9 months after the infection, the tube grows and pierces the host's cuticle to end in a sac. This process usually happens in August and September (Foxon 1940). In one day, the sac may reach 4 mm in diameter and is ready to contact the cypris male (Degale 1884; Foxon 1940; Ichikawa & Yanagimachi 1960). The male cypris attach to the surface, inserting their cellular mass into the mantle cavity. The cellular mass migrates into the cypris cells that actually represent differentiated spermatozoa (Yanagimachi 1961 a). After this, a much branched ovary develops on the externa. It produces eggs that are fertilized by spermatozoa from cypris cells. The fertilized eggs are then incubated in the mantle cavity. Usually in late summer this parasites releases many nauplius larvae in host.

Ecophysiology: This species lives longer on crab females than males. It is recorded than in England it lived for a year.

Habitat: A parasite on several crustacean species. In Adriatic it is found in Carcinus aestuarii, Liocavunus arcuatus and Pachygrapsus marmoratus (Pesta 1918; Vatova 1928; Boschma 1961), Achaeus cranchi, Eriphia verrucosa (Vatova 1928), Pisa nodipes (Boschma 1961). In Adriatic, this parasite is most often found on Pachygrapsus marmoratus (at Rovinj and Split) from the surface to 1 m of depth, while on host *Pisa nodipes* it was found on 20 m of depth (Boschma 1961).

Distribution: This is an European species, the autofertilizing hermaphrodite (Lutzen, 1984), on previously mentioned genera as well as on species of genus *Liocarcinus* etc. (Boschma 1972; Rainbow 1984; Høeg 1985).

Sacculina eriphiae **Smith 1906**

Boschma (1961) cites that this species is found on the host *Eriphia verrucosa* in Rovinj harbour (north Adriatic) on depth 0-1 m. The largest specimen had diameter of 40.5 mm. The same species is mentioned by Smith (1906) with even larger diameter of body (45 mm).

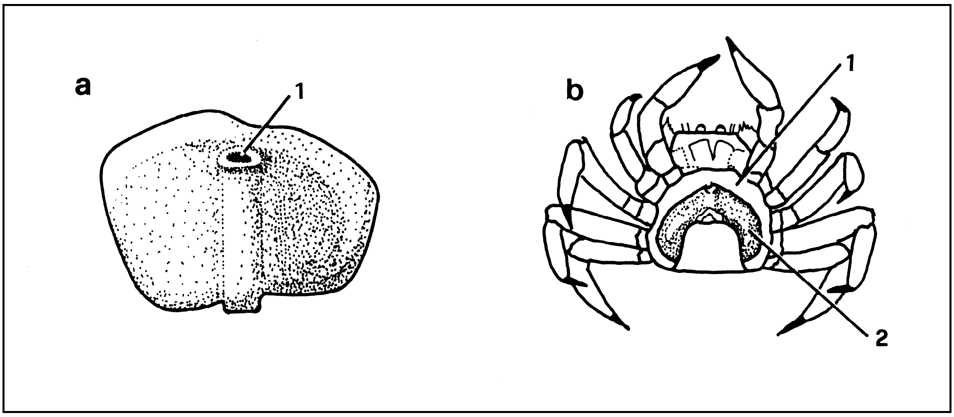

Figure 47. *Sacculina carcini* Thompson

a. external view of parasite
1. encyclical part of mantle with the opening parasite

b. host - *Carcinus maenas*
1. host
2. parasite

according to: R. Riedl, 1991.

***Sacculina gerbei* Bonnier**

The body shape is wide oval to trapezoidal. The front part of the body is wider than the middle. The short thick stalk is connected to the edge with its middle part. The oral opening lays under the top of a papilla, which is usually large and placed in the middle of front region, turning toward the left side somewhat. In the middle of the right side there is a deep longitudinal groove, as a result of pressure from the middle ridge of host's abdomen on the parasite. The other parts are smooth when observed by naked eye, but the microscope shows discrete tiny ridges so it looks strongly contracted over the whole of its surface.

Size: the dorsoventral diameter is 8 mm, the anterio-posterior is 6 mm (not including the papilla) and the thickness is 3 mm.

Habitat: In the Adriatic, this species was found at about 40 m of depth near Split on *Ethusa mascarone* (Boschma 1961), *Xantho granulicarpus*, *Pilumnus spinifer* and *Atelecyclus rotundatus* (Boschma 1955, 1958) (Fig. 48e).

