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DISAPPEARANCE OF *FUCUS VIRSOIDES* J. AGARDH FROM THE SLOVENIAN COAST (GULF OF TRIESTE, NORTHERN ADRIATIC)

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ABSTRACT

At the end of 2010, a significant decline in populations of Fucus virsoides *was observed in the Slovenian coast (Gulf of Trieste, northern Adriatic), which prompted the undertaking of a direct observation assessment of changes in the occurrence of these populations along the Slovenian coast over the period 2010–2015. The paper presents a comparison between historical and current data on the presence of* F. virsoides *along the Slovenian coast, gathered through in situ surveys and from literature, and proposes the possible causes that have led to the decline and disappearance of* F. virsoides *populations along the Slovenian coastline.*

Key words: *Fucus virsoides*, occurrence, disappearance, Slovenian coast, northern Adriatic

SCOMPARSA DI *FUCUS VIRSOIDES* J. AGARDH DALLA COSTA SLOVENA (GOLFO DI TRIESTE, ALTO ADRIATICO)

SINTESI

Un importante declino dei popolamenti a Fucus virsoides *è stato osservato verso la fine del 2010 lungo la costa della Slovenia (Golfo di Trieste, Alto Adriatico). Nella nota vengono riportati i risultati di uno studio sulla distribuzione di* F. virsoides *lungo la costa della Slovenia nel periodo 2010–2015, attraverso l'osservazione diretta. Si mettono inoltre a confronto i dati storici con quelli attuali sulla presenza di* F. virsoides *in quest'area attraverso uno studio in situ e su fonti bibliografiche. Vengono avanzate delle ipotesi sulle possibili cause che hanno portato al rapido declino e alla successiva scomparsa di questa specie lungo la costa della Slovenia.*

Parole chiave: *Fucus virsoides,* presenza, scomparsa, costa della Slovenia, Alto Adriatico

INTRODUCTION

The brown alga *Fucus virsoides* J. Agardh is the only species of the genus *Fucus* that occurs in the Adriatic Sea (Ardissone, 1886; Schiffner & Vatova, 1938; Linardić, 1949; Pignatti, 1962; Giaccone & Pignatti, 1967; Munda, 1972). In the past, it was the only brown alga and the most conspicuous canopy-forming macrophyte to be found along the Slovenian coast, patchily distributed on the hard substrates of its midlittoral zone (Vukovič, 1980, 1982; Munda, 1993a; Battelli, 2002; Lipej *et al*., 2004; Rindi & Battelli, 2005; Battelli, 2013; Orlando-Bonaca *et al*. 2013). *F. virsoides* has been recorded along the Adriatic shores from Venice in Italy to Albania (*e.g.*, Linardić, 1949; Kashta, 1995/96; Mačić, 2006). It is not clear which factors limit its occurrence. In addition to geomorphological characteristics, the key limiting factors are probably high salinity and high average annual temperatures (Vouk, 1938; Linardić, 1949). In recent years, particular attention has been paid to climate-related variables (Boero & Bonsdorff, 2007; Boero *et al*. 2008; Munda, 2008).

In studies carried out to date, the distribution pattern and abundance of *F. virsoides* have been related to substratum configuration, exposure to winds, wave direction (Lipizer *et al*., 1995; Orlando-Bonaca *et al*., 2013), low salinity of sea water (Vouk, 1938; Linardić, 1949; Giaccone & Pignatti, 1967; Munda, 1972), low concentration of pollutants (Vukovič, 1980, 1982; Munda & Kremer, 1977; Kremer & Munda, 1982; Munda, 1972, 1981, 1982, 1991, 1993a, 1993b), and type of substratum (Vukovič, 1982; Battelli, 2002; Rindi & Battelli, 2005; Battelli, 2013). Several authors revealed the midlittoral zone to be an extremely variable environment, characterized by periodic fluctuations of several ecophysiological parameters during the tidal cycles, such as light, temperature, hydrodynamics and grazing (Pignatti, 1962; Giaccone & Pignatti, 1967; Munda, 1972; Battelli, 2013).

The impact of anthropogenic disturbance on the structure, dynamics and composition of the macroalgal midlittoral assemblages of northern Adriatic was highlighted by several authors (Lipizer *et al.*, 1995; Vukovič, 1980, 1982; Munda, 1993a, 1993b, 2000; Battelli, 2002; Rindi & Battelli, 2005; Lipej *et al*., 2004, 2006; Falace *et al*., 2010; Orlando-Bonaca *et al*., 2013).

The use of historical data in marine ecology provides a valid instrument for detecting and understanding recent changes that may occur in marine ecosystems particularly due to human activities (Jackson *et al*., 2001). This approach is also important for designing appropriate policies for habitat management and conservation, so that the changes can be assessed through long-term analysis (*e.g*. Falace *et al*., 2010).

A significant decline in the abundance of populations of this species was observed at the end of autumn 2010 along the entire Slovenian coast (Gulf of Trieste, northern Adriatic). This appears to be the largest decline event ever recorded in the midlittoral assemblages of this area. To date, no explanation has been proposed about the cause(s) of this event.

In order to illustrate the decline of *F. virsoides* populations along the Slovenian coast, their historical distribution was compared to recent field observations. The aims of this study were: (a) to summarize the distribution of *F. virsoides* along the Slovenian coast based on literature information, and (b) to document the state of the populations of the species in this area during the period 2010–2015. Based on the current distribution, the possible causes of and the factors responsible for the observed disappearance of *F. virsoides* populations are proposed.

MATERIAL AND METHODS

Study area

The Slovenian coast is located in the southern part of the Gulf of Trieste and extends for approximately 46 km from Sv. Jernej's Bay (the cape Debeli rtič – the north side of the Koper Bay) to the Dragonja River (Piran Bay – near the Croatian border). Most of the shore is influenced by dominant winds blowing from North-North-East and from South-East. The sea surface temperature generally ranges between a minimum of 7 °C in February and a maximum of 28 °C in August; the salinity from 28 in spring and summer to 36–37 in winter. The vertical extent of the midlittoral zone (between Mean Higher High Water and Mean Lower Low Water) is approximately 90 cm (ARSO, 2015). The Slovenian coastal area is characterized by its two main bays: Koper Bay and Piran Bay. The rocky substrate consists mainly of Eocene flysch layers, with alternating solid sandstone and soft marl (Ogorelec *et al*., 1997); in the area of Izola (San Simon), the coast is formed of Alveoline-nummulitic limestone (Pavlovec, 1985). The morphology of the coastline varies from steep flysch cliffs to sloping beaches mainly composed of allochthonous substrata made of sandstone and marl gravel, and pebbles of different size. In the recent decades, the Slovenian coastal area has been subjected to many anthropogenic influences such as farming, mariculture, urbanization and large-scale tourism-related activities, with the result that nowadays only about 18% of the shore can be considered in its natural state (Turk *et al.*, 2007).

Historical information about the presence of *Fucus virsoides*

Long-term changes of the *F. virsoides* populations along the Slovenian coast were analysed and a comparison was made between historical data on the occurrence of these communities in the past and in the period 2010–2015. Only the collectors who gathered samples of *F. virsoides* from the Slovenian coast were cited. The first record dates back to 1856 – Pius Titius (1801–1884)

collected the species along the coast of Piran under the name *Fucus sherardi* (specimens held in the Herbarium of the Slovenian Museum of Natural History, Ljubljana) (Alberti & Battelli, 2002). Giuseppe Accurti (1824–1907), in 1858, first mentioned the presence of this alga along the shores of Koper Bay. In 1858, he published the article "*Cenno sulle alghe di Capodistria*", in which he described in detail 195 species of algae collected in Koper Bay. Another important collector of marine organisms of this period was Antonio Zaratin (1846–1923). His herbarium contains nine samples of *F. virsoides*: two of them, collected in Koper Bay (one in September 1886 and the other in March 1910) and reported as *F. vesiculosus* Ag., are part of, respectively, the "*Herbarium Patavinum*" collection of the Botanical Museum of Padua, and the "*Flora marina Iustinopolitana*" collection of the Gian Rinaldo Carli Gymnasium, Koper. Five samples of *F. virsoides* were collected in Koper Bay as *F. Scherardi* Ag. in May 1886, September 1886, October 1909, January 1910 and May 1910, and they are all preserved in the above-mentioned "*Flora marina Iustinopolitana*". The oldest voucher samples of the Zaratin collection were collected in Piran Bay in August 1885 as *F. Sherardi* Ag., and are currently conserved at the Ruđer Bošković Institute Centar za istraživanje mora, Rovinj - Centre for Marine Research, Rovinj (Croatia) (Battelli & Alberti, 2003).

Historical information about the distribution of *F. virsoides* populations

The past distribution of *F. virsoides* on the Slovenian coast was assessed using data obtained from a variety of sources, including all available published literature dealing with the presence of *F. virsoides* on the Slovenian coast (Accurti, 1858; Štirn, 1965; Matjašič & Štirn, 1975; Chiesa & Lorenzoni, 1980; Vukovič, 1980, 1982; Munda, 1991, 1993a, 1993b; Battelli, 1999, 2002; Alberti & Battelli, 2002; Battelli & Alberti, 2003; Lipej et al., 2004; Orlando-Bonaca *et al.*, 2013).

The first map of the distribution of *F. virsoides* along the Slovenian coast was drawn by Štirn (1965). Among subsequent publications, some presented detailed maps of the area in its totality (Lipej *et al.*, 2004; Orlando-Bonaca *et al.*, 2013), others only in parts (Piran Bay by Vukovič, 1980, and Koper Bay by Vukovič, 1982).

Environmental parameters

Data of several physical and chemical parameters of the sea surface, provided by the Environment Agency of the Republic of Slovenia (ARSO), were analysed. The selected parameters included: temperature (°C), salinity, nitrites (µmol NO_2/l), nitrates (µmol NO_3/l), ammonia (µmol NH_4), orthophosphates (µmol PO_4/l), total nitrogen (µmol N/l) and silicate (µmol SiO_2/l). The monthly means of these data were grouped into seasonal means for the period 2005–2014. The latter period was divided into two main periods, 2005–2010 and 2011–2014, since the onset of the decline of *F. virsoides* populations was observed in late 2010.

Field work: observations in the period 2010–2015

The distribution of *F. virsoides* on the Slovenian coast in the years 2010–2015 was assessed through year-round field observation, grouping the data by season (i.e. winter comprised the data for January, February and March; spring comprised the data for April, May and June; summer comprised the data for July, August and September; autumn comprised the data for October, November and December). We inspected the whole Slovenian coastline at selected sites, as shown in Table 1, from Sv. Jernej's Bay (the cape Debeli rtič) to the Dragonja River (near the Croatian border), paying special attention to the sites sampled by previous researchers.

The occurrence of *F. virsoides* was assessed visually along the coast during low tide, as the latter provides the best conditions for direct observations. For this purpose, the semi-quantitative categories for the abundance of macroalgae, based on the work of Ballesteros *et al*. (2007) and tested by Orlando-Bonaca *et al*., (2013), were used: F1= rare to scattered thalli, F2 = abundant patches, F3 = a continuous or almost continuous belt.

The vertical extent of the midlittoral surveyed zone was approximately 1 m and included sandstone and limestone boulders that are not moved by most waves, breakwaters composed of limestone, and sandstone boulders. Excluded from the survey were river mouths, inner parts of commercial harbours, sites to which access was forbidden (such as marinas, hotel beaches, etc.), areas composed of marl, and mobile substrates such as sand, mud, or pebbles, which are mobile in wave conditions, as they are all unsuitable for the development of *F. virsoides*.

Sampling of *Patella caerulea*

During the period 2010–2015, an increase in the number of the main grazers of the midlittoral zone, *P. caerulea,* was observed (*pers. obs.*). Therefore, throughout April 2015, the density of *P. caerulea* in the rocky midlittoral zone was assessed in 20 sites distributed along the Slovenian coast (from Sv. Jernej's Bay – the cape Debeli rtič to the Sečovlje saltpans). The study examined the same sites as the previous researchers who studied the occurrence of *F. virsoides* populations. In order to estimate the density of *P. caerulea,* the individuals were counted in five randomly chosen 400 cm^2 (20 x 20 cm) quadrats at each selected site.

Data analyses

To evaluate the differences between seasonal mean values of physical and chemical parameters of the sea

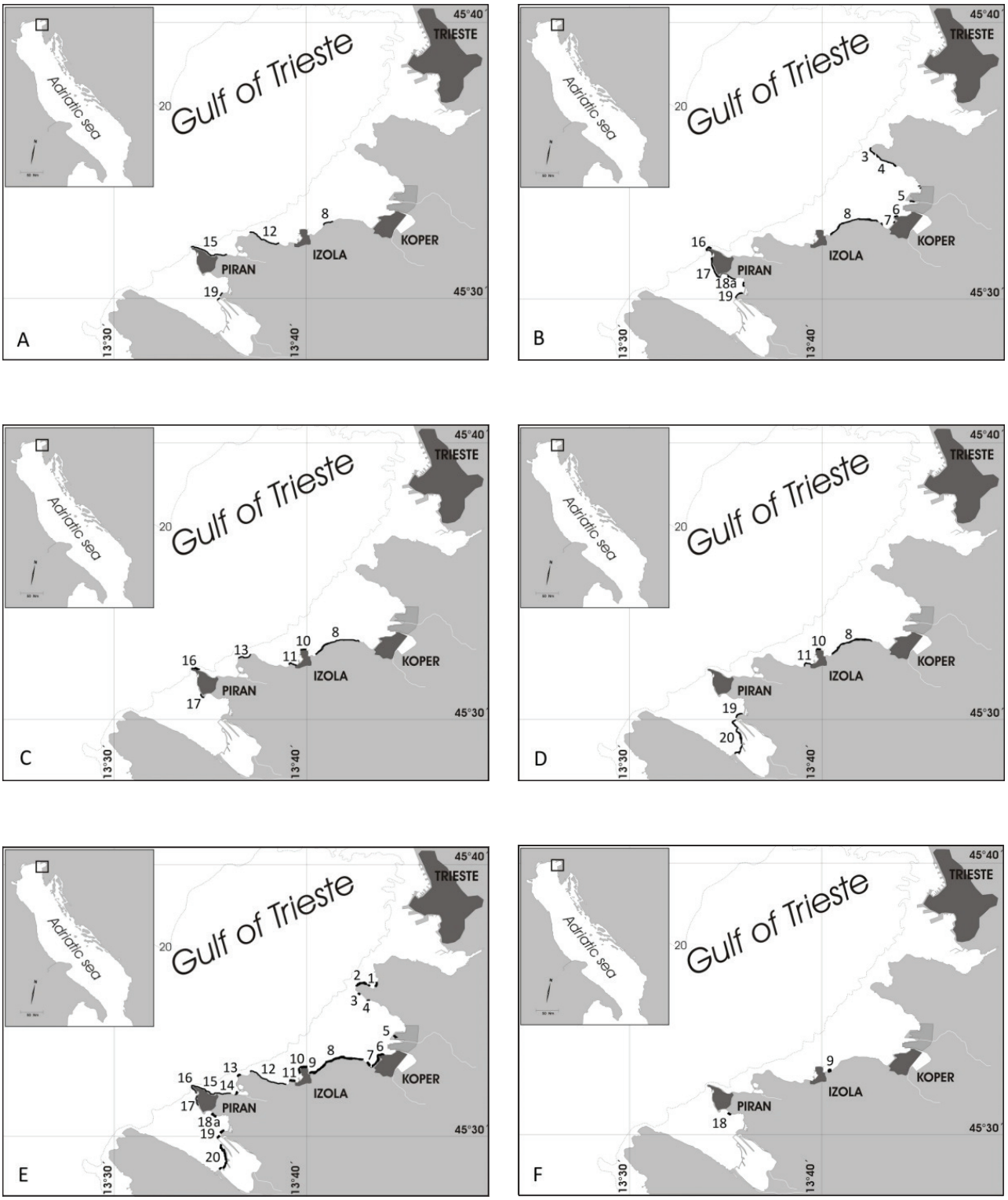

Fig. 1: Maps of the distribution of** Fucus virsoides **according to historical and recent data: (A) Štirn (1965); (B) Vukovič (1982); (C) Lipej** et al. **(2004); (D) Orlando-Bonaca** et al. **(2013); (E) this study, before autumn 2010, and (F) this study, during the period 2011–2015. The black bold lines with numbers indicate the presence of** F. virsoides**.
***Sl. 1: Zemljevid razširjenosti vrste** Fucus virsoides **glede na zgodovinske in novejše podatke: (A) Štirn (1965); (B) Vukovič (1982); (C) Lipej** et al. **(2004); (D) Orlando-Bonaca** et al. **(2013); (E) pričujoče delo; pred jesenjo 2010 in (F) pričujoče delo; v obdobju 2011–2015.* **Črne črte s številkami označujejo pojavljanje vrste** F. virsoides**.**

surface, the non-parametric Kruskal-Wallis test was used.

RESULTS AND DISCUSSION

Long-term distribution of *F. virsoides* populations

The historical and current distribution of the populations of *F. virsoides* along the Slovenian coastline is illustrated in Figure 1. Comparisons between the single distribution reports by Štirn (1965), Vukovič (1982), Lipej *et al*. (2004), Orlando-Bonaca *et al*. (2013) and the present study, for the period before autumn 2010, show an increase in the distribution of this species all along the Slovenian coast. To date, no explanation about the cause(s) of this event has been proposed.

A comparison between the distribution of *F. virsoides* before autumn 2010 (Fig. 1A, 1B, 1C, 1D, 1E) and the findings of the present study covering the period 2011–2015 (Fig. 1F) reveal a drastic decline that began after autumn 2010.

In the period from the winter to summer 2010, *F. virsoides* was present along the Slovenian coastline from Sv. Jernej's Bay (Debeli rtič – near Italian border) to the Sečovlje saltpans (near the Croatian border) (Fig. 1E) with an abundance that ranged between rare to scattered thalli (F1) and a continuous or almost continuous belt (F3) according to the substrates favourable for the development of this species. In Koper Bay, *F. virsoides* was sparsely distributed from Debeli rtič to Sv. Katarina's Bay, Ankaran (sites 1–5), with an abundance of rare to scattered (F1) because of the presence

Tab. 1: Occurrence and abundance (semi-quantitative) of *Fucus virsoides* ***in investigated sites, during different seasons. Legend: Sp – spring, Su – summer, A – autumn, W – winter, F1=rare to scattered thalli; F2=abundant patches; F3=a continuous or almost continuous belt.***
Tab. 1: Prikaz raziskanih mest pojavljanja bračiča (*Fucus virsoides****) in njegove abundance (semi-kvantitativne), v različnih časovnih obdobjih. Legenda: Sp – pomlad, Su- poletje, A- jesen, W – zima, F1=redke do razpršene steljke; F2=gručasta razporeditev; F3=skoraj sklenjen do sklenjen pas.***

No site	Site	Period					
		2010 (W, Sp, Su)	2010 A	2011 (W, Sp, Su, A)	2013 (W, Sp, Su, A)	2014 (W, Sp, Su, A)	2015 (W, Sp, Su, A)
1	Sv. Jernej Bay	F1	-	-	-	-	-
2	Cape Debeli rtič	F1	-	-	-	-	-
3	Port - Cape Debeli rtič	F1	-	-	-	-	-
4	Valdoltra	F1	-	-	-	-	-
5	Sv. Katarina	F1	-	-	-	-	-
6	Porporela harbor, Koper	F2	-	-	-	-	-
7	Koper - Semedela	F2	-	-	-	-	-
8	Koper - Izola	F2	-	-	-	-	-
9	Viližan bay	F2	F1	F1	F1	-	-
10	Izola	F3	-	-	-	-	-
11	San. Simon	F3	-	-	-	-	-
12	Cape Kane Strunjan	F1	-	-	-	-	-
13	Cape Strunjan	F1	-	-	-	-	-
14	Strunjan saltpans	F1	-	-	-	-	-
15	Fiesa–Madona - Piran	F1	-	-	-	-	-
16	Cape Madona Piran	F2	-	-	-	-	-
17	Bernardin	F1	-	-	-	-	-
18	»Pirat« Bernardin	F1	F1	F1	F1	F1	-
18a	Fizine	F1	-	-	-	-	-
19	Cape Seča	F1	-	-	-	-	-
20	Sečovlje saltpans	F1	-	-	-	-	-

of mobile substrata composed mainly of sand or marl and sandstone mobile pebbles in wave conditions. In the southern part of Koper Bay (along the coast between Koper and Izola in sites 7–9), *F. virsoides* populations were dominant on breakwaters with an abundance ranging from scattered thalli (F1) to abundant patches (F2). In the vicinity of ports and main urban areas (Koper, Izola and Piran; sites 6, 10, 16), where the coast is completely artificialized, only a few patches were preserved (F2). In the inner parts of the ports, *F. virsoides* was present as isolated individuals (F1) or in small patches (F2). The largest populations in abundant patches (F2) and in a continuous or almost continuous belt (F3) were observed on the limestone rocky coast all around Izola and Korbat Cape in San Simon near Izola (sites 10 and 11). Along the natural coast (sites 12, 13, 14, 15) extending from San Simon to the Cape of Strunjan, populations of *F. virsoides* were more fragmented with an abundance ranging from rare to scattered (F1) due to the presence of substrata unsuitable for the development of this alga, i.e. substrata composed mainly of sand, mud or marl and of sandstone pebbles that are mobile in wave conditions. A similar situation was observed on the coast stretching from Piran to Forma viva (sites 17–19), near Lucija, and on the breakwaters along the external part of the Sečovlje saltpans (site 20).

Decline of *Fucus virsoides* populations

During the period from autumn 2010 to autumn 2015, the situation of *F. virsoides* populations turned critical. One of the most striking observations was that no attached *F. virsoides* and not even one individual thallus was observed during field observation in this period, except for sites 9 and 18. At Viližan Bay (site 9), near Izola, and in the inner part of the Sailing Club Pirat near Bernardin (Piran Bay, site 18) (Fig. 1F; Tab. 1), *F. virsoides* were scattered or present with only rare thalli (F1).

Up to 2013, a few small individuals (F1) were observed growing on small natural sandstone pebbles at Viližan Bay, while at Bernardin a very small, patchily distributed population (F2) was observed on an artificial concrete surface of about 6 m^2, but unfortunately only up until autumn 2014 (Tab. 1).

Environmental parameters

From the comparisons of sea surface chemical parameters for the Slovenian coastal sea (MOP, ARSO, 2015), shown in Figure 2, it is evident that the differences in the mean values of single chemical parameters during the periods 2005–2010 (before the decline of *F. virsoides* populations) and 2011–2014, barring a few exceptions, are not that remarkable.

For instance, compared to the period 2005–2010, before the decline of the *F. virsoides* populations, the concentrations of nitrates in the period 2011–2014 were in general slightly lower in all seasons, but the difference was statistically non-significant. A very similar situation was found for total nitrogen, while in silicates, during the summer period, the differences in concentration were statistically significant ($P < 0.001$). For nitrites the concentration was higher—but not statistically significant—in winter and summer during the period 2011–2014. An increase in the concentration of orthophosphate was observed for almost all seasons in the period 2011–2014, especially in spring, when the difference was statistically significant ($P < 0.01$), and autumn, whereas in summer a slight but statistically non-significant decrease would occur. The concentration of ammonia was higher in winter, spring and summer in the period 2011–2014, but with statistical significance only in spring ($P < 0.05$) and summer ($P < 0.01$). The salinity was higher in all seasons except for summer, but not statistically significant. We noticed that the trend and the values of sea temperature remained very similar and statistically non-significant in all seasons in both periods (Fig. 2).

Two decades ago it was found that the trophic conditions in the Gulf of Trieste do not exert a significant impact on the distribution of *F. virsoides* (Lipizer *et al.,* 1995). During our observation many populations of *F. virsoides* were found growing inside small harbours or along boatyards, where fluctuations in salinity and nutrient concentrations are frequent, which is consistent with Lipizer *et al.* (1995) and Orlando-Bonaca *et al.* (2013). Although *F. virsoides* is able to tolerate a wide range of salinity and temperature, our opinion is that it is necessary to confirm this with experimental data, because at the present we do not know the limits of survival of this species in relation to salinity and temperature. According to several authors (e.g., Vouk, 1938; Linardić, 1949; Giaccone & Pignatti, 1967; Munda, 1972; Mačić, 2006), the limiting factors for the presence of *F. virsoides* seem to be extreme salinity and temperatures.

F. virsoides is considered an alga with a great tolerance to high pollution levels and variation in many environmental factors such as temperature, salinity, wave exposure, etc. (Lipizer *et al.*, 1995; Orlando-Bonaca *et al.*, 2013). At present we do not know what factor(s) should be considered the potential reason(s) for this drastic event.

The presence and abundance of grazers

During autumn 2010 (when the first decline of *F. virsoides* was noticed) a substantial increase in the individuals of *P. caerulea* distributed among and immediately above the *F. virsoides* populations was observed, but not evaluated.

The hypothesized increased densities of grazers can lead to the loss of dominant habitat forming species, such as *F. virsoides*. The main grazer that is involved in

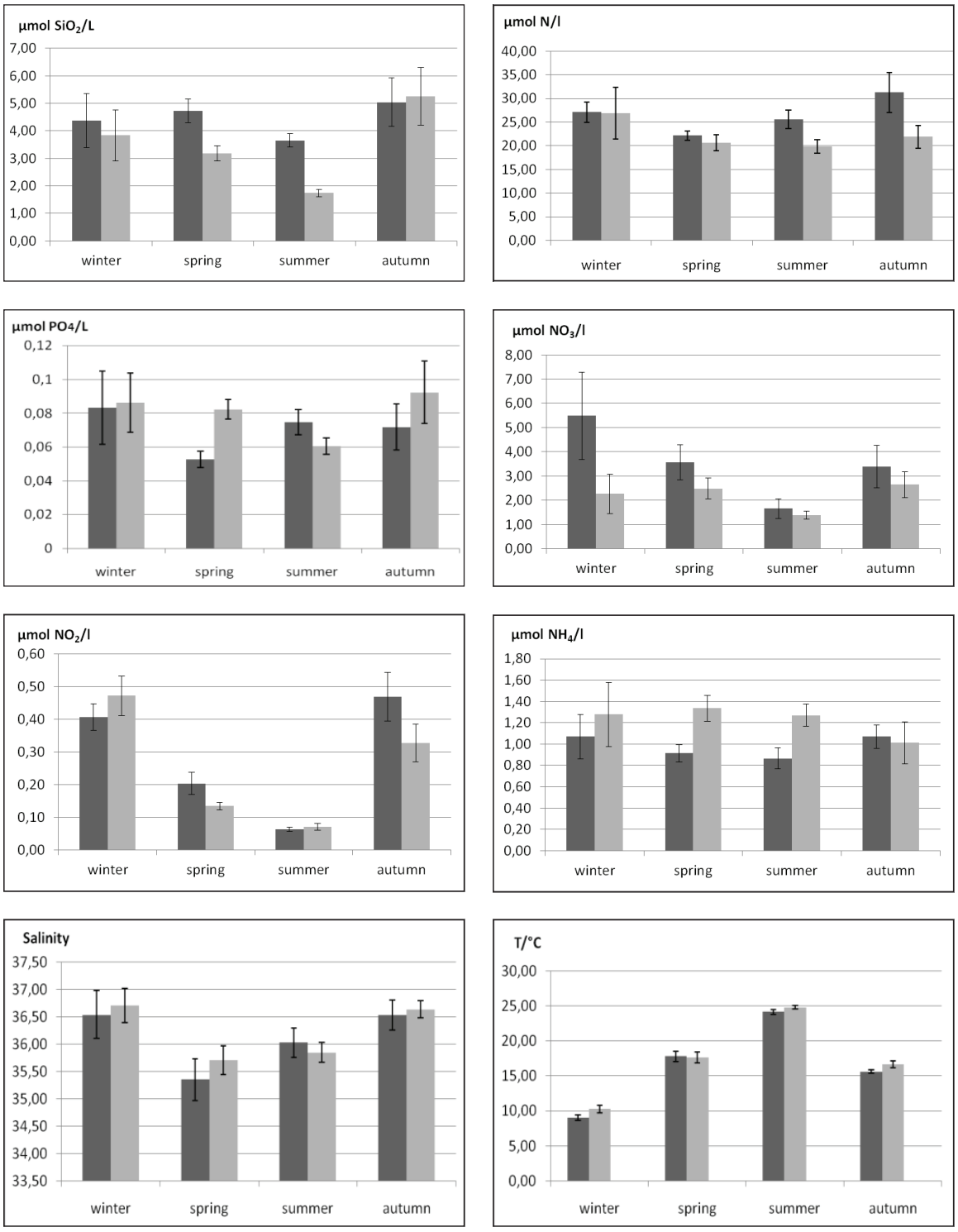

Fig. 2: Seasonal values (mean ± SE) of sea surface chemical parameters (silicate, nitrogen, orthophosphate, nitrate, nitrite, ammonia and salinity) and physical parameters (temperature) during the periods 2005–2010 (black columns) and 2011–2014 (grey columns) for the Slovenian coastal sea (Source of data: MOP, ARSO, 2015 - http://www.arso.gov.si/en/).

Sl. 2: Sezonske vrednosti (povprečje ± SN) kemijskih (silikati, dušik, ortofosfati, nitrati, nitriti, amonijak in slanost) in fizikalnih (temperatura) parametrov v obdobjih 2005–2010 (črni stolpci) in 2011–2014 (sivi stolpci) v površinskem sloju slovenskega morja (Vir podatkov: MOP, ARSO, 2015 - http://www.arso.gov.si/en/).

this process along the Slovenian coast is *P. caerulea* (De Min & Vio, 1997). Population densities of this species in different study sites are shown in Table 2. The densities occurring at the sites situated along the coastline between Koper and Izola and at Bernardin (both 11/400 cm^2) were higher than the average of limpets at selected sites along the Slovenian coastline. The minimum density was observed at site KP Semedela (3/400 cm^2).

The massive presence of *P. caerulea* along the Slovenian coastline leads us to consider the possibility that this might be one of the factors explaining the decline of *F. virsoides* populations. Our field observations are supported by several previous studies that considered limpets, such as *P. caerulea,* as important structuring agents of midlittoral communities, controlling the distribution of algae (Arrontes *et al*., 2004). It is well documented that the composition and dynamics of midlittoral communities in rocky shores are strongly influenced by the activity of grazers (Hawkins *et al*., 1992; Jenkins *et al*., 1999; Arrontes *et al*., 2004). It is obvious that not all species in the grazer assemblage have the same effect on algae (Underwood & Jernakoff, 1981). Other gastropods (Cervin & Åberg, 1997, Viejo *et al*., 1999), chitons (Dethier & Duggins, 1984) or crustaceans may play relevant roles, but limpets are very often the key grazers in midlittoral zone (Hawkins *et al.*, 1992; Johnson *et al.*, 1997, 1998; Jonsson *et al.*, 2006).

Tab 2. Average density (number of specimens/400 cm²) of** Patella caerulea **at selected sites along the Slovenian coast during April 2015.
Tab. 2: Povprečna gostota (št. osebkov/400 cm²) vrste** Patella caerulea **na izbranih postajah vzdolž slovenske obale v aprilu 2015.

No site	Site	Density (individuals/ 400 cm^2)	stdev
1	Sv. Jernej's Bay	5.00	0.71
2	Cape Debeli rtič	5.20	0.84
3	Port - Cape Debeli rtič	8.80	3.35
4	Valdoltra	5.25	0.45
5	Sv. Katarina's Bay	5.00	1.00
6	Porporela harbor, Koper	8.80	4.15
7	Koper - Semedela	3.00	0.71
8	Koper - Izola	11.00	3.65
9	Viližan Bay	5.80	0.84
10	Izola	4.80	0.45
11	San Simon	7.40	2.30
12	Cape Kane Strunjan	9.40	3.05
13	Cape Strunjan	7.60	1.14
14	Strunjan saltpans	5.80	2.49
15	Fiesa–Madona - Piran	7.80	2.17
16	Cape Madona Piran	7.40	2.30
17	Bernardin	11.00	6.08
18	»Pirat« Bernardin	4.80	1.30
18a	Fizine	8.50	1.92
19	Cape Seča	8.00	2.51
20	Sečovlje saltpans	3.60	1.14
	Total of averages	5.96	2.99

CONCLUSIONS

There are probably several reasons for the observed decline of *F. virsoides* populations. Many factors have been suggested as possible causes of this occurrence, including urbanization and eutrophication (Gessner, 1969; Gessner & Hammer, 1971; Munda, 1981, 1982; Kremer & Munda, 1982, Vukovič, 1982; Munda, 1993a, 1993b; Munda & Veber, 1996), as well as climate change (Munda, 2008). Some authors (*e.g.*, Munda, 1981; Kremer & Munda, 1982; Vukovič, 1982; Munda, 1997) suspect that an excess of nitrates may be responsible for the disappearance of *F. virsoides* populations from polluted sites, although Lipizer *et al*. (1995) considers *F. virsoides* to have a great tolerance to high pollution levels. The comparison of seasonal variation of nitrates during the period before the disappearance of this species with the values after its decline indicates a slight decrease in these values. Therefore, we are inclined to consider this parameter as insufficient to trigger this event. Describing the benthic vegetation in the midlittoral zone of Koper Bay, Vukovič (1982) highlights the presence of *F. virsoides* populations on solid substrates (natural sandstone and jetties) along the entire coastline from the cape Debeli rtič to Izola with preference for limestone, which is in accordance with our observations.

Based on our 2010–2015 field observations, the *F. virsoides* populations along the Slovenian coast can be considered highly endangered, and the high density of limpets, present all along the Slovenian coast, might be one of the factors explaining the decline of *F. virsoides* populations and, consequently, their disappearance.

More environmental data is needed to be able to establish precisely the causes leading to the decline of *F. virsoides* populations in the Slovenian coast. Experimental data is also needed on the effects of organic and chemical pollution on this species. The role of grazers, such as *P. caerulea,* highlighted in this study, deserves further attention, too. Therefore, we strongly believe that further research and monitoring programmes of biological, physical and chemical parameters are necessary to evaluate the level of their impact on *F. virsoides* populations.

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IZGINOTJE BRAČIČA (*FUCUS VIRSOIDES* J. Agardh) IZ OBALE SLOVENIJE (TRŽAŠKI ZALIV, SEVERNI JADRAN)

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POVZETEK

V članku avtor poroča o izrazitem upadanju bračiča (Fucus virsoides) *vzdolž obale Slovenije (Tržaški zaliv, severni Jadran), ki se je začelo proti koncu leta 2010. Podaja rezultate o razširjenosti bračiča v Sloveniji v obdobju 2010-2015, ki jih je avtor pridobil na podlagi opazovanja na terenu* (in situ). *Avtor primerja zgodovinske podatke o pojavljanju* bračiča *na tem območju s sedanjimi na temelju raziskav na terenu in bibliografskih virov. Podaja tudi nekatere predpostavke o morebitnih vzrokih, ki so povzročili hitri upad in posledično izginotje te vrste vzdolž obale Slovenije.*

Ključne besede: *Fucus virsoides,* pojavljanje, izginotje, obala Slovenije, severni Jadran

REFERENCES

Accurti, G. (1858): Cenno sulle alghe di Capodistria. Programma dell'I.R. ginnasio di Capodistria. Trieste, Lloyd Austr., pp. 1–9.

Alberti, G. & C. Battelli (2002): Un naturalista tra i Frati Minori Conventuali del convento di San Francesco a Pirano: Padre Pio Titius (1801-1884). Atti Mus. Civ. Stor. Nat., Trieste, 49, 213–239.

Ardissone, F. (1886): Phycologia mediterranea. Parte II, Oosporee – Zoosporee – Schizosporee. Tipografia Maj e Malmati, Varese, 336 pp.

Arrontes, J., F. Arenas, C. Fernández, J. M. Rico, J. Oliveros, B. Martínez, R. M. Viejo & D. Alvarez (2004): Effect of grazing by limpets on mid-shore species assemblages in northern Spain. Mar. Ecol. Prog. Ser., 277, 117–133.

ARSO (2015): Environment Agency of the Republic of Slovenia - Ministry of the Environment and Spatial Planning (http://www.arso.gov.si/vode/morje/)

Ballesteros, E., X. Torras, S. Pinedo, M. Garcia, 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. Poll. Bull., 55: 172–180.

Battelli, C. (1999): Giuseppe Accurti (1824–1907) - Esempio di connubio tra insegnamento e ricerca scientifica. Annales, Ser. Hist. Nat., Koper, 9, 1(15), 113–118.

Battelli, C. (2002): The macrophytobenthos on the hard upper midlittoral from two stations of Slovenian coast (Northern Adriatic Sea). Hacquetia, 1(2), 193–203.

Battelli, C. & G. Alberti (2003): Antonio Zaratin (1846-1923): Raccoglitore e preparatore d`alghe dell`Istria e del Quarnero. Atti - Cent. Ric. Stor., Rovigno, 33, 643–683.

Battelli, C. (2013): Struktura in dinamika makrobentoških združb alg v mediolitoralu slovenskega morja: doktorska disertacija = Structure and dynamic of midlittoral macrobenthic algal communities of the Slovenian sea: doctoral dissertation. Ljubljana, 146 pp.

Boero, F. & E. Bonsdorff (2007): A conceptual framework for marine biodiversity and ecosystem functioning. Mar. Ecol., 28, 134–145.

Boero, F., J.P. Féral, E. Azzurro, V. Cardin, B. Riedel, M. Despalatović, I. Munda, P. Moschella, J. Zaouali, S.Fonda Umani, A. Theocharis, K. Wiltshire & F. Briand (2008): Climate warming and related changes in Mediterranean marine biota. CIESM Workshop Monographs, 35, 5–21.

Cervin, G. & P. Åberg (1997): Do littorinids affect the survival of *Ascophyllum nodosum* germlings? J. Exp. Mar. Biol. Ecol., 218, 35–47.

Chiesa, S. & G.G. Lorenzoni (1980): Erbario e collezioni dell'Istituto di Botanica e Fisiologia Vegetale, (p. 18–29). In: AA. VV. - Collezioni Scientifiche dei Musei ed Orto Botanico. Facoltà di Scienze MM. FF. NN. dell'Università degli Studi di Padova, Padova, 64 pp.

De Min, R. & E. Vio (1997): Molluschi conchiferi del litorale sloveno. Ser. Hist. Nat., 11: 241–258.

Dethier, M.N. & D.O. Duggins (1984): An 'indirect commensalism' between marine herbivores and the importance of competitive hierarchies. Am. Nat., 124, 205–219.

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(1), 77– 90.

Gessner, F. (1969): Photosynthesis and ion loss in the brown algae *Dictyopteris membranacea* and *Fucus virsoides*. Mar. Biol., 4, 349–351.

Gessner, F. & L. Hammer (1971): Physiologische Untersuchung über die Toleranz von *Fucus virsoides* (Don.) J.Ag. Int. Rev. ges Hydrobiol., 56, 581–597.

Giaccone, G. & S. Pignatti (1967): Studi sulla produttività primaria del fitobentos nel Golfo di Trieste. - II. La vegetazione del Golfo di Trieste. Nova thalassia, 3(2), 1–28.

Hawkins, S.J., R.G. Harnoll, J.M. Kain & T.A. Norton (1992): Plantanimal interactions on hard substrata in the north-east Atlantic. In: John DM, Hawkins SJ, Price JH (eds) Plantanimal interactions in the marine benthos. Clarendon Press, Oxford, pp. 1–32.

Jackson, J.B.C., M.X. Kirby, W.H. Berger, K.A. Bjorndal, L.W. Botsford, B.J. Bourque, R.H. Bradbury, R. Cooke, J.A. Estes, T.P. Hughes, S. Kidwell, C.B. Lange & R.R. Warner (2001): Historical overfishing and the recent collapse of coastal ecosystems. Science, 293, 629–638.

