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FIRST CONTRIBUTION TO THE KNOWLEDGE OF CORALLINE ALGAE DISTRIBUTION IN THE SLOVENIAN CIRCALITTORAL ZONE (NORTHERN ADRIATIC)

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ABSTRACT

*Authors present new data on the coralline algal flora from Slovenia. They come from a recent inspection of the Slovenian part of the Gulf of Trieste where peculiar communities, such as the biocoenosis of the coastal detritic bottom, the agglomeration of bioconcretions known in the area under the name of »trezze« or »tegnue«, and the bank of Mediterranean stony coral *Cladocora caespitosa*, occur. In such communities 11 coralligenous red algae were found. Five of them, *Hydrolithon boreale*, *Lithothamnion minervae*, *L. philippii*, *L. sonderi* and *Neogoniolithon brassica-florida* are newly recorded for Slovenia.*

Key words: coralline algae, circalittoral, *Cladocora caespitosa*, northern Adriatic, Slovenia

PRIMO CONTRIBUTO ALLA CONOSCENZA DELLA DISTRIBUZIONE DELLE ALGHE CORALLINE NEL CIRCALITORALE SLOVENO (ADRIATICO SETTENTRIONALE)

SINTESI

*Gli autori presentano nuovi dati sulla flora delle alghe coralline della Slovenia. I risultati provengono da una recente ispezione della parte slovena del Golfo di Trieste, dove vivono peculiari comunità, come la biocenosi del fondo detritico costiero, gli agglomerati di bioconcrezioni conosciute nell'area come »trezze« o »tegnue«, e i banchi madreporici di *Cladocora caespitosa*. In queste comunità sono state trovate 11 specie di alghe rosse coralligene. Cinque specie, *Hydrolithon boreale*, *Lithothamnion minervae*, *L. philippii*, *L. sonderi* e *Neogoniolithon brassica-florida* sono nuove segnalazioni per la Slovenia.*

Parole chiave: alghe coralline, circalitorale, *Cladocora caespitosa*, Adriatico settentrionale, Slovenia

INTRODUCTION

Among the eight action plans adopted by the Contracting Parties of the Barcelona Convention, one is devoted to the coralligenous habitat: the Action plan for the conservation of the coralligenous and other calcareous bio-concretions in the Mediterranean Sea, UNEP-MAP-RAC/SPA (Ballesteros, 2008). Within this document, the coralligenous formations are considered a typical Mediterranean underwater seascape, comprising coralline algal frameworks that grow in dim light conditions and in relatively calm waters (Ballesteros, 2006). Data concerning the coralligenous biocoenosis occurring in the Mediterranean Sea are sparse and mostly regarding the north-western part of the basin, southern Italy and the Alboran Sea, while other regions are poorly known (Pergent, 2009). Therefore, the available lists of species, as well as the main engineering species, are mainly known from those areas, and they cannot be considered constant in the rest of the Mediterranean (UNEP-MAP-RAC/SPA, 2008).

The Gulf of Trieste, even if characterized by shallow bottoms, displays a high number of both species and habitats. The circalittoral of the Gulf of Trieste is mostly composed by the biocoenosis of the muddy detritic bottom (Lipej *et al.*, 2006). A patch of the biocoenosis of the coastal detritic bottom is present in the Piran Bay (Lipej *et al.*, 2006) and a solitary temperate reef made of the Mediterranean Stony coral (*Cladocora caespitosa*) is located off Cape Ronek. More recently, some studies have shown the presence of some peculiar and rather uncommon habitats in the Slovenian area. Among them, the precoralligenous bioformation is one of the most interesting, since it also hosts great fish diversity (Lipej *et al.*, 2003; Orlando-Bonaca & Lipej, 2005). In Slovenian waters, the precoralligenous bioformation is distributed in the lower infralittoral rocky zone, in the depth range from 3 to 14 m, within the area between Cape Ronek and Cape Madonna Nature Monument in Piran (Fig. 1).

The aim of this paper is to present new data on coralline algal species obtained from recent sampling in the circalittoral zone of the Slovenian coasts. Special attempt was given to a peculiar habitat such as the coral reef and to the biocoenosis of the coastal detritic bottom. A description of the recorded species is also given.

MATERIAL AND METHODS

The sampling for the present study was done according to the requirements of the Marine Strategy Framework Directive (2008/56/ES). The circalittoral zone was sampled during the spring and autumn period in 2010 (Tab. 1) in 4 Slovenian areas (Fig.1): open waters off Cape Madonna NM in Piran (1), open waters off Strunjan (2), near Cape Ronek (3), and the Bay of Piran (4).

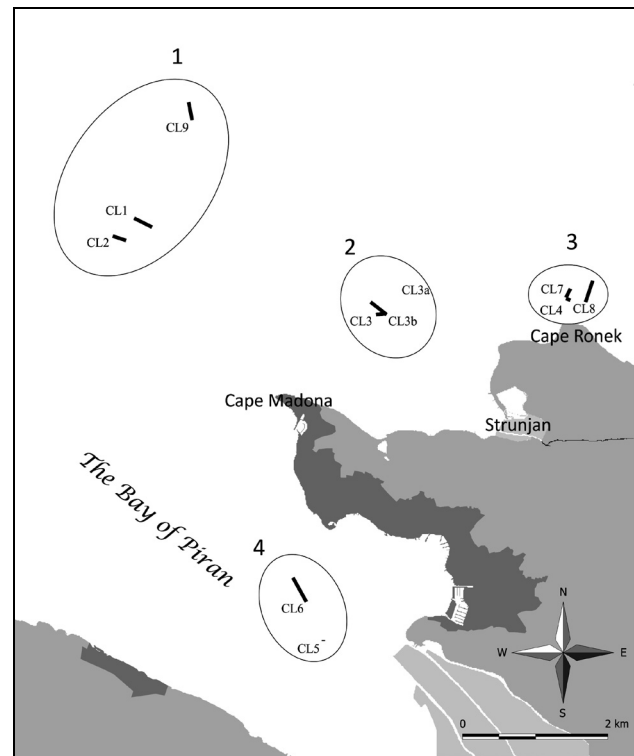


Fig. 1: The study area with sampling sites.

Sl. 1: Obravnavano območje z lokalitetami vzorčevanj.

The sampling was done by a benthos dredge (Pérés & Picard, 1964; Castelli *et al.*, 2003), more appropriate than grabs and cores for estimating the densities of little abundant benthic species. It is considered a semi-quantitative sampling method, owing to the problem of estimating the sampled area accurately (Holme & McIntyre, 1984).

On selected sampling areas, the dredge was trawled at a constant velocity of the research vessel (between 0.8 and 1.1 knots), for 5 to 8 minutes. The transect-lines dredged varied from 150 in 250 m in length. At the end, the dredge was raised on the vessel and the content was preserved in big sinks with seawater, while transported to the coast.

Only the transect CL8 located off Cape Ronek was not dredged, but surveyed with non-destructive visual methods, since it is located on the reef of *C. caespitosa*. Observations were made by divers in order to determine the algal species growing within this reef.

Algal samples were sorted in laboratory and fragments of material were air dried, mounted on aluminium stubs with acrylic adhesive and then analysed by scanning electron microscopy (SEM). Stubs were sonicated with a Vitec sonicator to remove sediments and diatoms and then coated with gold/palladium (with S150 Sputter Coater, Edwards) prior to viewing in a LEICA Stereoscan 430i at 20 kV.

Tab. 1: Samplings and sites characterization. *CL8 was only visual censused.**Tab. 1: Podatki o vzorčevanju in lokalitetah. Na lokaliteti *CL8 je bilo izvedeno le vzorčevanje z opazovalnimi tehnikami.**

Site	Date	Start of the dredging		End of the dredging		Depth (m)
		Lat (N)	Long (E)	Lat (N)	Long (E)	
CL1	1.6.2010	45°33.067'	13°32.433'	45°33.132'	13°32.247'	22.0-24.0
CL2	1.6.2010	45°32.963'	13°32.163'	45°32.997'	13°32.023'	22.0-24.0
CL3	10.6.2010	45°32.448'	13°34.915'	45°32.445'	13°34.815'	27.0
CL4	10.6.2010	45°32.592'	13°36.828'	45°32.660'	13°36.873'	19.8-21.6
CL5	14.6.2010	45°29.992'	13°34.323'	45°29.992'	13°34.323'	14.0
CL6	14.6.2010	45°30.285'	13°34.138'	45°30.462'	13°33.992'	16.6
CL1	22.10.2010	45°33.067'	13°32.433'	45°33.132'	13°32.247'	22.0-24.0
CL2	22.10.2010	45°32.963'	13°32.163'	45°32.997'	13°32.023'	22.0-24.0
CL7	22.10.2010	45°32.591'	13°36.828'	45°32.578'	13°36.877'	20.0
CL8*	5.11.2010	45°32.567'	13°37.032'	45°32.723'	13°37.101'	16.1-27.0
CL3a	15.11.2010	45°32.448'	13°34.915'	45°32.445'	13°34.815'	14.0-22.1
CL3b	15.11.2010	45°32.446'	13°34.930'	45°32.536'	13°34.765'	27.0
CL9	15.11.2010	45°33.872'	13°32.839'	45°34.005'	13°32.798'	23.2

* visual count sampling

Anatomical terminology follows Woelkerling (1988) and growth-form terminology follows Woelkerling *et al.* (1993). Herbarium abbreviations follow Thiers (2011). Descriptions and terminology follow Irvine and Chamberlain (1994).