***Sacculina gonoplaxae* Guérin-Ganivet 1911**

This species is mostly oval or more or less triangular, with somewhat stretched front angles. In both forms, the opening of the mantle lays at the top of the papilla at the mid of upper edge (oval form), or in the middle of the front region (triangular form), so it is slightly turned toward the left side of the body. The individuals may also be more or less rounded, so they stretch from the left and right side of host's abdomen. The male organs are normally developed (Fig. 48 a-c).

Color: according to Øksnebjerg et al., (1997), the immature specimens are light yellow, while the large ones were corroded, so their color was darker yellow on the sides and dented with light yellow on the spotted light-brown deep furrows.

Size: the size of two specimens on 15 m of depth was 7 and 8 mm in Turkish waters (Øksnebjerg et al., 1997). Boschma (1961) gives a detailed account on this species' size. In largest specimens the dorsoventral diameter is 7 mm, the anterio-posterior 5.5 mm and thickness 3 mm. According to the same author, the size decreases with depth, so at 20 m the largest diameters were 4 and 7 mm, and on 30 m they were 2.6 and 2.4 mm.

Habitat: this species favors bigger depths. At Rovinj on *Pilumnus spinifer* it was found on 20 m and 30 m of depth (Boschma 1961). Also on the south coast of Turkey, this parasite is found between 15 and 20 m of depth (Holthuis 1961), and even deeper at 18-59 m (Holthuis & Gottlieb 1958). Besides this host, it is also a parasite on *Goneplax rhomboides*.

Distribution: in Mediterranean on *Goneplax rhomboides* in Tyrrhenian sea and Marseille Bay (Richiardi 1875; Marion 1883), in Naples Bay (Smith 1906; Boschma 1927, 1927 a, 1933), on coast of Turkey and eastern Mediterranean (Øksnebjerg et al., 1997) and Adriatic (Boschma 1961).

***Drepanarchis neglecta* (Fraisse)**

This species is kidney-shaped. The rear part is protruding like wide lace above the stalk. The narrow opening of the mantle lies near the middle of front region. Their surrounding area does not stick out of the surface.

Size: the dorsoventral diameter is 8.5 mm, the anterio-posterior 5.5 mm and thickness 3 mm.

Habitat: it is found at about 25 m of depth between Dubrovnik and Lokrum on the crustacean *Inachus thoracicus*. Besides, this parasite was previously unknown in order *Rhizocephala*, while in recent times infections are known on several species of genera *Inachus* and *Macropoda* (Boschma 1961) (Fig. 48 f).

Remark: determination of these parasitic species is possible by basic characteristics of body shape, as *Sacculina gerbei* and *S. gonoplaxae* are shorter and egg shaped, while *S. carcini* is longer and egg shaped. There are also differences in wrinkles of mantle, and presence or absence of papilla around the opening. In *Sacculina carcini* there are no radial furrows at the opening although they are present on the surrounding parts of the mantle. *S. gerbei* and S. *gonoplaxae* have strong sphincters due to prominent wrinkleness of mantle opening papilla.