Jenkins, R.J., S.J. Hawkins & T.A. Norton (1999): Direct and indirect effects of a macroalgal canopy and limpet grazing in structuring a sheltered inter-tidal community. Mar. Ecol. Prog. Ser., 188, 81–92.

Jonsson, P.R., L. Granhag, P.S. Moschella, P. Aberg, S.J. Hawkins & R. Thompson (2006): Interactions between wave action and grazing control the distribution of intertidal macroalgae. Ecology, 87(5), 1169–1178.

Johnson, M.P., M.T. Burrows, R.G. Hartnoll & S.J. Hawkin, (1997): Spatial structure on moderately exposed rocky shores: patch scales and the interactions between limpets and algae. Mar. Ecol. Prog. Ser., 160, 209–215.

Johnson, M.P., M.T. Burrows & S.J. Hawkins (1998): Individual based simulations of the direct and indirect effects of limpets on a rocky shore *Fucus* mosaic. Mar. Ecol. Prog. Ser., 169, 179–188.

Kashta, L. (1995–1996): Rreth përhapjes dhe ekologjisë së *Fucus virsoides* J. Agardh në brigjet e Shqipërisë. (About the distribution and ecology of *Fucus virsoides* J. Agardh along the Albanian coast). – Universiteti i Shkodrës "Luigj Gurakuqi", Buletini i Shkencave Seria Shkencave Natyrore, nr., 48(1), 60–65.

Kremer, B.P. & I.M. Munda, (1982): Ecophysiological studies of the Adriatic seaweed, *Fucus virsoides*. Mar. Ecol., 3(1), 75–93.

Linardić, J. (1949): Studije o jadranskom fukusu (*Fucus virsoides*). Zagreb, Acta Botanica, 12, 13, 7–131.

Lipej, L., M. Orlando-Bonaca & T. Makovec (2004): Raziskovanje biodiverzitete v slovenskem morju. Morska biološka postaja, Nacionalni inštitut za biologijo. Piran, 136 pp.

Lipej, L., R. Turk & T. Makovec (2006): Endangered species and habitat types in the Slovenian Sea. Zavod RS za varstvo narave. Ljubljana, 264 pp.

Lipizer, M., G. Bressan, G. Catalano & L.A. Ghirardelli (1995): Adaptability of *Fucus virsoides* J.Ag. (Fucales, Chromophycophyta) to habitat variations in the Gulf of Trieste, North Adriatic Sea. Oebalia, 21, 51–59.

Mačić, V. (2006): Distribution of seaweed *Fucus virsoides* J. Agardh in Boka Kotorska Bay (South Adriatic Sea). Annales, Ser. Hist. Nat., Koper, 16, 1–4.

Matjašič, J. & J. Štirn (1975): Flora in favna severnega Jadrana. Ljubljana, Pris. 1., Slovenska Akademija Znanosti in Umetnosti, razprave, 4, 19–23.

Munda, M.I. (1972): Seasonal and ecologically conditioned variations in the *Fucus virsoides* association from the Istrian coast (Northern Adriatic). Dissertationes Slovenska Akademija Znanosti in Umetnosti, 15, 1–33.

Munda, I.M. & B.P. Kremer (1977): Chemical composition and physiological properties of fucoids under conditions of reduced salinity. Mar. Biol., 41, 4–15.

Munda, I.M. (1981): The effect of heavy metals on the growth and some chemical constituents of the brown alga *Fucus virsoides* (Don.) J. Agardh. Rapp. Comm. int. Mer Médit., 27, 233–234.

Munda, I.M. (1982): The effect of organic pollution on the distribution of fucoid algae from the Istrian coast (vicinity of Rovinj) Acta Adriat., 21, 333–354.

Munda, M.I. (1991): Algal resources in polluted sites of the Northern Adriatic (vicinity of Piran). Acta Adriatica, 32, 2, 683–704.

Munda, I.M. (1993a): Changes and degradation of seaweeds stands in the Northern Adriatic. Hidrobiologia, 260/261, 239–253.

Munda, I.M. (1993b): Impact of pollution on benthic marine algae in the Northern Adriatic. International J. Environ. Stud., 43, 185–199.

Munda, I.M. & M. Veber (1996): Simultaneous effects of trace metals and excess nutrients on the Adriatic seaweed *Fucus virsoides* (Don.) J. Ag. (Phaeophyceae, Fucales). Bot. Mar., 39, 297–309.

Munda, I.M. (1997): *Fucus virsoides* (Don.) J. Ag. as indicator of changing environments in the Adriatic Sea. Phycologia, 36, 75.

Munda, I.M. (2000): Long-term marine floristic changes around Rovinj (Istrian coast, North Adriatic) estimated on the basis of historical data from Paul Kuckuck's field diaries from the end of the 19th century. Nova Hedwigia, 71, 1–36.

Munda, I.M. (2008): Benthic marine algae as reflection of environmental changes in the Northern Adriatic Sea – Climate warming and related changes in Mediterranean marine biota – Helgoland, 27–31 May 2008, CIESM Workshop Monogr., 35, 65–72.

Ogorelec, B., J. Faganeli, M. Mišič & B. Čermelj (1997): Reconstruction of paleoenvironment in the bay of Koper (Gulf of Trieste, Northern Adriatic). Annales, Ser. Hist. Nat., Koper, 11, 187–200.

Orlando-Bonaca, M., P.A. Mannoni, D. Poloniato & A. Falace (2013): Assessment of *Fucus virsoides* distribution in the Gulf of Trieste (Adriatic Sea) and its relation to environmental variables. Bot. Mar., 56(5/6), 451–459.

Pavlovec, R. (1985): Numulitine iz apnencev pri Izoli (SW Slovenija). Razprave 4. razred Slovenska Akademija Znanosti in Umetnosti, 26, 219–230.

Pignatti, S. (1962): Associazioni di alghe marine sulla costa veneziana. Venezia, Ist. Ven. Sci. Lett. Art., 33, 3–131.

Rindi, F. & C. Battelli (2005): Spatio-temporal variability of intertidal algal assemblages of the Slovenian coast (Gulf of Trieste, northern Adriatic Sea). Bot. Mar., 48, 96–105.

Schiffner, V. & A. Vatova (1938): Le alghe della laguna di Venezia in La laguna di Venezia, 3, 250 pp.

Štirn, J. (1965): Onesnaženje (kontaminacija) morja v Tržaškem zalivu. Varstvo narave II-III, 157–184.

Turk, V., P. Mozetič & A. Malej (2007): Overview of eutrophication-related events and other irregular episodes in Slovenian sea (Gulf of Trieste, Adriatic sea). Annales, Ser. Hist. Nat., Koper, 17(2), 197–216.

Underwood, A.J. & P. Jernakoff (1981): Effects of interactions between algae and grazing gastropods on the structure of a low-shore intertidal algal community. Oecologia, 48, 221–233.

Viejo, R.M., P. Åberg, **G. Cervin & M. Lindegarth (1999):** The interactive effects of adult canopy, germling density and grazing on germling survival of the rockweed *Ascophyllum nodosum*. Mar. Ecol. Prog. Ser., 187, 113–120.

Vouk, V. (1938): Bilješke o Jadranskom Fukusu (*Fucus virsoides*) (Don.) J. Ag.). Godišnjak Oceanografskog instituta, Split, Sv., I, 153–159.

Vukovič, A. (1980): Asociacije morskih bentoških alg v Piranskem zalivu. Biološki vestnik, 28(2), 103–124.

Vukovič, A. (1982): Bentoška vegetacija Koprskega zaliva. Acta Adriat., 23(1/2), 227–235.

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UNUSUAL RECORDS OF TRIPLETAIL *LOBOTES SURINAMENSIS* (OSTEICHTHYES: LOBOTIDAE) FROM THE TUNIS SOUTHERN LAGOON (NORTH-EASTERN TUNISIA, CENTRAL MEDITERRANEAN SEA)

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ABSTRACT

The present paper reports on the captures of two female specimens of tripletail Lobotes surinamensis *(Bloch, 1790) in a peri-Mediterranean lagoon, the Tunis Southern Lagoon, located in north-eastern Tunisia. Both specimens are herein described and their intrusion in such brackish area is explained. It appears that in the past decade, captures of* L. surinamensis *in the Mediterranean have been increasing. Such a phenomenon suggests that a sustainable population is successfully established in this sea. However, migrations from the eastern Tropical Atlantic and the Red Sea cannot be ruled out completely.*

Key words: *Lobotes surinamensis*, brackish area, migrations, morphometric measurements, meristic counts.

SEGNALAZIONI INSOLITE DEL PESCE FOGLIA *LOBOTES SURINAMENSIS* (OSTEICHTHYES: LOBOTIDAE) NELLA LAGUNA MERIDIONALE DI TUNISI (TUNISIA NORD-ORIENTALE, MEDITERRANEO CENTRALE)

SINTESI

Nel presente lavoro gli autori riportano le catture di due femmine di pesce foglia, Lobotes surinamensis *(Bloch, 1790), in una laguna peri-mediterranea, la laguna meridionale di Tunisi, situata nel nord-est della Tunisia. Entrambi gli esemplari vengono descritti e viene spiegata la ragione della loro intrusione in tale area. Le catture di* L. surinamensis *risultano in aumento nell'ultimo decennio nel Mediterraneo. Tale fenomeno suggerisce che si sia stabilita una popolazione sostenibile in questo mare. Tuttavia, le migrazioni dall'Atlantico tropico-orientale e dal mar Rosso non possono venir del tutto escluse.*

Parole chiave: *Lobotes surinamensis*, zona salmastra, migrazioni, misurazioni morfometriche, conte meristiche.

INTRODUCTION

Tripletail *Lobotes surinamensis* (Bloch, 1790) is a cosmopolitan species widely distributed in warm temperate and warm seas of the Pacific (Kharin *et al*., 2009) and Indian Oceans and on either side of the Atlantic (Carpenter & Robertson, 2015). In the western Atlantic, the habitat of *L. surinamensis* extends from Massachusetts, the Gulf of Mexico and the Caribbean Sea (Franks *et al*., 2003) southward to Argentina (Sazima *et al*., 2009). In the eastern Atlantic, it is reported in the area spanning from southern Portugal to Angola, including the Canary and Cape Verde Islands (Fischer *et al*., 1981; Roux, 1986; Carpenter & Robertson, 2015).

Lobotes surinamensis is reported from warm Mediterranean areas (Carpenter & Robertson, 2015) and could be considered as a Herculean migrant (*sensu* Quignard & Tomasini, 2000), despite the fact that its first record came from Sicilian waters (Doderlein, 1875). The occurrence of the species has been noted off the Italian coast (Bini, 1968; Zava *et al*., 2007), Spain (Palom, 1991) and eastward, in the Aegean Sea, where several records have been summarized by Minos & Economidis (2015). *L. surinamensis* has also been recorded in the Adriatic Sea (Dulčić & Dragičević, 2011; Dulčić *et al*., 2014a), where the northernmost record in the Mediterranean was reported by Dulčić *et al*. (2014b).

Lobotes surinamensis is reported from southern Mediterranean areas such as the Gulf of Gabès (Bradaï, 2000), the Algerian coast (Hemida *et al*., 2003) and the Maltese islands (Deidun *et al*., 2010). Investigations regularly conducted in the Tunis Southern Lagoon allowed us to collect two specimens of *L. surinamensis* which are the object of the present paper. Both specimens are herein described and the species distribution in the area and the entire Mediterranean Sea is commented and discussed.

MATERIAL AND METHODS

For several years, surveys have regularly been conducted in the Tunis Southern Lagoon to assess the impact and results of the ecological restoration of this brackish area and to compile an inventory of autochthonous and allochthonous species recently found in the area, mainly crustaceans and fishes (Mejri *et al*., 2004; Ben Souissi *et al*., 2005; Ounifi-Ben Amor *et al*., *in press*, a, b).

The Tunis Southern Lagoon is a peri-Mediterranean lagoon (*sensu* Quignard & Zaouali, 1980) adjoining the city of Tunis, located in the southwestern region of the Gulf of Tunis (36°47′ N and 10°17′ E). The Tunis Lagoon is divided into two areas separated by a navigation channel: the Tunis Northern Lagoon and the Tunis Southern Lagoon (see Fig. 1B). The latter area extends over 720 ha, has a regular depth of about 2.1 m and a maximum depth of 4 m. Its shores have been excavated and protected by large rocky stones.

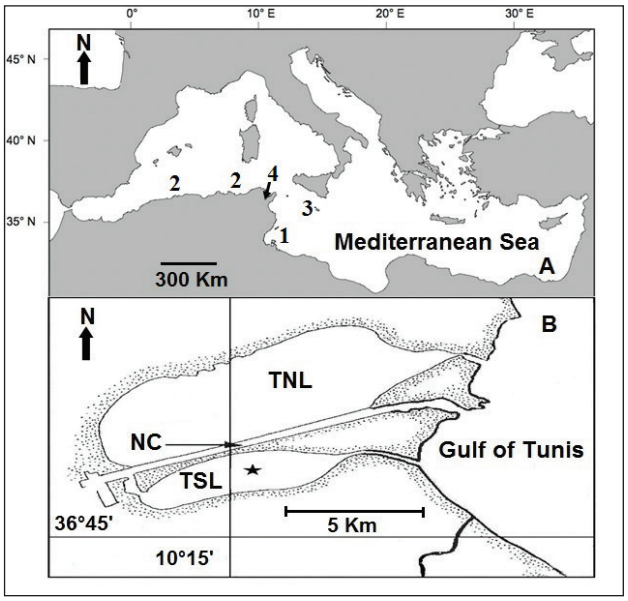

Fig. 1: A - Map of the Mediterranean Sea showing the captures site of** Lobotes surinamensis **(Bloch, 1790) in southern regions. Legend: 1. Gulf of Gabès (Bradaï, 2000). 2. Coast of Algeria (Hemida** et al**., 2003). 3. Maltese waters (Deidun** et al., **2010). 4. Tunis Southern Lagoon (this study). B – details of the Tunis Southern Lagoon.
Sl. 1: A – Zemljevid Sredozemskega morja z označenimi lokalitetami, kjer so bili ujeti primerki vrste** Lobotes surinamensis **(Bloch, 1790) v južnih predelih. Legenda: 1. Gabeški zaliv (Bradaï, 2000). 2. Obala Alžirije (Hemida** et al**., 2003). 3. Malteške vode (Deidun** et al., **2010). 4. Tuniška južna laguna (ta raziskava). B – detajli Tuniške južne lagune.

On 19th March 2015, captures of two specimens of *L. surinamensis* occurred in the Tunis Southern Lagoon. The local fishermen aware of the fishing grounds informed us that both captures were carried out by trammel net with a 16 mm stretched size at a depth of 3.6 m approximately, on soft bottom, partially covered by seagrass, at 36°47′35″ N and 10°13′48″ E (Fig. 1), together with small crustacean and teleost species. Total length (TL) and other morphometric measurements were carried out to the nearest millimetre, meristic counts followed Hemida et *al*. (2003), while total body weight (TBW) and total eviscerated body weight (TEBW) were recorded to the nearest gram (Tab. 1). Both specimens were preserved in 10% buffered formalin and deposited in the Ichthyological Collection of the Faculté des Sciences de Tunis, catalogued under numbers FST-Lobo-suri-01 and FST-Lobo-suri-02, respectively.

RESULTS AND DISCUSSION

Both specimens were females and their stomachs contained remains of crustacean species, such as spher-

Tab. 1: Morphometric measurements (in mm and as % of standard length), meristic counts and masses (in grams) recorded in the tripletail** Lobotes surinamensis **(Bloch, 1790) collected in the Tunis Southern Lagoon.
Tab. 1: Morfometrične meritve (v mm in izražene v % standardne dolžine), meristična štetja in masa (v gramih) primerkov vrste** Lobotes surinamensis **(Bloch, 1790) v Tuniški južni laguni.

Reference	**FST-Lobo-suri-01**		**FST-Lobo-suri-02**	
Sex	**Adult Female**		**Adult Female**	
Morphometric measurements	**mm**	**%SL**	**mm**	**%SL**
Total length (TL)	390	116.77	250	125.63
Standard length (SL)	334	100.00	199	100.00
Fork length	311	93.11	175	87.94
Space between tip of snout to caudal fin origin	302	90.42	149	74.87
Head length	55	16.47	51	25.63
Interorbital space	20	5.99	16.5	8.29
Space between tip of snout to dorsal fin origin	67	20.06	51	25.63
Space between tip of snout to pelvic fin origin	57	17.07	47	23.62
Space between tip of snout to anal fin origin	225	67.37	158	79.40
Space between snout and vent	245	73.35	166	83.42
Dorsal fin length	260	77.84	170	85.43
Pectoral fin length	61	18.26	45	22.61
Pelvic fin length	81	24.25	53	26.63
Anal fin length	77	23.05	49	24.62
Caudal fin length	38	11.38	30	15.08
Caudal fin width	35	10.48	28	14.07
Meristic counts				
Pelvic fin rays	I + 5		I + 5	
Dorsal fin rays	XII + 16		XII + 15	
Anal fin rays	III + 13		III + 12	
Pectoral fin rays	12		12	
Caudal fin rays	18		18	
Ctenoid scales on tail	10		10	
Weight (gram)				
Total body	1450		950	
Eviscerated body	1280		820	
Gonad	7.5		6.8	
Stomach content	95		74	

omatids and amphipods, and algae. The specimen referenced FST-Lobo-suri-01 measured 390 mm TL and weighed 1450 g (TBW), while the specimen referenced FST-Lobo-suri-02 measured 250 mm TL and weighed 950 g (TBW). Carpenter & Robertson (2015) noted that 50% maturity is attained at 485 mm for females, therefore both specimens were still immature females.

Both specimens were identified by the following combination of characteristics: body deep, compressed; head small, concave behind the eye in profile, looks

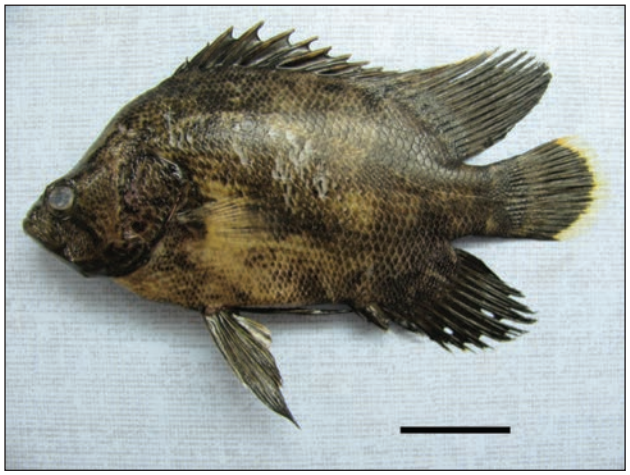

Fig. 2: Specimen of** Lobotes surinamensis **(Bloch, 1790) collected in the Tunis Southern Lagoon (Ref.: FST-Lobo-suri-01), scale bar = 40 mm.
Sl. 2: Primerek vrste** Lobotes surinamensis **(Bloch, 1790) ujet v Tuniški južni laguni (Ref.: FST-Lobo-suri-01), merilo = 40 mm.

like a hump above gill cover; dorsal and anal fins long, rounded, symmetrical; pectoral fin short, rounded; preopercle strongly serrated; mouth large, oblique with protractile upper jaw; colour grey to yellow brown to dark brown with various mottling, sometimes with 2-3 dark lines radiating from the eye, posterior margin of caudal fin yellow (Fig. 2).

Description, morphometric measurements, meristic counts and colour are in total accordance with Fischer *et al*. (1981), Roux (1986), Hemida *et al*. (2003), Kharin *et al*. (2009), Dulčić & Dragičević (2011) and Dulčić *et al*. (2014a) and, therefore, confirm the proper identification of *Lobotes surinamensis* in the Tunisian waters and its northernmost extension range in this area. Additionally, these two new captures constitute the first records of *L. surinamensis* in a peri-Mediterranean lagoon (*sensu* Quignard & Zaouali, 1981).

Lobotes surninamesis is known to inhabit bays, muddy estuaries and river mouths (Carpenter & Robertson, 2015); it is a sluggish species, which lives solitary or in pairs, floating on its side on the water surface together with other objects (Smith & Randall, 1997), and it is possible that both specimens were carried by the currents into the Tunis Southern Lagoon. This species preferentially feeds on small crustacean species (Franks *et al*., 2003), the stomachs of the present specimens contained large quantities of spheromatids and amphipods, which abound in the Tunis Southern Lagoon (Ounifi-Ben Amor *et al*., in press a). This means that *L. surinamensis* probably found in this brackish area a favourable biological environment; similar patterns were reported for other fish species (Méjri *et al*., 2004; Ben Souissi *et al*., 2004, 2005; Ben Amor *et al*., 2009; Ounifi-Ben Amor *et al*., *in press* b).

Tortonese (1975) noted that tripletail was occasionally captured in Italian waters and that its behaviour pattern served as camouflage against predators. However, for at least a decade, Mediterranean records of the species appear to be more frequent (Hemida *et al*., 2003; Dulčić & Dragičević, 2011; Dulčić *et al*., 2014a; Minos & Economidis, 2015). The theory by Hemida *et al*. (2003) about a progressive invasion of the Mediterranean from the eastern Atlantic remains speculative, although it cannot be totally ruled out, because the waters of this sea are becoming warmer (Francour *et al*., 1994) and this promotes the introduction of allochthonous species (Ben Rais Lasram & Mouillot, 2009). Additionally, Carpenter & Robertson (2015) noted that the species is widely distributed and popular in recreational fishing, and there are no known major threats to the global population of *L. surinamensis* nor to the population that has successfully established in the Mediterranean, but monitoring of recreational landings is necessary to avoid over-harvesting.

NEOBIČAJEN ZAPIS O POJAVLJANJU VRSTE *LOBOTES SURINAMENSIS* (OSTEICHTHYES: LOBOTIDAE) IZ TUNIŠKE JUŽNE LAGUNE (SEVEROVZHODNA TUNIZIJA, OSREDNJE SREDOZEMSKO MORJE)

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POVZETEK

V pričujočem prispevku avtorji poročajo o ulovu dveh samic vrste Lobotes surinamensis *(Bloch, 1790) v perimediteranski Tuniški južni laguni v severovzhodni Tuniziji. Avtorji opisujejo primerka in razlagajo pojavljanje te vrste v tovrstnem somornem okolju. Kaže, da je v zadnjih desetletjih vse več primerov pojavljanja vrste* L. surinamensis *v Sredozemskem morju. Pojav dveh primerkov najverjetneje kaže, da se je vrsta v novem okolju uspešno ustalila. Vsekakor pa ni možno ovreči možnosti, da primerki te vrste prihajajo iz tropskega Atlantika in iz Rdečega morja.*

Ključne besede: *Lobotes surinamensis*, somorno okolje, selitve, morfometrične meritve, meristična štetja.

REFERENCES

Ben Amor, M.M., J. Ben Souissi, M. Ben Salem & C. Capapé (2009): Confirmed occurrence of the longjaw snake eel, *Ophisurus serpens* (Osteichthyes: Ophichthidae) in Tunisian waters (Central Mediterranean). Pan-Amer. J. Aquat. Sci., 4 (3), 251-254.

Ben Raïs Lasram, F. & D. Mouillot (2009): Increasing southern invasion enhances congruence between endemic and exotic Mediterranean fish fauna. Biol. Inv., 11 (3), 697-711.

Ben Souissi, J., H. Mejri, J. Zaouali, A. El Abed, O. Guélorget & C. Capapé (2004): On the occurrence of the John Dory *Zeus faber* Linnaeus, 1758 (Osteichthyes: Zeidae) in a perimediterranean lagoon: the Tunis Southern Lagoon (Northern Tunisia). Annales, Ser. Hist. Nat, 14 (2), 219-224.

Ben Souissi, J., H. Méjri, J. Zaouali, A. El Abed, M. Ben Salem, O. Guélorget & C. Capapé (2005): Teleost species recorded in Tunis Southern Lagoon after environmental restoration (Northern Tunisia, Central Mediterranean). Annales, ser. Hist. Nat,15 (2), 157-164.

Bini, G. (1968): Un Pesce Perciforme raro per i mari italiani (*Lobotes surinamensis* Bloch, 1790). Atti. Soc. Pelorit Sci. Fis. Mat. Nat., 14 (1-2), 49-53.

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

Bradaï, M. N., J.P. Quignard, A. Bouaïn, O. Jarboui, A. Ouannes-Ghorbel, L. Ben Abdallah, J. Zaouali & S. Ben Salem (2004): Ichtyofaune Autochtone et Exotique des côtes tunisiennes: recensement et biogéographie. Cybium, 28 (4), 315-328.

Carpenter, K.E. & R. Robertson (2015): *Lobotes surinamensis*. The IUCN Red List of threatened species 2015: e.T198670A16644032. Downloaded on 23 January 2016.

Deidun, A., P. Vella, A. Sciberras & R. Sammut (2010): New records of *Lobotes surinamensis* (Bloch, 1790) in Maltese coastal waters. Aquat. Inv., 5 (1), 113-116.

Doderlein, P. (1875): Descrizione di una specie del genere esotico *Lobotes* preso nelle acque del Contorno Palermo . Atti Accad. Sci. Palermo, 5 (3), 1-112.

Dulčić, J. & B. Dragičević (2011): First record of the Atlantic tripletail, *Lobotes surinamensis* (Bloch, 1790), in the Adriatic Sea. J. Appl. Ichthyol., 27 (6), 1385-1386.

Dulčić, J., B. Dragičević, N. Antolović, J. Sulić-Šprem, V. Kožul & R. Gričević (2014a): Additional records of *Lobotes surinamensis*, *Caranx crysos*, *Enchelycore anatina*, and *Lagocephalus sceleratus* (Actinopterygii) in the Adriatic Sea. Acta Ichthyol. Piscat., 44 (1), 71-74.

Dulčić, J., B. Dragičević, L. Lipej & M. Štifanić (2014b): Range extension of tripletail, *Lobotes surinamensis* (Lobotidae) in the Adriatic Sea. A northernmost record in the Mediterranean. Cybium, 58 (2), 153-154.

Fischer, W., G. Bianchi & W.B. Scott (1981): Fiches FAO d'identification des espèces pour les besoins de la pêche. Atlantique centre-est; zones de pêche 34, 47 (en-partie). Canada Fond de dépôt. Ottawa, Ministère des Pêcheries et Océans du Canada, en accord avec l'organisation des Nations-Unies pour l'Alimentation et l'Agriculture, Vol. 65, pag. var.

Francour, P., C. F. Boudouresque, J. G. Harmelin, M. L. Harmelin-Vivien & J.-P. Quignard (1994): Are the Mediterranean waters becoming warmer? Mar. Poll. Bul., 28 (9), 523-526.

Franks, J.S., K.E. Vanderkooy & N.M. Garber (2003): Diet of tripletail, *Lobotes surinamensis*, from Mississipi coastal water. Gulf. Carib. Res., 15 (1), 27-32.

Hemida, F., D. Golani, Y. Diatta & C. Capapé (2003): On the occurrence of the tripletail, *Lobotes surinamensis* (Bloch, 1790) (Osteichthyes: Lobotidae) off the coast of Algeria (southern Mediterranean). Annales, ser. Hist. Nat., 13 (2), 131-135.

Kharin, V.E., D.I. Vyshkvartsev & O.A. Maznikova (2009): About the taxonomic status of rare fish species Surinam triple tail *Lobotes surinamensis* (Lobotidae) and new discovery of this species in Russian waters. J. Ichthyol., 49 (1), 32-38.

Mejri, H., J. Ben Souissi , J. Zaouali, A. El Abed, O. Guélorget & C. Capapé (2004): On the recent occurrence of elasmobranch species in a perimediterranean lagoon: the Tunis Southern Lagoon (Northern Tunisia). Annales, Ser. Hist. Nat., 14 (2), 143-158.

Ounifi Ben Amor, K., M. Rifi, & J. Ben Souissi (2015): Description, reproductive biology and ecology of the *Sphaeroma walkeri* (Crustacea: Isopoda) alien species from the Tunis southern Lagoon (Northern Tunisia: Central Mediterranean). Annales, Ser. Hist. Nat., 25 (1), 35-44.

Ounifi Ben Amor, K., Ben Amor, M.M. & C. Capapé (*in press* a). Annotated list of crustacean species recorded from Tunis Southern Lagoon (Northern Tunisia, Central Mediterranean). Annales, Ser. Hist. Nat.

Ounifi Ben Amor, K., Ben Souissi, J., Capapé, C. & M.M. Ben Amor (*in press* b). Unusual record of Bluemouth Rockfish *Helicolenus dactylopterus* (Osteichthyes: Scorpaenidae) in Tunis Southern Lagoon (northern Tunisia, Central Mediterranean). J. Ichthyol.

Minos, G. & P.S. Economidis (2015): More records on the tripletail, *Lobotes surinamensis* (Bloch, 1790) from the Aegean Sea. Front. Mar. Sci. Conference Abstract: XV European Congress of Ichthyology. doi: 10.3389/conf.fmars.2015.03.00056.

Palom, O. (1991): Primera cita de *Lobotes surinamensis* (Bloch, 1790) (Pisces: Lobotidae) para la ictiofauna iberica. Miscel. Zool., 15, 240-242.

Quignard, J.-P. & J. A. Tomasini (2000): Mediterranean fish biodiversity. Biol. Mar. Med., 7, 1-66.

Quignard, J.-P. & J. Zaouali, J. (1980): Les lagunes périméditerranéennes. Bibliographie icthyologique annotée. Première partie: les étangs français de Canet à Thau. Bull. Off. natn Pêch. Tunisie, 4(2), 293-360.

Roux, C. (1986): Lobotidae. 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. 2. Unesco, Paris, pp. 854-855.

Sazima, I., A. Grossmana, A. Carvalho-Filhoa & C. Sazima (2009): First record of the tripletail or blackfish (*Lobotes surinamensis*) from an oceanic island in the South Atlantic. Mar. Biodiv. Rec., 2 (2009), e97. DOI:<http://dx.doi.org/10.1017/S1755267209001195. Published online: 06 May 2009.

Schmid, H. & J.E. Randall (1997): First record of the tripletail, *Lobotes surinamensis* (Pisces: Lobotidae) , from the Red Sea. Fauna of Saudi Arabia, 16, 353-355.

Tortonese, E. (1975): Osteichthyes, Pesci ossei, parte 2. In: Fauna d'Italia, 12, 1-686.

Zava, B., P. Giancuzza & S. Riggio (2007): Nuova cattura di *Lobotes surinamensis* (Bloch, 1790) in Tirreno meridionale (Osteichthyes: Lobotidae). Biol. Mar. Mediterr., 14(2), 370-371.

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FIRST RECORD OF A LESSEPSIAN MIGRANT, THE DUSKY SPINEFOOT, *SIGANUS LURIDUS* (RÜPPELL, 1829) IN THE STRAIT OF MESSINA (CENTRAL MEDITERRANEAN SEA)

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ABSTRACT

A specimen of Siganus luridus *(Rüppell, 1829) was caught during a spear-fishing on 18 October 2015 in Pace locality (Ionian Sicilian coast of Strait of Messina – Central Mediterranean Sea). This is the first record of this species in the Strait of Messina. It is interesting to record the presence of S. luridus in this area, as its peculiar hydrodynamic characteristics does not allow an easy dispersal of organisms between the East and Western Mediterranean basins.*

Key words: *Siganus luridus*, lessepsian species, Strait of Messina.

PRIMA SEGNALAZIONE DI PESCE CONIGLIO (SPECIE MIGRANTE LESSEPSIANA), *SIGANUS LURIDUS* (RÜPPELL, 1829), NELLO STRETTO DI MESSINA (MEDITERRANEO CENTRALE)

SINTESI

Viene riportata la prima segnalazione di un esemplare di pesce coniglio, Siganus luridus *(R*üppell*, 1829), catturato durante una battuta di pesca subacquea, nell'ottobre 2015 lungo la costa della località Pace a Messina (costa ionica dello Stretto di Messina – Mediterraneo centrale).*

Parole chiave: *Siganus luridus*, specie lessepsiana, Stretto di Messina

INTRODUCTION

Siganus luridus (Rüppell, 1829) is an herbivorous littoral fish species, living in rocky habitats (Stergiou, 1988). It usually lives in small groups of adults and large schools of juveniles (Golani *et al*., 2002). It is distributed along the Red Sea, eastern Africa to Mauritius and Reunion Island to the Arabian Gulf and to date, all over the eastern Mediterranean Sea (Golani *et al*., 2002; Letourneur *et al*., 2004; Azzurro & Andaloro, 2004). It is a species spreading from the Red Sea as a lessepsian migrant through the Suez Canal into the Mediterranean Sea where it was first recorded in 1956 along the Levantine coasts of Israel (Ben-Tuvia, 1964). Subsequently it was recorded in 1969 in the Gulf of Tunis, in 1974 in the Gulf of Gabès (Bradai *et al*., 2004) and in the Gulf of Patras (Kaspiris, 1976).

Recent data have shown its constant presence along Lebanon, Cyprus, the southern coast of Turkey, Rhodes

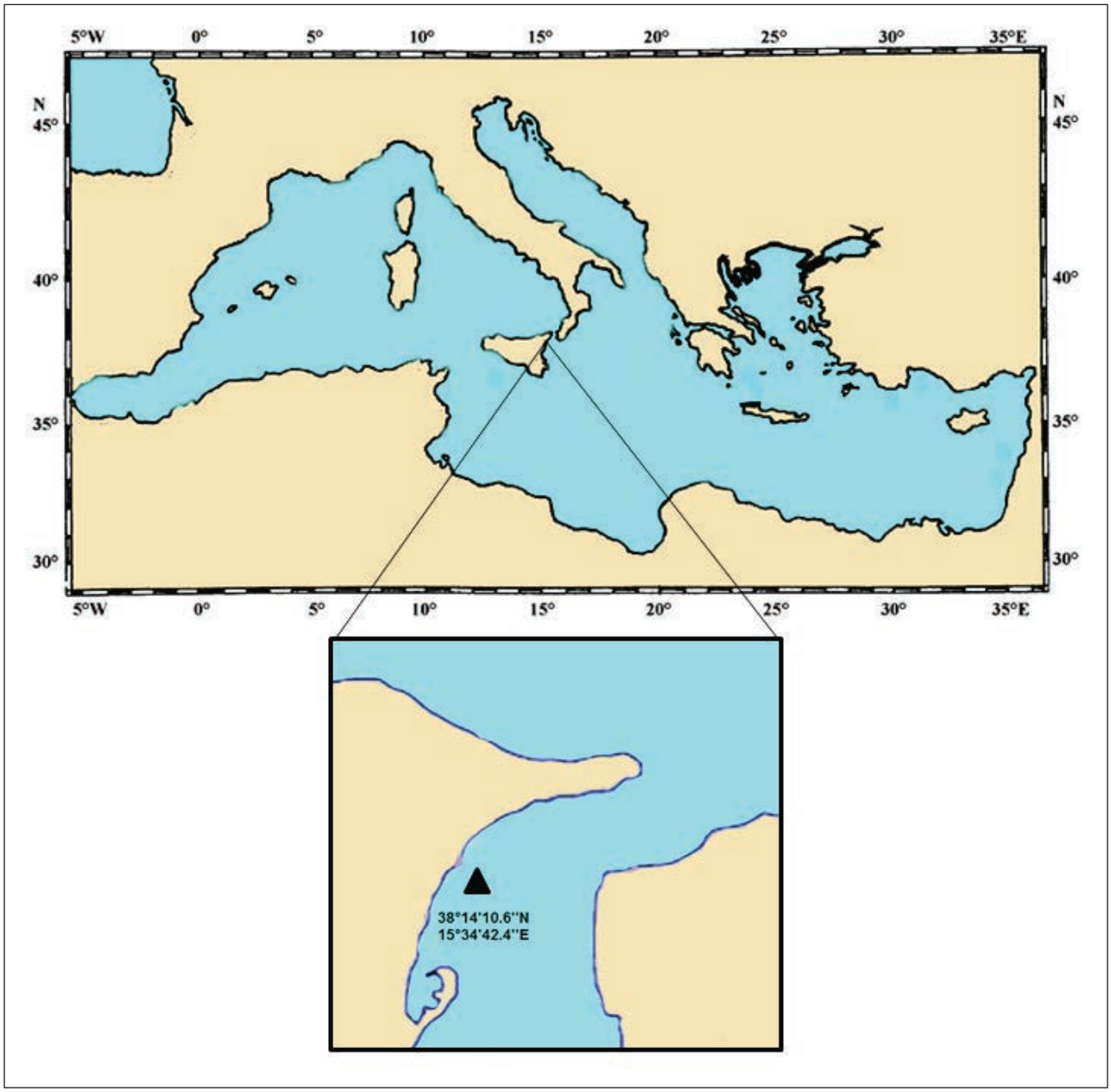

Fig. 1: Map of the area and the locality where the specimen of *S. luridus* ***was caught.***
Sl. 1: Zemljevid obravnavanega območja z označeno lokaliteto, kjer je bil ujet primerek *S. luridus*.

and central Aegean Sea (Ben-Tuvia, 1977; Papaconstantinou, 1987; Torcu & Mater, 2000); it was also recorded in Cretan waters (Golani *et al*., 2004). Some specimens have been recently recorded in the Pelagie Islands (Azzurro & Andaloro, 2004), in the Adriatic Sea (Poloniato *et al*., 2010; Dulčić *et al*., 2011, 2013; Đurović *et al*., 2014) and in north Tyrrhenian Sea (Daniel *et al*., 2009).

In this paper, the first record of the lessepsian migrant *Siganus luridus* (Rüppell, 1828) in the Strait of Messina is presented.

MATERIAL AND METHODS

On 18 October 2015, during a spear-fishing along the Strait of Messina coast (38°14′10.6″N 15°34′42.4″E), (Fig. 1) one male specimen of *S. luridus* was captured on a rocky bottom to 7 m depth (Fig. 2). Immediately after capture, morphometric (Tab. 1) and meristic data were recorded. The specimen was preserved and deposited in the Ichthyologic collection of the Wildlife Museum of Veterinary Science Department – University of Messina (802/MF).

Tab. 1: Basic morphometric measurements for *S. luridus*.
Tab. 1: Temeljni morfometrični podatki za vrsto *S. luridus*.

Morphometric measurements	mm	%TL
Total length	191	100
Fork length	171	89.5
Standard length	150	78.5
Head length	38	19.9
Eye diameter	13	6.8
Preorbital distance	12	6.3
Postorbital distance	24	12.6
Interorbital distance	15	7.8
Base of 1st dorsal fin	119	62.3
Base of anal fin	79	41.4
Predorsal distance	40	20.9
Prepectoral distance	36	18.8
Preanal distance	77	40.3
Prepelvic distance	45	23.6
Pectoral length	23	12.0
Pelvic length	25	13.1
Body depth	22	11.5
Body height	67	35.1

RESULTS AND DISCUSSION

Basic morphometric data are given in Tab. 1 for comparative purposes with other studies. Meristic data are the followings: 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 Ben-Tuvia (1986). The specimen weighed 142.3 gr.

This capture of *S. luridus* represents a first record for the Strait of Messina and constitutes a considerable extension of the known distribution range of the species within the Mediterranean sea. The origin of these individuals is not clear and at least two hypotheses may be done. The first is that specimens could have been transported from another site of the eastern Mediterranean Sea or Red Sea through ship-ballast' waters, since the Strait of Messina represents a very important thoroughfare between the eastern and western Mediterranean Sea. The second hypothesis is that the new record is a natural extension of the species areal distribution, considering that siganid larvae may be dispersed for up to approximately 1000 km (Azzurro *et al.* 2006).

Nowadays, *S. luridus* was recorded in many areas in both eastern and western Mediterranean Sea. According to some authors, the species already acquired competitive advantage over native herbivore species such as salema *(Sarpa salpa)* and wrasses (family Labridae) (Bariche *et al*., 2004).

