

ANNALES

Anali za istrske in mediteranske študije
Annali di Studi istriani e mediterranee
Annals for Istrian and Mediterranean Studies
Series Historia Naturalis, 31, 2021, 1





ANNALES

**Anali za istrske in mediteranske študije
Annali di Studi istriani e mediterraneei
Annals for Istrian and Mediterranean Studies**

Series Historia Naturalis, 31, 2021, 1

**UREDNIŠKI ODBOR/
COMITATO DI REDAZIONE/
BOARD OF EDITORS:**

Alessandro Acquavita (IT), Nicola Bettoso (IT), Christian Capapé (FR), Darko Darovec, Dušan Devetak, Jakov Dulčić (HR), Serena Fonda Umani (IT), Andrej Gogala, Daniel Golani (IL), Danijel Ivajnskič, Mitja Kaligarič, Marcelo Kovačič (HR), Andrej Kranjc, Lovrenc Lipej, Vesna Mačič (ME), Alenka Malej, Patricija Mozetič, Martina Orlando-Bonaca, Michael Stachowitsch (AT), Tom Turk, Al Vrezec

**Glavni urednik/Redattore capo/
Editor in chief:**

Darko Darovec

**Odgovorni urednik naravoslovja/
Redattore responsabile per le scienze
naturali/Natural Science Editor:**

Lovrenc Lipej

Urednica/Redattrice/Editor:

Martina Orlando-Bonaca

Lektor/Supervisione/Language editor:

Polona Šergon (sl.), Petra Berlot Kužner (angl.)

Prevajalci/Traduttori/Translators:

Martina Orlando-Bonaca (sl./it.)

**Oblikovalec/Progetto grafico/
Graphic design:**

Dušan Podgornik, Lovrenc Lipej

Tisk/Stampa/Print:

Založništvo PADRE d.o.o.

Izdajatelj/Editori/Published by:Zgodovinsko društvo za južno Primorsko - Koper / Società storica del Litorale - Capodistria®
Inštitut IRRIS za raziskave, razvoj in strategije družbe, kulture in okolja / Institute IRRIS for Research, Development and Strategies of Society, Culture and Environment / Istituto IRRIS di ricerca, sviluppo e strategie della società, cultura e ambiente®**Sedež uredništva/Sede della redazione/
Address of Editorial Board:**Nacionalni inštitut za biologijo, Morska biološka postaja Piran / Istituto nazionale di biologia, Stazione di biologia marina di Pirano / National Institute of Biology, Marine Biology Station Piran SI-6330 Piran / Pirano, Fornače/Fornace 41, tel.: +386 5 671 2900, fax +386 5 671 2901;
e-mail: annales@mbss.org, **internet:** www.zdjp.si

Redakcija te številke je bila zaključena 30. 06. 2021.

**Sofinancirajo/Supporto finanziario/
Financially supported by:**

Javna agencija za raziskovalno dejavnost Republike Slovenije (ARRS), Luka Koper in Mestna občina Koper

Annales - Series Historia Naturalis izhaja dvakrat letno.**Naklada/Tiratura/Circulation:** 300 izvodov/copie/copiesRevija *Annales, Series Historia Naturalis* je vključena v naslednje podatkovne baze / *La rivista Annales, series Historia Naturalis* è inserita nei seguenti data base / *Articles appearing in this journal are abstracted and indexed in:* BIOSIS-Zoological Record (UK); Aquatic Sciences and Fisheries Abstracts (ASFA); Elsevier B.V.: SCOPUS (NL); Directory of Open Access Journals (DOAJ).To delo je objavljeno pod licenco / *Quest'opera è distribuita con Licenza / This work is licensed under a Creative Commons BY-NC 4.0.*Navodila avtorjem in vse znanstvene revije in članki so brezplačno dostopni na spletni strani <https://zdjp.si/en/p/annalesshn/>
The submission guidelines and all scientific journals and articles are available free of charge on the website https://zdjp.si/en/p/annalesshn/
Le norme redazionali e tutti le riviste scientifiche e gli articoli sono disponibili gratuitamente sul sito https://zdjp.si/en/p/annalesshn/

VSEBINA / INDICE GENERALE / CONTENTS 2021(1)

BIOINVAZIJA
BIOINVASIONE
BIOINVASION**Luca CASTRIOTA & Manuela FALAUTANO**

Reviewing the Invasion History of the Blue Crab
Callinectes sapidus (Portunidae) in Sicily (Central
Mediterranean): an Underestimated Alien Species ... 1
Revizija zgodovine invazije modre rakovice
Callinectes sapidus (Portunidae) na Siciliji
(osrednje Sredozemsko morje):
podcenjena tujerodna vrsta

**Alan DEIDUN, Bruno ZAVA, Maria CORSINI-
FOKA, Johann GALDIES, Antonio DI NATALE &
Bruce B. COLLETTE**

First Record of the Flat Needlefish, *Ablennes hians*
(Belonidae) in Central Mediterranean Waters
(Western Ionian Sea) 9
Prvi zapis o pojavljanju ploščate morske igle,
Ablennes hians (Belonidae) v vodah osrednjega
Sredozemskega morja (zahodno Jonsko morje)

**Mohamed Mourad BEN AMOR,
Khadija OUNIFI-BEN AMOR,
Marouène BDIOUI & Christian CAPAPÉ**

Occurrence of Reticulated Leatherjacket
Stephanolepis diaspros (Monacanthidae)
in the Central Mediterranean Sea,
and New Record from the Tunisian coast 17
Pojavljanje afriškega kostoroga,
Stephanolepis diaspros (Monacanthidae),
v osrednjem Sredozemskem morju in
prvi podatek za tunizijsko obalo

**Sara AL MABRUK, Ioannis GIOVOS &
Francesco TIRALONGO**

New Record of *Epinephelus areolatus* in the
Mediterranean Sea: First Record from Syria 23
Novi zapis o pojavljanju rdečepikaste kirnje
(*Epinephelus areolatus*) v Sredozemskem
morju: prvi podatki za Sirijo

SREDOZEMSKI MORSKI PSI
SQUALI MEDITERRANEI
MEDITERRANEAN SHARKS**Primo MICARELLI, Francesca Romana REINERO &
Emilio SPERONE**

