

First record of the fouling tubeworm *Ficopomatus enigmaticus* (Fauvel, 1923) in the Montenegrin waters

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ABSTRACT

The number of non-indigenous species is increasing every day in the Mediterranean Sea. This trend continues in the Adriatic area, although less than in other parts of the Mediterranean. For the Montenegrin part of the southern Adriatic, the literature data indicate the presence of 25 alien benthic species. One of the species that is widely distributed today in coastal areas of subtropical and temperate zones is the colonial tubeworm *Ficopomatus enigmaticus* (Fauvel, 1923). For Europe, is listed as one of the 100 worst invasive species but so far, there are no unified strategies for its control or management. The finding of *F. enigmaticus* in the Ulcinj Saline is the first record of this species for Montenegrin waters. As the area of the salt pan is placed into the land, connection to the sea via the Port Milena channel, could be possible vector of introduction of species on the location where it was recorded. Dominant conditions such as calm water, no ripples and lower salinity are favour for the development of this tubeworm species so that an increase in population size and potential impact on the ecosystem is expected.

Keywords: introduced species, cryptogenic species, Montenegro, Adriatic Sea, Polychaeta

INTRODUCTION

The Mediterranean Sea has been under pressure from the arrival of new species for hundreds of years. According to Galanida *et al.*, (2023) 1006 alien taxa have been recorded in that region so far. A significant number of non - indigenous species is considered as

established expanding population and occupies new locations. Compared to other parts of the Mediterranean, the same authors (2023) noted the lowest number of introduced species (211) for the Adriatic Sea. Of that number, 25 species of algae and invertebrates are noted in

the area of the Montenegrin part of the Adriatic Sea (MESPU, 2021).

One of the species that is widely distributed today in coastal areas of subtropical and temperate zones is the colonial tubeworm *Ficopomatus enigmaticus* (Fauvel, 1923). This species previously known as *Mercierella enigmatica* Fauvel, 1923, is sedentary suspension-feeding polychaete belonging to family Serpulidae. According to ten Hove *et al.*, (1978), *Ficopomatus enigmaticus* is a worldwide alien invasive of unknown origin, although increasingly it seems likely to be a native of Australia (Zibrowius & Thorp, 1989). Although most literature data defines this species as non-indigenous (Hove *et al.*, 1978; Galanida *et al.*, 2023), it is necessary to undertake more detailed genetic research with the aim of better understanding its origin and distribution (Oliva *et al.*, 2020). In cases where there is not sufficient data to support distribution history of the species such as for *F. enigmaticus*, it can also be considered as cryptogenic. For Europe, is listed as one of the 100 worst invasive species (Roy *et al.*, 2009) but so far, there are no unified strategies for its control or management. *F. enigmaticus* is an ecosystem engineering, brackish-water serpulid polychaete that builds calcareous aggregates in estuarine and coastal environments throughout the world.

The first record in Europe was in the Channel de Caen in the northern France in 1921, and later at the London docks in 1922 (Eno *et al.*, 1997). In the Black Sea it was first recorded from the brackish Paleostomi Lake in Georgia (Annenkova, 1929). In the Adriatic Sea, *F. enigmaticus* was found for the first time in the Venice Lagoon in 1934, the Northern Adriatic (Fauvel, 1938), while for the eastern part of the Adriatic Sea this species is recorded in the Krka River Estuary and Neretva River Delta (Cukrov *et al.*, 2010) and for the

Albanian coast in the Seaman River Delta (Shumka *et al.*, 2014)

The aim of the paper is to document the first finding of the species in Montenegrin coastal waters.

MATERIAL AND METHODS

The Ulcinj Saline is located in the immediate vicinity of Ulcinj, in the southeastern part of the Montenegrin coast (Fig. 1A). It occupies about 14.5 km² of salt pools. Originally, the Zoganjsko blato, an impassable swamp (about 25 km²) with brackish water, was located in that area. The salt pan was built in 1934 and was in operation until 2013, when it lost its original purpose. In 2006, the Saline area became recognized as a potential Emerald area, which represents a network of ecological areas of special importance for protection under the Bern Convention (Iković, 2020). Today, it is one of the most important locations in Europe due to the great diversity of birds that visit it.

Field activities were carried out in June and November 2023. A series of photographs were taken and large fouling aggregations (Fig. 1B) were collected for laboratory processing and several specimens were deposited in collections of Institute of marine biology, Kotor. The physico-chemical parameters of water temperature and salinity were measured in November. The morphometric characteristics of the sample were determined in the Laboratory for benthos and marine protection of the Institute of Marine Biology using the stereomicroscop Zeiss Stemi 508 with AxioCam 208 and softver ZEN blue 3.2. Measurements of calcareous tubes for both diameter and loglines were taken.



Figure 1. Sampling site, Ulcinj Saline (A-positions where samples are collected; B-fouling aggregations *in situ*)

RESULTS AND DISCUSSION

Fycopomatus enigmaticus (Fauvel, 1923) is a sessile polychaete tubeworm that builds and inhabits white calcareous tubes that have ring-like extensions at the apical opening and collar-like rings along their length (Fig. 2). They usually form small spherical colonies in the form of hills or they can join together in large groups resembling coral reefs that reach up to 7 m in length (Fig. 1B).