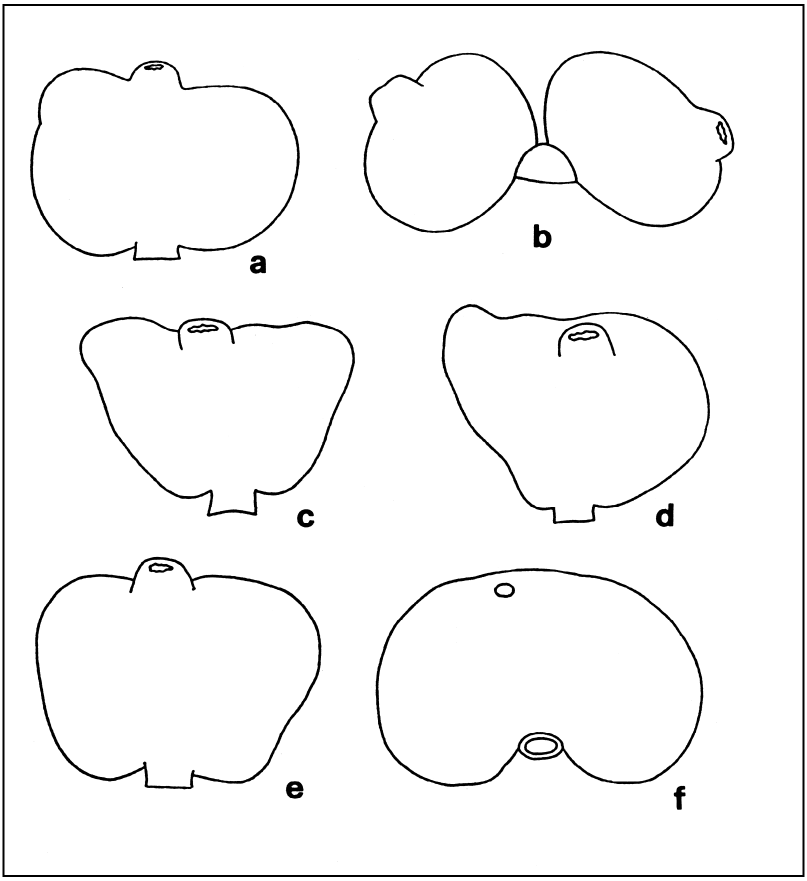

Figure 48.

a.,c. *Sacculina gonoplaxae* Guérin-Gamivet; two large of the specimens

b. two smaller of the specimens; attached on the host - *Pilumnus spinifer*

d. *Sacculina carcini* Thomas 1830 parasite on crabs - *Pisa nodipes*, *Carcinus maenas* etc.

e. *Sacculina gerbei* Bonnier parasite on crab - *Ethusa mascarone*

f. *Drepanarchis neglecta* (Fraisse) parasite on host - *Inachus thoracicus*

according to: H. Boschma, 1961

Family Peltogastridae

They are spherical, rounded or curved. The stalk is between the dorsal side and the rear one.

Genus *Peltogaster* Rathke 1842

This species has elongated oval body. The stalk is on the back or on the rear part. They are parasites on crustaceans, mostly decapode and principally hermit crabs - *Paguridae*.

Peltogaster paguri (Rathke 1842)

The body is regularly cylindrical, and the opening of the mantle is pointed frontward.

Color: Adult specimens are red and the roots are green.

Size: the average body length is 2-3 mm, and the maximal one was 5 mm.

Distribution: Vatova (1928) cites this species for the first time in the Adriatic as a parasite on a crustacean *Pagurus cuanensis* (Fig. 49 a, b). This species is less common in our and other seas (for example, North Sea). On the coast of Netherlands, this species was found several times on *Pagurus bernhardus* with 2.4% infection of 820 examined hosts (Adema & Huwae 1982).

Peltogaster curvatus Kossmann 1873

It lives as a parasite on the abdomen of the crustacean *Pagurus prideaux* (Stossich 1880).

Peltogaster longissimus Kossmann 1873

It lives on the same host as the previous species that is *Pagurus prideaux* (Stossich 1880).

Parthenopea subterranea Kossmann 1873

This is the parasite of the crustacean *Calianassa subterranea* (Stossich 1880).

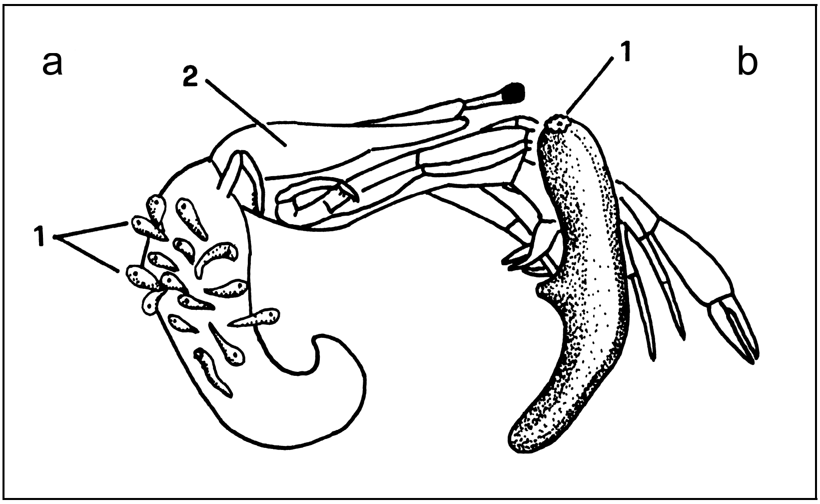

Figure 49. *Peltogaster paguri* (Rathke, 1842)

a. parasite and host
1. parasite
2. host - *Pagurus cuanensis*

b. parasite; body irregular cylindrically, red colour

according to: R. Riedl, 1991

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Do 1758. godine binominalna nomenklatura u zoologiji nije validna. Jer, prema internacionalnom kodeksu zoološke nomenklature, obeležavanje i generalno primenjivanje binominalne nomenklature u zoologiji uvažava se od Linnae-ove 10 edicije "Systema natura" 1758 godine; citirano u - Principles of

Systematic Zoology, edit. Mayer, E.-Mc Grow-Hill Book Company. New York St. Lous San Francisco, Toronto, London, Sydney, 428 pp., 1969.

