UDK 5 ISSN 1408-533X

ANNALES

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

Series historia naturalis, 24, 2014, 2

KOPER 2014

ISSN 1408-533X UDK 5 Letnik 24, leto 2014, številka 2

Izdajatelj/*Editore/Published by:* Zgodovinsko društvo za južno Primorsko - Koper / *Società storica del Litorale - Capodistria*©

Za izdajatelja/*Per Editore/ Publisher represented by:* Salvator Žitko

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 671 2901;
e-mail: annales@mbss.org, ***internet:*** www.zdjp.si

Redakcija te številke je bila zaključena 15. 12. 2014.

Sofinancirajo/*Supporto finanziario/ Financially supported by:* Javna agencija za raziskovalno dejavnost Republike Slovenije (ARRS)

Annales - series historia naturalis izhaja dvakrat letno.

Naklada/*Tiratura/Circulation:* 300 izvodov/copie/copies

Revija Annales series historia naturalis je vključena v naslednje podatkovne baze: BIOSIS-Zoological Record (UK); Aquatic Sciences and Fisheries Abstracts (ASFA); Elsevier B.V.: SCOPUS (NL).

ANNALES · Ser. hist. nat. · 24 · 2014 · 2

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

UDK 5 Letnik 24, Koper 2014, številka 2 ISSN 1408-533X

VSEBINA / *INDICE GENERALE / CONTENTS*

RECENTNE SPREMEMBE V SREDOZEMSKI BIODIVERZITETI

CAMBIAMENTI RECENTI DELLA BIODIVERSITÀ MEDITERRANEA

RECENT CHANGES IN THE MEDITERRANEAN BIODIVERSITY

Original scientific article
Received: 2014-10-20

UDK 593.73:591.9(262.3)

THE LESSER-KNOWN MEDUSA *DRYMONEMA DALMATINUM* HAECKEL 1880 (SCYPHOZOA, DISCOMEDUSAE) IN THE ADRIATIC SEA

Alenka MALEJ & Martin VODOPIVEC
Marine Biology Station, National Institute of Biology, SI-6330 Piran, Fornače 41, Slovenia
E-mail: malej@mbss.org

Davor LUČIĆ & Ivona ONOFRI
Institute for Marine and Coastal Research, University of Dubrovnik, POB 83, HR-20000 Dubrovnik, Croatia

Branka PESTORIĆ
Institute for Marine Biology, University of Montenegro, POB 69, ME-85330 Kotor, Montenegro

ABSTRACT

Authors report historical and recent records of the little-known medusa Drymonema dalmatinum *in the Adriatic Sea. This large scyphomedusa, which may develop a bell diameter of more than 1 m, was first described in 1880 by Haeckel based on four specimens collected near the Dalmatian island Hvar. The paucity of this species records since its description confirms its rarity, however, in the last 15 years sightings of* D. dalmatinum *have been more frequent.*

Key words: scyphomedusa, *Drymonema dalmatinum*, historical occurrence, recent observations, Mediterranean Sea

LA POCO NOTA MEDUSA *DRYMONEMA DALMATINUM* HAECKEL 1880 (SCYPHOZOA, DISCOMEDUSAE) NEL MARE ADRIATICO

SINTESI

Gli autori riportano segnalazioni storiche e recenti della poco conosciuta medusa Drymonema dalmatinum *nel mare Adriatico. Questa grande scifomedusa, che può sviluppare un cappello di diametro di oltre 1 m,* è stata descritta per la prima volta nel *1880 da Haeckel, in base a quattro esemplari catturati vicino all'isola di Lèsina (Hvar) in Dalmazia. La scarsità delle segnalazioni di questa specie dalla sua prima descrizione conferma la sua rarità. Tuttavia, negli ultimi 15 anni gli avvistamenti di* D. dalmatinum *sono stati più frequenti.*

Parole chiave: scifomedusa, *Drymonema dalmatinum*, avvistamenti storici, segnalazioni recenti, mare Mediterraneo

INTRODUCTION

Large scyphomedusae are more common in cold seas and in the Mediterranean only a few species are known to reach more than 5 kg wet weight and exceed a bell diameter of 40 cm. Among these *Rhizostoma pulmo* is a rather common native species along Mediterranean coasts (Kogovšek *et al*., 2010; Fuentes *et al*., 2011). *Phacellophora camtschatica* is, in contrast, very rare in the Mediterranean and to our knowledge has not been observed since the late 1930s (Mayer, 1910; Fedele, 1937). *Phyllorhiza punctata*, another large-sized rhizostomid, was observed for the first time in the Mediterranean in 1965 off the Israeli coast (Galil *et al*., 1990) but has since been sighted only occasionally, mainly in the central Mediterranean (Abed-Navandi & Kikinger, 2007; Boero *et al*., 2009). Another large scyphomedusa *Rhopilema nomadica* is a Lessepsian invader that has been noted in the Mediterranean from the early 1970's (Galil *et al*., 1990). Since then this scyphomedusae swarms recurrently along the Levantine coast with serious economic and environmental consequences (Galil, 2012).

Among native scyphomedusae found in the Mediterranean which may grow to an even larger size than these rhizostomids is the species *Drymonema dalmatinum* (Haeckel, 1880). Despite its conspicuous size this medusa has been very rarely observed in any Mediterranean area. The only recent information appears in Bayha & Dawson's (2010) description of a new scyphozoan family Drymonematidae which mentions *D. dalmatinum* near Foça, Turkey. Mayer (1910) and Kramp (1961) listed two species: *D. dalmatinum* inhabiting the Mediterranean Sea and the West African coast, and *Drymonema gorgo* (Müller, 1883) from the Brazilian coast. According to Bayha & Dawson (2010) there are currently three valid *Drymonema* species from the three biogeographic provinces: *D. dalmatinum* from the Mediterranean (Haeckel, 1880), *Drymonema larsoni* (Bayha & Dawson, 2010) from the Caribbean and *D. gorgo* from the Brazilian provinces; authors also speculate that the medusa described from the west coast of Africa (Kramp, 1959) may be *D. gorgo* or a novel form characteristic of the Guinean or Benguelan provinces.

In our contribution we review historical and recent observations of *D. dalmatinum* in the Mediterranean and specifically in the Adriatic Sea. Moreover, we provide new information improving the morphological description of this medusa.

MATERIAL AND METHODS

Our study of *D. dalmatinum* occurrences was focused on the Adriatic Sea, although, as far as possible, information was also collected from the other parts of the Mediterranean Sea. We have reviewed published data sources since Haeckel's first description of this species in 1880. Information on the recent occurrences of the studied species originates from the author's own observations as well as from informed citizens who provided photographs upon which the determination of species was based. With few exceptions, the photographers were also sources of information on the size of medusae. Photographs were also used for the description of the main characteristics of medusae.

RESULTS AND DISCUSSION

Figure 1 shows locations and dates of historical and recent *D. dalmatinum* sightings in the Adriatic Sea while in Table 1 we report on sources of information and give some data on the size of medusae observed in the Adriatic and the Mediterranean Sea.

Historical occurrence

In his publication System der Acraspeden Haeckel (1880) gave the first but only a brief diagnosis of *D. dalmatinum* (p. 642/3) based on four medusae that were given to him by G. Bučić. The well-known Croatian naturalist Bučić (Dulčić, 2001) collected medusae near the southern Adriatic island Hvar. The medusa name is derived from the Δφυός = a wood, νήμα = threads, and the place (Dalmatia) where they were found. In the second part of Monographie der Medusen which appeared translated into English in the Challenger Report, Haeck-

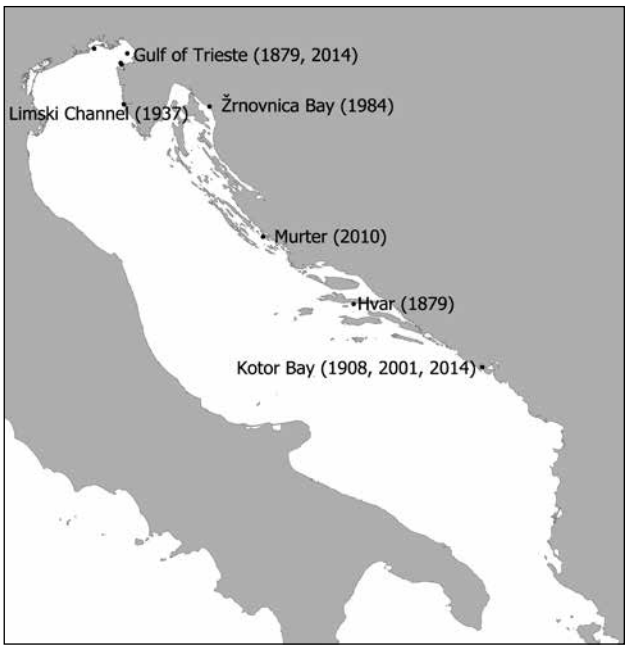


Fig. 1: Scheme of the Adriatic Sea with marked places/ dates of *Drymonema dalmatinum* ***sightings.***
Sl. 1: Shematski prikaz Jadranskega morja z označenimi mesti in leti opazovanj dalmatinske lasaste meduze *(Drymonema dalmatinum)*

Tab. 1: *Drymonema dalmatinum* ***observations in the Mediterranean Sea since its description by Haeckel (1880).*** *In situ* ***estimated size (bell diameter) marked by *, other measurements on fixed material.***
Tab. 1: Pregled pojavov dalmatinske lasaste meduze *Drymonema dalmatinum* ***v Sredozemskem morju od njenega opisa l. 1880 (Haeckel, 1880). Premer klobuka, ocenjen*** *in situ****, je označen z *, ostale meritve opravljene na fiksiranem materialu***

Locality	Date obs.	No. ind. observed	Depth obs.	Estimated size (bell diameter)	Comments & Source
Gibraltar Strait	16 Jan 1873		1097 m	fragments	Haeckel, fragments in samples Challenger exp. stat. 4 (Haeckel, 1882)
Gulf of Izmir, eastern Mediterranean Sea	1887	bloom	shallow	50 - > 100 cm*, 10-25 cm	Haeckel's samples examined by Antipa (1892). Large ind. observed by Haeckel *in situ*, measurements of preserved medusae by Antipa
Hvar, southern Adriatic	1879	four		12-16 cm	Haeckel, material provided by Grgur Bučić (Haeckel, 1880)
Gulf of Trieste, northern Adriatic	1879-1882			fragments	Fragments in samples, Graeffe also observed *Cyanea*-like medusa at sea which escaped (Graeffe, 1884)
North-eastern Kotor Bay, southern Adriatic	29 May 1908	several in group	3 m	12 cm	Babić observed several individuals which escaped; one individual sampled and analysed (Babić, 1910, 2013)
Limski channel, northern Adriatic	20 Apr 1937	three	shallow water	9.5 cm	Kolosváry (1937), Stiasny examined Kolosváry's material (Stiasny 1940a, b)
Bay of Žrnovnica, northern Adriatic	3 Nov 1984	one	6 m	50 cm*	This paper (photo credit C. Mlinar)
Orahovac, Kotor Bay, southern Adriatic	12 Jun, 3 and 14 Jul, 10 Aug 2001	two, one, one, one	few m		This paper (own observations, photo credit V. Mačić)
Foça, eastern Mediterranean Sea	19 May 2003	five	surface		Bayha *et al.* (2010)
Murter, middle Adriatic	11 May 2010	one	few m	40 cm*	This paper (photo credit B. Rameša).
North-eastern Kotor Bay, southern Adriatic	2 Jun 2014	one	surface	35 cm*	This paper (own observations, photo credit V. Mačić)
Piran, northern Adriatic	5 Jun 2014	one	surface	60 cm*	This paper (own observations, photo credit A. Popovič, T. Makovec)
Lignano, northern Adriatic	6 Aug 2014	one	few m	50 cm*	www.blueblog.net/p=2483
Piran near buoy VIDA, northern Adriatic	6 Aug 2014	one	3 m	>60 cm*	This paper (own observations)
Risan, Kotor Bay, southern Adriatic	8 Aug 2014	one	few m	20 cm	This paper (own observations, photo credit V. Mačić)

el (1882) gave the most in depth description we have of *D. dalmatinum* (p. 124-132, pls. 30, 31). The medusa was renamed as *Drymonema victoria*, and Haeckel added additional information obtained from material collected in the Strait of Gibraltar considering this medusa as a deep-water species. Mayer (1910) who reviewed g. *Drymonema* concluded that there was only one Mediterranean species, namely *D. dalmatinum*. Haeckel also created a new subfamily Drymonemidae within f. Cyaneidae recognizing differences among *Drymonema* and the other cyaneid genera. Graeffe (1884, p. 342) described numerous fragments of 'cyaneid-like oral curtains' in the collection of preserved plankton samples (1879-1882) from the Gulf of Trieste that might be fragments of *Drymonema*. Carus (1885) in his Prodromus Faunae Mediterraneae mentioned *D. dalmatinum* from Hvar and, in addition, he reported on another cyaneid *Cyanea lamarckii* collected near Nice (France). Babić (1910, p. 226-227), who observed and collected *D. dalmatinum* in the southern Adriatic, speculated that *Cyanea lamarckii* found near Nice was misidentified and was probably also *Drymonema*. Babić (1913) also reported his finding of *Drymonema* off the north-eastern coast of Kotor Bay in his review of planktonic coelenterates from the Adriatic.

During his second trip to Asia Minor in 1887 Haeckel found 'the entire Gulf of Izmir filled with numerous medusae that belonged to the Drymonemidae' (Antipa, 1892). Since medusae were found by a place called Cordelio, Haeckel named them *Drymonema cordelio*. As he did not have time to examine sampled and preserved material himself, Haeckel passed medusae to Antipa who analysed 10 individuals and described them, keeping the name *D. cordelio*. The medusae observed in life were very large having an average bell diameter of about 50 cm, the largest exceeding 100 cm (Antipa, 1892). There were no further observations of *Drymonema* in the Adriatic since Babić's (1910) finding in Kotor Bay (southern Adriatic) till the late 1930s. In 1937 Kolosváry collected three individuals in the Limski Channel (northern Adriatic) and reported this finding in his contributions on the Adriatic coelenterates (Kolosváry, 1937, 1945). Stiasny, who examined the collection of Rhizostomida of the British Museum of Natural History in London, (Stiasny, 1931), mentioned some other remarkable 'pieces' of this museum's Scyphomedusae collection among which was also Haeckel's *D. dalmatinum* from Hvar. Stiasny who 'tried for many years to obtain at least one sample of this beautiful medusa' (Stiasny, 1940a) received one specimen from Kolosváry; he also obtained a photograph of *Drymonema* swimming freely in the Rovinj Aquarium from Prof. A. Steuer (Stiasny, 1940a, p. 16, Abb 1). Stiasny described the Kolosváry specimen in detail (Stiasny, 1940b) and kept Haeckel's original name of *D. dalmatinum*. Later it was listed in a review of Scyphomedusae in the Adriatic Sea (Avian & Rottini Sandrini, 1994).

Recent observations and species description

We have found no information on *Drymonema* in the Adriatic from 1937 till 1984 when a diver photographed one individual in the small eastern Adriatic Bay of Žrnovnica (Tab. 1, Fig. 1, Fig. 2c). On the other hand there were several observations from 2000 to the present in the northern, middle and southern Adriatic with most sightings in the southern Adriatic. Medusae were seen in the upper water column (Tab. 1) with the exumbrella prevailingly oriented upwards or, more rarely, side-wards with tentacles trailing below (Fig. 2a-f). The size of the observed individuals varied from rather small (20 cm bell diameter) to very large (> 60 cm).

The following is a description of the Adriatic specimens based on observations and underwater photography of specimens with bell diameters from 20 to 60 cm (Fig. 2a-f):

The umbrella is in the form of a flat disc consisting of a thicker and more rigid central part and a thin peripheric velarium with 20 lappets per octant. Four oral arms are very broad, have a large, curtain-like surface, and are nearly as long as the diameter of the bell. There are four, long-band shaped gonads (Fig. 2a). In larger specimens there are clear brownish radial strakes on the exumbrellar surface that branch towards the bell margin (Fig. 2b) while in smaller specimens they are not so obvious. Tentacles are numerous, of unequal lengths and thickness, originate diffusely (Fig. 2c, d, f) from a wide zone of the subumbrella and do not appear in clusters as in genera *Desmonema* and *Cyanea*. The colour of larger specimens is darker (Fig. 2d, e) than that of smaller (Fig. 2f) which appear nearly transparent.

Temporal and spatial variations

Stiasny (1940b) suggested an approx. 30-year periodicity for this species based on records of *Drymonema* in the Adriatic since its description till 1940. However, in the last 40 years, *D. dalmatinum* was more frequently observed, *i.e.* in 1984, 2001, 2010 and 2014 with more sightings in the southern Adriatic (Tab. 1). With one exception, individuals observed in the middle and northern Adriatic were larger than those observed in the southern Adriatic (Tab. 1). We therefore speculate that specimens observed in the northern Adriatic were drifted from the south by currents during the winter-spring period when currents in a northern direction dominate general circulation in the eastern Adriatic Sea (Poulain, 2001; Vilibič & Orlić, 2002) and by SE winds (scirocco or jugo) which were very frequent this winter. Indeed, current measurements in 2014 at the location of oceanographic buoy Vida (45° 32′ 55.68″ N, 13° 33′ 1.89″ E; http://buoy.mbss.org/) before *Drymonema* sightings in the Gulf of Trieste showed a prevalent component in the northern direction, which might indicate that *Drymonema* was brought from the south in the days before it's capture.

Fig. 2a: *D. dalmatinum* ***collected on 2 June 2014 in Boka Kotorska, bell diameter 35 cm.***
Sl. 2a: Dalmatinska lasasta meduza, ulovljena 2. 6. 2014 v Boki Kotorski, premer klobuka 35 cm

Fig. 2b: *D. dalmatinum* ***collected on 2 June 2014 in Boka Kotorska, bell diameter 35 cm.***
Sl. 2b: Dalmatinska lasasta meduza, ulovljena 2. 6. 2014 v Boki Kotorski, premer klobuka 35 cm

Fig. 2c: *D. dalmatinum* ***photographed on 3 November 1984 in Bay of Žrnovica, bell diameter 50 cm.***
Sl. 2c: Dalmatinska lasasta meduza, fotografirana 3. 11. 1984 v zalivu Žrnovnica, premer klobuka 50 cm

Fig. 2d: *D. dalmatinum* ***photographed on 11 May 2010, Murter, bell diameter 40 cm.***
Sl. 2d: Dalmatinska lasasta meduza, fotografirana 11. 5. 2010 pri otoku Murter, premer klobuka 40 cm

Fig. 2e: *D. dalmatinum* ***photographed on 5 June 2014 in Piran port, bell diameter 60 cm.***
Sl. 2e: Dalmatinska lasasta meduza, fotografirana 5. 6. 2014 v piranskem pristanišču, premer klobuka 60 cm

Fig. 2f: *D. dalmatinum* ***photographed on 8 August 2014 in Boka Kotorska, bell diameter 20 cm.***
Sl. 2f: Dalmatinska lasasta meduza, fotografirana 8. 8. 2014 v Boki Kotorski, premer klobuka 20 cm

If we assume a similar growth rate as determined for *D. dalmatinum* from the Caribbean Sea (Larson 1987), medusae could reach the size observed in the Gulf of Trieste (between 50 and 60 bell diameter) in about 3 – 4 months which is consistent with the estimated time of travel if we take into the account current speeds ranging from 5 to 10 cm/s. Larson (1987) maintained *Drymonema* on a diet of *Aurelia* medusae which were also shown to be heavily preyed upon by *D. larsoni* in northern Mexico (Bayha *et al*., 2012). Since the 1980s an increase of *Aurelia aurita* bloom incidence has been observed in the northern Adriatic (Kogovšek *et al*., 2010). Blooms have been recorded annually (Malej *et al*., 2012) since the early 2000s consistent with an observed pelagic trophic shift (Mozetič *et al*., 2012). It's interesting to note that a high abundance of *A. aurita* was also recorded during several years from 1874 – 1911 (see Table 1 in Kogovšek *et al*., 2010) when *Drymonema* was noted in the Adriatic Sea. However, while in the Adriatic *D. dalmatinum* has been observed only sporadically with few individuals, it formed large blooms in the Caribbean Sea where Williams *et al*. (2001) observed that an *Aurelia* outbreak preceded and coincided with the population explosion of *Drymonema*. With the increase of *Aurelia* blooms in the Adriatic, we may therefore expect that we will have the opportunity to observe and study *D. dalmatinum* more frequently in the near future.

ACKNOWLEDGEMENTS

We thank Vesna Mačić, Tihomir Makovec, Ciril Mlinar, Aleksandra Popovič, Branko Rameša, Valter Žiža, fishermen and divers for *Drymonema* photographs and reports of this medusa. This work was supported by Slovenian Research Agency program P1-0237, EU FP7 project PERSEUS, the Ministry of Science, Education and Sport of R Croatia and the Ministry of Science and Education of R Montenegro.

MANJ ZNANA MEDUZA *DRYMONEMA DALMATINUM* HAECKEL 1880 (SCYPHOZOA, DISCOMEDUSAE) V JADRANSKEM MORJU

Alenka MALEJ & Martin VODOPIVEC
Morska biološka postaja, Nacionalni inštitut za biologijo, SI-6330 Piran, Fornače 41
E-mail: malej@mbss.org

Davor LUČIĆ & Ivona ONOFRI
Institute for Marine and Coastal Research, University of Dubrovnik, POB 83, HR-20000 Dubrovnik, Croatia

Branka PESTORIĆ
Institute for Marine Biology, University of Montenegro, POB 69, ME-85330 Kotor, Montenegro

POVZETEK

Avtorji v prispevku predstavljajo malo znano klobučnjaško meduzo Drymonema dalmatinum *(dalmatinska lasasta meduza). Prvič jo je opisal Haeckel (1880) ravno na osnovi vzorcev meduz iz Jadranskega morja. Klobuk dalmatinske lasaste meduze lahko doseže premer preko enega metra, vendar so bili primerki iz Jadranskega morja manjši, največji so imeli premer okoli 60 cm. Na osnovi historičnih virov in novejših opazovanj avtorji v prispevku podajajo časovni pregled opazovanj te meduze od konca 19. stoletja do danes. Stiasny (1940b) je predlagal 30-letni ciklus pojavljanja, vendar smo v zadnjih desetletjih zabeležili pojave l. 1984, 2001, 2010 in 2014. Dalmatinska lasasta meduza je bila bolj pogosto zabeležena v južnem Jadranu, opazovani primerki pa so bili manjših dimenzij kot v severnem Jadranu, kar nakazuje njen transport z vodnimi masami ob vzhodnojadranski obali proti severu. Podatki iz literature kažejo, da so pomemben plen dalmatinske lasaste meduze uhati klobučnjaki, za katere v obdobju po letu 1980, zlasti pa po l. 2000, v severnem Jadranu ugotavljamo pogostejše masovno pojavljanje.*

Ključne besede: redek klobučnjak, dalmatinska lasasta meduza, historični zapisi, nova opazovanja

REFERENCES

Abed-Navandi, D. & R. Kikinger (2007): First record of the tropical scyphomedusa *Phyllorhiza punctata* von Lendenfeld, 1884 (Cnidaria: Rhizostomeae) in the Central Mediterranean Sea. Aquatic Invasions, 2, 391-394.

Antipa, G. (1892): Eine neue Art von *Drymonema*. Jen. Z. Naturwiss., 27, 337-345.

Avian, M. & L. Rottini Sandrini (1994): History of Scyphomedusae in the Adriatic. Boll. Soc. Adriat. Sci., 75, 5-12.

Babić, K. (1910): Prilog fauni Jadranskog mora. Rad JAZU, 183, 207-227.

Babić, K. (1913): Planktonički celenterati iz Jadranskog mora. Rad JAZU, 200, 186-202.

Bayha, K. M. & M. N. Dawson (2010): New family of allomorphic jellyfishes, Drymonematidae (Scyphozoa, Discomedusae), emphasizes evolution in the functional morphology and trophic ecology of gelatinous zooplankton. Biol. Bull., 219, 249-267.

Bayha, K. M., W. M. Graham, J. III Higgins & H. Fletcher (2012): Predation potential of the jellyfish *Drymonema larsoni* Bayha & Dawson (Scyphozoa: Drymonematidae) on the moon jellyfish *Aurelia* sp. in the northern Gulf of Mexico. Hydrobiologia, 690, 189-197.

Boero, F., M. Putti, E. Trainito, E. Prontera, S. Piraino & T. A. Shiganova (2009): First records of *Mnemiopsis leidyi* (Ctenophora) from the Ligurian, Thyrrhenian and Ionian Seas (Western Mediterranean) and first record of *Phyllorhiza punctata* (Cnidaria) from the Western Mediterranean. Aquatic Invasions, 4, 675-680.

Carus, J. V. (1885): Prodromus faunae mediterraneae. Vol. I. Coelenterata, Echinodermata, Vermes, Arthropoda. E. Schweizerbart'sche Verlagshandlung, Stuttgart, 524 pp.

Dulčić, J. (2001): Grgur Bučić - the versatile naturalist (1828-1911). Annale, Ser. Hist. Nat., 11 (2), 307-312.

Fedele, M. (1937): Descrizione di una notevole Scifomedusa mediterranea e revisione del genere *Phacellophora* delle Scyphomedusae semaeostomae Ulmaridae. Zool. Anz., 119, 195-207.

Fuentes, V., I. Straehler-Pohl, D. Atienza, I. Franco, U. Tilves, M. Gentile, M. Acevedo, A. Olariafa & J.-M. Gili (2011): Life cycle of the jellyfish *Rhizostoma pulmo* (Scyphozoa: Rhizostomeae) and its distribution, seasonality and inter-annual variability along the Catalan coast and the Mar Menor (Spain, NW Mediterranean) Mar. Biol., 158, 2247-2266.

Galil, B. (2012): Truth and consequences: bioinvasions of the Mediterranean Sea. Integrative Zoology, 7, 299-311.

Galil, B., E. Spanier & W. W. Ferguson (1990): The Scyphomedusae of the Mediterranean coast of Israel, including two Lessepsian migrants new to the Mediterranean. Zool. Meded., 64, 95-105.

Graeffe, E. (1884): Übersicht der Seethierfauna des Golfes von Triest. III. Die Coelenteraten. Abd. Zool. Inst. Univ. Wien, 5, 333-362.

Haeckel, E. (1880): System der Acraspeden. Zweite Halfte des System der Medusen. Verlag von Gustav Fischer, Jena, p. 361-672.

Haeckel, E. (1882): Report on the deep-sea medusae dredged by H.M.S. Challenger during years 1873-1876. Rep. Sci. Res. H.M.S. Challenger (Zoology), 4, 1-154.

Kogovšek, T., B. Bogunović & A. Malej (2010): Recurrence of bloom-forming scyphomedusae: wavelet analysis of a 200-year time series. Hydrobiologia, 645, 81-96.

Kolosváry, G. (1937): Érdekes allatok az ézaki adriából. A Tenger, 8-9.

Kolosváry G. (1945): Beträge zur Kenntniss der Adriatischen Coelenteraten auf Grund der Sammlung des Ung. Nat. Mus. Riv. Biol., 37, 139-141.

Kramp, P. L. (1959): Medusae, mainly from the west coast of Africa. Bull. Inst. R. Sci. Nat. Belg., 3, 1-33.

Kramp, P. L. (1961): Synopsis of the medusae of the world. J. Mar. Biol. Assoc. U.K., 40, 1-469.

Larson, R. J. (1987): First report of the little-known Scyphomedusa *Drymonema dalmatinum* in the Caribbean Sea, with notes on its biology. Bull. Mar. Sci., 40, 437-441.

Malej, A., T. Kogovšek, A. Ramšak & L. Catenacci (2012): Blooms and population dynamics of moon jellyfish in the northern Adriatic. Cah. Biol. Mar., 53, 337-352.

Mayer, A. G. (1910): Medusae of the World. III. Scyphomedusae. Carnegie Institution, Washington, no. 109, p. 499-735.

Mozetič, P., J. Francé, T. Kogovšek, I. Talaber & A. Malej (2012): Plankton trends and community changes in a coastal sea (northern Adriatic): Bottom-up *vs.* top-down control in realtion to environmental drivers. Estuar. Coast. Shelf Sci., 115, 138-148.

Müller, F. (1883): *Drymonema* an der Küste von Brasilien. Zool. Anz., 6, 220-222.

Poulain, P. M. (2001): Adriatic Sea surface circulation as derived from drifter data between 1990 and 1999. J. Mar. Syst., 29, 3-32.

Stiasny, G. (1931): Die Rhizostomeen_Sammlung des British Museum (Natural History) in London. Zool. Meded., 14, 137-178.

Stiasny, G. (1940a): *Drymonema dalmatinum* Haeckel, eine seltene Scyphomeduse aus der Adria. Ann. Musei Nat. Hungarici. Pars Zoologica, 33, 14-18.

Stiasny, G. (1940b): Über *Drymonema dalmatinum* Haeckel. Zool. Jb. Abt. Anat., 66, 437-461.

Vilibić, M. & M. Orlić (2002): Adriatic water masses, their rate of formation and transport through the Otranto Straits. Deep Sea Res., 49, 1321-1340.

Williams, E. H. Jr., L. Bunkley-Williams, C. G. Lilyestrom, R. J. Larson, N. A. Engstrom, E. A. R. Ortiz-Corps & J. H. Timber. (2001): A population explosion of the rare tropical/subtropical purple sea mane, *Drymonema dalmatinum*, around Puerto Rico in the summer and fall of 1999. Caribb. J. Sci., 37, 127-130.

Short scientific article
Received: 2014-09-24

UDK 597.556.33:574.91(262.3)

ADDITIONAL RECORD OF A LESSEPSIAN MIGRANT - THE DUSKY SPINEFOOT, *SIGANUS LURIDUS* (RÜPPELL, 1829) IN THE EASTERN ADRIATIC (MONTENEGRIN COAST)

Mirko ĐUROVIĆ, Ana PEŠIĆ & Aleksandar JOKSIMOVIĆ
Institute for Marine Biology, University of Montenegro, POB 69, ME-85330 Kotor, Montenegro
E-mail: acojo@ac.me

Jakov DULČIĆ
Institute of Oceanography and Fisheries, POB 500, HR-21000 Split, Croatia

ABSTRACT

A specimen of Siganus luridus *was caught with trammel net on 7 September 2014 in Bigova (cape Trašte) (southern Adriatic Sea, Montenegrin coast). This is the first record of this species for Montenegrin coast, and fourth for the Adriatic Sea.*

Key words: *Siganus luridus*, additional record, Lessepsian migrant, Montenegrin coast, Adriatic Sea

SEGNALAZIONI AGGIUNTIVE DI UN MIGRANTE LESSEPSIANO – IL PESCE CONIGLIO, *SIGANUS LURIDUS* (RÜPPELL, 1829), NELL'ADRIATICO ORIENTALE (COSTA MONTENEGRINA)

SINTESI

Un esemplare di pesce coniglio, Siganus luridus*, è stato catturato con tramaglio il 7 settembre 2014 a Bigova (punta Trašte) (Adriatico meridionale, costa montenegrina). Si tratta del primo avvistamento di questa specie per la costa montenegrina ed il quarto per il mare Adriatico.*

Parole chiave: *Siganus luridus*, segnalazioni aggiuntive, migrante lessepsiano, costa montenegrina, mare Adriatico

INTRODUCTION

Thirteen species of Lessepsian fish migrants have been recently reported from the Adriatic Sea (Dulčić & Dragičević, 2011). Among them, the dusky spinefoot *Siganus luridus* (Rüppell, 1829) was recorded in at least three occasions (Poloniato *et al*., 2010; Dulčić *et al*., 2011, 2013). Its first record in the Mediterranean dates back to 1955 from the coast of Israel (Ben-Tuvia, 1964) and shortly after its discovery it became very common in most coastal areas of the Mediterranean (see Dulčić *et al*., 2011).

The aim of this paper is to present additional record of dusky spinefoot *S. luridus* in the eastern Adriatic, which is at the same time the first record in waters off Montenegro.

MATERIAL AND METHODS

A male specimen of *S. luridus* was caught with trammel net on 7 September 2014 in Bigova (cape Trašte) (southern Adriatic Sea, Montenegrin coast) at a depth of approximately 4 m, on a rocky bottom (Fig. 1). Main distinguishing characters of the specimen are: body deep, ellipsoid, compressed; dorsal fin origin above pectoral fin base; dorsal ray portion margin round; caudal fin truncated; anal fin origin beneath 810 dorsal spines, its margin round; pelvic fin origin behind pectoral fin base, its inner spine connected by a membrane to the abdomen; head slightly concave with blunt snout; mouth small with distinct lips; maxilla not reaching vertical of eye.

The morphology of the observed specimen agrees with taxonomic description in Dulčić & Dragičević (2011). The specimen was carefully measured with a calliper and weighed. The specimen is preserved and deposited in the Ichthyological collection of the Institute for Marine Biology in Kotor (IBMKotor-179SL).

Fig. 1: A specimen of** Siganus luridus **caught in Bigova (cape Trašte) (southern Adriatic Sea, Montenegrin coast). (Photo: Z. Ikica)
Sl. 1: Primerek morskega kunca** Siganus luridus**, ujet v Bigovi (rt Trašte) (južni Jadran, črnogorska obala). (Foto: Z. Ikica)

RESULTS AND DISCUSSION

Basic morphometric data are given in Table 1 for comparative purposes with other studies. Meristic data are as follows: dorsal fin rays XIV+10, anal fin rays VII+9, pectoral fin rays 16, pelvic fin rays I+3+I, caudal fin rays 19. Morphometric measurements are in agreement with those presented by Dulčić *et al*. (2013).

