

Short scientific article  
Received: 2005-01-17

UDC 582.26(262.3 Boka Kotorska)

## DISTRIBUTION OF SEAWEED *FUCUS VIRSOIDES* J. AGARDH IN BOKA KOTORSKA BAY (SOUTH ADRIATIC SEA)

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### ABSTRACT

*The aim of this work was to contribute to the knowledge of spatial distribution of Fucus virsoides J. Agardh, an endemic alga of the Adriatic Sea. Boka Kotorska Bay was defined as one of the southernmost limits of F. virsoides, so we investigated its distribution in this area. The research was carried out by snorkelling and observing from the coast. 14 localities of F. virsoides were found and additional 4 which, however, already disappeared or were in the process of disappearing.*

**Key words:** *Fucus virsoides*, Boka Kotorska Bay, South Adriatic

## DISTRIBUZIONE DELL'ALGA MARINA *FUCUS VIRSOIDES* J. AGARDH NELLA BAIJA DI BOKA KOTORSKA (ADRIATICO MERIDIONALE)

### SINTESI

*Lo scopo del presente studio era quello di ampliare le conoscenze in merito alla distribuzione spaziale dell'alga endemica dell'Adriatico, Fucus virsoides J. Agardh. La baia di Boka Kotorska è stata definita come uno dei limiti più meridionali di F. virsoides, pertanto l'autrice ha studiato la distribuzione dell'alga in tale area. La ricerca è stata condotta mediante osservazioni dalla costa e ispezioni in acqua con l'ausilio del boccaglio. Sono state trovate 14 località colonizzate da F. virsoides, ed è stato inoltre osservato il processo di regressione in 4 località.*

**Parole chiave:** *Fucus virsoides*, baia di Boka Kotorska, Adriatico meridionale

## INTRODUCTION

The most sinuous part of Adriatic coast, Boka Kotorska Bay, is situated in the southeastern part of the Adriatic (Fig. 1). In comparison with the open part of Montenegrin coast, this aquatic area shows a large number of differences. Boka Kotorska Bay (coastline of the bay is 105 km) comprises inlets and four smaller bays (Kotor Bay, Risan Bay, Tivat Bay and Herceg Novi Bay) with specific hydrographic characteristics and features of submarine relief. Because of the specific abiotic conditions, marine life in the Bay is specific as well. Unfortunately, benthic flora and vegetation of this bay are poorly known. One of the first remarks on this topic was made by Linardić (1949) in the "Studies on the Adriatic *Fucus*". Later, information on *Fucus virsoides* was sparse. Solazzi (1971), who was the first to study benthic flora in Boka Kotorska Bay, recorded *F. virsoides* at two localities in Kotor Bay (Radimiri and Institute of Marine Biology). Antolić & Špan (1990) provided important additional information of benthic flora on this bay. For the *F. virsoides* there is no indication as to its precise locality, but merely Boka Kotorska Bay as a whole. Although Boka Kotorska Bay was defined as the southern limit of

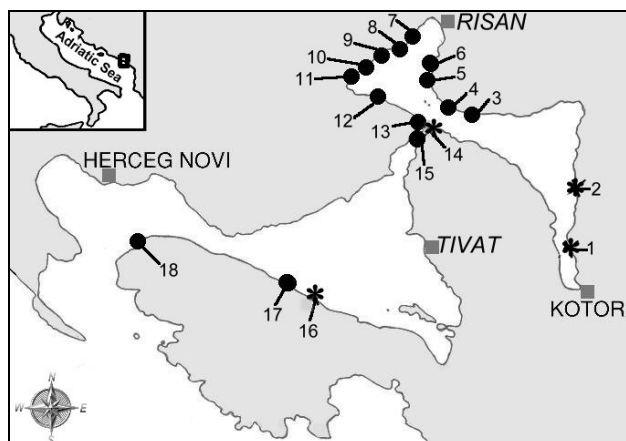
the species' area (Linardić, 1949), Kashta (1995/96) reported on disjunction in the area of *F. virsoides* along the Albanian coast. The aim of this work was to expand the knowledge of spatial distribution of this endemic alga for the Adriatic Sea at one of the southernmost limits of its range.

## MATERIAL AND METHODS

The research was carried out in Boka Kotorska Bay by snorkelling in the summer months of 2003–2004 and by observation from the coast during the entire period. Localities in Kotor and Risan Bays were observed occasionally during ten-year period. The fixation of few samples was done with 4% formalin seawater, whereas the rest of algal material is preserved as herbarium material.

## RESULTS AND DISCUSSION

During the studies carried out in the investigated area, *Fucus virsoides* was found in non-continuous zone, at 14 localities (Fig. 1). The alga is widely distributed in the Risan Bay (9 localities), in contrast to other parts of Boka Kotorska Bay. Rocky bottom, as required by *Fucus* sp., is present only on the small inter-tidal surfaces of the Bay, and one of the reasons for numerous *Fucus* sites in Risan Bay is the rocky substrate in the inter-tidal zone. Regarding the localities of Krašići and Gospa od Anđela, disappearance of *Fucus* was observed. The reason for such state of affairs is anthropogenic, i.e. the habitat disturbance. The rapid urbanization and construction of numerous buildings close to the shore-line caused disappearance of the tiny rocky habitat for *F. virsoides*. The disappearance of the species in Kotor Bay is also caused by anthropogenic factor, although in a slightly different way. Urbanization is very rapid in this zone, too, but habitat disturbance is probably not as crucial as eutrophication. The Bay of Boka Kotorska is a natural eutrophic zone, but due to its numerous sewage system outputs as well as city harbours and weak hydro-dynamism, it could no longer be tolerated by *F. virsoides*. Munda (1982) indicates a partial restitution of *F. virsoides* at some fairly polluted sites, probably due to the increased resistance or gradual adaptation to pollution by organic wastes, but restitution of *F. virsoides* sites have never been observed in Boka Kotorska Bay. Additional reasons for the disappearance of *F. virsoides* from the Bay could be partial changes in the abiotic conditions (temperature and salinity). *F. virsoides* is a euryhaline and eurythermal alga, but the increase in seawater temperature, air temperature and salinity (Regner *et al.*, 2003) at one of the southern localities of its range could be the factor of its elimination, although experimental data are necessary to clarify this hypothesis. Regarding the habitat characteristic, the well sheltered Risan Bay is certainly most appropriate not only because