ANEX 1

Classification of Cirripedia to higher taxonomic categories (to the level of order):

Order		Author
Ascothoracica	do not live in Adriatic	Waterman (1960), Newman & Ross (1976), Newman (1987)
Acrothoracica	do not live in Adriatic	Waterman (1960), Kaestner (1967), Newman & Ross (1976), Zarenkov (1982), Huwae(1985)
Rhizocephala	live in Adriatic	Waterman (1960), Kaestner (1967), Newman & Ross (1976), Zarenkov (1982)*, Huwae (1985) Newman, (1987)
Thoracica	live in Adriatic	Waterman (1960), Kaestner (1967), Newman & Ross (1976), Zarenkov (1982), Huwae (1985), Newman (1987)

* Zarenkov (1982) classified suborder Cirripedia to taxonomic cattegory: order, and mentioned orders he classified to suborders

ANEX 2

Classification of Cirripedia according to Newman (1987)

Classis MAXILLOPODA Dahl 1956 (Copepodoidea Befclemischey 1952).

Subclassis CIRRIPEDIA Burmeister 1834 (Cirrhipèdes Lamarck 1818)

Order ASCOTHORACICA Lacaze Duthiers 1880 (Ascothoracida ili Rhizothoracida Lacaze-Duthiers 1880, razmatrano je kao posebna Subclassis Maxillopoda; Grygier 1984)
Waginella, Synagoga, Laura, Petrarca, Ascothorax, Ulophysema & Dendrogaster

Order Rhizocephala Müller 1862 (mogu predstavljati posebnu podklasu – Newman, 1982)

Suborder Akentrogonida Häfele 1911
Chthamalophilus

Suborder Kentrogonida Delage 1884
Lernaediscus & Sacculina

Order THORACICA Darwin 1854a

Suborder Lepadomorpha Pilsby 1916 (Lepadidae sensu Darwin l851a)

Superfamily Cyprilepadoidea Newman et al. 1969 (stat. nov.) + Cyprilepas

Superfamily Praelepadoidea Chernyshev 1931 (stat. nov.) + Praelepas

Superfamily Ibloidea Leach 1815 (nom. trans. Zevina 1980) Ibla

Superfamily Heteralepadoidea Nilsson-Cantell 1921 (stat. et sensu nov.)
Heteralepas, Paralepas & ? + Priscansermarinus

Superfamily Lepadoidea Darwin l851a (nom. trans. Zevina 1978) Lepas, Conchoderma, Alepas, Poecilasma, Octolasmis & Pagurolepas

Superfamily Scalpelloidea Pilsbry 1916 (nom. trans. Zevina 1980) + Archaelepas, + Eolepas, Neolepas, Scillaelepas , Calantica , Capitulum, Pallicipes, +Cretiscalpellum, + Zeugmatolepas , + Stramentum, Smilium, Euscalpellum & Arcoscalpellum sensu lato

Suborder Verrucomorpha Pilsbry 1916 (Verrucidae sensu Darwin l854a)

+ Eoverruca, + Proverruca & Verruca

Suborder Brachylepadomorpha Withers 1923 (Brachylepadidae sensu Woodward 1901)

+ Pycnolepas & + Brachylepas

Suborder Balanomorpha Pilsbry 1916 (Balanidae sensu Darwin 1854a)

Superfamily Chionelasmatoidea Buckeridge 1983 (stat. nov.)
Chionelasmus

Superfamily Pachylasmatoidea Utinomi 1968 (nom. trans. Buckeridge 1983)
Pachylasma

Superfamily Chthamaloidea Darwin 1854a (nom.trans. Newman & Ross 1976)
Catophragmus, Catomerus, Octomeris, Chthamalus, Chamaesipho & Terrachthamalus

Superfamily Coronuloidea Leach 1817 (nom. trans. Newman & Ross 1976)
Chelonibia, Bathylasma, Austrobalanus & Tetraclita

Superfamily Balanoidea Leach 1817 (nom. trans. Newman & Ross 1976)
Semibalanus, Conopea, Boscia (= Megatrema), Creusia, Chirona, Notobalanus, Elminius, Balanus & Megabalanus