The first record of the dusky spinefoot in the northern Adriatic Sea is from 2010 from the Gulf of Trieste (Poloniato *et al*., 2010) (Fig. 2). A second record occurred in the southern Adriatic (Mljet channel) the very same year in the month of November (Dulčić *et al*., 2011). Juveniles were for the first time observed in Molunat Bay (southern Adriatic, Croatian coast) on 15 December 2011 (Dulčić *et al*., 2013). All these records, including the record from this study, could indicate self-sustaining populations, especially in the southern Adriatic. Records of juvenile stages support such statement and indicate possible local reproductive activities of species. Golani *et al*. (2011) noted that it is universally accepted that the immediate publication of the first record of an invasive species is essential, but it is no less important to publish second and

Tab. 1: Basic morphometric measurements for** S. luridus **from Montenegrin waters.
Tab. 1: Osnovne morfometrične meritve morskega kunca, ujetega v črnogorskih vodah

Morphometric measurement	cm	% TL
Total length (TL)	17.4	100
Fork length (FL)	16.8	96.6
Standard length (SL)	14.6	83.9
Pre-ocular length (POC)	1.4	
Eye diameter (O)	1.2	
Post-ocular length (ZOC)	1.1	
Head length (LC)	3.2	18.4
Abdominal length (LTR)	2.3	
Pre-anal length (PA)	6.1	35.1
Tail length (LCA)	10.4	59.8
Tail fin length (C)	2.6	
Caudal peduncle length (PC)	1.6	
Minimum body height (h)	0.5	
Maximum body height (H)	5.7	
Pectoral fin length (LP)	2.8	
Anal fin base length (BA)	6	34.5
Dorsal fin base length (BD)	10	57.5

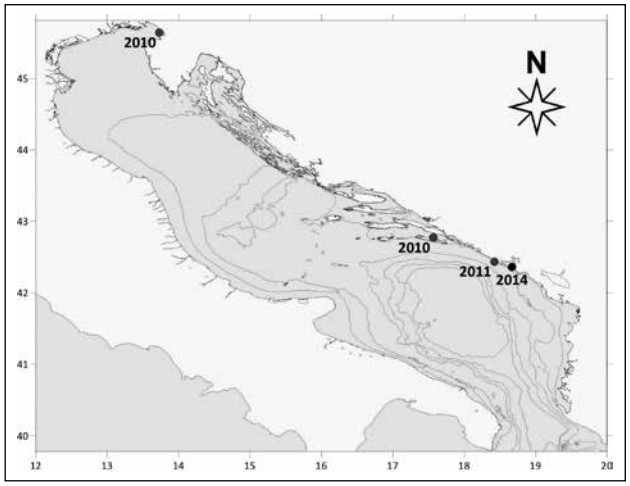


Fig. 2: Map indicating locations of records of *S. luridus* ***in the eastern Adriatic.***
Northern Adriatic: Gulf of Trieste, 2010 (Poloniato *et al.*, ***2010); southern Adriatic: Island of Mljet, 2010 (Dulčić*** *et al.*, ***2011), Molunat Bay, 2011 (Dulčić*** *et al.*, ***2013), present study, 2014.***
Sl. 2: Zemljevid z lokalitetami ujetih morskih kuncev v vzhodnem Jadranu.
Severni Jadran: Tržaški zaliv, 2010 (Poloniato *et al.*, ***2010); južni Jadran: otok Mljet, 2010 (Dulčić*** *et al.*, ***2011), zaliv Molunat, 2011 (Dulčić*** *et al.*, ***2013), pričujoče delo, 2014***

subsequent records of the invasive species in order to verify the establishment and distribution extension in its new habitat. Subsequent records indicate that previous records of some species in new geographic region were not accidental sightings of fish but represent a possibility that this region is included in the zoogeographic range of these fish species (Golani & Levy, 2005).

It should be also noted that all of these records occurred exclusively along the eastern coast of the Adriatic Sea and can be associated with the effects of the Adriatic ingressions and BiOS (Bimodal Oscillating System) (Civitarese *et al.*, 2010; Dulčić *et al.*, 2011).

Ben Ras Lasram *et al*. (2008) reported that dusky spinefoot has a strong dispersal potential and its success should be attributed to its large eco-physiological plasticity. *S. luridus* seems to take competitive advantage over native herbivorous fish species such as salema *Sarpa salpa* and wrasses (family Labridae) in its new environment (Bariche *et al.*, 2004), and has already altered the community structure and the native food web along the Levantine rocky infralittoral zone. Due to the increasing occurrence of this species in the eastern Adriatic Sea similar effects may be also expected in the near future in the Adriatic environment and as such its impact certainly deserves full attention.

ACKNOWLEDGMENTS

We are thankful to Mr Nikola Lazarević (Dado) for providing us the specimen of dusky spinefoot. We are also thankful to Mr Zdravko Ikica for a photo of the specimen.

NOV ZAPIS O POJAVLJANJU LESEPSKEGA SELIVCA MORSKEGA KUNCA *SIGANUS LURIDUS* (RÜPPELL, 1829) V VZHODNEM JADRANU (ČRNOGORSKA OBALA)

Mirko ĐUROVIĆ, Ana PEŠIĆ & Aleksandar JOKSIMOVIĆ
Institute for Marine Biology, University of Montenegro, POB 69, ME-85330 Kotor, Montenegro
E-mail: acojo@ac.me

Jakov DULČIĆ
Institute of Oceanography and Fisheries, POB 500, HR-21000 Split, Croatia

POVZETEK

Primerek morskega kunca Siganus luridus *je bil 7. septembra 2014 ujet s povlečno mrežo v Bigovi (rt Trašte, južni Jadran, Črna gora). To je prvi zapis o pojavljanju te vrste ob črnogorski obali in četrti za Jadransko morje.*

Ključne besede: *Siganus luridus,* novi zapis, lesepska selivka, črnogorska obala, Jadransko morje

REFERENCES

Bariche, M., Y. Letourneur & M. Harmelin-Vivien (2004): Temporal fluctuations and settlement pattern of native and Lessepsian herbivorous fishes on the Lebanese coast (eastern Mediterranean). Environ. Biol. Fishes, 70, 81-90.

Ben Ras Lasram, F., J. A. Tomasini, F. Guilhaumon, M. S. Rondhame, T. Do Chi & D. Moulliot (2008): Ecological correlates of dispersal success in Lessepsian fishes. Mar. Ecol. Prog. Ser., 363, 273-286.

Ben-Tuvia, A. (1964): Two siganid fishes of red Sea origin in the eastern Mediterranean. Bull. Sea Fish. Res. Stn., 37, 1-9.

Civitarese, G., M. Gačić, M. Lipizer & G. I. Eusebi Borzelli (2010): On the impact of the Bimodal Oscillating System (BiOS) on the biogeochemistry and biology of the Adriatic and Ionian Seas (Eastern Mediterranean). Biogeosciences, 7, 3987-3997.

Dulčić, J. & B. Dragičević. (2011): Nove ribe Jadranskog i Sredozemnog mora. Institut za oceanografiju i ribarstvo, Split, Državni zavod za zaštitu prirode, Zagreb, 160 pp.

Dulčić, J., B. Dragičević, R. Grgičević & L. Lipej (2011): First substantiated record of a Lessepsian migrant – the dusky spinefoot, *Siganus luridus* (Actinopterygii: Perciformes: Siganidae), in the Adriatic Sea. Acta Ichthyol. Piscat., 41, 141-143.

Dulčić, J., N. Antolović, V. Kožul, B. Dragičević & L. Lipej (2013): First records of juveniles of two Lessepsian migrants, *Fistularia commersonii* Rüppell, 1838 and *Siganus luridus* (Rüppell, 1829), in the Adriatic Sea. J. Appl. Ichthyol., 29, 661-662.

Golani, D. & Y. Levy (2005): New records and rare occurrences of fish species from the Mediterranean coast of Israel. Zool. Middle East, 36, 27-32.

Golani, D., O. Sonin & D. Edelist (2011): Second records of the Lessepsian fish migrants *Priacanthus sagittarius* and *Platax teira* and distribution extension of *Tylerius spinosissimus* in the Mediterranean. Aquatic Invasions, 6 (Suppl. 1), 7-11.

Poloniato, D., S. Ciriaco, R. Odorico, J. Dulčić & L. Lipej (2010): First record of the dusky spinefoot *Siganus luridus* (Rüppell, 1829) in the Adriatic Sea. Annales, Ser. Hist. Nat., 20 (2), 161-166.

SREDOZEMSKE HRUSTANČNICE

PESCI CARTILAGINEI DEL MEDITERRANEO

MEDITERRANEAN ELASMOBRANCHS

Original scientific article
Received: 2014-08-07

UDK 597.315.3:591.9(262.4/.5)

NOT DISAPPEARED, JUST RARE! STATUS OF THE BRAMBLE SHARK, *ECHINORHINUS BRUCUS* (ELASMOBRANCHII: ECHINORHINIDAE) IN THE SEAS OF TURKEY

Hakan KABASAKAL
Ichthyological Research Society, Tantavi Mahallesi, Menteşoğlu Caddesi, İdil Apt., No: 30, D: 4, Ümraniye, TR-34764 İstanbul, Turkey
E-mail: kabasakal.hakan@gmail.com

Murat BILECENOGLU
Adnan Menderes University, Faculty of Arts & Sciences, Department of Biology, 09010, Aydın, Turkey

ABSTRACT

Status of the bramble shark, Echinorhinus brucus *(Bonnaterre,1788), in the seas of Turkey has always been a point of debate until early 2000's. With the addition of 7 recent records from the seas of Turkey, which constitues the 22.5 percent of the historical and contemporary records of the bramble shark from entire Mediterranean Sea, 31 individuals of* E. brucus *have been recorded from the entire region, and the record no. 7 of the present study is probably the most recently captured bramble shark, to date. Since 5 of the 7 recent records of* E. brucus *have been reported from the Sea of Marmara, special attention of research should be focused to this small inland sea to figure out whether this species has a localized population in this region or not.*

Key words: bramble shark, *Echinorhinus brucus*, Echinorhinidae, status, Turkey, Mediterranean

NON SCOMPARSO, SOLO RARO! STATO DELLO SQUALO RONCO, *ECHINORHINUS BRUCUS* (ELASMOBRANCHII: ECHINORHINIDAE) NEI MARI DELLA TURCHIA

SINTESI

Lo stato dello squalo ronco, Echinorhinus brucus *(Bonnaterre, 1788), nei mari della Turchia* è sempre stato un *punto di discussione, fin dai primi anni 2000. Con l'aggiunta di sette avvistamenti recenti nei mari della Turchia, che rappresentano il 22,5 per cento delle segnalazioni storiche e contemporanee del ronco in tutto il Mediterraneo, il numero di individui di* E. brucus *registrati in questa regione sale a 31. La segnalazione numero 7 del presente studio* è probabilmente *la cattura più recente del ronco ad oggi. Visto che 5 delle 7 recenti segnalazioni di* E. brucus *risalgono al Mar di Marmara, la ricerca dovrebbe prestare particolare attenzione a questo piccolo mare interno, per capire se la specie ha o meno una popolazione localizzata in questa regione.*

Parole chiave: squalo ronco, *Echinorhinus brucus*, Echinorhinidae, stato, Turchia, mare Mediterraneo

INTRODUCTION

Bramble shark, *Echinorhinus brucus* (Bonnaterre, 1788), is primarily a deepwater species on the continental slope between depths of 200 and 900 metres (Serena, 2005). At least in one case it has been recorded at depth of 1214 m in the Sea of Marmara (Kabasakal *et al*., 2005). It is considered to be fairly common in all three oceans (Compagno, 1984; McEachran & Branstetter, 1984), with localized records throughout its global distributional range. Although *E. brucus* is known from the western and central parts of the Mediterranean Sea, it is considered as a rare deep sea shark in the area (Tortonese, 1956; Hemida & Capapé, 2002; Lipej *et al*., 2004; Serena, 2005). *E. brucus* has been included by De Maddalena & Baensch (2008) in a list of the 13 most endangered species of Mediterranean sharks, needing immediate protection in the area because at risk of total disappearance from these waters.

First reports on the occurrence of the bramble shark in Turkey's waters dated back to Ninni (1923) and Deveciyan (1926). In his monumental book on fishes and fisheries of Turkey's waters, Deveciyan (1926) briefly reported on *E. brucus* (as *Echinorhinus spinosus*), and in contrast to aforementioned authors emphasizing the rarity of the bramble shark in the Mediterranean Sea, Deveciyan (1926) claimed that *E. brucus* was abundant in Turkey's waters and consumed by the people. Following Deveciyan's (1926) work, occurrence of *E. brucus* in Turkey's waters has also been reported by Akşıray (1987); however, this author did not describe precise captures. Furthermore, due to lack of the bramble shark in the fishery records since 1980s, Kabasakal (2002) suggested that the species had probably disappeared from the seas of Turkey. However, recent sightings (Kabasakal *et al*., 2005) or captures (Kabasakal & Dalyan, 2011) of specimens from the Sea of Marmara showed that *E. brucus* still occurs in the region. In the present article, authors report on three recent captures of *E. brucus* from Turkey's waters and based on available data, discuss the status of the species in the area.

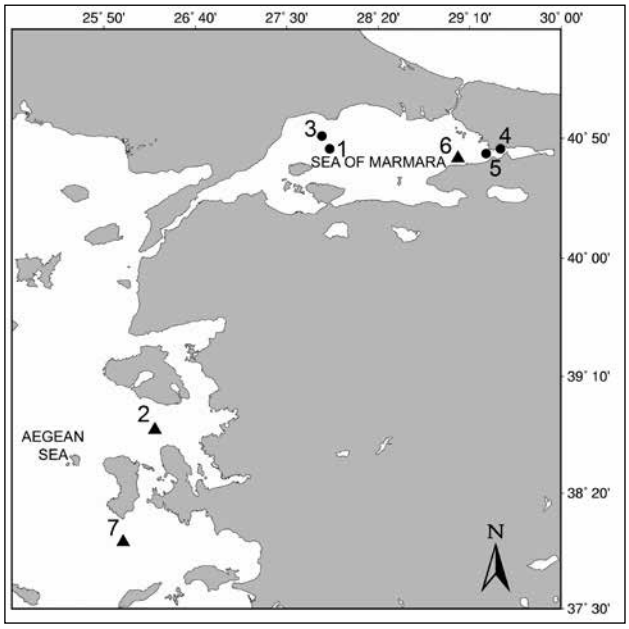


Fig. 1: General view of the study area and the localities of captures of recently recorded bramble sharks from Aegean and Marmara seas. Legend: (●)previously reported specimens, (▲) specimens examined in the present study. Numbers are same as the numbers seen in "No." column in Table 1.
Sl. 1: Prikaz širšega območja in lokalitete, kjer so bili v zadnjem desetletju ujeti bodičasti morski psi v Egejskem in Marmarskem morju. Legenda: (●) predhodno potrjeni primerki, (▲) primerki, obravnavani v pričujočem delu. Številke se ujemajo s številkami iz tabele 1 (stolpec "No.")

MATERIALS AND METHODS

The present study is part of an extensive research on sharks from Turkey's waters, which has been carried out by Ichthyological Research Society (IRS) since 2000. Data on bramble sharks have been collected from the following sources: (a) scientific literature, (b) daily newspapers and internet sources, as far as such popular sources are concerned, the validity of the recordings has been confirmed by means of direct contact with the fishermen reported in the source, and (c) visiting the fishing ports. For each examined bramble shark, the following data were recorded: total length (TL), weight (W), sex, date and locality, fishing gear and depth. TL is the horizontal line from tip of snout to tip of the upper lobe of caudal fin, where the caudal fin depressed to body axis (Serena, 2005). Identification and nomenclature of the present specimens are based on Compagno (1984) and Serena (2005). Photographs of the examined bramble sharks, of which the details are described below, are kept in the archives of IRS.

RESULTS AND DISCUSSION

On 13 May 2005, a bramble shark (record no. 2, Fig. 2A, B) was caught by a commercial bottom trawler off the Karaburun coast (Aegean Sea, Fig. 1). Total length of the shark was 230 cm. After being landed at the İzmir fish market, the head was removed and photographed by the second author. Another bramble shark (record no. 6, Fig. 2C) was caught on 19 May 2010 by a commercial gill-netter, 2 km off Yalova coast (Sea of Marmara, Fig. 1) at depth of 300 m. It was a female of 220 cm TL and its mass was 300 kg. The third examined individual was also a female of 200 cm TL and 140 kg in weight (record no. 7, Fig. 2D). It has been caught by a commercial gill-netter off Karaburun coast on January 6, 2013.

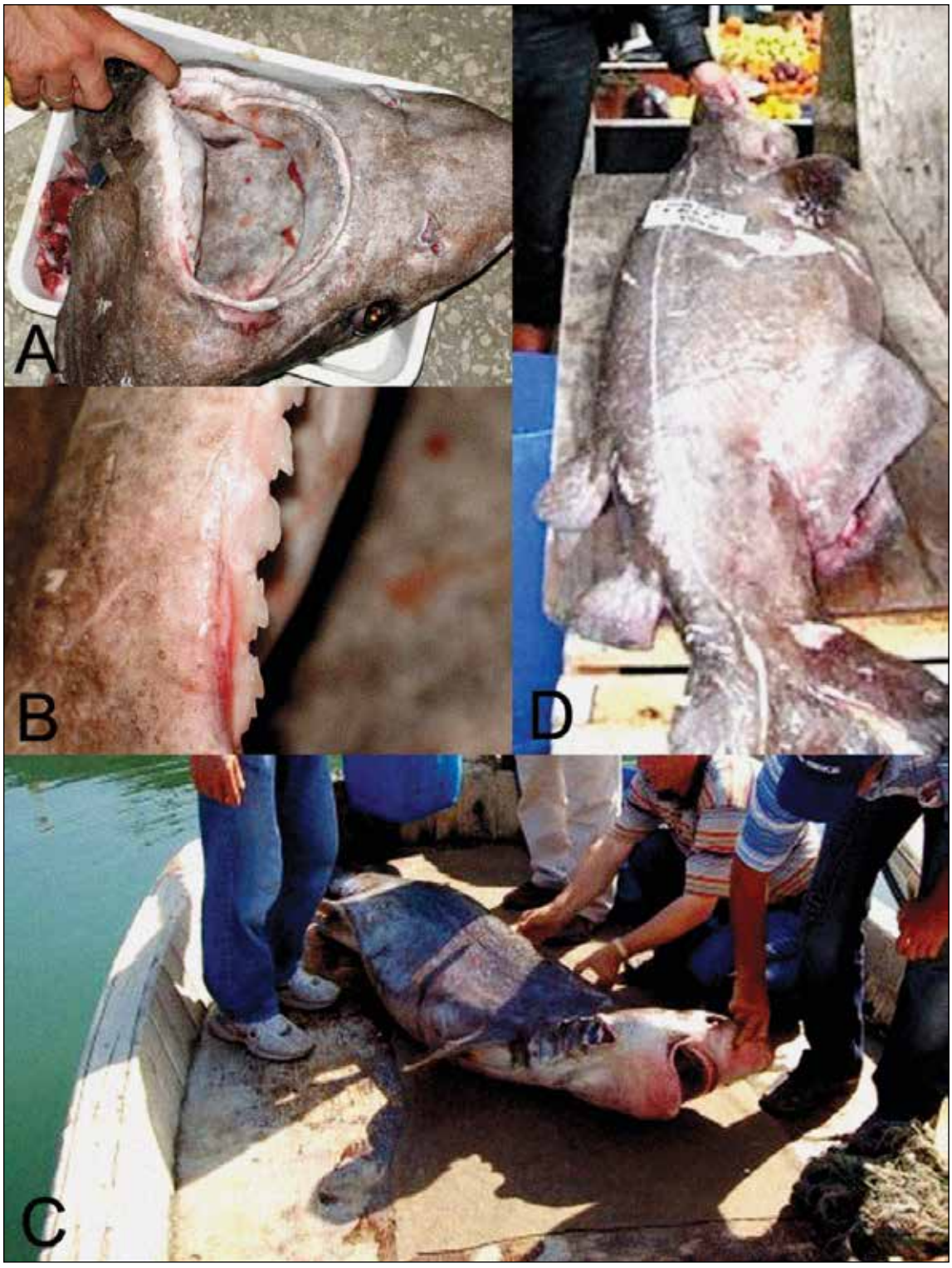


Fig. 2: Specimens of the bramble shark, *Echinorhinus brucus*, ***recently caught off Turkey's coast. (A) specimen no. 2, (B) close up view of the teeth of specimen no. 2, (C) specimen no. 6, and (D) specimen no. 7, examined in the present study. Specimen numbers are same as the numbers seen in "No." column in Table 1.***
Sl. 2: Primerki bodičastih morskih psov, *Echinorhinus brucus*, ***ki so bili v zadnjem desetletju ujeti ob turških obalah. (A) primerek št. 2, (B) bližinski posnetek zobovja primerka št. 2, (C) primerek št. 6 in (D) primerek št. 7, analiziran v pričujočem delu. Številke primerkov so enake številkam v tabeli 1(stolpec "No.")***

The following description of *E. brucus* is based on above specimens, which are shown in Figures 2A-D: body elongated and rather cylindrical, lateral line beginning at the level of the first gill opening and consisting of a marked furrow flanked on both sides by a cutaneous ridge (Fig. 2D), head flattened above, ending with a broadly rounded snout, eyes are rather circular with a small spiracle behind them, large nostrils with a long and acute nasal valve (Fig. 2A), rather closer to mouth than to the tip of the snout, five pairs of relatively small gill slits, all located anteriorly to pectoral fin origin, first gill slits shorter than the following, no anal fin, dorsal fins located backward, first dorsal fin origin located over pelvic fins; first dorsal fin slightly larger than second (Fig. 2D). Teeth in both jaws exhibiting a pointed medial cusp strongly oblique towards the commissure of the mouth, medial cusp more developed in the medial series (Fig. 2A, B). An inner ridge of two to three smaller cusplets present on the medial teeth (Fig. 2B); one or two commissural cusplets may present on the outer ridge, 26 teeth in the upper jaw and 22 in the lower jaw. Body colour is brownish on the dorsal to blackish on the ridges of the fins, with reddish violet shades, ventral side of the head pale to whitish (Fig. 2C, D). Dermal denticles are whitish. Body covered by numerous, sparse and irregularly distributed dermal denticles (Fig. 2C, D), large, some fused into plates with one or two, even three cusps with 22 cm as diameter of the largest plate, margins not stellate but with slight furrows.

Status of the bramble shark in the seas of Turkey has always been a point of debate until early 2000s. Although, historical records by Ninni (1923) and Deveciyan (1926) pointed out that the species occurred in Turkey's waters, the lack of *E. brucus* in the fishing records during a period from early 1930s to early 2000s, the experts were trying to answer the question, whether the bramble shark is still present in the area. Furthermore, due to the fact that *E. brucus* was not confirmed in contemporary ichthyological surveys carried out in the Sea of Marmara (Kocataş *et al*., 1993; Meriç, 1995; Karakulak *et al*., 2000; Bayhan *et al*., 2006), researchers concluded that the bramble shark had probably disappeared in Marmaric, as well as in Turkey's waters (Kabasakal, 2002).

E. brucus has always been rare in the Mediterranean Sea. According to Hemida & Capapé (2002), who emphasized the rarity of the species in the Mediterranean Sea, the bramble shark should be probably considered as an extinct species in the eastern Mediterranean Sea. During the extensive survey on the deep sea chondrichthyans occurring in the Mediterranean Sea, Sion *et al*. (2004) did not record *E. brucus*, neither from Balearic nor from Ionian seas. In a recent survey on the deep sea ichthyofauna of the eastern Mediterranean Sea, Goren & Galil (2002) fail to record the *E. brucus* in the area, as well. According to Golani *et al*. (2006) and Serena (2005), *E. brucus* is very rare in the eastern Mediterranean. Therefore, recent records of *E. brucus* from Turkey's waters are significant evidences prooving the contemporary occurrence of this species in the eastern Mediterranean, as well.

According to De Maddalena & Zuffa (2003), the first individual of *E. brucus* in the Mediterranean Sea has been recorded off Nice (France) in 1798, while last recorded specimen was found in waters off Annaba coast (Algeria, western Mediterranean Sea) in 2 April 2000. Another individual has also been caught off Nice, but its date of capture not reported by the authors. Based on the data given by De Maddalena & Zuffa (2003), 24 historical and contemporary records of *E. brucus* from western and central Mediterranean Sea have been recorded over a period of 202 years, indicating the rarity of the species and sporadic nature of reports. With the addition of recent records (7) from the seas of Turkey, which constitues the 22.5 percent of the historical and contemporary records of the bramble shark from entire Mediterranean Sea, 31 individuals of *E. brucus* have been recorded from the entire region, and the record no. 7 of the present study is probably the most recently captured bramble shark, to date. All of the new observations of the present study came from field research, suggesting that such an increase in the number of records over this 11-year period is due to systematic data collection. Because of the hard efforts of systematic research, now, the bramble shark reoccurred in ichthyological lists of Turkey's waters, which are based on recent catch records (e.g. Keskin & Eryılmaz, 2010). The present results show that the paucity of the bramble sharks in the seas of Turkey can be attributed in part to be the cryptic life habits of this species. Contemporary records of the bramble shark in the seas of Turkey since 2002 are summarised in Table 1.

Today, bramble sharks are rarely caught by professional fishermen operating in the study area. They are taken only as bycatch, caught accidentally while fishing other commercial species. However, according to Deveciyan (1926), the bramble shark was caught in high numbers in Turkey's waters during the first quarter of the 20th century, indicating that species distribution overlapped with those of historical Turkey's fisheries. The absence of *E. brucus* in Turkey's fishery during the second half of the 20th century could simply be due to the fact that the stocks might have changed their depth distribution in response to fishing pressure, by shifting in deeper waters. Today, introduction of modern fishing equipments allows Turkey's fishermen to catch fish in deeper zones of the sea, once they could not reached. With the exception of record no. 1, which was sighted by means of an ROV in northern Sea of Marmara (Tab. 1) and record nos. 4 and 5, the remaining 4 bramble sharks (record nos. 2, 3, 6 and 7) have been caught by means of fishing gears deployed in deep water over continental slope. Because of this reason, this assumed depth shift of *E. brucus* stocks seems that it can not provide further protection to this rare shark in its deeper sanctuaries.

E. brucus is one of the 20 large predatory sharks in the Mediterranean Sea, where such large predators declined dramatically over the last two centuries (Ferretti *et al*.,

2008). Among 34 identified shark species from the seas of Turkey (Kabasakal, 2011), *E. brucus* is one of the least known species, due to its cryptic life histories. However, implementation of new research techniques such as remotely operated vehicles, offer us the possibility to study the bramble shark *in situ* without the risk of jeopardizing the survival of this rare species. Since 5 of the 7 recent records of *E. brucus* have been reported from the Sea of Marmara, special attention of research should be focused to this small inland sea to figure out whether this species has a localized population in this region or not?

ACKNOWLEDGEMENTS

We thank to the fishermen from Yalova and İzmir fishing ports, and Dr. Erhan Irmak for their help during the field work to obtain the bramble shark specimens. Special thank goes to wife and son of the first author for their endless love and support. Mr. Mark Taylor, professional diving instructor, photographer and English teacher, for editing. *In memoriam*: Umut Tural – a brilliant colleague and a close friend.

Tab. 1: Recent records of** E. brucus **from Turkey's waters in the period from 2002 to 2013. SM: Sea of Marmara, AE: Aegean Sea.
Tab. 1: Recentni zapisi o pojavljanju vrste** E. brucus **v turških morjih v obdobju med 2002 in 2013. SM: Marmarsko morje, AE: Egejsko morje

No.	Region	TL (cm)	W (kg)	Sex	Date of capture or sighting	Depth of capture or sighting (m)	Type of gear
1	SM	-	-	-	Oct 2002	1214	ROV
2	AE	230	-	-	13 May 2005	200-250	Bottom trawl
3	SM	170	45	♀	9 Dec 2005	600-700	Otter-trawl
4	SM	225	140	♀	20 Nov 2008	100	Gill-net
5	SM	250	175	♀	28 Dec 2009	150	Gill-net
6	SM	220	300	♀	19 May 2010	300	Gill-net
7	AE	200	140	♀	6 Jan 2013	350	Gill-net

STATUS BODIČASTEGA MORSKEGA PSA *ECHINORHINUS BRUCUS* (ELASMOBRANCHII: ECHINORHINIDAE) V TURŠKIH MORJIH: ŠE VEDNO PRISOTEN, ČEPRAV REDEK

Hakan KABASAKAL
Ichthyological Research Society, Tantavi Mahallesi, Menteşoğlu Caddesi, İdil Apt., No: 30, D: 4, Ümraniye, TR-34764 İstanbul, Turkey
E-mail: kabasakal.hakan@gmail.com

Murat BILECENOGLU
Adnan Menderes University, Faculty of Arts & Sciences, Department of Biology, 09010, Aydın, Turkey

POVZETEK

Status bodičastega morskega psa Echinorhinus brucus *(Bonnaterre,1788) v turških morjih je bil že od začetka novega tisočletja predmet razprave. S sedmimi novimi zapisi, ki predstavljajo 22,5 % vseh historičnih in sodobnih podatkov o pojavljanju te vrste v Sredozemskem morju, je skupno znanih 31 vseh zapisov za celo območje. Primer št. 3, ki ga predstavljamo v tem prispevku, je do danes najverjetneje najmlajši zapis o pojavljanju te vrste. Ker izvira 5 od 7 recentnih zapisov o bodičastem morskem psu iz Marmarskega morja, bi bilo treba temu majhnemu in zaprtemu morju z raziskovalnega vidika posvetiti posebno pozornost, da bi ugotovili, ali prebiva v tem morju izolirana populacija te vrste.*

Ključne besede: bodičasti morski pes, *Echinorhinus brucus*, Echinorhinidae, status, Turčija, Sredozemsko morje

REFERENCES

Akşiray, F. (1987): Türkiye Deniz Baliklari Ve Tayin Anahtari, 2nd Edition. Publications of Istanbul University, no. 3490, Istanbul, 811 pp.

Bayhan, Y. K., E. Çiçek, T. Ünlüer & M. Akkaya (2006): Catch and by-catch composition of the shrimp fishery by beam trawl in the southeastern Marmara Sea. EgeJFAS, 23, 277-283.

Compagno, L. J. V. (1984): FAO species catalogue. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. FAO Fish. Synop., FAO, Rome, vol. 125 (4/1), 1-249.

De Maddalena, A. & M. Zuffa (2003): A gravid female bramble shark, *Echinorhinus brucus* (Bonnaterre, 1788), caught off Elba Island (Italy, northern Tyrrhenian Sea). Annales, Ser. Hist. Nat., 13 (2), 167-172.

De Maddalena, A. & H. Baensch (2008): Squali del mare Mediterraneo. Class Editori, Milano, 240 pp.

Deveciyan, K. (1926): Pêche et Pécheries en Turquie. Imprimerie de l'Administration de la Dette Publique Ottomane, Istanbul, 480 pp.

Ferretti, F., R. A. Myers, F. Serena & H. K. Lotze (2008): Loss of large predatory sharks from the Mediterranean Sea. Conserv. Biol., 22, 952-964.

Golani, D., B. Öztürk & N. Başusta (2006): Fishes of the eastern Mediterranean. Turkish Marine Research Foundation, Istanbul, 260 pp.

Goren, M. & B. S. Galil (2002): Records of *Cataetyx laticeps* and *Ophidion barbatum* (Ophidiiformes) in the eastern Mediterranean, with comments on the deep sea ichthyofauna. Cybium, 26, 150-152.

Hemida, F. & C. Capapé (2002): Observations on a female bramble shark, *Echinorhinus brucus* (Bonnaterre, 1788) (Chondrichthyes: Echinorhinidae), caught off the Algerian coast (southern Mediterranean). Acta Adriat., 43, 103-108.

Kabasakal, H. (2002): Elasmobranch species of the seas of Turkey. Annales, Ser. Hist. Nat., 12 (1), 15-22.

Kabasakal, H. (2011): Türk sularında köpekbalıkları. 4 Deniz Yayınları, Istanbul, 128 pp. *(In Turkish)*

Kabasakal, H. & C. Dalyan (2011): Recent records of the bramble shark, *Echinorhinus brucus* (Chondrichthyes: Echinorhinidae), from the Sea of Marmara. Marine Biodiversity Records, 4 (e12), 1-4.

Kabasakal, H., M. İ. Öz, S. Ü. Karhan, Z. Çaylarbaşı & U. Tural (2005): Photographic evidence of the occurrence of bramble shark, *Echinorhinus brucus* (Bonnaterre, 1788) (Squaliformes: Echinorhinidae) from the Sea of Marmara. Annales, Ser. Hist. Nat., 15 (1), 51-56.

Karakulak, F. S., A. N. Tarkan & B. Öztürk (2000): Preliminary study on the demersal fish stocks in the northern Marmara Sea. In: Öztürk, B., M. Kadıoğlu & H. Öztürk (eds.): Marmara Denizi 2000 Sempozyumu Bildiriler Kitabı. 11-12 November 2000, Ataköy Marina, Istanbul, p. 500-512.

Keskin, Ç. & L. Eryilmaz (2010): Fish fauna of the Sea of Marmara and Demersal Fish Assemblages. Proceedings of The Symposium The Marmara Sea. 25-26 September 2010, Istanbul, Turkey, p. 289-311.

Lipej, L., A. De Maddalena & A. Soldo (2004): Sharks of the Adriatic Sea. Knjižnica Annales Majora, Koper, 253 pp.

Kocataş, A., T. Koray, M. Kaya & Ö. F. Kara (1993): Fisheries and Environment Studies in the Black Sea System. Part 3: A Review of the Fishery Resources and their Environment in the Sea of Marmara. Studies and Reviews, vol. 64. General Fisheries Council for the Mediterranean, FAO, Rome, p. 87-143.

McEachran, J. D. & S. Branstetter (1984): Squalidae. In: Whitehead, P. J. P., M.-L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese (eds.): Fishes of the North-eastern Atlantic and the Mediterranean. Vol. I. UNESCO, Paris, p. 128-147.

Meriç, N. (1995): A study on existence of some fishes on the continental slope of the Sea of Marmara. Turk. J. Zool., 19, 191-198.

Ninni, E. (1923): Primo contributo allo studio dei pesci e della pesca nelle acque dell'impero Ottomano. Missione Italiana per l'Esplorazione dei Mari di Levante. Premiate Officine Grafiche Carlo Ferrari, Venezia, 187 pp.

Serena, F. (2005): Field identification guide to the sharks and rays of the Mediterranean and Black Sea. FAO Species Identification Guide for Fishery Purposes. FAO, Rome, 97 pp.

Sion, L., A. Bozzano, G. D'Onghia, F. Capezzuto & M. Panza (2004): Chondrichthyes species in deep waters of the Mediterranean Sea. Sci. Mar., 68, 153-162.

Tortonese, E. (1956): Fauna d'Italia. Leptocardia, Ciclostomata, Selachii. Edizioni Calderini, Bologna, 334 pp.

Original scientific article
Received: 2014-07-31

UDK 597.315.1:591.9(262.16)

ADDITIONAL RECORDS OF A RARE ELASMOBRANCH SPECIES, SHARPNOSE SEVEN-GILL SHARK *HEPTRANCHIAS PERLO* (HEXANCHIDAE) OFF THE NORTHERN TUNISIAN COAST (CENTRAL MEDITERRANEAN)

Olfa EL KAMEL-MOUTALIBI, Néjia MNASRI-SIOUDI, Sihem RAFRAFI-NOUIRA & Moncef BOUMAÏZA
Laboratoire d'Hydrobiologie Littorale et Limnique, Université de Carthage, Faculté des Sciences, Zarzouna, 7021 Bizerte, Tunisia

Christian REYNAUD
Centre d'Ecologie Fonctionnelle et Evolutive – CNRS UMR 5175, 1919 route de Mende, 34293, Montpellier Cedex 5, France

Christian CAPAPÉ
Laboratoire d'Ichtyologie, case 104, Université Montpellier 2, Sciences et Techniques du Languedoc,
34095 Montpellier cedex 5, France
E-mail: capape@univ-montp2.fr

ABSTRACT

Four sharpnose seven-gill sharks Heptranchias perlo *were captured off the northern Tunisian coast between 2007 and 2014: two males, one juvenile and one adult, and two females, one juvenile and one adult*. H. perlo *is considered as a rare species, probably threatened but still present in the area. Additionally, the occurrence of a sustainable population in waters surrounding the Eskerkis Bank remains a suitable hypothesis which cannot be ruled out*.