RESULTS AND DISCUSSION

During the present study, 11 species of coralline algae were found in the circalittoral, 5 of which, *Hydrolithon boreale*, *Lithothamnion minervae*, *Lithothamnion philippii*, *Lithothamnion sonderi*, *Neogoniolithon brassica-florida* were first recorded in Slovenia (Tab. 2).

In samples from sites CL1 and CL2 the encrusting forms prevailed in autumn, while the rhodoliths, both living and fossil, were more abundant in spring (75% and 55% respectively). The most frequently collected species were: *Lithothamnion philippii* (encrusting, rarely rhodolith), *L. sonderi* (encrusting), *L. minervae* (rhodolith and encrusting) and *Pneophyllum confervicola* (encrusting), followed by *L. pustulatum* (encrusting and rhodolith) and *Neogoniolithon brassica-florida* (rhodolith and encrusting). In site CL9 the algal composition was similar, but with a greater abundance of not living thalli of *L. minervae*. The CL8 site was characterised by a large presence of not living rhodoliths of *L. racemus* and *L. minervae*, and by encrusting forms of *L. minervae*, *L. philippii*, *L. sonderi*, and *P. fragile*, mainly as epiphytes on *C. caespitosa*. However, most of the thalli collected

were partially depigmented, infertile and with evident signs of bioeroding activity.

Species survey

Hydrolithon boreale (Foslie) Y. M. Chamberlain

Basionym: *Melobesia farinosa* f. *borealis* Foslie

Lectotype locality: Roundstone, Co. Galway, Ireland

Only encrusting bisporangial thalli were observed (Fig. 2). The plants were 10 mm in diameter and 15 µm in thickness and presented a smooth surface with grainy texture, while the thin margin frequently showed orbital rings. Trichocytes were frequent. The domed chambers of conceptacles measured 60–85 µm in diameter and were 55–85 µm high. This alga was rarely seen in the study area, with few specimens found only in CL1 and CL2 sites (spring sampling) at ca. 22–24 m of depth.

Lithophyllum pustulatum (J. V. Lamouroux) Foslie

Basionym: *Melobesia pustulata* J. V. Lamouroux

Type locality: France

Bisporangial plants were adherent on the substrate with entire margin (diameter up to 20 mm). The uniporate bisporangial conceptacles, convex and crowded with a developed columella at the base (Fig. 3), had chambers of 134–326 µm in diameter and 82–233 µm height. This species was observed in all the sampling sites, except in CL8. It was more abundant in CL2 and CL9.

Tab. 2: Check-list of crustose coralline algae from the Slovenian part of the Gulf of Trieste. The 11 species in bold were found during the present study in the circalittoral belt. Taxa indicated with * are first records.

Tab. 2: Seznam skorjastih koraligenih alg iz slovenskega dela Tržaškega zaliva. 11 vrst, izpisanih krepko, je bilo najdenih tekom pričujoče raziskave v cirkalitoralnem pasu. Taksoni, označeni z *, se beležijo kot nove najdbe.

Taxa	Synonyms and records
<i>Amphiroa kuetzingiana</i> Trevisan	as <i>Amphiroa verruculosa</i> Kützinger : Trieste: Giaccone, 1978; Slovenia: Vukovič, 1984. North Adriatic - <u>Rovinj</u> : Giaccone, 1978.
<i>Amphiroa rigida</i> J.V.Lamouroux	Trieste: Giaccone, 1978; Bressan <i>et al.</i> , 2000. Slovenia: Matjašič <i>et al.</i> , 1975; Vukovič, 1980; Turk & Vukovič, 1994. North Adriatic: <u>Rovinj</u> : Giaccone, 1978; Munda, 1979; <u>Gulf of Kvarner</u> : Giaccone, 1978.
<i>Boreolithon van-heurckii</i> (Heydrich) A.S.Harvey & Woelkerling	as <i>Melobesia van-heurckii</i> (Heydrich) Cabioch : Trieste: Giaccone, 1978; Slovenia: Vukovič, 1980, 1984.
<i>Choreonema thuretii</i> (Bornet) F.Schmitz	Trieste: Giaccone, 1978; Slovenia: Matjašič <i>et al.</i> , 1975; Vukovič, 1980. Adriatic: Bressan, 1974; North Adriatic- <u>Gulf of Kvarner</u> : Giaccone, 1978.
<i>Corallina officinalis</i> Linnaeus	as <i>Corallina officinalis</i> Linnaeus : <u>Gulf of Trieste</u> : Giaccone & Pignatti, 1967; Pignatti & Giaccone, 1967; Giaccone, 1970; Bressan, 1974; Giaccone, 1978; Franzosini <i>et al.</i> , 1983/84; Franzosini & Bressan, 1988; Bressan <i>et al.</i> , 1991; Bussani & Vukovič, 1992; Bressan <i>et al.</i> , 2000; Falace, 2000; Falace <i>et al.</i> , 2005; Slovenia: Avčin <i>et al.</i> , 1973; Matjašič <i>et al.</i> , 1975; Vukovič, 1980; Turk & Vukovič, 1994. North Adriatic - <u>Rovinj</u> : Giaccone, 1978; Munda, 1979; <u>Gulf of Kvarner</u> : Giaccone, 1978. As <i>Corallina officinalis</i> var. <i>flabellifera</i> Schiffner : Slovenia: Vukovič, 1980, 1984; Turk & Vukovič, 1994; Munda, 1991.
<i>Fosliella farinosa</i> f. <i>solmsiana</i> (Falkenberg) Foslie	Slovenia: Matjašič <i>et al.</i> , 1975; Vukovič, 1980, 1982a.
<i>Haliptilon virgatum</i> (Zanardini) Garbary & H.W.Johansen	as <i>Corallina granifera</i> J.Ellis & Solander : Trieste: Giaccone, 1978; Bressan <i>et al.</i> , 1991; Falace, 2000; Falace <i>et al.</i> , 2005. Slovenia: Avčin <i>et al.</i> , 1973; Matjašič <i>et al.</i> , 1975; Vukovič, 1980, 1982b; Vrišer <i>et al.</i> , 1981; Turk & Vukovič, 1994.
* <i>Hydrolithon boreale</i> (Foslie) Y.M.Chamberlain	Trieste: Falace, 2000; Bressan <i>et al.</i> , 2006. North Adriatic - <u>Rijeka</u> : Zavodnik & Zavodnik, 1992.
<i>Hydrolithon farinosum</i> (J.V.Lamouroux) D.Penrose & Y.M.Chamberlain	as <i>Hydrolithon farinosum</i> (J.V.Lamouroux) D.Penrose & Y.M.Chamberlain : Trieste: Falace, 2000; Bressan <i>et al.</i> , 2006. Slovenia: Orlando & Bressan, 1998. as <i>Fosliella farinosa</i> (J.V.Lamouroux) M.A.Howe : Trieste: Bressan, 1974; Bressan <i>et al.</i> , 1977; Giaccone, 1978; Franzosini <i>et al.</i> , 1983/84. Slovenia: Avčin <i>et al.</i> , 1973, 1974; Matjašič <i>et al.</i> , 1975; Vukovič, 1980, 1982a. North Adriatic: - <u>Gulf of Venezia</u> - <u>Rovinj</u> - <u>Gulf of Kvarner</u> : Giaccone, 1978. as <i>Melobesia farinosa</i> J.V.Lamouroux : Trieste: Schiffner (1916); Giaccone & Pignatti, 1967; Pignatti & Giaccone, 1967; Giaccone, 1970.
<i>Hydrolithon cruciatum</i> (Bressan) Y.M.Chamberlain	Trieste as <i>Fosliella cruciata</i> Bressan : Bressan <i>et al.</i> , 1977; Giaccone, 1978. Slovenia: Orlando & Bressan, 1998.
<i>Jania longifurca</i> Zanardini	Trieste: Giaccone, 1978; Bressan <i>et al.</i> , 2000; Falace <i>et al.</i> , 2005. Slovenia: Matjašič <i>et al.</i> , 1975. North Adriatic - <u>Rovinj</u> : Giaccone, 1978.
<i>Jania rubens</i> (Linnaeus) J.V.Lamouroux	Trieste: Giaccone & Pignatti, 1967, 1972; Pignatti & Giaccone, 1967; Giaccone, 1970; Ghirardelli <i>et al.</i> , 1973; Giaccone, 1978; Bressan <i>et al.</i> , 1991; 2000; Falace, 2000; Falace <i>et al.</i> , 2005; Bressan <i>et al.</i> , 2006. Slovenia: Avčin <i>et al.</i> , 1973; Matjašič <i>et al.</i> , 1975; Vukovič, 1980. North Adriatic - <u>Rovinj</u> : Giaccone, 1978; Munda, 1979. <u>Gulf of Kvarner</u> : Giaccone, 1978.
<i>Lithophyllum corallinae</i> (P.L.Crouan & H.M.Crouan) Heydrich	Adriatic: as <i>Dermatolithon corallinae</i> (P.L.Crouan & H.M.Crouan) Foslie : Giaccone, 1978; Munda, 1979. As <i>Titanoderma corallinae</i> (P.L.Crouan & H.M.Crouan) Woelkerling, Y.M.Chamberlain & P.C.Silva : Slovenia: Orlando & Bressan, 1998.