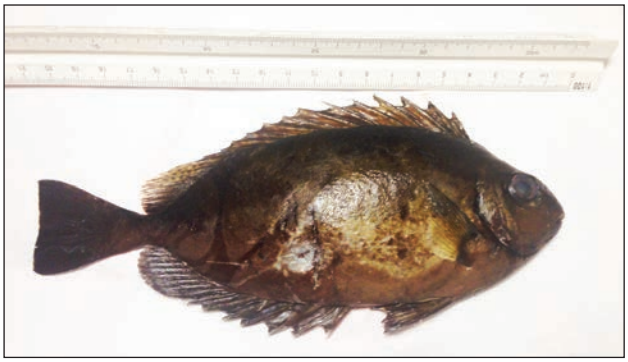

Fig. 2: Specimen of *S. luridus* ***caught at locality Pace (Messina) (Ionian Sicilian coast of the Strait of Messina – central Mediterranean Sea).***
Sl. 2: Primerek morskega kunca ujet na lokaliteti Pace (Messina) (jonska obala Sicilije ob messinski ožini).

The record, witnessing the presence of this species in the Strait of Messina, which physical, chemical, hydrodynamic and physiological peculiarities selectively regulates the dispersion of many animal and plant species (Bianchi, 2004), may represent a critical step for the radiation of the dusky spinefoot towards the western basin of the Mediterranean Sea.

The strong organic plasticity and the important potential dispersion of *S. luridus* lead to the hypothesis that dusky spinefoot exploits the Strait of Messina for further colonization of coastal areas of the entire Tyrrhenian sea and further northwest areas, as previously proposed by Castriota & Andaloro (2005).

We should also consider the fact that *S. luridus*, a thermophilic species, was found in one of the coldest sectors of the whole Mediterranean Sea, indicating a significant climatic change in this area (Francour *et al.,* 1994).

PRVI ZAPIS O POJAVLJANJU MORSKEGA KUNCA, *SIGANUS LURIDUS* (RÜPPELL, 1829), LESEPSKE SELIVKE V MESSINSKI OŽINI (OSREDNJE SREDOZEMSKO MORJE)

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Primerek morskega kunca Siganus luridus *(Rüppell, 1829) je bil ujet s podvodno puško 18 oktobra 2015 na lokaliteti Pace (jonska obala Sicilije v messinski* ožini*, osrednje Sredozemsko morje). To je prvi zapis o pojavljanju te vrste v messinski ožini. Pojavljanje morskega kunca v tem okolju je nekoliko nenavadno, saj je razširjanje organizmov med vzhodnim in zahodnim delom Sredozemlja zaradi posebnih hidrodinamičnih razmer otežkočeno.*

Ključne besede: *Siganus luridus*, lesepska selivka, messinska ožina.

REFERENCES

Azzurro, E. & F. Andaloro (2004): A new settled population of the Lessepsian migrant *Siganus luridus* (Pisces: Siganidae) in Linosa Island, Sicily Strait. J. Mar. Biol. Ass. U.K., 84, 819-821.

Azzurro, E., D. Golani, G., Bucciarelli & G. Bernardi (2006): Genetics of the early stages of invasion of the Lessepsian rabbitfish *Siganus luridus*. J. Exp. Mar. Biol. Ecol., 333, 190-201

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

Ben-Tuvia, A. (1977): Immigration of fishes through the Suez Canal. Fishery Bulletin, 76, 249–255.

Ben-Tuvia, A. (1986): Siganidae. In: P.J.P. Whitehead et al. (eds.). Fishes of the North-eastern Atlantic and the Mediterranean (FNAM). Unesco, Paris, vol. II, 964-966.

Bianchi, C. N. (2004): Proposta di suddivisione dei mari italiani in settori biogeografici. Notiziario SIBM n° 46-2004.

Bradai, M.N., J.-P. Quignard, A. Bouain, O. Jarboui, A.Ouannes-Ghorbel, L. Ben Abdallah, J. Zaouali & S. Ben Salem (2004): Ichtyofaune autochtone et exotique des côtes tunisiennes: recensement et biogéographie. Cybium, 28, 315-328.

Castriota, L. & F. Andaloro (2005): First record of the Lessepsian fish *Siganus luridus* (Osteichthyes: Siganidae) in the Tyrrhenian Sea. J. Mar. Biol. Assoc. 2 – Biodiv. Rec. 5122, 1-2.

Daniel. B., S. Piro, E. Charbonnel, P. Francour, Y. Letourneur (2009): Lessepsian rabbitfish *Siganus luridus* reached the French Mediterranean coasts. Cybium 33, (2), 163-164.

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.

Đurović, M., A. Pešić, A. Joksimović & J. Dulčić (2014): Additional record of a Lessepsian migrant - the Dusky-spinefoot, *Siganus luridus* (Rüppell, 1829) in the Eastern Adriatic (Montenegrin Coast). Annales, Ser. Hist. Nat. · 24·(2), 87-90.

Francour, P., C.F. Boudouresque, J.G. Harmelin, M.L. Harmelin-Vivien, J.P. Quignard (1994): Are the Mediterranean waters becoming warmer? Information from biological indicators. Mar. Pollut. Bull. 29, 523–526.

Golani, D., L. Orsi-Relini, E. Massuti & J.P. Quignard (2002): CIESM atlas of exotic species in the Mediterranean. Vol I. Fishes (ed. F. Briand). Monaco: CIESM Publisher.

Golani, D., L. Orsi-Relini, E. Massuti & J.P. Quignard (2004): Dynamics of fish invasions in the Mediterranean: update of the CIESM Fish Atlas. Rapports de la Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée, 37, 367.

Kaspiris, P. (1976): New fish records from the Greek part of the Ionian Sea. Revue des Travaux de l'Institut des Pêches Maritimes, 40, 627-628.

Letourneur, Y., P. Chabanet, P., Durville, M. Taquet, E. Teissier M. Parmentier J.-C Quéro & K. Pothin (2004): An updated checklist of the marine fish fauna of Reunion Island, south-western Indian Ocean. Cybium, 28, 199-216.

Papaconstantinou, C. (1987): Distribution of the Lessepsian fish migrants in the Aegean Sea. Biologia Gallo-hellenica., 13, 15-20.

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.

Stergiou, K.I. (1988): Feeding habits of the Lessepsian migrant *Siganus luridus* in the Eastern Mediterranean, its new environment. J. Fish Biol., 33, 531-543.

Torcu, H. & S. Mater, S. (2000): Lessepsian fishes spreading along the coasts of the Mediterranean and the Southern Aegean Sea of Turkey. Turkish J. of Zool., 24, 139–148.

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THE SECOND RECORD OF LESSEPSIAN MIGRANT *ETRUMEUS GOLANII* FROM THE NORTH-EASTERN AEGEAN SEA (IZMIR BAY, TURKEY)

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ABSTRACT

A specimen of Etrumeus golanii *(Dussumieriidae)(180 mm TL) was caught on 13th October 2015 with a purse-seine from the Bay of Izmir, north-eastern Aegean Sea, at a depth of 63 m. This is the second finding of this species for the north-eastern Aegean Sea and the eighth report of Lessepsian fish for the Bay of Izmir.*

Keywords: *Etrumeus golanii,* Lessepsian fish, new record, Izmir Bay, Aegean Sea.

SECONDA SEGNALAZIONE DEL MIGRANTE LESSEPSIANO *ETRUMEUS GOLANII* NEL MAR EGEO NORD-ORIENTALE (BAIA DI SMIRNE, TURCHIA)

SINTESI

Un esemplare di Etrumeus golanii *(Dussumieriidae) (TL pari a 180 mm) è stato catturato il 13 ottobre 2015 con una rete da circuizione nella baia di Smirne, nell'Egeo nord-orientale, ad una profondità di 63 m. Si tratta del secondo ritrovamento di questa specie nell'Egeo nord-orientale e dell'ottava segnalazione di un pesce lessepsiano nella baia di Smirne.*

Parole chiave: *Etrumeus golanii,* pesce lessepsiano, nuova segnalazione, baia di Smirne, mar Egeo.

INTRODUCTION

The genus *Etrumeus* was redefined by DiBattista *et al*. (2012) and *Etrumeus golanii* DiBattista, Randall & Bowen, 2012 since a new holotype was previously misidentified as *E. teres* in the Mediterranean. *E. golanii* is an inshore pelagic species, which colonized the Mediterranean from the Red Sea via the Suez Canal in spite of its original Indo-Pacific distribution (Golani *et al.,* 2006).

In the 1990s, it became very common in the Israeli coast, and extended its distribution to Iskenderun Bay and Cyprus (Golani *et al*., 2006). Six specimens of *E. golanii* were caught off Karataş, Iskenderun Bay during the 1994–1996 sampling period by means of a mid-water trawl, and this was the first report from Turkish seas (Başusta *et al.,* 1997). Between November 1997 and May 1998, *E. golanii* was collected abundantly by purse-seine fishery in the Gulf of Antalya, Turkey (Yılmaz & Hoşsucu, 2003). Then, this fish was apparently well established in Cypriot waters, since many specimens were observed in the local market in 1999 (Golani, 2000). Consecutively, *E. golanii* was reported from the Rhodes in December 2003 (Corsini *et al*., 2005), the Cyclades (*i.e*. Paros, Naxos and Ios islands) in May 2004 (Kallianiotis & Lekkas, 2005), Crete in July 2005 (Kasapidis *et al*., 2007) and from the Hydra Island in November 2005 (Zenetos *et al*., 2008) in the Greek Aegean Sea. *E. golanii* reached as far as the Island of Lampedusa in the Strait of Sicily in September 2005 (Falautano *et al*., 2006). Erguden *et al*. (2009) analysed the length-to-weight relationship of *E. golanii* in Iskenderun Bay, Turkey for the first time. Nevertheless, the fish expanded its distribution not only westward but also northward in the Mediterranean (*i.e*. Aegean Sea). Yarmaz *et al*. (2010) reported a single specimen of *E. golanii* from Dikili coast, Izmir, in February 2009. This was the northernmost record for the Aegean Sea.

This paper presents the second report of the Lessepsian *E. golanii* from the coasts of Izmir, north-eastern Aegean Sea, which, however, does not indicate an established population yet.

Fig. 1. *Etrumeus teres,* ***caught from Izmir Bay, NE Aegean Sea (Photo: O. Akyol)***
Sl. 1: Primerek vrste *Etrumeus golanii****, ujet v Izmirskem zalivu v severovzhodnem Egejskem morju (Foto: O. Akyol)***

MATERIAL AND METHODS

On 13th October 2015, a specimen of *Etrumeus golanii* with a total length (TL) of 180 mm (Fig. 1) was captured by a commercial purse-seiner targeting anchovy and sardine off Karaburun, at the entrance to Izmir Bay (Coordinates: 38°33′46″N-26°36′34″E) at a depth of 63 m. The specimen was fixed with a 10% formaldehyde solution and deposited in the fish collection of the Fisheries Faculty, Ege University (ESFM-PIS/2015-08).

RESULTS AND DISCUSSION

The origin of the pelvic fin is behind the dorsal fin. Measurements, counts and selected body proportions

Tab. 1: Morphometric measurements as percentages of total length (%TL) and counts recorded in *Etrumeus golanii****, captured from Izmir Bay, NE Aegean Sea.***
Tab. 1: Morfometrične meritve izražene kot delež celotne dolžine (%) in meristični podatki za primerek vrste *Etrumeus golanii****, ujetega v Izmirskem zalivu v severovzhodnem Egejskem morju.***

Reference	**ESFM-PIS/2015-08**	
Measurements	**Size (mm)**	**Proportion (%)**
Total length (TL)	180	100.0 TL
Fork length (FL)	159	88.3 TL
Standard length (SL)	153	85.0 TL
Maximum body depth	28	15.6 TL
Predorsal fin length	66	36.7 TL
Prepectoral fin length	38	21.1 TL
Pre-anal fin length	127	70.6 TL
Head length (HL)	34	18.9 TL
Eye diameter	11	32.4 HL
Preorbitary length	12	35.3 HL
Meristic ounts		
Dorsal fin rays	17	
Anal fin rays	9	
Ventral fin rays	8	
Pectoral fin rays	16	

are shown in Table 1. All the determined measurements and colour patterns are in accordance with the descriptions by Başusta *et al*. (1997), Golani (2000), Corsini *et al*. (2005) and DiBattista *et al*. (2012).

Lefkaditou *et al*. (2010) endorses that this Lessepsian fish might be considered as rather regularly occurring in the catches of trawl, beach- and purse-seine in the southernmost areas of the Hellenic territorial waters. The species results well established in the South-eastern Aegean Sea (Corsini-Foka *et al.,* 2015). The recent two records indicated that it probably shifted towards northern latitudes due to the changed hydrological conditions. The EastMed report (2010) notified that the North Aegean cold water fauna and the Central-South warm water fauna were changing positions, moving northwards along the Aegean coasts. In this way, *E. golanii* appears in the northern Aegean Sea, but it is very rare for now.

As mentioned above, *E. golanii* has been already recorded in the area under study (Yarmaz *et al*., 2010) and this short report confirms the occurrence of the species in Izmir Bay, north-eastern Aegean Sea. Moreover, with the addition of *E. golanii* to the previously recorded *Saurida lessepsianus* (Russell, Golani & Tikochinski, 2015)*, Lagocephalus sceleratus* (Gmelin, 1789)*, Siganus luridus* (Rüppell, 1828)*, S. rivulatus* (Forsskal, 1775)*, Champsodon vorax* (Günther, 1867), *Stephanolepis diaspros* (Fraser-Brunner, 1940) and *Upeneus molluccensis* (Bleeker, 1855) (ESFM-PIS/2016-03, unpublished data), the list of Lessepsian fish in the Bay now counts eight species.

DRUGI ZAPIS O POJAVLJANJU LESEPSKE SELIVKE VRSTE *ETRUMEUS GOLANII* IZ SEVERNOVZHODNEGA EGEJSKEGA MORJA (IZMIRSKI ZALIV, TURČIJA)

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POVZETEK

Primerek vrste Etrumeus golanii *(Dussumieriidae) (180 mm TL) je bil ujet 13 oktobra 2015 z zaporno plavarico v Izmirskem zalivu v severovzhodnem Egejskem morju na globini 63 m. Gre za drugi zapis o pojavljanju te vrste v severovzhodnem Egejskem morju in osmi zapis o pojavljanju lesepskih vrst rib v Izmirskem zalivu.*

Ključne besede: *Etrumeus golanii,* lesepske selivke, nov zapis, Izmirski zaliv, Egejsko morje.

REFERENCES

Başusta, N., Ü. Erdem & S. Mater (1997): A new Lessepsian immigrant fish species in Iskenderun Bay: Red-eyed Sardine, *Etrumeus teres* (DeKay, 1842). [in Turkish]. Mediterranean Fisheries Congress, 9-11 April, Izmir, pp. 921-924.

Corsini, M., P. Margies, G. Kondilatos & P.S. Economidis (2005): Lessepsian migration of fishes to the Aegean Sea: First record of *Tylerius spinosissimus* (Tetraodontidae) from the Mediterranean and six more fish records from Rhodes. Cybium, 29, 347-354.

Corsini-Foka M., A. Zenetos, F. Crocetta, M.E. Çinar, F. Koçak, D. Golani, S. Katsanevakis, K. Tsiamis, E. Cook, C. Froglia, M. Triandophyllou, S. Lakkis, G. Kondylatos, E. Tricarico, A. Žuljević, M. Almeida, F. Cardigos, S. Çağlar, F. Durucan, A.M.D. Fernandes, J. Ferrario, I. Haberle, P. Louizidou, J. Makris, M. Maric, D. Micu, C. Mifsud, C. Nall, E. Kytinou, D. Poursanidis, D. Spigoli, G. Stasolla, S. Yapici & H.E. Roy (2015): Inventory of alien and cryptogenic species of the Dodecanese (Aegean Sea, Greece): Collaboration through COST Action Training School. Management of Biological Invasions, 6, 351-366.

DiBattista, J.D., J.E. Randall & B.W. Bowen (2012): Review of the round herrings of the genus *Etrumeus* (Clupeidae: Dussumieriinae) of Africa, with descriptions of two new species. Cybium, 36, 447-460.

EastMed (2010): Report of the sub-regional technical meeting on the Lessepsian migration its impact on Eastern Mediterranean fishery. GCP/INT/041/EC-GREITA/TD-04. 59 pp.

Erguden, D., C. Turan & M. Gurlek (2009): Weight-length relationships for 20 Lessepsian fish species caught by bottom trawl on the coast of Iskenderun Bay (NE Mediterranean Sea, Turkey). J. Appl. Ichthyol., 25, 133-135.

Falautano, M., L. Castriota & F. Andalaro (2006): First record of *Etrumeus teres* (Clupeidae) in the Central Mediterranean Sea. Cybium, 30, 287-288.

Golani, D. (2000): The Lessepsian migrant, the Red-eye Round Herring, *Etrumeus teres* (DeKay, 1842), a new record from Cyprus. Zoology in the Middle East, 20, 61-64.

Golani, D., B. Öztürk & N. Başusta (2006): The fishes of the eastern Mediterranean. Turkish Marine Research Foundation (Publication No. 24), Istanbul, Turkey.

Kallianiotis, A. & V. Lekkas (2005): First documented report on the Lessepsian migrant *Etrumeus teres* De Kay, 1842 (Pisces: Clupeidae) in the Greek Sea. Journal of Biological Research, 4, 225-229.

Kasapidis, P., P. Peristeraki, G. Tserpes & A. Magoulas (2007): A new record of the Lessepsian invasive fish, *Etrumeus teres* (Osteichthyes: Clupeidae) in the Mediterranean Sea (Aegean, Greece). Aquatic Invasions, 2, 152-154.

Lefkaditou, E., V. Vassilopoulou, G. Petrakis, P. Peristeraki, S. Kavadas, C.Y. Politou, A. Kapantagakis, A. Machias & C. Papaconstantinou (2010): The effect of Lessepsian immigrants to the Hellenic fisheries. EastMed Sub-regional Technical meeting on the Lessepsian migration and its impact on eastern Mediterranean Fishing. Nicosia, Cyprus, 7-9 December 2010. GCP/INT/041/EC-GRE-ITA/TD-04, pp. 60-73.

Yarmaz, A., C. Balaban, M. Türkakın, & D. Türker-Çakır (2010): A new record of Lessepsian migrant *Etrumeus teres* (DeKay, 1842)(Osteichthyes: Clupeidae) from the northern Aegean Sea. J. Appl. Ichthyol., 26, 134-136.

Yılmaz, R. & B. Hoşsucu (2003): Some biological parameters of Round Herring, *Etrumeus teres* (DeKay, 1842) in the Gulf of Antalya (Mediterranean Sea). Ege J. Fish. Aqua. Sci., 20:1-8.

Zenetos, A., V. Vassilopoulou, M. Salomidi & D. Poursanidis (2008): Additions to marine alien fauna of Greek waters (2007 update). Marine Biodiversity Records, Vol.1, e91, pp. 1-8.

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CAPTURE OF A JUVENILE SHORTFIN MAKO SHARK, *ISURUS OXYRINCHUS* RAFINESQUE, 1810 (CHONDRICHTHYES: LAMNIDAE) IN THE BAY OF EDREMIT, NORTHERN AEGEAN SEA (TURKEY)

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ABSTRACT

*A male shortfin mako shark (*Isurus oxyrinchus*) was caught on April 8, 2016, in the coastal waters of the Bay of Edremit by a commercial fisherman using nets set at the depths between 20 and 25 m. The specimen measured 74.7 cm in total length and weighed 2.75 kg. Its claspers were uncalcified, soft and shorter than the pelvic fins, revealing that it was a juvenile specimen. Upper and lower beaks of a cuttlefish (*Sepia officinalis*) were found in the stomach content. The nursery ground characteristics of* I. oxyrinchus *in relation to the feeding habit is also discussed.*

Key words: Shortfin mako, Aegean Sea, incidental catch, large elasmobranch

CATTURA DI UN GIOVANE SQUALO MAKO, *ISURUS OXYRINCHUS* RAFINESQUE, 1810 (CHONDRICHTHYES: LAMNIDAE), NELLA BAIA DI EDREMIT, EGEO SETTENTRIONALE (TURCHIA)

SINTESI

*Un maschio di squalo mako (*Isurus oxyrinchus*) è stato catturato con reti da posta l'8 aprile 2016 nelle acque costiere della baia di Edremit, ad una profondità tra i 20 e i 25 m. L'esemplare era lungo 74,7 cm e pesava 2,75 kg. I clasper (o pterigopodi) non erano calcificati, ma morbidi e più corti delle pinne pelviche, rivelando che si trattava di un esemplare giovane. Nel contenuto stomacale sono state trovate le parti superiori ed inferiori dei becchi di seppia (*Sepia officinalis*). Vengono discusse anche le caratteristiche dell'area di nursery di* I. oxyrinchus *in relazione alle abitudini di alimentazione della specie.*

Parole chiave: squalo mako, mar Egeo, catture accidentali, grandi elasmobranchi

INTRODUCTION

One of the prominent large predatory sharks, shortfin mako, *Isurus oxyrinchus* Rafinesque, 1810, is cosmopolitan in all warm-temperate and tropical waters of the world oceans (Compagno, 2001). It is a pelagic, coastal and oceanic species occurring at or near the surface or deeper down at depths of up to at least 500 m (Compagno, 2001; Serena, 2005). *I. oxyrinchus* is present in the entire Mediterranean, where it is incidentally caught by tuna longline fisheries and seldom by swordfish longliners and drift netters (Serena, 2005; Damalas & Megalofonou, 2012). The first record of *I. oxyrinchus* in Turkish waters was reported by Akşıray (1954; in Bilecenoğlu *et al*., 2002).

In the present study, we report on a recent capture of a young shortfin mako shark in the Bay of Edremit, northern Aegean Sea, off Turkish coast. Morphometric measurements and brief biological data of the present specimen are given.

MATERIAL AND METHODS

A male shortfin mako shark was caught on April 8, 2016, in the coastal waters of the Bay of Edremit (Fig. 1) by a commercial fisherman using nets set at the depths between 20 and 25 m. The specimen was transferred to the ichthyological laboratories of Çanakkale Onsekiz Mart University (ÇOMU), where morphometric measurements were recorded following Compagno (2001). The stomach and spiral valve of the specimen were removed and preserved in 70% ethanol for content analysis. Identification and measurements of cephalopod beaks found in the stomach contents were carried out following Mangold & Fioroni (1966). A binocular microscope

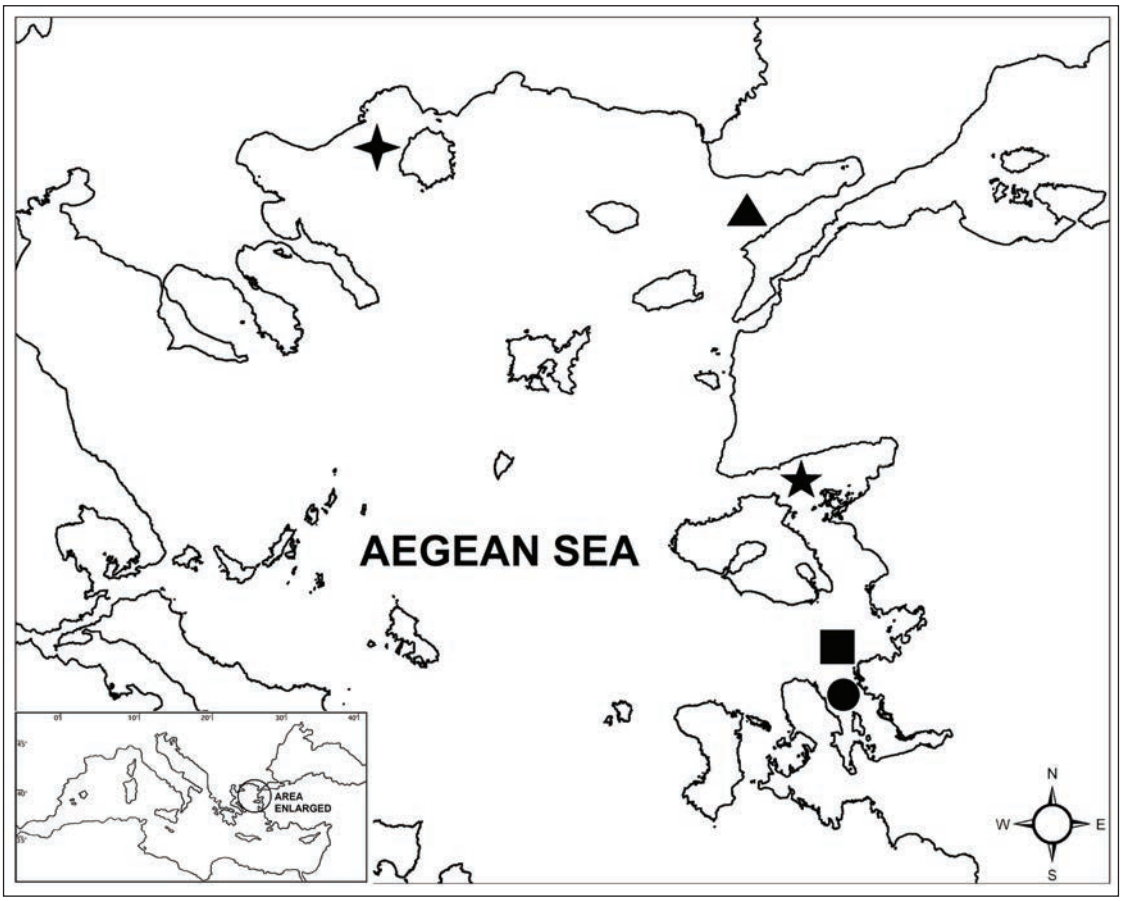

Fig. 1. Map showing the localities of historical and contemporary records of** I. oxyrinchus **caught in the northern Aegean Sea. Legend: (✦) Kavala specimen recorded by Konsuloff & Drensky (1943; in Papaconstantinou, 1988); (●) İzmir specimen recorded by Geldiay (1969); (▲) Bay of Saroz specimen recorded by Kabasakal & Kabasakal (2013); (■) Foça specimen recorded by Kabasakal (2015); and (★) present specimen.
Sl. 1: Zemljevid severnega dela Egejskega morja z zgodovinskimi in recentnimi zapisi o pojavljanju morskega psa maka** I. oxyrinchus**. Legenda: (✦) primerek iz Kavale, Konsuloff & Drensky (1943; v Papaconstantinou, 1988); (●) primerek iz İzmira, Geldiay (1969); (▲) primerek iz zaliva Saroz, Kabasakal & Kabasakal (2013); (■) primerek iz lokalitete Foça, Kabasakal (2015); in (★) primerek, o katerem poročata avtorja pričujočega prispevka.

Tab. 1: Morphometric measurements of the specimen of shortfin mako shark, *I. oxyrinchus.*
Tab. 1: Morfometrične meritve primerka morskega psa maka, *I. oxyrinchus.*

Measurements	Present specimen ♂	
	cm	%TOT
Total Length (TOT, cm)	74.7	100
Snout tip to		
outer nostrils	3.3	4.41
eye	6.2	8.29
mouth	5.5	7.36
1st gill opening	16.5	22.08
pectoral origin	20.2	27.04
pelvic origin	42.5	56.89
1st dorsal origin	28.0	37.48
2nd dorsal origin	55.5	74.29
dorsal caudal origin	62.0	82.99
Distance between bases		
1st and 2nd dorsal fins	17.5	23.42
2nd and caudal fins	4.5	6.02
pelvic and anal fins	15.0	20.08
anal and caudal fins	14.2	19
nostrils; between inner corners	2.8	3.74
mouth; width	5.2	6.96
mouth; length	7.2	9.63
Gill opening lengths		
1st	7.1	9.5
3rd	6.5	8.7
5th	5	6.69
Eye		
horizontal diameter	1.8	2.4
vertical diameter	1.5	2
interorbital width	1.8	2.4
1st dorsal fin		
overall length	7.5	10.04
length of base	5.5	7.36
height	6.4	8.56
2nd dorsal fin		
overall length	2.0	2.67
length of base	0.7	0.93
height	1.2	1.6
Pectoral fin		
length of base	7.2	9.63
length of anterior margin	12.0	16.06
length of distal margin	8.5	11.37
length of posterior margin	7.5	10.04
Pelvic fin		
overall length	6.0	8.03
length of base	3.2	4.28
length of anterior margin	3.3	4.41
length of clasper, outer	2.0	2.67
length of clasper, inner	4.5	6.02
Anal fin		
overall length	1.1	1.47
length of base	0.9	1.2
length of anterior margin	3.6	4.81
length of distal margin	3.5	4.68
Caudal fin		
length of dorsal lobe	16.0	21.41
length of ventral lobe	13.2	17.67
dorsal tip to notch	9.0	12.04
depth of notch	1.5	2

(magnification 16x) with an eyepiece micrometre was used to examine and measure the cephalopod beaks. Dorsal mantle length estimation of the prey is based on the ratios proposed by Mangold & Fioroni (1966). The dissected specimen is stored in the collections of the Piri Reis Museum at ÇOMU, without a catalogue number.

RESULTS AND DISCUSSION

The shortfin mako specimen (Fig. 2) measured 74.7 cm in total length and weighed 2.75 kg. Morphometric measurements are given in Table 1. The claspers of the present specimen were uncalcified, soft and shorter than the pelvic fins, revealing that it was juvenile. Second dorsal and anal fins are minute (Fig. 2); strong keels on caudal peduncle with a crescentic caudal fin (Fig. 2); no secondary keels on caudal base. Large blade-like teeth are without cusplets or serrations. Lower anterior teeth are strongly protruding and horizontal on jaws even when mouth is closed (Fig. 3). Dorsal surface of body is dark bluish, ventral surface whitish, and lighter shades of dorsal coloration extend over gill area (Fig. 2). Ventral surface of the snout is white, with a distinct black spot visible on the tip of the snout (Fig. 3). Length of the anterior margin of the pectoral fin was 16.06% of the total length and 59.4% of the head length. In *I. oxyrinchus*, the anterior margin of the pectoral fin is approximately between 16% and 22% of total length, and shorter than head length (Compagno, 2001).

Upper and lower beaks of a cuttlefish (*Sepia officinalis*) were found in the stomach contents. Based on the proportions obtained by correlating dorsal mantle length of Mediterranean cephalopods with their beak measurements (Mangold & Fioroni, 1966), the dorsal mantle

length of the specimen of *S. officinalis* was estimated to range from 106.7 mm (♂) to 113 mm (♀). In a recent study on the food habits of the shortfin mako shark caught off the southwestern coast of Portugal, Maia *et al.* (2006) found that cephalopods are relatively important in the diet of *I. oxyrinchus*, with a 40.4% occurrence in the examined stomach contents of 112 shortfin makos. According to Compagno (2001), cuttlefish (*Sepia*, Sepiidae) is one of the cephalopods preyed upon by *I. oxyrinchus*. *S. officinalis* is a neritic, demersal species, found on the continental shelf at a depth range from subtidal waters to 200 m, most abundant in the upper 100 m (Jereb & Roper, 2005). A previous study revealed that *S. officinalis* is one of the common prey items of demersal sharks occurring in northern Aegean Sea (Kabasakal, 2002). However, the results of the present study suggest that shortfin mako, a pelagic predator, can also prey on demersal species during its early life period.

The occurrence of the shortfin mako shark in the northern Aegean Sea dates back to the mid-20th century, based on a historical record of *I. oxyrinchus* recorded off Kavala, Greek coast by Konsuloff & Drensky (1943; in Papaconstantinou, 1988). Another historical record of this species was reported by Geldiay (1969) off İzmir, Turkey. Although caught in the south-eastern part of the sea, a third specimen of *I. oxyrinchus* was reported by Kabasakal & De Maddalena (2011), based on a photographic record of a huge specimen captured off Marmaris (SE Aegean Sea, Turkey) in the 1950s. Besides the historical records of *I. oxyrinchus* in the northern Aegean Sea, Kabasakal & Kabasakal (2013) recorded a young male shortfin mako in the coastal waters of the Bay of Saroz, which was caught by hook and line on March 30, 2012. Recently, a newborn female (TL 65 cm) was also caught in the coastal waters off Foça coast, Turkey, on May 19, 2015 (Kabasakal, 2015). Localities of historical and contemporary records of *I. oxyrinchus* caught in the northern Aegean Sea are shown in Fig. 1.

In recent years, several newborn and juvenile lamniform sharks, *Carcharodon carcharias* and *I. oxyrinchus*, have been incidentally caught off Turkish coast of the northern Aegean Sea, by commercial fishermen (Kabasakal, 2014, 2015; Kabasakal & Kabasakal, 2013, 2015). Occurrence of these young lamniform sharks in the mentioned area over the years since 2008 pose the question whether a breeding and nursery ground of lamniform sharks is present in the northern Aegean Sea. The diverse topography of the study area is spotted by several small and large islands just a few kilometres off the coast and farther (Fig. 1). Several authors investigating the nursey ground characteristics of *I. oxyrinchus* in several regions of the world suggested an island-oriented movement pattern for young shortfin mako sharks due to biological requirements such as feeding (Holts & Bedford, 1993; Vélez-Marin & Márquez-Farías, 2009). Secure environments of coastal shark nurseries are known to provide opportunities of open sea to the future predator for fine tuning its foraging tactics and capture before shifting to feed on more energetic prey (Clua & Reid, 2013). Unfortunately, this potential coastal breeding and nursery ground of lamniform sharks in the northern Aegean Sea off Turkish coast is also a remarkable

Fig. 2: Lateral view of present shortfin mako shark. (Photo: Sezginer Tunçer).
Sl. 2: Primerek morskega psa maka iz boka (Foto: Sezginer Tunçer).

fishing ground of artisanal fishermen, where small-scale fisheries of coastal netters and longliners are active all the year round (H. Kabasakal, *pers. obs*.) Due to the geographical overlap of this shark nursery and fishing grounds, the survival of newborn, young and adult sharks is threatened. At present, no pregnant adults of *C. carcharias* or *I. oxyrinchus* have been captured in the vicinity of this shark nursery; however, newborns, young-of-the-years or young specimens of both lamniforms are sighted or get caught in the mentioned region almost all year round. (Kabasakal, 2014, 2015). Furthermore, there is always a competition between the fishermen and the marine predators feeding on the commercially valuable species, like *S. officinalis* and other cephalopods. In most cases this competition between sharks and fishermen results in shark mortality. Since *I. oxyrinchus* is categorized as a 'critically endangered' shark in the Mediterranean Sea (Cavanagh & Gibson, 2007), targeted and non-targeted fishing pressure on young and adult shortfin mako sharks would increase the current threats to the survival of *I. oxyrinchus*. Therefore, an extensive study is needed for a better understanding of seasonal occurrence and feeding habits of lamniform sharks in the vicinity of this potential shark nursery. Implementation of regulatory measurements for the coexistence of lamniform sharks and a sustainable coastal fishery in an area, where the shark and fishermen are competing for the same resources, could only be possible after reading the conclusions of such research.

Fig. 3. Close-up view of the head of shortfin mako shark. (Photo: Sezginer Tunçer).
Sl. 3: Bližinski posnetek glave kratkoplavutega maka (Foto: Sezginer Tunçer).

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ZAPIS O ULOVU MLADEGA PRIMERKA MORSKEGA PSA MAKA , *ISURUS OXYRINCHUS* RAFINESQUE, 1810 (CHONDRICHTHYES: LAMNIDAE) IZ ZALIVA EDREMIT, SEVERNO EGEJSKO MORJE (TURČIJA)

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POVZETEK

*Samec morskega psa maka je 8 aprila 2016 v obrežnih vodah zaliva Edremit v ribiško mrežo ujel poklicni ribič na globini med 20 in 25 m. Primerek je meril 74.7 cm v dolžino in tehtal 2.75 kg. Klasperja sta bila mehka in nekalcificirana ter krajša od trebušnih plavuti, kar je značilno za mladiče. V želodcu so bile najdeni spodnji in zgornji deli kljunov sipe (*Sepia officinalis*).*

Ključne besede: mako, Egejsko morje, naključni ulov, velike hrustančnice

REFERENCES

Akşıray, F. (1954): Türkiye Deniz Balıkları Tayin Anahtarı. Sayı 1. Istanbul: Hidrobiyoloji Araştırma Enstitüsü Yayınları, 277 pp.

Bilecenoğlu, M., E. Taşkavak, S. Mater & M. Kaya (2002): Checklist of the marine fishes of Turkey. Zootaxa 113, 1–194.

Cavanagh, R. D. & C. Gibson (2007): Overview of the conservation status of cartilaginous fishes (Chondrichthyans) in the Mediterranean Sea. IUCN, Gland, Switzerland and Malaga, Spain, 42 pp.

Clua, E. & D. Reid (2013): Features and motivation of a fatal attack by a juvenile white shark, *Carcharodon carcharias*, on a young male surfer in New Caledonia (South Pacific). J. Forensic Leg. Med., 20 (5), 551-554.

Compagno, L. J. V. (2001): Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Vol. 2. Bullhead, mackerel and carpet sharks (Hederodontiformes, Lamniformes and Orectolobiformes). FAO Species Catalogue for Fishery Purposes, FAO, Rome, no. 1, 269 pp.

Damalas, D. & P. Megalofonou (2012): Occurrences of large sharks in the open waters of the southeastern Mediterranean Sea. J. Nat. Hist., 46 (43-44), 2701-2723.

Geldiay, R. (1969): İzmir Körfezinin baslica baliklari ve muhtemel invasionlari [Important fishes found in the Bay of Izmir and their possible invasions]. Izmir: Ege Üniversitesi Fen Fakültesi Monografileri, 135 pp.

Holts, D. B. & D. W. Bedford (1993): Horizontal and vertical movements of the shortfin mako shark, *Isurus oxyrinchus*, in the southern California Bight. Aust. J. Mar. Fresh. Res., 44, 901–909.

Jereb, P. & C. F. E. Roper (*eds.*) (2005): Cephalopods of the world. An annotated and illustrated catalogue of cephalopod species known to date. Volume 1. Chambered nautiluses and sepioids (Nautilidae, Sepiidae, Sepiolidae, Sepiadariidae, Idiosepiidae and Spirulidae). FAO Species Catalogue for Fishery Purposes. No. 4, Vol. 1. Rome, FAO. 262 p.

Kabasakal, H. (2002): Cephalopods in the stomach contents of four elasmobranch species from the northern Aegean Sea. Acta Adriat., 43 (1), 17-25.

Kabasakal, H. (2014): The status of the great white shark (*Carcharodon carcharias*) in Turkey's waters. Marine Biodiversity Records, 7, e109. doi:10.1017/S1755267214000980.

Kabasakal, H. (2015): Occurrence of shortfin mako shark, *Isurus oxyrinchus* Rafinesque, 1810, off Turkey's coast. Marine Biodiversity Records, 8, e134. doi: 10.1017/S1755267215001104.

Kabasakal, H. & A. De Maddalena (2011): A huge shortfin mako shark *Isurus oxyrinchus* Rafinesque, 1810 (Chondrichthyes: Lamnidae) from the waters of Marmaris, Turkey. Annales, Ser. Hist. Nat., 21 (1), 21-24.

Kabasakal, H. & Ö. Kabasakal (2013): First record of a shortfin mako shark, *Isurus oxyrinchus* Rafinesque, 1810 (Chondrichthyes: Lamnidae) from the Bay of Saroz (NE Aegean Sea). Annales, ser. hist. nat., 23(1), 27-32.

Kabasakal, H. & Ö. Kabasakal (2015): Recent record of the great white shark, *Carcharodon carcharias* (Linnaeus, 1758), from central Aegean Sea off Turkey's coast. Annales, ser. hist. nat., 25(1), 11-14.

Konsuloff, S. & P. Drensky (1943): Die fischfauna der Aegäis. Annuaire de l'Université de Sofia Faculté des Sciences Naturelles, 39, 293–308.

