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ISSN 0469-6255
(68-71)

TOXIC AND POTENTIALLY TOXIC PHYTOPLANKTON SPECIES IN THE MALI STON BAY (EASTERN ADRIATIC)

Toksične i potencijalno toksične vrste fitoplanktona u Malostonskom zaljevu (istočni Jadran)

UDK 574.583(262.3)"MALOSTONSKI ZALJEV")
Review
Pregledni članak

Abstract

The Mali Ston Bay has been qualified as a moderately/naturally eutrophicated ecosystem. Extensive phytoplankton blooms (red-tides) were not recorded. One hundred and ninety-five phytoplankton taxa were determined in the bay so far. The phytoplankton species composition and diversity reflect stable conditions throughout most of the year. Although toxic diatoms (Pseudo-nitzschia spp.) and dinoflagellates (e.g. Dinophysis acuta, D. fortii) were evident, there was no toxic impact on either shellfish or people. Changes in the physical-chemical conditions of the environment need to be monitored alongside species composition.

Key words: phytoplankton, toxic species, the Mali Ston Bay, eastern Adriatic

Sažetak

Malostonski zaljev pripada skupini prirodno-umjereno eutroficiranih ekosustava. "Cvatnji" ("red-tide") fitoplanktona u zaljevu nema. Dosada je utvrđeno 195 svojti fitoplanktona (vrsta i nižih sistematskih kategorija). Struktura fitoplanktonskih populacija ukazuje na stabilne uvjete tijekom cijele godine. U flornom sastavu je zastupljeno nekoliko toksičnih i/ili potencijalno toksičnih vrsta dijatomeja (Pseudo-nitzschia spp.) i dinoflagelata (npr. Dinophysis acuta, D. fortii). Toksični učinak na školjkaše i ljude koji ih konzumiraju nije zabilježen. I ubuduće je, uz sastav fitoplanktona, nužno pratiti fizičko-kemijske parametre.

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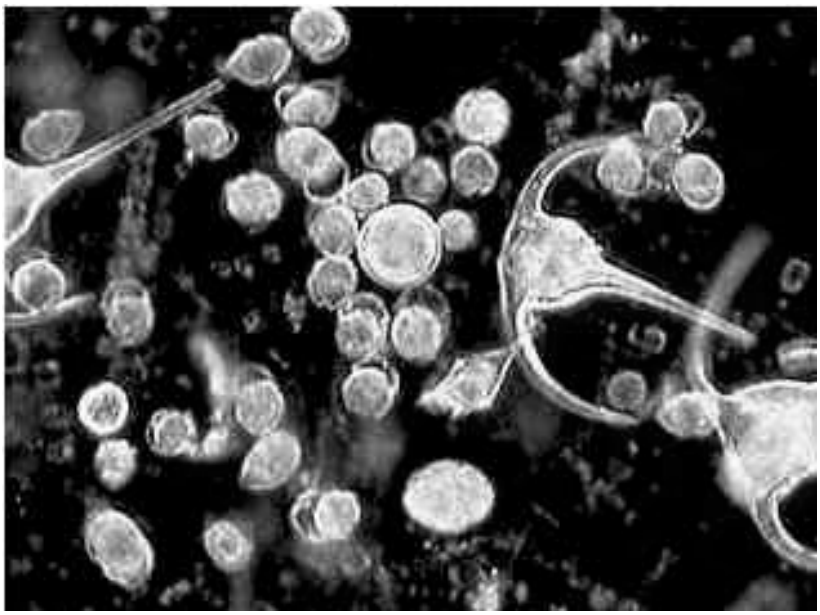
Ključne riječi: fitoplankton, toksične vrste, Malostonski zaljev, istočni Jadran

Introduction
Uvod

According to recent insights, the phytoplankton of the eastern Adriatic Sea is composed of 888 phytoplankton taxa (Viličić *et al*. 2002). An in-depth study on the taxonomy and ecology of phytoplankton in the Mali Ston Bay was made during the periods 1979-1985, 1988-1989, and 2001-2002. One hundred and ninety five microphytoplankton taxa were determined (Viličić *et al*. 1998). The bay has been qualified as a moderately/naturally eutrophicated ecosystem, based on the frequency distribution of phytoplankton cell density values (Viličić 1989).