**Fig. 1: Map of the investigated area and localities of *F. virsoides*: ● – existing sites, \* – disappeared sites.**

**Legend:** 1 – Institute of Marine Biology; 2 – Radimiri; 3 – Dražin Vrt; 4 – Perast1; 5 – Perast2; 6 – Ban; 7 – Carine; 8 – Sopot; 9 – Strp; 10 – Lipci; 11 – Morinj; 12 – Kamenari; 13 – Turski rt; 14 – Gospa od Anđela; 15 – Andrići; 16 – Krašići; 17 – Krašići2; 18 – Male Rose.

**Sl. 1: Zemljevid raziskanega območja z lokalitetami vrste *F. virsoides*: ● – obstoječe lokalitete, \* – izginule lokalitete.**

**Legenda:** 1 – Inštitut za morsko biologijo, Kotor; 2 – Radimiri; 3 – Dražin Vrt; 4 – Perast1; 5 – Perast2; 6 – Ban; 7 – Carine; 8 – Sopot; 9 – Strp; 10 – Lipci; 11 – Morinj; 12 – Kamenari; 13 – Turski rt; 14 – Gospa od Anđela; 15 – Andrići; 16 – Krašići; 17 – Krašići2; 18 – Male Rose.

of its rocky substrate but also because of great input of fresh water. This is why salinity values are significantly lower in relation to Kotor Bay and especially to Tivat and Herceg Novi Bays. Lower temperature values (particularly in the surface layers) are also significant (Stjepčević, 1967; Vukanić, 2004) and favourable for *F. virsoides*. Developing of conceptacles (reproductive organs), which could be found not only in spring but also in late summer and autumn, are the proof of favourable habitat conditions in Risan Bay (Fig. 2).

The ramification of all collected samples is typically dichotom-dichopodial, with numerous proliferations appearing on the bitten parts. There are also many anomalous formations on the thallus, but as Boka Kotorska Bay is one of the southernmost limits of its range, the morphological variability of the collected samples was not taken into consideration.



**Fig. 2:** *F. virsoides* in the Risan bay.

**Sl. 2:** *F. virsoides* v Risanskem zalivu.

## CONCLUSION

The aim of this work was to expand the knowledge of spatial distribution of *Fucus virsoides* J. Agardh, an endemic alga of the Adriatic Sea, in Boka Kotorska Bay, one of the southernmost limits of the species' range. The results of our field studies indicate 14 *F. virsoides* localities, with most of them situated in Risan Bay. Favourable conditions for *F. virsoides* in Risan Bay are due to the great input of fresh water, lower temperature and salinity values (considerably differing from those of the open part of the Adriatic Sea), rocky surface in the inter-tidal zone, and relatively undisturbed environment.

During the recent studies, disappearance of 2 sites was observed (Krašići and Gospa od Anđela), while 2 sites virtually disappeared before these studies were carried out (Radimiri and Institute of Marine Biology). The disappearance of these sites was probably caused by anthropogenic influence, but further research would be necessary to evaluate the level of impact caused by habitat disturbances, concentration of organic wastes, temperature and salinity increase or variability of other chemical and physical parameters.

## RAZŠIRJENOST MORSKE ALGE *FUCUS VIRSOIDES* J. AGARDH V ZALIVU BOKA KOTORSKA (JUŽNO JADRANSKO MORJE)

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### POVZETEK

Namen raziskave je bil prispevati k poznavanju razširjenosti alge *Fucus virsoides* J. Agardh, endemične vrste v Jadranskem morju, ki je eno najjužnejših meja njenega areala. Vzorci razširjenosti alge *F. virsoides* so bili preučevani v Zalivu Boka Kotorska (južni Jadran), terenske raziskave pa so pokazale, da v Zalivu uspeva na 14 lokalitetah. Večina izmed teh leži v Risanskem zalivu (delu Zaliva Boka Kotorska), predvsem zaradi ugodnih razmer v njih, in sicer kamnite površine v medbivičnem pasu, precejšnjega dotoka sladke vode, njenih nižjih vrednosti temperature in slanosti in razmeroma neokrnjenega okolja.

Med nedavnimi raziskavami je bilo ugotovljeno, da alga izginja z dveh lokalitet in da je na nadaljnjih dveh izginila že pred raziskavami. Avtorica domneva, da je treba razlog za izginjanje te vrste iskati v antropogenih vplivih, in dodaja, da bi bile potrebne dodatne raziskave, da bi lahko ocenili negativne vplive zaradi antropogenih motenj in pritiskov na njihov habitat in variabilnosti drugih kemijskih in fizičnih parametrov.

**Ključne besede:** *Fucus virsoides*, Zaliv Boka Kotorska, južni Jadran

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