Key words: Chondrichthyes, description, measurements, deep sea waters, threatened population

SEGNALAZIONI AGGIUNTIVE DI UNA SPECIE RARA DI ELASMOBRANCHI, LO SQUALO MANZO *HEPTRANCHIAS PERLO* (HEXANCHIDAE), AL LARGO DELLA COSTA TUNISINA SETTENTRIONALE (MEDITERRANEO CENTRALE)

SINTESI

Quattro esemplari di squalo manzo Heptranchias perlo *sono stati catturati al largo della costa tunisina settentrionale tra il 2007 e il 2014: due maschi, un adulto e un esemplare giovanile, e due femmine, un adulto e un esemplare giovanile*. H. perlo è *considerata una specie rara, probabilmente minacciata, ma ancora presente nell'area esaminata. Inoltre, la presenza di una popolazione sostenibile nelle acque che circondano Eskerkis, rimane una valida ipotesi che non può essere esclusa*.

Parole chiave: Condroitti, descrizione, misurazioni, acque marine profonde, popolazione minacciata

INTRODUCTION

Sharpnose seven-gill shark *Heptranchias perlo* (Bonnaterre, 1788) is known as a semi cosmopolitan species, occuring in temperate and warm temperate waters (Boeseman, 1984). The species is reported in the western Pacific from Japan to South Australia and New Zealand (Tanaka & Mizue, 1977; Compagno, 1984), and in the eastern Pacific, off northern Chile (Compagno, 1984). *H. perlo* is known in the western Atlantic from Carolina (USA), Caribbean Sea (Bigelow & Schroeder, 1948), Gulf of Mexico (Amorim *et al*., 1998), and southward to Brazil and Argentina (Compagno, 1984). The occurrence of *H. perlo* was reported also from the Great Meteor Seamount, in the central Atlantic by Frentzel-Beyme & Köster (2002) who locally noted the presence of a sustainable population. Off the eastern Atlantic, Wheeler (1969) considered as a suitable hypothesis the presence of *H. perlo* off the British Isles, which was further confirmed by records from the north of the Bay of Biscay (Quéro *et al*., 1988; Henderson & Williams, 2001). Southward, *H. perlo* is reported of Spain (Ortea & De La Hoz, 1979) and Portugal (Albuquerque, 1945-1956). South the Strait of Gibraltar, *H. perlo* is continuously reported from the coast of Morocco (Collignon & Aloncle, 1972; Lloris & Rucabado, 1998) to the South African coast (Bass *et al*., 1975; Compagno, 1984).

The occurrence of sharpnose seven-gill shark is well documented throughout the Mediterranean Sea (Capapé, 1980; Boeseman, 1984), it is also known in the Adriatic Sea (Lipej & Dulčić, 2010) and in the eastern Levant Basin (Golani, 2005). De Maddalena *et al*. (2002) recorded *H. perlo* in Sicilian waters (central Mediterranean), based on the capture of 7 specimens. Schembri *et al*. (2003) reported the species as rather frequent in Maltese waters. However, they noted that the local status of the species is difficult to assess, because some specimens sold in Maltese fish markets probably originated from other areas of the Sicilian Channel. Additionally, Maliet (*pers. comm.*) informed us that some specimens were regularly caught off Corsica by local fishermen. Although the species was considered as rare in Turkish waters, the species occurs in both northern and southern Aegean coast (Filiz & Mater, 2002; Öziç & Yilmaz, 2006; Kabasakal & Ince, 2008).

In the Tunisian waters, captures of *H. perlo* appear to be rather restricted in northern areas, such as the Eskerkis Bank, off Tabarka, city close to the Algerian border, and around Jalta Island (Quignard & Capapé, 1971; Capapé, 1980). Additionally, Bradaï (2000) reported the capture in the Gulf of Gabès of a free-swimming specimen having 390mm total length and weighing 138 g, on 4 February 1991, this finding constituting to date the southernmost extension range of *H. perlo* from the Tunisian coast. Investigations conducted since 2006 off the northern Tunisian coast, including the Lagoon of Bizerte allow us to provide some papers about species occurring in the area, concerning their distribution (El Kamel *et al*., 2009) and also some traits of their food and feeding habits (Mnasri *et al*., 2012; El Kamel-Moutalibi *et al*., 2013a) and their reproductive biology (El Kamel-Moutalibi *et al*., 2013b, Capapé *et al*., 2014).

In this paper, we report additional captures of *H. perlo*, off the northern Tunisian coast, and the distribution of the species in the area, and in the Mediterranean Sea is commented and discussed. These records allow us to complete and assess the real status of the elasmobranch species in the region, in order to prepare a national plan for elasmobranchs in the same region as well.

MATERIAL AND METHODS

Two specimens, a male and female were collected in the fish market of Zarzouna, city close to Bizerte on 1 April 2007 and 15 July 2008, respectively. However, a limited information was provided about the site of capture, which occurred off the northern coast of Tunisia.

Additionally, two other specimens were kindly given to us by a fisherman on 21 May 2014. Both specimens

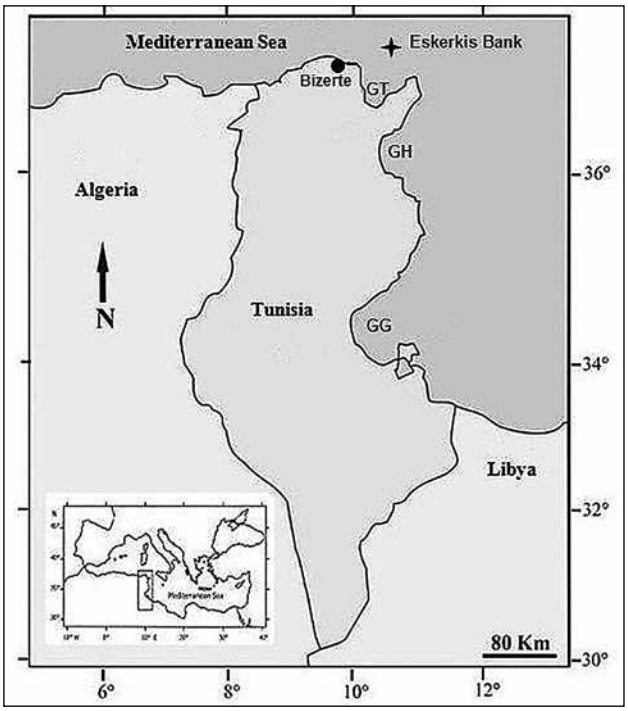


Fig. 1: Map of the Mediterranean showing Tunisia and map of the coast of Tunisia with black star pointing out the capture site of *Heptranchias perlo* ***in waters surrounding the Eskerkis Bank. GG: Gulf of Gabès, GH: Gulf of Hammamet, GT: Gulf of Tunis.***
Sl. 1: Zemljevid tunizijske obale v Sredozemskem morju, na katerem je označena lokaliteta v vodah, ki obkrožajo Eskerkis Bank, kjer so bili ujeti morski psi sedmeroškrgarji. GG: Gabèški zaliv, GH: Hammametski zaliv, GT: Tuniški zaliv

Tab. 1: Morphometric measurements in mm and as % total length (% TL), meristic counts and total body masses recorded in male and female *Heptranchias perlo* ***caught off the northern Tunisian coast.***
Tab. 1: Morfometrične meritve, izražene v mm in kot delež celotne dolžine (% TL), meristični podatki in celotna telesna masa samic in samcev morskih psov sedmeroškrgarjev, ujetih ob severni tunizijski obali

Reference	**FSB Hep-per.01**		**FSB Hep-per.02**	
Sex	**Male**		**Female**	
Morphometric measurements	**mm**	**% TL**	**mm**	**% TL**
Total length	700	100.00	790	100.00
Precaudal length	492	70.29	550	69.62
Fork length	554	79.14	610	77.22
Pre-first dorsal length	354	50.57	380	48.10
Prepectoral length	147	21.00	170	21.52
Head length	145	20.71	168	21.27
Prebranchial space	115	16.43	130	16.46
Preoral length	34	4.89	37	4.70
Pelvic fin length	85	12.17	72	9.11
Second dorsal-caudal length	96	13.67	93	11.77
Prepelvic length	285	40.71	320	40.51
Preanal length	388	55.43	425	53.80
Pelvic-anal length	55	7.90	47	5.95
Pelvic-caudal length	158	22.57	175	22.15
Anal-caudal length	62	8.84	76	9.62
Snout-vent length	315	45.00	340	43.04
Vent-caudal length	175	25.00	170	21.52
Prenasal length	16	2.34	22	2.78
Intergill length	7	1.00	10	1.24
Eye width	25	3.54	26	3.29
Eye height	13	1.87	15	1.90
Internasal length	22	3.17	22	2.73
Mouth width	53	7.56	63	7.97
First dorsal height	28	3.93	40	5.01
First dorsal base	44	6.27	52	6.58
First dorsal inner margin	13	1.83	15	1.85
First dorsal anterior margin	50	7.17	57	7.19
Pectoral height	66	9.36	80	10.13
Pectoral inner margin	36	5.17	38	4.85
Pectoral anterior margin	79	11.24	89	11.28
Caudal anterior margin	210	30.00	238	30.13
Caudal terminal lobe	34	4.91	40	5.06
Insertion dorsal -anal insertion	40	5.71	42	5.27
Trunk height	82	11.71	87	11.05
Caudal peduncle height	28	4.06	33	4.23
Clasper length	54	7.66	-	-
First gill slit length	55	7.79	55	7.01
Fifth gill slit length	23	3.26	24	3.09
Counts				
Teeth rows upper jaw	9+9		9+9	
Teeth rows lower jaw	5+1+5		5+1+5	
Total boby mass	1000		1280	

were caught by trawling off the Eskerkis Bank at depth between 150 and 300 m, on rocky bottoms, by 37° 45′ N and 10° 49′ 59.99″ E (Fig. 1). They were delivered at the laboratory where they were carefully studied. They were measured to the nearest millimetre and weighed to the nearest gram. Morphometric measurements, including percents of total length followed Capapé (1980) and Compagno (1984), and are presented in Table 1. Both specimens were preserved in 10 % buffered formalin and preserved in the Ichthyological Collection of the Faculté des Sciences of Bizerte (Tunisia), under the catalogue numbers FSB Hep-per.01 and FSB Hep-per.02, respectively (Fig. 2A, B).

RESULTS AND DISCUSSION

All specimens were identified following Capapé (1980), Boeseman (1984) and Compagno (1984), with

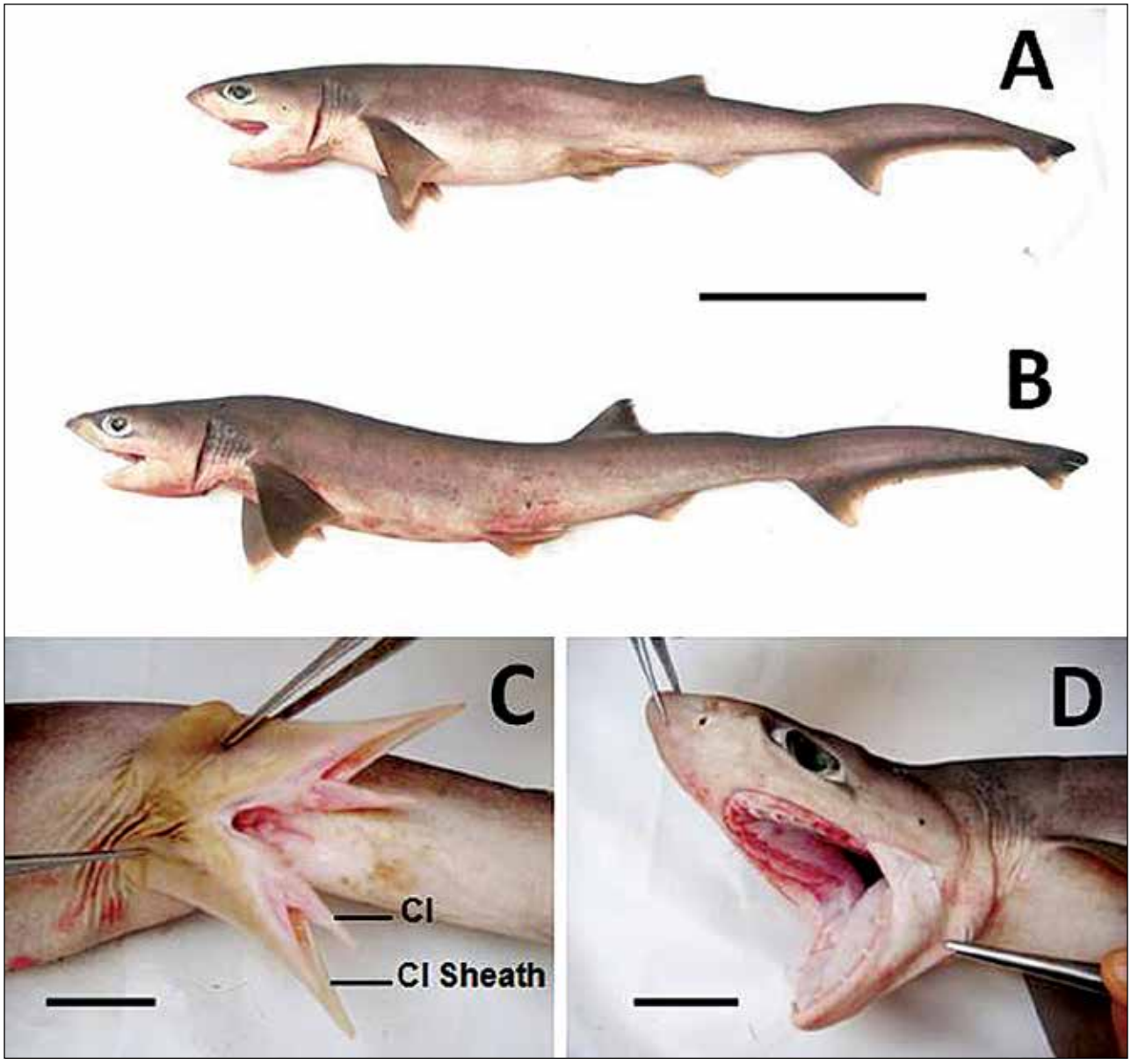


Fig. 2: *Heptranchias perlo*. ***(A) Male specimen (ref. FSB Hep-per.01); (B) female specimen (ref. FSB Hep-per.02), with scale bar = 200 mm for both specimens; (C) clasper (Cl) and clasper sheath (Cl Sheath), scale bar = 50 mm; (D) mouth opening, scale bar = 20 mm.***
Sl. 2: *Heptranchias perlo*. ***(A) Samec (ref. FSB Hep-per.01); (B) samica (ref. FSB Hep-per.02), merilo = 200 mm velja za oba primerka; (C) klasper (Cl) in klasperjeva guba (Cl Sheath), merilo = 50 mm; (D) razprta usta, merilo = 20 mm***

main characters as follows: body slender, with seven gill-slits broadly separated, narrow head, with long, pointed and conical snout, eyes very large, minute nostrils, a single dorsal fin with base before that of anal fin, caudal fin with moderate lower lobe, pectoral fins rather short and triangular, pelvic fins are displaying a sexual dimorphism, those are short and triangular, those of males exhibit an expansion which entirely surround the clasper as a sheath (Fig. 2C), however no viscous substance was secreted by the internal surface of the clasper. Teeth are different in shape on each jaw. Teeth of upper jaw, from the median region present a single cusp rather strong and oblique, while in the lateral region, teeth exhibited minute cusplets on both sides of the cusp. Teeth of lower jaws are large, comblike, with a large anterior cusp preceeded by a few smaller ones, and followed by 7 or 8 distal cusplets (Fig. 2D). Colour brown-grey, with small lighter spots, belly beige to whitish.

Captures remain very rare and during three decades and records were not reported in the area. Such pattern could be due to the fact that no survey focusing on elasmobranch species was conducted in the area between 1990 and 2006. *H. perlo* inhabits deep sea waters, on rocky bottoms, where it is not easy to catch them with usual fishing gears. Frentzel-Beyme & Koster (2002) noted the absence or underrepresentation among adult specimens caught from the great Meteor Seamount. They explained this absence with the fact that large specimens, agile and slender, could escape from the trawl. Similar patterns were reported by Garrick & Paul (1971) from New Zealand waters. The species is known for having a poor economical value, and small specimens are generally discarded at sea (Compagno, 1984). In the Tunisian waters, populations of *H. perlo* live in restricted areas, which could be considered as areas, they leave after attaining sexual maturity and becoming adults, as other elasmobranch species (Muñoz-Chapuli, 1984). Frentzel-Beyme & Köster (2002) reported that the smallest free-swimming specimen of *H. perlo* was a female of 390 mm TL, while Bigelow & Schroeder (1948) recorded a new-born caught in Japanese waters of 260 mm TL and Capapé (1980) noted that in Tunisian waters the size at birth occurred at 300 mm TL and the weight of approximately 60 g. Size at sexual maturity occurred between 950 and 1000 mm in females from the western Atlantic (Bigelow & Schroeder, 1948), and between 800 and 1050 mm in those from the Japanese waters (Tanaka & Mizue, 1977). Amorim et al. (1998) noted that off southern Brazil males and females reached maturity at 790 mm and 900 mm TL, respectively. De Maddalena et al. (2002) recorded a mature male in Sicilian waters of 850 mm TL. Kabasakal & Ince (2008) recorded an immature female of 850 mm TL, which weighed 1700 g. Conversely, Henderson & Williams (2001) that a female having 1010 mm TL was considered as juvenile, and noted that it was surprising that the specimen was totally immature. Intraspecific latitudinal differences could not be ruled out concerning size at sexual maturity between elasmobranch species (Mellinger, 1989). Additionally, it remains difficult to assess the size at sexual of maturity from a single specimen.

The specimens collected on 1 April 2007 and 15 July 2008 were a male and a female measuring 810 mm and 1100 mm TL, respectively and weighing 3000 g and 5000 g, respectively. Taking in account previous observations of Capapé (1980), both were adults. The two specimens caught on 21 May 2014 were juvenile. Additionally, the fact that no viscous substances were secreted by the internal surface of clasper sheath of the adult specimen enhances such statement (Tanaka et al., 1975; Capapé, 1980; Frentzel-Beyme & Köster, 2002).

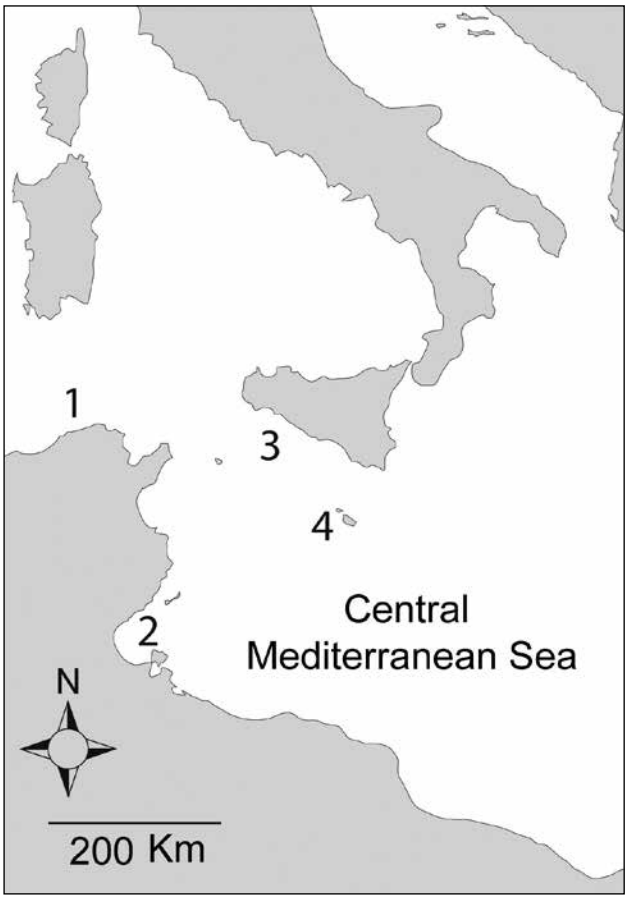


Fig. 3: Map of the central Mediterranean Sea pointing out the capture sites of** H. perlo**. 1: northern Tunisian coast (Capapé, 1980; this study); 2: Gulf of Gabès, southern Tunisia (Bradaï, 2000); 3: Sicily (De Maddalena** et al.**, 2002); 4: Malta (Schembri** et al.**, 2003).
Sl. 3: Zemljevid osrednjega Sredozemlja z označenimi lokalitetami, kjer so bili ulovljeni morski psi sedmeroškrgarji. 1: severna tunizijska obala (Capapé, 1980; pričujoča raziskava); 2: Gabèški zaliv, južna Tunizija (Bradaï, 2000); 3: Sicilija (De Maddalena** et al.**, 2002); 4: Malta (Schembri** et al.**, 2003)

These four records show that *H. perlo* still occurs off the northern Tunisian coast, despite a gap of several years. Such pattern is mainly due to the fact the elasmobranch species were not particularly focused in the area during this period, rather than a lack of captures. Although a decline of captures cannot be totally ruled out, such as in other Mediterranean regions (Paul & Fowler, 2003), however *H. perlo* is probably threatened off the Tunisian coast but not yet extinct since sustainable population, still occurs in restricted area, such as the Eskerkis Bank, and other regions located in the central Mediterranean (Fig. 3). It remains a suitable hypothesis due to the fact that the species inhabits restricted and deep areas, not usually submitted to an important fishing pressure and with a favourable biological environment. Additionally, *H. perlo* is an active and experienced feeder and its diet displayed a very large spectrum of ingested preys and, consequently the vacuity index exhibited low values whatever the area (Capapé, 1980; Frentzel-Beyme & Koster, 2002).

DODATNI ZAPISI O REDKEM MORSKEM PSU SEDMEROŠKRGARJU *HEPTRANCHIAS PERLO* (HEXANCHIDAE) IZ SEVERNIH TUNIZIJSKIH VODA (OSREDNJE SREDOZEMLJE)

Olfa EL KAMEL-MOUTALIBI, Néjia MNASRI-SIOUDI, Sihem RAFRAFI-NOUIRA & Moncef BOUMAÏZA
Laboratoire d'Hydrobiologie Littorale et Limnique, Université de Carthage, Faculté des Sciences, Zarzouna, 7021 Bizerte, Tunisia

Christian REYNAUD
Centre d'Ecologie Fonctionnelle et Evolutive – CNRS UMR 5175, 1919 route de Mende, 34293, Montpellier Cedex 5, France

Christian CAPAPÉ
Laboratoire d'Ichtyologie, case 104, Université Montpellier 2, Sciences et Techniques du Languedoc,
34095 Montpellier cedex 5, France
E-mail: capape@univ-montp2.fr

POVZETEK

Štirje primerki morskih psov sedmeroškrgarjev Heptranchias perlo *so bili ujeti ob obalah severne Tunizije v obdobju med letoma 2007 in 2014. Dva sta bila samca, eden mladostni primerek in eden odrasel, druga dva pa samici, od katerih je bila ena mladostni primerek, druga pa odrasla. Sedmeroškrgarja danes obravnavajo kot redko in verjetno ogroženo vrsto, ki pa je še vedno prisotna v danem okolju. Avtorji menijo, da hipoteze, da v vodah okoli Eskerkis še vedno domuje stabilna populacija sedmeroškrgarjev, ne gre kar tako ovreči.*

Ključne besede: Chondrichthyes, opis, meritve, globokomorsko okolje, ogrožena populacija

REFERENCES

Albuquerque, M. B. (1954-1956): Peixes de Portugal. Port. Act. Biol, 5, 1-1164.

Amorim, A. F., C. A. Arfelli & L. Fagundes (1998): Pelagic elasmobranchs caught by long liners off southern Brazil during 1974-97: an overview. Mar. Freshw. Res., 49, 621-632.

Bass, A. J., J. D. D'Aubrey & N. Kistnasamy(1975): Sharks of the east coast of southern Africa. V. The families Hexanchidae, Chlamydoselachidae, Heterodontidae, Pristiophoridae, and Squatinidae. S. Afr. Ass. Mar. Biol. Res., Oceanogr. Res. Inst., Invest. Rep., 43, 50 pp.

Boeseman, M. (1984): Hexanchidae. In: Whitehead, P. J. P., M. L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese (eds.): Fishes of the North-eastern Atlantic and the Mediterranean, Vol. 1. Unesco, Paris, p. 205-209.

Bigelow, H. B. & W. C. Schroeder (1948): Sharks. In: Tee-Van, J., C. M. Breder, S. F. Hildebrand, A. E. Parr & W. C. Schroeder (eds.): Fishes of the Western North Atlantic. Memoir Sears Foundation for Marine Research, Yale University, Vol. 2, 588 pp.

Bradaï, M. N. (2000): Diversité du peuplement ichtyque et contribution à la connaissance des sparidés du golfe de Gabès. Ph.D. Thesis. University of Sfax, Tunisia, 600 pp.

Capapé, C. (1980): Nouvelle description de *Heptranchias perlo* (Bonnaterre, 1788) (Pisces, Pleurotramata, Hexanchidae). Données sur la biologie de la reproduction et le régime alimentaire des spécimens des côtes tunisiennes. Bull. Off. Natl. Tunis., 4, 231-264.

Capapé, C., N. Mnasri-Sioudi, O. El Kamel-Moutalibi, M. Boumaïza, M. M. Ben Amor & C. Reynaud (2014): Production, maturity, reproductive cycle and fecundity of *Scyliorhinus canicula* (Chondrichthyes, Torpedinidae) from the Lagoon of Bizerte (northeastern Tunisia, central Mediterranean). J. Ichthyol., 54, 11-126.

Collignon, J. & H. Aloncle (1972): Catalogue raisonné des poissons des mers marocaines, I: Cyclostomes, Sélaciens, Holocéphales. Bull. Inst. Pêch. Maroc, 19, 1-164.

Compagno, L. J. V. (1984): FAO Species Catalogue, Sharks of the World. An annotated and illustrated catalogue of shark species known to date. *FAO Fish. Synop.,* FAO, Rome, vol. 125 (4/1) (non-carcharhinoids), p. 1-250.

De Maddalena, A., A. Celona, M. Zuffa & A. Vanadia (2002): Su alcune catture di notidiano cinereo, *Heptranchias perlo* (Bonnaterre, 1788), nelle acque della Sicilia. Thalassia Salentina, 26, 39-44.

El Kamel, O., N. Mnasri, J. Ben Souissi, M. Boumaïza, M. M. Ben Amor & C. Capapé (2009): Inventory of elasmobranch species caught in the Lagoon of Bizerte (north-eastern Tunisia, central Mediterranean). Panam JAS, 4, 383-412.

El Kamel-Moutalibi, O., N. Mnasri, M. Boumaïza, C. Reynaud & C. Capapé (2013a): Diet of common torpedo *Torpedo torpedo* (Chondrichthyes:Torpedinidae) from the Lagoon of Bizerte (northeastern Tunisia, central Mediterranean). Cah. Biol. Mar., 54, 209-220.

El Kamel-Moutalibi, O., N. Mnasri, M. Boumaïza, C. Reynaud, M. M. Ben Amor & C. Capapé (2013b): Maturity, reproductive cycle and fecundity of common torpedo, *Torpedo torpedo* (Chondrichthyes, Torpedinidae) from the Lagoon of Bizerte (northeastern Tunisia, central Mediterranean). J. Ichthyol., 59, 758-774.

Filiz, H. & S. Mater (2002): A preliminary study on length-weight relationships for seven elasmobranch species from north Aegean Sea, Turkey. E.U. J. Fish. Aquat. Sci., 19, 401-409.

Frentzel-Beyme, B. Z. & F. W. Köster (2002): On the biology of the sharpnose sevengill shark, *Heptranchias perlo*, from the Great Meteor Seamount (central eastern Atlantic). In: Vacchi, M., G. La Mesa, F. Serena & B. Séret (eds.): Proceedings of the 4th European Elsamobranch Association Meeting. Livorno (Italy), 2000, p. 77-96.

Garrick, J. A. F. & L .J. Paul (1971): *Heptranchias dakini* (Whitley, 1931), a synonym of *H. perlo* (Bonnaterre, 1788), the sharpnouted sevengill or perlon shark, with notes on sexual dimorphism in this species. Zool. Publ. Victoria Univ. Wellington, 54, 1-14.

Golani, D. (2005): Check-list of the Mediterranean Fishes of Israel. Zootaxa, 947, 1-200.

Henderson, A. C. & R. S. Williams (2001): A new record of the sharpnose seven-gill shark *Heptranchias perlo*, from the north-east Atlantic. J. Mar. Biol. Ass. U.K., 81, 707-708.

Kabasakal, H. & P. Ince (2008): Note on a sharpnose sevengill shark, *Heptranchias perlo* (Bonnaterre, 1788) (Chondrichthyes: Hexanchidae), stranded in Saroz Bay (NE Aegean Sea, Turkey). Annales, Ser. Hist. Nat., 18 (2), 173-176.

Lipej, L. & J. Dulčić (2010): Checklist of the Adriatic Sea fishes. Zootaxa, 2859, 1-92.

Lloris, D. & J. Rucabado (1998): Guide FAO d'identification des espèces pour les besoins de la pêche. Guide d'identification des ressources marines vivantes pour le Maroc. FAO, Rome, 263 pp.

Mellinger, J. (1989): Reproduction et développement des Chondrichthyens. Océanis, 15, 283-303.

Mnasri, N., O. El Kamel, M. Boumaïza, C. Reynaud & C. Capapé (2012): Food and feeding habits of the small-spotted catshark, *Scyliorhinus canicula* (Chondrichthyes: Scyliorhinidae) from the northern coast of Tunisia (central Mediterranean). Cah. Biol. Mar., 53, 139-150.

Muñoz-Chapuli, R. (1984): Ethologie de la reproduction chez quelques requins de l'Atlantique-Nord. Cybium, 8, 1-14.

Ortea, J. A. & M. M. De La Hoz (1979): Peces marinos de Asturias. Ayalga Editiones, Salinas, 230 pp.

Özіç, F. & F. Yılmaz (2006): An investigation of demersal fishes of Gökova Bay in Aegean Sea. Ekoloji, 15, 16-20.

Paul, S. & S. Fowler (2003): *Heptranchias perlo*. The UICN Red List of Threatened species. Version 2014.1. www.iucnredlist.org (21 July 2014)

Quéro, J.-C., M. H. Du Buit, J. Fonteneau & J. J. Vayne (1988): Observations ichtyologiques effectuées en 1987. Ann. Soc. Sci. Nat. Charente-Marit., 7, 721-725.

Quignard, J.-P. & C. Capapé (1971): Liste commentée des Sélaciens de Tunisie. Bull. Inst. Natl. Sci. Tech. Oceanogr. Peche. Salammbô, 2, 131-141.

Schembri, T., I. K. Fergusson & P. J. Schembri (2003): Revision of the records of shark and ray species from the Maltese Islands (Chordata: Chondrichthyes). The Central Mediterranean Naturalist, 4, 71-104.

Tanaka, S. & K. Mizue (1977): Studies on sharks XI. Reproduction in female *Heptranchias perlo*. Bull. Fac. Fish. Nagasaki Univ., 42, 1-9.

Tanaka, S., K. Teshima & K. Mizue (1975): Studies on sharks X. Morphological and ecological study on the reproductive organs in male *Heptranchias perlo*. Bull. Fac. Fish. Nagasaki Univ., 40, 15-22.

Wheeler, A. (1969): The fishes of the British Isles and North-West Europe. McMillan, London, 613 pp.

FLORA

FLORA

FLORA

Original scientific article
Received: 2014-10-01

UDK 582.27:581.9(262.32)

RECURRENCE OF *SARGASSUM VULGARE* C. AGARDH IN SLOVENIAN COASTAL WATERS (ADRIATIC SEA)

Martina ORLANDO-BONACA & Borut MAVRIČ
Marine Biology Station, National Institute of Biology, SI-6330 Piran, Fornače 41, Slovenia
E-mail: martina.orlando@mbss.org

ABSTRACT

Perennial species from the genus Sargassum *are considered to be indicators of high environmental quality and are therefore used in the assessment of the Ecological Status of Mediterranean coastal waters according to the European Water Framework Directive (WFD, 2000/60/EC). Over the past three decades a significant decline in* Sargassum *populations has been reported in the Gulf of Trieste, as well as in other Adriatic and Mediterranean areas. In Slovenian coastal waters the presence of* Sargassum *spp. had not been confirmed since 1980, after a severe decline due to overgrazing by the sea urchin* Paracentrotus lividus. *Recently, however, some thalli of* S. vulgare *were found in Piran Bay. The recurrence of this species is discussed in the paper, as well as the possible causes that led to the non-recovery in its populations in last decades in Slovenian coastal waters.*

Key words: *Sargassum vulgare*, new data, non-recovery of populations, Gulf of Trieste, Mediterranean Sea

RICOMPARSA DI *SARGASSUM VULGARE* C. AGARDH IN ACQUE COSTIERE SLOVENE (MARE ADRIATICO)

SINTESI

Specie perenni del genere Sargassum *sono considerate indicatrici di elevata qualità ambientale e vengono quindi utilizzate nella valutazione dello stato ecologico delle acque costiere del Mediterraneo secondo la Direttiva Europea Quadro sulle Acque (WFD 2000/60/CE). Nel corso degli ultimi tre decenni* è *stato più volte segnalato un rilevante calo nelle popolazioni di* Sargassum *nel Golfo di Trieste, così come in altre zone dell'Adriatico e del Mediterraneo. Nelle acque costiere slovene la presenza di specie del genere* Sargassum *non* è più *stata confermata dopo il 1980, a seguito di un forte calo dovuto all'eccessivo pascolo del riccio di mare* Paracentrotus lividus. *Recentemente, alcuni talli di* S. vulgare *sono stati trovati nella baia di Pirano. Nell'articolo viene discussa la ricomparsa di questa specie, così come le possibili cause che hanno portato al mancato recupero delle sue popolazioni negli ultimi decenni nelle acque costiere slovene.*

Parole chiave: *Sargassum vulgare*, nuovi dati, mancato recupero delle popolazioni, Golfo di Trieste, mare Mediterraneo

INTRODUCTION

Worldwide the genus *Sargassum* includes a large number of species, with a great morphological variability and extensive geographic and depth distribution (Špan, 2005). In contrast, in the Mediterranean Sea the genus *Sargassum* is represented by a relatively small number of taxa, since only six species were reported in the check-list of brown seaweeds (Ribera *et al*., 1992). Of those species, only three occur along the eastern Adriatic coast (Antolić *et al*., 2010): *S. acinarium* (Linnaeus) Setchell, *S. vulgare* C. Agardh, and *S. hornschuchii* C. Agardh. They were also reported for Slovenian coastal waters during the seventies of the last century (Avčin *et al*., 1973; Matjašič *et al.,* 1975; Vukovič, 1980). However, the macroalgal belt off the Slovenian coast experienced a severe decline due to overgrazing by the sea urchin *Paracentrotus lividus* (Lamarck, 1816) in the seventies (Vukovič, 1982; Turk & Vukovič, 1994). Virtually all infralittoral vegetation was consumed by this echinoderm, and it took decades for the flora to recover. Species from the genus *Cystoseira* recovered quite well, while *Sargassum* species didn't recover at all. Also Curiel *et al*. (2008) and Falace *et al*. (2010) reported a significant decrease in perennial species indicators of high environmental quality (like *Cystoseira* spp. and *Sargassum* spp.) over the past three decades for the Venice Lagoon and for the Italian part of the Gulf of Trieste, respectively; this was mainly a result of anthropogenic disturbances. Species from both genera have relatively large thalli compared to the average size of other Mediterranean seaweeds, and their canopies provide suitable habitats for a large number of other algal and animal species (Ballesteros *et al*., 1998; Orlando-Bonaca *et al*., 2008a; Pitacco *et al*., 2014). Those species are therefore used in the assessment of the Ecological Status of Mediterranean coastal waters according to the European Water Framework Directive (WFD, 2000/60/EC) (Ballesteros *et al*., 2007; Orfanidis *et al*., 2001, 2011). Moreover, species from the genera *Cystoseira* (except *Cystoseira compressa*) and *S. hornschuchii* are included in Annex II (List of endangered or threatened marine species in the Mediterranean) of the Barcelona Protocol concerning Specially Protected Areas and Biological Diversity (UNEP, Decision IG.21/6; entry into force: 30 March 2014).