In the Mali Ston Bay, diatoms dominate the population density of phytoplankton throughout most of the year, whereas dinoflagellates are more predominant in summer (Jasprica & Carić 1997, 2001; Jasprica *et al.* 1997). The contribution of the other groups (silicoflagellates, coccolithophorids, euglenophytes) in phytoplankton population density generally does not surpass 20%. Changes in the ecological conditions of the pelagial (e.g. increased input of nutrients), can result in the intensive growth of phytoplankton biomass ("bloom") that accompany changes in the structure of phytoplankton communities. Certain species can disappear under increased eutrophic conditions, and "opportunistic" species can dominate the floral composition, while seasonal fluctuations are less pronounced.



Alexandrium sp. , Scrippsiella sp., Ceratium sp.

Toxic and potentially toxic phytoplankton taxa

Toksične i potencijalno toksične fitoplanktonske svojte

Some phytoplankton species are able to produce toxins (=phycotoxins). Shellfish and filter feeders passively accumulate the toxins and when consumed may cause toxic episodes such as amnesic shellfish poison (ASP), diarrhetic shellfish poison (DSP), neurotoxic shellfish poison (NSP) and paralytic shellfish poisoning (PSP). Toxic episodes could result in serious health problems and enormous loss of revenue to growers. The most significant public health problems caused by toxic algae are presented in Table 1. Problems and symptoms caused by toxic algae are similar to those caused by pathogenic bacteria (*Salmonella*, *Shigella*, *Vibrio*), which complicates diagnostic procedure and treatment (table 1).

While developing a phycotoxin programme the following facts should be considered: 1) not all phytoplankton taxa are toxigenic, 2) toxins are produced by certain strains of algae, 3) the same toxin may be produced by a variety of biota, e.g. saxitoxin and neosaxitoxin are produced by bacteria and dinoflagellates as well, 4) toxin production may be a response to nutrient or biochemical stress, 5) the rate of production of toxin varies with the physiological state of the algae and therefore algae should be harvested at various stages of growth for toxin analyses, 6) toxin may be released into a medium and therefore the dissolved form of toxin has also to be determined. For the extraction, detection and quantization of the toxins it is advisable to consult Hallegraeff *et al.* (1995). Potentially bloom-forming, red-tide, and harmful/or toxigenic marine phytoplankton species were listed by Subba Rao (2002).

Even though harmful "blooming" has not been confirmed for the southern coastal regions of the Adriatic, attention should be brought towards controlling the floral composition of phytoplankton, especially in those regions geared towards fish and shell farming (Jasprica *et al.* 2001). Although potentially toxic diatoms and dinoflagellates were evident in the Mali Ston Bay, there was no toxic impact on either shellfish or people. Some bloom-forming species, although producing no toxins, may harm fish populations. Some diatoms produce mucus, while the spines on the chaete of *Chaetoceros* may cause abrasion of fish gills, resulting in fish mortalities.

Diatoms

Alge kremenjašice

Many diatoms can be harmful, especially in a "bloom". The results of each bloom have been species-specific, and species identification remains a high priority. Bloom genesis is related to the response of the diatom (sinking, floating) to varying environmental conditions, and applied ecology can result in predictive tools. According to Fryxell & Villac (1999), seven diatom species (*Cerataulina pelagica*, *Chaetoceros convolutus*, *Leptocylindrus danicus, L. minimus*, *Pseudo-nitzschia delicatissima*, *P. seriata* and *Skeletonema costatum*) can be considered as potentially toxic or harmful (domoic acid, ASP) in the Mali Ston Bay. Shellfish beds are closed to harvesting when the domoic acid concentration reaches 20 μg g^{-1} in shellfish meat. The most serious problem is the possible impact of *Pseudo-nitzschia* spp. – a common taxon in the Mali Ston Bay with a maximum population density greater than 10^5 cells l^{-1}. As the genus *Pseudo-nitzschia* is morphologically very complex, some species cannot be differentiated without SEM (scanning electron

Table 1. The most significant public health problems caused by toxic algae
Tablica 1. Najznačajniji zdravstveni problemi koje uzrokuju toksične alge