Maia, A., N. Queiroz, J. P. Correia & H. Cabral (2006): Food habits of the shortfin mako, *Isurus oxyrinchus*, off the southwest coast of Portugal. Environ. Biol. Fish., 77, 157-167.

Mangold, K. & P. Fioroni (1966): Morphologie et biométrie des mandibules de quelques céphalopodes Méditerranéens. Vie et Milieu, Série A, 17, 1139-1196.

Papaconstantinou, C. (1988): Check-list of marine fishes of Greece. Athens: National Center for Marine Research & Hellenic Zoological Society, 257 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.

Vélez-Marín, R. & J. F. Márquez-Farías (2009): Distribution and size of the shortfin mako (*Isurus oxyrinchus*) in the Mexican Pacific Ocean. PANAMJAS 4 (4), 490–499.

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NEW RECORD OF WHITE GROUPER *EPINEPHELUS AENEUS* (OSTEICHTHYES: SERRANIDAE) IN CROATIAN ADRIATIC WATERS

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ABSTRACT

Authors report an additional record of the white grouper Epinenephelus aeneus *in the Adriatic Sea (Croatian waters). On 4th October 2015 an adult specimen (TL = 50.0 cm; W= 1,320 g) was caught with a fish trap at a depth of 10 m near the Island of Čiovo (eastern middle Adriatic). This species can be considered as very rare in the Adriatic Sea.*

Key words: *Epinephelus aeneus*, new record, very rare species, Adriatic Sea

NUOVA SEGNALAZIONE DELLA CERNIA BIANCA *EPINEPHELUS AENEUS* (OSTEICHTHYES: SERRANIDAE) IN ACQUE ADRIATICHE CROATE

SINTESI

Gli autori riportano una nuova segnalazione della cernia bianca Epinenephelus aeneus *nel mare Adriatico (in acque croate). Un esemplare adulto (TL = 50,0 cm; W= 1320 g) è stato catturato il 4 ottobre 2015 con una nassa a 10 m di profondità nei pressi dell'isola di Bua (Čiovo, Adriatico centro-orientale). La specie può venir considerata molto rara nel mare Adriatico.*

Parole chiave: *Epinephelus aeneus*, nuova segnalazione, specie molto rara, mare Adriatico

INTRODUCTION

The white grouper *Epinephelus aeneus* (Geoffroy Saint-Hilaire, 1817) is distributed in the Eastern Atlantic (along the west coast of Africa down to southern Angola) and southern Mediterranean. It is considered as very rare in the Adriatic Sea and biological information on it is quite scarce (Dulčić & Dragičević, 2011).

Numerous species, previously classified as either rare or completely absent, have recently became more common in the Adriatic Sea. But although the first records of the species are usually documented, the tracing of the species establishment or its subsequent expansion rarely is. As a consequence, the status of species considered rare or very rare usually remains unchanged in spite of the species establishment or further expansion. Additionally, subsequent records may indicate that previous occurrences were not just accidental, but may suggest that a new region is now included in the zoographic range of the species (Golani & Levy, 2005).

The aim of the present work is to report an additional record of white grouper *E. aeneus* in Croatian Adriatic waters.

MATERIAL AND METHODS

The geographical area concerned in this study is the eastern Adriatic (Croatian coast, the Island of Čiovo). Information on the occurrence of the studied species mostly originates from the citizens (mostly professional and sport fishermen) who provided either photographs upon which the determination of the species was based or the entire specimen. When possible, basic measurements were taken, such as TL (Total Length) and W (Weight).

Morović (1973) proposed a classification of fishes based on their rarity: a) if the species is recorded fewer than five times, it should be treated as a "very rare species", b) if there are up to ten records, then the species is considered to be "rare", c) fish species caught in certain areas and only in a specific season should be treated as "fairly rare". Morović also suggested that the number of occurrences should be evaluated based on scientifically documented reports.

Fig. 1: White grouper caught near the Island of Čiovo (Croatian coast, Adriatic Sea) (Photo: K. Lučev)
Sl. 1: Primerek bele kirnje, ujete blizu otoka Čiovo (hrvaška obala, Jadransko morje)(Foto: K. Lučev).

RESULTS AND DISCUSSION

On 4th October 2015 an adult specimen (TL = 50.0 cm; W = 1,320 g) (Fig. 1) of the white grouper was caught with a fish trap at a depth of 10 m near the Island of Čiovo (eastern middle Adriatic) (Latitude: 43.513370°N, Longitude: 16.235880°E). All other catch in the fish trap was *Sepia officinalis*. The identification was done based on the main characteristic for distinguishing *E. aeneus* from other grouper species, which is 3 or 4 pale blue (or white) lines across the operculum. Some meristic characters of the caught specimen were: dorsal fin rays - D XI + 16, anal fin rays A III + 8, pectoral fin rays P 18.

The first record of this species in the Adriatic Sea dates to 22nd February and September 1999 (two specimens), just a few kilometres off Dubrovnik (southern Adriatic, Croatian coast) (Glamuzina *et al*., 2000). The second record was on 5th March 2006 off the island of Dugi Otok (Dulčić *et al*., 2006). Beside the publication of a first record of a non-indigenous fish species in a new area, it is no less important to publish subsequent records of those species in order to verify the establishment and distribution in its new habitat. Subsequent records may indicate that previous sightings were not just accidental, but may suggest that the zoogeographic range of the species has extended to include this new region (Golani *et al*., 2011). Given this record as like as all the previous, it may be established, if we consider Morović (1973), that this species is still very rare in the Croatian waters.

The latest finding is interesting primarily because it comes over 9 years after the previous record (16 years after the first finding) of this species in the Adriatic Sea. Several questions could arise based on this new, additional record of white grouper in the Adriatic Sea. Has this species established a population or is it a seasonal visitor (the sightings were made in autumn and winter)? Although there is no evidence of a permanent population in the study area, the capture described here might be an indication of expansion of the distribution of white grouper in the Adriatic Sea. It is known that species respond to changes in climatic environment by shifting geographically. Climate warming is also favouring native warm water species (such as those from the genus *Epinephelus*), which are extending their distribu-

tion northwards, and induced tropicalisation of marine communities (Dulčić *et al.,* 2006). Groupers of the genus *Epinephelus* are mostly tropical species and their distribution in subtropical and temperate waters is limited, in fact, only five species are native to the Mediterranean waters (Dulčić *et al*., 2006). As a top carnivorous species and one of the largest coastal fish species, groupers could influence the behaviour and ecology of many native fish species and affect local artisanal fishery (Glamuzina e*t al*., 2000).

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NOVI ZAPIS O POJAVLJANJU BELE KIRNJE, *EPINEPHELUS AENEUS* (OSTEICHTHYES: SERRANIDAE), V HRVAŠKIH JADRANSKIH VODAH

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POVZETEK

*Avtorji poročajo o novem zapisu o pojavljanju bele kirnje (*Epinenephelus aeneus*) v Jadranskem morju (hrvaške vode). Četrtega oktobra 2015 je bil ujet odrasli primerek (TL = 50,0 cm; W = 1320 g) v vršo na 10 m globine blizu otoka Čiovo (vzhodni srednji Jadran). Ta vrsta je v Jadranskem morju opredeljena kot zelo redka.*

Ključne besede: *Epinephelus aeneus*, novi zapis o pojavljanju, zelo redka vrsta, Jadransko morje

REFERENCES

Dulčić, J., P. Tutman & M. Ćaleta (2006): Northernmost occurrence of the white grouper, *Epinephelus aeneus* (Perciformes: Serranidae), in the Meditteranean area. Acta Ichthyologica et Piscatoria, 36 (1), 73-75.

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.

Glamuzina, B., P. Tutman, J.A. Geffen, V. Kožul & B. Skaramuca (2000): First record of white grouper *Epinephelus aeneus* (Serranidae) in the south eastern Adriatic. Cybium, 24, 306-308.

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 (Supplement 1), 7-11.

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.

Morović, D. (1973): Rijetke ribe u Jadranu. Pomorski zbornik, 11, 36–383.

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FIRST TAXONOMICAL ANALYSES OF PIKE POPULATIONS (ESOCIDAE, *ESOX*) IN FRIULI VENEZIA GIULIA (NORTHEAST ITALY)

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ABSTRACT

Recent studies have addressed to the taxonomical characterization of Italian pike as a new species named Esox cisalpinus*, which differs from the European* Esox lucius*. A taxonomical study of the pike features in the Friuli Venezia Giulia region (Northeast Italy) is here presented, since previous studies did not consider this area which could represent an overlapping zone for the two species. Main meristic characters were investigated, and genetic analyses were carried out using molecular markers. Our results confirm the genetic separation from the* E. lucius*, while among meristic characters only the number of lateral-line scales differs between the species.* E. cisalpinus *was observed in most of the investigated sites, except for an isolated lentic habitat where* E. lucius *was found. As* E. cisalpinus *is likely autochthonous in Friuli Venezia Giulia as in other Italian regions, we highlight the requirement of further analyses in order to clarify if hybridization can occur and to plan appropriate management safeguards for native populations.*

Key words: *Esox cisalpinus, Esox lucius,* taxonomy, COI, Cytb

PRIME INDAGINI TASSONOMICHE A CARICO DELLE POPOLAZIONI DI LUCCIO (ESOCIDAE, *ESOX*) IN FRIULI VENEZIA GIULIA (NORDEST ITALIA)

SINTESI

Studi recenti hanno permesso la caratterizzazione tassonomica del luccio in Italia identificando una nuova specie, chiamata Esox cisalpinus*, la quale differisce dalla specie europea* Esox lucius*. In questo lavoro viene presentato uno studio tassonomico sulle caratteristiche del luccio, effettuato nella regione Friuli Venezia Giulia (Nordest Italia) poiché i precedenti studi non hanno considerato quest'area, la quale può rappresentare una potenziale zona di sovrapposizione per le due specie. Sono stati indagati i principali caratteri meristici e sono state condotte analisi genetiche utilizzando marcatori molecolari. I risultati confermano la separazione a livello genetico da* E. lucius*, mentre per quanto attiene i caratteri meristici soltanto il numero di scaglie della linea laterale differisce tra le due specie.* E. cisalpinus *è stato rinvenuto nella maggior parte dei siti monitorati, ad eccezione di un habitat lentico isolato, in cui è stata registrata la presenza di* E. lucius*, probabilmente dovuta a immissioni per scopi alieutici. Poiché* E. cisalpinus *è verosimilmente autoctono in Friuli Venezia Giulia come in altre regioni italiane, si evidenzia il bisogno di ulteriori analisi volte allo scopo di verificare la possibilità di ibridazione tra le due specie, e la pianificazione di appropriate azioni di gestione volte alla salvaguardia delle popolazioni native.*

Parole chiave: *Esox cisalpinus, Esox lucius,* tassonomia, COI, Cytb

INTRODUCTION

The northern pike (*Esox lucius* Linnaeus, 1758) is widespread in the temperate and cold temperate belts, occurring in Europe, North America and Asia, north of 40° N and south of the Arctic Circle (Jacobsen *et al*., 2005; Lucentini *et al*., 2006, 2010a). Furthermore, the northern pike natural distribution area has been considerably expanded because of introductions conducted in Spain, Madagascar, Uganda, Morocco, Portugal, Tunisia, Ethiopia and Azores (Welcomme, 1988). In fact, this is the most widespread Esocidae species in the world and is naturally present in Europe, occupying a wide range of different lotic and lentic habitats (Lucentini *et al*., 2014).

Despite the great geographical variability distribution, Nilsson *et al*. (2008) consider all pike populations as a part of the same species, even though molecular analyses carried out by Nicod *et al*. (2004) highlighted some distinctive characters in the populations of the Lake Maggiore and Lake Trasimeno (Italy), allowing the hypothesis of an isolation of the Italian populations. In Italy, pike is native to the Po river basin, Tuscany and Lazio regions (Zerunian, 2004), where it was classified as *E. lucius* until a few years ago. However, Bianco and Delmastro (2011) have recently assigned Italian populations to a new species named *Esox cisalpinus*, on the basis of phenotypic analyses, in agreement with genetic investigations conducted by Lucentini *et al*. (2011), which describe the distinct Italian species named *Esox flaviae*. These two species nomenclatures probably refer to the same organism (Skog *et al*., 2014), because their description are very similar for the main characters, such as color pattern and number of scales on the lateral line (Bianco, 2014a, 2014b). For priority rule and used hereafter in the manuscript, *E. cisalpinus* is the reference name and *E. flaviae* represents a junior synonym, as the vernacular name is cisalpine pike (Bianco, 2014a) or southern pike (Skog *et al*., 2014). Following findings of these recent works, pike's taxonomical identification is gaining increasing scientific attention, particularly in Italy and in the Mediterranean area, even though it was already essential because of the pike ecological role. In fact, it is the main native predator in its habitat and acts as an active control factor in the balancing of different populations within the fish communities (Craig, 2008). However, in the past pike was often treated as a harmful species for freshwater environments due to its dietary requirements (Paradisi, 2005) and it was subjected to intensive recreational fishing pressure. More recently, the concept of this Esocid, as a voracious predator, has been reconsidered from an ecological perspective and its presence has become of great worth, even though the interest for pike as a fishery resource remains high (Gandolfi *et al*., 1991). Nevertheless, the decline of pike populations is well documented in Europe (Lorenzoni *et al*., 2002; Westin & Limburg, 2002; Jacobsen *et al*., 2005; Lucentini *et al*., 2006, 2009), especially in the main Mediterranean countries, such as Italy, where declining population trends have led to some recovery projects both for conservation and for fishing purposes. Unfortunately, the lack of knowledge about proper taxonomical identification caused allochthonous introductions in the last decades, because the species was often stocked with fry of unknown origin or from Northern Europe (Lucentini *et al*., 2006, 2011, 2014). Anthropogenic alterations represent another cause of decline for *Esox* populations, especially when changes involve the elimination of aquatic vegetation (Casselman & Lewis, 1996; Craig, 2008), which is one of the most important factors for survival of this species (Raat, 1988; Grimm, 1989; Bry, 1996; Grimm & Klinge, 1996).

Friuli Venezia Giulia is a region in the northeastern Italy, where pike lives primarily in the alluvial spring watercourses and drainage channels of the lowland hydrographic network, with generally large and well-structured populations (Stoch *et al*., 1992; Pizzul *et al*., 2006). Except for two specimens from the Isonzo Basin, examined by Bianco and Delmastro (2011), Friuli Venezia Giulia was not included in recent studies regarding pike taxonomical identification. Therefore, a clarification about the systematics of Esocidae populations was deemed necessary, especially considering the geographical position of this region, bordering Austria and Slovenia. In addition, increasing informations are needed and result fundamental for the managing activities and for the biodiversity safeguard of this area.

Consequently, phenotypical and genetic analyses were carried out, using information provided by Bianco and Delmastro (2011) and by Lucentini *et al*. (2011) as a starting point. Our main goal was to check for the presence of southern pike *E. cisalpinus* and/or the northern species *E. lucius* in freshwater habitats of Friuli Venezia Giulia.

MATERIALS AND METHODS

Ethical statement

The treatments of the specimens and procedures applied in this survey are consistent with National regulations and indications of the Ethic Committee of the University of Trieste. Further approvals from the Ethics Committee were not necessary given the nature of the data collected, such as the collection of morphometric measurements, pictures of individuals, or the cut of a small portion of the dorsal fin. Samples for DNA analysis were collected with non-invasive techniques and once collected the samples, animals were released at the same sampling site.

Sample collection

Fish were captured at 6 sampling sites included in four river basins (Fig. 1), representative for the habitat

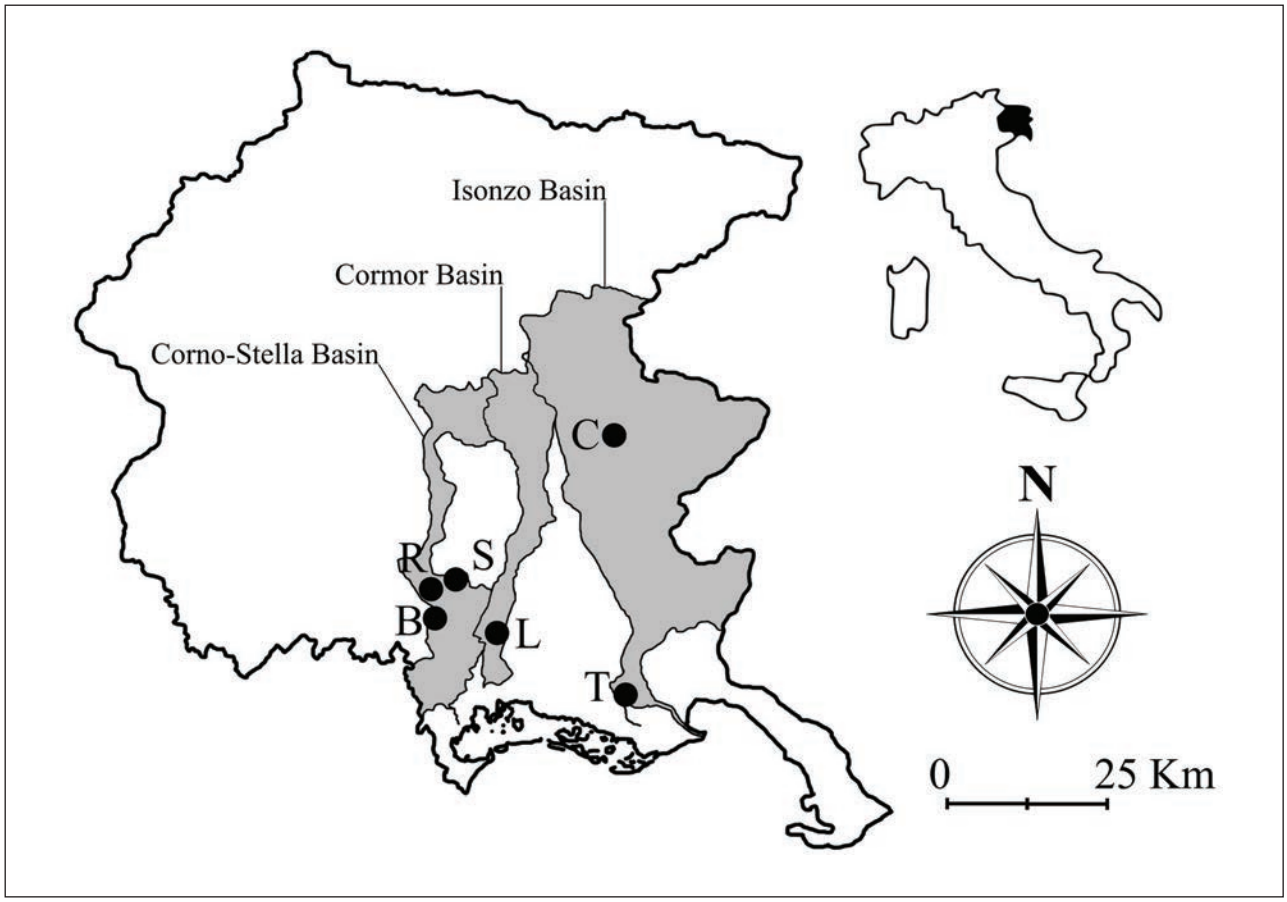

Fig. 1: Geographic position of sampling sites located in the Friuli Venezia Giulia Region (UTM coordinates) and relative basins: B – Roggia Barbariga (33T 346674 E; 5082594 N); R – Roggia Ribosa (33T 347336 E; 5086680 N); S – Springs of the Stella River (33T 350299 E; 5087525 N); L – Roggia Levada (33T 356793 E; 5079430 N); C – Campeglio Fish Ponds (33T 375966 E; 5069040 N); T – Tiel ditch (33T 374615 E; 5109142 N).
Sl. 1: Geografski položaj vzorčevalnih lokalitet na območju Furlanije Julijske krajine (UTM koordinate) in v vzorčevalnih vodnih telesih: B – Roggia Barbariga (33T 346674 E; 5082594 N); R – Roggia Ribosa (33T 347336 E; 5086680 N); S – izviri reke Stella (33T 350299 E; 5087525 N); L – Roggia Levada (33T 356793 E; 5079430 N); C – ribniki Campeglio (33T 375966 E; 5069040 N); T – lokaliteta Tiel (33T 374615 E; 5109142 N).

of the investigated species. In detail, the sampling sites Roggia Barbariga (site B), Roggia Ribosa (site R) and Springs of the Stella River (site S) belong to the Corno-Stella basin, Roggia Levada (site L) is included in the Cormor basin and Tiel ditch (site T) is an independent watercourse belonging to a little isolated alluvial spring basin (A.A.V.V., 2010), formerly included in the Isonzo basin by Mosetti (1983). Finally, Campeglio Fish ponds (site C) is considered as separate from the other basins, because they are hydrologically isolated even though these ponds are placed within the Isonzo basin area.

Overall, 51 specimens were collected, partially by electrofishing (pulsed direct current; 0.7-7 A; 150-380 V), partially with fishing rods by local fishermen.

Standard length (SL) and weight (W) were recorded for each captured specimen (length was expressed in centimeters; weight was expressed in grams). Mean, median, minimum and maximum values and CV [%] were calculated for each basin except for the specimen sampled in the Tiel ditch, because only one fish was captured. Data are reported in Table 1.

Pictures of each captured fish were taken, in order to have information about the color pattern, and a small portion of the dorsal fin was cut for genetic analyses and stored in 96% ethanol until DNA extraction. Once sampled, fish were released at the same site to minimize consequences for vitality and to avoid possible mixing among populations constituted by the two different *Esox* species.

Phenotypic analysis

The following meristic characters were recorded for each captured specimen: number of lateral-line scales

Tab. 1: Mean, median, minimum, maximum and [%] values Coefficient of Variation calculated for each biometric parameter relative to the different monitored basins. Corno-Stella basin= sites B, R and S; Cormor basin=site L; Campeglio Fish Ponds= site C; Tiel basin= site T.
Tab. 1: Srednja, mediana, minimalna, maksimalna vrednost ter delež [%] vrednosti koeficienta variacije. Vrednosti so podane za vsak biometrični parameter v vzorčevanih vodnih telesih. Legenda: bazen Corno-Stella = lokalitete B, R in S; bazen Cormor = lokaliteta L; ribniki Campeglio = lokaliteta C; bazen Tiel = lokaliteta T.

Basin	N		Weight (g)	SL (cm)
Corno-Stella	35	Mean	120.74	22.05
		Median	58.00	19.50
		Min	4.00	5.98
		Max	950.00	43.31
		CV %	151.01	39.69
Cormor	12	Mean	223.83	28.47
		Median	151.50	27.05
		Min	62.00	17.25
		Max	861.00	41.33
		CV %	104.70	28.27
Campeglio Fish Ponds	3	Mean	172.67	27.83
		Median	173.00	26.50
		Min	135.00	21.67
		Max	210.00	27.90
		CV %	21.72	13.55
Tiel	1	Mean	688.00	47.00
		Median	-	-
		Min	-	-
		Max	-	-
		CV %	-	-

(LL), number of undivided dorsal fin rays (UDFR), number of divided dorsal fin rays (DDFR), number of undivided anal fin rays (UAFR), number of divided anal fin rays (DAFR), and number of submandibular pores (PM). Mean, median, minimum and maximum and CV [%] values were reported for all considered parameters (Tabs. 1 and 3) and for each group of specimens collected in the different basins (Corno-Stella, Cormor and Campeglio Lakes), except for the specimen sampled in the Tiel ditch, because only one fish was captured.

Genetic analysis

Subsets of at least four specimens collected in each site investigated in this study were randomly selected. Genomic DNA (gDNA) was extracted from each fin by using the E.Z.N.A.® Mollusc DNA Kit (Omega Biotek) following the manufacturer's instructions and its quality was assessed through the Nanodrop 2000 (Thermo Scientific).

Two fragments from the mitochondrial genes Cytochrome Oxidase Subunit I (COI) and Cytochrome b (Cytb) were selected to perform genetic analysis. In addition, we tested two nuclear AFLP-derived markers called "band 9" and "band 24" (Lucentini *et al*., 2011). Table 2 reports the complete collection of primers used in this study. Standard PCR reactions were accomplished for all the systems tested by following the thermal profile: 94°C for 2'30", 35 cycles at 95°C for 30", 57°C for 30" and 72°C for 45" with a final extension step at 72°C for 5', and by using Go Taq (R) G2 DNA polymerase (Promega).

Phylogenetic analysis

PCR products were sequenced by an external service (IGA, Udine, Italy) and sequences were aligned and analyzed through MEGA 6 software (Tamura *et al*., 2013). One sample from Roggia Levada (site L, Corno-Stella basin), indicated as L2 in Figure 2, was excluded from the COI analysis since the sequence was of poor quality. First, the most suitable model was tested by using the internal tool of MEGA 6, and then the Maximum Likelihood statistic method with 1000 bootstrap replica was selected. For both the COI and Cytb markers the best model resulted to be the Hasegawa-Kishino-Yano model (Hasegawa *et al*., 1985) plus Gamma distribution, which has been settled to a number of 5 discrete Gamma categories. All the branches that were not supported at the default cutoff value of bootstrap confidence level ≥50 were condensed together. The sequences reported in Table 2 by Lucentini *et al*. (2011) were used as a reference dataset.

RESULTS

Phenotypic analysis

Color pattern of the 51 captured pikes belonged to four types of those described by Lucentini *et al*. (2010b): diagonal bars, vertical bars, stellate spots and round spots were taken into account (Fig. 2). The diagonal bar pat-

Tab. 2: Sets of primers used in this study (Lucentini** et al**., 2011).
Tab. 2: Nizi začetnih oligonukleotidov uporabljenih v raziskavi (Lucentini** et al.**, 2011).

Primer ID	5′-3′ sequence
F-COI-El	GTGGCAATCACACGCTG
R-COI-El	CGGGTGTCCGAAGAATC
cytbf	TCGGACTCTACCAAAACCAA
cytbr	GTTCAACGGGTATTCCTCCA
9FW	CAGTTGTAAGGCCCAGGAAG
9RV	GGAAATACGTTGTGGAACTGC
24extFW	GATCTCTGGACCATTTGGAC
24extRV	TGGCTACATGCGACATCAG

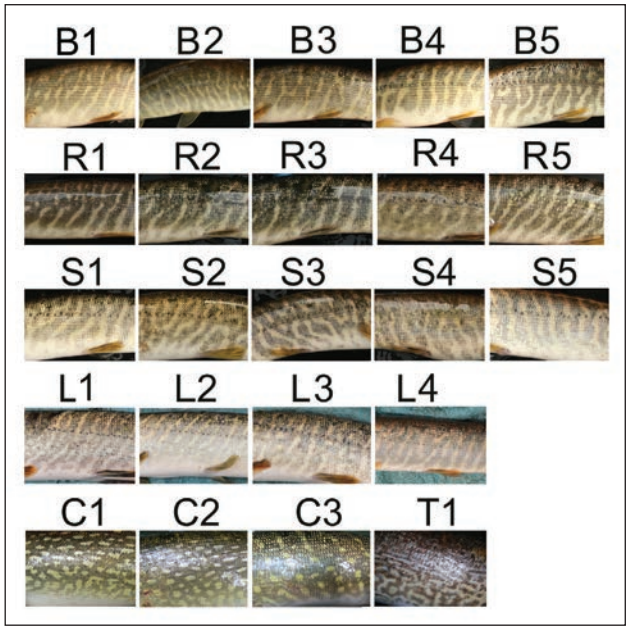

Fig. 2: Colored patterns collection from adult pikes analyzed in this study. B, R, S, L, C and T represent different sampling sites: B – Roggia Barbariga; R – Roggia Ribosa; S – Springs of the Stella River; L – Roggia Levada; C – Fish Ponds of Campeglio; T – Tiel ditch.
Sl. 2: Zbirka barvnih vzorcev odraslih ščuk, ki smo jih analizirali v pričujoči raziskavi. B, R, S, L, C in T so različne vzorčevalne lokalitete: B – Roggia Barbariga; R – Roggia Ribosa; S – izviri reke Stelle; L – Roggia Levada; C – ribniki Campeglio; T – lokaliteta Tiel.

tern was the most frequent (88% of collected specimens) and it was observed in all fish captured in the Cormor basin (site/samples L) and in the Corno-Stella basin (sites/samples B, R, S). Round spot pattern was found only in the samples collected from the Campeglio Lakes (site/samples C) and it was observed for each fish; the only specimen analyzed from the Tiel ditch (site/sample T) was stellate spotted. In agreement with color pattern reported by Bianco and Delmastro (2011), Lucentini *et al*. (2011) and Bianco (2014a, 2014b), two groups were identified: the first showing the southern pike color patterns (sites/samples B, R, S, and T) and the second showing the northern pike color pattern (site C) (Fig. 2).

Concerning the meristic characters (Tab. 3), the number of lateral-line scales (LL) ranged from 95 to 107 in the first group, and from 109 to 115 in the second group. Regarding other meristic characters (number of undivided dorsal fin rays: UDFR; number of divided dorsal fin rays: DDFR; number of undivided anal fin rays: UAFR; number of divided anal fin rays: DAFR; and number of submandibular pores: PM), observed ranges always seem to overlap.

Analysis of the two AFLP-derived markers

The molecular analyses were conducted by using two AFLP-derived markers, hereafter named "band 9" and "band 24" (Lucentini *et al*., 2011). However, only "band 24" was amplified from our samples, and the resulting PCR amplicon has been sequenced, confirming the presence of the reported C/G polymorphism (C in round spotted color-pattern specimens and G in the other color-pattern phenotypes).

Phylogenetic analysis

Fragments of Cytochrome Oxidase I (COI) and Cytochrome b (Cytb) mitochondrial genes were sequenced to assign our samples to one of the two species of pike, accordingly to Lucentini *et al*. (2011).

Phylogenetic trees for COI (Fig. 3) and Cytb (Fig. 4) were obtained by applying the Hasegawa-Kishino-Yano model (Hasegawa *et al*., 1985) plus Gamma distribution. In both trees, two groups, corresponding to the *E. cisalpinus* and *E. lucius* clades, were well defined and separated from the other *Esox* spp.

The three specimens, characterized by the round-spotted colored pattern (namely, C1, C2, and C3), clustered within the *E. lucius* clade, whereas the stellate spot pattern specimen (T1) and all the other pikes characterized by vertical and diagonal bars grouped within *E. cisalpinus* clade.

DISCUSSION

Recent studies pointed out the existence of two pike lineages, the first one corresponding to the northern pike

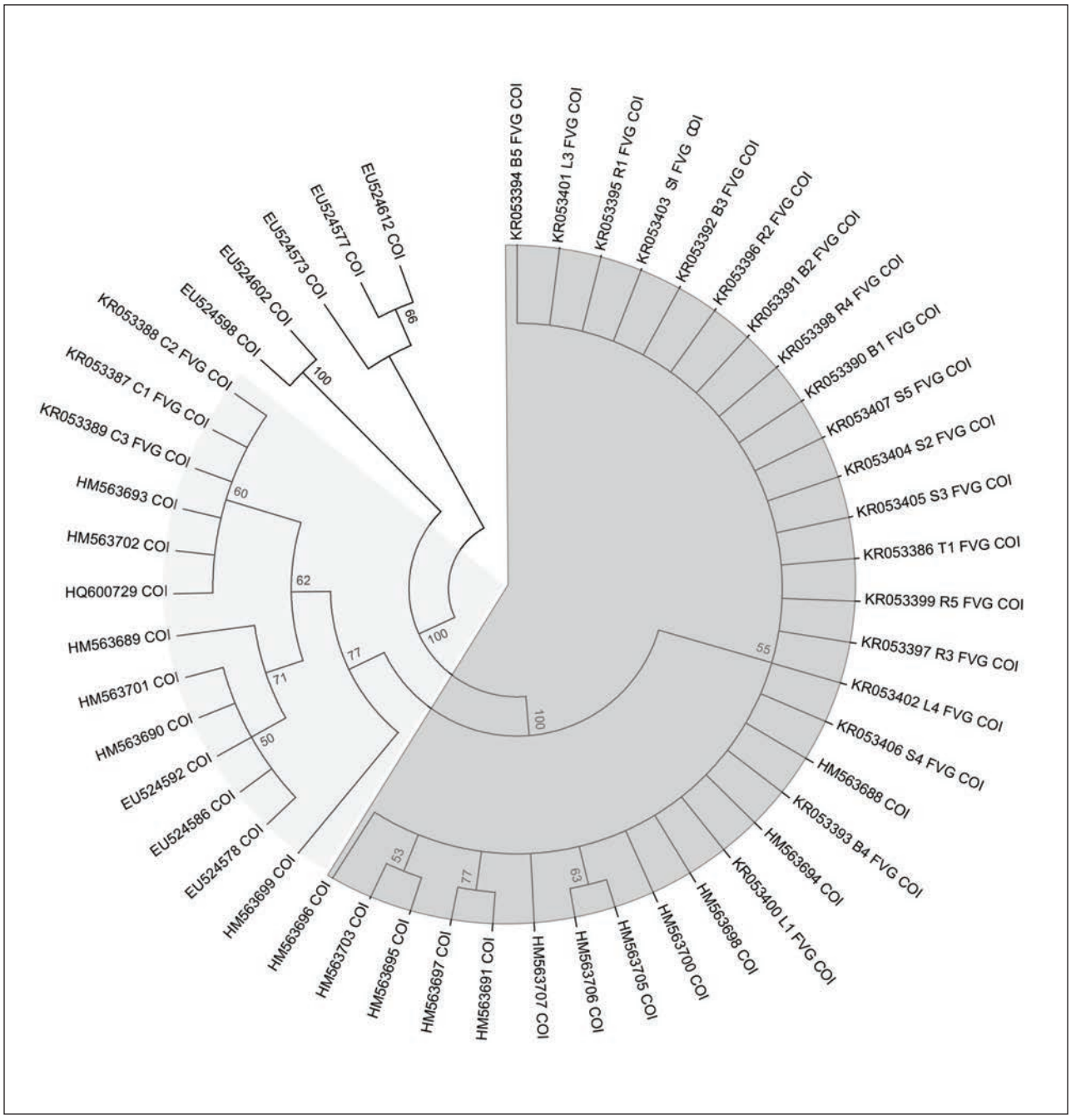

Fig. 3: Bootstrap consensus of the COI gene tree. All the branches that were not supported at the default cutoff value of bootstrap confidence level ≥50 were condensed together. Light grey groups the *Esox lucius* ***clade, whereas dark grey clusters*** *E. cisalpinus* ***specimens. Specimens are listed with their GenBank IDs and, for pikes sampled in this study, by the site names as in Fig. 1. Outgroups of the two clades are:*** *Esox niger* ***(EU524612),*** *Esox americanus americanus* ***(EU524577),*** *Esox americanus vermiculatus* ***(EU524573),*** *Esox masquinongy* ***(EU524602), and*** *Esox masquinongy* ***(EU524598).***

Sl. 3: Filogenetsko drevo na osnovi gena za COI. Statistične podpore drevesa so določene z neparametričnim testom ponovnega vzorčenja. Vse razvejitve pod mejo zaupanja ≥50 so bile združene. S svetlo sivo barvo so označene skupine iz klada navadne ščuke *Esox lucius****, s temno sivo pa primerki vrste*** *E. cisalpinus****. Primerki so razvrščeni skupaj z njihovimi GenBank IDs in pri ščukah, vzorčevanih v tej študiji na podlagi lokalitet tako kot na sliki 1. Izdanki obeh kladov so:*** *Esox niger* ***(EU524612),*** *Esox americanus americanus* ***(EU524577),*** *Esox americanus vermiculatus* ***(EU524573),*** *Esox masquinongy* ***(EU524602) in*** *Esox masquinongy* ***(EU524598).***

Tab. 3: Mean, median, minimum, maximum, and [%] Coefficient of Variation calculated for each meristic parameter relative to the different monitored basins. Corno-Stella basin= sites B, R and S; Cormor basin=site L; Campeglio Fish Ponds= site C; Tiel basin= site T.
Tab. 3: Srednja, mediana, minimalna, maksimalna vrednost in delež [%] vrednosti koeficienta variacije, izračunane za vsak biometrični parameter v preiskanih vodnih telesih. Legenda: bazen Corno-Stella = lokalitete B, R in S; bazen Cormor = lokaliteta L; ribniki Campeglio = lokaliteta C; bazen Tiel = lokaliteta T.

Basin	N		LL	UDFR	DDFR	UAFR	DAFR	PM
Corno-Stella	35	Mean	99.17	5.06	13.37	3.97	12.46	4.03
		Median	99.00	5.00	13.00	4.00	13.00	4.00
		Min	95.00	5.00	11.00	3.00	11.00	4.00
		Max	107.00	6.00	15.00	4.00	14.00	5.00
		CV %	2.58	4.66	7.71	4.26	7.63	4.20
Cormor	12	Mean	99.92	5.00	13.75	4.00	12.75	4.08
		Median	99.50	5.00	13..50	4.00	13.00	4.00
		Min	95.00	5.00	11.00	4.00	10.00	4.00
		Max	106.00	5.00	15.00	4.00	13.00	5.00
		CV %	3.00	0.00	9.37	0.00	6.79	7.07
Campeglio Fish Ponds	3	Mean	112.33	5.00	14.33	4.00	13.00	4.33
		Median	113.00	5.00	13.00	4.00	13.00	4.00
		Min	109.00	5.00	13.00	4.00	13.00	4.00
		Max	115.00	5.00	17.00	4.00	13.00	5.00
		CV %	2.72	0.00	16.11	0.00	0.00	13.32
Tiel	1	Mean	105.00	5.00	13.00	4.00	13.00	5.00
		Median	-	-	-	-	-	-
		Min	-	-	-	-	-	-
		Max	-	-	-	-	-	-
		CV %	-	-	-	-	-	-

(*E. lucius*), widely distributed in the Palearctic region, and the second lineage of southern pike, naturally occurring in Italy (Bianco & Delmastro, 2011; Lucentini *et al*., 2011; Bianco, 2014a; Lucentini *et al*., 2014). Based on the use of meristic characters, and mtDNA (COI and Cytb gene fragments) genetic traits, this study supports the proposal of a newly described endemic species, southern pike *E. cisalpinus* here reported in Friuli Venezia Giulia (FVG) region, as well.