From 2006 to date, species from the genus *Sargassum* were never found in any macroalgal samples regularly collected in Slovenian coastal waters twice per year. Benthic macroalgae were sampled in the upper infralittoral belt (depth range from 1 to 4 m) at 53 sites (Fig. 1) selected in order to assess the ecological status of macroalgal communities, as required by the WFD (Orlando-Bonaca et al., 2008b; Orlando-Bonaca & Lipej, 2009; *unpubl. data*). Additionally, macroalgae were surveyed from the water surface down to 10 m depth in order to characterize benthic macro- and micro- habitat types (Lipej *et al*., 2007, 2008). The sampling depth range of macroalgae was recently broadened to the lower infralittoral belt (from 4 to 8 m) to assess the environmental status of the sea, as required by the Marine Strategy Framework Directive (2008/56/EC) (Orlando-Bonaca *et al*., 2012a, 2012b).

Surprisingly, some thalli of *S. vulgare* were unexpectedly found in Piran Bay in 2012, during a scuba survey that was not part of any monitoring program, and the species became much more abundant in 2014. The aim of this paper is to provide data about the recurrence of this species, describe the collected thalli, and discuss the possible causes that led to the non-recovery in last decades of populations of *S. vulgare* in Slovenian coastal waters.

MATERIAL AND METHODS

The Slovenian coastal sea (that covers the southern part of the Gulf of Trieste) is a shallow semi-enclosed gulf with a maximum depth of ca. 33 m. Its diverse coastline is approximately 46.7 km long (Fig. 1). In recent decades the Slovenian natural shoreline has been modified by many human activities, like urbanisation, intensive hinterland farming and massive tourism. Nowadays, less than 18 % of the coastline is in its natural state (Turk, 1999). The coastal sea has also suffered from

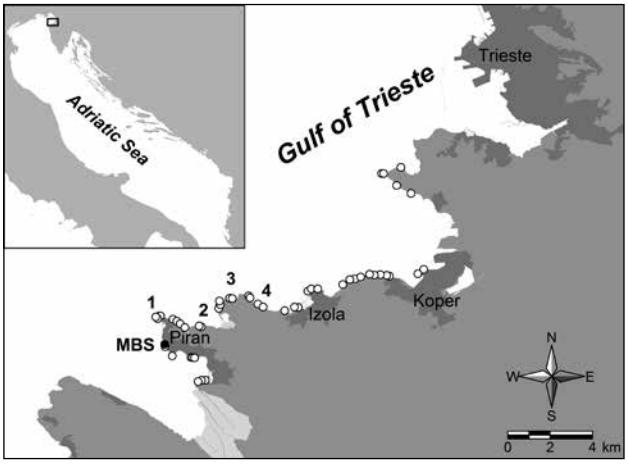


Fig. 1: Slovenian coastal waters and 53 sampling sites for macroalgae in the upper infralittoral belt (white dots) and the MBS site (black dot) where *Sargassum vulgare* ***was found. 1: Cape Madona Nature Monument, 2: Fiesa-Pacug area, 3: Strunjan Nature Reserve, 4: Bele Skale.***

Sl. 1: Slovenske obalne vode in 53 vzorčnih mest za makroalge v zgornjem infralitoralnem pasu (bele točke) ter mesto MBS (črna točka), kjer so bile najdene steljke vrste *Sargassum vulgare****. 1: Naravni spomenik Rt Madona, 2: območje Fiesa-Pacug, 3: Naravni rezervat Strunjan, 4: Bele Skale***

many anthropogenic impacts such as intensive fishing, sewage outfalls and mariculture (Francé & Mozetič, 2006; Mozetič *et al.,* 2008; Grego *et al.*, 2009).

In May 2012, during a scuba diving survey in Piran Bay (in front of the Marine Biology Station of the National Institute of Biology), some thalli of *S. vulgare* were found in the upper infralittoral rocky belt. In May 2014 it was observed that the species became much more abundant. The area covered by the species was photographed, its extension was measured and some samples were taken to the laboratory. Species identification was carried out in accordance with Špan (2005). It was planned to collect thalli of *S. vulgare* once per month in the summer period, for a complete morphological analysis. Samples were again collected in June 2014. Thalli were examined under a microscope in order to find any reproduction branches, with fertile cryptosomata (conceptacles) with reproductive organs (oogonia and antheridia). Unfortunately, during the scuba diving surveys in July and August 2014, only small flattened plates (holdfast, rhizoid), and caespitose stipes (central axis, caulioid) of *S. vulgare* were present, while erect branches and phylloclades (blades) were missing.

RESULTS AND DISCUSSION

In front of the Marine Biology Station in Piran (MBS in Fig. 1) thalli of *S. vulgare* were found growing among thalli of *Cystoseira compressa* (Esper) Gerloff & Nizamuddin (Fig. 2), in an area approximately 100 m × 5 m, in a depth range from 1.2 to 2.5 m. The alga was growing on sandstone boulders approx. half a meter wide and half a meter tall. Other abundant algal species were *Padina pavonica* (Linnaeus) Thivy and *Dictyota dichotoma* (Hudson) J. V. Lamouroux.

Specimens of *S. vulgare* were characterized by a high density of all parts of the thallus (secondary branches, phylloclades, and bladders (aerocysts)) (Fig. 3). None presented reproduction branches with conceptacles. The thalli were on average 20 cm in height. Two or three stipes were found growing from the holdfast of each thalli, the central of them having around 3 primary branches at the tip. Those branches had around 15 short secondary branches, with many phylloclades. Longer phylloclades (3-4 cm) were found in lower parts of primary branches, while shorter phylloclades (1-2 cm) were in the upper parts of thalli. Their edges were frequently wave-like. Aerocysts were numerous, egg-shaped and often had flattened elongation on the top.

According to Špan (2005), the most intensive development of annual thallus parts (branches and phylloclades) of *S. vulgare* takes place in winter and spring, so branches reach their maximum lengths approximately at the end of May. This means that thalli collected in Slovenian waters probably had reached their maximum development and height. In the central-southern Adriatic Sea, conceptacles of *S. vulgare* are known to be fully ripe in June and July (Špan, 2005). Since our samples from June 2014 did not present reproduction branches, we were planning to search for them in July and August 2014. Unfortunately, in both months large schools of *Sarpa salpa* (Linnaeus, 1758) were observed feeding on the vegetation cover in the sampled area and thalli of *S. vulgare* (and also *C. compressa*) were almost completely eaten. Usually in July thalli of *C. compressa* are still densely ramified, while the fall of older branches occurs at the end of summer/beginning of autumn (Fal-

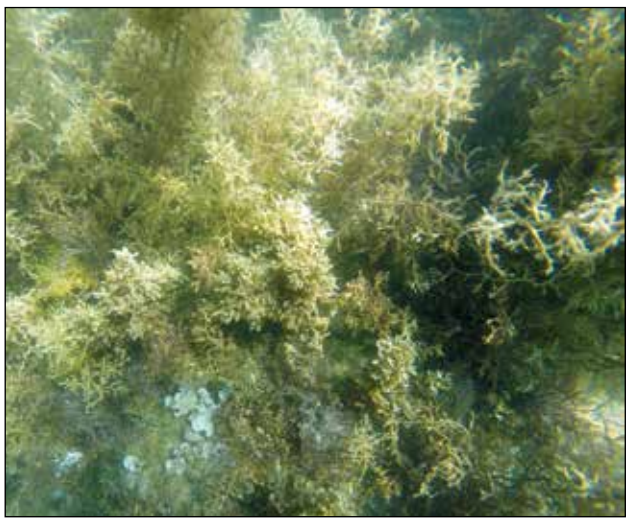


Fig. 2: Thalli of** S. vulgare **growing among thalli of** Cystoseira compressa**, in a depth range from 1.2 to 2.5 m.
Sl. 2: Steljke vrste** S. vulgare**, ki rastejo med steljkami vrste** Cystoseira compressa**, v globinskem razponu 1,2–2,5 m

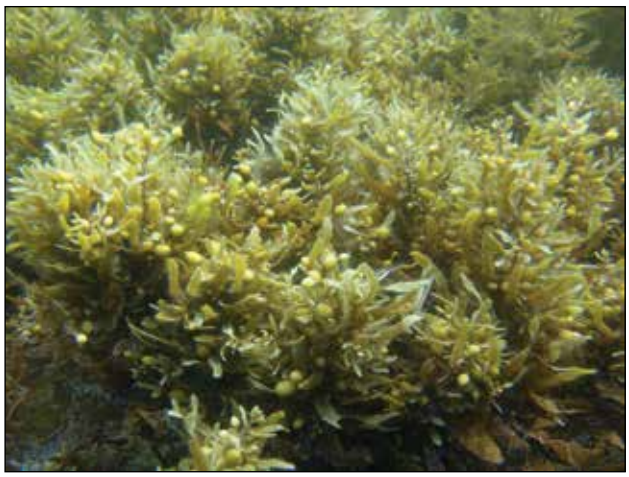


Fig. 3: Thalli of** S. vulgare **were characterized by a high density of secondary branches, phylloclades, and aerocysts.
Sl. 3: Steljke vrste** S. vulgare **z visoko gostoto sekundarnih vej, filoidov in plavalnih mehurjev (aerocist)

ace *et al*., 2005). The sparid *S. salpa* is well known for its herbivorous diet (Verlaque, 1990; Havelange *et al*., 1997; Tomec *et al*., 2000; Vergés *et al*., 2009; Steele *et al*., 2014). Moreover, Azzurro *et al*. (2007) analyzed gut contents of some herbivorous fish and reported that 27 taxa of benthic algae were identified in the stomach of *S. salpa*, with a predominance of *S. vulgare*.

Along the eastern Adriatic coast, *S. vulgare* was recorded from Strunjan (Avčin *et al*., 1973) to the Molunat Peninsula and to the outermost Adriatic islands (Špan, 2005). However, no data is available about the density of populations reported. After the overgrazing by *P. lividus* in the seventies, infralittoral vegetation in Slovenian coastal waters recovered and nowadays is rather homogenously classified into two *Cystoseiretum crinitae* subassociations: *Halopithetosum incurvae* and *Cystoseiretosum compressae*, and into *Cystoseiretum barbatae* association (Orlando-Bonaca *et al*., 2008b). Communities dominated by late-successional species of the genera *Cystoseira* are indicative of a quite pristine state, especially along the coastline from Bele Skale (near Izola, see Figure 1) to Piran, where the Ecological Status according to macroalgae was assessed as "high" (Orlando-Bonaca *et al*., 2008b). This coastal belt was previously defined as very important from the nature-conservation point of view (Turk, 1999), since it comprises also two MPAs (Cape Madona Nature Monument, Strunjan Nature Reserve) and some non-protected areas (like Fiesa and Pacug) with an exceptional richness of habitat types and fish assemblages (Orlando-Bonaca & Lipej, 2005; Orlando-Bonaca *et al*., 2008a). Therefore, at least along this part of the Slovenian coastal belt where *Cystoseira* species recovered very well, reasons for the non-recovery of *Sargassum* species in last decades remain quite unclear. Thibaut *el al*. (2005) reported the total collapse of the genus *Sargassum*, accompanied by a decline in the number of *Cystoseira* species off the north-western Mediterranean coast of France. Among causes leading to this decline they listed chemical pollution from agriculture, increased water turbidity, overgrazing by sea urchins and *S. salpa*, and habitat destruction (Thibaut *el al*., 2005). Those factors probably also played an important role in the non-recovery of the genus *Sargassum* in Slovenian coastal waters but, in our judgment, the disappearance of *S. vulgare* thalli in the early summer 2014 can be attributed primarily to overgrazing by schools of *S. salpa*. We assume that this fish consumed *S. vulgare* thalli before the start of fructification. However, since the vegetative period of this species extends year-round (Špan, 2005), further scuba surveys are planned in order to find and collect new thalli of this species. We intend to continue the study of *S. vulgare* morphology, its reproductive cycle and ecology in Slovenian coastal waters and possibly to clarify the causes that are leading to the non-recovery of *Sargassum* species.

ACKNOWLEDGEMENTS

The authors would like to thank Milijan Šiško and Valentina Pitacco for technical assistance.

PONOVNO POJAVLJANJE VRSTE *SARGASSUM VULGARE* C. AGARDH V SLOVENSKEM OBALNEM MORJU (JADRANSKO MORJE)

Martina ORLANDO-BONACA & Borut MAVRIČ
Morska biološka postaja, Nacionalni inštitut za biologijo, SI-6330 Piran, Fornače 41
E-mail: martina.orlando@mbss.org

POVZETEK

Trajnice iz rodu Sargassum *veljajo za indikatorske vrste visoke kakovosti okolja in se zato uporabljajo pri oceni ekološkega stanja sredozemskih obalnih voda v skladu z evropsko Okvirno vodno direktivo (WFD, 2000/60/ES). V zadnjih treh desetletjih so raziskovalci večkrat poročali o pomembnem upadu populacij teh vrst tako v Tržaškem zalivu kot tudi v drugih jadranskih in sredozemskih območjih. V slovenskih obalnih vodah prisotnost vrst iz rodu* Sargassum *ni bila več potrjena po letu 1980, po hudemu padcu zaradi prekomerne paše morskega ježka* Paracentrotus lividus. *V Piranskem zalivu so bile nedavno najdene steljke navadne sargaške alge (*S. vulgare*), ki so rasle med steljkami cistozir (*Cystoseira compressa*), v globinskem razponu med 1,2 in 2,0 m. Žal so bile na raziskanem območju v poletnih mesecih opažene salpe (*Sarpa salpa*) med pašo, ki so skoraj v celoti pojedle vse steljke omenjenih trajnic.* Članek obravnava ponovno najdbo *vrste* S. vulgare *kakor tudi možne vzroke, ki so privedli do neokrevanja njenih populacij v zadnjih desetletjih v slovenskih obalnih vodah.*

Ključne besede: *Sargassum vulgare, novi podatki, neokrevanje populacij, Tržaški zaliv, Sredozemsko morje*

REFERENCES

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.

Avčin, A., I. Keržan, L. Kubik, N. Meith-Avčin, 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.

Azzurro, E., E. Fanelli, E. Mostarda, M. Catra & F. Andaloro (2007): Resource partitioning among early colonizing *Siganus luridus* and native herbivorous fish in the Mediterranean: an integrated study based on gut-content analysis and stable isotope signatures. J. Mar. Biol. Assoc. U.K., 87, 991-998.

Ballesteros, E., E. Sala, J. Garrabou & M. Zabala (1998): Community structure and frond size distribution of a deep water stand of *Cystoseira spinosa* (Phaeophyta) in the North- western Mediterranean. Eur. J. Phycol., 33, 121-128.

Ballesteros, E., X. Torras, S. Pinedo, M. García, L. Mangialajo & M. de Torres (2007): A new methodology based on littoral community cartography dominated by macroalgae for the implementation of the European Water Framework Directive. Mar. Pollut. Bull., 55, 172-180.

Curiel, D., C. Miotti & M. Marzocchi (2008): Distribuzione quali-quantitativa delle macroalghe dei moli foranei della Laguna di Venezia. Boll. Mus. Civ. Stor. Nat. Venezia, 59, 3-18.

European Commission (EC) (2000): Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community actions in the field of water policy. Official Journal of the European Communities, 22.12.2000, L327, p. 1-73.

European Parliament Council (EPC) (2008): Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 Establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

Falace, A., E. Zanelli & G. Bressan (2005): Morphological and reproductive phenology of *Cystoseira compressa* (Esper) Gerloff & Nizamuddin (Fucales, Fucophyceae) in the Gulf of Trieste (North Adriatic Sea). Annales, Ser. Hist. Nat., 15 (1), 1-8.

Falace, A., G. Alongi, M. Cormaci, G. Furnari, D. Curiel, E. Cecere & A. Petrocelli (2010): Changes in the benthic algae along the Adriatic Sea in the last three decades. Chem. Ecol., 26 (suppl.), 77-90.

Francé, J. & P. Mozetič (2006): Ecological characterization of toxic phytoplankton species (*Dinophysis* spp., Dinophyceae) in Slovenian mariculture areas (Gulf of Trieste, Adriatic Sea) and the implications for monitoring. Mar. Pollut. Bull., 52, 1504-1516.

Grego, M., M. De Troch, J. Forte & A. Malej (2009): Main meiofauna taxa as an indicator for assessing the

spatial and seasonal impact of fish farming. Mar. Pollut. Bull., 58, 1178-1186.

Havelange, S., G. Lepoint, P. Dauby & J.-M. Bouquegneau (1997): Feeding of the Sparid Fish *Sarpa salpa* in a Seagrass Ecosystem: Diet and Carbon Flux. Mar. Ecol., 18, 289-297.

Lipej, L., Ž. Dobrajc, J. Forte, B. Mavrič, M. Orlando-Bonaca & M. Šiško (2007): Kartiranje habitatnih tipov in popis vrst na morskih zavarovanih območjih NS Debeli rtič, NR Strunjan in NS Rt Madona. Zaključno poročilo. Morska biološka postaja, NIB, Piran, št. 92, 56 str.

Lipej, L., Ž. Dobrajc, J. Forte, B. Mavrič, M. Orlando-Bonaca & M. Šiško (2008): Kartiranje habitatnih tipov in popis vrst izven zavarovanih območij. 2. fazno zaključno poročilo. Morska biološka postaja, NIB, Piran, 10 str.

Matjašič, J., J. Štirn, A. Avčin, L. Kubik, T. Valentinčič, F. Velkovrh & A. Vukovič (1975): Flora in favna severnega Jadrana, prispevek 1. Razprave SAZU, IV. razred, 75 str.

Mozetič, P., V. Malačič & V. Turk (2008): A case study of sewage discharge in the shallow coastal area of the Adriatic Sea (Gulf of Trieste). Mar. Ecol., 29, 483-494.

Orfanidis, S., P. Panayotidis & N. Stamatis (2001): Ecological evaluation of transitional and coastal waters: A marine benthic macrophytes-based model. Medit. Mar. Sci., 2, 45-65.

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. Medit. Mar. Sci., 12, 199-231.

Orlando-Bonaca, M. & L. Lipej (2005): Factors affecting habitat occupancy of fish assemblage in the Gulf of Trieste (Northern Adriatic Sea). Mar. Ecol., 26, 42-53.

Orlando-Bonaca, M. & L. Lipej (2009): Benthic macroalgae as bioindicators of the ecological status in the Gulf of Trieste. Varstvo narave, 22, 63-72.

Orlando-Bonaca, M., R. Turk, B. Ozebek & L. Lipej (2008a): Ovrednotenje asociacij s cistoziro v naravnem rezervatu Strunjan z uporabo ribje favne kot indikatorske skupine. Varstvo narave, 21, 61-72.

Orlando-Bonaca, M., L. Lipej & S. Orfanidis (2008b): Benthic macrophytes as a tool for delineating, monitoring and assessing ecological status: the case of Slovenian coastal waters. Mar. Pollut. Bull., 56, 666-676.

Orlando-Bonaca, M., L. Lipej, A. Malej, J. Francé, B. Čermelj, O. Bajt, N. Kovač, B. Mavrič, V. Turk, P. Mozetič, A. Ramšak, T. Kogovšek, M. Šiško, V. Flander Putrle, M. Grego, T. Tinta, B. Petelin, M. Vodopivec, M. Jeromel, U. Martinčič & V. Malačič (2012a): Začetna presoja stanja slovenskega morja. Poročilo za člen 8 Okvirne direktive o morski strategiji. Zaključno poročilo za leto 2012. Poročila MBP, št. 140. Morska biološka postaja, Nacionalni Inštitut za Biologijo, Piran, 345 str.

Orlando-Bonaca, M., L. Lipej, A. Malej, J. Francé, B. Čermelj, O. Bajt, N. Kovač, B. Mavrič, V. Turk, P. Mozetič, A. Ramšak, T. Kogovšek, M. Šiško, V. Flander Putrle, M. Grego, T. Tinta, B. Petelin, M. Vodopivec, M. Jeromel, U. Martinčič & V. Malačič (2012b): Določanje dobrega okoljskega stanja. Poročilo za člen 9 Okvirne direktive o morski strategiji. Zaključno poročilo za leto 2012. Poročila MBP, št. 141. Morska biološka postaja, Nacionalni Inštitut za Biologijo, Piran, 177 str.

Pitacco, V., M. Orlando-Bonaca, B. Mavrič, A. Popovič & L. Lipej (2014): Mollusc fauna associated with the *Cystoseira* algal associations in the Gulf of Trieste (Northern Adriatic Sea). Medit. Mar. Sci., 15, 225-238.

Ribera, M. A., A. Gómez-Garreta, T. Gallardo, M. Cormaci, G. Furnari, & G. Giaccone (1992): Check-list of Mediterranean Seaweeds. I. *Fucophyceae*. Bot. Mar., 35, 109-130.

Steele, L., K. M. Darnell, J. Cebrián & J. L. Sanchez-Lizaso (2014): *Sarpa salpa* herbivory on shallow reaches of *Posidonia oceanica* beds. Anim. Biodiversity Conserv., 37, 49-57.

Špan, A. (2005): The genus *Sargassum* in the Adriatic Sea: Morphology, systematics, and ecology. Acta Adriat., 46 (suppl. 1), 9-80.

Thibaut, T., S. Pinedo, X. Torras & E. Ballesteros (2005): Long-term decline of the populations of Fucales (*Cystoseira* spp. and *Sargassum* spp.) in the Alberes coast (France, North-western Mediterranean). Mar. Pollut. Bull., 50, 1472-1489.

Tomec, M., N. Glavić, Z. Teskeredžić & B. Skaramuca (2000): Feeding and nutritional values of the sparid fish *Sarpa salpa* L. in the southern Adriatic (Croatia). Period. Biol., 102, 309-312.

Turk, R. (1999): Ocena ranljivosti slovenskega obrežnega pasu in njegova kategorizacija z vidika (ne)dopustnih posegov, dejavnosti in rabe. Annales, Ser. Hist. Nat., 9 (1), 37-50.

Turk, R. & A. Vukovič (1994): Preliminarna inventarizacija in topografija flore in favne morskega dela Naravnega rezervata Strunjan. Annales, Ser. Hist. Nat., 4, 101-112.

UNEP (2014): Annex II (List of endangered or threatened marine species in the Mediterranean) of the Barcelona Protocol concerning Specially Protected Areas and Biological Diversity (Decision IG.21/6).

Vergés, A., T. Alcoverro & E. Ballesteros (2009): Role of fish herbivory in structuring the vertical distribution of canopy algae *Cystoseira* spp. in the Mediterranean Sea. Mar. Ecol. Prog. Ser., 375, 1-11.

Verlaque, M. (1990): Relations entre *Sarpa salpa* (Linnaeus, 1758) (Téléostéen, Sparide), les autres poissons brouteurs et le phytobentos algal méditerranéen. Oceanol. Acta, 13, 373-388.

Vukovič, A. (1980): Asociacije morskih bentoških alg v Piranskem zalivu. Biol. vestn., 28, 103-124.

Vukovič, A. (1982): Florofavnistične spremembe infralitorala po populacijski eksploziji *Paracentrotus lividus* (L.). Acta Adriat., 23, 237-241.

Short scientific article
Received: 13-08-14

UDK 582.263:581.96(262.3)

NEW RECORDS OF *CAULERPA CYLINDRACEA* SONDER (CAULERPALES, CHLOROPHYTA) IN ISTRIA, CROATIA

Barbara SLADONJA
Institute of Agriculture and Tourism Poreč, HR-52440 Poreč, Karla Huguesa 8, Croatia
E-mail: barbara@iptpo.hr

Vesna BANOVAC-KUČA
Primary School Poreč, HR-52440 Poreč, Karla Huguesa 7, Croatia

ABSTRACT

In this paper new records of the invasive green alga Caulerpa cylindracea *Sonder along the Istrian coast from Vrsar to Zambratija are presented. So far, the presence of this species in Istria has been limited to a few locations in the southern part of the peninsula, with the northernmost confirmed record in Vrsar. This new data points out the continuous spread of* C. cylindracea *populations northwards.*

Key words: *Caulerpa cylindracea* Sonder, non-indigenous alga, spread, northern Istria

NUOVE SEGNALAZIONI DELL'ALGA *CAULERPA CYLINDRACEA* SONDER (CAULERPALES, CHLOROPHYTA) IN ISTRIA, CROAZIA

SINTESI

L'articolo presenta nuove segnalazioni dell'alga verde invasiva Caulerpa cylindracea *Sonder lungo la costa istriana, da Orsera a Zambrattia. Fino ad ora la presenza della specie in Istria era limitata a poche località nell'area meridionale della penisola, con l'avvistamento più settentrionale confermato a Orsera. I dati presentati evidenziano la continua estensione dei popolamenti di* C. cylindracea *verso nord.*

Parole chiave: *Caulerpa cylindracea* Sonder, alga non indigena, estensione, Istria settentrionale

INTRODUCTION

Marine algal invasions can significantly affect benthos community structures around the world (Ribera & Boudouresque, 1995; Meinesz *et al*., 2001; Kružić *et al.,* 2008; Antolić *et al.,* 2008; Cebrian & Balesteros, 2009). On the basis of the criteria elaborated by Boudouresque & Verlaque (2002), *Caulerpa cylindracea* Sonder, a green alga widely distributed in warm temperate and tropical seas, is one of 10 introduced macrophyte species which can be considered as the most invasive marine species in the Mediterranean Sea (Klein & Verlaque, 2008).

C. cylindracea was observed in the Mediterranean Sea for the first time in 1991 in Libya (Žuljević *et al*., 2007). The first occurrence of the species in the Adriatic Sea dates from the year 2000 (Žuljević *et al*., 2003). Predominantly spread by currents, up to the end of 2006 there were more than 50 locations in the Adriatic Sea where the alga was recorded (Žuljević *et al.,* 2007). Several new investigations regarding the occurrence of *C. cylindracea* in the Adriatic Sea have been done recently. The potential impact of the species on sediments under the invasive alga was studied by Matijević *et al*. (2013), while its reproduction and the impact on other marine organisms by Antolić *et al*. (2008), Kružić *et al*. (2008) and Žuljević *et al*. (2008, 2011, 2012). So far, *C. cylindracea* has been recorded only in a few locations along the Istrian coast, at Cape Marlera in southern Istria and near Vrsar, representing the northernmost settlement of this species in the Mediterranean Sea (Iveša & Devescovi, 2006). Since these last records, the species has experienced an impressive speed of spreading northwards.

The aim of this paper is to give evidence of new records of the invasive species *C. cylindracea* along the North Adriatic coast.

MATERIAL AND METHODS

Study area and field methods

The present survey was conducted along the coastline from Vrsar to Zambratija, about 80 km in length. Data was collected during the summer periods of 2013 and 2014, by the use of snorkelling and professional SCUBA diving. During the summer of 2013 only sites around Poreč were examined, but the massive presence of *C. cylindracea* recorded (Fig. 1) motivated us to expand our research area during the next summer. Altogether, 12 sites from Vrsar to the Mirna River estuary were examined in 2013 and 6 more sites were examined in 2014 (Fig. 1).

Data were collected *in situ* by using the transect technique (Harmelin, 1987), a non-destructive visual census methodology. Vertical transects, 30 m in length, were laid out perpendicular to the coast, in a depth range from 0 to 15 m. At each sampling site two researchers employed at least two diving hours for each survey. All the sites were geo-referenced by GPS coordinates (Tab. 1). GPS points corresponded to the points on the sea shore where the transect began. The coverage of the alga was estimated along the transect, 10 m to the left and 10 m to the right of the line, and classified within three levels. Levels are expressed as: 1: low abundance described sporadic algal patches not wider than 4 m^2 of investigated algae; 2: medium for non-continuous presence along the transect but with patches larger than 4 m^2; 3: high for continuous algal covering all along the transect. On sites 3, 4, 5, 9 and 11, qualitative data about the extension of the area covered by the species was obtained over two consecutive years.

RESULTS AND DISCUSSION

Of the 18 examined sites, *C. cylindracea* was found in 14 of them (Fig. 2). The presence of the species was confirmed at all sampling stations in the Poreč area in 2013. Moreover, the repetition of surveys at the same sites in the second year revealed wider and thicker populations of the alga. Changes in algal cover are presented in Table 1. The northernmost record of *C. cylindracea* populations appears to be the Zambratija bay. This site was not surveyed during the first year, therefore the extension of the area covered by the species was not calculated, but in 2014 the coverage of the alga was estimated to be about 800 m^2 (sites 17 and 18).

The results of the present study confirm the presence of *C. cylindracea* in 14 new locations along the western Istrian coast. It can be stated that this non-indigenous species has quickly spread all along the coast from Vrsar to Zambratija. Since its introduction in the 1990s, the alga has extended throughout the whole Mediterranean Sea, usually forming dense and large populations with

Fig. 1: The carpet of the alien algae *Caulerpa cylindracea* ***Sonder.***
Sl. 1: Preproga iz alge *Caulerpa cylindracea* ***Sonder***

Tab. 1: Description of investigated sites and** C. cylindracea **coverage along vertical transects in 2013 and 2014. Coverage levels are expressed as: 1: low coverage, which describes sporadic algal patches not wider than 4 m²; 2: medium coverage for non-continuous algal presence along the transect with patches larger than 4 m²; 3: high coverage for continuous algal patches along the transect; n. r.: not recorded.
Tab. 1: Opis vzorčevalnih mest in številčnost vrste** C. cylindracea **vzdolž vertikalnih transektov v letih 2013 in 2014 Pokrovnost je izražena kot: 1: nizka – prevleke alge, manjše od 4 m²; 2: srednja – nepovezana navzočnost alge vzdolž transekta, ki obsega prevleke, večje od 4 m²; 3: velika – neprekinjene prevleke alge vzdolž transekta; n. r.: ni zabeleženo

Site	GPS coordinates		Site description	Bottom type	Coverage level 2013	Coverage level 2014
	Lat (N)	Long (E)				
1	45° 9′ 47″	13° 36′ 8″	exposed shore	rock, sand	n. r.	2
2	45° 11′ 46″	13° 34′ 53″	exposed shore	rock, sand	n. r.	1
3	45° 12′ 18″	13° 35′ 10″	exposed shore	rock, sand	2	3
4	45° 12′ 44″	13° 35′ 24″	sheltered bay	rock, sand	2	3
5	45° 12′ 56″	13° 35′ 39″	sheltered bay	seagrass bed	2	3
6	45° 13′ 59″	13° 35′ 54″	sheltered bay, muddy area	mud	n. r.	1
7	45° °14′ 9″	13° 35′ 44″	slightly exposed shore	rock, sand	n. r.	1
8	45° 14′ 49″	13°35′ 34″	exposed shore	rock	n. r.	1
9	45° 14′ 54″	13° 35′ 29″	slightly exposed shore	rock	n. r.	2
10	45° 15′ 56″	13° 34′ 43″	sheltered bay	mud, seagrass bed	2	3
11	45° 16′ 9″	13° 34′ 48″	sheltered bay	rock	2	3
12	45° 17′ 43″	13° 34′ 21″	exposed shore	rock	n. r.	1
13	45° 18′ 53″	13° 34′ 15″	sheltered bay, brackish water	sand, mud	n. r.	-
14	45° 22′ 57″	13° 32′ 12″	exposed shore	rock, sand	n. r.	-
15	45° 24′ 2″	13° 32′ 10″	sheltered bay	rock, sand	n. r.	-
16	45° 24′ 14″	13° 31′ 44″	slightly exposed shore	rock, sand	n. r.	-
17	45° 28′ 14″	13° 30′ 35″	sheltered bay	sand, rock	n. r	3
18	45° 28′ 33″	13° 30′ 16″	sheltered bay	seagrass bed	n. r.	2

an invasive behaviour (Panayotidis & Žuljević, 2001; Klein & Verlaque, 2008). During the present study *C. cylindracea* has been found on exposed shores as well as in sheltered bays, as previously found by Klein & Verlaque (2008). They also concluded that it tolerates high levels of pollution (Klein & Verlaque, 2008). During our surveys, in fact, its occurrence was not affected by the proximity of fishing and recreational boating harbours. This result does not necessarily demonstrate an affinity of the species for polluted areas, but may be a consequence of the secondary dispersal mechanisms via tourist or fishing activities (Klein & Verlaque, 2008). Regarding the impact of this invasive alga on native habitats Piazzi *et al.* (2001) observed that it causes an anoxic layer under thick algal layers. Moreover, the same authors showed modifications caused by *C. cylindracea* invasion on the structure of the benthic macro algal community. The species is capable of reproducing sexually and vegetatively (Klein & Verlaque, 2008) and it is considered a strong competitor species in moderate areas (Blažina *et al.*, 2009). Its prolific development can be explained in part by the effective vegetative propagation mechanisms in addition to sexual reproduction. So far, management strategies have been concentrated on manual and chemical control of the spread of the alga. For the Adriatic Sea Žuljević *et al.* (2007) reported the successful eradication of the species in areas with small colonies. The need for researches about biological control mechanisms was underlined (Žuljević *et al.*, 2007; Klein & Verlaque, 2008).