Notes on a Rare Case of Bluntnose Sixgill Shark
Hexanchus griseus Stranded on the Coast of
Tuscany in the Central Tyrrhenian Sea 31
Zapis o redkem primeru morskega psa
šesteroškrgarja Hexanchus griseus, ki je nasedel
na toskanski obali v osrednjem Tirenskem morju

Alen SOLDO

The Occurrence of the Common Angel Shark
Squatina squatina in the Adriatic Sea 37
Pojavljanje navadnega sklata (Squatina squatina)
v Jadranskem morju

**Hakan KABASAKAL, Deniz AYAS &
Deniz ERGÜDEN**

Intentional Stranding of a Blue Shark,
Prionace glauca (Carcharhiniformes:
Carcharhinidae), in Pursuit of Prey 45
Namerno nasedanje sinjega morskega psa,
Prionace glauca (Carcharhiniformes:
Carcharhinidae), med zasledovanjem plena

**Patrick L. JAMBURA, Julia TÜRTSCHER,
Alessandro DE MADDALENA,
Ioannis GIOVOS, Jürgen KRIWET,
Jamila RIZGALLA & Sara A. A. AL MABRUK**

Using Citizen Science to Detect Rare
and Endangered Species: New Records
of the Great White Shark *Carcharodon*
carcharias Off the Libyan Coast 51
Uporaba ljubiteljske znanosti za
pridobivanje podatkov o redki in
ogroženi vrsti: novi podatki
o pojavljanju belega morskega volka
Carcharodon carcharias
ob Libijski obali

IHTIOLOGIJA
ITTILOGIA
ICHTHYOLOGY

Sihem RAFRAFI-NOUIRA, Christian REYNAUD & Christian CAPAPÉ

A New Record of *Clinitrachus argentatus* (Osteichthyes: Clinidae) from the Tunisian Coast (Central Mediterranean Sea)..... 63
Novi zapis o pojavljanju srebrnice Clinitrachus argentatus (Osteichthyes: Clinidae) iz tunizijske obale (osrednje Sredozemsko morje)

Mauro CAVALLARO, Giovanni AMMENDOLIA, Ignazio RAO, Alberto VILLARI & Pietro BATTAGLIA

Variazioni pluriennali del fenomeno dello spiaggiamento di specie ittiche nello stretto di Messina, con particolare attenzione alle specie mesopelagiche 69
Večletne spremembe v nasedanju ribjih vrst v Mesinski ožini s posebnim ozirom na mezopelaške vrste

Sihem RAFRAFI-NOUIRA, Christian REYNAUD & Christian CAPAPÉ

Skeletal and Pughead Deformities in the Saddle Bream *Oblada melanura* (Osteichthyes: Sparidae) from the Tunisian Coast (Central Mediterranean Sea) ... 85
Deformacije skeleta in glave pri črnorepki, Oblada melanura (Osteichthyes: Sparidae) iz tunizijske obale (osrednje Sredozemsko morje)

Murat BILECENOGLU & Seydi Ali DOYUK

Uncommon Thermophilic Fishes from the Marmara and Black Seas 95
Nenavadne toploljubne ribe iz Marmarskega in Črnega morja

Christian CAPAPÉ, Adib SAAD, Ahmad SOLAIMAN, Issa BARAKAT & Waad SABOUR

First Substantiated Record of Armless Snake Eel *Dalophis imberbis* (Osteichthyes: Ophichthidae) from the Syrian Coast (Eastern Mediterranean Sea) ... 101
Prvi dokumentiran primer pojavljanja kačaste jegulje, Dalophis imberbis (Osteichthyes: Ophichthidae), vzdolž sirske obale (vzhodno Sredozemsko morje)

Khaled RAHMANI, Fatiha KOUDACHE, Amaria Latefa BOUZIANI & Alae Eddine BELMAHI

Length-Weight Relationships and Metric Characters of the Atlantic Horse Mackerel, *Trachurus trachurus* (Perciformes: Carangidae), Caught in Béni-Saf Bay, Western Mediterranean (Algeria) 107
Odnos med dolžino in maso in metrični znaki navadnega šnjura, Trachurus trachurus (Perciformes: Carangidae), ujetega v zalivu Béni-Saf, zahodno Sredozemsko morje (Alžirija)

Tülin ÇOKER & Okan AKYOL

On the Occurrence of *Pomadasyus incisus* (Haemulidae) in the Turkish Aegean Sea (Eastern Mediterranean Sea) 123
O pojavljanju vrste Pomadasyus incisus (Haemulidae) v turškem Egejskem morju (vzhodno Sredozemsko morje)

Sihem RAFRAFI-NOUIRA, Mohamed Mourad BEN AMOR, Khadija OUNIFI-BEN AMOR, Marouène BDIQUI & Christian CAPAPÉ

First Substantiated Record of Opah, *Lampris guttatus* (Osteichthyes: Lamprididae), from the Tunisian Coast (Central Mediterranean Sea)..... 129
Prvi dokumentiran zapis o pojavljanju svetlice, Lampris guttatus (Osteichthyes: Lamprididae), iz tunizijske obale (osrednje Sredozemsko morje)

FLORA
FLORA
FLORA

Claudio BATTELLI & Marcello CATRA

First Report of *Cystoseira aurantia* (Sargassaceae, Fucophyceae) from the Lagoon of Strunjan (Gulf of Trieste, Northern Adriatic) 139
Prvo poročilo o vrsti Cystoseira aurantia (Sargassaceae, Fucophyceae) v strunjanski laguni (Tržaški zaliv, severni Jadran)

Amelio PEZZETTA

Le Orchidaceae di Pinguente (Buzet)..... 147
Kukavičevke Buzeta

FAVNA
FAVNA
FAVNA

Ahmet ÖKTENER & Ivan SAZIMA

Caligus minimus (Copepoda: Caligidae) Parasitic on the Gills of a Remora *Echeneis naucrates* Attached to a Seabass *Dicentrarchus labrax* in Köyceğiz-Dalyan Lagoon Lake, Aegean Sea, Turkey 159
Caligus minimus (Copepoda: Caligidae), zajedavec na škregah prilepa (Echeneis naucrates), pritrjenega na brancina (Dicentrarchus labrax) v laguni Köyceğiz-Dalyan v Egejskem morju, Turčija