Order ACROTHORACICA Gruvel 1905 (Amdominalia Darwin 1895a)

Suborder Pygophora Berndt 1907

Weltneria, Lithoglyptes, Kochlorine & Cryptophialus

Suborder Apygophora Berndt 1907

Alcippe (= Trypetesa)

ANEX 3

Clasiffication of Balanomorpha according to	
Newman & Ross (1976)	Newman-(1987)
Order Balanomorpha	Suborder Balanomorpha*
Superfamily. Chthamaloidea	
Family Catophragmidae	
Family Chthamalidae	
Superfamily Balanomorphoidea	Superfamily Coronuloidea*
Family Coronulidae	
Family Bathylasmatidae	
Family Tetraclitidae	
Superfamily Balanoidea	
Family Archaeobalanidae	
Family Pyrgomatidae	
Family Balanidae	
Superfamily Chthamaloidea	
Family Catophragmidae	
Family Chthamalidae	
Subfamily Pachylasminae	
Subfamily Euraphiinae	
Subfamily Chthamalinae	
Superfamily Balanomorphoidea	Superfamily Coronuloidea*
Family Coronulidae	
Subfamily Chelonibiinae	
Subfamily Emersoniinae	
Subfamily Platylepadinae	
Subfamily Coronulinae	
Family Bathylasmatidae	

* in text classification according to Newman (1987)

Clasiffication of Balanomorpha according to	
Newman & Ross (1976)	Newman-(1987)
Subfamily Bathylasmatinae	
Subfamily Hexelasminae	
Family Tetraclitidae	
Subfamily Austrobalaninae	
Subfamily Tetraclitellinae	
Subfamily Tetraclitinae	
Superfamily Balanoidea	
Family Archaeobalanidae	
Subfamily Archaeobalaninae	
Subfamily Semibalaninae	
Family Pyrgomatidae	
Subfamily Pyrgomatinae	
Subfamily Ceratoconchinae	
Subfamily Bosciinae	
Family Balanidae	

SUMMARY
- CIRRIPEDIA OF ADRIATIC -

The cirriped crustacean are prevailing fouling component represent in 86.5% in relation to all the others foulers (Christie & Dall ey, 1987), mostly economical important, because of the great damage results done in all immersed objects (ships, hydroinstallations etc.), edible organisms (crustaceans, molluscs, fish and so on) using by the man. For elimination of the negative consequences (reduction of the speed of ships, the damage of the substratum etc.) annual average of the expenses are about $2x10^8$ dollars (Chistie & Dalley, 1987). This is the main reason why it is necessary to make a complete study of this animal group crustaceans, because for up to day there were not written the complete study for all species.

In the paper it is given the main characteristic of the Cirripedia as sessile and very adaptable organisms on the various natural and artificial substrata. Also it is given the examples of Cirripedia as epibionts on the different species (molluscs, crustaceans, fishes etc.) endobionts (for example into the sponges) and parasite (Rhizocephala). The description was given on their vertical distribution; from supralittoral to the larger depths (settlement on the transoceanic cables), while there are the large geographical distribution all over the world, mostly because of anthropological cosmopolitism.

In the history of investigations mostly there are quoted by the cirripedologists from the taxonomic aspect. Also, there were mentioned from the other aspects, mostly ecological, and in lesser degree ecophysiological, genetical, biochemical. As well, there were mentioned in the monograph about Cirripedia as critical review on the same (for example Darwin's, 1854). Except that there were mentioned in the important works about the barnacles on the artificial substrata (ships different test substrata) and on the organisms (ruin esthetical view of host and reduce their comercial value). For Adriatic sea there were mentioned in total 73 Cirripedia (Tabl. l), that include species, synonyms, varietes, forms. Among the species it is mentioned one that does not live in Adriatic sea (*Balanus inexpectatus*) which was described in detail by Kolosváry (1947). It seems that the same species most probably were wrongly determined (Relini, 1980). A similar case is with the other species that also do not live in Adriatic sea (*Megabalanus tintinnabulum tintinnabulum*), but they can be found in convinient microhabitats near by thermoelectric plants with higher themperature of the sea water. This species was described by Kolosváry (1947) and Sigo (1942) in Venice lagoons as *Balanus tintinnabulum tintinnabulum* , and by Relini & Montanari (1973) in Ligurian sea. From these reasons, because

it adapted itself on such sites, can be treated as potential settler, which can be quite possible distributed in the other parts of Adriatic sea. In the working methods it is described the way of conservation of the fresh material (Relini, 1980; Kim, II. & Kim, H. S., 1980). Also there were described characteristics that were taken into consideration for determination of species as following: description of the shell; opercular valves; look of base (Southward,1963; Newman&Ross,1979; Relini, 1980b),construction of shell's wall, lip apparatus (labrum, maxillae, mandibula) and cirripedia's legs (Henry & McLaughlin, 1975).