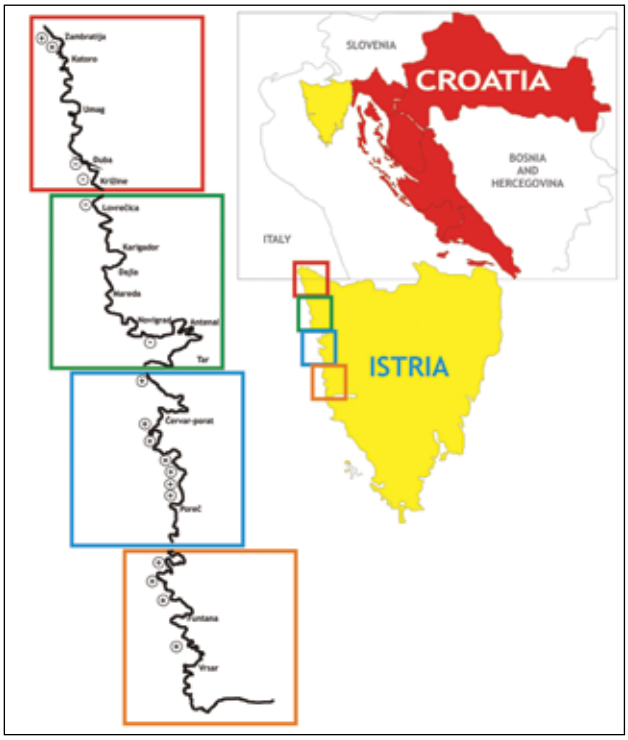


Fig. 2: Sampling sites and distribution of *C. cylindracea* ***along the western Istrian coast from Vrsar to Zambratija.***
Sl. 2: Vzorčevalna mesta in razširjenost vrste *C. cylindracea* ***vzdolž zahodne istrske obale med Vrsarjem in Zambratijo***

Further studies and monitoring are needed in order to ascertain other *C. cylindracea* locations, follow its spread in the Adriatic Sea and to establish successful prevention and perhaps eradication programmes. As this invasive species spreads steadily to almost all of the Mediterranean Sea (Cebrian & Ballesteros, 2009), it is possible that it will be soon present in the whole northern Adriatic Sea. Common efforts between Croatia, Slovenia and Italy are needed in order to complete the dataset about *C. cylindracea* spreading and to establish an effective monitoring system.

ACKNOWLEDGMENTS

The authors wish to thank friends and colleagues who provided us with field data: Miloš Trifunac from Ronilački klub Poreč (Brulo), Marko Martinčić, Marta Sušek, Diego Makovac, Dejan Gabrič and Mateo Popic. Special thanks to Nina, Ivan and Kina Sladonja for devoted field work in data collection during the summers of 2013 and 2014.

The authors wish to thank an anonymous referee for the critical and constructive approach and useful comments on the manuscript.

NOVI ZAPISI O POJAVLJANJU ALGE *CAULERPA CYLINDRACEA* SONDER (CAULERPALES, CHLOROPHYTA) OB ISTRSKI OBALI (HRVAŠKA)

Barbara SLADONJA
Institut za poljoprivredu i turizam Poreč, HR-52440 Poreč, Karla Huguesa 8, Hrvatska
E-mail: barbara@iptpo.hr

Vesna BANOVAC-KUČA
OŠ Poreč, HR-52440 Poreč, Karla Huguesa 7, Hrvatska

POVZETEK

V zadnjih letih je postalo širjenje invazivnih vrst v morskem okolju zelo zaskrbljujoče. Caulerpa cylindracea *Sonder je invazivna vrsta zelene alge, ki se razširja v Sredozemskem morju. Prvič so jo zabeležili leta 1991, v Jadranskem morju pa leta 2000. Doslej je bila navzočnost te vrste omejena na nekaj lokalitet v južnem predelu istrskega polotoka z najsevernejšo znano lokaliteto Vrsar. V tem prispevku smo želeli podati nove podatke o pojavljanju te vrste na območju od Vrsarja do Zambratije. Od 18 preiskanih lokalitet je bila na 14 potrjena navzočnost vrste* C. cylindracea. *Spričo razširjanja te vrste proti severu je smiselno pripraviti spremljanje stanja vrste na Hrvaškem, v Sloveniji in Italiji z namenom načrtovanja programov učinkovitega monitoringa, uspešnega preprečevanja in morebitnega odstranjevanja te vrste.*

Ključne besede: *Caulerpa cylindracea* Sonder, tujerodna alga, razširjanje, severna Istra

REFERENCES

Antolić, B., A. Žuljević, M. Despalatović, I. Grubelić & I. Cvitković (2008): Impact of the invasive green alga *Caulerpa racemosa* var. *cylindracea* on the epiphytic macroalgal assemblage of Posidonia oceanica seagrass rhizomes in the Adriatic Sea. Nova Hedwigia, 86, 155-167.

Blažina, M., Lj. Iveša & M. Najdek (2009): *Caulerpa recemosa*: adaptive varieties studied by fatty acid composition (Northern Adriatic Sea, Vrsar, Croatia). Eur. J. Phycol., 44, 183-189.

Boudouresque, C.-F. & M. Verllaque (2002): Biological pollution in the Mediterranean Sea invasive versus introduced macrophytes. Mar. Pollut. Bull., 44, 32-38.

Cebrian, E. & E. Ballesteros (2009): Temporal and spatial variability in shallow and deep-water populations of the invasive *Caulerpa racemosa* var. *cylindracea* in the Western Mediterranean. Est. Coast. Shelf Sci., 83, 469-474.

Harmelin, J. G. (1987): Structure et variabilité de l'ichtyofaune d'une zone rocheuse protégée en Méditeranée (Parc national de Port-Croos, France). P.S.Z.N.I. Mar. Ecol., 8, 263-284.

Iveša, Lj. & M. Devescovi (2006): Seasonal vegetation patterns of the introduced *Caulerpa racemosa* (Caulerpales, Chlorophyta) in the northern Adriatic Sea (Vrsar, Croatia). Period. Biol., 108, 111-116.

Klein, J. & M. Verlaque (2008): The *Caulerpa racemosa* invasion: A critical review. Mar. Pollut. Bull., 56, 205-225.

Kružić, P., A. Žuljević & V. Nikolić (2008): The highly invasive alga *Caulerpa racemosa* var. *cylindracea* poses a new threat to the banks of the coral *Cladocora caespitosa* in the Adriatic Sea. Coral Reefs, 27, 441-444.

Matijević, S., D. Bogner, N. Bojanić, A. Žuljević, M. Despalatović, B. Antolić, V. Nikolić & J. Bilić (2013): Biogeochemical characteristics of sediments under the canopy of invasive alga *Caulerpa racemosa* var. *cylindracea* (Pelješac Peninsula, Adriatic Sea). Fresenius Environ. Bull., 22, 3030-3040.

Meinesz, A., T. Belsher, T. Thibaut, B. Antolic, K. Ben Mustapha, C.-F. Boudouresque, D. Chiaverini, F. Cinelli, J.-M. Cottalorda, A. Djellouli, A. El Abed, C. Orestano, A. M. Grau, Lj. Ivesa, A. Jaklin, H. Langar, E. Massuti-Pascual, A. Peirano, L. Tunesi, J. de Vaugelas, N. Zavodnik & A. Zuljevic (2001): The introduced green alga *Caulerpa taxifolia* continues to spread in the Mediterranean. Biol. Invasions, 3, 201-210.

Panayotidis, P. & A. Žuljević (2001): Sexual reproduction of the invasive green alga *Caulerpa racemosa* var. *occidentalis* in the Mediterranean Sea. Oceanol. Acta, 24, 199-203.

Piazzi, L., G. Ceccherelli & F. Cinelli (2001): Threat to macroalgal diversity: effects of the introduced green alga *Caulerpa racemosa* in the Mediterranean. Mar. Ecol. Prog. Ser., 210, 149-159.

Ribera, M. A. & C.-F. Boudouresque (1995): Introduced marine plants, with special reference to macroalgae: mechanisms and impact. In: Round, F. E. & D. J. Chapman (eds.): Progress in Phycological Research, 11, p. 187-268, Biopress Ltd., Bristol.

Žuljević, A., B. Antolić & V. Onofri (2003): First record of *C. racemosa* (Caulerpales: Chlorophyta) in the Adriatic Sea. J. Mar. Biol. Ass. U.K., 83, 711-712.

Žuljević, A., V. Nikolić, V. Onofri, P. Srsen, A. Tefan, P. Kružić, K. Fabrio, A. Obarčanin & M. Petrić (2007): Eradication of invasive alga *Caulerpa racemosa* var. *cylindracea* in national park Mljet (Croatia). Rapp. Comm. int. Mér Medit., 38, p. 649.

Žuljević, A., V. Nikolić, M. Despalatović & B. Antolić (2008): Experimental in situ feeding of the sea urchin *Paracentrotus lividus* with invasive algae *Caulerpa racemosa* var. *cylindracea* and *Caulerpa taxifolia* in the Adriatic Sea. Fresenius Environ. Bull., 17, 2098-2102.

Žuljević, A., T. Thibaut, M. Despalatović, J. M. Cottalorda, V. Nikolić, I. Cvitković & B. Antolić (2011): Invasive alga *Caulerpa racemosa* var. *cylindracea* makes a strong impact on the Mediterranean sponge *Sarcotragus spinosulus*. Biol. Invasions, 13, 2303-2308.

Žuljević, A., B. Antolić, V. Nikolić, M. Despalatović & I. Cvitković (2012): Absence of successful sexual reproduction of *Caulerpa racemosa* var. *cylindracea* in the Adriatic Sea. Phycologia, 51, 283-286.

FAVNA

FAUNA

FAUNA

Original scientific article
Received: 2014-09-15

UDK 594.35:591.9(262.32)

NEW RECORDS OF OPISTHOBRANCH GASTROPODS IN THE WATERS OFF SLOVENIA (GULF OF TRIESTE, NORTHERN ADRIATIC SEA)

Lovrenc LIPEJ & Borut MAVRIČ
Marine Biology Station Piran, National Institute of Biology, SI-6330 Piran, Fornače 41, Slovenia
E-mail: lipej@mbss.org

Jan SIMIČ
Mediteranum Piran – The Magical World of Shells, SI-6330 Piran, Tartinijev trg 15, Slovenia

Domen TRKOV
Biodiva – Conservation biologist society, SI-6000 Koper, Kettejeva 1, Slovenia

ABSTRACT

The paper deals with four opisthobranch molluscs, which were found in the Slovenian marine waters as new records. The pleurobranchomorph Pleurobranchea meckeli *was found on two occasions on muddy detritic bottom in the Gulf of Piran in June of 2013 and 2014. The nudibranch* Favorinus branchialis *was found in May and June 2014 on turf vegetation in a very shallow area off the pier in Koper harbour. Its spawn with white eggs was also found nearby. The second nudibranch* Facelina rubrovittata *was found in March 2010 crawling in the intertidal zone of the Nature reserve Strunjan. The third nudibranch* Dondice banyulensis *was found in waters of the Nature Monument Debeli rtič on sedimentary bottom. With the finding of these four species, the total number of opisthobranchs recorded to date in the Slovenian part of the Adriatic Sea increased to 75 species.*

Key words: opisthobranch fauna, Gulf of Trieste, Slovenia

NUOVE SEGNALAZIONI DI GASTEROPODI OPISTOBRANCHI NELLE ACQUE AL LARGO DELLA SLOVENIA (GOLFO DI TRIESTE, ADRIATICO SETTENTRIONALE)

SINTESI

L'articolo riporta il ritrovamento in acque marine slovene di quattro nuovi molluschi opistobranchi. La specie Pleurobranchea meckeli *(ordine Pleurobranchomorpha)* è *stata trovata in due occasioni su fondo detritico fangoso nella baia di Pirano, nel mese di giugno del 2013 e del 2014. Il nudibranco* Favorinus branchialis è *stato trovato in maggio e in giugno del 2014, sul basso tappeto di vegetazione chiamato turf, a poca profondità al largo del molo nel porto di Capodistria. Le uova bianche di questa specie sono state trovate nelle vicinanze. Il secondo nudibranco* Facelina rubrovittata è *stato trovato nel marzo 2010 nel piano mediolitorale della Riserva naturale di Strugnano. Il terzo nudibranco* Dondice banyulensis è stato trovato nelle acque del *Monumento naturale di Punta grossa, su fondo sedimentario. Con il ritrovamento di queste quattro specie, il numero totale di opistobranchi confermati fino ad oggi nella parte slovena del mare Adriatico è salito a 75 specie.*

Parole chiave: fauna di opistobranchi, Golfo di Trieste, Slovenia

INTRODUCTION

Although the Gulf of Trieste is considered to be a pioneer region in marine biological research, some rare, less known and even alien marine species have been discovered during recent decades. Research of sea slugs discovered in the area shows similar patterns. One of the main reasons is the fact that nowadays the number of SCUBA divers is continuously increasing and many of them are skilled underwater photographers as well.

However, the opisthobranch fauna of the Slovenian part of the Adriatic Sea did not attract particular scientific attention in the past in comparison with other Mediterranean areas. Only a few papers dealt with the opisthobranchs of the area. The very first paper was published by Graeffe (1903), who studied the mollusks in the Gulf of Trieste. However, the great majority of data mentioned are related to the harbour of Trieste and adjacent areas. In the Slovenian part of the Gulf of Trieste, the first data on opisthobranchs can be found in a catalogue on mollusks, published by De Min & Vio (1997). In a checklist of opisthobranchs in the Adriatic Sea, with particular reference to the Slovenian part, Turk (2000) presented the first data on this group in Slovenian waters. This checklist was complemented further by later works of Turk (2005a, b), Šamu (2007), Lipej *et al*. (2008, 2012), Desco (2008-2009) and Mavrič & Lipej (2012). Certain species, such as *Cumanotus beaumonti* (Turk, 2005a, b) and *Piseinotho-ecus sphaerifera* (Mavrič & Lipej, 2012) were previously found only in a few places in the Mediterranean and in other parts of the world's oceans.

In this paper we report on four new records of four opisthobranch species, which were found in the Slovenian marine waters.

MATERIAL AND METHODS

Opisthobranchs were collected using a hand net in different areas of the Slovenian coastal sea (Gulf of Trieste) during regular and occasional samplings (Fig. 1). The species identity of sea slugs has been assessed by the use of different identification keys such as Pruvot-Fol (1954), Barletta (1980), Schmekel & Portmann (1982) and Trainito (2005). Specialized internet web sites such as www.seaslugforum.net were helpful as well. The taxonomy and nomenclature are in accordance with the World Register of Marine Species - WoRMS (www.marinespecies.org). The specimens were photographed and measured alive and subsequently fixed in 70 % alcohol solution. The material is deposited in the collection of the Marine Biology Station (MBS) of the National Institute of Biology.

RESULTS AND DISCUSSION

Order Pleurobranchomorpha
Pleurobranchaeidae Pilsbry, 1896
***Pleurobranchaea* Leue, 1813**
***Pleurobranchea meckeli* (Blainville, 1825)**
Material:

6th June 2013, 2 specimens, 21 m depth, biocoenosis of detritic bottom, 1nm W of Piran, Gulf of Piran; 7th June 2014, 1 specimen, 20 m depth, biocoenosis of detritic

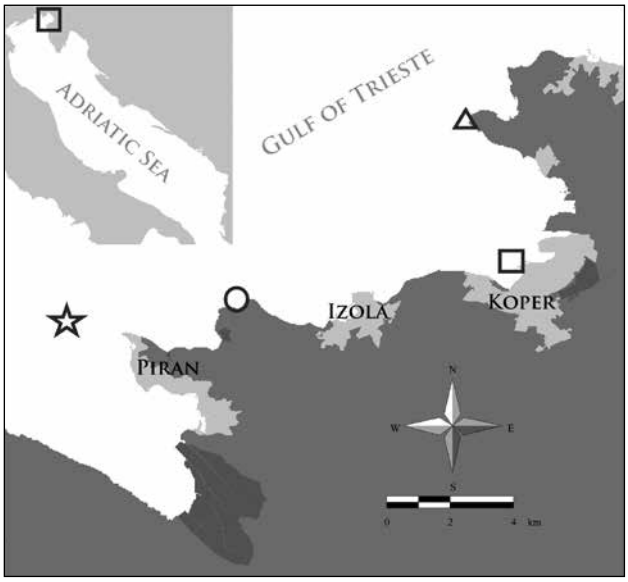


Fig. 1: Map of the studied area with localities where opisthobranchs were found.
Sl. 1: Zemljevid obravnavanega območja z lokalitetami, na katerih smo našli polže zaškrgarje
Legend / Legenda: ☆ *- Pleurobranchea meckelii,* ○ *- Facellina rubrovittata,* □ *- Favorinus branchialis,* Δ *- Dondice banyulensis*

Fig. 2: A specimen of** Pleurobranchea meckelii **caught in the Gulf of Piran by a dredge on the detritic coastal bottom in June 2014. (Photo: L. Lipej)
Sl. 2: Primerek vrste** Pleurobranchea meckelii**, ujet s pridneno mrežo na obrežnem detritnem dnu v juniju 2014 (Foto: L. Lipej)

bottom, 1nm NW of Piran, Gulf of Piran. The third specimen is housed in the collection of MBS.

Three specimens of *P. meckeli* (Fig. 2) were found within the material collected with a benthic dredge in June 2013 and 2014. The specimens were transferred into aquarium tanks; however they died some days later. This species was previously not recorded in waters off Slovenia. In the broader area, Graeffe (1903) mentioned this species in the checklist of sea slugs in the Gulf of Trieste. He pointed out that *P. meckeli* inhabits deeper areas of the Gulf and is often caught in fishermen's nets.

Order Nudibranchia
Family Facelinidae Bergh, 1889
***Favorinus* M. E. Gray, 1850**
***Favorinus branchialis* (Rathke, 1806)**
Material:

Koper harbour, 29th May 2014, 1 m depth, pier wall covered with turf, 1specimen; 30th May 2014, 1 m depth, turf, 2 specimens; 3rd June 2014, turf, 1 m depth, 2 specimens, stored in the collection of MBS.

Six specimens of *Favorinus branchialis* (Fig. 3) were found on three different sampling days in May and June 2014 in the commercial harbour of the coastal town of Koper. All specimens were found on a low algal vegetation belt (known as turf) at 1 m depth. Other sea slug species, such as *Elysia viridis,* were found grazing in the same area. On 29th May the eggs of *F. branchialis* were found as well. White eggs were located in a spiral-shaped band (Fig. 4).

The specimens were easily identified due to the bulbous swelling below the top of their rhinophores (Schmaeckel & Portmann, 1982). All specimens were more or less whitish with darker cerata. The colour also depends on feeding habits. *F. branchialis* was reported to feed on the eggs of other opisthobranchs (Schmekel & Portmann, 1982).

Graeffe (1903) mentioned this species as found in the Gulf of Trieste. Odhner (1914) and Vatova (1928) reported *F. branchialis* from the northern Adriatic area of Rovigno (in Thompson, 1985/1986), while recently Rinaldi (2012) mentioned this species in waters off Ravenna. Perrone (1983) found many *F. branchialis* specimens in the mediolitoral belt on or under rocks (which was also the case for our specimens) at San Vito in the Ionian Sea.

***Facelina* Alder & Hancock, 1855**
***Facelina rubrovittata* (Costa A., 1866)**
Material:

Single specimen, Mesečev zaliv, Nature reserve Strunjan, March 2010, < 1 m depth, bare rocks. Specimen was photographed and released.

A specimen of *F. rubrovittata* (Fig. 5) in shallow water in the intertidal zone on a rocky area. The specimen was an adult, since its rhinophora were lamellated. The studied specimen fits well with the description of Schmaeckel & Portmann (1982): large oral tentacles, cylindrical rhinophora with brown basal parts, five groups of pointed cerata on the flanks, the tail without cerata and broken reddish lines on the back.

According to Schmekel & Portmann (1982), *F. rubrovittata* feeds on colonial hydrozoan cnidarians of the genus *Eudendrium*. At the site where it was found the sandstone boulders are frequently covered with such hydroid colonies, which are grazed mainly by a nudibranch *Cratena peregrina*.

F. rubrovittata has been already recorded in the western Mediterranean, off the Atlantic coast of Spain

Fig. 3: A specimen of** Favorinus branchialis **found on turf in May 2014 in Koper harbour. (Photo: D. Trkov, L. Lipej)
Sl. 3: Primerek vrste** Favorinus branchialis**, najden na turfu v maju 2014 v koprskem pristanišču (Foto: D. Trkov, L. Lipej)

Fig. 4: Spawn of** Favorinus branchialis **found on turf at 1 m depth in the harbour of Koper. (Photo: B. Mavrič)
Sl. 4: Leglo vrste** Favorinus branchialis**, najdeno na turfu v maju 2014 v koprskem pristanišču (Foto: B. Mavrič)

Fig. 5: A specimen of** Facelina rubrovittata **found in the intertidal zone of Mesečev zaliv within the marine protected area of Strunjan. (Photo: N. Erbida)
Sl. 5: Primerek vrste** Facelina rubrovittata**, najden v bibavičnem pasu v Mesečevem zalivu znotraj Naravnega rezervata Strunjan (Foto: N. Erbida)

(Schmekel & Portmann, 1982; Rudman, 2000) and in the eastern part of the waters of southern Turkey (Yokes, 2001). Graeffe (1903) mentioned this species from the Gulf of Trieste under the name *Acanthopsole albida*. Recently a record from western part of Adriatic Sea was reported by Magnani (2006) for the Tremiti islands.

***Dondice* Marcus, 1958**
***Dondice banyulensis* Portmann & Sandmeier, 1960**
Material:
Single specimen, aquatory in front of the lighthouse, Nature Monument Debeli rtič, 9th September 2014, depth 10 m, sedimentary detritic bottom. Specimen is stored in the collection at MBS.

Fig. 6: A specimen of** Dondice banyulensis **on a polychaet** Spirographis spallanzani **on the bottom of the Debeli rtič Nature Monument on 9th September 2014. (Photo: B. Mavrič)
Sl. 6: Primerek vrste** Dondice banyulensis **na mnogoščetincu** Spirographis spallanzani **v Naravnem spomeniku Debeli rtič, fotografiran 9. septembra 2014 (Foto: B. Mavrič)

A single specimen of *D. banyulensis* was found in the eastern part of Slovenian coastal waters at the depth of 10 m. The 4 cm long specimen was crawling on the polychaet *Spirographis spallanzani* (Fig. 6) on the sedimentary detritic bottom made of the dead corallites of *Cladocora caespitosa*. The species was easily recognized due to its size, colour pattern, huge tentacles, lamellate rhinophora and three white lines, a median line and two lateral lines (see Portmann & Sandmeier, 1960; Schmekel & Portmann, 1982). Though this species is not supposed to be a rare or less known species, it was previously not reported in the Slovenian waters. Turk (2000) mentioned this species to be seasonally more frequent in the vicinity of submerged freshwater springs near Jurjevo in the northern Adriatic Sea (Croatia) with the comment that it is probably a rare species. However, there are some records of this species in the northern Adriatic reported in the www.seaslugforum.net.

Species richness of opisthobranchs in Slovenia

Taking into consideration the finding of the four studied species and *Piseinothecus sphaerifera,* recently recorded in the nearby area of the Koper harbour (Mavrič & Lipej, 2012), the total number of species recorded to date in Slovenia has grown to 75 species. Although the Slovenian coastal sea represents only a very small portion of the Adriatic Sea, we agree that the list of opisthobranchs will be expanded even more in the near future. Records of opisthobranchs are strongly related to three main factors: (i) their detectability, (ii) the availability of proper habitat type, in terms of feeding and grazing (*sensu* Lipej *et al.,* 2008) and (iii) the improvement of sampling techniques. The nudibranch *F. branchialis* was recorded on turf in a very shallow area in the rather polluted harbour of Koper. The inspection of turf vegetation and similar peculiar habitat types in areas of intense maritime traffic could be helpful in finding other opisthobranchs not yet recorded in the studied area, as well as non indigenous species, which are known to colonize impoverished ecosystems. In fact, the finding of the rare and less known *P. sphaerifera* occurred in a similar habitat type in the harbour of Koper (Mavrič & Lipej, 2012).

It has to be taken into consideration also the fact that Graeffe (1903) found many opisthobranchs in the broader area of the Gulf of Trieste, which have not yet been confirmed in the waters off Slovenia. The number of species inhabiting the Slovenian part of the Adriatic Sea would probably increase also with the solving of some taxonomical problems related to certain species found in the area but not yet identified.

ACKNOWLEDGMENTS

We would like to express our gratitude to our colleague Nina Erbida who provided us with photographs of the studied species. Special thanks go also to two anonymous reviewers for improving the quality of our paper.

NOVI ZAPISI O POJAVLJANJU POLŽEV ZAŠKRGARJEV (OPISTHOBRANCHIA) V VODAH SLOVENIJE (TRŽAŠKI ZALIV, SEVERNI JADRAN)

Lovrenc LIPEJ & Borut MAVRIČ
Morska biološka postaja, Nacionalni inštitut za biologijo, SI-6330 Piran, Fornače 41
E-mail: lipej@mbss.org

Jan SIMIČ
Mediteranum Piran, Čarobni svet školjk, SI-6330 Piran, Tartinijev trg 15

Domen TRKOV
Biodiva – Društvo varstvenih biologov, SI-6000 Koper, Kettejeva 1

POVZETEK

Prispevek obravnava podatke o štirih vrstah polžev zaškrgarjev (Opisthobranchia), ki so bili najdeni v slovenskem delu Jadranskega morja. V letih 2013 in 2014 smo našli nekaj primerkov vrste Pleurobranchea meckelii. *Gološkrgarja vrste* Favorinus branchialis *smo našli na nizki blazinasti vegetaciji v plitvem morju ob koprskemu pomolu v maju in juniju 2014. V bližini je bil tudi njegov mrest. O tej vrsti so znani zapisi iz okolice Rovinja in Ravenne. Drugega gološkrgarja vrste* Facelina rubrovittata *smo našli v Mesečevemu zalivu v naravnem rezervatu Strunjan marca 2010. Ta vrsta je bila doslej znana predvsem iz zahodnega dela Sredozemskega morja, v Jadranskem morju pa je znan le zapis z zahodne obale južnega Jadrana iz leta 2006. Tretjega gološkrgarja* Dondice banyulensis *smo odkrili na dnu naravnega spomenika Debeli rtič, kjer se je plazil po perjanici cevkastega mnogoščetinca* Spirographis spallanzani. *Z novimi najdbami se je število v slovenskem morju ugotovljenih vrst polžev zaškrgarjev povečalo na 75. Te najdbe potrjujejo hipotezo, da je vrstna pestrost slovenskega dela Jadranskega morja izjemno velika, hkrati pa se bo seznam novoodkritih polžev zaškrgarjev v prihodnosti nedvomno še dopolnjeval z novimi zapisi.*

Ključne besede: polži zaškrgarji, Tržaški zaliv, Slovenija

REFERENCES

Barletta, G. (1980): Guide per il riconoscimento delle specie animali delle acque lagunari e costiere italiane. 3. Gasteropodi nudi. C.N.R., AQ/1/92, Genova, 124 pp.

De Min, R. & E. Vio (1997): Molluschi conchiferi del litorale sloveno. Annales, Ser. Hist. Nat., 7 (1), 241-258.

Desco, K. (2008-2009): The ecology of Opisthobranch mollusks (Mollusca: Gastropoda) of the Gulf of Trieste (Northern Adriatic). M. Sc. Thesis. Joint Study, Universita' degli Studi di Trieste & University of Primorska, 106 pp.

Graeffe, E. (1903): Uebersicht der Fauna des Golfes von Triest nebst Notizen über Vorkommen, Lebensweise, Erscheinungs- und Laichzeit der einzelnen Arten. VI. Mollusca. Arbeiten aus den Zoologischen Instituten der Universität Wien und der Zoologischen Station in Triest, 14 Bd., p. 89-136.

Lipej, L., Ž. Dobrajc, B. Mavrič, S. Šamu **& S. Alajbegović (2008):** Opisthobranch molluscs (Mollusca: Gastropoda) from Slovenian coastal waters (Northern Adriatic). Annales, Ser. Hist. Nat., 18 (2), 213-226.

Lipej, L., S. Moškon & B. Mavrič (2012): New recordings of opisthobranch mollusks (Mollusca: Opisthobranchia) in the Slovenian portion of the Adriatic Sea. Annales, Ser. Hist. Nat., 22 (2), 133-136.

Magnani, C. (2006): Is this *Facelina rubrovittata*? [Message in] Sea Slug Forum. Australian Museum, Sydney. Available from http://www.seaslugforum.net/find/17536

Mavrič, B. & L. Lipej (2012): On the rare and less known nudibranch *Piseinotecus sphaeriferus* (Schmekel, 1965) (Gastropoda, Nudibranchia, Piseinotecidae) in the Adriatic Sea. Acta Adriat., 53, 473-476.

Odhner, N. H. J. (1914): Notizen uber die fauna der Adria bei Rovigno. Beitrage zur Kenntnis der marinen Molluskenfauna von Rovigno in Istrien. Zoologischer Anzeiger, 44, 156-170.

Perrone, A. (1983): Opisthobranchi (Aplysiomorpha, Pleurobranchiomorpha, Sacoglossa, Nudibranchia) del litorale salentino (Elenco – contributo primo). Thalassia Salentina, 12, 118-144.

Portmann, A. & E. Sandmeier (1960): *Dondice banyulensis*, sp. nov., un Eolidien nouveau de la Méditerranée. Rev. Suisse Zool., 67, 159-168.

Pruvot-Fol, A. (1954): Mollusques opisthobranches. Lechevalier, Paris, p. 1-457.

Rinaldi, A. (2012): Atlante della fauna e flora marina dell'Adriatico nord-occidentale. Editrice La Mandragora s.r.l, 639 pp.

Rudman, W. B. (2000): *Facelina rubrovittata* (A. Costa, 1866). [Message in] Sea Slug Forum. Australian Museum, Sydney. Available from www.seaslugforum.net/factsheet/facerubrovittata.

Schmekel, L. & A. Portmann (1982): Opisthobranchia des Mittelmeeres Nudibranchia und Saccoglossa. Berlin, Springer Verlag.

Šamu, S. (2007): The survey of opisthobranch molluscs in the Slovenian coastal sea. B. Sc. Thesis. University of Maribor, Maribor, 57 pp. (In Slovenian)

Thompson, T. E. (1985/1986): Annotated checklist of the benthic opisthobranch molluscs of the Adriatic Sea, with special reference to localities in the Rovinj area. Thalassia Jugoslavica, 21/22, 99-108.

Trainito, E. (2005): Nudibranchi del Mediterraneo: guida ai molluschi opistobranchi. Il Castello, 96 pp.

Turk, T. (2000): The Opistobranch mollusks (Cephalaspidea, Saccoglossa, Notaspidea, Anaspidea and Nudibranchia) of the Adriatic Sea with special reference to Slovenian coast. Annales, Ser. Hist. Nat., 10 (2), 161-172.

Turk, T. (2005a): *Cumanotus* from Slovenia [2]. [Message in] Sea Slug Forum. Australian Museum, Sydney. Available from www.seaslugforum.net/find.cfm?id=13517

Turk, T. (2005b): Unusual Sea Slug from Cape Madona (Piran, Slovenia) – the first record of *Cumanotus beaumonti* (Eliot, 1906) in the Mediterranean Sea. Annales for Istrian and Mediterranean Studies 15(1): 1-4.

Yokes, B. (2001): *Facelina rubrovittata?* from Turkey. [Message in] Sea Slug Forum. Australian Museum, Sydney. Available from www.seaslugforum.net/find/5677

Original scientific article
Received: 2014-10-06

UDK 594.1(262.32):591.134

THE STOCK STATUS OF *CALLISTA CHIONE* (LINNAEUS, 1758) EXPLOITED IN THE GULF OF TRIESTE

Cristina COGLIEVINA, Manuel DE MUNARI, Domenico CIORCIARO & Donatella DEL PIERO
Department of Life Sciences, University of Trieste, I-34127 Trieste, I-34127 Trieste, Via L. Giorgieri 10, Italy
E-mail: delpiero@units.it

ABSTRACT

The study investigated smooth clam Callista chione *(Linnaeus, 1758), collected in July 2010 at 23 sample sites in the Gulf of Trieste. From the results it was found that in some groups, an inverse correlation exists between length--at-age (estimated from the number of the tiny slowing growth translucent bands with a LED pointer) and sampling depth. The results confirmed observation from 1992 and 1993 surveys and the environmental features at different depths are still largely unknown. Unfortunately in 2013 and 2014 the clam beds were affected by a mass mortality that could compromise this fishery in the maritime District of Monfalcone, so a rapid growth assessment could be helpful for fishermen activity and management decision.*

Key words: *Callista chione,* Gulf of Trieste, length-at-age, population structure

STATO DELLO STOCK DI *CALLISTA CHIONE* (LINNAEUS, 1758) NEL GOLFO DI TRIESTE

SINTESI

Nella ricerca, condotta nell'ambito dei rapporti di collaborazione con il CO.GE.MO. di Monfalcone è stata analizzata la popolazione di Callista chione *(Linnaeus, 1758) campionata a mezzo di un'imbarcazione professionale a fine luglio 2010 in 23 stazioni del Golfo di Trieste. Dai risultati, è emerso che organismi della stessa età stimata dall'enumerazione delle sottili bande chiare visibili per trasparenza, hanno lunghezza minore a profondità maggiore. Tale fenomeno potrebbe essere dovuto alle caratteristiche ambientali, tuttora in massima parte ignote, alle diverse profondità. Nel 2013 e nel 2014 le aree di pesca sono state interessate da episodi di mortalità che potrebbero mettere a rischio l'attività almeno nel C.M. di Monfalcone per cui un sistema rapido di censimento demografico può risultare di estrema utilità anche per gli operatori della pesca.*

Parole chiave: *Callista chione,* Golfo di Trieste, età - lunghezza, struttura di popolazione

INTRODUCTION

Callista chione (Linnaeus, 1758) is an infaunal species that lives in the Atlantic and in the Mediterranean, generally on sandy substrates at depths ranging from 10 to 130 m (Poppe & Goto, 1993; Moura *et al*., 2008) up to 180 m (Ezgeta-Balić *et al*., 2011).

The species is exploited in Portugal (Gaspar *et al*., 2001, 2002; Moura *et al*.,2009), Spain (Tirado *et al*., 2002; Baeta *et al*., 2014), France (Charles *et al*., 1999) Croatia (Ezgeta-Balić *et al*., 2011), Greece (Metaxatos, 2004; Leontarakis & Richardson, 2005), and in Italy mainly in the Gulf Trieste (Valli *et al*., 1983-1984; Del Piero, 1994, 1997-1998) and in the Gulf of Venice (Marano *et al*., 1998).