Kazalo k slikam na ovitku 165
Index to images on the cover 165

FIRST REPORT OF *CYSTOSEIRA AURANTIA* (SARGASSACEAE,
FUCOPHYCEAE) FROM THE LAGOON OF STRUNJAN
(GULF OF TRIESTE, NORTHERN ADRIATIC)

Claudio BATTELLI

Frane Marušič 4, 6310 Izola, Slovenia
e-mail: claudio.battelli@guest.arnes.si

Marcello CATRA

Laboratory of Phycology, Department of Biological, Geological and Environmental Sciences,
University of Catania, Via Empedocle 58, 95128 Catania, Italy
e-mail: m.catra@unict.it

ABSTRACT

The authors report the first record of the brown alga Cystoseira aurantia Kützinger, found in the Stjuža Lagoon of Strunjan (Gulf of Trieste, Slovenia). During field surveys conducted in March 2021, dense free-floating hanks of this alga were observed on the water's surface along the eastern margins of the lagoon, at depths not exceeding 0.5 m. These acropleustophytic hanks were composed of abundantly branched single thalli and fragments of thalli firmly intertwined and entangled. Branches of every order were cylindrical, slender (1–2 mm in diameter), omnidirectional, with no leafy branchlets or thorny appendages. No fertile specimens were found. Among the possible factors leading to the formation of free-floating masses of C. aurantia, mechanic processes due to a constant water movement under the action of winds and tidal currents were considered. The habitat and the morphological characters of the specimens studied are described.

Key words: *Cystoseira aurantia*, Stjuža lagoon Strunjan, Slovenia, northern Adriatic

PRIMA SEGNALAZIONE DI *CYSTOSEIRA AURANTIA* (SARGASSACEAE, FUCOPHYCEAE)
NELLA LAGUNA DI STRUGNANO (GOLFO DI TRIESTE, ALTO ADRIATICO)

SINTESI

Gli autori riportano la prima segnalazione dell'alga bruna Cystoseira aurantia Kützinger, trovata nella Laguna Schiusa di Strugnano (Golfo di Trieste, Slovenia). Durante le indagini sul campo, condotte nel marzo 2021, sono state osservate delle dense masse di quest'alga fluttuanti sulla superficie dell'acqua lungo il margine orientale della laguna, a profondità non superiore a 0,5 m. Le masse acropleustofitiche liberamente flottanti in superficie, si presentano composte da singoli talli abbondantemente ramificati e saldamente intrecciati. Non sono stati riscontrati esemplari fertili. Tra i possibili fattori responsabili della formazione delle masse fluttuanti di C. aurantia, assume un carattere particolarmente rilevante la costante variazione delle correnti superficiali, all'interno della Laguna, dovuta alla marea. Vengono descritti l'habitat e i caratteri morfologici degli esemplari studiati.

Parole chiave: *Cystoseira aurantia*, laguna Schiusa Strugnano, Slovenia, Alto Adriatico

INTRODUCTION

The brown alga *Cystoseira aurantia* (Sargassaceae, Fucophyceae) is a perennial free-living species forming free-floating hanks. Since its description by Kützing (1843), based on specimens collected in 1835 at the Gulf of Trieste (type locality), it has been reported from both Black Sea and Mediterranean coastal areas. In the latter area, it was reported from the Balearic Islands (Spain) (Ribera *et al.*, 1996), the Adriatic Sea (Giaccone 1978; Ribera *et al.*, 1992; Taskin *et al.*, 2012), Corsica (France) (Taskin *et al.*, 2012), Sardinia, Sicily, and Tuscany (Italy) (Ribera *et al.*, 1992; Furnari *et al.*, 1999; Rindi *et al.*, 2002; Taskin *et al.*, 2012), Turkey (Taskin *et al.*, 2012), the Bay of Cadiz (Spain) (Gallardo *et al.*, 2016), Tunisia (Bouafif *et al.*, 2016), and more recently from the Mediterranean coast of Morocco (Ramdani *et al.*, 2021). The species, reduced to a form of *C. barbata* (Stackhouse) C. Agardh [= *Gongolaria barbata* (Stackhouse) Kuntze] by Giaccone in Amico *et al.* (1986) as *C. barbata* f. *aurantia* (Kützing) Giaccone, was recently reinstated as a distinct species by Orellana *et al.* (2019).

According to literature, *C. aurantia* was reported from the northern Adriatic Sea by Giaccone (1974) as *C. barbata* C. Agardh var. *aurantia* (sic!); from Ferrara by Amico *et al.*, [1986, as *C. barbata* (Goodenough & Woodward) J. Agardh f. *aurantia* (Kützing) Giaccone]. Gómez Garreta *et al.* (2001) considered *C. barbata* f. *aurantia* to be synonymous with *C. barbata* f. *repens* Zinova & Kalugina, but erroneously so, since the former form takes precedence over the latter (Cormaci *et al.*, 2012). Interestingly, there are no records of this species from the eastern Adriatic Sea (Antolić *et al.*, 2010), except that from the Middle Adriatic Sea (the Island

of Palagruža) by Giaccone (1978). In this paper, we report the occurrence of *C. aurantia* from the Stjuža marine lagoon of Strunjan (Slovenia). It represents the first record of this species from Slovenian coastal waters.