The results included 9 species from suborder Lepadomorpha, one species from suborder Verrucomorpha, 12 species and 3 forms from suborder Brachylepadomorpha, as well as 6 species from order Rhizocephala. Among described species, the most frequent species is *Balanus amphitrite*, especially important as bioindicator of organic pollution tolerant on the low oxygen concentrations and relatively higher concentrations of $N\text{-}NH_4$ (Relini & Relini-Orsi, 1970). Otherwise this is species which is the mostly adaptive (in relation on the other barnacles) on toxic antivegetative, antifouling paints (Igić,1982). However, this species is more sensitive on the some stronger concentration of some kind of heavy matals (Hg, Ma, Co, Cd, Zn, Pb) (Patarnello et al., 1991), or detergents. Also the important species are *B. eburneus* and *B. improvisus* especially because they tolerate lower concentration salt in water, so they are frequently in estuaries, i.e. in the mouth of rivers (Davenport, 1976; Mook , 1980). However, *B. eburneus* because of larger dimensions by intensive settlement is important because of enermous biomass (3785g/m (Igić, 1983). Species *B. perforatus* is also larger size, so that in cleaner environment to which it prefers, sometime can produce large biomass, especially on the wharves, stones or at the different test substrata. For that barnacle it is important yet that lives longest from all barnacles in fouling complex; on the average about 8 months, extremely up to 11 months. The other Adriatic species are of the less ecological importance for fouling communities, especially Chthamalida, for they are rather rare on the artificial substrata, and dense on the natural substrata. Regarding to the vertical stratification Brachilepadomorpha, in the coastal areas they extend up to about 50 m of depth of the sea, but the most abundantly to the upper infralittoral (about 5-6 m of depth). However, Lepadomorpha are typical for off shore waters ("off shore species"), mostly settle on the floating objects. Opposite, Verrucomorpha are very rare inhabitants of Adriatic, and they prefer larger depths, till about 100 m. Otherwise, for all Cirripedia of Adriatic, seasonal distribution is all over the year except winter period, with peaks of the settlement from about mid-July till October.

This kind of paper gives the complete insight in the very important animal group; in the faster determination of the species. Also, knowing their biology, especially ecology, makes it possible effective and faster discover of the better means for the prevention of their settlements on the all immersed substrata which are beneficial for the men.

BIOGRAPHY

Ljubimka Igić was born on the March 18th, 1934 in Despotovo, Serbia. She finished elementary school in Despotovo and secondary school in Novi Sad in 1953. She was graduated in Biology, Faculty of Natural Sciences, University of Belgrade, in 1959.

Postgraduate studies of Oceanology she finished in the Faculty of Natural Sciences, University of Zagreb in 1971 with thesis entitled: "Contribution to the investigations of the fouling associations in the Northern Adriatic".

She sustained the Doctorate thesis entitled "Dynamics of the fouling communities on oysters (*Ostrea edulis*) and mussels (*Mytilus galloprovincialis*)" in 1976.

From 1960 to 1965, she worked in the Medical Faculty of the University of Novi Sad. From 1965 to 1969 she worked in the Institute of Marine Biology in Rovinj, and from 1969 to 2000 in the Institute "Ruđer Bošković" Center for Marine researches, Rovinj.

In the Medical Faculty she worked as a lecturer and the scientist from fields of physiology and anthropology.

In Rovinj, she investigated fouling communities on living and non-living bases in unpolluted and polluted waters, and on fouling of navigable objects: ships, boats, rafts and float-gauges. Besides scientific problems, she was interested in practical application of scientific results.

She participated with her results at considerable number of scientific meetings. She also was a member of national and international societies.

From her scientific papers, ecological studies about fouling are of special interest, as publication „The fouling of ships" in Marine encyclopedia (1972).

Finally, her name was put in the Croatian biographic Lexicon (2003). That affirms the importance of her contribution to the scientific investigations from the field of oceanology.

She also gathered the large collection of the fouling communities and very important literature about fouling.

After she retired, she continued to occupy herself with scientific work.