Taxa	Synonyms and records
<i>Lithophyllum cystoseirae</i> (Hauck) Heydrich	as <i>Dermatolithon cystoseirae</i> (Hauck) H.Huvé : <u>Trieste</u> : Giaccone, 1978. <u>Slovenia</u> : Avčín <i>et al.</i> , 1973, Matjašič <i>et al.</i> , 1975; Vukovič, 1980, 1982a, 1982b; Turk & Vukovič, 1994. North Adriatic - <u>Rovinj</u> : Giaccone, 1978. as <i>Dermatolithon papillosum</i> var. <i>cystoseirae</i> (Hauck) M.Lemoine : <u>Trieste</u> : Giccone & Pignatti, 1967. as <i>Titanoderma cystoseirae</i> (Hauck) Woelkerling, Y.M.Chamberlain & P.C.Silva : <u>Trieste</u> : Bressan & Babbini, 2003.
<i>Lithophyllum decussatum</i> (J.Ellis & Solander) Philippi	as <i>Lithophyllum decussatum</i> (J.Ellis & Solander) Philippi : <u>Slovenia</u> : Turk & Vukovič, 1994.
<i>Lithophyllum incrustans</i> Philippi	<u>Trieste</u> : Giaccone, 1978; Franzosini & Bressan, 1988; Falace, 2000; Falace <i>et al.</i> , 2005; Bressan <i>et al.</i> , 2006. <u>Slovenia</u> : Matjašič <i>et al.</i> , 1975; Vukovič, 1980; Munda 1991. North Adriatic - <u>Rovinj</u> : Giaccone, 1978; Munda, 1979.
<i>Lithophyllum papillosum</i> Zanardini	<u>Trieste</u> : Giaccone, 1970. As <i>Goniolithon papillosum</i> (Zanardini ex Hauck) Foslíe : <u>Slovenia</u> : Vukovič, 1984. North Adriatic - <u>Rovinj</u> : Giaccone, 1978.
<i>Lithophyllum pustulatum</i> (J.V.Lamouroux) Foslíe	<u>Trieste</u> : Pignatti & Giaccone, 1967; Curiel <i>et al.</i> , 2000-2001; Gordini <i>et al.</i> , in press. As <i>Dermatolithon hapalidiodes</i> (P.L.Crouan & H.M.Crouan) Foslíe : <u>Trieste</u> : Giaccone & Pignatti, 1967; Pignatti & Giaccone, 1967; Giaccone, 1970, 1978; Franzosini <i>et al.</i> , 1983/84; Franzosini & Bressan, 1988; Falace & Bressan, 1990, 1994. <u>Slovenia</u> : Avčín <i>et al.</i> , 1979. North Adriatic - <u>Rovinj</u> : Giaccone, 1978. As <i>Dermatolithon pustulatum</i> (J.V.Lamouroux) Foslíe : <u>Trieste</u> : Schiffner, 1916; Giaccone, 1970, 1978. North Adriatic: <u>Rovinj</u> - <u>Gulf of Kvarner</u> : Giaccone, 1978. As <i>Titanoderma pustulatum</i> (J.V.Lamouroux) Nägeli : <u>Trieste</u> : Falace & Bressan, 2002; Falace, 2000; Falace <i>et al.</i> , 2005; Bressan & Giaccone, 2005. <u>Slovenia</u> : Orlando & Bressan, 1998. As <i>Titanoderma pustulatum</i> var. <i>canellatum</i> (Kützing) Y.M.Chamberlain : <u>Trieste</u> : Bressan <i>et al.</i> , 2006.
<i>Lithophyllum racemus</i> (Lamarck) Foslíe	<u>Trieste</u> : Giaccone & Pignatti, 1967; Pignatti & Giaccone, 1967; Giaccone, 1970; Giaccone, 1978; Bressan, 1988; Bussani & Vukovič, 1992; Gordini <i>et al.</i> , in press. <u>Slovenia</u> : Matjašič <i>et al.</i> , 1975; Avčín <i>et al.</i> , 1979; Vukovič, 1980; Turk & Vukovič, 1994. North Adriatic - <u>Rovinj</u> : Giaccone, 1978.
<i>Lithophyllum stictaeforme</i> (Areschoug) Hauck	<u>Slovenia</u> : Matjašič <i>et al.</i> , 1975; Avčín <i>et al.</i> , 1979; Vukovič, 1980, 1982b; Turk & Vukovič, 1994; Munda, 1991. North Adriatic: - <u>Rovinj</u> - <u>Gulf of Kvarner</u> : Giaccone, 1978.
<i>Lithothamnion corallioides</i> (P.L.Crouan & H.M.Crouan) P.L.Crouan & H.M.Crouan	<u>Trieste</u> : Bressan, 1974; Giaccone, 1978; Bressan & Nichetto, 1994; Bressan & Giaccone, 2005; Gordini <i>et al.</i> , in press; as <i>Lithophyllum solutum</i> (Foslíe) M.Lemoine : <u>Slovenia</u> : Avčín <i>et al.</i> , 1979.
* <i>Lithothamnion minervae</i> Basso	<u>Trieste</u> : Bressan & Giaccone, 2005; Bressan <i>et al.</i> , 2006; Gordini <i>et al.</i> , in press
* <i>Lithothamnion philippii</i> Foslíe	<u>Trieste</u> : Pignatti & Giaccone, 1967; Giaccone, 1970, 1978; Bressan & Giaccone, 2005; Gordini <i>et al.</i> , in press. North Adriatic - <u>Rovinj</u> : Foslíe, 1905; Giaccone, 1978
* <i>Lithothamnion sonderi</i> Hauck	<u>Trieste</u> : Giaccone, 1978
<i>Melobesia membranacea</i> (Esper) J.V.Lamouroux	<u>Trieste</u> : Giaccone, 1978. <u>Slovenia</u> : Matjašič <i>et al.</i> , 1975; Vukovič, 1980. As <i>Epilithon membranaceum</i> (Esper) Heydrich : <u>Trieste</u> : Schiffner, 1916; Pignatti & Giaccone, 1967; Giaccone, 1970. North Adriatic - <u>Rovinj</u> : Giaccone, 1978; Munda, 1979. <u>Gulf of Kvarner</u> : Giaccone, 1978.
* <i>Neogoniolithon brassica-florida</i> (Harvey) Setchell & Mason	<u>Trieste</u> : Falace, 2000. As <i>Neogoniolithon notarisii</i> (Dufour) G.Hamel & M.Lemoine : <u>Trieste</u> : Giaccone & Pignatti, 1967; Pignatti & Giaccone, 1967; Giaccone, 1970, 1978. North Adriatic - <u>Rovinj</u> : Giaccone, 1978.
<i>Neogoniolithon mamillosum</i> (Hauck) Setchell & L.R.Mason	<u>Trieste</u> : Giaccone & Pignatti, 1967; Giaccone, 1978; Gordini <i>et al.</i> , in press. <u>Slovenia</u> : Avčín <i>et al.</i> , 1973, 1979; Matjašič <i>et al.</i> , 1975; Vukovič, 1980. North Adriatic - <u>Rovinj</u> - <u>Gulf of Kvarner</u> : Giaccone, 1978.

