

ADRIATIC ENDEMIC 3. BOREAL CALCIFYING ALGAE OF KVARNER GULF

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ABSTRACT. NE. Adriatic has a variable salinity, lower temperature, dominant Bora storms, and cold exposed NE. cliffs with paleoendemic calcifying algae: intertidal *Valonia incrustans*-*Lithophyllum hieroglyphicum*, subtidal *Corallina squamata*-*Amphiroa beauvoisii*, and estuarine *Lamprothamnion mediterraneum*-*Chara rabenhorstii*. Flat rocks: *Cystoseira spicata*, deeper *C. adriatica*-*C. corniculata*.

RESUME. Endémiques adriatiques — 3) Algues calcifiantes boréales du Golfe de Kvarner. L'Adriatique nord-est a une salinité variable, températures plus basses, orages de Bora dominantes et falaises du NE froides et battues à algues calcifiantes paléoen — démiques: celles mediolittorales de *Valonia incrustans*-*Lithophyllum hieroglyphicum*, infralittorales de *Corallina squamata*-*Amphiroa beauvoisii* et estuariennes de *Lamprothamnion mediterraneum*-*Chara rabenhorstii*. Roches plates: en haut *Cystoseira spicata*, plus bas *Cystoseira adriatica*-*C. corniculata*.

The central and southern Adriatic is dominated by a Mediterranean benthos, especially rich in external SW. shores of the isles exposed to the Sirocco of open sea. In NE. Adriatic and especially in Kvarner Gulf, just the opposite continental Bora storms dominate. The exposed and extreme habitats there are in the internal NE. insular shores, with a very specific benthos, up today ignored and neglected, except in few exposed and less interesting SW. shores. A Bora over 150 days in year, the variable salinity and sea cooler than 22°C in summer, there confine an exotic luxuriant phytobenthos, presenting a cardinal node of the richness and diversity in Charales, Siphonales, and Fucales of Adriatic with some euryhaline and eurythermic endemics: *Nitellopsis ulvoides* (Bert.) MG., *Charopsis stalii* (Vis.) Men., *Chara rabenhorstii* A. Br., *Codium coralloides* Kütz., *C. cattaniae* Vouk, *Valonia incrustans* Kütz. (*V. cespitula* Zan.), *Fucus virsoides* J. Ag., *Cystoseira tophosa* Fil., *C. moniliformis* Kütz. (? *C. jabukae* Erc.), *C. aurantia* Kütz., *C. spicata* Erc. s. str., *C. crinitophylla* Erc., *C. fimbriata* ssp. *plana* Erc., *C. barbata* v. *crinoides* Fil., *Lithophyllum hieroglyphicum* Zan. s. str. (*L. ercegovicii* Lov.), etc. The Rhodophyta there have a low endemism and inferior diversity.

The shady exposed cliffs with calcified formations are mapped along 160 km of NE. shores in Kvarner: E. Istra, isles of Cres, Plavnik, Krk (SE), Grgur, Goli, and Rab. Their apogee is in the excessively stormy and cold archipelago at Senj with more than 200 days of Bora and with a periodical winter ice belt up to 1–2 m thick in shore. The perpetuate stormy surf there produces an enormous supralittoral belt 8–25 m high, and also an infralittoral fringe of 9–15 m, resulting by the exotic zonation of very specific calcified formations in whole littoral transect. This paleoendemic calcifying complex of *Valonio-Lithophylletum/Codio-Corallinetum* includes supralittoral lithophytic cyanobacteria in 5–8 m, at superior limit with the organo-mineral incrustations and tubercules of pelagosite up to an altitude 10–30 m; then below the mediolittoral cushions, cornices, and pavements (*Valonio-Lithophylletum*) to 3 m wide of the calcified *Valonia incrustans* 7e, *Lithophyllum hieroglyphicum* 9e (more compact and rigid than its vicariad *L. tortuosum* of Mediterranean) with an epiflore of *Catenella repens* 8d, *Enteromorpha clathrata* 4d (exclusive fauna: *Mihovilia adriatica* 1e, a tertiary epibiotic of *Pulmonata-Valencienniidae* from Para-Tethys — cf. LOVRIĆ 1977); and the infralittoral incrustations of *Codio-Corallinetum* to 7-12 m deep: *Corallina squamata* 9d, *Amphiroa beauvoisii* 6, *Codium coralloides* 6e, epiflore of *Lomentaria articulata* 4d, *Cystoseira fimbriata* ssp. *plana* 6e (preferential epifauna: *Aglaophenia septifera*, *A. tubulifera*, *Eudendrium rameum*, *Sertularella polyzonias*, *Botrylloides* sp.).

Sciaphilic cliff coralligene: at the normal salinity it is comparable to the circumlittoral of Mediterranean, except its elevation in 12–30m provoked by the cliff shade and cold Bora: *Pseudolithophyllum*, *Peyssonellia polymorpha* (*Eunicella*, *Porella*). Deep precoralligene: deeper than 30m the melobesias and bryozoa disappear and *Codium bursa*, *Palmophyllum*, *Mesophyllum*, *Zanardinia* (*Leptopsammia*, *Paramuricea*) dominate. The deep rocks at strong current of pure brackish water in Karst estuarine canyons have a lagunar „pseudocoralligene” of

endemic halophytic Charales (*Lamprothamnio-Cystoseiretum*): incrustations of *Lamprothamnion mediterraneum* 5s and *Chara rabenhorstii* 7e, epiflore of *Ch. salsa* 2, *Ch. stalii* 3e, *Nitellopsis ulvoides* 3e, *Cystoseira aurantia* 3e, *C. myriophylloides* 6.

The subhorizontal complex of exposed NE. rockfields, *Cystoseiretum spicatae/Cy. adriaticae*, includes an infralittoral fringe (*Cystoseiretum spicatae*) of *Cystoseira spicata* 7e, *C. moniliformis* 3e, *C. tamariscifolia* 3d, *Pylaiella* 6d, *Halimeda* 7, then a deeper *Cystoseiretum adriaticae* with *C. adriatica* 7s, *C. corniculata* 8s, *C. crinitophylla* 5s, *Codium cattaninae* 3e, and muddy rocks (*Sargasso-Cystoseiretum*): *C. schiffneri* 8, *C. tophosa* 2e, *Sargassum salicifolium* 7s, *Phyllaria reniformis* 1d. Sheltered shores with *Fucetum/Zosteretum* complex: emergent *Fucetum virsoidis*, deeper rocks with *Cystoseiretum barbatae*, and *Zosteretum marinae* in mud.

This paleoendemic Liburnian benthos, exotic to Mediterranean, presents considerable correlations to the fossil benthos of the Pannonian sea. It has almost a preglacial Para-Tethyan origin from its Oligo-Miocene Liburnian gulf, and subsequent Liburnian lagoon in Pleistocene. Due to local euhaline conditions between the subsaline Para-Tethys and hypersaline Mediterranean, Liburnia was a Messinian marine refugium, and a sea-way essential for Pliocene regeneration of Mediterranean benthos since its Messinian crisis.