During the fieldwork in the area of the Ulcinj Saline, large quantities of tubes of *F. enigmaticus* were recorded. It occurs as single

tubes or as large dense fouling aggregations in shallow water scattered on the bottom or mostly on solid objects such as dead rooted remains of the sea rush *Juncus maritimus* Lam (Fig. 3) and the salt cedar *Tamarix dalmatica* B.R.Baum as well as on artificial structures. The intertwined tubes are often coated with bryozoans.

In our measurements (Fig. 2), the tubes had a mouth diameter in the range of 1.85–2.6 mm and are 16–40 mm in length which is in accordance with the dimensions recorded for the Albanian part of the Adriatic Sea (Shumka *et al.*, 2014). As suggested by literature (ten Hove & Weerdenburg, 1978) the body length without the tube is approximately 44 mm but this measure is highly variable among sites. Analysis of the collected material showed that the calcareous tubes were empty, i.e. without a living organism in them, so it was not possible to measure the body size of the specimens in the area of the Ulcinj Saline. As explanation we consider the fact that the material was collected outside the water and that low tide created unfavorable conditions that caused the death of the organisms in the tubes, while there is a probability that the tubes that are permanently in the water are inhabited by living individuals.

Our data of water salinity and temperature measured on sampling point in November 2023 showed 18.65‰ and 18°C, respectively. According to literature the polychaetes settles mainly in brackish water areas and have a high tolerance range for different salinity levels (Eno *et al.*, 1997; Fornós *et al.*, 1997). *F. enigmaticus* is known to be most numerous in deltas, estuaries and lagoons with brackish water of variable salinity (Voß & Dippner, 2017).

Serpulids have a great impact on the ecosystem in which they live (Bastida-Zavala *et al.*, 2017) since they are filter feeders and a substantial part of fouling communities. *F.*



Figure 2. Calcareous tubes



Figure 3. Tubeworm colony in shallow water

enigmaticus also acts as an ecosystem engineer, as the species forms tubes and colonizes, consequently forming reefs (Hartmann-Schröder, 1967). For example, the structure protruding into the water alters the flow and thus the displacement of sediment (Martínez-Taberner *et al.*, 1993). For other species, the reef serves as a substrate and provides shelter (Schwindt & Iribarne, 2000). Observations have shown that the suspended sediment concentration is clearly higher where polychaetes show higher biomass (Shumka *et al.*, 2014). According to McQuaid & Griffiths (2014) in Zandvlei Estuary Nature Reserve near Cape Town in South Africa the total invertebrate biomass in the estuary is estimated to have increased by almost 200 fold from 1942 to 2012. Considering that it is not abundant yet in the Ulcinj saline, and because

the species was not observed before, it can be assumed that it inhabited this area relatively recently.

As the species mostly appears near the ports areas, it is considered that the probable mechanism of introduction is hull fouling and/or in ballast water of large vessels (Cukrov *et al.*, 2010). The locality where it was recorded in Montenegro is far from the sea and is located within the salt pan, therefore the introduction vector is not very clear. As the Port Milena channel stretches along the salt pan, connecting the sea and Saline, through which sea water enters the area, that is the only reasonable explanation how the species reached the site. Being the species sensitive to the action of waves, it occurs on calm and sheltered parts of the coast or in deltas with slow-flowing water, hence, the conditions in the Saline are suitable for its survival.

F. enigmaticus has a fast growth rate, high tolerance to variable environmental conditions, and it is causing important ecological impacts by modifying the ecological and the physical processes of the ecosystems (Bianchi & Morri, 1996). In some locations, economic impacts occur due to the prolific growth that can cause blocking of thermal effluents and fouling of aquaculture ponds and leisure crafts.

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Prvi nalaz obraštajnog cjevastog crva *Ficopomatus enigmaticus* (Fauvel, 1923) u crnogorskim vodama

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SAŽETAK

Broj stranih vrsta se svakim danom povećava u Sredozemnom moru. Ovaj trend se nastavlja i na području Jadrana, ali u manjem iznosu u odnosu na ostale dijelove Mediterana. Za crnogorski dio južnog Jadrana literaturni podaci ukazuju na prisustvo 25 stranih bentoskih vrsta. Jedna od vrsta koja je danas široko rasprostranjena u obalnim područjima suptropskih i umjerenih zona je kolonijalni cjevasti crv *Ficopomatus enigmaticus* (Fauvel, 1923). Za Evropu je navedena kao jedna od 100 najgorih invazivnih vrsta, ali do sada ne postoje jedinstvene strategije za njenu kontrolu ili upravljanje. Nalaz *F. enigmaticus* u Ulcinjskoj solani je prvi zapis ove vrste za crnogorske vode. Kako je područje solane uvučeno u kopno, veza sa morem preko kanala Port Milena mogla bi biti moguć vektor unošenja vrste na lokaciju na kojoj je zabilježena. Dominantni uslovi kao što su mirna voda, bez talasanja i niži salinitet su pogodni za razvoj ove vrste cjevastog crva tako da se očekuje povećanje veličine populacije i potencijalni uticaj na ekosistem.

Ključne riječi: unesene vrste, kriptogene vrste, Crna Gora, Jadransko more, Polichaeta