Taxa	Synonyms and records
<i>Phymatolithon lenormandii</i> (J.E. Areschoug) W.H.Adey	<u>Trieste</u> : Giaccone, 1978; Falace, 2000; North Adriatic - <u>Rovinj</u> : Giaccone, 1978. As <i>Lithothamnion lenormandii</i> (J.E.Areschoug) Foslie : <u>Trieste</u> : Pignatti & Giaccone, 1967; Giaccone, 1970. <u>Slovenia</u> : Matjašič <i>et al.</i> , 1975; Vukovič, 1980; Munda, 1991.
<i>Pneophyllum confervicola</i> (Kützing) Y.M.Chamberlain	<u>Trieste</u> : Falace, 2000; Bressan & Babbini, 2003; Gordini <i>et al.</i> , in press. as <i>Fosliella minutula</i> (Foslie) Ganesan : <u>Trieste</u> : Giaccone, 1978. <u>Slovenia</u> : Matjašič <i>et al.</i> , 1975; Vukovič, 1980. North Adriatic - <u>Rovinj</u> : Giaccone, 1978.
<i>Pneophyllum fragile</i> Kützing	<u>Trieste</u> : Falace, 2000; Bressan & Babbini, 2003; Bressan <i>et al.</i> , 2006. <u>Slovenia</u> : Orlando & Bressan, 1998. As <i>Fosliella lejolisii</i> (Rosanoff) M.A.Howe : <u>Trieste</u> : Simonetti, 1972; Bressan <i>et al.</i> , 1977; Giaccone, 1978; Franzosini <i>et al.</i> , 1983/84. <u>Slovenia</u> : Vukovič, 1980, 1984. North Adriatic: - <u>Rovinj</u> - <u>Gulf of Kvarner</u> : Giaccone, 1978. As <i>Melobesia lejolisii</i> Rosanoff : <u>Trieste</u> : Giaccone & Pignatti, 1967; Pignatti & Giaccone, 1967; Giaccone, 1970; <u>Grado</u> : Simonetti, 1971. As <i>Pneophyllum lejolisii</i> (Rosanoff) Y.M.Chamberlain : <u>Trieste</u> : Della Valle <i>et al.</i> , 1993.
<i>Spongites fruticulosa</i> Kützing	as <i>Spongites fruticulosus</i> : <u>Trieste</u> : Bressan & Giaccone, 2005. As <i>Lithothamnium fruticosum</i> (Kützing) Foslie : <u>Trieste</u> : Giaccone & Pignatti, 1972; Giaccone, 1978. <u>Slovenia</u> : Matjašič <i>et al.</i> , 1975; Avčin <i>et al.</i> , 1979; Vukovič, 1980. North Adriatic - <u>Rovinj</u> : Giaccone, 1978. As <i>Spongites fruticulosa</i> f. <i>clavulatum</i> Foslie : <u>Trieste</u> : Giaccone, 1970; Pignatti & Giaccone, 1967; Bussani & Vukovič, 1992.

***Lithophyllum racemus* (Lamarck) Foslie**Basionym: *Millepora racemus* Lamarck

Type locality: Sicily

The observed plants were unattached, forming branched sub-globular spheres with branches not densely crowded (Fig. 4). Thalli measured up to 23 mm in diameter and were smaller than standard specimens (up to 80 mm). Only old tetrasporangial uniporate conceptacles immersed in the protuberances were found. Chambers, with a pronounced columella at the base (Fig. 5), had a diameter of 236–327 µm and height of 72–196 µm. Few living thalli were found only in CL1 spring sampling, whilst some not living samples were observed also in CL8.

***Lithothamnion minervae* Basso**

Type locality: Pontian Islands, Tyrrhenian Sea

Both encrusting and sub-globular thalli were found (Fig. 6). The encrusting thalli measured up to 20 mm, with short protuberances (0.5–1 mm), while rhodolites were up to 35 mm with longer protuberances (1–3 mm). Only tetrasporangial plants were found with multiporate conceptacles developing in groups at the apices of the branches. The elliptical chambers had a diameter of 248–487 µm and were 123–218 µm high. Living and not-living thalli were collected in CL1, more rarely in CL2 and CL8, where thalli without reproductive structures and with grazing signs were observed.

***Lithothamnion philippii* Foslie**

Type locality: Funafuti, Ellice Islands

The encrusting thalli were up to 5 cm in diameter and to 6 mm thick. The plant surface was flat or with small mounds, while the margin was thick. The hemispherical or conical gametangial conceptacles were raised (Fig. 7), measuring up to 1000 µm in diameter. The diameter of the chamber was 398–436 µm, and the height was 146–189 µm (Fig. 8). The multiporate conceptacles were convex or with flat roof (Fig. 9), with elliptical chamber of 60–85 µm in diameter and 55–85 µm in height. Old conceptacles were buried in thallus. Tetrasporangial plants were commonly collected in all the examined sites, while the gametangial thalli were observed only in CL2.

***Lithothamnion sonderi* Hauck**

Holotype locality: Helgoland, Germany

The encrusting thalli were thin or up to 3 mm thick, with a diameter of 3–5 cm. The plant surface was smooth, the margin entire, thin or sometimes lobed. Confluences of adjacent thalli formed small crests. The multiporate conceptacles were slightly raised (Fig. 10), with flat roof and elliptical chamber (Fig. 11) of 140–418 µm in diameter and 88–137 µm in height.

This species was observed in all the sampling sites.

***Neogoniolithon brassica-florida* (Harvey) Setchell & L. R. Mason**Basionym: *Melobesia brassica-florida* Harvey

Type locality: Algoa Bay, Cape Province, South Africa

The plants were encrusting, with diameter up to 36 mm and thickness up to 1 mm. The surface of thalli was smooth, sometimes glossy, with margin entire and thick. Gametangial conceptacles were numerous and flask-shaped with chambers measuring 290–380 µm in diameter and 340–567 µm in height. Tetrasporangial conceptacles were uniporate, hemispherical or conical (Fig. 12). The chambers measured 330–657 µm in diameter and were 211–267 µm high. Old conceptacles were buried in thallus. Trichocytes were common.

Few samples of this species were observed only in spring sampling in CL1 and CL2 sites.

***Neogoniolithon mamillosum* (Hauck) Setchell & L. R. Mason**Basionym: *Lithothamnion mamillosum* Hauck

The encrusting thalli were frequently mamillate (Fig. 13), reaching up to 6 cm in diameter and 0.5–0.8 mm of thickness. The margin was entire and thin. Gametangial conceptacles were raised, flask-shaped, with chambers measuring 316–540 µm in diameter and 187–370 µm in height. Tetrasporangial conceptacles were uniporate, raised, hemispherical or conical. Chambers were 269–390 µm in diameter and 100–188 µm in height. Few samples were observed in all sites, except for CL8.

***Phymatolithon lenormandii* (Areschoug) W. H. Adey**Basionym: *Melobesia lenormandii* Areschoug

Type locality: Arromanches-les-Bains, Calvados, France

The encrusting thalli had a diameter up to 4.5 cm and thickness up to 190 µm. All the collected thalli had flat surface and entire margin, with or without orbital ridges.

Only tetrasporangial plants with multiporate conceptacles were observed (Fig. 14), slightly raised and with a flat roof. Chambers measured 135–223 µm in diameter, and 67–134 µm in height. Specimens were observed only at CL2, and one single specimen was found at CL9.

***Pneophyllum confervicola* (Kützinger) Y. M. Chamberlain**Basionym: *Phylactidium confervicola* Kützinger

Type locality: Trieste, Italy

Thalli were encrusting, orbicular or partially unconsolidated, with diameter of 12 mm and 8 µm of thickness. The surface had a mat texture and the margin was thin. Trichocytes were common (Fig. 15). Only tetra/bisporangial uniporate bubble-like conceptacles (Fig. 16) were observed, with domed chambers measur-

ing 54–93 µm in diameter and 31–77 µm in height. Sometimes, at the base of the chambers a small *columella* was present.

***Pneophyllum fragile* Kützinger**

Type locality: Mediterranean Sea

Type species (holotype) of the genus *Pneophyllum*

The encrusting thalli were orbicular with a diameter up to 6 mm and thickness up to 15 µm. The surface of the plant had a grainy texture and the margin was lobed and thin (Fig. 17). Trichocytes were common. Only tetra/bisporangial plants were observed. The elliptical conceptacles had a chambers diameter of 52–110 µm and height of 26–67 µm. It was observed in all the sampling sites, except in spring in CL1 and CL2.

Coralline algal flora in the circalittoral zone

So far, 31 species of coralline algae have been reported in the literature for the Slovenian coast (Tab. 2). However, some of these species were observed only once (Tab. 2) and have not been detected in more recent studies, so their presence should be reinvestigated.