Type of poisoning	Causative organisms	Toxin produced	Symptoms
Amnesic Shellfish Poisoning (ASP)	*Pseudo-nitzschia* spp.	Domoic Acid	Gastroenteritis usually develops within 24 hours of the consumption of toxic shellfish; symptoms include nausea, vomiting, abdominal cramps, and diarrhea. In severe cases, neurological symptoms also appear, usually within 48 hours of toxic shellfish consumption. These symptoms include dizziness, headache, seizures, disorientation, short-term memory loss, respiratory difficulty, and coma.
Diarrhetic Shellfish Poisoning (DSP)	*Dinophysis acuta*, *D. fortii*	Okadaic Acid	DSP produces gastrointestinal symptoms, usually beginning within 30 min to a few hours after consumption of toxic shellfish. The illness, which is not fatal, is characterized by incapacitating diarrhea, nausea, vomiting, abdominal cramps, and chills. Recovery occurs within three days, with or without medical treatment.
Neurotoxic Shellfish Poisoning (NSP)*	*Gymnodinium* cf. *breve*	Brevetoxins	In this case, gastrointestinal and neurological symptoms predominate. In addition, formation of toxic aerosols by wave action can produce respiratory asthma-like symptoms. Recovery is generally complete in a few days. In the literature, no deaths have been reported.
Paralytic Shellfish Poisoning (PSP)*	*Alexandrium* spp., *Gymnodinium catenatum, Pyrodinium bahamense*	Saxitoxins	PSP is a life-threatening syndrome. Symptoms are purely neurological and their onset is rapid. Duration of effects is a few days in non-lethal cases. Symptoms include tingling, numbness, and burning of the perioral region, ataxia, giddiness, drowsiness, fever, rash, and staggering. The most severe cases result in respiratory arrest within 24 hours of consumption of the toxic shellfish. If the patient is not breathing or if a pulse is not detected, artificial respiration and CPR may be needed as first aid. There is no antidote, supportive therapy as the rule and survivors recover fully.

**** Toxic and potentially toxic species of NSP and PSP are not recorded in the Mali Ston Bay.***

microscopy) observations. For this reason, all Adriatic *Pseudo-nitzschia* spp. must be submitted to SEM analyses, including toxicology tests.

Dinoflagellates
Dinoflagelati

Marasović (1990) mentions seven toxic or potentially toxic species of dinoflagellates in the middle Adriatic waters. Considering their toxicity, dinoflagellates have not been well investigated in the southern Adriatic.

The species *Dinophysis acuta* and *D. fortii* – present in the Mali Ston Bay – can cause DSP poisoning even at low concentrations (Tangen 1983, Boni *et al.* 1993). *D. sacculus*, which caused the mussels toxicity in Kaštel Bay in the summer of 1995, (Marasović *et al.* 1998), was not recorded in the Mali Ston Bay. The remaining potentially toxic *Dinophysis* sp. (e.g. *D. tripos*, *D. caudata*) are rare species in the coastal regions of the Adriatic.

Some *Alexandrium* sp. are considered potential producers of the PSP toxin. Even though species of the genus *Alexandrium* have not been noted up to now along southern Adriatic shores, Marasović *et al.* (1995) recorded a bloom of *A. minutum* alongside the species *Prorocentrum triestinum* and *Eutreptiella* sp. in the Kaštel Bay. According to Giacobbe *et al.* (1996), *A. minutum* never dominated the phytoplankton communities of the Mediterranean Sea.

Some *Prorocentrum* sp. are potentially toxic (*P. lima*, *P. minimum*). *Prorocentrum minimum* in the Mali Ston Bay is seldom present, with a maximum density of 80 cells l^{-1}. This species is frequent in the Šibenik harbour and in the northern Adriatic – regions with poor exchanges in water masses and high nutrient input (Marasović *et al.* 1990).

Lingulodinium polyedra, one of the best-known red-tide species, has been categorized as toxic by most authors, even though its toxicity has never been laboratory confirmed. In the summer, it frequently causes blooms in the Kaštel Bay (Marasović *et al.* 1995). It is

rare in the Mali Ston Bay, and the maximum population density was 320 cells l^{-1} (Viličić *et al.* 1998).

Conclusion
Zaključak

Even though the highest numbers of potentially toxic species on the eastern shores of the Adriatic are autochthonous, there is a danger of introducing cysts of toxic and non-toxic dinoflagellates, as well as the vegetative cells of other phytoplankton species (alien organisms), which most frequently occurs through the ships' ballast waters. In the Mali Ston Bay, for now there are no potentially toxic species that cause neurotoxic and paralytic shellfish poisoning. Monitoring programs (based on cell counts, mouse-test, assessing toxin levels in mussels and oysters) need to be planned for preventing human intoxication.

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Rukopis primljen: 28. ožujka 2003.