Following the observation of meristic characters and color patterns, two groups have been identified in the samples: the first group comprises pikes collected in the Corno-Stella basin, Tiel basin (in the context of the Isonzo basin) and Cormor basin, and it shows a lower number of lateral line scales (95-107) and color patterns with diagonal bars, vertical bars and stellate spots. These characters correspond to those of the typically Italian species *E. cisalpinus*. These features are

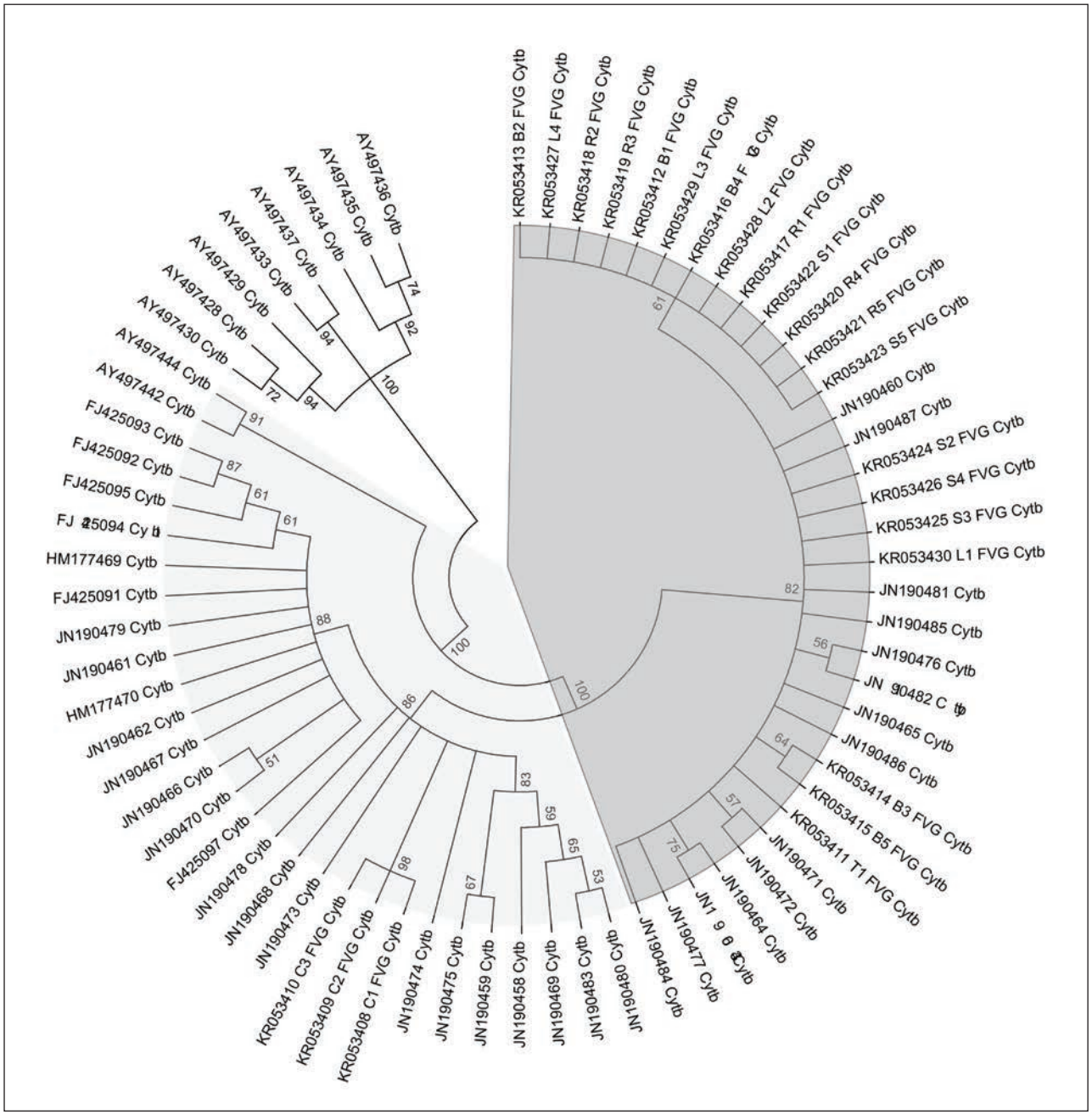

Fig. 4: Bootstrap consensus of the Cytb gene tree. All the branches that were not supported at the default cutoff value of bootstrap confidence level ≥50 were condensed together. Light grey groups the *Esox lucius* ***clade, whereas dark grey clusters*** *E. cisalpinus* ***specimens. Specimens are listed with their GenBank IDs and, for pikes sampled in this study, by the site names as in Fig. 1. Outgroups of the two clades are:*** *Esox americanus vermiculatus* ***(AY497428),*** *Esox americanus vermiculatus* ***(AY497429),*** *Esox americanus vermiculatus* ***(AY497430),*** *Esox americanus americanus* ***(AY497433),*** *Esox americanus* ***(AY497434),*** *Esox americanus* ***(AY497435), and*** *Esox americanus* ***(AY497436).***

Sl. 3: Filogenetsko drevo na osnovi gena za Cytb. Statistične podpore drevesa so določene z neparametričnim testom ponovnega vzorčenja. Vse razvejitve pod mejo zaupanja ≥50 so bile združene. S svetlo sivo barvo so označene skupine iz klada navadne ščuke *Esox lucius*, ***s temno sivo pa primerki vrste*** *E. cisalpinus*. ***Primerki so razvrščeni skupaj z njihovimi GenBank IDs in pri ščukah, vzorčevanih v tej študiji na podlagi lokalitet tako kot na sliki 1. Izdanki obeh kladov so:*** *Esox americanus vermiculatus* ***(AY497428),*** *Esox americanus vermiculatus* ***(AY497429),*** *Esox americanus vermiculatus* ***(AY497430),*** *Esox americanus americanus* ***(AY497433),*** *Esox americanus* ***(AY497434),*** *Esox americanus* ***(AY497435) in*** *Esox americanus* ***(AY497436).***

reported by Bianco and Delmastro (2011), who analyzed specimens collected in the Po basin, Central Italy and two specimens from Friuli Venezia Giulia, and by Lucentini *et al*. (2011), Lucentini *et al*. (2014), who analyzed populations from Northern Italy (Po basin) and Central Italy (Tevere basin) and compared them with populations of *E. lucius* collected in continental Europe (the Netherlands, Switzerland, Czech Republic, Hungary and Sweden). Specimens belonging to the second group, including only individuals collected in the Campeglio Lakes, show a higher number of lateral line scales (109-115) and round spotted color patterns, which are typical characters of the northern pike *E. lucius* (Bianco & Delmastro, 2011; Bianco, 2014a). These are public lakes, managed by the local Authority for recreational fishing.

In agreement with these results, molecular analyses confirmed the discrimination between *E. lucius* and *E. cisalpinus* species with 3 out of 4 molecular markers proposed by Lucentini *et al*. (2011): COI sequence, Cyt b sequence, and band 24.

In conclusion, most of the analyzed specimens are recognized as *E. cisalpinus*, while *E. lucius* was only found in the Campeglio lakes, where sport fishing is usually practiced, and where introductions of allochthonous specimens could be probably conducted by some private fishermen without the permission of the regional management agency.

Therefore, appropriate management practices are urgently needed for the safeguard of native populations and for preserving their distribution within the local habitats. In addition, repopulations could be carried out if necessary, but only with severely genetically controlled material.

Due to these reasons, further analyses are planned over a wider number of sampling sites, covering the whole pike distribution area. Moreover, it is of great interest to extend this analysis to the nearby Austrian and Slovenian populations, not investigated by the authors cited above, which share waters with some populations from Friuli Venezia Giulia.

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We would like to thank the Fishing Management Agency of Friuli Venezia Giulia (Ente Tutela Pesca – ETP in its Italian acronym) which provided personnel for the sampling operations. Many thanks to Valdo Barbiani, Stefano Gigante and Davide Lesa, who provided additional data and samples.

PRVA TAKSONOMSKA ANALIZA POPULACIJ ŠČUKE (ESOCIDAE, *ESOX*) V FURLANIJI JULIJSKI KRAJINI (SEVEROVZHODNA ITALIJA)

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POVZETEK

Recentne raziskave taksonomske opredelitve ščuk v Italiji so obelodanile prisotnost nove vrste ščuke, opisane kot Esox cisalpinus*, ki se loči od vrste* Esox lucius. *V prispevku avtorji poročajo o taksonomski raziskavi ščuk na območju Furlanije Julijske krajine (severovzhod Italije), kjer se je izkazalo, da se prekrivata areala dveh vrst. Avtorji so raziskali glavne meristične značilnosti, poleg njih pa so opravili še genetsko analizo na podlagi molekularnih markerjev. Dobljeni rezultati potrjujejo genetsko razmejitev med vrstama, medtem ko se na merističnem nivoju razlikujeta le na podlagi števila lusk v pobočnici. Vrsta* E. cisalpinus *je bila ugotovljena na veliki večini raziskanih lokalitet z izjemo le enega izoliranega lentičnega habitata, kjer je bila najdena le navadna ščuka* E. lucius*, ki so jo verjetno naselili ribiči. Glede na dejstvo, da je vrsta* E. cisalpinus *avtohtona v Furlaniji Julijski krajini in v drugih italijanskih pokrajinah, so potrebne nadaljnje analize z namenom ugotavljanja potencialnega križanja med vrstama in pripravo akcijskega načrta za ohranjanje naravnih populacij.*

Ključne besede: *Esox cisalpinus, Esox lucius,* taksonomija, COI, Cytb

REFERENCES

A.A.V.V. (2010): Piano di gestione dei bacini idrografici delle Alpi Orientali. 11 – Bacino dei tributari della Laguna di Marano-Grado. Documento tecnico, 208 pp.

Bianco, P. G. (2014a): An update on the status of native and exotic freshwater fishes of Italy. J. Appl. Ichtyol., 30, 62-77.

Bianco, P. G. (2014b): Aggiornamento sistematico dei pesci d'acqua dolce autoctoni italiani: proposta di un workshop. It. J. Fresh. Ichtyol., 2014(1), 133-162.

Bianco, P. G. & G. B. Delmastro (2011): Recenti novità tassonomiche riguardanti i pesci d'acqua dolce autoctoni in Italia e descrizione di una nuova specie di luccio. Research. Wildl. Conserv., 2 (Suppl), 1-14.

Bry, C. (1996): Role of Vegetation in the life cycle of pike. In: Craig J. (ed.): Pike: Biology and Exploitation. Chapman & Hall, London, p. 45-67.

Casselman, J. M. & C. A. Lewis (1996): Habitat requirements of northern pike (*Esox lucius*). Can. J. Fish. Aquat. Sci., 53(Suppl. 1), 161–174.

Craig, J.F. (2008): A short review of pike ecology. Hydrobiologia, 601, 5-16.

Gandolfi, G., S. Zerunian, P. Torricelli & A. Marconato (1991): I pesci delle acque interne italiane. Istituto Poligrafico dello Stato, Roma, 617 pp.

Grimm, M. P. (1989): Northern pike (*Esox lucius* L.) and aquatic vegetation, tools in the management of fisheries and water quality in shallow waters. Hydrobiol. Bull., 23, 59-65.

Grimm, M. P. & M. Klinge (1996): Pike and some aspects of its dependence on vegetation. In: Craig J.F. (ed.): Pike-Biology and exploitation. Chapman & Hall, London, p. 125–156.

Hasegawa, M., H. Kishino & T. Yano (1985): Dating of the human-ape splitting by a molecular clock of mitochondrial DNA. J. Mol. Evol., 22, 160–174.

Jacobsen, B. H., M. M. Hansen & V. Loeschcke (2005): Microsatellite DNA analysis of northern pike (*Esox lucius* L.) populations: Insights into the genetic structure and demographic history of a genetically depauperate species. Biol. J. Linn. Soc., 84, 91-101.

Lorenzoni, M., M. Corboli, A. J. M. Dörr, M. Mearelli & G. Giovinazzo (2002): The growth of pike (*Esox lucius* Linnaeus, 1758) in Lake Trasimeno (Umbria, Italy). Fish. Res., 59, 239-246.

Lucentini, L., A. Palomba, H. Lancioni, L. Gigliarelli, M. Natali & F. Panara (2006): Microsatellite polymorphism in Italian populations of northern pike (*Esox lucius* L.). Fish. Res., 80, 251-262.

Lucentini, L., A. Palomba, L. Gigliarelli, G. Sgaravizzi, H. Lancioni, L. Lanfaloni, M. Natali & F. Panara (2009): Temporal changes and effective population size of an Italian isolated and supportive-breeding managed northern pike (*Esox lucius*) population. Fish. Res., 96, 139-147.

Lucentini, L., M. Natali and F. Panara (2010a): Il Luccio del Lago Trasimeno. Provincia di Perugia, Ponte San Giovanni (PG), 150 pp.

Lucentini, L., C. Ricciolin, A. Palomba, L. Gigliarelli, M. A. Puletti, L. Lanfaloni & F. Panara (2010b): I marcatori molecolari AFLP, ma non micro satelliti, indicano un relazione fra genotipo e livrea nel luccio (*Esox lucius*). Studi Trent. Sci. Nat., 87, 67-71.

Lucentini, L., M. E. Puletti, C. Ricciolini, L. Gigliarelli, D. Fontaneto, L. Lanfaloni, F. Bilò, M. Natali & F. Panara (2011): Molecular and phenotypic evidence of a new species of genus *Esox* (Esocidae, Esociformes, Actinopterygii): the southern pike, *Esox flaviae*. PLoS One, 6, e25218. doi:10.1371/journal.pone.0025218.

Lucentini, L., M. E. Puletti, L. Gigliarelli, C. Ricciolini, A. Palomba, F. Bilò, M. Natali, L. Lanfaloni & F. Panara (2014): Evaluation of the relationship between colour pattern and genotypes in northern pike (*Esox lucius*, Linnaeus, 1758) evaluated through nuclear and mitochondrial DNA. It. J. Fresh. Ichtyol., 2014(1), 109-123.

Mosetti, F. (1983): Sintesi sull'idrologia del Friuli-Venezia Giulia. Quaderni ETP, Rivista di Limnologia, 6, 295 pp.

Nicod, J. C., Y. Z. Wang, L. Excoffier & C. R. Largiadèr (2004): Low levels of mitochondrial DNA variation among central and southern European *Esox lucius* populations. J. Fish Biol., 64, 1442-1449.

Nilsson, P. A., C. Skov & J. M. Farrell (2008): Current and future directions for pike ecology and management: a summary and synthesis. Hydrobiologia, 601, 137–141.

Paradisi, S. (2005): Pesci. In: Stoch (ed.): Quaderni Habitat. Ministero dell'Ambiente e della Tutela del Territorio e Museo Friulano di Storia Naturale, Udine, p. 95-101.

Pizzul, E., G. A. Moro & F. Battiston (2006): Pesci e acque interne del Friuli Venezia Giulia. Aggiornamento parziale della Carta Ittica 1992. Database interattivo. Ente Tutela Pesca del Friuli Venezia Giulia, Udine.

Raat, A. J. P. (1988): Synopsis of biological data on the northern pike, *Esox lucius* Linnaeus 1758. F.A.O. Fish. Synop., 30, Rev. 2, 1-178.

Skog, A., L. A. Vøllestad, N. C. Stenseth, A. Kasumyan & K. S. Jakobsen (2014): Circumpolar phylogeography of the northern pike (*Esox lucius*) and its relationship to the Amur pike (*E. reichertii*). Front. Zool., 2014, 11-67.

Stoch, F., S. Paradisi & M. Buda Dancevich (1992): Carta Ittica del Friuli Venezia Giulia. Ente Tutela Pesca, Regione Autonoma Friuli Venezia Giulia, 285 pp.

Tamura, K., G. Stecher, D. Peterson, A. Filipski & S. Kumar (2013): MEGA6: Molecular Evolutionary Genetics Analysis Version 6.0. Mol. Biol. Evol., 30, 2725-2729.

Welcomme, R. L. (1988): International Introductions of Inland Aquatic Species. FAO Fisheries Technical Paper No.294. Food and Agriculture Organization of the United Nations, Rome, 318 pp.

Westin, L. & K. E. Limburg (2002): Newly discovered reproductive isolation reveals sympatric populations of *Esox lucius* in the Baltic. J. Fish Biol., 61, 1647-1652.

Zerunian, S. (2004): Pesci delle acque interne d'Italia. Ministero Ambiente Istituto Nazionale Fauna Selvatica, Roma, 257 pp.

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ANNOTATED LIST OF CRUSTACEAN SPECIES RECORDED IN THE TUNIS SOUTHERN LAGOON (NORTHERN TUNISIA, CENTRAL MEDITERRANEAN)

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ABSTRACT

During investigations conducted after the environmental restoration of the Tunis Southern Lagoon, a total of 44 crustacean species belonging to 27 families were recorded, including 19 decapods, 11 isopods, 10 amphipods, 3 cirripeds and a single stomatopod. Of these 44 species, 31 were autochthonous and 13 allochthonous. Six species were recorded in the area for the first time. The Tunis Southern Lagoon provides favourable environmental conditions for the settlement of alien species, mainly crustaceans. The occurrence of alien crustaceans plays an important economic and ecological role in this restricted brackish area, and enhances anthropogenic activities such as fishery of cephalopods and fishes.

Keywords: Brackish waters, autochthonous species, allochthonous species, ecological restoration, new settlements

ELENCO AGGIORNATO DELLE SPECIE DI CROSTACEI TROVATI NELLA LAGUNA MERIDIONALE DI TUNISI (TUNISIA SETTENTRIONALE, MEDITERRANEO CENTRALE)

SINTESI

Durante le indagini condotte dopo il ripristino ambientale della laguna meridionale di Tunisi sono state trovate 44 specie di crostacei appartenenti a 27 famiglie, tra cui 19 decapodi, 11 isopodi, 10 anfipodi, tre cirripedi e un unico stomatopoda. Di queste 44 specie, 31 sono autoctone e 13 alloctone. Sei specie sono state rinvenute nell'area per la prima volta. La laguna meridionale di Tunisi offre condizioni ambientali favorevoli all'insediamento di specie aliene, soprattutto di crostacei. La presenza di crostacei non-indigeni svolge un ruolo economico ed ecologico importante in questa ristretta area salmastra, e accresce le attività antropiche quali la pesca di cefalopodi e pesci.

Parole chiave: acque salmastre, specie autoctone, specie alloctone, ripristino ecologico, nuovi insediamenti

INTRODUCTION

The Tunis Southern Lagoon had been strongly polluted by anthropogenic activities (Ben Souissi, 2002; Hermi & Aissa, 2002) and required thorough environmental restoration, which was achieved in September 2001 (Vandenbroek & Ben Charrada, 2001; Ben Souissi, 2002). Furtherly, investigations were conducted throughout the lagoon to assess the restoration level and improvement of water quality (Jouini *et al.*, 2005; Ben Souissi *et al*., 2005a). Occurrence of elasmobranch and teleost species, substantially established in the Tunis Southern Lagoon, could be considered as the most favourable consequence of the ecological restoration of this brackish area (Mejri *et al*., 2004; Ben Souissi *et al*., 2004, 2005b). However, analysis of stomach contents of many fish species has shown that crustaceans are generally recorded as prey species (Mejri, 2003; Ben Souissi *et al*., 2004). It suggests that crustacean species play both ecological and economic roles in the Tunis Southern Lagoon, improving and enlarging the successful establishment of cephalopod and fish populations, as well as fishery activities.

The presence of crustacean species in the Tunis Southern Lagoon has been previously reported by Ben Souissi *et al*. (2003; 2005a). It generally concerned small species belonging to the genus *Sphaeroma* Latreille, 1802; however, an overall study of crustacean fauna inhabiting the area had yet to be prepared. The aims of this paper are therefore to present a thorough inventory of crustacean species inhabiting the Tunis Southern Lagoon, with a particular emphasis on their origin, abundance and capture sites, and to examine the ecological and economic roles they play in this area.

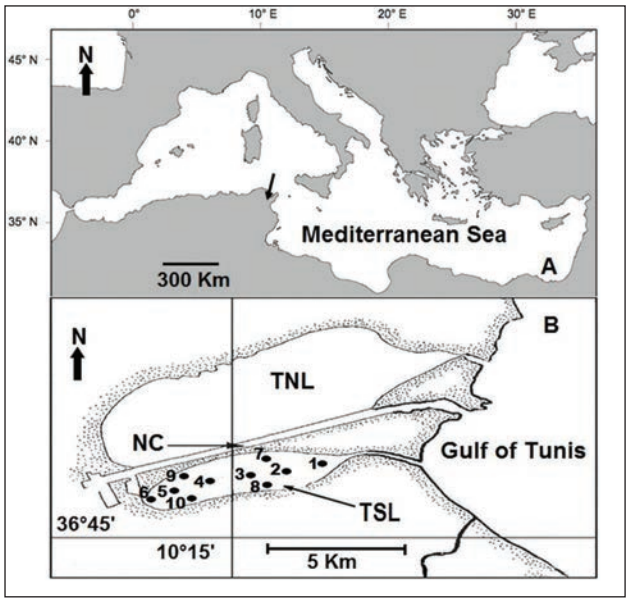

Fig. 1: A. Map of Tunisia pointing out in the north the site of Tunis Southern Lagoon. B. Tunis Northern Lagoon (TNL) separated from Tunis Southern Lagoon (TSL) by a navigation channel (NC). ST1-ST10 sampling stations in TSL.
Sl. 1: A. Zemljevid Tunizije z označeno Tuniško južno laguno v severnem predelu. B. Tuniška severna laguna (TNL), razmejena od južne (TSL) s plovnim kanalom (NC). ST1-ST10 vzorčevalne postaje v TSL.

MATERIAL AND METHODS

Study area

The Tunis Southern Lagoon (36°47′ N, 10°17′ E) is the southern part of the Lake of Tunis, which is divided in two areas by a navigation channel (Fig. 1). The Tunis Southern Lagoon, which extends over an area of 720 ha, has a regular depth of about 2.1 m and a maximum depth of 3.8 m. It appears as an ellipse stretching in the SW-NE direction, between 36°46′47″and 36°48′00″N, and 10°12′22″ and 10°16′41″E. Its shores have been excavated and protected by large rocky stones.

Sampling procedure

Between February 2012 and June 2015, sampling was conducted in shallow coastal waters, at a depth of less than 3 m, at 10 stations. Samples were collected by dredging and scuba diving in stations 1 to 6, which are characterized by muddy bottom. At stations 7 to 10, located in intertidal rocky shores covered by algae, sampling from under stones was conducted manually (Fig. 1). The animals were removed by rinsing the vegetation in a big tray and recovered on a 1 mm mesh sieve, which retained all individuals, including small species. The retained specimens were sorted, fixed in 70% alcohol and then identified, using different identification keys (Fisher *et al.*, 1987; Froglia & Manning, 1989; Noel, 1992). The nomenclature adopted in this paper follows the World Register of Marine Species (WoRMS).

RESULTS AND DISCUSSION

A total of 44 crustacean species from 27 families were recorded in the Tunis Southern Lagoon. The most abundantly represented taxa were decapods (19 species), isopods (11 species), amphipods (10 species), barnacles (3 species) and stomatopods (1 species), with 6 species recorded in the area for the first time. Of the 44 crustacean species, 31 were autochthonous and 13 allochthonous (Tab. 1). The annotated list of identified species is given below.

Checklist of the Tunis Southern Lagoon

ORDER DECAPODA BRACHYURA
Family Euryplacidae
Eucrate crenata (De Haan, 1853) (Fig. 2A)

Tab. 1: List of the crustacean species in the Tunis Southern Lagoon per station.
✶ Alien species ● New records for the Tunis Southern Lagoon.
Tab. 1: Seznam vrst rakov na posamezni postaji v Tuniški južni laguni.
✶ Tujerodne vrste ● Novi podatki za Tuniško južno laguno.

Stations	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
Order: Decapoda										
Family: Euryplacidae										
✶*Eucrate crenata* (De Haan, 1853)	+	-	-	-	-	-	-	-	-	-
Family: Piluminidae										
✶*Pilumnopeus vauquelini* (Audouin, 1826)	+	+	+	-	-	-	-	-	-	-
Family: Panopeidae										
✶*Rhithropanopeus harrisii* (Gould, 1841)	-	-	-	-	-	-	+	+	+	-
Family: Varunidae										
✶*Hemigrapsus sanguineus* (De Haan,1835)	-	+	-	-	-	-	-	-	-	-
Brachynotus sexdentatus (Risso, 1827)	+	+	-	-	-	-	-	-	-	-
Family: Porcellanidae										
Porcellana plathycheles (Pennant, 1777)	-	-	-	-	-	-	+	-	+	-
Pisidia longicornis Linnaeus, 1767	+	-	-	-	-	-	-	-	-	-
Family: Plagusidae										
Euchirograpsus liguricus H. Milne Edwards, 1853	-	-	-	-	-	-	-	-	+	-
Family: Portunidae										
Carcinus aestuarii Nardo, 1847	+	+	+	-	-	-	-	-	-	-
Family: Grapsidae										
Pachygrapsus marmoratus (Fabricius, 1787)	-	-	-	-	-	-	-	-	+	+
Family: Polybiidae										
● *Liocarcinus vernalis* (Risso, 1816)	-	-	-	-	-	-	-	+	-	-
Family: Inachidae										
Inachus dorsettensis (Pennant, 1777)	-	-	+	-	-	-	-	-	-	-
Family: Palaemonidae										
Palaemon serratus (Pennant, 1777)	-	+	+	-	-	-	-	-	-	-
Palaemonvarians Leach, 1813	-	-	+	+	-	-	-	-	-	-
● *Palaemon xiphias* Risso, 1816	-	-	+	+	-	-	-	-	-	-
Palaemon elegans Rathke, 1837	-	-	+	-	-	-	-	-	-	-
Family: Penaeidae										
Penaeus kerathurus (Forskål, 1775)	+	+	-	-	-	-	-	-	-	-
Family: Upogebiidae										
Upogebia pusilla (Petagna, 1792)	-	-	-	+	+	-	-	-	-	-
Family: Diogenidae										
Diogenes pugilator (Roux 1829)	+	-	-	-	-	-	-	-	-	-
Order: Isopoda										
Family: Sphaeromatidae										

Cymodoce truncata (Leach, 1814)	+	+	+	+	+	+	+	+	+	+
Sphaeroma serratum (Fabricius, 1787)	-	-	-	-	-	+	+	+	+	+
✶*Sphaeroma walkeri* Stebbing, 1905	-	-	+	+	+	+	-	-	-	-
✶*Sphaeroma venustissimum* (Monod, 1931)	-	-	-	-	-	-	+	+	+	+
✶*Paradella dianae* (Menzies, 1962)	-	-	-	-	-	-	-	+	+	+
✶*Paracerceis sculpta* (Holmes, 1904)	+	+	+	+	+	+	+	+	+	+
Dynamene edwardsi (Lucas, 1849)	-	-	-	-	-	-	+	+	+	-
Family: Idoteida										
Idotea balthica (Pallas, 1772)	+	+	+	-	-	-	-	-	-	-
Idotea chelipes (Slabber, 1778)	-	-	-	+	+	-	-	-	-	-
Family: Cymothoidea										
●✶*Anilocra pilchardi* Bariche & Trilles, 2006	+	+	-	-	-	+	-	-	-	-
Family: Janiridae										
Jaera (Jaera) hopeana Costa, 1853	-	-	-	-	-	-	+	+	+	+
Order: Amphipoda										
Family: Caprellidae										
●✶*Caprella scaura* Templeton, 1836	-	-	-	-	-	+	-	-	-	-
Caprella equilibra Say, 1818	-	-	-	-	+	+	-	-	-	-
Family: Ampithoidae										
✶*Cymadusa filosa* Savigny, 1816	+	+	+	+	+	+	+	+	-	-
Family: Corophiidae										
Monocorophium acherusicum (Costa, 1853)	+	+	+	+	+	+	+	+	+	+
Monocorophium insidiosum (Crawford, 1937)	-	-	-	-	-	-	-	+	+	+
Corophium orientale Schellenberg, 1928	-	-	-	-	-	-	+	+	-	-
Family: Gammaridae										
Gammarus aequicauda (Martynov, 1931)	+	+	+	+	+	+	+	+	-	-
Gammarus insensibilis (Stock, 1966)	-	-	-	-	-	-	-	+	+	+
Family: Talitridae										
Orchestia stephenseni Cecchini, 1928	-	-	-	-	-	+	-	-	-	-
Family: Melitidae										
● *Melita palmata* (Montagu, 1804)	-	-	+	+	-	-	-	-	-	-
Order: Cirripedia										
Family: Balanidae										
✶*Amphibalanus eburneus* (Gould, 1841)	-	-	-	-	-	-	+	+	-	-
Amphibalanus amphitrite (Darwin, 1854)	-	-	-	-	-	-	+	+	+	+
Family: Sacculinidae										
● *Sacculina carcini* Thompson, 1836	+	+	-	-	-	-	-	-	-	-
Order: Stomatopoda										
Family: squillidae										
✶*Erugosquilla massavensis* (Kossmann, 1880)	-	-	+	-	-	-	-	-	-	-

Eucrate crenata originates from the Red Sea and was recorded in the Mediterranean off Port Said (Egypt) by Calman (1927), off southern Turkey (Enzenross *et al*., 1992) and in Haifa Bay, Israel (Galil, 1997). In Tunisian waters, the species had first colonized the southern Gulf of Gabès, where it became abundant (Zaouali, 1993; Enzenross & Enzenross, 2000). *E. crenata* migrated northward to the Gulf of Tunis (Ben Souissi *et al*., 2003) and the Bizerte Lagoon (Shaiek *et al*., 2010). In the Tunis Southern Lagoon *E. crenata* was harvested in Station ST1 from among algae. All collected specimens were males of substantially the same average size – about 20 mm carapace width. The species was found in Station ST1 in a water column that was rather cloudy due to suspended matter inflowing from the Gulf of Tunis. In the Gulf of Gabès, the species inhabits muddy bottoms or *Posidonia* meadows (Zaouali, 1993).

Family Piluminidae
Pilumnopeus vauquelini (Audouin, 1826) (Fig. 2B)

Pilumnopeus vauquelini originating from the Red Sea was recorded in the Mediterranean off Egypt (Calman, 1927), Israel and southern Turkey (Kocatas, 1981). The occurrence of *P. vauquelini* in the Tunis Southern Lagoon is the second record for the southern Mediterranean and the first record for Tunisian waters (Ben Souissi *et al*., 2003). Male and female specimens were equally collected throughout the eastern part of the lagoon (ST1, ST2, and ST3). The average width of the specimens was 14.5 mm.

Family Panopeidae
Rhithropanopeus harrisii (Gould, 1841) (Fig. 2C)

Rhithropanopeus harrisii is a crab native to the Atlantic Ocean and was reported for the first time in the Mediterranean Sea from the Lagoon of Marano (Italy) and the Etang de Berre (France) (see Galil *et al*., 2002). In Tunisian waters it was collected for the first time in the Tunis Southern Lagoon (Ben Souissi *et al*., 2004). In recent surveys conducted in the area the crabs have been found under stones and among decaying vegetation.

Family Varunidae
Hemigrapsus sanguineus (De Haan, 1835) (Fig. 2D)

The Asian crab *Hemigrapsus sanguineus* was accidentally introduced to Le Havre harbour in 1999 (Breton *et al*., 2002; Dauvin *et al*., 2009). In Tunisian waters, the species was reported in the Tunis Southern Lagoon (Ben Souissi *et al*., 2003). Three specimens, one male and two females, were sampled at Station ST2. The species is known to tolerate wide temperature and salinity changes (Epifanio *et al*., 1998).

Brachynotus sexdentatus (Risso, 1827)

Brachynotus sexdentatus is an autochthonous Mediterranean species inhabiting all types of substrates and is most abundant among algae and in harbours, under stones (Bouvier & Marcheurs, 1940). *B. sexdentatus* is a rare species in the Mediterranean and in the Atlantic (Stevčić & Galil, 1994), too. Only a few specimens were sampled in the lagoon on muddy bottoms at Station ST1.

Family Porcellanidae
Porcellana platycheles (Pennant, 1777)

This crab is common along the French coast and in Italian lagoons, where it lives under rocks (Zariquiey-Alvarès, 1956). In Tunisian waters it is considered rare (Zaabar, 1998). Three specimens were collected in the Tunis Southern Lagoon, from stations ST7 and ST10, both close to the navigation channel.

Pisidia longicornis Linnaeus, 1767 (Fig. 2E)

Pisidia longicornis is common throughout the European coast and western Mediterranean (Koukouras *et al*., 2002), but rare in the Tunis Southern Lagoon: only 3 females were sampled at Station ST1.

Family Plagusiidae
Euchirograpsus liguricus H. Milne Edwards, 1853

The species is endemic to the Mediterranean, first reported from Spain (Zariquiey-Alvarès, 1968) and throughout the seashores of this sea (Stevčić & Galil, 1994). The first Tunisian specimen was recorded in the Lagoon of Bizerte, on rocky and sandy bottoms (Zaabar, 1998). In the Tunis Southern Lagoon, it was found on rocky substrate at Station ST9.

Family Portunidae
Carcinus aestuarii Nardo, 1847

The species is abundant in lagoons, estuarine waters and harbour basins (Cottiglia, 1983). This crab was previously recorded along the Tunisian coast (Zaabar, 1998). Our survey has shown that *C. aestuarii* is the most abundant crab collected in the Tunis Southern Lagoon, especially in its eastern areas at stations ST1, ST2 and ST3.

Family Grapsidae
Pachygrapsus marmoratus (Fabricius, 1787)

The species is known throughout the Mediterranean (Stevčić & Galil, 1994). In Tunisian waters, it was first reported on rocky bottom off Kelibia, a city located in the Cape Bon Peninsula (Forest & Guinot, 1956). The samples of this species studied in this survey were collected at Stations ST9 and ST10.

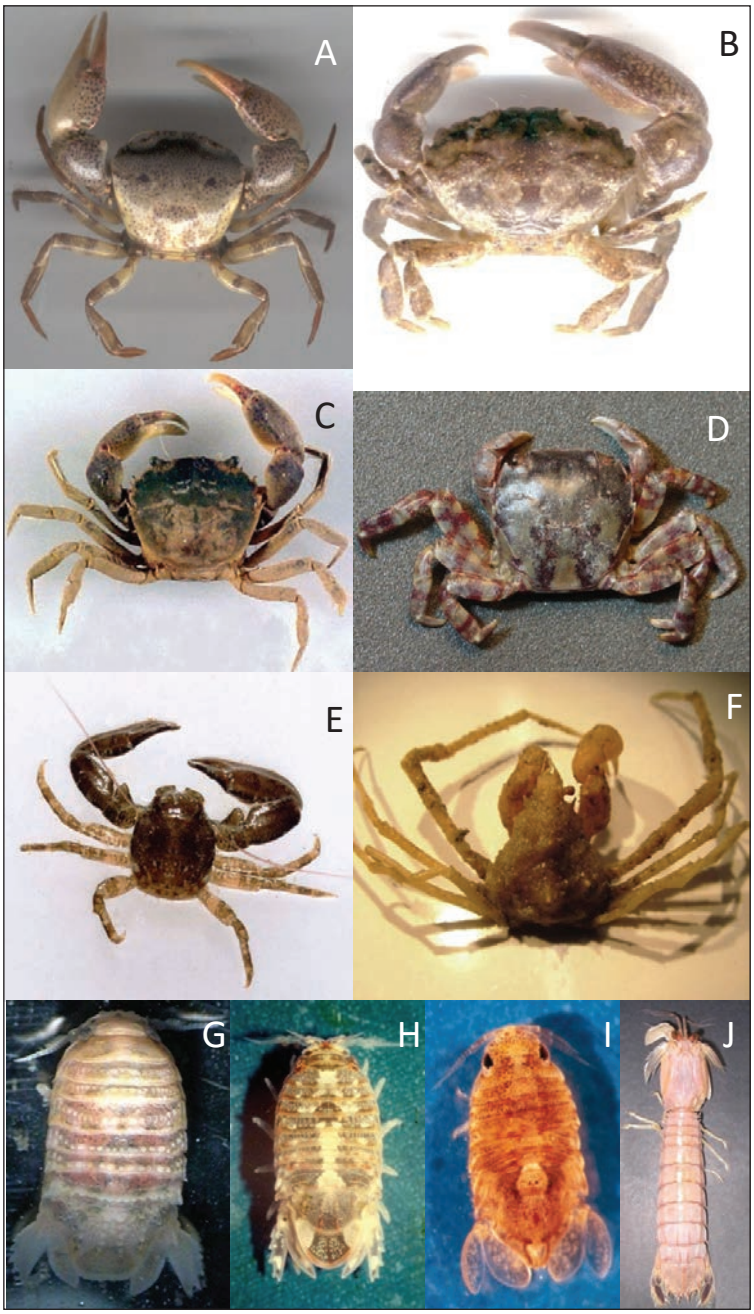

Fig. 2: Crustaceans species sampled in the Tunis Southern Lagoon. *(A) Eucrate crenata*: **adult male (Carapace width - CW = 20 mm; carapace length - CL = 26 mm); (B)** *Pilumnopeus vauquilini*: **adult male (CW = 20 mm; CL = 11.5 mm);(C)** *Rhithropanopeus harrisii*: **adult male (CW = 12 mm ; CL = 10 mm); (D)** *Hemigrapsus sanguineus*: **adult female (CW = 20 mm ; CL = 18 mm); (E)** *Pisidia longicornis*: **adult female (CW = 8 mm; CL = 9.5 mm); (F)** *Inachus dorsettensis*: **adult female (CW = 15 mm; CL = 30 mm); (G)** *Sphaeroma walkeri:* **adult male (CL = 14 mm); (H)** *Sphaeroma venustissimum*: **adult male (CL = 15 mm); (I)** *Paradella dianae*: **adult male (CL = 8 mm); (J)** *Erugosquilla massavensis*: **adult male (CL = 201 mm).**

Sl. 2: Vrste rakov, ugotovljenih v Tuniški južni laguni. *(A) Eucrate crenata*: **odrasel samec (CW = 20 mm; CL = 26 mm); (B)** *Pilumnopeus vauquilini*: **odrasel samec (CW = 20 mm; CL = 11.5 mm);(C)** *Rhithropanopeus harrisii*: **odrasel samec (CW = 12 mm ; CL =10 mm); (D)** *Hemigrapsus sanguineus*: **odrasla samica (CW = 20 mm ; CL = 18 mm); (E)** *Pisidia longicornis*: **odrasla samica (CW = 8 mm; CL = 9.5 mm); (F)***Inachus dorsettensis*: **odrasla samica (CW = 15 mm; CL = 30 mm); (G)** *Sphaeroma walkeri:* **odrasel samec (CL = 14 mm); (H)** *Sphaeroma venustissimum*: **odrasel samec (CL = 15 mm); (I)** *Paradella dianae*: **odrasel samec (CL = 8 mm); (J)** *Erugosquilla massavensis*: **odrasel samec (CL = 201 mm).**

Family Polybiidae
Liocarcinus vernalis (Risso, 1816)

The species is reported throughout the Mediterranean (Forest & Guinot, 1956; Zariquiey-Alvarès, 1956; Noël, 1992; Stevčić & Galil, 1994). In Tunisia it was first recorded off Zembra Island (Forest & Guinot, 1956). In the Tunis Southern Lagoon, a single ovigerous female was collected. *L. vernalis* is a coastal species, living in the sandy intertidal zone and brackish lagoons (Fischer *et al*., 1987).

Family Inachidae
Inachus dorsettensis (Pennant, 1777) (Fig. 2F)

The species is reported throughout the Mediterranean (Zariquiey-Alvarès, 1956; Noël, 1992; Stevčić & Galil, 1994). The first Tunisian specimen was recorded in the Gulf of Tunis (Forest & Guinot, 1956) and the subsequent ones in the Gulf of Gabès (Ktari-Chakroun & Azzouz, 1971). During our study, specimens of this species were found at Station ST3 in seagrass *Cymodocea nodosa* (Ucria) Ascherson, 1870.

DECAPODA CARIDEA
Family Palaemonidae
Palaemon serratus (Pennant, 1777)

The species is widely distributed in the Atlantic, the Mediterranean and the Black Sea (Zariquiey- Alvarès, 1968). *P. serratus* has been reported in moderately polluted harbour basins (Cottiglia, 1983). This shrimp is rare in the Tunis Southern Lagoon, in fact, only 12 specimens were collected from the fronds of algae during the autumn period.

Palaemon varians Leach, 1813

Palaemon varians is a Mediterranean brackish water shrimp (Hayward & Ryland, 1996). The species was first recorded in Tunisian waters in the Sebkha Kelbia salt flat (Heldt, 1954). The species is rare in the lagoon under study.

Palaemon xiphias Risso, 1816

The species is found throughout the Mediterranean and in the Atlantic areas such as Morocco, the Canary Islands and Madeira (Holthuis, 1980). In the Tunis Southern Lagoon, we collected ovigerous females from *Cymodocea* seagrass. This species is typically found in seagrass meadows (Fresi *et al*., 1984).

Palaemon elegans Rathke, 1837

The species is widely distributed in European coastal waters, from the Black Sea, Mediterranean Sea and North Sea to the Atlantic shore of Norway (Grabowski, 2006). In Tunisian waters the species was first reported off Salammbô by Karen & Raymond (1972). Five specimens of *Palaemon elegans* were captured during our survey at Station ST3 in the Tunis Southern Lagoon.