MATERIAL AND METHODS

Study area

The Strunjan Lagoon is a shallow, semi-enclosed oligotrophic brackish coastal lagoon situated in the eastern part of the Strunjan Bay (45°31'30" N, 13°36'20" E) (Figs. 1a–1b), about 10 hectares in surface area and divided into two sub-basins: a smaller discharge lagoon and the larger Stjuža Lagoon. Geologically, it represents a large area of the Late-Glacial and Holocene estuary of the Strunjan stream, formed during the last transgression of the sea into that area (Šmuc, 2020). It is the only Slovene marine lagoon, and not entirely natural. For about half a century it has been an abandoned fish farm. The newly created lagoon has remained connected with the sea only by an entrance channel of about 20 meters in width and 5–6 meters in depth, and three much smaller tidal channels (Fig. 1b), which allow for a better circulation of water masses in the lagoon and a reduced organic pollutant load (Avčín *et al.*, 1973; Avčín *et al.*, 1974; Vrišer, 2002). The Stjuža Lagoon is characterised by *Cymodocea nodosa* (Ucria) Ascherson and *Zostera noltei* Hornemann meadows on its margins. It is mostly very shallow, with some of its areas breaking the surface at the lowest tide (Šajna & Kaligarič, 2005; Lipej *et al.*, 2019). Seagrass meadows host a diverse lagoon fish fauna and demersal invertebrates (Avčín *et al.*, 1973; Šajna & Kaligarič, 2005; Lipej *et al.*, 2019).

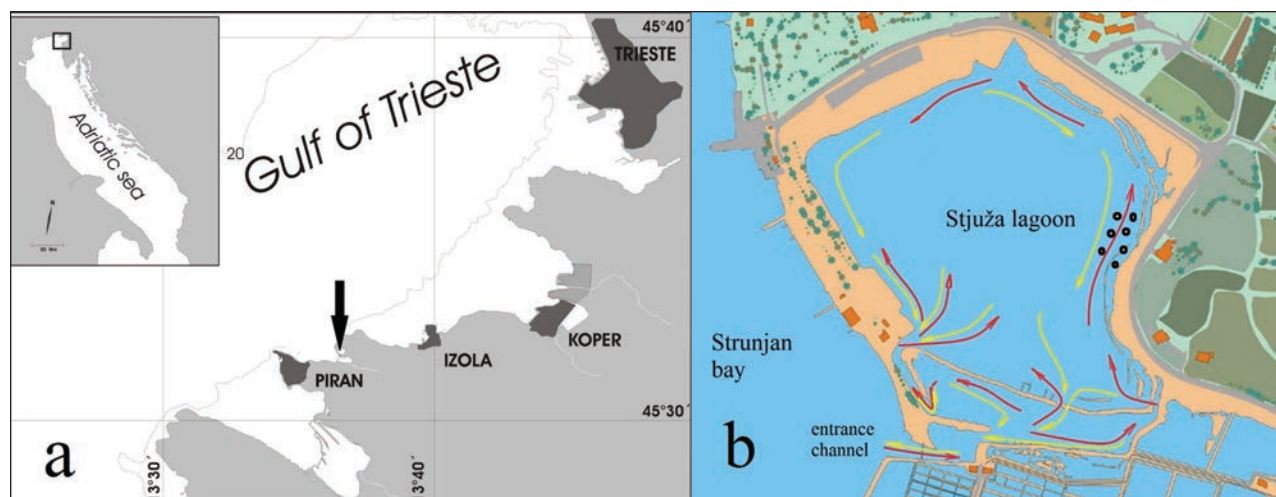


Fig. 1: a) Maps of the study area; b) Stjuža Lagoon of Strunjan, indicating sampling site of *Cystoseira aurantia* (black circles), and the direction of seawater currents during the tide (after Avčín *et al.*, 1973). The yellow arrows indicate the output flow, the red arrows the entry flow.

Sl. 1: a) Karta raziskovalnega območja; b) Laguna Stjuža Strunjan z vzorčevalnimi postajami alge *Cystoseira aurantia* (črni krogci), in smer toka morske vode med plimovanjem. Rumene puščice predstavljajo smer izhoda in rdeče smer vhoda morske vode med bibavico (po Avčín *et al.*, 1973).

Today, the lagoon area is an important part of the Strunjan Stjuža Nature Reserve, falling within the Natura 2000 network, the primary objective of which is to preserve biodiversity.

The study area is also characterised by the presence of a diverse fish fauna, demersal invertebrates closely associated with the environment of seagrasses: numerous molluscs (bivalves, gastropods), benthic crustaceans (mysids, amphipods, decapods, isopods), echinoderms (brittlestars, starfishes), and many species of polychaetes. Recently a total of 15 macroalgal taxa, both substrate-attached and free-floating, were recorded (Lipej *et al.*, 2004; 2019; Battelli & Gregorič, 2020).

Environmental parameters

Because of its shallow depth (only about 0.5–1 m), the thermal conditions in the Stjuža Lagoon seasonally move from one extreme to the other: ranging between 5 °C and 10 °C in wintertime and between 24 °C and 27 °C during the summer; during the other seasons the water temperatures are similar to the atmospheric temperatures. The salinity, oxygen content, and thermal conditions in the Stjuža Lagoon are related to the large water exchange and usually similar to those of Strunjan Bay (Avčín *et al.*, 1973). The lagoon receives freshwater inputs through small canals from agricultural areas (Vrišer, 2002). The average tidal amplitude is 67 cm, with high tide 35 cm above mean sea level, and low tide 31 cm below mean sea level (Slovenian Environment Agency (ARSO): (www.arso.gov.si/water/sea; http://www.arso.gov.si/vode/podatki/amp/H9350_g_1.html).

Sampling procedure and data analysis

The fieldwork was carried out in March 2021, when dense free-floating hanks of *Cystoseira aurantia* were observed in the lagoon. The study was conducted along the eastern margins of the lagoon, as showed in Fig. 1b, since this was the only site where free-floating aggregates of the studied alga occurred in high abundance. The substrate of the research site consisted of a soft sediment composed of compact-fine argillaceous silt with a slight admixture of sand, with a thin (0.5–1 cm) yellowish brown layer of flocculent organic detritus (Vrišer, 2002; Šmuc, 2020).

The salinity, pH, oxygen content (O₂), and water temperature were measured in the Stjuža Lagoon and Strunjan Bay, using a Hanna HI98194 multiparameter waterproof meter.