In the Gulf of Trieste the fishery is mainly carried out in an area 3-6 nm from the coast with hydraulic dredges. According to the Ministry of Agriculture, Food and Forestry (Ministero delle Risorse Agricole, Alimentari e Forestali, 1994) the smooth clams live burrowed in the sediment and are found on sandy beds with 200-300 m in extension and 50-100 cm in height. They are less frequent on the pelitic substrate. The Monfalcone Consortium for molluscs management (CO.GE.MO.) restricted the fishery in his own district and assayed the restocking of the bivalve beds in 2007 aiming at the recovery of the smooth clams populations in the area. With this purpose 20 metric tons of clams (with no size selection) were moved from an area 20-22 m in depth to a shallower one 14-16 m in depth. In addition the exploitation of the beds where the experiment took place was restricted. This decision was partly supported by previous data (Rebec, 1997-1998; Braida, 2001-2002). These authors, counted the macro-growth bands in the shell (dark and

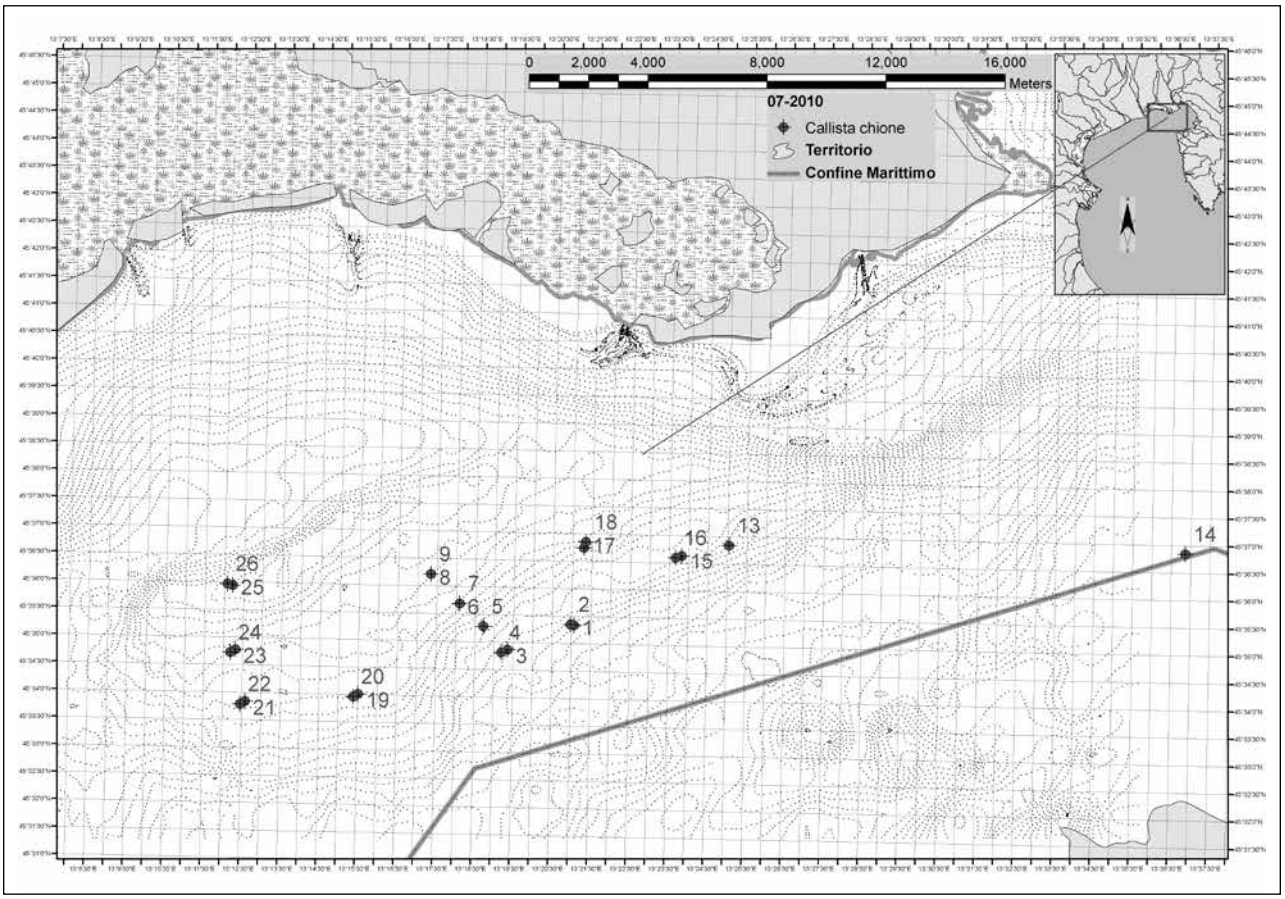


Fig. 1: Sampling stations, schematic outline (courtesy M. Burca, OGS). The detailed bathymetric map of the Gulf of Trieste was elaborated by the RIMA Dept. of the National Institute of Oceanography and Experimental Geophysics (OGS) (Dr. Diviacco and Dr. Burca) on the basis of a previous publication (Gordini** et al.**, 2003 with author's permission).

Sl. 1: Vzorčevalne postaje in shematski pregled (z dovoljenjem: M. Burca OGS). Natančni batimetrični zemljevid Tržaškega zaliva je bil izdelan v oddelku RIMA iz Nacionalnega inštituta za oceanografijo in eksperimentalno geofiziko (OGS) (dr. Diviacco in dr. Burca) na podlagi predhodne publikacije (z avtorjevim dovoljenjem Gordini** et al.**, 2003).

translucent, roughly one year), found a difference of three years among clams of the same length (45 mm) sampled at 16 and 22 m depth. Due to the results of Keller *et al*. (2002), showing that growth is faster till the clams reach the fourth year, it seemed a promising idea to transfer clams into a shallower area where the growth rate is supposed to be faster. All these results underlined the necessity of demography implementation in stock management of *C. chione*, being the minimum size only (25 mm, but fishermen select the clams from 40 mm onwards) an insufficient parameter for this long-living and still poorly known species. The objectives of the study are to underline the importance of demographic structure and growth rate as a support for the management strategies.

MATERIAL AND METHODS

The samples analysed in this study were collected in July 2010, onboard a commercial fishing boat equipped with a commercial dredge (bar space 25 mm). A total of 26 stations were sampled in the Monfalcone maritime District (Fig. 1). No clams were found on three stations (10, 11 and 12). Moreover, sample 25 was erroneously discarded after the first measurements and therefore no data is presented. The sampling sites were chosen in order to satisfy the management needs of the Consortium, by sampling both currently exploited areas and sites unfished for a long time. For each sample site the coordinates at the beginning and at the end of the haul were recorded by using the GPS receiver. Depth was obtained using the echo sounder on the vessel. The clams were weighed on board using a steelyard and were subsequently processed in the laboratory at the Department of Life Sciences, University of Trieste. Shell length was measured on a total of 1989 individuals with a digital calliper to the lowest mm. In addition, shell height and shell thickness of at least 30 randomly selected clams (786 individuals in total), were measured to the lowest mm with a digital calliper following Valli *et al*. (1983-1984, 1994).

The Kolmogorov-Smirnov D test was applied to the frequency distributions and 14 samples with significant difference in cumulative distribution distance are reported. On these 14 samples age-at-length estimates were done. The description of the shell structure can be found in Taylor *et al*. (1973). The estimated age was obtained counting the narrow bright bands on the left valve with a support of a LED pointer (Fig. 2). The tiny bright band is formed once a year (Rebec, 1997-1998; Braida 2001-2002) due to a lower growth rate, the latter being related to the local gonadal cycle (described by Valli *et al.*, 1983-1984) for the Gulf of Trieste area. For each subsample the individuals at 5th percentile, at the median value and at the 95th percentile were examined. In few dubious cases thin sections of the right valve (courtesy of Mr. L. Furlan, Prof. F. Princivalle and Prof. G. Fontolan, director of the Department of Mathematics and Geosciences of University of Trieste) were performed and then the growth rings were examined using a stereomicroscope. However not all dubious cases were resolved and therefore the individuals were excluded from the present analysis and stored for subsequent examination.

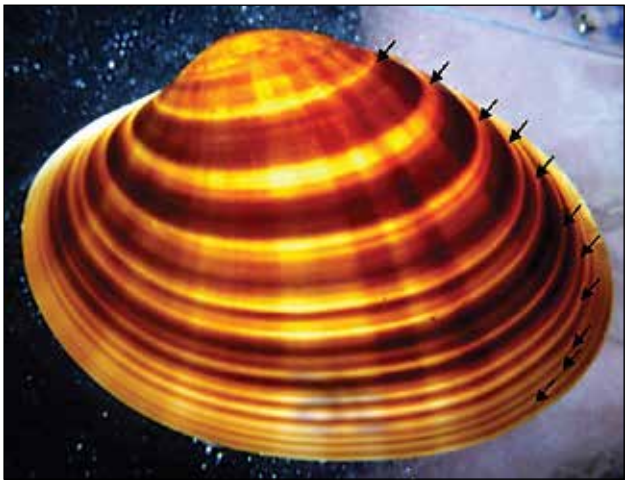


Fig. 2: Slow growth bright bands (marked by black arrows) and age estimate: length 6.4 cm, height 4.5 cm, thickness 2.7 cm. The clam is presumed to be 11 years old (credits C. Coglievina).
Sl. 2: Svetli trakovi, ki označujejo počasno rast (označeni s črnimi puščicami) in ocena starosti: dolžina 6,4 cm, višina 4,5 cm, debelina 2,7 cm. Starost školjke je ocenjena na 11 let (avtor C. Coglievina).

The Spearman's ρ test was performed to evaluate the relation between estimated length-at-age and station depth. The statistical analyses were performed using Statgraphics Centurion XVI.

RESULTS AND DISCUSSION

The results obtained from each station are summarized in Table 1. It can be observed that the lower density was found at station 13. In Table 3 are summarized the results for the 14 samples used for age analysis. The presence in the samples of specimen restocked in 2007 (st. 25 and 26) from a deeper to a shallower area showed a recovery in growth rate (Del Piero *et al*., 2010) suggesting to search for a rapid method for determining the age of the clams. The samples chosen were the ones showing significant differences in the Kolmogorov-Smirnov D test (Tab. 2) and were also different in the regression calculated between ln valve weight and ln dry weight (data not shown).

The data on distribution are important for management, as a proxy for testing the fishery area status and could help in management strategy and the differences in the regression slope among the variables reported

Tab.1: Survey results summary: only the sites where** C. chione **was found are reported.
***Tab. 1: Pregled dobljenih rezultatov z lokalitet, kjer je bila najdena školjka vrste** C. chione*

Station	Date	Depth (m)	Density (g/m²)	Abundance	Mean shell length ±SD (cm)	Median (cm)
1	26/07/10	18	28.4	99	5.56 ± 1.401	5.8
2		18/15	19.2	82	6.18 ± 0.93	6.25
3		18	9.3	68	6.28 ± 0.84	6.2
4		17	8	59	6.11 ± 0.663	6.2
5		17	18.5	108	6.28± 1.007	6.3
6		15	20.4	112	5.11 ± 1.489	5.2
7		15	4.2	72	5.07± 1.349	5.3
8		13	38.8	118	6.31 ± 0.804	6.3
9		13.5	49	120	5.43± 1.705	5.9
13	27/07/10	17.9	1.9	52	5.37± 1.383	5.7
14		17.5	2.5	19	5.58 ± 1.058	6
15		17	2.8	24	5.48±1.225	5.5
16		17.5	4.7	40	5.17± 1.468	5.65
17		15	16.6	117	5.45± 1.342	5.6
18		15.5	10.2	80	5.69±1.183	6.1
19	28/07/10	15.5	58.1	134	5.86±0.785	5.95
20		15	39.4	88	6.04± 0.746	6
21		15	164.2	94	6.20±0.756	6.2
22		15	127.5	102	5.87± 0.806	6
23		14	64.9	94	5.94±0.877	6
24		14.5	156.8	100	6.00±0.726	6.1
25*		12	68.8	104	5.84±1.042	5.9
26		11	157.1	103	5.83±0.866	5.9

* The sample 25 was erroneously discarded after the first measurements.

above, but not discussed here, may be also important for checking some population characteristics.

The age estimation was performed from the inner side of the left valve with a LED pointer from the umbo to the ventral margin: dark bands relatively large (fast-growing) and thin translucent (slow-growing; Taylor *et al*., 1973) become clearly visible. The periodicity of growth rate in this species and in this area was first reported in Hall *et al*. (1974). The observation was performed referring to past experiences, when massive growth ring counts and estimated age results were largely confirmed by isotopic analysis (Keller *et al*., 2002). In the umbo there are no particular problems discerning the two different bands, at the ventral margin it becomes more and more difficult. The ventral margin of the clams presented a tiny clear band. As the survey was done between 26 and 28 July, it can be assumed that the last translucent band represents the slowing or stopping of growth in 2010, probably due to reproduction cycle as observed by Rebec (1997-1998) and Braida (2001-2002). Similar pattern seems not to be uncommon since it was also found by Kelly & Cerrato (2007) in *Mercenaria mercenaria* in Narrangasett Bay (RI, USA).

In some special cases, bands of slow growth have been enumerated observing thin sections even if some patterns remain unresolved. Table 3 and Figure 3 show that similar lengths may correspond to different estimated age and in many cases less depth means higher length-at-year. The Spearman's ρ test was performed on clams assigned to the age-class 3 and 8 to explore if the supposed pattern was maintained among different cohorts in different years. The individuals younger than three and older than eight years were poor represented in the collected samples. The results showed the presence of an inverse correlation between length and depth. For the 3 years group (5 individuals) the ρ

Tab. 2: Results of the Kolmogorov-Smirnov D test. Dα - max difference obtained between two samples, D - max expected difference at p = 0.05.
Tab. 2: Rezultati Kolmogorov-Smirnovega D testa. Dα - maksimalna razlika med dvema vzorcema, D - maksimalna pričakovana razlika na nivoju p = 0,05

St	St	Dα	D
1	9	0.18439	0.17020
	13	0.23260	0.18434
	15	0.30900	0.22854
	24	0.19255	0.15263
5	16	0.25137	0.23981
6	9	0.17843	0.11726
	16	0.25016	0.24643
8	9	0.17607	0.11370
	18	0.19669	0.18665
13	19	0.22189	0.12859
	22	0.23141	0.17308
	23	0.23472	0.17676
	24	0.23219	0.23000
	25	0.23066	0.17308
14	16	0.37840	0.31711
	19	0.33293	0.21524
	22	0.33935	0.21465
	23	0.34161	0.25700
	24	0.33988	0.32211
16	19	0.30103	0.16791

was -1, n = 5, $p < 0.01$ and in the case of the group of 8 years (8 individuals) the ρ value was -0.729, n = 8, $p < 0.05$.

The hypothesis of difference in length-at-age due to the depth emerged previously (Del Piero, 1997-1998) as a result of the analysis of two surveys conducted in September 1992 and May 1993 when a rough relationship between exploitation strategies and the structure of the population studied was found. At the beginning of 90ies in order to increase the income, fishermen used to land smaller individuals because they were sold at a higher price. A warning was done about this practice that could drive, in the long run, to an imbalance in the age-classes structure with possible negative effect on recruitment due to a probable competition adults – recruits in the fishery areas at least, because at that time in unexploited clam beds (deeper than 20 m), no such effect was observed (Del Piero, 1997-1998).

The differences found in the distributions among samples could also be a consequence of a commercial strategy because often the fishermen are requested to land molluscs of size interval comprised between 4 cm and 6 cm regardless of the age. However, these results showed that difference might be primarily related to the depth, and this may be influenced by many causes all to be tested quite urgently. One of the reasons could be the exploitation carried out by fishermen usually on areas closer to the coast and at a shallower depth, causing a decrease in smooth clam density. Fishing closer to the coast is less expensive too, in terms of time and fuel spent and it could be the only chance to work in rough conditions at sea. It must be emphasized that there is a greater exploitation on the areas closer to the coast when sea conditions are unfavourable and it's possible to sell clams less valuable due to dark bands on the shell. These black bands are frequent on clams fished near rivers mouths and are due to presence of adsorbed FeS present in the upper layer of the shell as resulted through *elemental probe* X-ray microanalysis. The reddish colour of the shell is due to iron oxides in the external carbonate layer (Braida, 2001-2002; F. Princivalle, *pers. comm.*). The clams collected in those areas were in general larger (Del Piero, 1997-1998) probably due to the lower fishery pressure exerted.

Tab. 3 Samples from stations resulting significantly different in slope: three specimens randomly selected at 5th percentile (P 0.05), median and 95th percentile (P 0.95).
Tab. 3: Vzorci s postaj, ki so se značilno razlikovali v naklonu: trije naključno izbrani primerki na nivoju 5. percentila (P 0.05), mediane in 95. percentila (P 0.95)

Station	Depth (m)	Percentile	Length (cm)	Height (cm)	Thickness (cm)	Band no.
1	18	P 0.05	3.2	2.4	1.2	3
		median	5.8	4.6	2.8	8
		P 0.95	7.4	5.8	3.3	9
5	17	P 0.05	4.7	3.6	2.0	6
		median	6.4	4.5	2.7	11
		P 0.95	7.7	6.3	3.9	13
6	15	P 0.05	2.6	1.8	1.0	1
		median	5.1	3.8	2.2	5
		P 0.95	7.2	5.5	3.2	9
8	13	P 0.05	4.9	3.6	2.1	3
		median	6.4	4.8	2.9	8
		P 0.95	7.5	5.5	3.3	8
9	13.5	P 0.05	2	1.4	0.8	1
		median	5.9	4.4	2.5	6
		P 0.95	7.5	5.7	3.4	13
13	17.9	P 0.05	2.9	2.2	1.2	2
		median	5.7	4.4	2.6	8
		P 0.95	7.4	5.6	3.3	9
14	17.5	P 0.05	3.2	2.4	1.4	2
		median	6	4.6	2.8	7
		P 0.95	6.3	4.8	3.0	7
15	17	P 0.05	3.7	2.8	1.6	3
		median	5.4	3.9	2.4	7
		P 0.95	6.3	4.7	2.7	10
16	17.5	P 0.05	3.4	2.6	1.4	3
		median	5.7	4.2	2.7	6
		P 0.95	7	5.3	3.2	8
18	15.5	P 0.05	4	3	1.6	2
		median	6.1	4.6	2.9	7
		P 0.95	7.3	5.6	3.5	15
19	15.5	P 0.05	4.6	3.3	2.0	3
		median	6	4.5	2.7	8
		P 0.95	7	5.4	3.5	10
22	15	P 0.05	4.5	3.3	2.0	5
		median	6	4.5	2.8	6
		P 0.95	6.8	5.1	3.0	7
23	14	P 0.05	4.4	3.2	1.7	4
		median	6	4.5	2.7	7
		P 0.95	7.5	5.7	3.5	8
24	14.5	P 0.05	5	3.8	2.0	5
		median	6.1	4.4	2.6	7
		P 0.95	7.2	5.3	3.1	8

CONCLUSIONS

The survey carried out in 2010 depicts a quite complex situation of the population status of the smooth clam, with variable estimated density, distribution and length-at-age. The assessment of the latter was done using a rapid evaluation method.

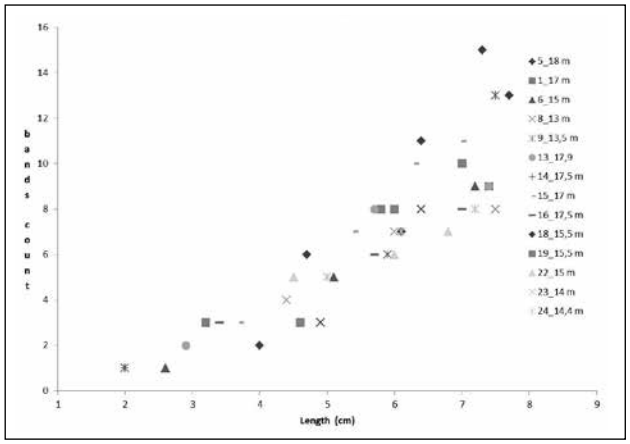


Fig. 3: Bands count and length (cm) in the 14 stations with significantly different regression slope for ln valve length and ln dry weight.
Sl. 3: Štetje trakov in dolžina (cm) na 14 postajah z značilnim različnim naklonom za ln dolžine lupine in ln suhe teže

Compared to more sophisticated techniques, *e.g.* fluorescence (Wanamaker *et al.*, 2009), acetate peel and isotopic analysis, the use of LED pointer for massive clear bands counts seems to be reliable, and compared with the thin sections obtained for this study, correct. This methodology has been verified in the past by Keller (1996-1997), Keller *et al.* (2002), Rebec (1997-1998) and Braida (2001-2002), which offered the possibility to obtain valuable information for the present work. It was confirmed that the restocking done by fishermen was successful (at least from the repeated analysis of the clams, Del Piero *et al.*, 2010). Unfortunately, parts of the shallower areas designed for repopulation were affected by mortality in late summer 2013 and early summer 2014 (*unpubl. data*). The causes are still unknown but at least in 2013 the molluscs didn't seem to suffer pathologies (G. Arcangeli, *pers. comm.*).

The differences in the length-at-age related to the depth were confirmed. Nevertheless, the ecological questions emerging from this study are at present far to be resolved. It seems urgent to modify the present fisheries regulation taking into account the demographic structure of *C. chione* population, a long-living species, with complex demography and still uncovered recruitment dynamics.

ACKNOWLEDGEMENT

The research was done as part of the agreement with the CO.GE.MO. of Monfalcone.

POPULACIJSKI STATUS ŠKOLJKE *CALLISTA CHIONE* (LINNAEUS, 1758) V TRŽAŠKEM ZALIVU

Cristina COGLIEVINA, Manuel DE MUNARI, Domenico CIORCIARO & Donatella DEL PIERO
Department of Life Sciences, University of Trieste, I-34127 Trieste, I-34127 Trieste, Via L. Giorgieri 10, Italy
E-mail: delpiero@units.it

POVZETEK

Julija 2010 smo v raziskavi analizirali školjke vrste Callista chione *(Linnaeus, 1758) na 23 lokalitetah. Dobljeni rezultati kažejo, da je za nekatere skupine značilna obratno sorazmerna korelacija med dolžino na določeni stopnji starosti (ocenjena na podlagi števila tankih, počasi rastočih prozornih trakov, ugotovljenih z uporabo LED kazalcev) in globino vzorčenja. Rezultati potrjujejo ugotovitve raziskav iz let 1992 in 1993, okoljske značilnosti na različnih globinah pa so še vedno pretežno neznane. Na žalost je v letih 2013 in 2014 nasade školjk prizadel množični pogin, ki bi lahko drastično vplival na ribištvo, povezano z ulovom školjk. S tega vidika bi bilo ugotavljanje hitrosti rasti za ribiško dejavnost in upravljavce zelo koristno.*

Ključne besede: *Callista chione,* Tržaški zaliv, dolžina ob določeni starosti, struktura populacije

REFERENCES

Baeta, M., M. Ramón & E. Galymani (2014): Decline of a *Callista chione* (Bivalvia: Veneridae) bed in the Maresme coast (northwestern Mediterranean Sea). Ocean Coast. Manage., 93, 15-25.

Braida, M. (2001-2002): Valutazione dell'accrescimento nella conchiglia del mollusco bivalve *Callista chione*: aspetti biologici, mineralogici e geochimici. Tesi di Laurea in Biologia della pesca. Università di Trieste, 58 pp.

Charles, F., J. M. Amouroux & A. Grémare (1999): Comparative study of the utilization of bacteria and microalgae by the suspension-feeding bivalve: *Callista chione*. J. Mar. Biol. Ass. U.K., 79, 577-584.

Del Piero, D. (1994): The clam fishery in the Gulf of Trieste. In: Wells, P. G. & P. J. Ricketts (eds.): Coastal Zone Canada "94. Conference Proceedings, no. 4, p. 1645-1660.

Del Piero, D. (1997-1998) (ed. 1999): Aspetti peculiari della pesca di *Callista chione* nel Golfo di Trieste. Boll. Soc. Adriatica Sci., 78, 101-108.

Del Piero, D., M. Bolgan, M. Burca, G. Calcagno, C. Coglievina, S. D'Antoni, P. De Flego, M. De Munari & P. Diviacco (2010): Three years after: What about Callista chione restoration plans. 13th International Conference on Shellfish Restoration Charleston, South Carolina (USA). http://www.scseagrant.org/content/?cid=705 (5. 8. 2014)

Ezgeta-Balić, D., M. Peharda, C. A. Richardson, M. Kuzmanić, N. Vrgoč & L. Isajlović (2011): Age, growth, and population structure of the smooth clam *Callista chione* in the eastern Adriatic Sea. Helgol. Mar. Res., 65, 457-465.

Gaspar, M. B., M. D. Dias, A. Campos, C. C. Monteiro, M. N. Santos, A. Chícharo & L. Chícharo (2001): The influence of dredge design on the catch of *Callista chione* (Linnaeus, 1758). Hydrobiologia, 465, 153-167.

Gaspar, M. B., M. N. Santos, P. Vasconcelos & C. C. Monteiro (2002): Shell morphometric relationships of the most common bivalve species (Mollusca: Bivalvia) of the Algarve coast (southern Portugal). Hydrobiologia, 477, 73-80.

Gordini, E., S. Caressa & R. Marocco (2003): Nuova carta morfo-sedimentologica del Golfo di Trieste (da Punta Tagliamento alla foce dell'Isonzo). Gortania, 25, 5-29.

Hall, C. A. Jr., W. A. Dollasè & C. E. Corbatò (1974): Shell growth in *Tivela stultorum* (Mawe, 1823) and *Callista chione* (Linnaeus, 1758) (Bivalvia): annual periodicity, latitudinal differences, and diminution with age. Palaeogeogr. Palaeoclimatol. Palaeoecol., 15, 33-61.

Keller, N. (1996-1997): La composizione isotopica del carbonato della conchiglia nella valutazione dell' accrescimento dei Molluschi Bivalvi *Chamelea gallina* (L.) e *Callista chione* (L.) nel Golfo di Trieste. Tesi di Laurea in Zoologia. Università di Trieste, 69 pp.

Keller, N., D. Del Piero & A. Longinelli (2002): Isotopic composition, growth rates and biological behavior of *Chamelea gallina* and *Callista chione* from the Gulf of Trieste (Italy). Mar. Biol., 140, 9-15.

Kelly, M. H. & R. M. Cerrato (2007): The annual macroscopic growth pattern of the northern quahog [=hard clam, *Mercenaria mercenaria* (L.)], in Narragansett Bay, Rhode Island. J. Shellfish Res., 26, 985-993.

Leontarakis, P. K. & C. A. Richardson (2005): Growth of the smooth clam, *Callista chione* (Linnaeus, 1758) (Bivalvia: Veneridae) from the Thracian Sea, northeastern Mediterranean. J. Molluscan Stud., 71, 189-198.

Marano, G., R. Vaccarella, A. M. Pastorelli, C. Piccinetti & D. Del Piero (1998): Valutazione della biomassa di *Callista chione* (L.) (fasolaro) in Adriatico. Biol. Mar. Medit., 5, 451-456.

Metaxatos, A. (2004): Population dynamics of the venerid bivalve *Callista chione* (L.) in a coastal area of the eastern Mediterranean. J. Sea Res., 52, 293-305.

Ministero delle Risorse Agricole, Alimentari e Forestali (ed.) (1994): Valutazione della biomassa di *Callista chione* (L.) (fasolaro) in Adriatico. Dipartimento di Biologia, Università di Trieste, Laboratorio di Biologia Marina e Pesca, Università Di Bologna, ICRAM Roma, Laboratorio di Biologia Marina e Pesca Bari, 26 pp.

Moura, P., M. B. Gaspar & C. C. Monteiro (2008): Gametogenic cycle of the smooth clam *Callista chione* on the south-western coast of Portugal. J. Mar. Biol. Ass. U.K., 88, 161-167.

Moura, P., M. B. Gaspar. & C. C. Monteiro (2009): Age determination and growth rate of a *Callista chione* population from the southwestern coast of Portugal. Aquat. Biol., 5, 97-106.

Poppe, G. T. & Y. Goto (1993): European Seashells. Volume II (Scaphopoda: Bivalvia, Cephalopoda). Verlag Christa Hemmen, Wiesbaden, Germany, 221 pp.

Rebec, B. (1997-1998): Caratteristiche della popolazione sfruttata di *Callista chione* (Linnaeus, 1758) nel Golfo di Trieste nel 1994. Tesi di Laurea in Zoologia. Università di Trieste, 34 pp.

Taylor, J. D., W. J. Kennedy & A. Hall (1973): The shell structure and mineralogy of the Bivalvia. II. Lucinacea-Clavagellacea, Conclusions. Bull. Br. Mus. (Nat. Hist.) Zool., 22, 253-294.

Tirado, C., F. A. Rodriguez, M. A. Buzón, J. L. López, C. Salas & I. Márquez (2002): La Reproducción de Bivalvos y Gasterópodos de Interés Pesquero en Andalucía. Consejería de Agricultura y Pesca, Junta de Andalucía, Huelva, 129 pp.

Valli, G., E. Bidoli & C. Marussi (1983-1984): Osservazioni preliminari sulla riproduzione e sulla biometria di *Callista chione* (L) (Mollusca, Bivalvia) del Golfo di Trieste. Nova Thalassia, 6, 97-103.

Valli, G., N. Marsich & M. Marsich (1994): Riproduzione, biometria e contenuto di metalli in *Callista chione* (L.) (Mollusca, Bivalvia) del Golfo di Trieste nel

corso di un ciclo annuale. Boll. Soc. Adriatica Sci., 75, 441-446.

Wanamaker, A. D. Jr., A. Baker, P. G. Butler, C. A. Richardson, J. D. Scourse, I. Ridgway & D. J. Reynolds (2009): A novel method for imaging internal growth patterns in marine molluscs: A fluorescence case study on the aragonitic shell of the marine bivalve *Arctica islandica* (Linnaeus). Limnol. Oceanogr. Methods, 7, 673-681.

Original scientific article
Received: 2014-09-13

UDK 574.58:592(282)(450.36)

A COMPARISON BETWEEN BIOMONITORING METHODS FOR THE ANALYSIS OF MACROBENTHIC INVERTEBRATE COMMUNITIES IN DIFFERENT RIVER TYPES OF FRIULI VENEZIA GIULIA

Marco BERTOLI, Marzia AZZONI & Elisabetta PIZZUL
Department of Life Sciences, University of Trieste, I-34127 Trieste, I-34127 Trieste, Via L. Giorgieri 10, Italy
E-mail: pizzul@units.it

ABSTRACT

According to the Framework Water Directive, 2000/60/EC, macrobenthic invertebrates are very important as bioindicators for the definition of the Ecological Status of lotic systems. In Italy, different collection methods are requested for the application of biotic indices in wadeable and non-wadeable rivers: a proportionally distributed multi-habitat sampling (MH) and the use of artificial substrates (AS), respectively. This work was performed to compare the results obtained with both methods in three different lotic environments: an alpine stream, a high plain river and a spring fed channel. Data obtained from the application of the two different techniques have led to a good overlapping of results for all analysed watercourses, even though some macrobenthic invertebrate taxa showed selectivity in the artificial substrate colonization. No significant differences were found even among the metrics of the STAR_ICMi index, provided by the D.M. 260/2010 for the assessment of the watercourses ecological status in Italy.

Key words: macrobenthic invertebrates, freshwater ecosystems, North-east Italy, multi-habitat sampling, artificial substrates

DIFFERENTI STRATEGIE DI MONITORAGGIO PER LO STUDIO DELLE COMUNITÀ MACROZOOBENTONICHE IN DIVERSE TIPOLOGIE FLUVIALI DEL FRIULI VENEZIA GIULIA

SINTESI

I macroinvertebrati bentonici sono bioindicatori di fondamentale importanza nella definizione dello stato ecologico delle acque lotiche, ai sensi della Direttiva 2000/60/CE. In territorio italiano gli indici biotici, previsti dal D.M. 260/2010, riportano metodiche di monitoraggio diverse per i fiumi guadabili e per quelli non guadabili, prevedendo nel primo caso un campionamento multi-habitat proporzionale (MH) e nel secondo caso l'impiego di substrati artificiali (SA). Per questo studio, è stato ritenuto interessante effettuare un confronto tra tali metodiche di raccolta del macrozoobenthos, utilizzando entrambe in tre diverse tipologie fluviali: un corso d'acqua montano, uno di pianura ed uno di risorgiva. I dati ottenuti dopo l'applicazione delle due tecniche di campionamento hanno portato a risultati concordanti in tutte le tipologie fluviali analizzate, benché sia stata osservata una certa selettività da parte di alcuni taxa nella colonizzazione dei substrati artificiali. Inoltre, non sono state rilevate differenze significative tra i valori delle metriche che compongono l'indice STAR_ICMi, previsto dal D.M. 260/2010, portando a concludere che le due metodiche conducono a risultati ampiamente confrontabili tra loro.

Parole chiave: macroinvertebrati bentonici, ecosistemi d'acqua dolce, Nord Est Italia, campionamento multi-habitat proporzionale, campionamento con substrati artificiali

INTRODUCTION

The wadeable rivers can be crossed easily and all riverbed parts and micro-habitats are easily reachable in all seasons, except during periods of high-water and flooding. In these cases, the sampling protocol used for macrobenthic invertebrates collection is based on a multi-habitat procedure, originally proposed in the United States for the "Rapid Bio-assessment Protocol" (Barbour *et al*., 1999) and successively adopted to develop methods which can fit the requirements of the Water Framework Directive 2000/60/EC (Directive 2000/60/EC). The basic principles of this method were tested during the European AQEM project (Integrated Assessment System for the Ecological Quality of Streams and Rivers throughout Europe using Benthic Macro-invertebrates) (Buffagni *et al*., 2001; Hering *et al*., 2004) and the multi-habitat technique was then applied during the STAR project (STAndardisation of River Classifications). The principal rule foresees the collection of samples in proportion to the number of different micro-habitats observed in a river (both biotic and abiotic substrates) whose presence must be previously determined. Three different monitoring types (surveillance, operational and investigative) are indicated by the Water Framework Directive 2000/60/EC, depending of the desired information level and requiring both a different number of sub-samples and a different taxonomical identification level for the collected taxa (Buffagni & Erba, 2007). In the wadeable watercourses, the Surber net is the appropriate sampler for the multi-habitat procedure. However, there are some river types where a representative sample cannot be collected due to different reasons such as high water depth, elevated current speed, dispersal of microhabitats over wide areas, different riverbank types (Buffagni *et al*., 2007). In Italy, the D.M. 260/2010 recommends the protocol of Buffagni *et al*. (2007) to collect macrobenthic invertebrates in non-wadeable watercourses, using Hester-Dendy modified hardboard artificial substrates (AS) (Cairns & Dickson, 1971; Battegazzore, 1994; Buffagni *et al*., 2000). This method can be applied to different watercourse types, as well as big rivers, spring fed watercourses, channels and brooks with sharply sloped banks and/or high water depth. This study investigates the macrobenthic invertebrate communities of three different lotic environments using both multi-habitat and artificial substrates sampling techniques.

