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

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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-

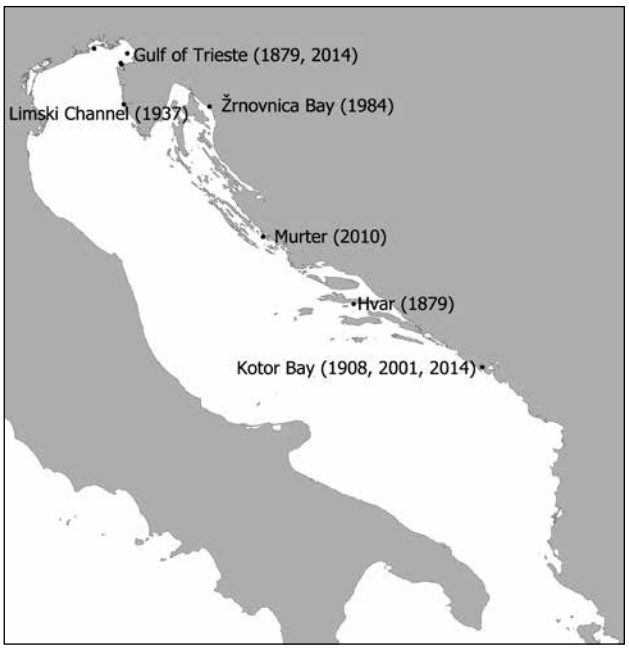

Fig. 1: Scheme of the Adriatic Sea with marked places/ dates of *Drymonema dalmatinum* ***sightings.***
Sl. 1: Shematski prikaz Jadranskega morja z označenimi mesti in leti opazovanj dalmatinske lasaste meduze *(Drymonema dalmatinum)*

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.

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

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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

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