Ten thalli of *C. aurantia* were randomly collected during the sampling period. Fresh samples were manually collected at the survey site, immediately placed in plastic bags containing water, and transported to the Laboratory of the Faculty of Mathematics, Natural Sciences and Information Technologies (FAMNIT) of Koper for further observation. Some samples were dried, pressed, and preserved in the personal herbarium of one of the authors (C.B.). The algal material collected was carefully sorted and examined using

an Olympus SZ61 stereo microscope with a XC50 digital camera for morphological observation and measurements. The following measurements were carried out: thallus length from the basal part to the apex; length and diameter of main axes; length and diameter of primary axes. The occurrence of aerocysts, their length, diameter, and position, were recorded. The different positions of the conceptacles were described; in addition, the sizes of the ostioles of the conceptacles present either along the thalli or on aerocysts, were measured. The averages of all the conducted measurements were calculated.

Species were identified based on papers by Maggs & Hommersand (1993), Bressan & Babbini (2003), Brodie *et al.* (2007), Sfriso (2010), Cormaci *et al.* (2012, 2014). The nomenclature follows Guiry & Guiry (2021).

RESULTS AND DISCUSSION

Samples of *Cystoseira aurantia* were collected in the eastern part of the Stjuža Lagoon (Fig. 1b), the only site of its occurrence. The alga was found unattached on the mobile substrate, between 0 and 0.5 m depth, forming a free-floating hank of thalli of various shapes and sizes (Fig. 2a). These aggregates were composed by abundantly branched fragments of the alga, firmly intertwined and dispersedly arranged. Individual thalli in the aggregations were entangled with each other; consequently, branches growing in different directions (Fig. 2b) were observed within the hank.

Morphological characteristics of *Cystoseira aurantia*

The axes were cylindrical, reaching up to 20.77 cm in length, and 1.0 mm in diameter. The alga was white-brown in colour, non-iridescent; holdfast absent; primary branches cylindrical, without thorny appendages, up to 7.21 cm long and 0.9 mm in diameter; secondary branches cylindrical, without spinose appendages; ultimate branches filiform. In some thalli abundant aerocysts occurred, fairly regularly arranged on the branches, ovoid, 6.68 mm long and 1.73 mm in diameter, isolated or in short series of 2–3 (Fig. 2c). Cryptostomata were abundant in all branches. The ostioles of the conceptacles present along the branches were fusiform, 0.23 mm long and 0.09 mm width, with a l/w ratio of 2.64, while those on aerocysts were more ovoid, 0.22 mm long and 0.14 mm width, with a l/w ratio of 1.62 (Tab. 1). Despite the large number of conceptacles present on the thalli, the specimens examined were still infertile; in fact, we observed no sexual cells within the conceptacles. Our specimens agree well with previous descriptions and illustrations of the taxon (Cormaci *et al.*, 2012; Bouafif *et al.*, 2016; Ramdani *et al.*, 2021).

Algal vegetation in the Stjuža Lagoon

In the Stjuža Lagoon, many algal species were present in both attached and unattached forms. *C. aurantia* was always present in free-floating form. It was collected mainly between

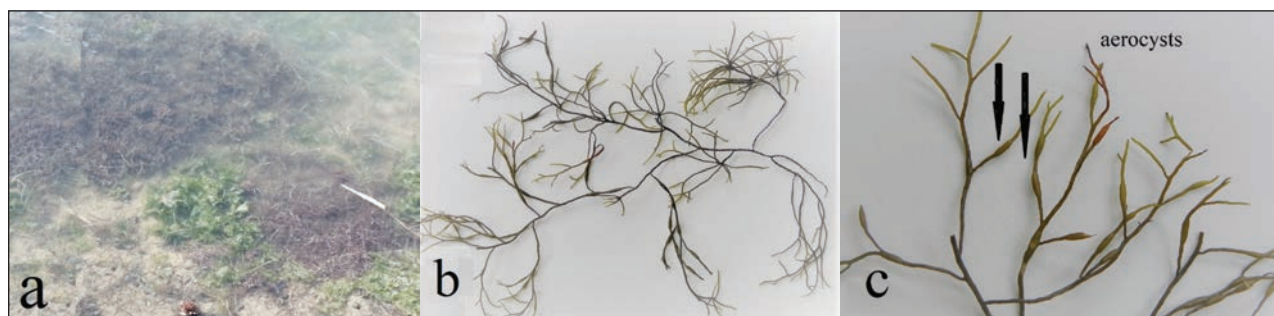


Fig. 2: a) Free-floating hanks of alga in the natural habitat; b) habit of *Cystoseira aurantia*; c) aerocysts isolated and in short series, indicated by arrows.

Sl. 2: a) Prosto plavajoči skupki alge v naravnem okolju; b) steljka alge *Cystoseira aurantia*; c) posamezne aerociste in v zaporedju, označene s puščicami.

the water surface and 0.5 m of depth and over soft substrate. The soft bottom is clearly unsuitable for the development of a highly diverse attached macroalgal vegetation. The spatial formation of free-floating hanks of *C. aurantia* (Fig. 2a) was probably owed to an accumulation and aggregation of many intertwined thalli caused by winds and tidal currents flowing during the tidal switch, as illustrated in Fig. 1b, where the yellow and red arrows indicate, respectively, the outflow and inflow of seawater during the change of tides.

According to Fritsch (1965) and Smith (1950), the phenomenon of the aggregation of free-floating algae can be considered the result of a dynamic action of the waves' motion caused by winds or water currents.

Pleustophyte populations, typical of lagoon environments of the Mediterranean Sea, are mainly characterised by *Valonia aegagropila* C. Agardh, *Rytiphlaea tinctoria* (Clemente) C. Agardh, *Lychaete echinus* (Biaioletto) Wynne, and *Chaetomorpha linum* (O.F. Müller) Kützing (Calvo *et al.*, 1980; Orestano & Calvo, 1985; Cecere *et al.*, 1992).

The most abundant unattached algal species found in the Stjuža Lagoon were green algae of the genus *Ulva*, *U. rigida* C. Agardh, and *U. australis* Areschoug. Together with *Enteromorpha*-type forms of *Ulva* (*U. compressa* Linnaeus and *U. intestinalis* Linnaeus), *Chaetomorpha linum* (O.F. Müller) Kützing, *Lychaete echinus*, *Cladophora lehmanniana* (Lindenberg) Kützing, and *C. liniformis* Kützing, they formed mostly unattached aggregates. Some red algae, such as *Ceramium* sp., *Polysiphonia* sp., and *Polysiphonia spinosa* (C. Agardh) J. Agardh, were also present. The long thallus in the free-floating form of *C. aurantia* facilitates the formation of dense aggregations and consequently the colonisation of the lagoon habitat.