Our aim was to verify if the monitoring performed with artificial substrates could give results comparable with those obtained from a multi-habitat approach, even though the AS are applied in a single micro-habitat.

MATERIAL AND METHODS

Study area

Three different watercourse types were monitored: a mountain stream, a high plain river and a spring fed channel (Fig. 1). The sampling sites were chosen con-

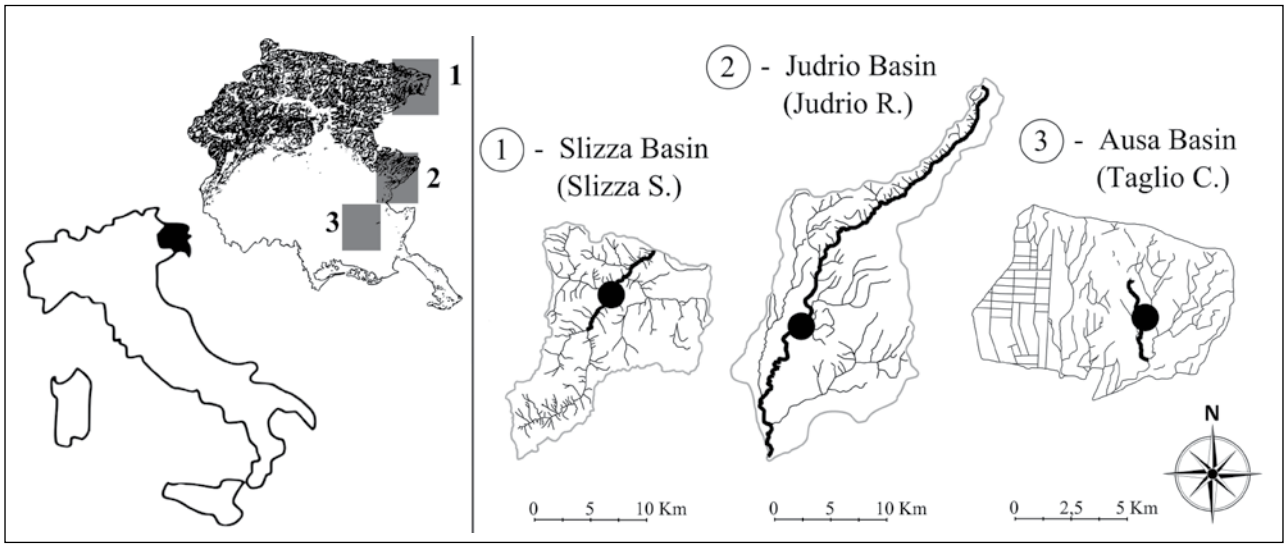


Fig. 1: Study areas and basins including the monitored sites placed in three different watercourses types (UTM coordinates): site 1: N 33T 5149448.84 – E 391576.81; site 2: N 33T 5092992.04 – E 380051.86; site 3: N 33T 5078066.48 – E 370729.18) (www.regionefvg.it, modified).
Sl. 1: Območje raziskovanja, vključno z lokalitetami v treh različnih vodnih telesih (UTM koordinate): lokaliteta 1: N 33T 5149448,84 – E 391576,81; lokaliteta 2: N 33T 5092992,04 – E 380051,86; lokaliteta 3: N 33T 5078066,48 – E 370729,18) (www.regionefvg.it, prirejeno)

sidering the possibility to apply both methods (multihabitat sampling and artificial substrates) in relation to riverbed characteristics, especially water depth and flow velocities. In the mountain area, we have choose the Slizza stream whose basin is located in the most northeastern part of Friuli Venezia Giulia and it is included in the Danube basin. The Slizza stream originates from the confluence of two creeks (Rio del Lago Inferiore from the Lake Predil and the Rio Freddo) and flows in a Northeast direction, first crossing the Italian town of Tarvisio then entering Austrian territory, until it flows into the Gail River. This stream exhibits a torrential regime, high current velocity, and great flow rate variation, with strong flood events followed by marked low water levels. At the site, during sampling operations, the mean width of stream bed was 9.0 m and the bottom substrate was mainly constituted by rocks and boulders, even though gravel and pebbles were observed.

In the plains area, the second study site was placed on the Judrio River, included in the Isonzo Basin. It originates from the springs of the Colvarat Mount and flows with a torrential regime near the boundaries between Italy and Slovenia. The Judrio River then runs along the hills near the eastern portion of Friuli Venezia Giulia and finally along the lowland with wide meanders, until it flows into the Torre Stream (Autorità di Bacino, 2010). The mean width of the stream bed was 12.0 m and the bottom substrate mainly consisted of gravel and pebbles. Coarse particulate organic matter was also observed. The last sampling site was placed in the Taglio Channel, a spring fed watercourse included in the Ausa Basin. The mean width was 10.0 m and the bottom substrate was mainly covered by vegetation (submerged macrophytes) or consisted of fine gravel.

Sampling design

At each site, two sampling campaigns were conducted, using both multihabitat protocol (MH) and artificial substrates (AS). Collection activities were performed seasonally during the late spring (from June to the beginning of July) and the autumn (from November to December) of the year 2012.

The MH samplings were carried out following an operational protocol using appropriate Surber nets for the specific monitored Hydro-ecoregions (HER) (Buffagni & Erba, 2007), covering 1 m^2 sampling area for the Slizza site, placed in the HER 02 (Calcareous southern Alps and Dolomites) and 0.5 m^2 for the Judrio and Taglio sites, placed in the HER 06 (Po Plain). A 50 m length stream longitudinal section, representative of each monitored watercourse, was generally considered for each sampling site. Sorting operations and taxonomical identification were performed mainly on field, but some individuals belonging to the orders Diptera and Plecoptera and to the class Oligochaeta were later identified in the laboratory due to the small size of the organisms. Taxonomical identification was conducted to the lowest possible level, and at least to the family level, for the application of the STAR_ICMi index (Buffagni *et al*., 2008). The sampling operations with AS were conducted using Hester-Dendy substrates (Buffagni *et al*., 2007). According to the sampling protocols indicated for non-wadeable streams, the AS were built with ten hardboard plates separated by rubber rings and groups of five AS were chosen as sample unit, with a total area of 0.5 m^2. Two sampling units were placed in the monitored watercourses along non-wadeable sections, and suspended at 0.5-1.5 m water depth by ropes secured to trees or to artificial structures and secured to the bottom using bricks. The AS were collected after 30 days of submersions: the plates were cleaned from organisms and other material and the resulting samples were sieved with a 500 µm sieve. Sorting and taxonomical identification were conducted as for the MH samples, which were collected during the same day.

In addition, values of chemical and physical water parameters (temperature, °C; pH; conductivity, µS cm^{-1}; dissolved oxygen concentration, mg l^{-1}) were monthly registered with field meters (Hanna Instruments, Padova, Italia) and the water depth (cm) was also monitored using a graduated rod. During the sampling operations, substrate composition and vegetation bottom cover were registered, as requested for the application of the MH protocol (Buffagni & Erba, 2007).

Data analysis

All ecological data were initially processed using Microsoft Excel 2007. A graph describing the macrobenthic invertebrate community structure was produced with the same software. The Sörensen index (Sörensen, 1948) was used for comparing the two sampling methods. Calculations were made considering the family taxonomical level, as usually considered for the application of the STAR_ICMi index (Buffagni *et al*., 2008). In addition, the non-parametric Multi-Dimensional Scaling (N-MDS) and the one-way PERMANOVA (999 permutations) (Anderson, 2001), both based on the Bray-Curtis similarity matrix, were performed to assess differences between the two methods, using density data (ind m^{-2}) of all families collected with MH and AS techniques. The STAR_ICMi metrics were used as community descriptors because they provide information based on taxa tolerance (ASPT), organisms abundance (Log_{10}(Sel_EPTD+1) and 1-GOLD) and biodiversity (Total Families Number, EPT Families Number and Shannon-Wiener index). Differences among metrics values calculated both from the MH and AS datasets were investigated with the non-parametric Wilcoxon paired-sample test. All data were previously log(x+1) transformed, and normality of datasets was assessed using the Kolmogorov-Smirnov test with software STATISTICA 7.1. The same software was used for the Wilcoxon paired-sample test, while N-MDS and

Tab. 1: Seasonal mean values and standard deviations (± S.D.) of chemical and physical water parameters measured during the monitoring period.
Tab. 1: Povprečne vrednosti po sezonah in standardna deviacija (± S.D.) kemijskih in fizikalnih parametrov, izmerjenih v obdobju monitoringa

		Depth (cm)	Dissolved oxygen (mg l^{-1})	Temperature (°C)	pH	Conductivity (µS cm^{-1})
Slizza S.	Spring	42.48 ± 1.55	9.69 ± 0.22	9.53 ± 0.59	8.52 ± 0.37	339.67 ± 64.59
	Autumn	54.71 ± 10.77	9.92 ± 0.29	7.48 ± 2.14	8.57 ± 0.22	256.75 ± 96.15
Judrio R.	Spring	55.57 ± 6.98	7.61 ± 0.22	21.97 ± 0.75	8.19 ± 0.27	462.00 ± 51.97
	Autumn	69.82 ± 20.64	9.31 ± 1.02	11.85 ± 5.19	8.33 ± 0.16	542.25 ±130.93
Taglio C.	Spring	101.04 ± 4.97	6.60 ± 0.60	16.20 ± 2.10	7.80 ± 0.13	652.00 ± 61.73
	Autumn	103.67 ± 2.06	8.91 ± 1.19	14.75 ± 1.71	8.08 ± 0.31	597.00 ± 50.00

one-way PERMANOVA were performed using the PAST 3 application (Hammer *et al*., 2001).

RESULTS

Seasonal mean values of main chemical and physical parameters for all sampling sites are given in Table 1. The full list of the collected taxa is given in Table 2.

Macrobenthic invertebrates community structure observed both with MH and AS sampling techniques during the two monitoring seasons are shown in Figure 2. With each sampling technique in the Slizza spring 19 taxa were collected. Nearly all (96 %) collected organisms were assigned to the class Hexapoda, but the order Ephemeroptera was the more abundant taxon in the MH samples while in the AS samples the Diptera Chironomidae were dominant. Unfortunately, the autumn AS sample was lost due to a strong flood event so that the comparison between methods was precluded for those seasonal samples. The low number of organisms (179 individuals, belonging to the Ephemeroptera order) collected in the MH fall samples was probably a consequence of this flood event.

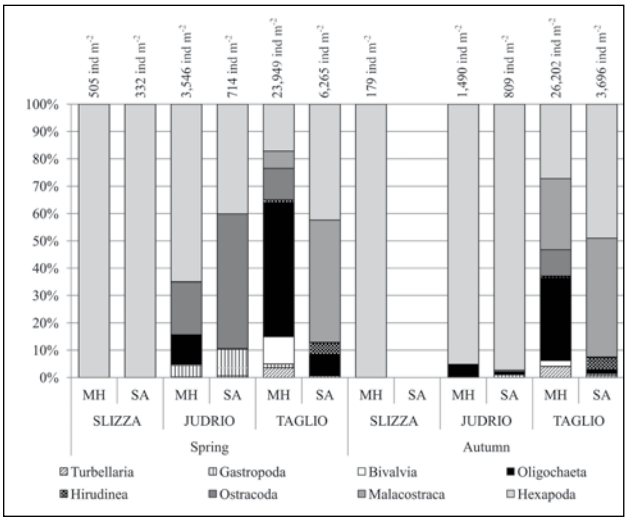


Fig. 2: Occurrences of the main taxa observed in the MH and AS samples during the two monitoring seasons. Sl. 2: Pojavljanje glavnih taksonov v vzorcih MH in AS v dveh spremljanih sezonah

The Judrio River community showed a higher biodiversity (number of taxa) than the Slizza spring (Fig. 2). Using the MH sampling allowed collection of 27 taxa while in the AS 22 taxa were identified. The MH samples were dominated by Hexapoda, especially by Diptera Chironomidae in spring and Ephemeroptera Caenidae (genus *Caenis*) in autumn. In this latter season *Caenis* was the most abundant taxon also in the AS samples, but in spring the class Ostracoda was dominant. Finally, 41 taxa were identified in the MH spring samples and 19 in the autumnal samples collected at the Taglio site: Oligochaeta Lumbriculidae and Crustacea Asellidae were the most abundant taxa in spring and in autumn respectively. Asellidae was also the dominant among 34 taxa in the AS spring samples while Trichoptera Hydropsychidae showed the highest abundance in the AS autumnal samples, when 37 taxa were identified.

The application of the Sörensen index provided values ranging between 0.72 and 0.97, indicating a comparable community composition observed in samples collected using the two sampling techniques. The N-MDS applied on the two biotic datasets, obtained from the densities of all the observed families, also showed a good comparability of the two methods (Fig. 3) hence appearing consistent with the results of the Sörensen index. In addition, the one-way PERMANOVA did not show significant differences between communities due to the sampling method ($F = 0.714$, $p > 0.05$). Finally, also the STAR_ICMi metrics values calculated from the MH and AS biotic datasets did not show significant differences between the two sampling approaches (Wil-

Tab. 2: Taxa observed in the Multi-habitat samples (MH) and in the Artificial Substrates (AS). The list follows an evolutionary criterion, as reported by the Checklist of the Italian Fauna (www.faunaitalia.com).

Tab. 2: Taxa observed in the Multi-habitat samples (MH) and in the Artificial Substrates (AS). The list follows an evolutionary criterion, as reported by the Checklist of the Italian Fauna (www.faunaitalia.com).

Class	**Order**	**Familiy**	**Subfamily / Genus**	Spring						Autumn					
				Slizza S.		Judrio R.		Taglio C.		Slizza S.		Judrio R.		Taglio C.	
				MH	SA	MH	SA	MH	SA	MH	SA	MH	SA	MH	SA
Turbellaria	Seriata	Dugesiidae	*Dugesia*			+	+	+	+					+	+
		Planariidae	*Planaria*			+	+	+	+					+	+
			Polycelis					+	+					+	+
		Dendrocoelidae	*Dendrocoelum*											+	
Adenophorea	Mmermithida	Mermithidae						+	+				+	+	+
Gastropoda	Neotaenioglossa	Bithyniidae	*Bithynia*					+	+					+	+
		Hydrobiidae				+	+	+							+
	Ectobranchia	Valvatidae	*Valvata*			+	+	+	+					+	+
	Pulmonata	Physidae	*Physa*			+	+						+	+	
		Planorbidae	*Planorbis*			+									+
			Gyraulus			+	+	+	+				+		
Bivalvia	Veneroidea	Sphaeriidae	*Pisidium*					+	+					+	+
			Sphaerium			+		+	+						
			Musculium			+		+							
Oligochaeta	Lumbriculida	Lumbriculidae				+		+	+			+	+	+	+
	Haplotaxida	Haplotaxidae							+			+			
	Tubificida	Tubificidae				+		+	+			+		+	+
		Naididae				+		+							
		Propappidae						+							
		Enchytraeidae						+					+		
	Opisthopora	Lumbricidae						+	+					+	+
Hirudinea	Rhynchobdellida	Glossiphoniidae	*Glossiphonia*			+	+	+	+						+
			Helobdella					+	+					+	+
	Arhynchobdellida	Erpobdellidae	*Erpobdella*					+	+					+	+
Arachnida	Actinedida			+	+	+	+	+	+					+	+
Ostracoda						+	+	+	+					+	+
Malacostraca	Isopoda	Asellidae						+	+			+	+	+	+
	Amphipoda	Gammaridae						+	+					+	+
		Niphargidae						+	+					+	+
Hexapoda	Ephemeroptera	Baetidae	*Baetis*	+	+	+	+	+	+	+		+	+		+
		Caenidae	*Caenis*			+	+					+	+		+
		Heptageniidae	*Ecdyonurus*	+	+					+					
			Electrogena	+								+			
			Rhithrogena	+	+					+					
		Leptophlebiidae	*Choroterpes*			+	+					+	+		
			Habrophlebia									+			
			Paraleptophlebia										+		
	Odonata	Calopterygidae	*Calopteryx*												+
		Platycnemididae					+								
		Gomphidae											+	+	
	Plecoptera	Perlodidae	*Perlodes*	+	+										
			Isoperla	+	+					+					
		Nemouridae	*Nemoura*	+	+					+			+		
			Protonemura	+	+					+					
		Leuctridae	*Leuctra*	+	+	+				+		+	+		
	Coleoptera	Haliplidae					+	+	+					+	+
		Dytiscidae						+					+		
		Hydrophilidae						+							
		Hydraenidae		+	+										
		Elmidae				+	+	+	+			+	+	+	+
	Megaloptera	Sialidae						+							
	Diptera	Limoniidae		+	+					+					
		Simuliidae		+	+			+	+			+	+	+	+
		Ceratopogonidae						+	+			+	+	+	+
		Chironomidae	Chironominae		+	+	+	+	+				+	+	+
			Prodiamesinae	+	+	+	+	+	+			+	+	+	+
			Tanypodinae		+	+	+	+	+			+	+	+	+
		Empididae		+	+			+	+			+	+	+	+
	Trichoptera	Rhyacophilidae		+	+			+		+					+
		Hydroptilidae				+	+	+	+					+	+
		Hydropsychidae						+	+			+	+	+	+
		Polycentropodidae		+		+	+		+			+	+	+	+
		Limnephilidae		+	+					+				+	
		Leptoceridae				+	+								
		Sericostomatidae		+	+	+	+								+

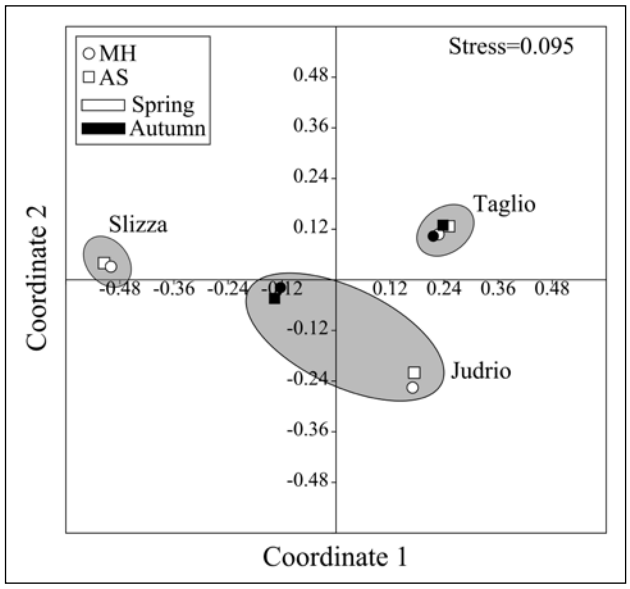


Fig. 3: N-MDS applied to the biotic datasets obtained from the two sampling techniques (MH and AS).
Sl. 3: N-MDS (nemetrično večvrstično lestvičenje) biotskih nizov podatkov, dobljenih iz obeh tehnik vzorčenja (MH in AS)

coxon paired-sample test: at least $p > 0.05$ for all comparisons) (Tab. 3).

DISCUSSIONS AND CONCLUSIONS

In the present study, the values obtained using the Sörensen index and those resulting from the comparison of the STAR_ICMi metrics values have shown that the macrobenthic invertebrate communities monitored with the multi-habitat sampling method (MH) and with Artificial Substrate samplers (AS) were not significantly different regardless of the lotic system here investigated. This is in contrast with the results of other investigations, where the Artificial Substrates did not allow a collection of representative samples of the whole macrobenthic community (Rosenberg & Resh, 1993; Braioni, 2001; Buffagni *et al*., 2007). This has been attributed to a single microhabitat being investigated and to the selectivity of the artificial substrate for some macrobenthic taxa that could lead to an underestimation of the global community richness.

Different occurrences due to the sampling methodology observed in the present investigation for some taxa at the same site, agree with previous studies (Genoni & Strada, 2000) also showing that the artificial substrate technique allows abundant colonization by Diptera Chironomidae and Trichoptera Hydropsychidae, which are very competitive and very able to colonize new substrates (Hall, 1982; Hemphill & Cooper, 1983; Braioni, 2001). Contrary to habits shown by more tolerant taxa, Valenty & Fisher (2012) reported that Ephemeroptera, Plecoptera and Trichoptera (which can influence one of the STAR_ICMi metrics) show negative preferences for newly built substrates, probably due to roughness of plates, residual oils or leaching toxins, but we have not observed similar tendencies in our samples. Occurrences of Oligochaeta and Bivalvia families were generally lower than in the multihabitat samples. As suggested by Buffagni *et al*. (2007) this is probably due to the poor swimming ability of such organisms which are disadvantaged in the colonization of substrates placed in the water column. On the other hand, in the Judrio River the occurrence of Gastropoda in the AS samples was higher than in the MH ones due to the scarce presence of macrophytes on the substrates. In fact, the vegetation cover

Tab. 3: Values of the STAR_ICMi metrics and results of the non-parametric Wilcoxon paired-sample test.
Tab. 3: Vrednosti metrik indeksa STAR_ICMi in rezultati ne-parametričnega Wilcoxonovega testa parnih vzorcev

Metrics	Spring						Autumn						Wilcoxon paired-sample test	
	Slizza		Judrio		Taglio		Slizza		Judrio		Taglio			
	MH	AS	MH	AS	MH	AS	MH	AS	MH	AS	MH	AS	W	p-level
ASPT	7	7	5.16	5.39	3.54	3.64	7.86	-	5.26	5.06	4	4.7	8	0.273
Log10 (Sel_EPTD+1)	2.24	1.65	1.45	1.06	2.02	2.46	2.05	-	1.23	1.18	2.05	1.51	12	0.224
1-GOLD	0.85	0.58	0.55	0.71	0.21	0.31	0.92	-	0.78	0.65	0.43	0.73	9	0.685
Total families	15	14	23	20	34	28	8	-	16	20	29	32	6	0.787
ETP families	9	8	8	7	4	4	7	-	7	7	4	7	3	1.000
Shannon-Wiener index	2.05	2.07	2.31	1.82	1.88	1.3	1.46	-	1.29	1.61	1.87	1.71	11	0.345

in this site was lower than the threshold value of 10% required for the operational sampling protocol applied in this study. The results of the N-MDS application showed good comparability between biotic datasets obtained from the two sampling techniques. This suggests that both sampling methods could lead to similar and reliable descriptions of the macrobenthic invertebrate communities. In the Slizza stream, high occurrences were registered for Ephemeroptera, Plecoptera and Trichoptera which are related to high water oxygen concentrations, low water temperature and coarse substrates (mainly macro-and megalithal). In the Judrio sampling sites, the most abundant taxa were Ephemeroptera, Odonata, Coleoptera and some Gastropods genera (*Physa*, *Planorbis* and *Gyraulus*) which appeared more related to a fine substrate (micro- and mesolithal), slightly higher trophic levels and presence of coarse particulate organic matter. Finally, in the Taglio channel the most abundant taxa were Oligochaeta, Diptera, Turbellaria, Hirudinea Bivalvia and Gastropoda. The community structure in this site appeared related to the less coarse bottom composition, high presence of submerged vegetation (which covers a great section of the river bed) and slightly lower water oxygen levels which seemed consistent with the impact of human presence in the area (*i.e.* a fish farm and agricultural activities).

In conclusion, our results have shown that the Hester-Dendy artificial substrates could lead to results which can be comparable to those obtained with multi-habitat sampling in different lotic environments. As reported by Calpcott *et al*. (2012) this instrument allows quantitative sampling of macrobenthic invertebrates in the non-wadeable watercourses to be performed and could be applied to many different habitats even though the risk of loss and/or damages and the potential selectivity of some taxa could be a limit of the technique.

PRIMERJAVA METOD BIOMONITORINGA ZA ANALIZO MAKROBENTOŠKIH SKUPNOSTI NEVRETENČARJEV V RAZLIČNIH REČNIH TIPIH FURLANIJE - JULIJSKE KRAJINE

Marco BERTOLI, Marzia AZZONI & Elisabetta PIZZUL
Department of Life Sciences, University of Trieste, I-34127 Trieste, I-34127 Trieste, Via L. Giorgieri 10, Italy
E-mail: pizzul@units.it

POVZETEK

Evropska vodna direktiva (2000/60/ES) opredeljuje makrobentoške nevretenčarje kot zelo pomembne pokazatelje ekološkega stanja lotičnih sistemov. V Italiji uporabljajo različne metode vzorčevanja, ki jih potrebujejo za aplikacijo biotskih indeksov v prehodnih in neprehodnih rekah, kot sta proporcionalno razširjeno vzorčevanje multi-habitatov (MH) in uporaba umetnih substratov (AS). Namen tega prispevka je primerjava rezultatov, dobljenih z obema metodama v treh različnih lotičnih okoljih (planinski potok, reka na planoti in izvirski kanal). Podatki obeh metod so pokazali dobro prekrivanje vseh raziskanih lotičnih sistemov, čeprav je bila pri nekaterih taksonomskih skupinah opažena selektivnost v naseljevanju umetnih substratov. Tudi med metrikami uporabljenega indeksa STAR_ICMi, ki ga je priporočila odredba ministrstva (D.M. 260/2010) za ovrednotenje ekološkega stanja vodnih teles v Italiji, ni bilo značilnih razlik.

Ključne besede: makrobentoški nevretenčarji, sladkovodni ekosistemi, severovzhodna Italija, multihabitatno vzorčevanje, umetni substrati

REFERENCES

Anderson, M. J. (2001): A new method for a non-parametric multivariate analysis of variance. Austral Ecol., 26, 32-46.

Autorità di Bacino dell'Adige, Autorità di Bacino dell'Alto Adriatico (2010): Piano di gestione dei Bacini Idrografici delle Alpi orientali. Adottato con delibera dei Comitati Istituzionali dell'Autorità di Bacino dell'Adige e dell'Alto Adriatico in seduta comune in data 24 febbraio 2010. Bacino del Fiume Isonzo, 13, 203 pp.

Barbour, M. T., J. Gerristen, B. D. Snyder & J. B. Stribling (1999): Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Bentic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency, Office of Water, Washington, D.C., 339 pp.

Battegazzore, M. (1994): Procedure di campionamento del macrobenthos per la valutazione della qualità dei corsi d'acqua. Rapporto interno IRSA - Gruppo Metodi Biologici.

Braioni, M. G. (2001): Analisi biologiche-ecologiche in alcune aree campione fluviali dell'Adige. Autorità di Bacino Nazionale dell'Adige & Università di Padova, Padova, 71 pp.

Buffagni, A. & S. Erba (2007): Macroinvertebrati acquatici e Direttiva 2000/60/CE (WFD) - Parte A: Metodo di campionamento per fiumi guadabili. Not. Metod. Analitici IRSA - CNR, 1, 2-27.

Buffagni, A., A. Pieri, F. Bordin & L. Galbiati (2000): Comunità macrobentoniche del Fiume Po - Parte I: Taxa rinvenuti e integrità delle comunità degli Efemerotteri. Quad. Ist. Ric. Acque, 113, 175-225.

Buffagni, A., J. L. Kemp, S. Erba, C. Belfiore, D. Hering & O. Moog (2001): A Europe wide system for assessing the quality of rivers using macroinvertebrates: the AQEM project and its importance for southern Europe (white special emphasis in Italy). J. Limnol., 60 (suppl. 1), 39-48.

Buffagni, A., E. Moruzzi, C. Belfiore, F. Bordin, M. Cambiaghi, S. Erba, L. Galbiati & R. Pagnotta (2007): Macroinvertebrati acquatici e Direttiva 2000/60/CE (WFD) - Parte D: metodo di campionamento per i fiumi non guadabili. Not. Metod. Analitici IRSA - CNR, 1, 69-93.

Buffagni, A., S. Erba & R. Pagnotta (2008): Direttiva 2000/60/CE (WFD) - Condizioni di riferimento per fiumi e laghi – Classificazione dei fiumi sulla base dei macroinvertebrati acquatici. Not. Metod. Analitici IRSA - CNR, Numero speciale 2008, p. 24-46.

Cairns, J. Jr. & K. L. Dickson (1971): A simple method for the biological assessment of the effects of waste discharges on aquatic bottom-dwelling organism. J. Water Pollut. Control Fed., 43, 755-772.

Clapcott, J., M. Pingram & K. J. Collier (2012): Review of functional and macroinvertebrate sampling methods for non-wadeable rivers. Report No. 2222. Cawthron Institute, Nelson, 65 pp.

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. OJ L 327, 22.12.2000, p. 1-73.

D.M. 260/2010: Regolamento recante i criteri tecnici per la classificazione dello stato dei corpi idrici superficiali, per la modifica delle norme tecniche del decreto legislativo 3 aprile 2006, n.152, recante norme in materia ambientale, predisposto ai sensi dell'art. 75, comma 3, del medesimo decreto legislativo. Gazzetta Ufficiale n. 31/L del 07 febbraio 2011, Supplemento Ordinario n. 30.

Genoni, P. & L. Strada (2000): Confronto tra metodi di prelievo per l'analisi quantitative del macrobenthos. Biologia Ambientale, 14, 17-22.

Hall, T. J. (1982): Colonizing macroinvertebrates in the Upper Mississippi River with a comparison of basket and multiplate samplers. Freshw. Biol., 12, 211-215.

Hammer, Ø., D. A. T. Harper & P. D. Ryan (2001): PAST: Paleontological statistics software package for education and data analysis. Palaeontol. Electronica, 4, 1-9.

Hemphill, N. & S. D. Cooper (1983): The effect of physical disturbance on the relative abundances of two filter-feeding insects in a small stream. Oecologia, 58, 378-382.

Hering, D., C. Meier, C. Rawer-Jost, C. K. Feld, R. Biss, A. Zenker, A. Sundermann, S. Lohse & J. Bömer (2004): Assessing streams in Germany with benthic invertebrates: selection of candidate metrics. Limnologica, 34, 398-415.

Rosenberg, D. M. & V. H. Resh (1993): Freshwater biomonitoring and benthic macroinvertebrates. Chapman & Hall, New York, 488 pp.

Sörensen, T. (1948): A method for establishing groups of equal amplitude in plant sociology based on similarity of species content and its application to analyses of the vegetation on Danish commons. K. danske vidensk. Selsk. Skr. Biol. Skr., 5, 1-34.

Valenty, J. & S. J. Fisher (2012): Effect of previous use and processing technique on performance of multiplate Hester-Dendy samplers. Freshw. Sci., 31, 78-82.

DELA NAŠIH ZAVODOV IN DRUŠTEV

ATTIVITÀ DEI NOSTRI ISTITUTI E DELLE NOSTRE SOCIETÀ

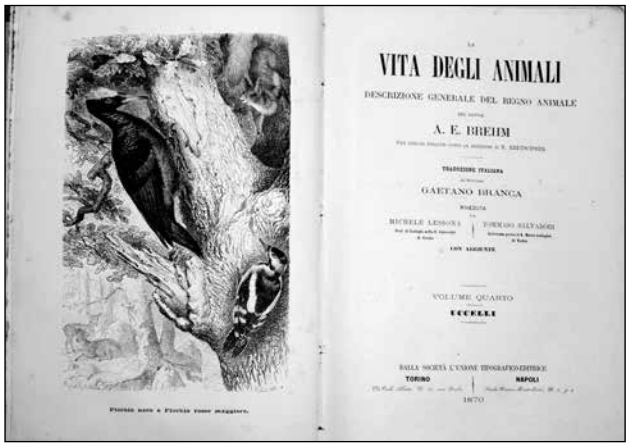
ACTIVITIES BY OUR INSTITUTIONS AND ASSOCIATIONS

BREHM'S *LIFE OF ANIMALS* FROM 1872 IN POREČ, CROATIA

Brehm's *Life of Animals* is one of the most well-known books on zoology ever written. It was composed by Alfred Edmund Brehm in the 19th century. Brehm was born in 1829 in Unterrenthendorf and died in 1884 in Renthendorf (Germany). Because of his book, originally named *Brehms Tierleben* (Life of Animals), his name became a household word for popular zoological literature.

Due to his professional recognition in zoological circles, in 1860 he was commissioned to write a 10-volume zoological encyclopedia. The first six volumes of the encyclopedia appeared from 1864 to 1869, published by the Bibliographisches Institut under Herrmann Julius Meyer and illustrated under the direction of Robert Kretschmer. The second edition, which consisted of ten volumes, was published from 1876 to 1879. Charles Darwin reviewed some volumes of the encyclopedia. The second edition was reprinted from 1882 to 1884, and a third edition, published from 1890 to 1893, followed. The work has been translated into various languages. Immediately after the first edition was issued, the original publication was translated into Russian, French, Italian and Danish.

The Institute of Agriculture and Tourism library in Poreč holds a well preserved and complete sample of all six volumes of the original first edition in the Italian language published from 1869-1873. It is entitled *La vita degli animali (*Life of Animals), illustrated by Kretschmer and translated by Gaetano Branca and Stefano Travella. It is very likely the only copy of this edition in Croatia. The Institute is a successor to the research entity named Provincial Agriculture Institute founded in 1875 during the Austro-Hungarian period. The School, specialising in viticulture, enology and pomology, was founded 8 years later and its professors established a good library with the best natural sciences books available at that time. Many of these books are still in the Institute and represent a great historical heritage. Brehm's *Life of Animals* is one of them.



First page of the original first edition of the Brehm's book "La vita degli animali" (Life of Animals)

Worldwide, many editions in several languages were published in the 19th and 20th centuries, some in the form of abridged, one-volume works.

According to OPAC SBN (Catalogo del servizio bibliotecario nazionale) there are about 200 copies of this original Italian first edition published by Unione Tipografico Editrice in Torino in different Italian libraries but not many of those are complete or as well preserved as the one in Poreč. In 1891 the second Italian edition was published by the same publishing house, followed by several copies in the period up to 1963 when the publisher Armando Curcio Editore in Rome published a new book entitled *Vita degli animali*. Several other editions were also published, *i.e.* from Editrice Italiana di cultura (Rome), Istituto Editoriale Moderno (Milano), European Book (Milano), Padova: C.D.E. followed, with the last from Rizzoli (Milano) in 1983.

In Croatia, so far seven editions have been published. The first Croatian edition, named originally *Kako žive životinje* (How Animals Live), was published in 1937 by Minerva publishing house in Zagreb and the second, with the same title, in 1966 by Otokar Keršovani in Rijeka. In the same year, *Brehmove najljepše priče* (Brehm's Best Stories) was published in Zagreb followed two years later by the book entitled *Egzotične ptice* (Exotic Birds). The fifth edition Život životinja (Life of Animals) was issued in 1982 by the publishing house Prosvjeta and the second edition of the same book, in 1983 by Prosvjeta and Sveučilišna naklada Liber. The last edition was issued by the publishing house Orakul in Zagreb in 2002 under the same title, *i.e. Life of Animals*.