Family Penaeidae
Penaeus kerathurus (Forskål, 1775)

This large benthic shrimp is distributed within the 100 m of depth. It is widespread off the east coast of the Atlantic and throughout the Mediterranean Sea (Holthuis, 1980). All the specimens sampled from the eastern part of the lagoon under study were at a juvenile stage. The same trend has been observed in Italian lagoons, where only juvenile specimens enter the lagoons, while the adult ones return to the open sea (Cottiglia, 1983).

DECAPODA GEBIIDEA
Family Upogebiidae
Upogebia pusilla (Petagna, 1792)

This species occurs in the Mediterranean Sea, extending from the shores of the Iberian Peninsula (Zariquiey-Alvarès, 1956) across French waters (Noël, 1992) to the Aegean Sea (Lewinsohn & Holthuis, 1964). Specimens of *Upogebia pusilla* were harvested from the middle of the Tunis Southern Lagoon, covered in the *Caulerpa prolifera* algae. This species tolerates moderate changes in salinity, but cannot survive long periods in water with a salinity lower than that of marine water.

DECAPODA ANOMURA
Family Diogenidae
Diogenes pugilator (Roux 1829)

Diogenes pugilator has a wide geographical distribution in the eastern Atlantic, from Ireland to the Gulf of Guinea and the Mediterranean (Barnes, 1999). *D. pugilator* is a euryhaline hermit crab, inhabiting sandy and muddy sandy bottoms. It mainly occurs in lagoons and coastal areas, in shallow waters of up to several meters in depth (Cottiglia, 1983). In the lagoon under study, 9 specimens were collected from empty shells of *Cerithium vulgatum* at Station ST1.

ORDER ISOPODA
Family Sphaeromatidae
Cymodoce truncata (Leach, 1814)

This species has a wide geographic distribution throughout the seas and oceans of the world (Dumay, 1972). Dridi & Prunus (1980) were the first to report it in Tunisian lagoons. It is a very common species in the Tunis Southern Lagoon. *C. truncata* generally lives in association with the isopod *Sphaeroma serratum*, amidst various species of seaweed and wrapped in empty barnacle tests.

Sphaeroma serratum (Fabricius, 1787)

This isopod species inhabits the shallow waters of the Atlantic coasts of Europe and Africa, and of the Mediterranean Sea (De Hureaux, 1979). In the lagoon under study, the species was found under stones, algae and in empty barnacle tests. *S. serratum* is able to withstand large changes in temperature and salinity (Charmentier & Charmentier-Daures, 1994).

Sphaeroma walkeri Stebbing, 1905 (Fig. 2G)

Sphaeroma walkeri is commonly found in the Indian Ocean and the Red Sea among intertidal fouling communities, and has been reported in warm and warm-temperate waters (Galil, 2008). The species was first recorded in Tunisian waters in the Tunis Southern Lagoon by Ben Souissi *et al*. (2003), where *S. walkeri* was found in very shallow water, generally less than 3 m deep. All records so far are from the intertidal zone, except for one from India, where the isopod was collected in waters up to 46 m deep (Carlton & Iverson, 1981). *S. walkeri* inhabits different bottoms and is found among fouling communities. The species colonizes empty barnacle shells, such as *Balanus amphitrite amphitrite* Darwin, 1854, spaces between benthic fauna, oscula of sponges, especially *Ircinia* sp. and *Chondrosia reniformis* (Nardo, 1847), and ascidians, such as *Phallusia mammillata* (Cuvier, 1815), *Ecteinascidia turbinata* (Herdman, 1880), *Ascidiella aspersa*, (Müller, 1776), *Ciona intestinalis* (Linnaeus, 1767). Ounifi Ben Amor *et al*. (2010) noted that the highest densities of *S. walkeri* were observed among sponges during spring and summer. The presence of specimens in all developmental stages, throughout the year, showed that the species is substantially established in the Tunis Southern Lagoon (Ounifi Ben Amor *et al*., 2015 a).

Sphaeroma venustissimum (Monod, 1931) (Fig. 2H)

Sphaeroma venustissimum was first described from specimens collected off the Mauritanian coast (Monod, 1931). It has been reported in the waters off Morocco, the southwestern Iberian Peninsula (Hoestlandt, 1959), off Portugal (Jacobs, 1987) and Spain (Junoy & Castelló, 2003). The species entered the Mediterranean Sea through the Strait of Gibraltar and was first recorded in this region in the Tunis Southern Lagoon (Ben Souissi *et al*., 2005a). This species of tropical Atlantic origin, considered "alien" at the time of its first occurrence in the Mediterranean Sea, has since been removed from alien species lists, as its presence in the Mediterranean Sea can be explained by a natural range expansion rather than an anthropic action (Zenetos *et al*., 2012). *S. venustissimum* is an intertidal lucifugous species, often found under stones covered by biofouling, or inside empty tests of barnacles.

Paradella dianae (Menzies, 1962) (Fig. 2I)

Paradella dianae has a wide geographic distribution extending from the waters off Atlantic and Pacific coasts to South America and Brazil (Nelson & Demetriades, 1992). It is an immigrant species from the Red Sea, reported for the first time in the Mediterranean from the Alexandria harbour (Atta, 1987). The species was locally collected for the first time during surveys carried out in the Tunis Southern Lagoon (Bey *et al*., 2001). During our recent surveys, the species was sampled in seaweed and under stones from the lagoon shores.

Paracerceis sculpta (Holmes, 1904)

This is a migratory species of Indo-Pacific origin, reported for the first time in the Mediterranean by Rezig (1978) in the Tunis Northern Lagoon. In the Tunis Southern Lagoon, the species was collected among barnacle tests and algae in all stations and throughout the year.

Dynamene edwardsi (Lucas, 1849)

The species was mentioned in association with *Paracerceis sculpta* (Rezig, 1978). Dridi & Prunus (1980) also reported some specimens in the Bizerte Lagoon. *D. edwardsi* was collected among algae during spring and a similar pattern was reported by As Zaouali-Laidain (1974) and Ben Souissi (2002).

Family Idoteidae
Idotea balthica (Pallas, 1772)

The species has a wide geographical distribution. It has been reported in the Mediterranean Sea, the Black Sea, the Red Sea and in the Indian Ocean (Monod, 1923). It is uncommon in the Tunis Southern Lagoon; it was only found during spring and summer in zones characterized by a clear marine influence, at Stations ST1, ST2 and ST3.

Idotea chelipes (Slabber, 1778)

This isopod has a wide distribution and a high tolerance for confinement (Quignand, 1984). Several specimens were collected in the mid-part of the lagoon under study, hidden among the algae *Ulva* and *Gracilaria*.

Family Cymothoidae
Anilocra pilchardi Bariche & Trilles, 2006

Anilocra pilchardi is a parasitic of Indo-Pacific origin, first reported from off Lebanon (Bariche & Trilles, 2006). In previous studies, the species had been locally collected from the Lagoons of Boughrara and Bahiret El Bibans (Ben Souissi *et al*., 2010). In the present study, the species was collected from fish caught in the lagoon.

Family Janiridae
Jaera (Jaera) hopeana Costa, 1853

The species is found mainly in the Mediterranean and Black Seas (Prunus & Pantoustier, 1976). Qualified as an ectocommensal species by Naylor (1972), this minuscule isopod had been regularly collected from branchial appendices of *Sphaeroma serratum*, probably seeking better oxygenation. The spatial distribution of this isopod in the Tunis Southern Lagoon is similar to that of the lesser specimens of *S. serratum*, the ones not exceeding 10 mm in total length.

ORDER AMPHIPODA
Family Caprellidae
Caprella scaura Templeton, 1836

Caprella scaura, originating from the Indian Ocean, was first recorded in the Mediterranean Sea in the Lagoon of Venice (Sconfietti & Danesi, 1996). In Tunisia, 278 specimens in all were locally sampled for the first time in the Lagoons of Boughrara and Bibans among the algae *Gracilaria* and *Polysiphonia* (Ben Souissi *et al*., 2010). *C. scaura* was reported in the Tunis Southern Lagoon at Station ST6 among fronds of *Chaetomorpha linum* (O.F.Müller) Kützing, 1845.

Caprella equilibra Say, 1818

It is a cosmopolitan species from warm-temperate seas, found also in the Mediterranean and in the Black Sea, as well as in the Atlantic, Pacific and Indian Oceans (Chevreux & Fages, 1925). This amphipod had been previously mentioned in the Tunis Southern Lagoon by Zaouali-Laidain (1974). In this survey, several specimens were collected during spring and summer from the fronds of *Chaetomorpha linum*.

Family Ampithoidae
Cymadusa filosa Savigny, 1816

Cymadusa filosa is a Lessepsian species that has long been considered polymorphic and pantropical (Ledoyer, 1984). This amphipod was previously observed in the Lagoons of Ghar El Melh and Bizerte (Chevreux, 1910; Dridi & Prunus, 1980; Zakhama-Sraieb *et al*., 2009) and in the southern and northern parts of the Lagoon of Tunis (Ouirane, 1998; Gharbi, 2000), too. We collected this species in almost all the stations of the southern lagoon associated with the amphipod *Gammarus aequicauda* (Martynov, 1931). This amphipod is especially abundant during spring.

Family Corophiidae
Monocorophium acherusicum (Costa, 1853)

The species has a worldwide distribution (Bellan-Santini & Desrosiers, 1976). *M. acherusicum* pervades the entire Tunis Southern Lagoon (Vuillemin, 1965; Zaouali-Laidain, 1974), with its 11,605 specimens second in number only to *Cymodoce truncata*.

Monocorophium insidiosum (Crawford, 1937)

The species is commonly found in lagoons (Taramelli & Pezzali, 1986), but locally it is a less abundant species. A total of 274 specimens were observed at stations ST8, ST9 and ST10.

Corophium orientale Schellenberg, 1928

This is an endemic species of the Mediterranean Sea, found mainly in brackish waters under seaweed (Bellan Santini *et al*., 1992). In Tunisian waters, the species was previously found in Garaâ Ichkeul (Dridi & Prunus, 1980). A total of 1,579 specimens were sampled in the Tunis Southern Lagoon during our survey.

Family Gammaridae
Gammarus aequicauda (Martynov, 1931)

This species has a wide geographical distribution, and is considered very common in the Mediterranean (Bellan-Santini, *et al*., 1992). It is well documented in Tunisian waters (Gharbi, 2000), and common in the Tunis Southern Lagoon, where 10,285 specimens were collected.

Gammarus insensibilis (Stock, 1966)

This is a euryhaline and eurythermal species, widespread in the lagoon environments of the Mediterranean (Taramelli & Pezzali, 1986). It can be found at low depths (maximum 15 m) in slightly brackish water, under rocks and vegetation (Gharbi, 2000). The specimens of *G. insensibilis* collected in the study area were occasionally associated with *G. aequicauda*.

Family Talitridae
Orchestia stephenseni Cecchini, 1928

It is an endemic species of the Mediterranean Sea. In Tunisian waters, the species was first recorded in the northern lagoon by Gharbi (2000) and later confirmed in the southern lagoon, too (Ben Souissi, 2002). In the study area, 2,134 specimens were observed at Station ST6 among algae.

Family Melitidae
Melita palmata (Montagu, 1804)

Melita palmata is a common species in lagoons, estuaries and brackish waters off the European coast of the Atlantic Ocean, as well as of the Baltic, Mediterranean and Black Seas (Lincoln, 1979). *M. palmata* was report-

ed for the first time off Bizerte, in northern Tunisia by Chevreux (1911). We collected this species in the Tunis Southern Lagoon from algae and seagrasses.

ORDER CIRRIPEDIA
Family Balanidae
Amphibalanus eburneus (Gould, 1841)

Native to the entire western Atlantic, the species invaded the Mediterranean, the Black Sea, the Caspian Sea and spread further into the Indian Ocean, to Japan and other Pacific Islands (Hayward & Ryland, 1996). In Tunisian waters it was first found at an archaeological site in Carthage (Southward *et al*., 1998). Recently, it has been reported in the Gulf of Gabès by El Lakhrach *et al*. (2012). Its presence in the Tunis Southern Lagoon is limited to the shores.

Amphibalanus amphitrite (Darwin, 1854)

Amphibalanus amphitrite is a common species, found on both natural and artificial bottom (Relini, 1980). In the Tunis Southern Lagoon, the species is found in compact colonies on hard substrates, such as buoys and mussel shells. *A. amphitrite* was very abundant in the lagoon before its restoration.

Family Sacculinidae
Sacculina carcini Thompson, 1836

Sacculina carcini is a specific cirripede parasite of the crab *Carcinus aestuarii* (Lützen, 1981). It appears as a sort of sac, slightly flattened anteroposteriorly and of a vaguely pentagonal outline, implanted in the space between the crab's abdomen and cephalothorax. *S. carcini* invades the host completely and alters its hormonal balance (Larsen *et al*., 2013). In our survey, this species of parasite was observed in 4 adult males of *C. aestuarii*.

ORDER STOMATOPODA
Family Squillidae
Erugosquilla massavensis (Kossmann, 1880) (Fig. 2J)

The Mantis shrimp *E. massavensis* originates in the Persian Gulf and the Red Sea (Froglia & Manning, 1989). It migrated through the Suez Canal into the Mediterranean Sea, where it was first recorded off the Mediterranean coast of Egypt, wrongly identified as *Squilla africana* Calman, 1917 by Steuer (1936). Since 1960, *E. massavensis* has successively established in the eastern Levant and south-eastern Turkey (Holthuis, 1961; Galil *et al*., 2002; Bakir & Çevirgen, 2012). Its westernmost extension range to date has been reported in waters off the coast of Libya (Shakman & Kinzelbach, 2007) and recently in Tunisia in the Gulf of Gabès and the Tunis Southern Lagoon (Ounifi Ben Amor *et al*., 2015b). The captures of specimens in open waters, such as the Gulf of Gabès, and restricted brackish areas, such as the Tunis Southern Lagoon, suggest a possible adaptability of *E. massavensis* to salinity changes.

Crustacean fauna of the Tunis Southern Lagoon

Of the 44 crustacean species reported in the area only 29 were listed before the restoration. 6 species are new records for the Tunis Southern Lagoon, among them two Lessepsian species – the amphipod *Caprella scaura* and the isopod *Anilocra pilchardi* (Tab. 1). The distribution of the species in the lagoon shows that most of them (41%) were collected at the stations near the Bay of Tunis (ST1, ST2, ST3), which highlights the role of marine flux.

Although our study focuses on the crustacean species occurring in the Tunis Southern Lagoon, previous papers showed that molluscs and fishes were qualitatively and quantitatively represented in the area (Ben Souissi *et al*., 2005b; Eteres *et al*., 2011). Molluscs played an important role in the settlement of crustacean fauna in the lagoon. Indeed, we have observed that some species of crustaceans, such as *Sphaeroma serratum*, *S. walkeri and S. venustissimum,* take refuge in empty shells of bivalves. All specimens of hermit crab *Diogenes pugilator* were collected from empty shells of the gastropod *Cerithium vulgatum*. Some barnacles, such as *Amphibalanus eburneus* and *A. amphitrite,* were also related to the presence of empty mussel shells of *Fulvia fragilis* and *Mytilus galloprovincialis* (Lamarck, 1819).

The ichthyofauna is quite diversified and has concomitantly allowed for the resumption of fishing activities in the area after restoration. An investigation conducted in 2014 among the local fishermen aware of the fishing grounds showed that the fish fauna comprised at least 90 species (Ben Souissi *et al*., 2015). The presence of small crustaceans probably enhanced settlements of fish species in the lagoon, both elasmobranchs (Mejri *et al*., 2004) and teleosts (Ben Souissi *et al*., 2005a, 2005b; Ben Amor *et al*., 2008). Previous studies on the feeding habits of the elasmobranch and teleost species recorded in the area showed that their preferential preys or at least their secondary preys were crustaceans (Capapé & Azzouz, 1976; Capapé & Zaouali, 1979; Bradaï, 2000; Rafrafi-Nouira *et al*., 2016). Therefore, the occurrence of fishes in the area is closely related to the availability of crustaceans in the area.

A comparison was carried out between crustacean fauna of the Tunis Southern Lagoon and other brackish areas of Mediterranean and Tunisian lagoons, which is shown in Table 2. It is evident that the number of species in the Tunis Southern Lagoon is one of the largest, second only to that of the French Thau Lagoon and the Moroccan Merja Zerga, despite a smaller surface area. Such patterns confirm that the Tunis Southern Lagoon has been successfully restored and represents a favourable biological environment for numerous fish species.

Tab. 2: Number of crustacean species recorded in various Mediterranean lagoons.
Tab. 2: Število vrst rakov ugotovljenih v nekaterih sredozemskih lagunah.

Country	Lagoon	Species number	Area surface (ha)	Authors
Morocco	Merja Zerga	74	7300	Bazairi *et al*. (2003)
France	Thau Lagoon	110	7500	Cataudella *et al*. (2014)
Tunisia	Monastir Lagoon	10	340	Mortier (1979)
Tunisia	Ghar El Meleh Lagoon	12	3000	Ben Romdhane & Ktari-Chakroun (1986); Chakroun (2004)
Tunisia	Bizerte Lagoon	± 20	15000	Zaouali & Lévy (1981)
Tunisia	Tunis Northern Lagoon	44	2200	Tlig *et al*., 2008; Diawara *et al*. (2008)
Tunisia	Tunis Southern Lagoon	44	700	This study

New marine species are regularly and continuously recorded in Tunisian waters, mainly in lagoon environments, which are considered hotspots for the settlement of invasive species (Ounifi Ben Amor *et al*., 2016). Such colonisations are probably the result of the restoration of the area, which facilitated the introduction of species previously unknown to the area, and consequently the abundance of crustacean species reported in the present paper.

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DOPOLNJEN SEZNAM VRST RAKOV IZ TUNIŠKE JUŽNE LAGUNE (SEVERNA TUNIZIJA, OSREDNJI MEDITERAN)

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POVZETEK

V okviru raziskav po posegu okoljskega restavriranja Tuniške južne lagune so avtorji popisali 44 vrst rakov iz 27 družin, med katerimi je bilo 19 vrst rakov deseteronožcev, 11 vrst rakov enakonožcev, 10 vrst postranic, 3 vrste rakov vitičnjakov in ena vrsta morskih bogomolk. Med temi 44 vrstami je bilo 31 samoniklih in 13 tujerodnih. Šest vrst je bilo na obravnavanem območju prvič zabeleženih. Tuniška južna laguna nudi ugodne okoljske pogoje za naselitev tujerodnih vrst, predvsem rakov. Pojavljanje tujerodnih rakov ima pomembno ekonomsko in ekološko vlogo v omejenih somornih okoljih, obenem pa podpira razne antropogene dejavnosti kot sta lov glavonožcev in rib.

Ključne besede: somorne vode, samonikle vrste, tujerodne vrste, ekološko restavriranje, ponovno naseljevanje

REFERENCES

Atta, M. (1987): The occurrence of *Paradella dianea* (Menzies, 1962) (Isopoda, Flabellifera, Sphaeromatidae) in Mediterranean waters of Alexandria. Crustaceana, 60 (2), 213-217.

Bakir, K. & F. Cevirgen (2012): Stomatopods on the Turkish coasts with a new record *Allosquilla africana* (Manning, 1970) (Stomatopoda, Tetrasquillidae). Crustaceana, 85(3), 349.

Bariche, M. & J. P Trilles (2006): *Anilocra pilchardi n. sp.*, a new parasitic cymothoid isopod from off Lebanon (Eastern Mediterranean). Systematic parasitology, 64(3), 203-214.

Barnes, D.K.A. (1999): Ecology of tropical hermit crabs at Quirimba Island, Mozambique: shell characteristics and utilization. Mar. Ecol. Prog. Ser., 183: 241-251.

Bazaïri, H., A. Bayed, M. Glémarec & C. Hily (2003): Spatial organisation of macrozoobenthic communities in response to environmental factors in a coastal lagoon of the NW African coast (Merja Zerga, Morocco). Oceanologica Acta, 26(5), 457-471.

Bellan-Santini, D. & G. Derosiers (1976): Action d'un rejet thermique sur le zoobenthos installé sur substrat dur. Journées de thermoécologie, Centre Océanologique de Bretagne, 15/16 nov, 236-250.

Bellan-Santini, D., G. Fredj & G. Bellan (1992): Mise au point sur les connaissances concernant le benthos profond méditerranéen. Oebalia, 17, 21-36.

Ben Amor, M.M., J. Ben Souissi, M. Ben Salem & C. Capapé (2008): Confirmed occurrence of the longjaw snake eel, *Ophisurus serpens* (Osteichthyes: Ophichthidae) in Tunisian waters (Central Mediterranean). Pan-Amer. J. Aquat. Sci., 4(3), 251-254.

Ben Romdhane, M. S. & F. Ktari Chakroun (1986): Les peuplements benthiques de la lagune de Ghar El Meleh. Bull. Inst. Natl. Sci. Tech Mer. Salammbô., 13, 95-108.

Ben Souissi, J. (2002): Impact de la pollution sur les communautés macrobenthiques du lac sud de Tunis avant sa restauration environnementale. Ph. D. Thesis. University of Tunis.Tunisia, 267 pp.

Ben Souissi, J., M. Rezig & J. Zaouali (2003): Appearance of invasive species in the southern lake of Tunis. In: Özhan, E; (ed). Proceedings of the Sixth International Conference on the Mediterranean Coastal Environment. 7-11 October 2003, Ravenna, Italy, MEDCOST 03, vol. 2, pp. 911-922.

Ben Souissi, J., H. Mejri, J. Zaouali, A. El Abed, O. Guélorget & C. Capapé (2004): On the occurrence of John Dory *Zeus faber* Linnaeus, 1758 (Osteichthyes: Zeidae) in a perimediterranean lagoon:The Tunis Southern Lagoon (Northern Tunisia). Annales, Ser. Hist. Nat., 2004, 14 (2), 219-224.

Ben Souissi, J., N. Trigui El-Menif, S. Mahjoub, H. Mejri, J. Zaouali & C. Capapé (2005a): On the recent occurrence of marine exotic species in the Tunisian water. Proceedings of the Seventh International Conference on the Mediterranean Coastal Environment. MEDCOAST 05, 25-29 October 2005, Kusadasi, Turkey, pp. 529-540.

Ben Souissi, J., H. Mejri, J.Zaouali, A. El Abed, M. Ben Salem, O. Guélorget & C. Capapé (2005b): Teleost species recorded in Tunis Southern Lagoon after environmental restoration (Northern Tunisia, Central Mediterranean. Annales, Ser. Hist. Nat., 15 (2), 157-164.

Ben Souissi, J., C. Kahri, M. Ben Salem & J. Zaouali (2010): Les espèces non indigènes du macrobenthos des lagunes du Sud-Est tunisien: Point sur la situation. Rapp. Comm. Inter. Explor. Scient. Mer Médit., 39, pp: 449.

Ben Souissi, J., M. Rifi, R. Ben Charrada & J. Zaouali (2015): La lagune de Tunis: Un exemple de dépollution réussie ? In : Daumali X & L. Centemeri (eds). Pollution industrielle en Méditerranée. Maison Méditerranéenne des Sciences de l'Homme (France), 353-367.

Bey, A., M. Rezig, J. Ben Souissi & M. S. Dridi (2001): Première mention de *Paradella dianae* (Menzies, 1962) (Crustacé isopode) dans le lac sud de Tunis. Etude morphologique et écologique de l'espèce. Bull. Soc. Zool. Fr., 126(1-2), 220-223.

Bouvier, E. L. & Marcheurs, D (1940): Faune de France. Paris, Lechevalier et Fils, 37, 1-404.

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.

Breton, G., M. Faasse, P. Noël & T. Vincent (2002): A new alien crab in Europe: *Hemigrapsus sanguineus* (Decapoda: Brachyura: Grapsidae). J. Crust. Biol., 22(1), 184-189.

Calman, W. T. (1927): Report on the Crustacea Decapoda (Brachyura). Zoological results of the Cambridge Expedition to the Suez Canal, 1924. XIII. Trans. Zool. Soc. London, 22, 211-217.

Capapé, C. & A. Azouz (1976): Etude du régime alimentaire de deux Rajidæ communes dans le golfe de Tunis, *Raja miraletus*, Linné, 1758 et *R. radula* Delaroche, 1809, Rapp. Comm. int. Mer. Médit., 23 (8), 39-41.

Capapé, C. & J. Zaouali (1979): Etude du régime alimentaire de deux Sélaciens communs dans le golfe de Gabès (Tunisie): *Rhinobatos rhinobatos* (Linné, 1758) et *Rhinobatos cemiculus* (Geoffroy Saint-Hilaire, 1817). Arch. Inst. Pasteur, Tunis, 56 (3), 287-305.

Carlton, J. T. & E. W. Iverson (1981): Biogeography and natural history of *Sphaeroma walkeri* Stebbing (Crustacea: Isopods) and its introduction to San Diego Bay, California. J. Nat. Hist., 15, 31-48.

Cataudella, S., D. Crosetti, E. Ciccotti & F. Massa (2014): Mediterranean coastal lagoons: sustainable management and interactions among aquaculture, capture fisheries and environment. FAO, Studies and Reviews, (95).

Chakroun, R. (2004): Réponse de la macrofaune invertébrée benthique à l'état de dégradation du milieu:

Cas du "lac" sud de Tunis et de la lagune de Ghar El-Melh. Faculté des sciences de Bizerte. Ph. D. Thesis, 341 pp.

Charmentier, G. & M. Charmentier-Daures (1994): Ontogeny of osmoregulation and salinity tolerence in the Isopod crustacean *Sphaeroma serratum*. Mar. Ecol. Prog. Ser., 114, 93-102.

Chevreux, E. (1910): Notes sur crustacés Amphipodes d'Algérie et de Tunisie. Bull. Soc. Hist. Nat. Afrique N., 9, 1-3.

Chevreux, E. (1911): Campagnes de la Melita. Les Amphipodes d'Algérie et Tunisie. Mém. Soc. Zool. Fr., 23, 145-285.

Chevreux, E. & L. Fage (1925): Amphipodes; faune de France n°9. Eds. Lechevalier, Paris, 488 p.

Cottiglia, M. (1983): Crostacei Decapodi lagunari. Guide per il riconoscimento delle specie animali delle acque lagunari e costiere Italiane, 10, 1-148.

Dauvin, J. C., A. Tous Rius & T. Ruellet (2009): Recent expansion of two invasive crabs species *Hemigrapsus sanguineus* (de Haan, 1835) and *H. takanoi* Asakura and Watanabe 2005 along the Opal Coast, France. Aquat. Invasions, 4(3), 451-465.

De Hureaux, N. D. (1979): Etude du cycle biologique annuel d'une population de *Sphaeroma serratum* (Isopode, Flabellifere, Sphaeromatidae) du bassin d'Arcachon.Crustaceana, 37(1), 85-99.

Diawara, M., S. Zouari-Tlig, L. Rabaoui & O. K. Ben Hassine (2008): Impact of management on the diversity of macrobenthic communities in Tunis north lagoon: systematics. Cah. Biol. Mar., 49(1), 1-16.

Dridi, M. S. & G. Prunus (1980): Analyse qualitative et quantitative du peuplement en isopodes et amphipodes dans les milieux lagunaires du Nord de la Tunisie. Bull .Off. Nat. Pêch., 41, 17-25.

Dumay, D. (1972): Révision systématique du genre *Cymodoce* (Isopoda Flabellifera). Introduction et description de deux espèces: *Cymodoce truncata (Montagu)* et *C. (truncata) pilosa* Milne Edwards. Tethys, 6 (5), 130-140.

El Lakhrach, H., A. Hattour, O. Jarboui, K. Elhasni & A. A. Ramos-Espla (2012): Spatial distribution and abundance of the megabenthic fauna community in Gabes gulf (Tunisia, eastern Mediterranean Sea). Medit. Mar. Sci., 13(1), 12-29.

Enzenross, R., L. Enzenross & A. Kocatas (1992): Lessepsian migration: two Indo-Pacific crabs species (Crustacea, Decapoda) found on the Turkish Mediterranean coast. Journal of the Faculty of Science, Ege Univ., Izmir, (B), 14(2), 3-10.

Enzenross, R. & L. Enzenross (2000): Nichmediterrane Crustacea-Arten in Tunesischen gewässern (Decapoda, Macrura und Brachyura). Crustaceana, 73(2), 187-195.

Epifanio, C. E., A. I. Dittel, S. Park, S. Schwalm & A. Fouts (1998): Early life history of *Hemigrapsus sanguineus*, a non-indigenous crab in the Middle Atlantic Bight (USA). Mar. Ecol. Prog. Ser., 170, 231-238.

Eteres, E., K. Ounifi Ben Amor, M. Ben Salem & J. Ben Souissi (2011): « Faune malacologique actuelle de la lagune sud de Tunis (Tunisie Septentrionale)», in 2ème Congrès franco-maghrébin de zoologie et 4èmes Journées franco-tunisiennes de Zoologie, Zarzis, nov. 2010, Paris, Société Zoologique de France. Bull. soc. zool. Fr., p. 136.

Fisher, W., M.-L Bauchot & M. Schneider (1987): Fiches FAO d'identification des espèces pour les besoins de la pêche (Révision 1). Méditerranée et mer Noire. Zone de pêche **37**., Vol. I & II. Rome, FAO. 1530 pp.

Forest, J. & D. Guinot (1956): Sur une collection de Crustacés Décapodes et Stomatopodes des mers tunisiennes. Bull. Sta. Océanogr. Salammbô, 53, 24-43.

Fresi, E., L.A. Chessa, M. Scardi & C. Impagliazzo (1984): Feeding ecology of *Palaemon xiphias* Risso, from a *Posidonia oceanica* meadow near Alghero (Sardinia). In: Boudouresque A., de Grissac J., Oliver J. (Eds), International Workshop on *Posidonia oceanica* Beds. Vol. 1. GSI Posidonie Publications, Marseille, France: 331–334.

Froglia, C. & R.B. Manning (1989): Cheklist and key to adult Mediterranean stomatopod Crustacea. In: Biology of Stomatopods (E.A. Ferrero Eds.), pp. 265-273. U.Z.I., selected Symposia and Monographs, Modena, Italy.

Galil, B. S. (1997): Two Lessepsian migrant decapods new to the coast of Israel. Crustaceana, 70(1), 111-114.

Galil, B.S. (2008): *Sphaeroma walkeri* Stebbing, 1905 (Crustacea: Isopoda: Sphaeromatidae) established on the Mediterranean coast of Israel. Aquat. Invasions, 4, 443-444.

Galil, B., C. Froglia & P. Noël (2002): Crustaceans: decapods and stomatopods. In: Briand F (Eds), CIESM Atlas of Exotic Species in the Mediterranean, CIESM Publishers, Monaco, 2: 192.

Gharbi, O. (2000): Contribution à l'étude biosystématique des crustacés amphipodes dans le lac nord de Tunis. Diplôme d'Études approfondies Faculté des Sciences de Tunis, 92 pp.

Grabowski, M. (2006): Rapid colonization of the Polish Baltic coast by an Atlantic palaemonid shrimp *Palaemon elegans* Rathke, 1837. Aquat. Invasions, 1(3), 116-123.

Hayward, P.J. & J.S. Ryland (1996): Handbook of the marine fauna of north-west Europe, Oxford University Press, Oxford: 1-800.

Heldt, H. (1954): Contribution à l'étude de la faune carcinologique du lac de Tunis. Notes Stat Océanogr. Salammbo., 14, 99-102.

Hermi, M. & P. Aissa (2002): Impact de l'anthropisation du lac sud de Tunis (Tunisie) sur la structure automnale des peuplements de Nématodes libres. Bull. Inst. Natl. Sci. Tech. Mer. Salammbô, 29, 77-85.

Hoestlandt, H. (1959): Présence d'un Isopode marin africain, *Sphaeroma venustissimum* sur la côte Sud-Ouest de la péninsule Ibérique. Publications de l'institut de biologie appliquée (Barcelone), 29, 115-120.

Holthuis, L. B. (1961): Report on a collection of Crustacea Decapoda and Stomatopoda from Turkey and the Balkans. Zool. Verh., 47(1), 1-67.

Holtuis, L. B (1980): Shrimps and prawns of the world. FAO. Fish. Synop., 125(1), 271.

Jacobs, B.J.M. (1987): A taxonomic revision of the European Mediterranean and NWS African species generally placed in *Sphaeroma Bosc*, 1802 (Isopoda: Flabellifera: Sphaeromatidae). Zool. Verh., 238, 1-71.

Jouini, Z., R.B. Charrada & M. Moussa (2005): Caractéristiques du Lac Sud de Tunis après sa restauration. Mar. Life, 15(1-2), 3-11.

Junoy, J.Y. & J. Castelló (2003): Catálogo de las especies ibéricas y baleares de isópodos marinos (Crustacea: Isopoda). In: Viéitez J.M. and Junoy Y. J (Eds): IX Simposio ibérico de estudios del bentos marino Investigaciones sobre el bentos marino, 19-23 de febrero, 1996. Alcalá de Henares, Madrid, España. Bol. Inst. Esp. Oceanogr., 19 (1-4), 293-325.

Karen, J.R. & B.M. Raymond (1972): Background data on the decapods fauna associated with *cymodocea nodosa* meadown in Tunisia, with observation on *Clibanarius erythropus*. Department of invertebrate zoology. National Museum of Natural History Smithsonian Institution, Washington DC. USA., 12, 401-406.

Kocatas, A. (1981): Liste préliminaire et répartition des Crustacés Décapodes des eaux Turques. CIESM., 27(2), 161-162.

Koukouras, A., M. Mavidis & P. Y. Noël (2002): The genus *Pisidia* Leach (Decapoda, Anomura) in the northeastern Atlantic Ocean and the Mediterranean Sea. Crustaceana, 75(3), 451-463.

Ktari-Chakroun, F. & A. Azzouz (1971): Les fonds chalutables de la région sud-est de la Tunisie (Golfe de Gabès). Bull. Inst. Natl. Sci. Tech Mer. Salammbô, 2 (1), 5-48.

Larsen, M.H., J.T. Høeg & K.N. Mouritsen (2013): Influence of infection by *Sacculina carcini* (Cirripedia, Rhizocephala) on consumption rate and prey size selection in the shore crab *Carcinus maenas*. J. Exp. Mar. Biol. Ecol., 446, 209-215.

Ledoyer, M. (1984): Les Gammariens (Crustacea, Amphipoda) des herbiers de Phanerogames marines de Nouvelle Caledonie (Region de Noumea). Mus. Nat. Hist. Nat, Serie A, Zoologie, 129: 1-113.

Lewinsohn, C. & L. B. Holthuis (1964): New records of decapod Crustacea from the Mediterranean coast of Israel and the eastern Mediterranean. Zool. Meded. Leiden, 40 (8): 45-63.

Lincoln, R.J. (1979): British Marine Amphipoda: Gammaridea. B.M.N.H., 658 pp.

Lützen, J. (1981): Field studies on regeneration in *Sacculina carcini* Thompson (Crustacea: Rhizocephala) in the Isefjord, Denmark. J. Exp. Mar. Biol. Ecol., 53(2), 241-249.

Mejri, H. (2003): Impacts des aménagements sur l'ichtyofaune du lac sud de Tunis. P.F.E Institut National Agronomique de Tunis: 1-25.

Mejri, H., J. Ben Souissi, J. Zaouali, A .El Abed, Y.Vergne, O. Guélorget & C. Capapé (2004): On the recent occurrence of elasmobranch species in Tunis Southern lagoon "(Northern Tunisia, Central Mediterranean)". Annales, Ser. Hist. Nat., 14, 143-155.

Monod, T. (1923): Prodrome d'une faune des Tanaidacea et des Isopoda (excl. Epicaridea) des côtes de France (excl. Méditerranée). Annls. Acad. La Rochelle, 37, 19–124.

Monod, T. (1931): Tanaidaces et Isopodes aquatiques de l'Afrique occidentale et septentrionale. 3ème partie. Sphaeromatidae. Mém. Soc. Sci. Nat. Maroc, 29, 1-91.

Mortier, M. (1979): Première approche dans l'étude de la lagune de Monastir, Tunisie. Doctoral dissertation, Thèse université Aix Marseille, 82 pp.

Naylor, E. (1972): British Marine Isopods, Synopses of the British Fauna (New Series). The Linnean Society of London, Academic Press, 86 pp.

Nelson, W.G. & L. Demetriade (1992): Peracarids associated with sabellariid worm rock (*Phragmatopoma lapidosa* Kinberg) at Sebastian Inlet, Florida, USA. J. Crust. Biol., 647-654.

Noël, P.Y. (1992): Clé préliminaire d'identification des Crustacea Decapoda de France et des principales autres espèces d'Europe. Collection Patrimoines Naturels, Secrétariat Faune-Flore, M.N.H.N. Paris vol., 9, 1-145.

Ouirane, R. (1998): Contribution à l'étude d'un milieu lagunaire pollué (le lac sud de Tunis): physico-chimique et macrofaune benthique Diplôme d'études approfondies. Faculté Des Sciences de Bizerte, 142 pp.

Ounifi Ben Amor, K., M. Ben Salem & J. Ben Souissi (2010): *Sphaeroma walkeri* Stebbing, 1905 (Crustacea, Isopoda, Sphaeromatidae) introduced and established in Tunisia waters. Rapp. Comm. Inter. Explor. Scient. Mer Médit., 39, 615 pp.

Ounifi Ben Amor, K., M. Rifi & J. Ben Souissi (2015a): Description, reproductive biology and ecology of the *Sphaeroma walkeri* (Crustacea: Isopoda) alien species from the Tunis southern Lagoon (Northern Tunisia: Central Mediterranean. Annales, Ser. Hist. Nat., 25 (1), 35-44.

Ounifi Ben Amor, K., M. Rifi, S. Mili & J. Ben Souissi (2015 b): On the occurrence of mantis shrimp *Erugosquilla massavensis* (Crustacea: Squillidae) in the Tunisian waters (central Mediterranean). Cah. Biol. Mar., 56, 297-300.

Ounifi Ben Amor, K., M. Rifi, R. Ghanem, I. Draeif, J. Zaouali & J. Ben Souissi (2016): Update of alien fauna and new records from Tunisian marine waters. Medit. Mar. Sci., 17 (1), 124-143.

Prunus, G. & G. Pantoustier (1976): Le genre *Jaera Leach* (Isopode Asellote) sur les côtes de Tunisie. Etude morphologique et écologique. Arch. Zool. Exp. Gen., 117, 235-254.

Quignand, I. P. (1984): Les caractéristiques biologiques et environnementales des lagunes en tant

que base biologique de l'aménagement des pêcheries. Studies and Reviews-General Fisheries Council for the Mediterranean (FAO). no. 61, 1-35.

Rafrafi-Nouira, S., O. El Kamel-Moutalibi, M. Boumaïza, C. Reynaud & C. Capapé (2016): Food and feeding habits of black scorpionfish, *Scorpaena porcus* (Osteichthyes: Scorpaenidae) from the northern coast of Tunisia (central Mediterranean). J. Ichthyol., 56(1), 107-123.

Relini, G. (1980): Cirripedi Toracici. Guide per il riconoscimento delle specie animali delle acque lagunari e costiere italiane. AQ/1191 C.N.R. 2, 1-122.

Rezig, M. (1978): Sur la présence de *Paracerceis sculpta* (Crustacé, Isopode, Flabellifère) dans le lac de Tunis. Bull. Inst. Natl. Sci. Tech Mer., 2 (1-2), 175-191.

Sconfietti, R. & P. Danesi (1996): Variazioni strutturali in comunita di peracaridi agli estremi opposti del bacino di Malamocco (Laguna di Venezia). Soc. Ital. Ecol., Atti., 17, 407–410.