During the present study, the faunistic and floristic aspects of the biocoenosis of coastal detritic bottom in the circalittoral were analysed. Eleven species of coralline algae were recorded in circalittoral samples. Five of them represent a new record for the Slovenian part of the Gulf of Trieste, while they have already been recorded in the Italian part. In particular, *H. boreale* is a very common species, both as an epilith and epiphyte, mainly in the littoral but also at the '»Dosso of S. Croce«' at the depth of about 11 m (Bressan *et al.*, 2006). In the Gulf of Trieste, *P. fragile* is present as an epilith or epiphyte, in particular on *Corallina* and *Jania* species, and on seagrasses, while *L. minervae* and *L. philippii* are important coralline algae of the »Tegnùe« (Gordini *et al.*, in press). *L. minervae*, which is endemic in the Mediterranean Sea (Basso *et al.*, 2004), is commonly found in the Gulf of the Trieste as rhodolith on the detritic bottoms or as an encrusting species on rocks or shells, also near the »Dosso of Santa Croce«. Few specimens of *P. confervicola* were found only in the CL8 site, while in other parts of the Gulf of Trieste it is common as an epiphyte on algae and molluscs. *N. brassica-florida* is quite common, especially near fresh water springs as an epilith, while *L. sonderi* was rarely found (Giaccone, 1978). During the present research, *L. sonderi* was found widespread in all study sites, while *N. mamillosum* was less frequent. In the Gulf of Trieste it was found in the coralligenous of some »Tegnùe« (Gordini *et al.*, in press). These species are mentioned as important builders of coralligenous in the »Draft Lists of coralligenous/maërl populations and of main species to be considered by the inventory and monitoring« of the RAC-SPA (UNEP(DEPI)/MED WG.362/3, 2011). Never-

theless, *L. minervae* and *L. philippii*, abundant in all sampling sites, were not reported in this list even if they were previously mentioned as the main algal builders in the »Proposal of a Work Programme on Protecting the Coralligenous and other Calcareous Bio-Concretions in the Mediterranean« (UNEP(DEC)/MED WG. 308/9, 2007). These species can significantly contribute to the bioconstruction process (Bressan & Babbini, 2003; Bressan *et al.*, 2009; Giaccone *et al.*, 2009) in particular in the Northern Adriatic, where *L. minervae* represents one of the main reef forming algae on the »Tegnùe« of Chioggia (Fava *et al.*, 2008; Ponti *et al.*, 2011). Moreover, *L. philippii* seems to be one of the most important building species on the »Tegnùe« in the Gulf of Trieste (Gordini *et al.*, in press) and in the Gulf of Venice (ARPAV-MSN Venezia, 2008).

In the biocoenosis of the coastal detritic bottom (sites CL1 and CL2) the encrusting forms prevailed in autumn, while in spring a conspicuous presence of prâline rhodoliths (*sensu* Basso, 1998) was observed. The site CL9 revealed a similar algal composition, but with a greater abundance of *L. minervae* subfossil thalli. The endemic Mediterranean *L. racemus* is particularly frequent under constant and important current action (Basso, 1996). Few living thalli were found only in sites CL1 and CL2, while fossil thalli were abundant in site CL8 (on the *Cladocora caespitosa* bank). These observations seem to indicate that the rhodolith forming species *L. racemus* and *L. minervae* are occasionally forced to the Slovenian shore by currents from the central-western area of the Gulf of Trieste where these species are common (Orel *et al.*, 81/82; Bressan & Giaccone, 2005; Bressan *et al.*, 2006).

Banks of stony corals

The site located off Cape Ronek (CL8) is characterised by the presence of the Mediterranean Stony coral reef with dead basal colonies and fossil rhodoliths, as well as encrusting thalli. To our knowledge, such habitat types are not common in the studied area nor were they in the past. Banks of *C. caespitosa* are not frequent in the rest of the Mediterranean Sea either, since they are reported only in the Ligurian Sea (Morri *et al.*, 1994), the Adriatic Sea (Kružić & Požar-Domac, 2003) and the Aegean Sea (Kühlmann, 1996). Seven coralline algal species were found in such bioconcretions. However, the number of studied samples is rather small, so that the number of the recorded species could probably increase following new planned surveys in the studied area.

It seems that the Mediterranean stony coral is undergoing a rapid decrease in both size and spatial distribution in the Mediterranean Sea (Morri *et al.*, 2001); hence it would be of great importance to study and analyse biological and ecological aspects of such banks in the Slovenian part in order to establish possible measures of protection as well. We also believe that the bank of the Mediterranean stony coral of the northern Adriatic offers possibilities for new records of coralline algae.

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PRISPEVEK K POZNAVANJU RAZŠIRJENOSTI KORALIGENIH ALG V SLOVENSKEM CIRKALITORALNEM PASU (SEVERNI JADRAN)

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POVZETEK

Avtorji poročajo o novih najdbah koraligenske flore alg za Slovenijo, pridobljenih v slovenskem delu Tržaškega zaliva tekom recentnih vzorčevanj nekaterih posebnih habitatnih tipov, kot so biocenoza obrežnega detritnega dna, biokonkrecije iz koraligenih alg znane pod imenom »trezze« oziroma »tegnue« in koralnega grebena sredozemske kamene korale *Cladocora caespitosa*. Izmed teh je bilo pet vrst prvič ugotovljenih za slovenski del Tržaškega zaliva, in sicer vrste *Hydrolithon boreale*, *Lithothamnion minervae*, *L. philippii*, *L. sonderi* in *Neogoniolithon brassica-florida*.

Ključne besede: koraligene alge, cirkalitoral, *Cladocora caespitosa*, severni Jadran, Slovenija

REFERENCES

- ARPAV, MSN Venezia (2008):** Le tegnùe: ambiente organismi curiosità. Agenzia Regionale per la Protezione Ambientale del Veneto, Museo di Storia Naturale di Venezia, 127 p.
- Avčín, A., I. Keržan, L. Kubik, N. Meith-Avčín, J. Štirn, P. Tušnik, T. Valentinčič, B. Vrišer & A. Vukovič (1973):** Akvatični ekosistemi v Strunjskem zalivu I. Preliminarno poročilo. V: Akvatični sistemi v Strunjskem zalivu I: skupno delo. Prispevki k znanosti o morju. Inštitut za biologijo univerze v Ljubljani, Morska biološka postaja Portorož, 5, 168–216.
- Avčín, A., N. Meith-Avčín, A. Vukovič & B. Vrišer (1974):** Primerjava bentoških združb Strunjskega in Koprškega zaliva z ozirom na njihove polucijsko pogojene razlike. Biol. vestn., 22 (2), 171–208.
- Avčín, A., B. Vrišer & A. Vukovič (1979):** Ekosistemske spremembe na območju podmorskega izpusta mestnih odplak portoroško-piranskega omrežja. Slovensko morje in zaledje, 2–3, 281–299.
- Ballesteros, E. (2006):** Mediterranean coralligenous assemblages: a synthesis of present knowledge. Oceanogr. Mar. Biol. Ann. Rev., 44, 123–195.
- Ballesteros, E. (2008):** Action plan for the conservation of the coralligenous and other calcareous bio-concretion in the Mediterranean Sea. RAC/SPA, 25 p.
- Basso, D. (1996):** Soft bottom Mediterranean calcareous algae (non-geniculate Corallinales): Distribution and ecology. In: Atti del Congresso dell'Associazione Italiana di Oceanologia e Limnologia (Sorrento Ottobre 26–28 1994), Genova A.I.O.L. G. Albertelli, A. de Malo & M. Piccazzo (eds), 225–234.
- Basso, D. (1998):** Deep rhodolith distribution in the Pontian Islands, Italy: a model for the paleoecology of a temperate sea. Palaeogeography, Palaeoclimatology, Palaeoecology, 137, 173–187.
- Basso, D., G. Rodondi & M. Mari (2004):** A comparative study between *Lithothamnion minervae* and the type material of *Millepora fasciculata* (Corallinales, Rhodophyta). Phycologia 43, 215–223.
- Bressan, G. (1974):** Rodoficee calcaree dei mari Italiani. Boll. Soc. Adriat. Sci. Nat. Trieste, 59, 1–132.
- Bressan, G. (1988):** Appunti sulla fattibilità di una barriera artificiale sommersa nel Golfo di Trieste. Processi di colonizzazione e fitocenosi guida. Hydrores, 6, 47–56.
- Bressan, G., D. Miniati-Radin & L. Smunin (1977):** Ricerche sul genere *Fosliella* (Corallinales–Rhodophyta): *Fosliella cruciata* sp. nov. Giorn. Bot. Ital., 111, 27–44.
- Bressan, G., L. Sergi & C. Welker (1991):** Variazioni della distribuzione batimetrica di macroalghe dell'infra-litorale fotofilo nel Golfo di Trieste (Mare Adriatico). Boll. Soc. Adriat. Sci. Nat. Trieste, 72, 107–126.
- Bressan, G. & P. Nichetto (1994):** Some observations on the maerl distribution in the northern Adriatic Sea. Acta Adriatic., 35, 15–20.
- Bressan, G., F. Trebbi & L. Babbini (2000):** Variazioni di distribuzione batimetrica di macrofitobenthos nel Parco marino di Miramare (Golfo di Trieste) in rapporto a condizioni edafiche. Biol. Mar. Medit., 7, 528–540.
- Bressan, G. & L. Babbini (2003):** Biodiversità marina delle coste Italiane: Corallinales del Mar Mediterraneo: guida alla determinazione. Biol. Mar. Medit., 10 (Suppl. 2), 237 p.
- Bressan, G. & T. Giaccone (2005):** Corallinales fossili nei sedimenti del Dosso di S. Croce (Golfo di Trieste, Alto Adriatico): descrittori paleoambientali. Boll. Acc. Gioenia Sci. Nat., 38, 173–191.
- Bressan G, A. Di Pascoli & L. Babbini (2006):** Popolamenti fitobentonici. In: Studio della produttività primaria e della produzione secondaria delle strutture artificiali sommerse poste in prossimità del Dosso di S. Croce-Golfo di Trieste – Alto Adriatico, 23–43.
- Bressan, G, G. Giaccone & G. Relini (2009):** Proposte didattiche. In: Biocostruzioni marine, Elementi di architettura naturale. Ministero dell'Ambiente e della Tutela del Territorio e del Mare, Museo Friulano di Storia Naturale, Comune di Udine, 143–149.
- Bussani, M. & A. Vukovič (1992):** Le alghe di Miramare. Hydrores Information, 9 (Suppl.) 10, 1–48.
- Castelli, A., C. Lardicci & D. Tagliapietra (2003):** Il macrobenthos di fondo molle. Biol. Mar. Medit., 10 (Suppl.), 109–144.
- Curiel, D., G. Orel. & M. Marzocchi (2000–2001):** Prime indagini sui popolamenti algali degli affioramenti rocciosi del Nord Adriatico. Boll. Soc. Adriat. Scienze, 80, 3–16.
- Della Valle, G., C. Welker & G. Bressan (1993):** Short term variations in biofouling (Gulf of Trieste, North Adriatic Sea). Oebalia, 19, 173–182.
- Falace, A. (2000):** Variazioni fisionomiche spaziotemporali della vegetazione sommersa del Golfo di Trieste: analisi delle principali influenze ambientali. Ph.D. Thesis. University of Trieste.
- Falace, A. & G. Bressan (1990):** Dinamica della colonizzazione algale di una barriera artificiale sommersa nel Golfo di Trieste: macrofouling. Hydrores, 8, 5–27.
- Falace, A. & G. Bressan (1994):** Some observations on periphyton colonization of artificial substrata in the Gulf of Trieste (North Adriatic Sea). Bull. Marine Sciences, 55(2–3), 924–931.
- Falace, A. & G. Bressan (2002):** Evaluation of the incidence of inclination of substrate panels on seasonal changes in a macrophytobenthic community. 2002 ICES Journal of Marine Science, 59, 116–121.
- Falace, A., A. Di Pascoli & G. Bressan (2005):** Valutazione della biodiversità nella Riserva Marina di Miramare (Nord Adriatico): macroalghe marine bentoniche. Biol. Mar. Medit., 12(1), 88–98.