The first edition in Slovenian entitled *Življenje živali (*Life of Animals) was published in 1938 by Umetniška propaganda (three volumes in 1938 and one volume in 1940). In 1978 another edition under the name *Velika knjiga o* živali *(*The Great Book of Animals*)* was published by the Cankarjeva založba publishing house in Ljubljana. Two more editions of this book were published by the same publishing house in 1982 and 1986.

This book, published during Brehm's lifetime, and almost simultaneously with the German original, represents a valuable sample of this famous work and it is hoped that, in the near future, it will be properly preserved and restored, as well as made accessible to the public.

*Editorial information about Brehm's Life of Animals in Italy, Croatia and Slovenia was collected with the help of: Fogar Livio, 2014, Biblioteca del Museo Civico di Storia Naturale, Via Tominz, Trieste, Italy, Lopin Mirjam, 2014, Središnja informacijska služba, Nacionalna i sveučilišna knjižnica u Zagrebu, and Škerget Daniela 2014, Slovenska bibliografija, Narodna in univerzitetna knjižnica, Turjaška 1, Ljubljana, Slovenia.

Barbara Sladonja

STROKOVNA SREČANJA O OHRANJANJU KLJUČNIH SREDOZEMSKIH MORSKIH HABITATNIH TIPOV – SYMPOSIA ON THE CONSERVATION OF MEDITERRANEAN MARINE KEY HABITATS

Portorož, 27.–31. oktober 2014

ZAVOD REPUBLIKE SLOVENIJE ZA VARSTVO NARAVE

V zadnjem tednu oktobra se je na treh simpozijih o ohranjanju ključnih sredozemskih morskih habitatnih tipov – podvodnih travnikov ter rastlinskih združb trdnega dna, koraligena in temnih življenjskih okolij – v Grand Hotelu Bernardin v Portorožu zbralo skorajda 150 strokovnjakov s področja morske biologije z vseh koncev Sredozemlja. Simpoziji so potekali v okviru izvajanja akcijskih načrtov, ki so jih sprejele pogodbenice Barcelonske konvencije, katere podpisnica je tudi Slovenija. Barcelonska konvencija, natančneje Konvencija za varstvo morskega okolja in obalnega območja Sredozemlja, vključuje ob ukrepih za preprečevanje onesnaževanja morja tudi ukrepe za ohranjanje najbolj občutljivih in najvrednejših življenjskih okolij. Tistih življenjskih okolij, ki so na eni strani temelj izjemnega bogastva živega sveta pod morsko gladino, na drugi strani pa tudi bistveni pogoj za dolgoročni, trajnostni razvoj prebivalstva na njegovih obalah. To so akcijski načrt za ohranjanje morske vegetacije v Sredozemskem morju (*Action Plan for the Conservation of Marine Vegetation in the Mediterranean Sea*), ki je bil sprejet leta 1999, Akcijski načrt za varstvo koraligena in drugih apnenčastih bioformacij v Sredozemskem morju (*Action Plan for the protection of the coralligenous and others calcareous bio concretions*), sprejet leta 2008, ter Akcijski načrt za ohranjanje habitatov in vrst, vezanih na temna in zatemnjena življenjska okolja (*Action Plan for the conservation of Habitats and Species associated with seamounts, underwater caves and canyons, aphotic engineering benthic invertebrates and chemo-syntethic phenomena in the Mediterranean Sea – Dark Habitats Action Plan*), sprejet leta 2013. Simpozij sta organizirala Regionalni center za zavarovana območja, ki deluje v okviru Sredozemskega akcijskega načrta in Okoljskega programa Združenih narodov, ter Zavod RS za varstvo narave.

Stanje ključnih habitatnih tipov v slovenskem morju je v otvoritvenem delu prvega dneva simpozija predstavil dr. Lovrenc Lipej z Morske biološke postaje Piran Nacionalnega inštituta za biologijo, pomen simpozijev z vidika izvajanja akcijskih načrtov na regionalnem in nacionalnem nivoju ter z vidika uresničevanja slovenske naravovarstvene zakonodaje pa sodelavca Zavoda RS za varstvo narave, mag. Martina Kačičnik Jančar, vodja enote za biotsko raznovrstnost, ter mag. Robert Turk, vodja piranske območne enote in nacionalni koordinator Protokola o zavarovanih območjih in biotski raznovrstnosti (SPA BD Protokol) Barcelonske konvencije.

Vsi trije simpoziji so bili v prvi vrsti namenjeni izboru in predstavam najnovejših znanj o ključnih sredozemskih morskih habitatnih tipih in njihovem pomenu z vidika ohranjanja pestrosti morskega ekosistema ter izmenjavi informacij in izkušenj med raziskovalci. Kljub pretežno znanstveno-raziskovalnemu okviru prispevkov je bil pomemben del razprav namenjen tudi ukrepom in usmeritvam za ohranjanje ugodnega ohranitvenega stanja vrst in habitatnih tipov. V skladu z navedenim so bila ob koncu vsakega posameznega simpozija sprejeta priporočila za nadaljnje aktivnosti, tako na nivoju Sredozemlja in ob koordinaciji centra za zavarovana območja (RAC/SPA) kakor tudi na nacionalnem nivoju. Z vidika slovenskega morja so bila vsekakor najbolj zanimiva in aktualna priporočila, oblikovana ob zaključku simpozija o morski vegetaciji. Udeleženci so si bili edini, da je bilo že veliko narejenega tako z vidika raziskovanja kakor tudi spremljanja stanja vegetacijskih združb, vendar je bila velika večina dela opravljenega v SZ delu Sredozemlja. Zato so pozvali RAC/SPA k nadaljnji podpori tovrstnih aktivnosti s poudarkom na južnem in JV delu Sredozemlja. Izpostavljeno je bilo tudi slabše poznavanje algalnih združb in pa splošno nazadovanje rjavih alg ter celo uvrstitev večine vrst iz rodu *Cystoseira* na seznam ogroženih vrst SPA BD Protokola. V skladu z navedenim je bila predvsem poudarjena potreba po boljšem poznavanju bioloških danosti algalnih združb in posebej po poznavanju vzrokov za njihovo nazadovanje, kar je ključnega pomena za opredelitev ukrepov za izboljšanje stanja. Izpostavljena je bila tudi nujnost večje sinergije in učinkovitejše izmenjave informacij o stanju vegetacijskih združb na nivoju celotnega Sredozemlja, ne le med samimi raziskovalci, pač pa tudi med raziskovalci in »uporabniki«, tj. odločevalci na lokalnem in nacionalnem nivoju, upravljavci zavarovanih območij idr. Kot enega ključnih pogojev za vse navede-

Utrinek s strokovnega srečanja v Portorožu

ne in druge morebitne ukrepe in aktivnosti, namenjene poznavanju in ohranjanju vegetacijskih združb, so udeleženci izpostavili sistematično, dolgoročno spremljanje stanja, ki pa v večini sredozemskih držav (vključno s Slovenijo) pravzaprav nima zagotovljene »domovinske pravice«.

Robert Turk

PROF. DR. JADRAN FAGANELI – PREJEMNIK VELIKE NAGRADE MIROSLAVA ZEIA ZA ŽIVLJENJSKO DELO NA PODROČJU DEJAVNOSTI NACIONALNEGA INŠTITUTA ZA BIOLOGIJO

Prof. dr. Jadran Faganeli je vrhunski raziskovalec biogeokemičnih procesov v morju, zaposlen na Morski biološki postaji Nacionalnega inštituta za biologijo v Piranu. Njegov znanstveni opus je izjemen, saj obsega 122 izvirnih in preglednih znanstvenih prispevkov, od katerih je velika večina objavljenih v revijah s faktorjem vpliva. Prof. dr. Faganeli slovi kot mednarodno uveljavljeni raziskovalec, ki povezuje tako raziskovalce po svetu kot tudi raziskovalna področja z multidisciplinarnimi biogeokemičnimi raziskavami, katerih spoznanja uporabljajo na različnih raziskovalnih področjih, kot npr. v morski ekologiji in limnologiji. Gre za raziskovalca z raznolikim znanstvenim interesom, kar je razvidno tudi iz sodelovanja z različnimi strokovnjaki, kot so biokemiki, fiziki, oceanografi, mikrobiologi, geologi in biologi iz različnih profilov. Njegov znanstveni interes presega okvire raziskovanja morja, saj je raziskoval biogeokemične procese tudi v lagunah in celo visokogorskih jezerih. V izredno bogati znanstveni karieri z raznolikimi predmeti raziskovanj je težko izbrati specifične doprinose prof. Faganelija k mozaiku vedenja o biogeokemiji slovenskega dela Jadrana in severnega Jadrana. V zadnjem desetletju bi lahko združili njegovo znanstveno raziskovanje na tri širše sklope, in sicer na biogeokemijske pretvorbe živega srebra v obalnem morju in lagunah, sestavo in funkcijo koloidne organske snovi v morju s poudarkom na sluzastih makroagregatih ter pretvorbe sedimentirane organske snovi v stratificiranih alpskih jezerih. Raziskoval je z eminentnimi domačimi in tujimi znanstveniki različnih strok, od katerih izstopa izjemno tvorno sodelovanje s prof. dr. Bojanom Ogorelcem in prof. dr. Mileno Horvat, od tujih kolegov pa s prof. dr. Markom Hinesom (ZDA) in prof. dr. Stefanom Covellijem (Italija). O kvaliteti znanstveno-raziskovalnega dela prof. dr. Faganelija priča tudi izjemna znanstvena odmevnost. V zadnjem desetletju je zbral 1168 čistih citatov. Prof. Faganeli sodi med izjemno kvalitetne raziskovalce, kar dokazuje visok H-index njegovih objav (= 19), ki ga dosegajo redki raziskovalci.

Prof. dr. Jadran Faganeli je poleg vsega cenjen redni profesor na Fakulteti za pomorstvo in promet in tudi širše na ljubljanski univerzi, kjer predava predvsem vsebine, povezane z varstvom okolja in biogeokemičnimi procesi v morju. Bil je mentor številnim doktorandom, magistrandom in diplomandom na različnih slovenskih in tujih univerzah, v vrstah katerih so danes mnogi priznani in uveljavljeni raziskovalci. Je soavtor univerzitetnega učbenika in avtor več učnih gradiv na Univerzi v Ljubljani. Leta 1989 je za svoje dosežke s sodelavkama prejel Kidričevo nagrado za raziskave s področja spremljanja stanja morja in iskanje vzrokov za procese v njem.

Najinemu kolegu ob prejemu prestižne nagrade iskreno čestitava in mu želiva še veliko ustvarjalnega dela pri raziskovanju skrivnosti morja.

Lovrenc Lipej in Vlado Malačič

Direktorica NIB prof. dr. Tamara Lah Turnšek izroča Veliko nagrado Miroslava Zeia za življenjsko delo prof. dr. Jadranu Faganeliju (foto: arhiv NIB)

NAVODILA AVTORJEM

1. Revija ANNALES (*Anali za istrske in mediteranske študije* Series historia naturalis) objavlja **izvirne znanstvene** in **pregledne članke** z naravoslovnimi vsebinami, ki obravnavajo posebnosti različnih podpodročij sredozemskega naravoslovja: morska biologija in ekologija, ihtiologija, geologija s paleontologijo, krasoslovje, oljkarstvo, biodiverziteta Slovenije, varstvo narave, onesnaževanje in varstvo okolja, fizična geografija Istre in Mediterana idr. Vključujejo pa tudi **krajše** znanstvene prispevke o zaključenih raziskovanjih., ki se nanašajo na omenjeno področje.

2. Sprejemamo članke v angleškem, slovenskem in italijanskem jeziku. Avtorji morajo zagotoviti jezikovno neoporečnost besedil, uredništvo pa ima pravico članke dodatno jezikovno lektorirati.

3. Članki naj obsegajo do 48.000 znakov brez presledkov oz. 2 avtorski poli besedila. Članek je mogoče oddati na e-naslov annales@mbss.org (zaželjeno) ali na elektronskem nosilcu (CD) po pošti na naslov uredništva.

Avtor ob oddaji članka zagotavlja, da članek še ni bil objavljen in se obvezuje, da ga ne bo objavil drugje.

4. Naslovna stran članka naj vsebuje naslov članka, ime in priimek avtorja (avtorjev), ime in naslov inštitucije, kjer je (so) avtor(ji) zaposlen(i) oz. domači naslov in naslovom elektronske pošte (samo prvi oz. korespondenčni avtor).

5. Članek mora vsebovati **povzetek** in **izvleček.** Izvleček je krajši (cca. 10 vrstic) od povzetka (cca. 30 vrstic).

V *izvlečku* na kratko opišemo namen, metode dela in rezultate. Izvleček naj ne vsebuje komentarjev in priporočil.

Povzetek vsebuje opis namena in metod dela ter povzame analizo oziroma interpretacijo rezultatov. V povzetku ne sme biti ničesar, česar glavno besedilo ne vsebuje. V povzetku se avtor ne sklicuje na slike, tabele in reference, ki so v članku.

6. Avtorji naj pod izvleček članka pripišejo ustrezne **ključne besede** (največ 6). Zaželjeni so tudi angleški (ali slovenski) prevodi izvlečka, povzetka, ključnih besed, podnapisov k slikovnemu in tabelarnemu gradivu. V nasprotnem primeru bo za prevode poskrbelo uredništvo.

7. Glavni del besedila naj vključuje sledeča poglavja: Uvod, Material in metode, Rezultati, Razprava ali Rezultati in razprava, Zaključki (ali Sklepi), Zahvala (če avtor želi), Literatura. Dele besedila je možno oblikovati v podpoglavja (npr. Pregled dosedanjih objav v Uvodu, Opis območja raziskav v Material in metode). Podpisi k slikam so priloženi posebej za poglavjem Literatura.

8. Tabele avtor priravi posebej na ločenih straneh v programu Word, tako kot rokopis, jih zaporedno oštevilči in opremi z naslovom – kratkim opisom. V glavnem delu besedila se sklicuje na tabele tako, da jih na ustreznem mestu označi z npr. "(Tab. 1)".

9. Slikovno gradivo (grafi, zemljevidi, fotografije, table) avtor posreduje v ločenih datotekah (jpeg, tiff) z najmanj 300 dpi resolucije pri želeni velikosti. Največja velikost slikovnega gradiva je 17x20 cm. Vsa potrebna dovoljenja za objavo slikovnega gradiva (v skladu z Zakonom o avtorski in sorodnih pravicah) priskrbi avtor sam in jih predloži uredništvu pred objavo članka. Slike je potrebno tudi podnasloviti in zaporedno oštevilčiti (glej točko 7). V glavnem delu besedila se avtor sklicuje na slike tako, da jih na ustreznem mestu označi z npr. "(Sl. 1)".

10. Bibliografske opombe, s čimer mislimo na **citat** – torej sklicevanje na druge publikacije, sestavljajo naslednji podatki v oklepaju: *avtor* in *leto izida*; npr. (Novak, 2007). Če sta dva avtorja, se izpišeta oba (Novak & Kranjc, 2001), če so trije ali več pa se izpiše samo prvi, ki mu sledi okrajšava *et al*. (Novak *et al*., 1999). Več citatov je med seboj ločenih s podpičjem in si sledijo kronološko - z naraščajočo letnico izdaje, npr. (Novak *et al*., 1999; Adamič, 2001; Kranjc & Zupan, 2007). Osebno informacijo (ustno, pisno) izpišemo prav tako v oklepaju z navedbo kratice imena in priimka posredovalca informacije, za vejico pa dodamo "osebno sporočilo", npr. (J. Novak, *osebno sporočilo*).

11. Celotni **bibliografski podatki** so navedeni v poglavju Literatura v abecednem vrstnem redu. Pri tem avtor navede izključno dela, ki jih je v članku citiral. Če ima isti avtor več bibliografskih podatkov, se najprej kronološko izpišejo tisti, kjer je edini avtor, sledijo dela v soavtorstavu še z enim avtorjem in dela v soavtorstvu z več avtorji. Imena revij, v katerih so izšla citirana dela, se izpišejo okrajašano (splošno priznane okrajšave revij). Članki, ki še niso bili publicirani, se lahko citirajo le, če so bili dokončno sprejeti v tisk, pri čemer se na koncu bibliografskega podatka doda beseda "v tisku". Člankov, ki so šele bili poslani v recenzijo, se ne sme citirati.

Primeri navajanje različnih tipov bibliografskih podatkov:

članki v revijah:

Klock, J.-H., A. Wieland, R. Seifert & W. Michaelis (2007): Extracellular polymeric substances (EPS) from cyanobacterial mats: characterisation and isolation method optimisation. Mar. Biol., 152, 1077-1085.

Knjige in druge neserijske publikacije (poročila, diplomska dela, doktorske disertacije):

Wheeler, A. (1969): The fishes of the British Isles and North-West Europe. McMillan, London, 613 p.

Poglavje v knjigi:
McEachran, J. D. & C. Capapé (1984): Myliobatidae. In: Whitehead, P. J. P., M. L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese (eds.): Fishes of the North-eastern Atlantic and the Mediterranean, Vol. 1. Unesco, Paris, pp. 205-209.

12. Drugo: latinski izrazi kot npr. *in vivo*, *in situ*, *e.g.*, *i.e.*, ter rodovna (*Myliobatis* sp.) in vrstna (*Myliobatis aquila*) imena se izpišejo v fontu italic. Kadarkoli je možno, se uporabljajo enote iz sistema SI (Système international d'unités).

13. Prvi odtis člankov uredništvo pošlje avtorjem v **korekturo.** Avtorji so dolžni popravljeno gradivo vrniti v enem tednu. Besedilo popravljamo s korekturnimi znamenji, ki jih najdemo na koncu Slovenskega pravopisa (2001), Ljubljana, ZRC SAZU, 24–25.

Širjenje obsega besedila ob korekturah ni dovoljeno. Druge korekture opravi uredništvo.

14. Za dodatna pojasnila v zvezi z objavo člankov je uredništvo na voljo.

UREDNIŠTVO

ISTRUZIONI PER GLI AUTORI

1. La rivista ANNALES (*Annali per gli studi istriani e mediterranei*, Series historia naturalis) pubblica **articoli scientifici originali** e **compendii** dai contenuti scientifici relativi ai vari settori della storia naturale e pertinenti l'area geografica del Mediterraneo: biologia marina, ecologia, ittiologia, geologia, paleontologia, carsologia, olivicoltura, biodiversità della Slovenia, tutela della natura, inquinamento e tutela dell'ambiente, geografia fisica dell'Istria e del Mediterraneo ecc. La rivista pubblica anche articoli scientifici **brevi** relativi a ricerche concluse pertinenti a tali settori.

2. La Redazione accetta articoli in lingua inglese, slovena e italiana. Gli autori devono garantire l'ineccepibilità linguistica dei testi, la Redazione si riserva il diritto di una revisione linguistica.

3. Gli articoli devono essere di lunghezza non superiore alle 48.000 battute senza spazi, ovvero 2 fogli d'autore. Possono venir recapitati all'indirizzo di posta elettronica annales@mbss.org (preferibilmente) oppure su supporto elettronico (CD) per posta ordinaria all'indirizzo della Redazione.

L'autore garantirà l'originalità dell'articolo e si impegnerà a non pubblicarlo altrove.

4. Ogni articolo deve essere corredato da: **titolo**, nome e cognome dell'autore (autori), denominazione ed indirizzo dell'ente di appartenenza o, in alternativa, l'indirizzo di casa, nonché l'indirizzo di posta elettronica (solo del primo autore o dell'autore di corrispondenza).

5. I contributi devono essere corredati da un **riassunto** e da una **sintesi**. Quest'ultima sarà più breve (cca. 10 righe) del riassunto (cca 30 righe).

Nella *sintesi* si descriveranno brevemente lo scopo, i metodi e i risultati delle ricerche. La sintesi non deve contenere commenti e segnalazioni.

Il *riassunto* riporterà in maniera sintetica lo scopo, i metodi delle ricerche e l'analisi ossia l'interpretazione dei risultati. Il riassunto non deve riferirsi alle tabelle, figure e alla bibliografia contenuta nell'articolo.

6. Gli autori sono tenuti ad indicare le **parole chiave** adeguate (massimo 6). Sono auspicabili anche le traduzioni in inglese (o sloveno) della sintesi, del riassunto, delle parole chiave, delle didascalie e delle tabelle. In caso contrario, vi provvederà la Redazione.

7. Il testo principale deve essere strutturato nei seguenti capitoli: Introduzione, Materiali e metodi, Risultati, Discussione o Risultati e discussione, Conclusioni, Ringraziamenti (se necessari), Bibliografia. Il testo può essere strutturato in sottocapitoli (ad es. sottocapitolo Rassegna delle pubblicazioni nell'Introduzione; sottocapitolo Descrizione dell'area di ricerca nel capitolo Materiali e metodi). Le didascalie devono essere presentate separatamente, a seguito del capitolo Bibliografia.

8. Le tabelle saranno preparate in forma elettronica come il manoscritto (formato Word) e allegate in fogli separati alla fine del testo. Gli autori sono pregati di contrassegnare ogni tabella con un numero e il titolo ossia una breve descrizione. Nel testo la tabella viene richiamata come segue: (Tab. 1).

9. Il materiale grafico (grafici, carte geografiche, fotografie, tavole) va preparato in formato elettronico (jpeg o tiff) e consegnato in file separati, con una definizione di 300 dpi alla grandezza desiderata, purché non ecceda i 17x20 cm. Prima della pubblicazione, l'autore provvederà a fornire alla Redazione tutte le autorizzazioni richieste per la riproduzione del materiale grafico (in virtù della Legge sui diritti d'autore). Tutto il materiale grafico deve essere accompagnato da didascalie (vedi punto 7) e numerato.. Nel testo i grafici vengono richiamati come segue: (ad es. Fig. 1).

10. I riferimenti bibliografici (citazioni) richiamano un'altra pubblicazione (articolo). La nota bibliografica, riportata nel testo, deve contenere i seguenti dati tra parentesi: *cognome dell'autore*, *anno di pubblicazione*, ad es. (Novak, 2007). Se gli autori sono due, verranno indicati entrambi (Novak & Kranjc, 2001), nel caso di tre o più autori verrà indicato soltanto il primo, seguito dall'abbreviazione *et al.* (Novak *et al.,* 1999). Vari riferimenti bibliografici in una stessa nota vanno divisi dal punto e virgola e segnalati in ordine cronologico, ad. es. (Novak *et al.*, 1999; Adamič, 2001; Kranjc & Zupan, 2007). La testimonianza (orale, scritta) verrà indicata tra parentesi con l'abbreviazione del nome e con il cognome di chi l'ha trasmessa, seguiti dalla virgola e la dicitura "informazione personale", ad es. (J. Novak, *informazione personale*).

11. La bibliografia completa va inserita in ordine alfabetico nel capitolo Bibliografia. L'autore indicherà esclusivamente i lavori e le edizioni citati nell'articolo. Se si citano più lavori dello stesso autore, verranno indicati prima in ordine cronologico i lavori in cui l'autore appare solo, poi quelli in cui l'autore compare assieme ad un secondo coautore, seguiti infine da quelli in cui egli compare tra più coautori. I nomi delle riviste in cui sono pubblicati i lavori citati saranno indicati nella forma abbreviata (abbreviazioni ufficialmente riconosciute). Gli articoli inediti si possono citare soltanto se sono in corso di pubblicazione, facendo loro seguire la dicitura "in corso di pubblicazione". Gli articoli, non ancora recensiti non possono essere citati.

Esempio di lavoro bibliografico:

Articoli in riviste:

Klock, J.-H., A. Wieland, R. Seifert & W. Michaelis (2007): Extracellular polymeric substances (EPS) from cyanobacterial mats: characterisation and isolation method optimisation. Mar. Biol., 152, 1077-1085.

Libri ed altre pubblicazioni non periodiche (relazioni, tesi di laurea, dissertazioni di dottorato):

Wheeler, A. (1969): The fishes of the British Isles and North-West Europe. McMillan, London, 613 p.

Capitoli di libro:

McEachran, J. D. & C. Capapé (1984): Myliobatidae. In: Whitehead, P. J. P., M. L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese (eds.): Fishes of the North-eastern Atlantic and the Mediterranean, Vol. 1. Unesco, Paris, pp. 205-209.

12. Altro: Le espressioni latine come ad es. *in vivo*, *in situ*, *e.g.*, *i.e.*, i nomi dei generi famiglie (*Myliobatis* sp.) e delle specie (*Myliobatis aquila*) si scrivono con il carattere italic. Quando possibile saranno utilizzate le unità del sistema SI (*Système international d'unités*).

13. Gli autori ricevono le **prime bozze** di stampa per la revisione. Le bozze corrette vanno quindi rispedite entro una settimana alla Redazione. In questa fase, i testi corretti con segni adeguati (indicazioni in merito si trovano alla fine della pubblicazione "Slovenski pravopis" (2001), Ljubljana, ZRC SAZU, 24-25, non possono essere più ampliati. La revisione delle bozze è svolta dalla Redazione.

14. La Redazione rimane a disposizione per eventuali chiarimenti.

LA REDAZIONE

INSTRUCTIONS TO AUTHORS

1. The journal ANNALES (*Annals for Istrian and Mediterranean Studies,* Series historia naturalis) publishes **original scientific** and **review articles** in the field of natural studies related to the specifics of various subfields of Mediterranean natural studies: marine biology and ecology, ichthyology, geology with paleontology, karst studies, olive growing, biodiversity of Slovenia, nature protection, pollution and environmental protection, physical geography of Istria and the Mediterranean, etc. It also publishes **short** scientific papers on completed research projects related to the above-mentioned subfields.

2. The articles submitted can be written in the English, Slovene or Italian language. The authors should ensure that their contributions meet acceptable standards of language, while the editorial board has the right to have them language edited.

3. The articles should be no longer than 48,000 characters (spaces excluded) or 32 typewritten double-spaced pages. They can be submitted via e-mail annales@mbss.org (preferably) or regular mail, with the electronic data carrier (CD) sent to the address of the editorial board.

Submission of the article implies that it reports original unpublished work and that it will not be published elsewhere.

4. The **title page** should include the title of the article, the name and surname of the author(s), their affiliation (institutional name and address) or home address, and e-mail address (of the first author or the corresponding author only).

5. The article should contain the **summary** and the **abstract,** with the former (c. 30 lines) being longer than the latter (c. 10 lines).

The *abstract* contains a brief description of the aim of the article, methods of work and results. It should contain no comments and recommendations.

The *summary* contains the description of the aim of the article and methods of work and a brief analysis or interpretation of results. It can contain only the information that appears in the text as well. It should contain no reference to figures, table and citations published in the main text.

6. Beneath the abstract, the author(s) should supply appropriate **keywords** (max 6) and, if possible, the English (or Slovene) translation of the abstract, summary, keywords, and captions to figures and tables. If unprovided, the translation will be provided by the editorial board.

7. The **main text** should include the following chapters: Introduction, Material and Methods, Results, Discussion or Results and Discussion, Conclusion, Acknowledgement (not obligatory), References. Individual parts of the text can form a sub-chapter (e.g. Survey of Previous Studies under Introduction; Description of Research Area under Material and Methods). Captions to figures should appear on a separate page beneath References.

8. Each **table** should be submitted on a separate page in Word programme (just like the main text). It should be numbered consecutively and supplied with the title – brief description. When referring to the tables in the main text, use the following style: (Tab. 1).

9. Illustrative matter (diagrams, maps, photographs, plates) should be submitted as separate files (in jpeg or tiff format) and saved at a minimum resolution of 300 dpi per size preferred, with the maximum possible publication size being 17x20 cm. Prior to publication, the author(s) should obtain all necessary authorizations (as stipulated by the Copyright and Related Rights Act) for the publication of the illustrative matter and submit them to the editorial board. All figures should be captioned and numbered consecutively (cf. Item 7). When referring to the figures in the main text, use the following style: (Fig. 1).

10. **Bibliographic notes** or **citations** – i.e. references to other articles or publications – should contain the following data: *author* and *year of publication,* e.g. (Novak, 2007). If there are two authors, include both surnames (Novak & Kranjc, 2001); if there are more than two authors, include the surname of the first author followed by a comma and the abbreviation *et al.* (Novak *et al.*, 1999). If there is more than one reference, separate them by a semicolon and list them in ascending chronological order, e.g. (Novak *et al.*, 1999; Adamič, 2001; Kranjc & Zupan, 2007). When citing information obtained through personal communication (oral, written), provide the initial letter of the name and full surname of the informant followed by a comma and the phrase *personal communication,* e.g. (J. Novak, *personal communication*).

11. The entire list of **bibliographic data** should be published under References in alphabetical order. The author(s) should list only the works cited in the article. If you are listing several works by the same author with some of them written in co-authorship, first list those written by the author him/herself, then those written in co-authorship with another author, and finally those written in co-authorship with more than one author, with the entries listed in chronological order. The names of journals in which the works cited were published should be abbreviated (cf. list of official journal abbreviations). Unpublished articles can be cited only if they have been

approved for publication, which should be indicated by adding the phrase *in press* to the end of the relevant bibliography entry.

Some examples of how to cite different types of bibliographical data:

Articles published in serial publications:

Klock, J.-H., A. Wieland, R. Seifert & W. Michaelis (2007): Extracellular polymeric substances (EPS) from cyanobacterial mats: characterisation and isolation method optimisation. Mar. Biol., 152, 1077-1085.

Books and other non-serial publications (reports, diploma theses, doctoral dissertation):

Wheeler, A. (1969): The fishes of the British Isles and North-West Europe. McMillan, London, 613 p.

Chapters published in a book:

McEachran, J. D. & C. Capapé (1984): Myliobatidae. In: Whitehead, P. J. P., M. L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese (eds.): Fishes of the North-eastern Atlantic and the Mediterranean, Vol. 1. Unesco, Paris, pp. 205-209.

12. Miscellaneous: Latin phrases such as *in vivo*, *in situ*, *e.g.*, *i.e.*, and names of genera (*Myliobatis* sp.) and species (*Myliobatis aquila*) should be written in italics. Whenever possible, use the SI units (Système international d'unités).

13. The authors are sent the **first page proofs**. They should be returned to the editorial board within a week. When reading the proofs, the authors should use the correction signs listed at the end of the book Slovenski pravopis (2001), Ljubljana, ZRC SAZU, 24–25.

It is not allowed to lengthen the text during proof-reading. Second proof-reading is done by the editorial board.

14. For additional information regarding article publication contact the editorial board.

EDITORIAL BOARD

KAZALO K SLIKAM NA OVITKU

SLIKA NA NASLOVNICI:
V Tržaškem zalivu se je konec leta 2014 pojavila dalmatinska lasasta meduza (*Drymonema dalmatinum*), ki je pravi orjak med morskimi klobučnjaki. Opisal jo je sloviti naravoslovec Ernst Haeckel leta 1880 ravno na podlagi meduz iz Jadranskega morja. Slovel je tudi kot nadarjen risar, kar kaže tudi njegova ilustracija lasaste meduze iz leta 1882.
Sl. 1: Tujerodna vrsta alge *Caulerpa cylindracea* se vztrajno širi po Jadranskem morju. Letos so jo zasledili že povsem na severozahodu istrskega polotoka. (Foto: M. Trifunac)
Sl. 2: Zaradi čedalje bolj priljubljene podvodne fotografije potapljači odkrivajo in fotografirajo mnoge manj znane vrste pridnenih živali, kot je npr. polž zaškrgar *Philinopsis depicta*. (Foto: B. Mavrič)
Sl. 3: Zaradi večjega raziskovalnega napora odkrivajo morski biologi manj znane in redke vrste morskih nevretenčarjev. To velja tudi za trdoživnjaško meduzo vrste *Neoturris pileata*. (Foto: B. Mavrič)
Sl. 4: V Piranskem zalivu so bile nedavno najdene steljke navadne sargaške alge (*Sargassum vulgare*), ki so rasle med cistoziro (*Cystoseira compressa*). Trajnice iz rodu *Sargassum* so indikatorske vrste visoke kakovosti okolja in se zato uporabljajo pri oceni ekološkega stanja sredozemskih obalnih voda. (Foto: B. Mavrič)
Sl. 5: Živopisane podobe polžev gološkrgarjev so že od nekdaj privabljale podvodne fotografe. Eden tovrstnih lepotcev je vrsta *Dondice banyulensis*. (Foto: B. Mavrič)
Sl. 6: Trdoživnjaška meduza *Aequorea forskalea* je pravcati orjak med predstavniki svoje skupine, pa vendar meri v premeru kvečjemu 15 centimetrov. (Foto: B. Mavrič)

INDEX TO IMAGES ON THE COVER

FRONT COVER:
By the end of 2014 a scyphomedusa, *Drymonema dalmatinum,* a real giant among jellyfish*,* was reported. It was described and named by the renowned scientist Ernst Haeckel in 1880 on the basis of the findings in the Adriatic Sea. He was famous as a skilled illustrator, as can be seen from his drawing of the medusa dating from 1882.
Fig. 1: A non-indigenous alga, *Caulerpa cylindracea*, is steadily spreading northward in the Adriatic Sea. Recently it was confirmed off the northwestern shore of the Istrian Peninsula. (Photo: M. Trifunac)
Fig. 2: Due to the popularity of underwater photography divers discover many less well-known and rare sea slugs such as *Philinopsis depicta* depicted in the photo. (Photo: B. Mavrič)
Fig. 3: The increase in research has resulted in the discovery of many interesting, less well-known marine invertebrates. The same is true for the hydromedusa *Neoturris pileata*. (Photo: B. Mavrič)
Fig. 4: Some thalli of *Sargassum vulgare*, growing among *Cystoseira compressa*, were recently found in the Bay of Piran. Perennial species from the genus *Sargassum* are considered to be indicators of high environmental quality and are therefore used in the assessment of the Ecological Status of Mediterranean coastal waters. (Photo: B. Mavrič)
Fig. 5: The vivid coloration of nudibranch sea slugs has always attracted underwater photographers. One such colourful sea slug is *Dondice banyulensis*. (Photo: B. Mavrič)
Fig. 6: The hydromedusa *Aequorea forskalea* is a real giant in comparison with its relatives, although it measures only 15 cm across its bell diameter. (Photo: B. Mavrič)

ANNALES · Ser. hist. nat. · 24 · 2014

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

UDK 5 Letnik 24, Koper 2014 ISSN 1408-533X

VSEBINA / *INDICE GENERALE / CONTENTS*

RECENTNE SPREMEMBE
V SREDOZEMSKI BIODIVERZITETI
CAMBIAMENTI RECENTI DELLA BIODIVERSITÀ MEDITERRANEA
RECENT CHANGES IN THE MEDITERRANEAN BIODIVERSITY

SREDOZEMSKE HRUSTANČNICE
PESCI CARTILAGINEI DEL MEDITERRANEO
MEDITERRANEAN ELASMOBRANCHS