Some species of macroalgae were found as epiphytes on the thalli of *C. aurantia*, but they were very rare. Among them we observed *Ceramium* spp., *Titanoderma pustulatum* (J.V. Lamouroux) Näegeli, *Cladophora* spp, and *Cladosiphon zosteræ* (J. Agardh) Kjlin. We did not observe any species of invertebrates within *C. aurantia* free-floating hanks, except for a single occurrence of *Asterina gibbosa* (Pennant, 1777).

Water quality of the Stjuža Lagoon of Strunjan

Judging from the information available for other parts of the Mediterranean, we believe that certain environmental conditions characteristic of the Stjuža Lagoon favour the formation of free-floating forms of *C. aurantia*, namely: (i) shallowness (an average depth of about 0.5–1 m), which allows for continuous exposure to sunlight and, consequently, the growth of algal thalli in all directions; (ii) superficial and bottom water currents produced by winds blowing from the North-North-East (bora) and from the South-East (sirocco); (iii) a wide tidal range of about 67 cm; and (iv) a soft sedimentary bottom unfavourable to the development of attached macroalgae.

During the sampling period, the values of salinity, temperature, and pH of the sampling site were very similar to those of the open sea (Strunjan Bay), while greater differences were observed when comparing the oxygen values of the sampling site (9.98 ppm) with those of the waters of the Strunjan Bay (12.08 ppm) (Tab. 2). The results obtained from our measurements are prevalently in agreement with those obtained in previous studies (Avčin *et al.*, 1873; Vrišer, 2002; Lipej *et al.*, 2019).

C. aurantia clearly thrives as the lagoon ecosystem conditions improve, possibly because of its sensitivity to water quality and the hydrodynamic environment. The eastern part of the Stjuža Lagoon, where that alga is most common, is probably least exposed to less favourable environmental conditions and displaying conditions very similar to those of the water of Strunjan Bay (Tab. 2).

The connections with the sea through the entrance and the tidal channels, favouring water circulation, have probably facilitated the colonisation and spread of *C. aurantia*. Also, since this alga is unattached, water circulation patterns in the lagoon undoubtedly influence its distribution towards the eastern part of the Stjuža Lagoon. On the other hand, the sea connections ensure a better circulation of water masses in the lagoon and reduced organic pollution.

Tab. 1: Average values of some morphological measurements of brown alga *Cystoseira aurantia* from the Stjuža Lagoon of Strunjan.

Tab. 1: Povprečne vrednosti nekaterih morfoloških meritev pri rjavi algi *Cystosera aurantia* iz Lagune Stjuža v Strunjanu.

	Thallus		Primary branches		Aerocysts		Ostioles of conceptacles along the branches			Ostioles of conceptacles on aerocysts		
	length/cm	diam./mm	length/cm	diam./mm	length/cm	diam./mm	length/cm	diam./mm	ratio l/w	length/cm	diam./mm	ratio l/w
mean	20.77	1.00	7.21	0.90	6.68	1.73	0.23	0.09	2.64	0.22	0.14	1.62
stdev	7.46	0.11	2.59	0.13	0.96	0.18	0.02	0.02	0,55	0.02	0.01	0.25

Impact on the environment

Information on the presence in the Stjuža Lagoon of brown algae, which indicates a good status of water, are very scarce. From literature data, a total of 15 macroalgal taxa, attached and free-floating, were recorded in the lagoon (Lipej *et al.*, 2004, 2019; Battelli & Gregorič, 2020). Most of the macroalgal species found by Lipej *et al.* (2019) are ESG II class (Orfanidis *et al.*, 2011) and as such not indicative of good ecological status. From papers in Lipej *et al.* (2004) and Lipej *et al.* (2019) it results that brown algae *Cystoseira compressa* (Esper) Gerloff & Nizamuddin and *Fucus virsoides* J. Agardh, both indicators of good ecological status, were at

Tab. 2: Comparisons among the values of salinity, temperature, pH and oxygen recorded at the sampling site and in Strunjan Bay during the sampling period (March 2021).
Tab. 2: Primerjava vrednosti slanosti, temperature, pH in kisika na vzorčevalni postaji in v Strunjanskem zalivu, v obdobju vzorčenja (marec 2021).

Location	salinity	T (°C)	pH	O ₂ (ppm)
Stjuža lagoon	34.00	19.64	7.87	9.98
Strunjan bay	34.46	15.05	8.25	12.08

times present in the Stjuža Lagoon, but we did not encounter those species during our study. It is interesting to note that *F. virsoides* disappeared from the entire Slovenian coast a few years ago due to reasons still unknown (Battelli, 2016). Orlando-Bonaca & Rotter (2018) observed a certain regression of *Cystoseira* species in recent years in the coastal waters of Slovenia. Recently, Battelli and Gregorič (2020) reported the occurrence of *Cystoseira foeniculacea* (Linnaeus) Greville f. *tenuiramosa* (Ercegović) Gómez Garreta, Barceló, Ribera et Rull Lluch in the lagoon, attached to hard substrata and as epiphyte on a ball-like form of *Rytiphlaea tinctoria*, which is certainly evidence to the species diversity of the lagoon.

Unfortunately, up to now, there have been no studies about the ecological conditions that could somehow explain the occurrence of *C. aurantia* in the lagoon. Further investigation regarding the causes that have led to the presence of only two species of *Cystoseira* is desirable and necessary.

The present observations were limited to a single sampling period. Unfortunately, we did not have additional data on the environmental conditions that may have favoured the unusual formation of the free-floating form of this brown alga in the Stjuža Lagoon of Strunjan. Our assumptions are based exclusively on the observations made during the short research period and the study of the available literature. It is therefore evident that further investigations, repeated in time, will be necessary for a deeper understanding of this phenomenon.

CONCLUSIONS

On the basis of the cited literature and observations made during this study, we suppose that the formation of the free-floating forms of the unattached brown alga *Cystoseira aurantia* in the Stjuža Lagoon of Strunjan may be a consequence of (i) mechanic processes due to a consistent movement of water under the action of winds and tidal currents between high and low tides, and (ii) characteristics intrinsic to the species which allow the growth of the thallus in any direction and thereby an ever-changing exposure to light.