- Fava, F., M. Ponti & M. Abbiati (2008):** Possible effects of different protection levels on the epibenthic assemblages: the tegnùe of Chioggia. *Biol. Mar. Mediterr.*, 15(1), 158–159.
- Franzosini, C. & G. Bressan (1988):** Calibrazioni metodologiche nello studio del macrophytobenthos nella Riserva Parco Marino di Miramare (Trieste, Italy): 1. Rilievi senza prelievo. *Atti Mus. Civico Storia Nat. Trieste*, 41, 143–159.
- Franzosini, C., V. Verardo, L. A. Ghirardelli & G. Bressan (1983–1984):** La flora algale presso il Laboratorio di Biologia Marina di Aurisina-Filtri (Trieste – North Adriatic Sea): Macrophytobenthos. *Nova Thalassia*, 6, 83–95.
- Giaccone, G. (1970):** Raccolte di fitobenthos sulla banchina continentale Italiana. *Giorn. Bot. Ital.*, 103, 485–514.
- Giaccone, G. (1978):** Revisione della flora marina del mare Adriatico. *Annuario del WWF, Parco Marino di Miramare Trieste*, 6, 5–118.
- Giaccone, G. & S. Pignatti (1967):** Studi sulla produttività primaria del fitobentos nel Golfo di Trieste. II. La vegetazione del Golfo di Trieste. *Nova Thalassia*, 3, 1–28.
- Giaccone G. & S. Pignatti (1972):** Vegetazione algale costiera del Golfo di Trieste. *Inform. Bot. Ital.*, 3, 188–189.
- Giaccone, T., G. Giaccone, D. Basso & G. Bressan (2009):** Le alghe. In: *Biocostruzioni marine, Elementi di architettura naturale*. Ministero dell’Ambiente e della Tutela del Territorio e del Mare, Museo Friulano di Storia Naturale, Comune di Udine, 29–44.
- Ghirardelli, E., G. Orel & G. Giaccone (1973):** L’inquinamento del Golfo di Trieste. *Atti Mus. Civ. St. Nat. Trieste*, 28 (2), 431–450.
- Gordini, E., A. Falace, S. Kaleb, F. Donda, R. Marocco & G. Tunis (In press):** Methane-related carbonate cementation of marine sediments and related macroalgal coralligenous assemblages in the Northern Adriatic Sea. In: *Seafloor Geomorphology as Benthic Habitat: Geohab Atlas of Seafloor Geomorphic Features and Benthic Habitats*. Edit Elsevier Insights.
- Holme, N. A. & A. D. McIntyre (1984):** Methods for the study of marine benthos. Blackwell Scientific Publications, Oxford, 387 p.
- Irvine, L. M. & Y. M. Chamberlain (1994):** Seaweeds of the British Isles, 1 (2B). Corallinales, Hildenbrandiales. London: HMSO, vii + 276 p.
- Kružić, P. & A. Požar-Domac (2003):** Banks of the coral *Cladocora caespitosa* (Anthozoa, Scleractinia) in the Adriatic Sea. *Coral Reefs*, 22(4), 536.
- Kühlmann, D. H. H. (1996):** Preliminary report on Holocene submarine accumulations of *Cladocora caespitosa* (L., 1767) in the Mediterranean. *Göttinger Arbeit Geologie Paläontologie*, 2, 65–69.
- Lipej, L., M. Orlando-Bonaca & M. Šiško (2003):** Coastal Fish Diversity in Three Marine Protected Areas and One Unprotected Area in the Gulf of Trieste (Northern Adriatic). *P.S.Z.N.: Marine Ecology*, 24, 259–273.
- Lipej, L., R. Turk & T. Makovec (2006):** Endangered species and habitat types in the Slovenian Sea. *Zavod RS za varstvo narave*. Ljubljana, 264 p.
- Matjašič, J., J. Štirn, A. Avčin, L. Kubik, T. Valentinčič, F. Velkovich & A. Vukovič (1975):** Flora in favna Severnega Jadrana, prispevek 1. Slovenska akademija znanosti in umetnosti, Razred za prirodoslovne vede, 54 p.
- Morri, C., A. Peirano, C. N. Bianchi & M. Sassarini (1994):** Present day bioconstructions of the hard coral, *Cladocora caespitosa* (L.) (Anthozoa, Scleractinia), in the Eastern Ligurian Sea (NW Mediterranean). *Biol. Mar. Medit.*, 1(1), 371–372.
- Morri, C., A. Peirano & C. N. Bianchi (2001):** Is the Mediterranean coral *Cladocora caespitosa* an indicator of climatic change? *Archo Ocanogr. Limnol.*, 22: 139–144.
- Munda, I. M. (1979):** Some Fucacean associations from the vicinity of Rovinj, Istrian Coast, Northern Adriatic. *Nova Hedwigia*, 31, 607–666.
- Munda, I. (1991):** Algal resources in polluted sites of the Northern Adriatic (vicinity of Piran). *Acta Adriatica*, 32 (2), 682–704.
- Orel G., E. Vio & C. Brunello Zanitti (1981–82):** I popolamenti bentonici antistanti le lagune di Grado e di Marano (Alto Adriatico). *Nova Thalassia*, 5: 31–56.
- Orlando, M. & G. Bressan (1998):** Colonizzazione di macroepifiti algali su *Posidonia oceanica* (L.) Delile lungo il litorale sloveno (Golfo di Trieste - Nord Adriatico). *Ann. Ser. hist. nat.*, 13, 109–120.
- Orlando-Bonaca, M. & L. Lipej (2005):** Factors affecting habitat occupancy of fish assemblage in the Gulf of Trieste (Northern Adriatic Sea). *Marine Ecology*, 26, 42–53.
- Péres, J.-M. & J. Picard (1964):** Nouveau manuel de Bionomie benthique de la Mer Méditerranée. *Recueil des Travaux de la Station Marine d’Endoume*, 47 (31), 3–137.
- Pergent, G. (2009):** Coastal and marine key habitats in the Mediterranean Sea. *Varstvo Narave*, 22, 25–31.
- Pignatti, S. & G. Giaccone (1967):** Studi sulla produttività primaria del fitobentos nel Golfo di Trieste. I. Flora sommersa del Golfo di Trieste. *Nova Thalassia*, 3(1), 1–17.
- Ponti, M., F. Fava & M. Abbiati (2011):** Spatial-temporal variability of epibenthic assemblages on subtidal biogenic reefs in the northern Adriatic Sea. *Marine Biology (in press)*. <http://dx.doi.org/10.1007/s00227-011-1661-3>.
- Schiffner, V. (1916):** Studien über algen der Adriatischen meers. *Wiss. Meeresuntersuch., Abt. Helgoland.*, 11, 129–198.
- Simonetti, G. (1972):** I consorzi a fanerogame marine nel Golfo di Trieste. *Atti Ist. Veneto Sci. Lett. Arti, Cl. Sci. Mat. Nat.*, 131, 459–502.