Shaiek, M., M. S. Romdhane & A. Jenhani Ben Rejeb (2010): Communauté actuelle de crabes (Brachyura, Decapoda, Crustacea, Artropoda) de la lagune de Bizerte (Tunisie Septentrionale). Rapp. Comm. Inter. Explor. Scient. Mer Médit., 39.

Shakman, E. & R. Kinzelbach (2007): First record of the mantis shrimp, *Erugosquilla massavensis* (Kossmann, 1880), a Lessepsian migrant, in the coastal waters of Libya (Crustacea: Stomatopoda). Zool Middle East, 40, 109-111.

Southward, AJ., RS. Burton, S.L. Coles, PR. Dando, R. DeFelice, J. Hoover, PE. Parnell, T. Yamaguchi & WA. Newman (1998): Invasion of Hawaiian shores by an Atlantic barnacle. Mar. Ecol. Prog. Ser., 165, 119-126.

Steuer, A. (1936): Cumacea und Stomatopoda von Alexandrien in Ägypten. Notizen des Deutsch-Italienischen Institutes für Meeresbiologie in Rovigno d'Istria, 21, 1-19.

Stevčić, Z. & B. Galil (1994): Checklist of the Mediterranean Brachyura crabs. Acta Adriatica, 34: 65–76.

Taramelli, E. & S. Pezzali (1986): Ecology and distribution of crustaceous Amphipoda in the coastal lakes of Latina Province (Italy). Boll. Mus. Civ. Sto. Nat. Verona, Bot. Zool., 13, 295-318.

Tlig-Zouari, S. & F. Maamouri-Mokhtar (2008): Macrozoobenthic species composition and distribution in the northern lagoon of Tunis. Transit Waters Bulletin, 2, 1–15.

Vandenbroek, J. & R. Ben Charrada (2001): Restoration and development project of south Lake of Tunis and its shores. Terra Aqua, 85, 1-20.

Vuillemin, S. (1965): Contribution à l'étude écologique du Lac de Tunis. Biologie de *Mercierella enigmatica Fauve*. Ph. D. Thesis. University of Paris, 554 pp.

Zaabar, W. (1998): La biodiversité des crabes de Tunisie. Diplôme d'études approfondies. Faculté Des Sciences de Tunis, 142 pp.

Zakhama-Sraieb R., Y.R. Sghaïer & F. Charfi-Cheikhrouha (2009): Amphipod biodiversity of the Tunisian coasts: update and distributional ecology. Mar. Biodiv. Rec., 1 of 7.

Zaouali-Laidain, J. (1974): Les peuplements malacologiques dans les biocoenoses lagunaires tunisiennes. Etude de l'espèce pionnière *Cerastoderma glaucum* Poiret. Thèse Doctorat d'Etat Es-Sciences. Université de Caen, 335 pp.

Zaouali, J. (1993): Présence d'*Eucrate crenata* dans le golfe de Gabès (Crustacea, Decapoda, Brachyura). Mar. Life, 53-56.

Zaouali, J. & A. Levy (1981): Evolution spatiotemporelle de la macrofaune et de la microfaune dans le lac de Bizerte (Tunisie septentrionale). Rapport CIESM., 27(4), 189-190.

Zariquiey-Alvarès, R. (1956): Études carcinologiques méditerranéennes. I. Crustaceos Decapodos de la région de Cadaquès (Espana). Vie Milieu, 6(2), 397-409.

Zenetos, A., E. Ballesteros & Verlaque, M (2012): Alien species in the Mediterranean Sea by 2012. A contribution to the application of European Union's Marine Strategy Framework Directive (MSFD). Part 2. Introduction trends and pathways. Medi. Mar. Sci., 13(2), 328-352.

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CHANGES IN BIRD SPECIES COMPOSITION AND ABUNDANCE IN DRAGONJA VALLEY (SW SLOVENIA)

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ABSTRACT

*In 2015, breeding bird census was carried out in the Dragonja River Valley and its results compared with the census implemented there in 1996/97. In contrast to numerous other natural environments that have been thoroughly transformed and fragmented in the last few decades, a significant increase of the total number of breeding pairs with regard to the initial situation has been noted in the area under consideration. The species that reached the greatest degree of dominance remained the same throughout the observation period (Blackbird (*Turdus merula*), Blackcap (*Sylvia atricapilla*), Nightingale (*Luscinia megarhynchos*), Chaffinch (*Fringilla coelebs*)). Several new species were recorded as well, predominantly those characteristic of mature forests. Numbers of pairs are rising also in the great majority of cultural landscape species, forest species and generalists. The obtained results show that the Dragonja Valley plays an exceptionally significant role in the preservation of the endangered bird species' populations.*

Key words: Dragonja, sub-Mediterranean, bird census, conservation guidelines, land-use changes, secondary succession

CAMBIAMENTI IN COMPOSIZIONE ED ABBONDANZA DELLE SPECIE DI UCCELLI NELLA VALLE DEL DRAGOGNA (SLOVENIA SUD-OCCIDENTALE)

SINTESI

*Nel 2015 è stato eseguito un censimento delle specie nidificanti nella valle del fiume Dragogna e i risultati sono stati confrontati con quelli del censimento effettuato nel periodo 1996/97. In confronto a numerosi altri ambienti naturali che sono stati trasformati e frammentati negli ultimi decenni, è stato osservato nella zona in esame un aumento significativo del numero totale di coppie nidificanti. Le specie che hanno raggiunto il massimo grado di dominanza sono rimaste lo stesse durante tutto il periodo di osservazione: il merlo (*Turdus merula*), la capinera (*Sylvia atricapilla*), l'usignolo (*Luscinia megarhynchos*), ed il fringuello (*Fringilla coelebs*). Diverse nuove specie sono state registrate nell'area, prevalentemente quelle caratteristiche delle foreste mature. Il numero di coppie è in aumento anche nella maggioranza delle specie del paesaggio culturale, di quelle forestali e dei generalisti. I risultati ottenuti dimostrano che la valle del Dragogna svolge un ruolo particolarmente significativo nella conservazione delle popolazioni di specie di uccelli in via di estinzione.*

Parole chiave: Dragogna, area sub-mediterranea, censimento di uccelli, linee guida di conservazione, cambiamenti nell'uso del suolo, successione secondaria

INTRODUCTION

With the undreamed-of development of mass tourism as well as construction of residential buildings and infrastructure closely associated with these activities in most Mediterranean countries after World War II, natural and landscape-worthy areas have been rapidly disappearing in their coastal zones. In this respect, the Dragonja Valley in Slovenian Istria is something very special indeed, considering that it has managed to avoid agricultural intensification and watercourse regulation as well as great infrastructural and construction projects (Križan, 2002).

Until the first few decades of the 20th century, the Dragonja Valley had the characteristic image of the mosaic cultural landscape, which was in fact prevalent all over Istria. People inhabited villages and hamlets, making a living out of agriculture and livestock farming, as well as grain grinding in the characteristic mills on the Dragonja River. At the bottom of the valley, small fields, vineyards, plantations, orchards and pastures prevailed, whereas slopes were overgrown by mixed forests. After World War I, and especially World War II, people gradually abandoned agricultural production owing to its unprofitability and began to emigrate. Former arable plots, including the characteristic terraces with stone supporting walls, began to be overgrown with vegetation. Globevnik *et al*. (1995, 1999) ascertained that in 1971 22% of the Dragonja catchment was overgrown by forests, and no less than 62% in 1994; the surface area of meadows and pastures was reduced by 30% between 1971 and 1994. Arable land was reduced by one fifth. More rain water in the Dragonja River catchment than in old times is used for the growth of tree and shrub vegetation, which means that the water flow into the river is smaller as well (Globevnik, 1999). In turn, this causes lower annual flow rates on average in the Dragonja River (Globevnik *et al*., 1995).

In the valley, birds have been systematically surveyed from the mid-1980s (Gregori, 1987). There followed the surveys in 1996/97 (Sovinc, 1998), 2012 (Gregorič, 2013) and 2015 (this work). The results are highly significant if we wish to understand the importance of conservation of the last few natural or nature-like areas in the coastal strip and to designate appropriate conservation regime needed to retain favourable conservation status for species and habitats in these sanctuaries.

The key characteristics of composition and abundance of birds in the area under consideration along the Dragonja River during the survey conducted by Gregori in 1986 (Gregori, 1987) and results of the census implemented in 1996/97 by Sovinc (1998) can be summarized in the following:

- The total number of registered species did not change, although there is a slight difference in composition of the registered species; Gregori, for example, registered some bird species that have not been confirmed as breeding species in 1996/97 or at a later date (Little Bittern (*Ixobrychus minutus*), Tree Pipit (*Anthus trivialis*), Stonechat (*Saxicola rubicola*), Wren (*Troglodytes troglodytes*) and Jackdaw (*Corvus monedula*)).

- The surveys in 1996 and 1997 confirmed the newly established species in the survey area, *i.e.:* Sparrowhawk (*Accipiter nisus*), Collared Dove (*Streptopelia decaocto*), Hoopoe (*Upupa epops*), Mistle Thrush (*Turdus viscivorus*), Sardinian Warbler (*Sylvia melanocephala*), Starling (*Sturnus vulgaris*) and Corn Bunting (*Miliaria calandra*). Some species frequented the municipal waste landfill at Dragonja (but did not breed there), which is no longer functional, with Yellow-legged Gulls (*Larus michahellis*), Black-headed Gulls (*Chroicocephalus ridibundus*) and Hooded Crow (*Corvus cornix*) among them.

- The greatest rise in the number of breeding pairs in comparison with the previous survey by Gregori (1986) was recorded for Turtle Dove (*Streptopelia turtur*), Greenfinch (*Chloris chloris*), Goldfinch (*Carduelis carduelis*) and Woodlark (*Lullula arborea*), while Rock Bunting (*Emberiza cia*) was the only species for which a negative abundance trend was recorded between 1986 and 1996/97.

- Sovinc (1998) terminates the comparison with preliminary survey from 1986 with his conclusion that the abundance of most of the species of cultural landscape, forest-shrubland and populated areas in the area under consideration along the Dragonja River has increased.

The aim of this study is to discuss changes in the avifauna of the area as a result of changes in the land use patterns. Based on this analyses and evaluation of the conservation importance of the area, we would like to propose some management recommendations for the future land use, essential to safeguard favourable ecological conditions for the bird communities in the Dragonja valley.

MATERIALS AND METHODS

Study area

The Dragonja Valley covers 95 km^2 and is situated in the extreme south-western part of Slovenia along the border with Croatia. The Dragonja River has numerous tributaries and is 30 km long. It flows in east to west direction and drains into Piran Bay. Between the deep ravines which are cut in the flysch substratum, plateau-like hills are rising, on which hamlets and villages have developed in the past (Orožen-Adamič, 1979; Križan, 2002).

The entire area of Slovenian Istria, including the Dragonja Valley, is under the influence of sub-Mediterranean climate. Precipitation is evenly distributed all year round, with distinct dry and wet periods. The peak is reached in the autumn months and in early summer (May and June). The least rainfall is recorded during the transition season between winter and spring (from

January to April) and in peak summer months. Average January temperatures oscillate between 0°C and 4°C, while average July temperatures vary between 19°C and 22°C (Ogrin, 1995).

The Dragonja area belongs to the sub-Mediterranean phytogeographical region (Wraber, 1969). Owing to the cold flysch substratum, which is impermeable to water, no true evergreen Mediterranean plants thrive in the valley, but only thermophilous deciduous vegetation. Here, the association of Hop-Hornbeam and Downy Oak (*Ostryo-Quercetum pubescentis*) predominates (Kaligarič, 1997). A primary natural vegetation (*Seslerio-Quercetum*) is well preserved (Križan, 2002). Shady slopes of the valley are covered by Hornbeam stands (*Carpinus betulus*), while drier and thermophilous slopes are overgrown by Oriental Hornbeam (*Carpinus orientalis*). Quite common as far as trees are concerned, are Manna Ash (*Fraxinus ornus*) and Field Maple (*Acer campestre*) (Kaligarič, 1997). At the bottom of the valley and along the water we can find individual poplars (*Populus* sp.), black locust (*Robinia pseudoacacia*), willows (*Salix* sp.), maples (*Acer* sp.) and minor complexes of reed (*Phragmites* sp., *Arundo donax*), which are to a great extent overgrown by shrubs (Gregori, 2002). Shrub species are predominated by Blackthorn (*Prunus spinosa*) and English Hawthorn (*Crataegus oxyacantha*), which thrive especially in the Dragonja's hinterland. Some smaller areas are covered by grasslands (Kaligarič, 1997). Limestone islets (Sv. Štefan and Stena) are home to eu-Mediterranean plants, e.g. Holm Oak (*Quercus ilex*), Broad-leaved Phyllirea (*Phyllirea latifolia*), Yellow Germander (*Teucrium flavum*), etc. (Kaligarič, 1997; Wraber, 2002). Amongst cultural plants, Common Grape Vine (*Vitis vinifera*), Common Olive (*Olea europea*) and various fruit trees prevail.

Field methods

The survey was carried out according to the point count method at transect length with 23 count points some 500 metres apart, as was in the years 1996/97 (Sovinc, 1998). The survey route was approximately 10.5 km long (Fig. 1). This method has been used at the time of the first census in 1986 (Gregori, 1987) and used all surveys that followed in order to enable best possible comparision of results obtained.

Owing to certain indistinctness's in the interpretation of some data and count points from 1986 (Gregori, 1987), we decided to take the 1996/97 survey (Sovinc, 1998) as the initial survey for the comparison of composition and abundance trends in the Dragonja Valley.

Birds were identified mainly through their singing and calls. At each point, listening time lasted five minutes (DOPPS, 2006). In 2015, three field days were conducted, each time in the months of May and June. Surveys lasted from early morning till mid-day, when birds are most active. Every singing male was treated as a breeding pair. At all times, the highest of the values at the same point of registered singing males or breeding pairs was taken into consideration. Surveys did not take place during the night which explains absence of some potential night species, like owls.

Determination of the extent of habitat types is based on the estimate of phytogeographical and vegetation

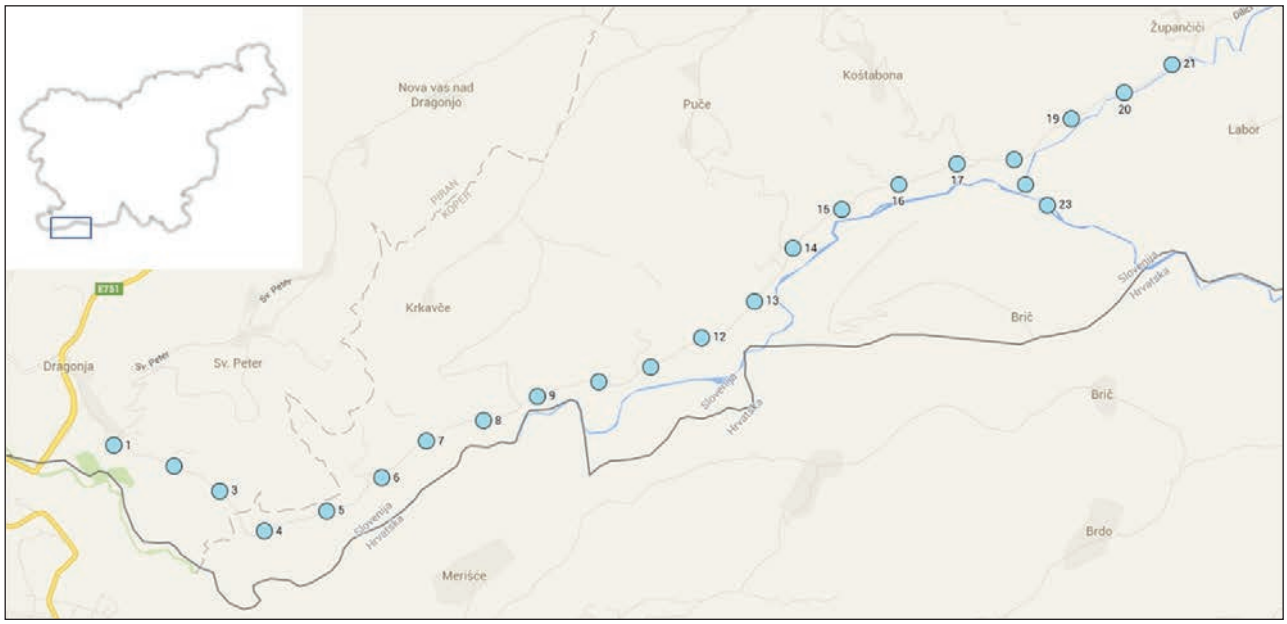

Fig. 1: Transect of the survey with count points (Source: adapted from Google maps: https://www.google.si/maps).
Sl.1: Transekt popisa s številnimi mesti (Vir: prirejeno po Google maps: https://www.google.si/maps).

characteristics, rate of overgrowth and land use; it was already Gregori (1987) who surveyed habitat types along the Dragonja River in the same manner, merging them into four groups: urban (residential buildings and other built up areas), vineyards, open areas (meadows, fields with trees, bushes and plantations in between, and overgrown areas (forest and scrubland). At each count point, the share of separate habitat type was estimated. Shares of habitat presence are given in %.

Data analysis

From collected data, the species dominance index (DOM) was calculated, which indicated relative frequency of the species in association (Tome, 2006). The dominance index was calculated according to the formula:

$$D = \frac{a}{S} \times 100\ (\%)$$

where *a* is the number of territorial males of species recorded along the entire transect, and S is a total number of all bird species records on the census spot (transect). A species is dominant when its index is at least 5%, and subdominant when its index oscillates between 2 and 5% (Tarman, 1992).

Index for separate species (POV index) was calculated in the survey covering the years 1996/97 (Sovinc, 1998) and calculated again for the year of 2015 to enable accurate comparison of results. The index smaller than 100 indicates a reduction of pair numbers in the area under consideration with regard to the initial year, whereas index greater than 100 indicates an increase of pairs.

Indicator bird species for groups were also stipulated: generalists, cultural landscape species, forest species, shrubland and grassland species. The indicator species were designated on the basis of report entitled *Monitoring of generally distributed bird species to determine Slovenian index of agricultural landscape bird species* (Kmecl *et al.*, 2014a).

For the evaluation of changes in number of breeding pairs of recorded bird species between 1996/97 and 2015, a Chi-square test was used. Test was not applied for the recorded species, which do not breed in the studied area.

RESULTS AND DISCUSSION

Numbers of probable and certain breeders

During the census carried out in the breeding season in the Dragonja Valley in 2015, 63 species were recorded, 57 of which are probable and certain breeders (Appendix 1). By 2015, the number of breeding bird species increased from the initial situation in the 1996/97 by 14 (Nuthatch (*Sitta europaea*), Song Thrush (*Turdus philomelos*), Black Woodpecker (*Dryocopus martius*), Woodpigeon (*Columba palumbus*), Raven (*Corvus corax*), Tawny Owl (*Strix aluco*), Lesser Spotted Woodpecker (*Dendrocopos minor*), Nightjar (*Caprimulgus europaeus*), Marsh Tit (*Poecile palustris*), Short-toed Treecreeper (*Certhia brachydactyla*), Fan-tailed Warbler (*Cisticola juncidis*), Great Reed Warbler (*Acrocephalus arundinaceus*), Grey-headed woodpecker (*Picus canus*) and Spanish Sparrow (*Passer hispaniolensis*)). Regarding the latter this is, to the best of our knowledge, the first confirmed breeding in Slovenian Istria (DOPPS, 2016). The majority of newly established breeders belong to the group of forest species, especially species of mature forest. In the last few decades, the areas overgrown with shrubs and young trees along the Dragonja River have gradually transformed into mature forests, where the share of undergrowth has been noted, which in fact explains the arrival of the already mentioned forest specialists. In the last three years, especially cultural landscape species reappeared in the area under consideration, while Great Reed Warbler and Kingfisher (*Alcedo atthis*) are closely associated with water habitats. The Kingfisher's breeding in the dug burrow in the Dragonja's bank has not been confirmed, as the river ran dry in the summer at that section, which could indicate that the breeding attempt ended unsuccessfully. Breeding of both species was confirmed in this area before (Geister, 1995).

As already established by Gregorič (2013), Hooded Crow has disappeared from the list of Dragonja Valley breeders in the last few decades. In contrast, its population has increased significantly in urban areas as well as settlements in the vicinity of the area observed (Senič, 2015). Among the local breeders, no Collared Dove pair was registered in 2015 in the village of Dragonja, the same as Rock Bunting, which was no longer registered during the last censuses along the Dragonja River, we can once more write that this species most probably does not breed here anymore.

In 2015, at least four bird species were registered, for which no confirmation of their potential breeding could be established although they were observed in the time of the breeding period and in suitable breeding habitats; so these four species were not added to the list of Dragonja Valley breeders. These are Bee-eater (*Merops apiaster*), Calandra Lark (*Melanocorypha calandra*), Whinchat (*Saxicola rubetra*) and Yellow Wagtail (*Motacilla flava*). Yellow-legged Gulls and Swifts (*Apus apus*) observed along the Dragonja River only feed here and breed outside the area discussed so they are not included on the list of breeding species.

At the time when we are daily faced with alarming data on decline in abundance and local disappearance of bird species, a glimpse at the number of the birds' breeding pairs along the Dragonja River is very pleasing indeed. Such a result is no doubt the consequence of various factors: in the last few decades, no great environmentally harmful and destructive encroachments

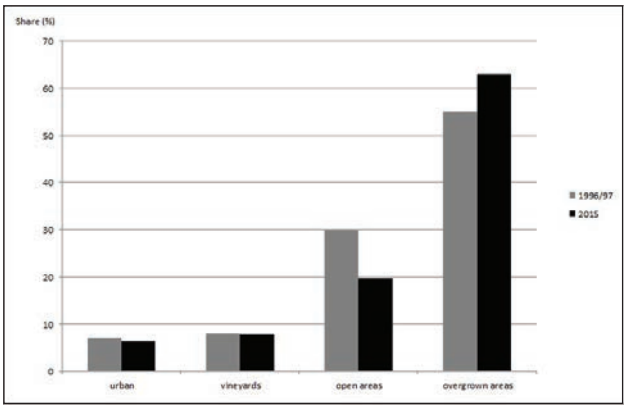

Fig. 2: Shares of habitat types (in %) between 1996/97 and 2015 - urban area, vineyards, open and overgrown areas.
Sl.2: Deleži habitatnih tipov: urbano okolje, vinogradi, odprta in zaraščena območja (v %) v letih 1996/97 in leta 2015.

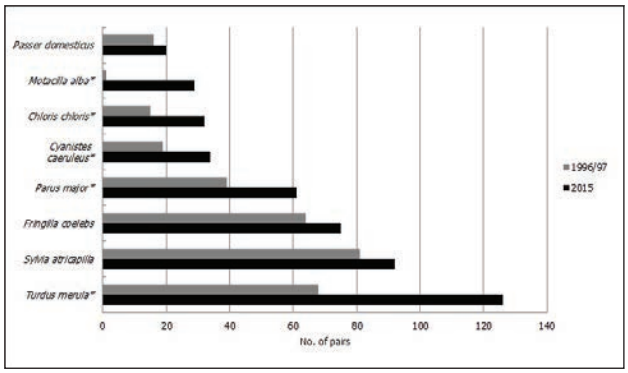

Fig. 3: Number of generalist pairs in 1996/97 (grey column) and 2015 (black column). Significance of Chi² test on the differences between 1996/97 and 2015 is marked with *: p = 0.02.
Sl. 3: Število parov generalistov v letih 1996/97 (sivi stolpiči) in 2015 (črni stolpiči). Statistično značilne razlike med leti 1996/97 in 2015 so bile izračunane s testom hi-kvadrat in so označene z *: p = 0,02.

upon space have taken place in the Dragonja Valley. Predominantly tarmac road still leads through the valley, which limits the density of motor traffic. Along the survey route no new constructions or large infrastructural investments can be seen. No areas where exploitation of natural resources in industrial manner (*e.g.* major felling of woods) would be carried out have been designated and no ambitious changes in land use made. Our own observations show relatively small estimates in land use change (Fig. 2).

Changes in degree of dominance

The details regarding the degree of dominance for separate species are shown in Appendix 1. During all three surveys along the Dragonja River four species were among the dominant ones, *i.e.* Blackbird (*Turdus merula*), Nightingale (*Luscinia megarhynchos*), Chaffinch (*Fringilla coelebs*) and Blackcap (*Sylvia atricapilla*). From the initial census in 1996/97, however, the degree of the birds' dominance – with the exception of Blackbird – has been reduced till this day. Increase in the share of subdominant species from the initial census is evident as well; in 1996/97, 9 species were subdominant, while in 2015 their number reached 13 species. Among subdominant and even dominant species in a separate census were always the following species: Serin (*Serinus serinus*), Melodious Warbler (*Hippolais polyglotta*), Golden oriole (*Oriolus oriolus*), Cirl Bunting (*Emberiza cirlus*), Blue Tit (*Cyanistes caeruleus*), Great Tit (*Parus major*) and Turtle Dove. Song Thrush, as a newly established breeder in 2012 (Gregorič, 2013), immediately appeared as a subdominant species.

The rise in dominance degree has been lately registered particularly in the species characteristic of open cultural landscape with trees and bushes (e.g. Red-backed Shrike (*Lanuis collurio*), Pheasant (*Phasanius colchicus*)) and the species inhabiting wooded areas bordering on open landscape with rarer trees and bushes (*e.g.* Blue Tit, Greenfinch, Turtle Dove, Jay (*Garrulus glandarius*), Cuckoo (*Cuculus canorus*)).

Generalists

Among generalists in the area under consideration are, quite expectedly, the species that also predominate with degree of dominance, such as Blackbird, Blackcap, Chaffinch as well as Great Tit, Blue Tit and Greenfinch. Numbers of pairs of the above mentioned species statistically significantly increased ($\chi 2$, p=0.02), with the exception of Blackcap and Chaffinch (Fig. 3). Most conspicuous amongst generalists is the Pied Wagtail (*Motacilla alba*) owing to the great statistical significantly increase ($\chi 2$, p=0.02) of its recorded pairs; from a single pair recorded in 1996/97, the number of this species' pairs rose to no less than 29 by 2015. In the Dragonja Valley, the Pied Wagtail is not closely linked only to the village of Dragonja and to the nearness of water, but it also breeds along fields and meadows in the entire valley. In Slovenia, a modest decline has been generally noted for this species (Kmecl *et al.*, 2014a).

Cultural landscape species

Among cultural landscape indicator species, increase of numbers of pairs is mostly noted (Fig. 4). During the 1996/97 surveys, only individual Hoopoes, Starlings and Wrynecks (*Jynx torquilla*) were recorded. The num-

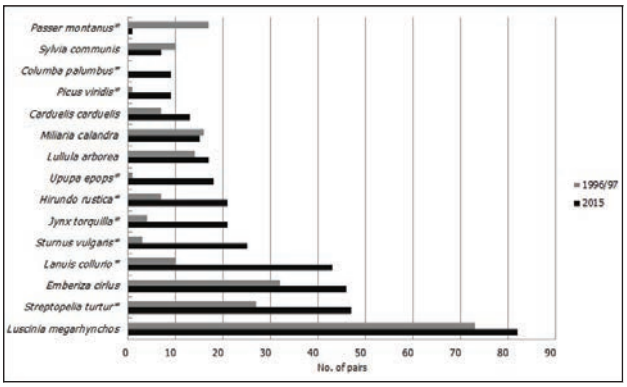

Fig. 4: Number of pairs of cultural landscape species in 1996/97 (grey column) and 2015 (black column). Significance of Chi² test on the differences between 1996/97 and 2015 is marked with *: p = 0.02.
Sl. 4: Število parov vrst iz kulturne krajine v letih 1996/97 (sivi stolpiči) in 2015 (črni stolpiči). Statistično značilne razlike med leti 1996/97 in 2015 so bile izračunane s testom hi-kvadrat in so označene z *: p = 0,02.

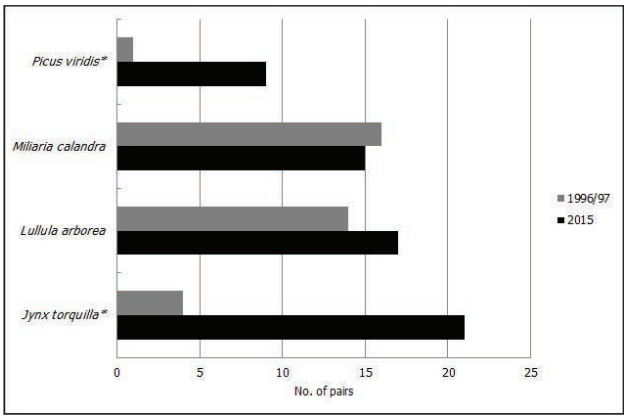

Fig. 5: Number of grassland species pairs in 1996/97 (grey column) and 2015 (black column). Significance of Chi² test on the differences between 1996/97 and 2015 is marked with *: p = 0.02.
Sl. 5: Število parov travniških vrst v letih 1996/97 (sivi stolpiči) in 2015 (črni stolpiči). Statistično značilne razlike med leti 1996/97 in 2015 so bile izračunane s testom hi-kvadrat in so označene z *: p = 0,02.

bers of these species pairs have statistically significally increased (χ2, p=0.02) along the Dragonja River in the last few years, which is very pleasing indeed, given that the above mentioned species, with the exception of Starling, are highly endangered in Slovenia, where their populations are rapidly declining (Kmecl *et al.*, 2014a).

In 1996/97, only a single pair of Green Woodpeckers (*Picus viridis*) was registered, while in 2015, 9 individuals were recorded. Very pleasing are the statistically significant rising numbers of pairs (χ2, p=0.02) and satisfactorily large breeding densities also in other elsewhere in Slovenia endangered species, such as Red-backed Shrike and Turtle Dove (Red List of Breeding Birds of the Republic of Slovenia, 2002), which are experiencing moderate or sharp decline (Kmecl *et al.*, 2014a). Also, number of Cirl Bunting pairs, in Slovenia endangered species (Red List of Breeding Birds of the Republic of Slovenia, 2002) have increased by 14.

The only indicator species of cultural landscape, the abundance of which has statistically significantly declined (χ2, p=0,02) in the last few years in the area along the Dragonja River, is Tree Sparrow (*Passer montanus*). In the valley, this bird is closely attached to the environs of individual secluded farms. Quite sensible for monitoring the trends of this species would be a survey on ridges of the slopes above Dragonja Valley with the characteristic densely packed settlements.

Grassland species

A look at the numbers of grassland species' pairs is encouraging, although some oscillations are noticeable. The number of Wryneck and Green Woodpecker statistically significantly increased (χ2, p=0.02), while Corn Bunting decreased by one pair (from 16 to 15). Woodlarks numbers of pairs increased from 14 to 17 pairs (Fig. 5). Grassland species are otherwise considered one of the most endangered groups of birds in Slovenia (Kmecl *et al.*, 2014a, b).

Shrubland species

There are only two species in this group: Melodious Warbler and Sardinian Warbler (Fig. 6). We are dealing with them separately as shrubland species, given that they are distinctly attached to bush stands during the breeding season and do not look for food outside these stands (in contrast to, for example, Red-backed Shrike, which breeds in bushes from where it lurks for prey, after which it flies into more open landscape). The number of recorded singing Melodious Warbler males fell from the initial count in 1996/97 (50 pairs) to 38 pairs in 2015. Even greater statistically significant decline (χ2, p=0.02) was noted in Sardinian Warbler, which is here distinctly attached to breeding sites in the stands of Spanish Broom (*Spartium junceum*). The decline of Sardinian Warbler's abundance (11 pairs during the initial census, and only 3 pairs in 2015) can be associated with the increasingly smaller stands of this plant. In the past, people systematically grew Spanish Broom in Istria and used its stems for tying their products (M. Kaligarič, *pers. comm.*). Today, the plant is hardly still utilized for this purpose, and is not grown by farmers any longer. In the competition for space with other species, which are characteristic of the first phases of natural succession, the Spanish Broom is least successful. It seems, therefore, that the Sardinian

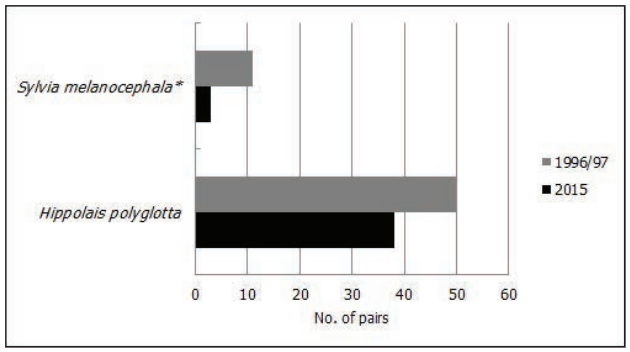

Fig. 6: Number of shrubland species pairs in 1996/97 (grey column) and 2015 (black column). Significance of Chi² test on the differences between 1996/97 and 2015 is marked with *: p = 0.02.
Sl. 6: Število parov grmovnih vrst v letih 1996/97 (sivi stolpiči) in 2015 (črni stolpiči). Statistično značilne razlike med leti 1996/97 in 2015 so bile izračunane s testom hi-kvadrat in so označene z *: p = 0,02.

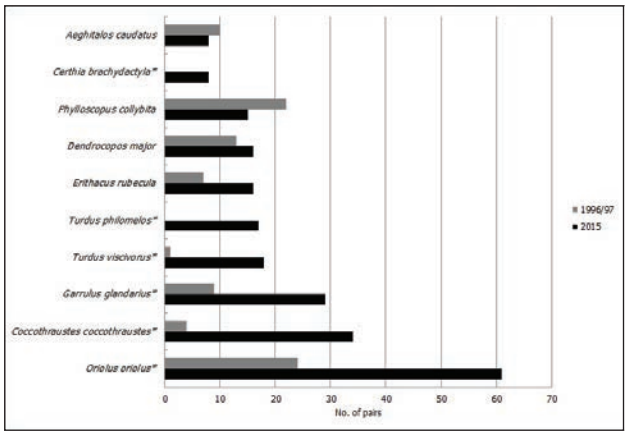

Fig. 7: Number of forest species pairs in 1996/97 (grey column) and 2015 (black column). Significance of Chi² test on the differences between 1996/97 and 2015 is marked with *: p = 0.02.
Sl. 7: Število parov gozdnih vrst v letih 1996/97 (sivi stolpiči) in 2015 (črni stolpiči). Statistično značilne razlike med leti 1996/97 in 2015 so bile izračunane s testom hi-kvadrat in so označene z *: p = 0,02.

Warbler is becoming increasingly rare in the Dragonja Valley for these very reasons.

Forest species

During the analysis of the number of registered species we wrote that forest species have predominated among new species in Dragonja Valley in the last decade and a half, particularly those that favour mature forest and are not attached to thick undergrowth characteristic of the early succession phases. A statistically significant increase ($\chi 2$, p=0.02) of abundance of other forest species is noticeable as well, including Jay, Golden Oriole, Mistle Thrush and – particularly in the last three years – Hawfinch (*Coccothraustes coccothraustes*) (Fig. 7). A similar increase in the number of this species has also been noted in the last year by I. Škornik (*pers. comm.*) in the section where the river drains into the sea. Among forest indicator species, the number of Chiffchaff (*Phylloscopus collybita*) pairs has decreased from 22 to 15. As the bird is not characteristic of dry and hot areas, it is more abundant mainly along the upper and somewhat colder parts of the Dragonja River. It would certainly be interesting to establish how the species reacts, in the area under consideration, to influences associated with climate change. In Slovenia as a whole, a moderate decline of this species has been noted (Kmecl *et al.*, 2014a). In comparison to similar study in the Southern France, where increase of woodland species due to rural abandonment and secondary succession was detected (Preiss *et al.*, 1997) the extent of woodland areas in the Dragonja valley is not increasing dramatically in the last time (Fig. 2), which enables favourable ecological conditions for both woodland and open habitat species.

CONCLUSIONS

The systematic survey of composition and abundance of birds in the Dragonja Valley, carried out in accordance with the comparable and recognized method in 1996/97, serves as initial situation for comparisons and identification of changes in bird fauna. This paper presents the results of the breeding bird census implemented in 2015.

The number of the registered birds' breeding pairs increased by 64% in the period from 1996/97 to 2015. The majority of new species are the characteristic representatives of forest birds, particularly those inhabiting mature forests. This is not surprising at all, considering that the Dragonja Valley has been for almost a century subjected to overgrowing of arable land owing to people leaving the area and abandonment of traditional land use. The extent of woodland areas in the Dragonja valley is not increasing dramatically in the last time, which enables favourable ecological conditions for both woodland and open habitat species. The species that reached the greatest degree of dominance remained the same throughout the observation period (Blackbird, Blackcap, Chaffinch). However, the degree of their dominance – with the exception of Blackbird – has changed to a certain extent. At the same time, the number of subdominant species has risen. Number of pairs increased also in the great majority of cultural landscape species, forest species and generalists. Among the species with large increase in their populations are elsewhere in Slovenia highly endangered species, such as Red-backed Shrike, Hoopoe, Wryneck, Green Woodpecker, Turtle Dove and others (Red List of

Breeding Birds of the Republic of Slovenia, 2002). Only a few species suffered a decline in their numbers, such as Sardinian Warbler, Melodious Warbler (both shrubland species), Tree Sparrow and Rock Bunting.

The obtained results show that the Dragonja Valley, where no extensive fragmentation has taken place, plays an exceptionally significant role in the preservation of the endangered bird species' populations.

It should thus be necessary to suitably protect the valley and to manage it as a nature reserve, where more effort would be invested in the preservation of conditions for the survival of endangered species and creation of conditions for stable populations of these bird species than to looking for opportunities for sustainable use and exploitation of natural resources. In practice this means that reckless and ambitious changing of current landscape image into an area of industrial production of crops, vegetables, vineyards and plantations with resulting changes in the manner of production (*e.g.* irrigation systems, fertilization, land consolidation, removal of hedgerows, early mowing, intensive grazing *etc.*) could have very similar negative consequences for the conservation of populations of most endangered bird species as would be imposed by industrial, infrastructural or urban land use in the valley.

ACKNOWLEDGEMENTS

In the 2015 survey, Dare Šere who conducted the first systematic bird survey in this valley, also took part. For his contribution, we wish to express our cordial thanks. Special thanks also to Primož Kmecl, for suggestions on the presentation of results and assistance in statistical evaluation of the results.

SPREMEMBE V SESTAVI IN ŠTEVILČNOSTI PTIČJIH VRST V DOLINI REKE DRAGONJE (JZ SLOVENIJA)

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POVZETEK

*V dolini reke Dragonje smo v letu 2015 opravili cenzus ptic gnezdilk in primerjali rezultate raziskave s cenzusom iz let 1996/97. V nasprotju z mnogimi drugimi naravnimi območji, ki so bila v zadnjih desetletjih fragmentirana ali povsem preoblikovana, beležimo na obravnavanem območju občutno povečanje skupnega števila gnezdečih parov glede na izhodiščno stanje. Vrste, ki dosegajo največjo stopnjo dominance, so skozi vso opazovalno obdobje enake (kos (*Turdus merula*), črnoglavka (*Sylvia atricapilla*), slavec (*Luscinia megarhynchos*), ščinkavec (*Fringilla coelebs*)). Ugotovljeno je bilo tudi več novih vrst, predvsem tistih, ki so značilne za zrele gozdove. Tudi pri veliki večini vrst kulturne krajine, pri gozdnih vrstah in generalistih je število parov naraslo v primerjavi z izhodiščnim letom. Zbrani rezultati kažejo, da ima dolina Dragonje izredno pomembno vlogo pri ohranjanju populacij ogroženih vrst ptic.*

Ključne besede: Dragonja, sub-Mediteran, cenzus ptic, varstvene usmeritve, spremembe rabe tal, sekundarna sukcesija

REFERENCES

DOPPS (2006): Strokovne podlage za določitev slovenskega indeksa ptic kmetijske krajine (Farmland Bird Index) in njegovo spremljanje – Končno poročilo. DOPPS, Ljubljana, 107 p.