ACKNOWLEDGEMENTS

We would like to thank several individuals who helped with the present study. We are particularly grateful to the director and the staff of Public Institute Landscape Park Strunjan (Slovenia), for allowing us to carry out the research. To Bojana Lipej from Škocjanski zatok Nature Reserve, who helped us during the measurements of physical and chemical parameters of the Lagoon. Special thanks to Professor Giovanni Furnari from the Laboratory of Phycology, Department of Biological, Geological and Environmental Sciences, University of Catania, whose valuable suggestions made a substantial contribution to the manuscript.

PRVO POROČILO O VRSTI *CYTOSEIRA AURANTIA* (SARGASSACEAE, FUCOPHYCEAE)
V STRUNJANSKI LAGUNI (TRŽAŠKI ZALIV, SEVERNI JADRAN)

Claudio BATTELLI

Frane Marušič 4, 6310 Izola, Slovenia
e-mail: claudio.battelli@guest.arnes.si

Marcello CATRA

Laboratory of Phycology, Department of Biological, Geological and Environmental Sciences,
University of Catania, Via Empedocle 58, 95128 Catania, Italy
e-mail: m.catra@unict.it

POVZETEK

Avtorja poročata o pojavu rjave alge *Cystoseira aurantia* iz morske lagune Stjuža v Strunjanu (Tržaški zaliv, severni Jadran), ki predstavlja prvi zapis o tej vrsti v obalnem morju Slovenije. Študija je bila izvedena marca 2021, na vzhodnem delu lagune, kjer je bila ugotovljena večja gostota prosto plavajočih prepletenih mas te alge, na globini, ki ni presegala 0,5 m. Opisani so življenjski prostor, morfološki znaki preučenih vzorcev. Ugotovljeno je bilo, da je mehko dno lagune očitno ugodno za razvoj nepritrjene vegetacije alg, katerih predstavnik je *C. aurantia*. Avtorja domnevata, da je nastanek prosto plavajočih mas te alge v Strunjanski laguni Stjuža mogoče razlagati kot posledico dinamičnega delovanja valov zaradi vetrov in plimskih tokov ter kot rezultat aktivne vloge alge, ki omogočajo rast steljke v vse smeri, saj nima pritrdilnih struktur, in s tem nenehno spreminja izpostavljenost svetlobi.

Ključne besede: *Cystoseira aurantia*, laguna Stjuža Strunjan, Slovenija, severni Jadran

REFERENCES

- Amico, V., G. Giaccone, P. Colonna, A.M. Mannino & R. Randazzo (1985):** Un nuovo approccio allo studio della sistematica del genere *Cystoseira* C. Agardh (Phaeophyta, Fucales). Boll. Accad. Gioenia Sci. Nat. Catania, 18, 887-985.
- Antolić, B., A. Špan, A. Žuljević, V. Nikolić, I. Grubelić, M. Despalatović & I. Cvitković (2010):** A checklist of the benthic macroalgae from the eastern Adriatic coast: II. Heterokontophyta: Phaeophyceae. Acta Adriat., 51, 9-33.
- Avčín, A., I. Keržan, L. Kubik, N. Meith-Avčín, J. Štirn, P. Tušnik, T. Valentinčič, B. Vrišer & A. Vukovič (1973):** Akvatični ekosistemi v Strunjanskem zalivu I: preliminarno poročilo. V: Akvatični sistemi v Strunjanskem zalivu I: skupno delo. Prispevki k znanosti o morju. Inštitut za biologijo univerze v Ljubljani, Morska biološka postaja Portorož, 5, str. 168-216.
- Avčín, A., N. Meith-Avčín, A. Vukovič, & B. Vrišer (1974):** Primerjava bentoških združb Strunjanskega in Koprškega zaliva z obzirom na njihove polucijsko pogojene razlike. Ljubljana, Biološki vestnik, 22, 2, 171–208.
- Battelli, C. (2016):** Disappearance of *Fucus virsoides* J. Agardh from the Slovenian coast (Gulf of Trieste, Northern Adriatic). Annales, Ser. hist. nat., 26(1), 1-12.
- Battelli, C. & N. Gregorič (2020):** First report of an aegagropilous form of *Rytiphlaea tinctoria* from the lagoon of Strunjan. Annales, Ser. hist. nat., 30(1), 61–68.
- Bouafif, C., M. Verlaque & H. Langar (2016):** New contribution to the knowledge of the genus *Cystoseira* C. Agardh in the Mediterranean Sea, with the reinstatement of species rank for *C. schiffneri* Hamel. Cryptogam. Algol., 37(2), 133-154.
- Bressan, G. & L. Babbini (2003):** Corallinales del Mar Mediterraneo: Guida alla determinazione. Biol. Mar. Mediterr., 10(2), 237 pp.
- Brodie J., Maggs C.A., John D.M. (eds) (2007):** Green Seaweeds of Britain and Ireland. London, BPS, 242 pp.
- Calvo, S., D. Drago, & M. Sortino (1980):** Winter and summer submersed vegetation maps of the Stagnone (Western Coast of Sicily). Rev. Biol. Ecol. Méd., 7(2), 89-96.
- Cecere, E., O.D. Saracino, M. Fanelli & A. Petrocelli (1992):** Presence of a drifting algal bed in the Mar Piccolo basin, Taranto (Ionian Sea, Southern Italy). J. Appl. Phycol., 4(3), 323-327.
- Cormaci, M., G. Furnari, M. Catra, G. Alongi & G. Giaccone (2012):** Flora marina bentonica del Mediterraneo: Phaeophyceae. Boll. Accad. Gioenia Sci. Nat., Catania, 45, 1-50.
- Cormaci, M., G. Furnari & G. Alongi (2014):** Flora marina bentonica del Mediterraneo: Chlorophyta. Boll. Accad. Gioenia Sci. Nat., Catania, 47, 11-436.
- Fritsch, E.F. (1965):** The structure and reproduction of the algae. Vol II. Univ. press, Cambridge.
- Furnari, G., M. Cormaci & D. Serio (1999):** Catalogo delle macroalghe marine bentoniche della costa italiana del mare Adriatico. Boccone, 12, 1-214.
- Gallardo, T., I. Bárbara, J. Afonso-Carrillo, R. Bermejo, M. Altamirano, A. Gómez Garreta, M.C. Barceló Martí, J. Rull Lluch, E. Ballesteros & J. De la Rosa (2016):** Nueva lista crítica de las algas bentónicas marinas de España. Una nuova lista di controllo di alghe marine bentoniche della Spagna. Algas. Boletín Informativo de la Sociedad Española de Ficología, 51, 7-52.
- Giaccone, G. (1974):** Lineamenti della vegetazione lagunare dell'Alto Adriatico ed evoluzione in conseguenza dell'inquinamento. Boll. Mus. Civ. Storia Naturale Venezia, 26, 87-98.
- Giaccone, G. (1978):** Revisione della flora marina del Mare Adriatico. Annuario Parco Marino Miramare, 6(19), 1-118.
- Gómez Garreta, A., M.C. Barceló i Martí, M.A. Ribera Siguán & J. Rull Lluch (2001):** *Cystoseira* C. Agardh. In: Flora Phycologica Iberica Vol. 1 Fucales. (Gómez Garreta, A. Eds) Murcia: Universidad de Murcia, 1, 99-166.
- Guiry, M.D. & G.M. Guiry (2021):** AlgaeBase. World-wide electronic publication, National University of Ireland, Galway. <https://www.algaebase.org>; searched on 18 April 2021.
- Kützing, F.T. (1843):** Phycologia generalis oder Anatomie, Physiologie und Systemkunde der Tange. Mit 80 farbig gedruckten Tafeln, gezeichnet und gravirt vom Verfasser. pp. [part 1]: [i]-xxxii, [1]-142, [part 2:] 143-458, 1, err.], pls 1-80. Leipzig: F.A. Brockhaus.
- Lipej, L., J. Forte, B. Mavrič, T. Makovec, C. Fišer, M. Kaligarič, N. Šajna & R. Vlk (2004):** Pestrost flore, favne in habitatnih tipov na območju Strunjanskih solin in Stjuže, Poročila MBP, 68, 40 pp.
- Lipej, L., B. Mavrič, M. Orlando-Bonaca, V. Pitačco, D. Trkov & L.L. Zamuda (2019):** Inventarizacija favne in flore Pretočne lagune, Stjuže in solin. Poročila MBP, 186, 44 pp.
- Maggs, C.A. & M.H. Hommersand (1993):** Seaweeds of the British Isles. Volume 1. Rhodophyta. Part 3A. Ceramiales. London: HMSO, 444 pp.
- Orestano, C. & S. Calvo (1985):** La fitocenosi in forma "*Aegagropila*" nelle acque dello Stagnone (Marsala, Sicilia). Boll. Acc. Gioenia Sci. Nat., 18(326), 809-820.
- Orfanidis, S., P. Panayotidis & K.I. Ugland (2011):** Ecological Evaluation Index continuous formula (EEI-c) application: a step forward for functional groups, the formula and reference condition values. Mediterr. Mar. Sci., 12, 199-231.