Thiers, B. [continuously updated]. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/>

Turk, R. & A. Vukovič (1994): Preliminarna inventarizacija in topografija flore in favne morskega dela naravnega rezervata Strunjan. *Annales, Ser. hist. nat.*, 4, 101–112.

UNEP(DEC)/MED WG, 308/9 (2007): Proposal of a Work Programme on Protecting the Coralligenous and other Calcareous Bio-Concretions in the Mediterranean. Ed. RAC/SPA, Tunis, 18 p.

UNEP-MAP-RAC/SPA (2008): Action plan for the conservation of the coralligenous and other calcareous bioconcretions in the Mediterranean Sea. Ed. RAC/SPA, Tunis, 21 p.

UNEP (DEPI)/MED WG.362/3 (2011): Draft Lists of coralligenous/maërl populations and of main species to be considered by the inventory and monitoring. Ed. RAC/SPA, Tunis, 11 p.

Vrišer, B., A. Avčin & A. Vukovič (1981): Značilnosti bentoških združb v Izolskem zalivu. *Slovensko morje in zaledje*, 4–5, 201–206.

Vukovič, A. (1980): Asociacije morskih bentoških alg v Piranskem zalivu. *Biol. vestn.*, 2 (28), 103–124.

Vukovič, A. (1982a): Bentoška vegetacija Koprškega zaliva. *Acta Adriat.*, 23 (1/2), 227–235.

Vukovič, A. (1982b): Florofavnistične spremembe infralitorala po populacijski eksploziji *Paracentrotus lividus* (L.) = Florofavnistic changes in the infralitoral zone after the sea urchin *Paracentrotus lividus* (L.) population explosion. *Acta Adriat.*, 23 (1/2), 237–241.

Vukovič, A. (1984): Prispevek k poznavanju flore morskih alg Slovenije = Contribution to the knowledge of marine benthic algae of Slovenia. *Slov. morje zaledje*, VII (6–7), 187–193.

Woelkerling, W. J. (1988): The coralline red algae: an analysis of the genera and subfamilies of nongeniculate Corallinales. British Museum (Natural History), Oxford University Press., 268 p.

Woelkerling, W. J., L. M. Irvine & A. S. Harvey (1993): Growth-forms in non-geniculate Coralline red algae (Corallinales, Rhodophyta). *Australian Systematic Botany*, 6, 277–293.

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Fig. 2: *Hydrolithon boreale*.

Sl. 2: *Hydrolithon boreale*.

Fig. 3: *Lithophyllum pustulatum* (uniporate sporangial conceptacles).

Sl. 3: *Lithophyllum pustulatum* (enoporni konceptakli na sporangijih).

Fig. 4: *Lithophyllum racemus*.

Sl. 4: *Lithophyllum racemus*.

Fig. 5: *Lithophyllum racemus* (conceptacle chamber with columella).

Sl. 5: *Lithophyllum racemus* (komora konceptakla z kolumelo).

Fig. 6: Free-living plant of *Lithothamnion minervae*.

Sl. 6: Prosto živeča *Lithothamnion minervae*.

Fig. 7: *Lithothamnion philippii* (gametangial conceptacle).

Sl. 7: *Lithothamnion philippii* (konceptakel na gametangiju).

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Fig. 8: *Lithothamnion philippii* (chamber of a gametangial conceptacle).

Sl. 8: *Lithothamnion philippii* (komora konceptakla na gametangiju).

Fig. 9: *Lithothamnion philippii* (sporangial multiporate conceptacle).

Sl. 9: *Lithothamnion philippii* (večporni konceptakel na sporangiju).

Fig. 10: *Lithothamnion sonderi* (multiporate conceptacles).

Sl. 10: *Lithothamnion sonderi* (večporni konceptakli).

Fig. 11: *Lithothamnion sonderi* (sporangial conceptacle).

Sl. 11: *Lithothamnion sonderi* (konceptakel na sporangiju).

Fig. 12: *Neogoniolithon brassica-florida* (tetrasporangial conceptacles).

Sl. 12: *Neogoniolithon brassica-florida* (konceptakli na tetrasporangiju).

Fig. 13: *Neogoniolithon mamillosum* (conceptacles grouped on the protuberances).

Sl. 13: *Neogoniolithon mamillosum* (konceptakli združeni v izbokline).

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Fig. 14: *Phymatolithon lenormandii* (multiporate conceptacles).

Sl. 14: *Phymatolithon lenormandii* (večporni konceptakli).

Fig. 15: *Pneophyllum confervicola* (trichocytes on thal-
lus surface).

Sl. 15: *Pneophyllum confervicola* (trihocite na površini
stelke).

Fig. 16: *Pneophyllum confervicola* (sporangial plant
with uniporate conceptacle).

Sl. 16: *Pneophyllum confervicola* (sporangij z enopornim
konceptaklom).

Fig. 17: *Pneophyllum fragile*.

Sl. 17: *Pneophyllum fragile*.

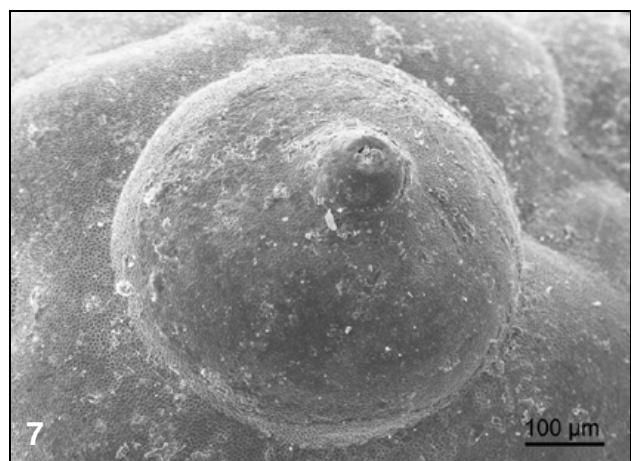
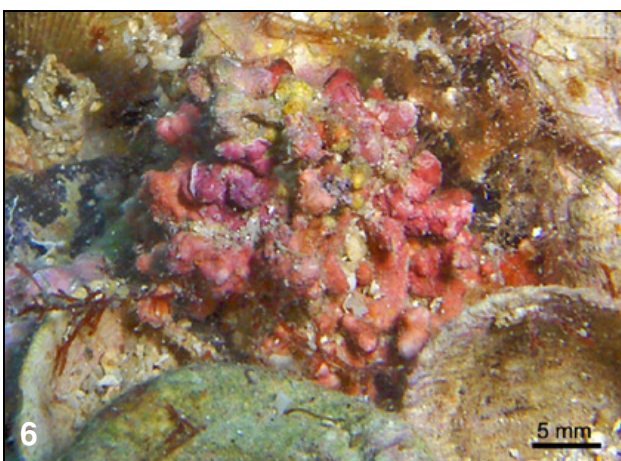
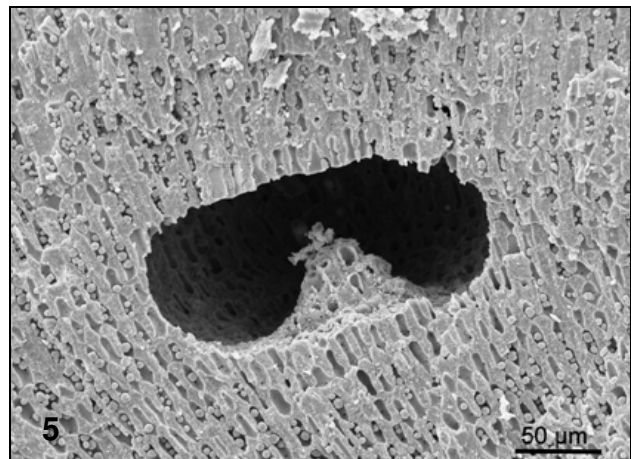
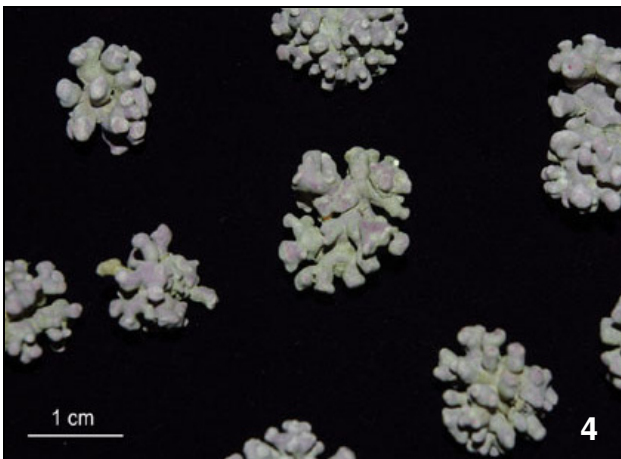
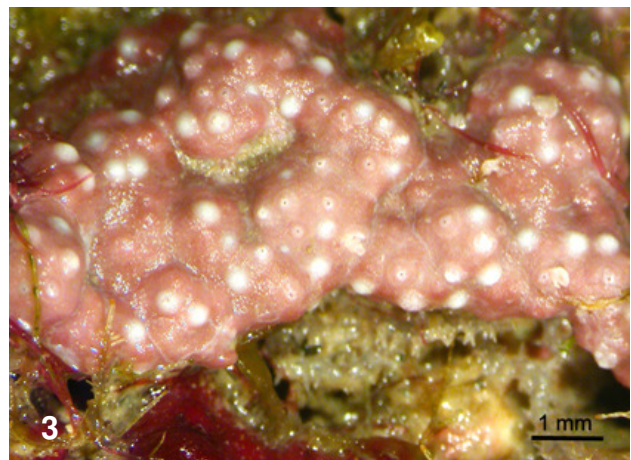
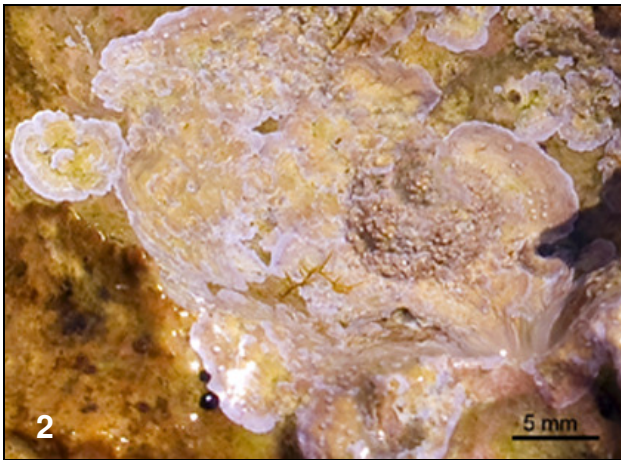


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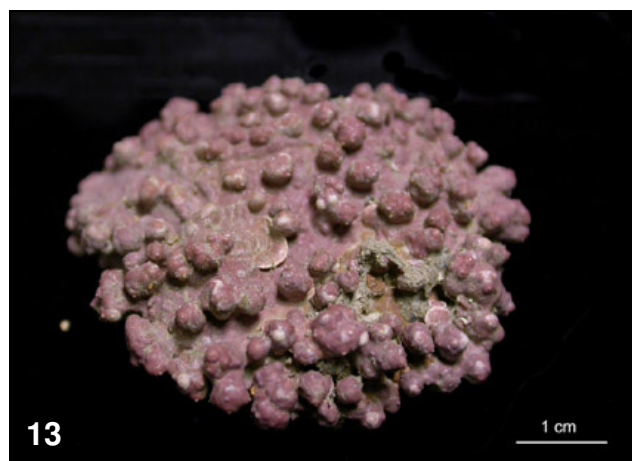
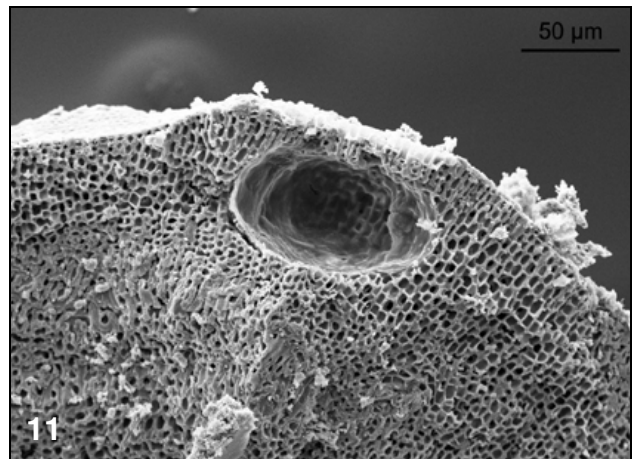
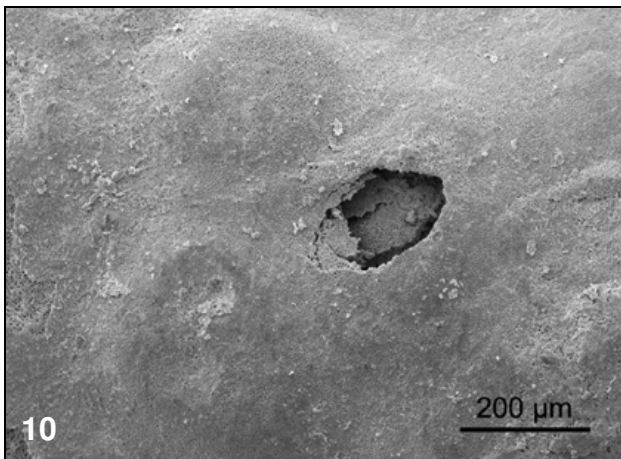
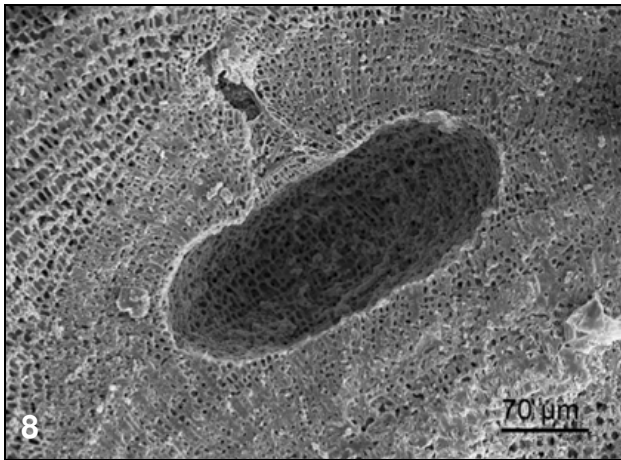


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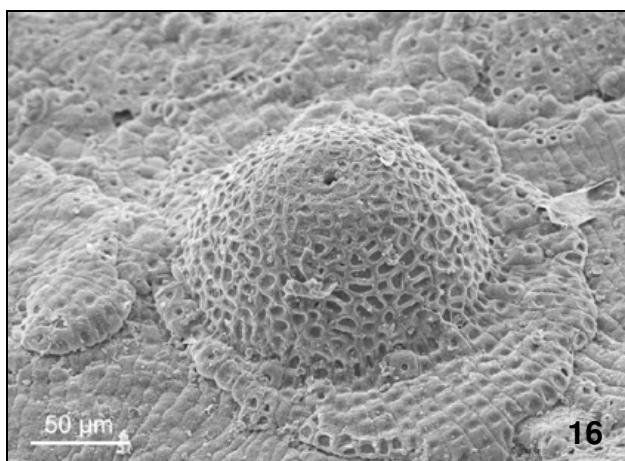
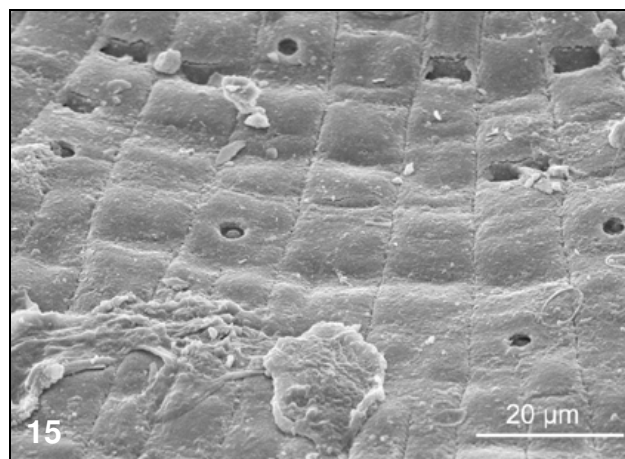
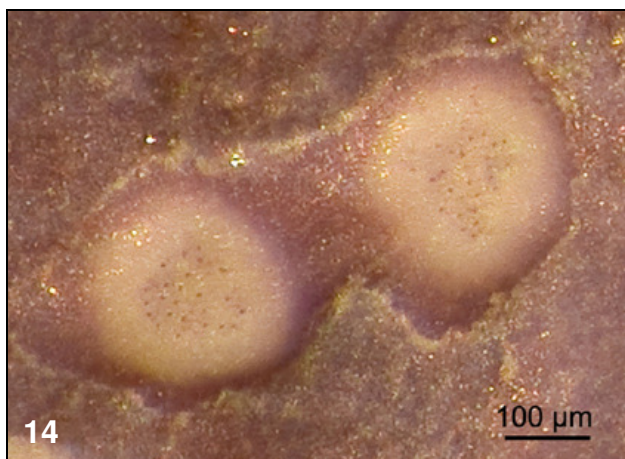


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