Orlando-Bonaca, M. & A. Rotter (2018): Any signs of replacement of canopy-forming algae by turf-forming algae in the northern Adriatic Sea? *Ecological Indicators*, 87, 272-284.

Orellana, S., M. Hernández & M. Sansón (2019): Diversity of *Cystoseira sensu lato* (Fucales, Phaeophyceae) in the eastern Atlantic and Mediterranean based on morphological and DNA evidence, including *Carpodesmia* gen. emend. and *Treptacantha* gen. emend. *Eur. J. Phycol.*, 54(3), 447-465.

Ramdani, M., M. Brahim Oufekkir, O. El Asri, N. El Khiati, M. Ramdani, F Denis & R.J. Flower (2021): First report of *Cystoseira aurantia* Kützinger from the Mediterranean coast of Morocco. *Bot. Mar.*, 64(1), 41–47.

Ribera, M.A., A. Gómez-Garreta, T. Gallardo, M. Cormaci, G. Furnari, G. & G. Giaccone (1992): Check-list delle alghe del Mediterraneo. I. Fucophyceae (Riscaldamento 1884). *Bot. Mar.*, 35, 109-130.

Ribera, M.A., A. Gómez Garreta, M.A. Barceló & J. Rull Lluch (1996): Mapas de distribución de algas marinas de la Península Ibérica e Islas Baleares. VIII. *Cystoseira* C. Agardh y *Sargassum* C. Agardh. *Bot. Complut.*, 20, 89-103.

Rindi, F., G. Sartoni & F. Cinelli (2002): Un resoconto floristico delle alghe marine bentoniche della Toscana (Mar Mediterraneo occidentale). *Nova Hedwigia*, 74(1-2), 201-250.

Taskin, E., R. Jahn, M. Öztürk, G. Furnari & M. Cormaci (2012): The Mediterranean *Cystoseira* with photographs) *Le Cistoseire mediterranee (con fotografie)*. Manisa, Turchia: Celar Bayar University, 2, 1-75.

Sfriso, A. (2010): Chlorophyta multicellulari e fanerogame acquatiche. Ambiente di transizione italiani e litorali adiacenti. Bologna, Arpa Emilia-Romagna, 318 pp.

Smith, G.S. (1950): *Freshwater algae of the United States*. New York.

Šmuc (2020): Geološki in klimatski razvoj zaliva Stjuža. Poročilo Univerze v Ljubljani, Naravoslovnotehniška fakulteta, Oddelek za geologijo, 58 pp.

Šajna, N. & M. Kaligarič (2005): Vegetation of the Štjuža coastal lagoon in Strunjan landscape park (Slavenia): a draft history, mapping and nature-conservancy evaluation. *Annales Ser. Hist. Nat.*, 15(1), 79-90.

Vrišer, B. (2002): The meiofauna of two protected wetlands on the Slovene coast: the Škocjan inlet and the Strunjan Lagoon. *Annales Ser. Hist. Nat.*, 12(2), 203-210.