DOPPS (2016): Atlas ptic. [http://atlas.ptice.si/atlas/index.php?r=site/page&view=about], 26/04/2016

Geister I. (1995): Ornitološki atlas Slovenije: razširjenost gnezdilk. DZS, Ljubljana, 287 p.

Globevnik, L. (1999): Analiza sprememb rabe tal, hidrološkega režima in erozijskih procesov v porečju Dragonje, Annales, Ser. hist. nat., 9, 51-62.

Globevnik, L., A. Sovinc & R. Fazarinc (1995): Erosion and Land Degradation of the Dragonja in Slovenian Mediterranean. In: Conference on Erosion and Land Degradation in the Mediterranean: International Geographical Union. Aveiro, Portugal, pp. 105-114.

Google (2015): Google maps. [https://www.google.si/maps], 04/12/2015.

Gregori, J. (1987): Pomen ptičev za naravovarstveno presojo doline Dragonje, Proteus, 49, 224-226.

Gregori, J. (2002): Ptiči doline Dragonje, njihove ekološke značilnosti in vprašanja varstva, Varstvo narave, 19, 77-88.

Gregorič, N. (2013): Spremembe favne ptic in ključnih habitatnih tipov med leti 1996/1997 in 2012 kot orodje za načrtovanje predlaganega Krajinskega parka Dragonja. UP FAMNIT, Koper, 37 pp.

Kaligarič, M. (1997): Rastlinstvo Primorskega krasa in Slovenske Istre: travniki in pašniki. Zgodovinsko društvo za južno Primorsko, Koper, 111 p.

Kmecl, P., J. Figelj & T. Jančar (2014a): Monitoring splošno razširjenih vrst ptic za določitev slovenskega indeksa ptic kmetijske krajine - poročilo za leto 2014. DOPPS, Ljubljana, 269 p.

Kmecl, P., T. Jančar & T. Mihelič (2014b): Spremembe v avifavni Kozjanskega parka med letoma 1999 in 2010: velik upad števila travniških ptic. Acrocephalus, 35, 125-138.

Križan, B. (2002): Naravna in kulturna dediščina doline Dragonje, Varstvo narave 19, 9-41.

Ogrin, D. (1995): Podnebje Slovenske Istre. Zgodovinsko društvo za južno Primorsko, Koper, 381 p.

Orožen-Adamič, M. O. (1979): Geografske značilnosti poplavnega sveta ob Dragonji in Drnici. Geografski zbornik XIX, 1979.

Preiss, E., J.-L. Martin & M. Debussche (1997): Rural depopulation and recent landscape changes in a Mediterranean region: Consequences to the breeding avifauna, Landscape Ecology 12, 51-61.

Rdeči seznam ptičev gnezdilcev Republike Slovenije (2002): Uradni list Republike Slovenije, št. 82/2002, p. 8893. [https://www.uradni-list.si/1/content?id=38615], 18/1/2016.

Senič, M. (2015): Vpliv plenilcev na gnezdeče populacije male (*Sternula albifrons*) in navadne (*Sterna hirundo*) čigre v Krajinskem parku Sečoveljske soline. UP FAMNIT, Koper, 58 pp.

Sovinc, A. (1998): Ptice doline Dragonje – deset let kasneje, Annales, Ser. hist. nat., 13, 81-90.

Tarman, K. (1992): Osnove ekologije in ekologija živali. Državna založba Slovenije, Ljubljana, 547 p.

Tome, D. (2006): Ekologija: Organizmi v prostoru in času. Tehniška založba Slovenije, Ljubljana, 344 p.

Wraber, M. (1969): Pflanzengeographische Stellung und Gliederung Sloweniens, Vegetatio 17, 176-199.

Wraber, T. (2002): Rastlinski svet doline Dragonje v naravovarstvenem pogledu, Varstvo narave 19, 43-51.

Appendix 1: List of surveyed bird species and numbers of their pairs in 1996/97 and 2015, comparison of number of pairs between 1996/97 and 2015 by a Chi² test (p = 0.02), Index POV and degree of dominance in 1996/97 and 2015.

Priloga 1: Seznam opaženih vrst ptic in število njihovih parov v letih 1996/97 in 2015, primerjava med pari v letih 1996/97 in 2015 z uporabo testa hi-kvadrat (p = 0,02) ter indeks POV in stopnja dominance v omenjenih letih.

Serial No.	English name	Latin name	No. of pairs		Chi² test	Index POV		Degree of dominance (%)	
			1996/97	2015		1996/97	2015	1996/97	2015
1	Barn Swallow	*Hirundo rustica*	7	21	0.0082	100	300	0.9	1.7
2	Bee-eater	*Merops apiaster*	0	7*				0.0	0.6
3	Black Woodpecker	*Dryocopus martius*	0	2	0.1573			0.0	0.2
4	Blackbird	*Turdus merula*	68	126	0.0000	100	185	9.0	9.9
5	Blackcap	*Sylvia atricapilla*	81	92	0.4030	100	114	10.7	7.2
6	Blue Tit	*Cyanistes caeruleus*	19	34	0.0394	100	179	2.5	2.7
7	Calandra Lark	*Melanocorypha calandra*	0	2*				0.0	0.2
8	Cetti's Warbler	*Cettia cetti*	8	1	0.0196	100	12	1.1	0.1
9	Chaffinch	*Fringilla coelebs*	64	75	0.3508	100	117	8.5	5.9
10	Chiffchaff	*Phylloscopus collybita*	22	15	0.2498	100	68	2.9	1.2
11	Cirl Bunting	*Emberiza cirlus*	32	46	0.1129	100	144	4.2	3.6
12	Collared Dove	*Streptopelia decaocto*	1	0	0.3173	100	0	0.1	0.0
13	Common Buzzard	*Buteo buteo*	6	6	1.0000	100	100	0.8	0.5
14	Corn Bunting	*Miliaria calandra*	16	15	0.8575	100	94	2.1	1.2
15	Cuckoo	*Cuculus canorus*	13	41	0.0001	100	315	1.7	3.2
16	Fan-tailed Warbler	*Cisticola juncidis*	0	2	0.1573			0.0	0.2
17	Golden Oriole	*Oriolus oriolus*	24	61	0.0001	100	254	3.2	4.8
18	Goldfinch	*Carduelis carduelis*	7	12	0.2513	100	171	0.9	0.9
19	Goshawk	*Accipiter gentilis*	1	0	0.3173			0.1	0.0
20	Great Reed Warbler	*Acrocephalus arundinaceus*	0	1	0.3173			0.0	0.1
21	Great Spotted Woodpecker	*Dendrocopos major*	13	16	0.5775	100	123	1.7	1.3
22	Great Tit	*Parus major*	39	61	0.0278	100	156	5.2	4.8
23	Green Woodpecker	*Picus viridis*	1	9	0.0114	100	900	0.1	0.7
24	Greenfinch	*Chloris chloris*	15	32	0.0131	100	213	1.9	2.5
25	Grey Wagtail	*Motacilla cinerea*	2	5	0.2568	100	250	0.3	0.4
26	Grey-headed woodpecker	*Picus canus*	0	1	0.3173			0.0	0.1
27	Hawfinch	*Coccothraustes coccothraustes*	4	34	0.0000	100	850	0.5	2.7
28	Hobby	*Falco subbuteo*	0	1*				0.0	0.1
29	Hooded Crow	*Corvus cornix*	1*	0				0.1	0.0
30	Hoopoe	*Upupa epops*	1	18	0.0001	100	1800	0.1	1.4
31	House Sparrow	*Passer domesticus*	16	20	0.5050	100	125	2.1	1.6
32	Jay	*Garrulus glandarius*	9	29	0.0012	100	322	1.2	2.3

33	Kingfisher	*Alcedo atthis*	0	2*				0.0	0.2
34	Lesser Spotted Woodpecker	*Dendrocopos minor*	0	1	0.3173			0.0	0.1
35	Long-tailed Tit	*Aeghitalos caudatus*	10	8	0.6374	100	80	1.3	0.6
36	Magpie	*Pica pica*	1	1	1.0000	100	100	0.1	0.1
37	Mallard	*Anas platyrhynchos*	0	7	0.0082			0.0	0.6
38	Marsh Tit	*Poecile palustris*	0	1	0.3173			0.0	0.1
39	Melodious Warbler	*Hippolais polyglotta*	50	38	0.2008	100	76	6.6	3.0
40	Mistle Thrush	*Turdus viscivorus*	1	18	0.0001	100	1800	0.1	1.4
41	Nightingale	*Luscinia megarhynchos*	73	82	0.4697	100	112	9.7	6.5
42	Nightjar	*Caprimulgus europaeus*	0	1	0.3173			0.0	0.1
43	Nuthatch	*Sitta europaea*	0	2	0.1573			0.0	0.2
44	Pheasant	*Phasanius colchicus*	9	38	0.0000	100	422	1.2	3.0
45	Pied Wagtail	*Motacilla alba*	1	29	0.0000	100	2900	0.1	2.3
46	Raven	*Corvus corax*	0	1	0.3173			0.0	0.1
47	Red-backed Shrike	*Lanuis collurio*	10	43	0.0000	100	430	1.3	3.4
48	Robin	*Erithacus rubecula*	7	16	0.0606	100	229	0.9	1.3
49	Rock Bunting	*Emberiza cia*	8	0	0.0047	100	0	1.1	0.0
50	Sardinian Warbler	*Sylvia melanocephala*	11	3	0.0325	100	27	1.5	0.2
51	Serin	*Serinus serinus*	20	22	0.7576	100	110	2.6	1.7
52	Short-toed Treecreeper	*Certhia brachydactyla*	0	8	0.0047			0.0	0.6
53	Song Thrush	*Turdus philomelos*	0	17	0.0000			0.0	1.3
54	Spanish Sparrow	*Passer hispaniolensis*	0	1	0.3173			0.0	0.1
55	Sparrowhawk	*Accipiter nisus*	1	1	1.0000	100	100	0.1	0.1
56	Spotted Flycatcher	*Muscicapa striata*	3	9	0.0833	100	300	0.4	0.7
57	Starling	*Sturnus vulgaris*	3	25	0.0000	100	833	0.4	1.9
58	Swift	*Apus apus*	7	7	1.0000	100	100	0.9	0.6
59	Tawny Owl	*Strix aluco*	0	1	0.3173			0.0	0.1
60	Tree Sparrow	*Passer montanus*	17	1	0.0002	100	6	2.2	0.1
61	Turtle Dove	*Streptopelia turtur*	27	47	0.0201	100	174	3.6	3.7
62	Whinchat	*Saxicola rubetra*	0	1*				0.0	0.1
63	Whitethroat	*Sylvia communis*	10	7	0.4669	100	70	1.3	0.6
64	Woodlark	*Lullula arborea*	14	17	0.5900	100	121	1.9	1.3
65	Woodpigeon	*Columba palumbus*	0	9	0.0027			0.0	0.7
66	Wryneck	*Jynx torquilla*	4	21	0.0007	100	525	0.5	1.7
67	Yellow Wagtail	*Motacilla flava*	0	1*				0.0	0.1
	No. of species		**46**	**63**					
	No. of breeders		**45**	**57**					
	No. of breeding pairs		**755**	**1243**					
	*Species does not breed								

SREDOZEMSKE KUKAVIČEVKE

ORCHIDEE MEDITERRANEE

MEDITERRANEAN ORCHIDS

saggio scientifico originale
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LE ORCHIDACEAE DELLA PROVINCIA DELL'AQUILA

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SINTESI

La "Provincia" dell'Aquila fa parte della regione Abruzzo. Nel suo territorio vi è un'elevata diversità floristica che comprende circa 2300-2500, taxa di piante vascolari. In quest'articolo, considerando gli studi condotti, le ricerche sul campo dell'autore e inedite di altri studiosi, è stato compilato un primo elenco di tutte le Orchidaceae presenti, seguito dall'analisi cronologica che mostra una lieve maggioranza del contingente Mediterraneo. Nell'elenco floristico sono riportati 86 taxa di cui 16 endemici o subendemici e 7 al limite della loro areale di distribuzione. I dati riportati confermano l'importanza naturalistica del territorio.

Parole chiave: Provincia dell'Aquila, Orchidaceae, check-list locale, elementi floristici

THE ORCHID FLORA OF THE PROVINCE OF L'AQUILA (ABRUZZO)

ABSTRACT

The Province of L'Aquila is part of the Abruzzo Region. It features a high floristic diversity comprising 2,300-2,500 taxa of vascular plants. Based on the studies conducted so far, the author's field research and unpublished reports by other researchers, the article presents a preliminary list of all Orchidaceae recorded in the area, followed by a chorological analysis, which shows a slight majority of the Mediterranean contingent. The checklist reports 86 taxa. A total of 16 entities are endemic or subendemic and 7 taxa are present at the limit of their distribution range. This data contributes to confirm the environmental importance of the area.

Keywords: Province of L'Aquila, Orchidaceae, local orchid check-list, floristic contingents.

INTRODUZIONE

Con il presente articolo si vuole compilare una Checklist aggiornata delle *Orchidaceae* segnalate nell'ambito oggetto di studio tenendo conto delle novità tassonomiche e nomenclaturali per ricavarne approfondimenti di carattere quantitativo e qualitativo.

Inquadramento dell'area d'indagine

Il territorio della Provincia dell'Aquila comprende una superficie di 5.035 km², non ha sbocchi sul mare ed è la meno popolata, più montuosa ed estesa tra le province abruzzesi. Esso è caratterizzato da vari massici montuosi che si dispiegano da NE a SO lungo tre direttrici più o meno parallele. Tra loro, a diversa altitudine, si sviluppano conche interne e bacini lacustri pleistocenici molto importanti per l'economia locale: la Valle Peligna, la Conca Aquilana, la Conca del Fucino, l'Altipiano delle Rocche e gli Altipiani Maggiori.

Il clima

A causa della presenza dei massicci più alti di tutto l'Appennino, del loro particolare orientamento e di altri fattori di dettaglio che possono ostacolare o favorire la circolazione delle masse d'aria più o meno umide e variare la durata e intensità dell'esposizione solare, si registrano varie tipologie climatiche.

La distribuzione delle precipitazioni è molto variabile. Infatti, oscilla da circa 600-700 mm nella valle peligna e nelle conche del Fucino e aquilana a oltre 1500 nei monti esposti ai venti umidi occidentali posti al confine con il Lazio e il Molise. Abbondante è anche la copertura nevosa che nell'Altopiano di Campo Imperatore può durare sino a otto mesi.

Per quanto riguarda le temperature si hanno diversi andamenti dei parametri termici in cui i valori minimi si registrano a Campo Imperatore (Baldoni *et al.*, 1999) mentre quelli massimi a Sulmona (Pirone *et al.*, 1997). A tal proposito si osserva quanto segue:

- le temperature medie annue oscillano fra 3,7°C e 13,74°C;
- la media delle temperature massime è compresa tra 6,4°C e 19,03°C;
- la media delle temperature minime è compresa tra 0,9°C e 8,4°C;
- i valori assoluti massimi e minimi registrati nell'area sono compresi tra +40°C registrato all'Aquila e -29.7°C registrato la notte del 21 gennaio 2016 a Rivisondoli.

Tenendo conto dei particolari andamenti dei parametri termopluviometrici sono individuabili diverse zone climatiche. In particolare, Tomaselli (1973) rileva:

- una zona a clima temperato definita ipomesaxerica che caratterizza le parti più basse della valle Peligna, la Conca aquilana e la piana del Fucino;
- una zona axerica fredda situata posta tra le quote di 900-1200 metri d'altitudine;
- una sottoregione temperato-fredda situata ad altitudini maggiori;
- una sottoregione molto fredda che caratterizza le principali vette dei massicci montuosi oltre 2000-2200 metri d'altitudine.

Flora e vegetazione

La bassa densità di popolazione, la presenza di aree incolte, la rilevante escursione altimetrica e le varietà microclimatiche, geomorfologiche e pedologiche portano alla formazione di habitat diversi e di grande interesse naturalistico in cui si sviluppano forme di vita vegetale e animale caratterizzate da entità rare. Per questi motivi parte del territorio provinciale è compreso: nel Parco regionale del Sirente-Velino; nei tre Parchi Nazionali della Majella, del Gran Sasso e Monti della Laga e, d'Abruzzo, Lazio e Molise; nelle riserve naturali di Zompo lo Schioppo, del Lago di Campotosto, delle Grotte di Pietrasecca, delle Gole di San Venanzio, del Monte Salviano e, del Monte Genzana e alto Gizio. Nel complesso le aree protette esclusive della Provincia ammontano a circa 13068 ha cui devono aggiungersi quelle dei tre Parchi Nazionali compresi anche in altre Province e/o Regioni.

Le formazioni vegetali sono anche il risultato dei modi con cui da tempi lontani si è esercitata l'attività dell'uomo. Infatti, da diversi millenni si sono esercitate l'agricoltura e la pastorizia che hanno portato alla riduzione dei boschi e a un incremento delle aree pascolative. Ora con la minor pressione antropica e delle greggi qua e là si stanno riformando stadi di vegetazione prenemorale e lentamente le essenze arboree ritornano a occupare i territori anticamente perduti.

La penetrazione di aria calda attraverso la valle dell'Aterno-Pescara consente a elementi floristici mediterraneo-termofili di attecchire in ambiti in cui per clima e posizione geografica ne dovrebbero esserne privi. In vari casi la vegetazione mediterranea di queste aree assume l'aspetto sia di macchia tipica sia di psuedomacchia e cioè di bosco impoverito da alcune screlofille che sono sostituite da essenze caducifoglie.

La vegetazione forestale, inizia a svilupparsi attorno a 600 metri d'altitudine con i querceti misti più o meno degradati che da 1000 a 1800-1900 metri sono sostituti dalle faggete. A tali fasce altitudinali si rinvengono anche prati-pascolo secondari e lembi di pseudogariche.

Sopra la faggeta, nell'Appennino Centrale, manca un vero e proprio orizzonte degli arbusti ma in vari gruppi montuosi dell'aquilano si rinvengono piccole formazioni con salici nani, rododendri, pino mugo, conifere prostrate e altro. Sopra questi arbusteti altomontani, e considerata anche la loro piccola diffusione, anche al disopra delle faggete si rinvengono varie tipologie di prati-pascolo (festuceti-trifoglieti, seslerieti, brachipo-

dieti) e formazioni tipiche di ambienti glaericoli e rocciosi.

Dalle quote più basse sino ai prati pascoli altitudinali, le *Orchidaceae* concorrono alla composizione floristica delle formazioni vegetali e con la loro bellezza e particolarità contribuiscono ad accrescere l'importanza e il valore naturalistico degli ambiti in cui sono presenti.

Per quanto riguarda la flora, allo stato attuale, non si sa l'esatta consistenza numerica del patrimonio floristico dell'intero territorio provinciale ma solo di alcune sue parti e spesso gli studi effettuati riguardano massicci montuosi e parchi naturali estesi anche in altre province dell'Abruzzo e regioni confinanti. Prima di fare una stima più o meno attendibile si riportano alcuni dati di ricerche sinora pubblicate.

Nel territorio del Parco Nazionale d'Abruzzo, Lazio e Molise sono presenti 2110 entità distinte in specie e sottospecie (Conti & Bartolucci, 2015).

La flora del Parco Nazionale della Majella che comprende anche Comuni appartenenti alle Province di Chieti e Pescara annovera 2114 entità (Conti & Tinti 2006) cui sono da aggiungere diverse altre segnalate in seguito.

La flora del Parco Regionale Sirente-Velino annovera 1650 taxa (Pirone *et al*., 2007).

Alla composizione del paesaggio vegetale di Rivisondoli concorrono 870 entità (Pirone, 1997).

Nel Parco Nazionale del Gran Sasso e Monti della Laga che comprende anche Comuni appartenenti alle Province di Rieti, Pescara e Teramo, sono presenti 2642 entità di piante vascolari distinte in specie e sottospecie, compresi 33 ibridi. (Conti & Bartolucci, 2016).

Tenendo conto dei dati sopra riportati e del fatto che entità presenti in un'area, sono assenti altrove, il patrimonio floristico provinciale si presume possa essere composto da 2300-2500 taxa, un numero considerevole che rappresenta il 70-75% della flora abruzzese.

Le ricerche floristiche sulle orchidee della provincia aquilana

Allo stato attuale non è stato pubblicato un lavoro specifico sulle orchidee della zona, nonostante i numerosi studi effettuati. Infatti, nel territorio provinciale le esplorazioni botaniche di una certa importanza iniziarono nel XIX secolo con Tenore (1811-1838) e continuarono con altri studiosi tra cui: Gravina (1812), Brocchi (1822), Gussone (1826), Mauri *et al*. (1830), Tenore & Gussone (1842), Marchesetti (1875), Groves (1880), Nardelli (1883), Crugnola (1894) e Falqui (1899).

Per quanto riguarda le *Orchidaceae*, gli studi monografici sull'intera regione allo stato attuale sono quattro (Lastoria, 1988; Conti & Pellegrini, 1990; Colella *et al*., 2011; Pezzetta, 2013). A essi vanno aggiunte pubblicazioni specifiche che segnalano vari ritrovamenti che hanno contribuito a incrementare il patrimonio orchidologico regionale.

Materiali e metodi

L'elenco floristico è stato realizzato tenendo conto delle ricerche sul campo dell'autore condotte a intervalli più o meno regolari nel corso di oltre un decennio, delle segnalazioni inedite di vari studiosi e dei dati ricavati dalle consultazioni bibliografiche. Esso comprende le specie, le sottospecie e gli ibridi mentre non sono state prese in considerazione le varietà cromatiche e morfologiche. Non sono stati considerati e riesaminati i materiali d'erbario.

Per la nomenclatura dei vari taxa si sono seguite le indicazioni riportate nel recente volume del GIROS (2009) e nel saggio di Biagioli *et al.* (2015). Per la loro determinazione si sono utilizzati i testi di Delforge (2005), GIROS (2009) e Romolini & Souche (2012).

Per l'assegnazione dei tipi corologici si è tenuto conto di quanto riportato in Pignatti (1982) e Pezzetta (2011). Inoltre per alcune entità, tenendo conto delle nuove segnalazioni e dell'attuale distribuzione geografica, si è operata una ridefinizione del corotipo di appartenenza.

A causa della vastità degli studi botanici riguardanti la flora abruzzese, si è deciso di considerare quale punto di partenza il saggio di Baumann e Baumann (1988) in cui si descrivono due ibridi non ripresi in quelli successivi e gli altri dati alla stampa dopo il 1990, anno in cui Conti & Pellegrini pubblicarono una monografia sulle orchidee regionali. Inoltre si è deciso di scegliere in caso di più pubblicazioni di un autore per lo stesso territorio e/o riassuntive, quelle più recenti.

Nell'indicazione delle località sono state riportate sia le indicazioni generiche riguardanti il territorio di un parco, di un gruppo montuoso, di un altipiano e altro che quelle delle singole località o altre parti che ricadono negli stessi ambiti.

RISULTATI E DISCUSSIONE

Elenco florisitico

Nell'elenco floristico per ogni taxon sono elencati i siti di ritrovamento, preceduti fra parentesi dai nomi degli autori delle segnalazioni abbreviati con le seguenti sigle:

!: osservazione diretta dell'autore; A: Baumann e Baumann, 1988; AH: Conti & Pellegrini, 1990; AX: Luchese & Lattanzi, 1991; AY: Pedrotti *et al*., 1992; B: Petriccione, 1993; BH: Conti, 1993; BX: Conti, 1995; CY: Abbate *et al*., 1996; C: Daiss & Daiss, 1996; CX: Frizzi *et al*., 1996; D: Guarrera & Tammaro, 1996; DX: Betti, 1997; E: Pirone, 1997; EX: Pirone *et al*., 1997; F: Conti, 1998; FX: Tammaro, 1998; FY: Ballelli, 1999; G: Biondi *et al*., 1999; GX: Hennecke & Hennecke, 1999; H: Di Pede, 2001; HF: Di Bartolomeo *et al*., 2002; HL: Abbate *et al*., 2003; HN: Bongiorni *et al*., 2006; HP: Conti *et al*., 2006; HR: Hertel & Presser, 2006; HX: Conti &

Tinti, 2008; HY: Conti *et al*., 2008; I: Galetti, 2008; IH: Imprescia & Picone, 2008; IL: Rempicci *et al*., 2008; IN: Rossi *et al*., 2008; IW: Soca, 2008; IX: Souche, 2008; IY: Conti & Tinti 2009; IW: Faurholdt 2009; IZ: Hertel & Presser 2009; L: Griebl 2010; LX: Pirone *et al*., 2010; M: Colella *et al*., 2011; MX: Paris & Scivola, 2011; N: Romolini & Soca, 2011a; NX: Romolini & Soca, 2011b; O: Allasia, 2012; OX: Conti & Tinti, 2012; OY: Gransinigh *et al*., 2012; P: Rempicci *et al*., 2012; PX: Romolini & Souche, 2012; Q: Petrucci, 2013; QX: Pezzetta, 2013; QJ: Bongiorni *et al*., 2014, QY: Soca, 2014; QW: Brunamonte *et al*., 2015; R: Conti & Bartolucci, 2015; RH: Hertel & Presser, 2015; RX: Pezzetta, 2015; RY: Soca, 2015; SH: Conti & Bartolucci, 2016; SX: Lastoria informazione personale; SY: Nicolai informazione personale; T: Soca (Souche) informazione personale; TX: Tandè informazione personale; TY: Muller informazione personale.

1. *Anacamptis coriophora* subsp. *fragrans* (Pollini) R.M. Bateman, Pridgeon & M.W. Chase – Eurimediterraneo. (!, AX, C, D, F, M, QX, SY). Aielli, Alfedena, Campo Felice, Canistro, Capistrello, Cappadocia, Capitignano, Castellafiume, Lucoli, Massa d'Albe, Monte Sirente, Ovindoli, Pacentro, Pescina.
2. *Anacamptis laxiflora (*Lam.) R.M. Bateman, Pridgeon & M.W. Chase – Eurimediterraneo. (C, D, F, H, QW, S). Alfedena, Barrea, Cappadocia, Monte Sirente, Monte Velino, Ortona dei Marsi, Roccaraso, Valle Roveto.
3. *Anacamptis morio* (L.) R.M. Bateman, Pridgeon & M.W. Chase – Europeo-Caucasico. (!, B, BX, C, CX, D, E, EX, FX, GX, H, HF, HX, IW, L, M, MX, NX, OX, Q, QX, QW, RX, RY, SX, SY, TX, TY). Alfedena, Assergi (L'Aquila), Ateleta, Avezzano, Barisciano, Barrea, Bominaco, Cagnano Amiterno, Calascio, Camosciara (Civitella Alfedena), Campo di Giove, Campo Felice, Campo Imperatore, Campotosto, Canistro, Capestrano, Capitignano, Cappadocia, Carsoli, Castel del Monte, Castel di Sangro, Castelvecchio Calvisio, Castelvecchio Subequo, Cocullo, Collarmele, Collelongo, Collepietro, Forca d'Acero, Gioia dei Marsi, Gole del Sagittario (Anversa degli Abruzzi), Gole di Celano, Introdacqua, L'Aquila, Lucoli, Magliano dei Marsi, Massa d'Albe, Montereale, Monte Sirente, Monte Velino, Morino, Ocre, Opi, Ortona dei Marsi, Pacentro, Passo del Diavolo, Pescina, Pescocostanzo, Pettorano sul Gizio, Pietransieri, Pizzoli, Pratola Peligna, Raiano, Rivisondoli, Roccacinquemiglia, Rocca Pia, Roccaraso, San Benedetto in Perillis, Santo Stefano di Sessanio, Scontrone, Scurcola Marsicana, Sulmona, Tagliacozzo, Tornimparte, Trasacco, Valle Roveto, Villalago, Villa Santa Lucia, Villavallelonga, Villetta Barrea.
4. *Anacamptis papilionacea* (L.) R.M. Bateman, Pridgeon & M.W. Chase – Eurimediterraneo. (!, HF, RX, SX, SY, TY). Cansano, Capitignano, Collepietro, Introdacqua, Montereale, Morino, Navelli, Raiano, Rocca Pia.
5. *Anacamptis pyramidalis* (L.) Rich. – Eurimediterraneo. (!, B, BX, C, D, E, GX, H, IY, L, NX, Q, RX, RY, SY). Alfedena, Ateleta, Assergi, Barisciano Bisegna, Cagnano Amiterno, Campo di Giove, Campo Felice, Campotosto, Canistro, Capitignano, Capistrello, Carsoli, Castel di Sangro, L'Aquila, Massa d'Albe, Monte Sirente, Monte Velino, Morino, Opi, Ortona dei Marsi, Ovindoli, Pacentro, Paganica, Passo del Diavolo, Passo Godi, Pescina, Pettorano sul Gizio, Pietransieri, Pizzoli, Pratola Peligna, Raiano, Rivisondoli, Rocca di Cambio, Rocca di Mezzo, Roccaraso, Scontrone, Tagliacozzo, Valle Roveto, Villa Santa Lucia, Villetta Barrea.
6. *Cephalanthera damasonium* (Mill.) Druce – Eurimediterraneo. (!, AX, B, BX, C, DX, E, EX, FX, G, GX, H, HF, HL, IY, L, LX, M, OX, OY, P, Q, QX, RX, RY, SY, TX). Alfedena, Avezzano, Barisciano, Barrea, Camosciara (Civitella Alfedena), Campo Felice, Campo di Giove, Campo Imperatore, Campotosto, Canistro, Capestrano, Caporciano, Carsoli, Cocullo, Collepietro, Fonte Cerreto (Assergi), Forca d'Acero, Gioia dei Marsi, Gole del Sagittario (Anversa degli Abruzzi), Introdacqua, Magliano dei Marsi, Massa d'Albe, Montereale, Monte Velino, Morino, Navelli, Ortona dei Marsi, Passo delle Capannelle (Pizzoli), Pescasseroli, Pettorano sul Gizio, Raiano, Rivisondoli, Rocca di Mezzo, Roccaraso, San Benedetto in Perillis, Santo Stefano di Sessanio, Scanno, Serra Lunga (Collelongo), Valle Peligna, Valle Roveto, Villavallelonga, Villetta Barrea.
7. *Cephalanthera longifolia* (L.) Fritsch – Eurasiatico. (! AX, B, BX, C, D, E, EX, FX, G, GX, H, Pirone & Manzi 2003, HX, LX, QX, RX). Alfedena, Avezzano, Campo di Giove, Campo Imperatore, Campotosto, Capestrano, Carsoli, Civitella Alfedena, Forca d'Acero, Macchia Grande (Assergi), Molinia Aterno, Montereale, Monte Sirente, Monte Velino, Morino, Opi, Pacentro, Passo Godi, Passo delle Capannelle (Pizzoli), Pescasseroli, Pettorano sul Gizio, Rivisondoli, Scontrone, Serra Lunga (Collelongo), Tornimparte, Val Fondillo (Opi), Valle Peligna, Valle Roveto, Villa Santa Lucia, Villavallelonga, Villetta Barrea.
8. *Cephalanthera rubra* (L.) Rich. – Eurasiatico (!, AX, B, BX, C, D, DX, E, FX, HL, M, O, OX, QX, RX, SY) Alfedena, Altipiani Maggiori, Assergi, Barisciano, Barrea, Camosciara (Civitella Alfedena), Campo di Giove, Campo Felice, Campo Imperatore, Capitignano, Gole del Sagittario (Anversa degli Abruzzi), Monte Sirente, Monte

Velino, Pacentro, Pettorano sul Gizio, Piani di Pezza (Rocca di Mezzo), Scanno, Serra Lunga (Collelongo), Valle Roveto.

9. *Coeloglossum viride* (L.) Hartm. – Circumboreale. (!, AX, B, BX, C, E, FX, G, HX, L, M, O, Q, QX, RX, SY). Altipiani Maggiori, Barrea, Campo di Giove, Campo Imperatore, Campotosto, Capitignano, Monte Aquila, Monte Camicia, Monte Cornacchia (Villavallelonga), Monte Velino, Opi , Passo Godi, Rivisondoli, Roccaraso, Scontrone, Valle Roveto, Villetta Barrea.
10. *Corallorhiza trifida* Chatel. – Circumboreale. (AH, B, BX, C, DX, E, FX, GX, HF, M, RX). Altipiani Maggiori, Camosciara (Civitella Alfedena), Campo di Giove, Capistrello, Monte Cappucciata (Castel del Monte), Lucoli, Monte Sirente, Monte Velino, Morino, Opi, Pizzalto (Pescocostanzo), Scanno, Scontrone, Serra Lunga (Collelongo), Villavallelonga, Villetta Barrea.
11. *Cypripedium calceolus* L. – Eurosiberiano. (AH, BX, C, F, FX, I, R). Camosciara (Civitella Alfedena), Val Fondillo (Opi) (Fig. 1).
12. *Dactylorhiza incarnata* (L.) Soó – Eurosiberiano. (AH, AY, BX, C, DX, E, F, FX, HX, Q, QX, RX, T, TX). Alfedena, Altipiani Maggiori, Barrea, Campo di Giove, Campo Imperatore, Campotosto, Capitignano, Cappadocia, Gioia dei Marsi, La Brionna (Castel di Sangro), Monte Sirente, Ovindoli, Passo Godi, Pescocostanzo, Pescasseroli, Pizzoli, Rivisondoli, Val Fondillo (Opi), Valle Roveto, Villetta Barrea (Fig. 2).
13. *Dactylorhiza maculata* subsp. *fuchsii* (Druce) Hyl . – Eurasiatico (D, DX, HX, Q). Alfedena, Barrea, Camosciara (Civitella Alfedena), Campotosto, Cappadocia, Carsoli, Monte Sirente, Pettorano sul Gizio, Rivisondoli.
14. *Dactylorhiza maculata* subsp. *saccifera* (Brongn.) Diklić – Paleotemperato. (!, C, DX, GX, HF, L, OX, QX, RX, T). Alfedena, Campo di Giove, Campo Imperatore, Campotosto, Canistro, Capistrello, Capitignano, Cappadocia, Castel di Sangro, Gole del Sagittario (Anversa degli Abruzzi), Gioia dei Marsi, L'Aquila, Montereale, Morino, Ovindoli, Passo Godi, Pietransieri, Roccaraso, Tagliacozzo, Villetta Barrea.
15. *Dactylorhiza romana* (Sebast.) Soó – Stenomediterraneo. (GX, QX) Campo di Giove.
16. *Dactylorhiza sambucina* (L.) Soó – Europeo (!, B, BX, C, D, E, FX, FY, G, GX, HF, HX, L, M, O, OX, Q, QX, RX, RY, SX, SY, TX). Altipiani Maggiori, Ateleta, Barrea, Campo di Giove, Campo Imperatore, Castel del Monte, Campotosto, Capitignano, Gioia dei Marsi, Gole del Sagittario (Anversa degli Abruzzi), L'Aquila, Magliano dei Marsi, Monte Camicia, Monte Prena, Monte Sirente, Monte Velino, Morino, Ovindoli, Passo del Diavolo, Passo Godi, Passo San Leonardo (Pacentro), Pescocostanzo, Pettorano sul Gizio, Piani di Pezza (Rocca di Mezzo) , Pizzoli, Rivisondoli, Rocca di Cambio, Roccaraso, Santo Stefano di Sessanio, Scanno, Scontrone, Tornimparte, Sella Monte Aquila, Valico Capo le Serre (Castel del Monte), Valle Roveto, Villavallelonga, Villa Santa Lucia.
17. *Epipactis atrorubens* (Hoffm.) Besser – Europeo. (!, B, BX, C, GX, L, LX, M, QX, RX). Alfedena, Barrea, Camosciara (Civitella Alfedena), Campo di Giove, Campo Felice, Campo Imperatore, Fonte Cerreto (Assergi), Massa d'Albe, Monte Cappucciata (Castel del Monte), Monte Velino, Monte Zurrone (Roccaraso), Pacentro, Passo Godi, Rocca di Mezzo, Santo Stefano di Sessanio, Tagliacozzo, Villa Santa Lucia, Villavallelonga, Villetta Barrea.
18. *Epipactis helleborine* subsp. *helleborine* (L.) Crantz – Paleotemperato. (!, AX, B, BX, BY, C, CX, D, E, FX, G, HF, HX, HL, LX, M, OX, P, QX, RX, SY). Alfedena, Altipiani Maggiori, Assergi, Avezzano, Barrea, Bisegna, Bosco S. Antonio (Pescocostanzo), Campo di Giove, Campo Felice, Campo Imperatore, Campotosto, Capestrano, Capitignano, Carsoli, Gioia dei Marsi, Gole del Sagittario (Anversa degli Abruzzi), Gole di Celano, Monte Sirente, Monte Velino, Monte Zurrone (Roccaraso), Monte Pettino (L'Aquila), Morino, Ofena, Pettorano sul Gizio, Raiano, Rivisondoli, Rocca di Mezzo, Santo Stefano di Sessanio, Scanno, Serra Lunga (Collelongo), Valle Roveto, Villetta Barrea.
19. *Epipactis helleborine* subsp. *latina* W. Rossi & E. Klein – Subendemico. (A, BH, F, QJ, R, RX). Alfedena, Anversa degli Abruzzi, Avezzano, Barrea, Castel del Monte, Gioia dei Marsi, Opi, Pacentro, Pizzoli, Santo Stefano di Sessanio, Villa Santa Lucia, Villetta Barrea.
20. *Epipactis helleborine* (L.) Crantz subsp. *orbicularis* (K. Richt.) E. Klein. – Centro-Europeo. (OX, R). Gole del Sagittario (Anversa degli Abruzzi).
21. *Epipactis leptochila* subsp. *leptochila* (Godfery) Godfery – Centro-Europeo. (BX, F, M). Prato Lonaro (Lucoli), Val Fondillo (Opi).
22. *Epipactis lucana* H. Presser, S. Hertel & V. A. Romano – Endemico. (RH). Campo di Giove.
23. *Epipactis microphylla* (Ehrh.) Sw. – Europeo-Caucasico (!, BX, D, FX, H, HX, L, QX, RX). Alfedena, Ateleta, Avezzano, Barrea, Campotosto, Collelongo, Gioia dei Marsi, Gole del Sagittario (Anversa degli Abruzzi), Monte Sirente, Pacentro, Santo Stefano di Sessanio, Scanno, Valle Roveto, Villavallelonga.
24. *Epipactis muelleri* Godfery – Centro-Europeo. (!, A, AH, BX, C, E, F, QX, R, RX, SH, SY). Altipiani Maggiori, Barrea, Campo di Giove, Castel del Monte, Passo delle Capannelle (Pizzoli),

25. *Epipactis palustris* (L.) Crantz – Circumboreale. (AH, BX, C, F, FX, HX, I, QX, RX). Alfedena, Camosciara (Civitella Alfedena), Campotosto, Cagnano Amiterno, Forca d'Acero (Opi), M. Morrone, Passo delle Capannelle (Pizzoli), Rocca di Mezzo, Valle del Sangro tra Ateleta e Castel di Sangro, Val Fondillo (Opi), Villetta Barrea.
26. *Epipactis persica* subsp. *gracilis* (B. Baumann & H. Baumann) W. Rossi – Sud-Est-Europeo. (A, AH, BX, C, HY, R, RX, SY). Alfedena, Bosco del Chiarino (L'Aquila), Monte Cappucciata (Castel del Monte), Montereale, Monte Rotondo (Velino), Passo delle Capannelle (Pizzoli).
27. *Epipactis purpurata* Sm. – Subatlantico. (AH, BX, E, HN, HY, R, RX). Bosco S. Antonio (Pescocostanzo), Bosco del Chiarino (L'Aquila), Valle Iannanghera (Barrea).
28. *Epipogium aphyllum* Sw. – Eurosiberiano. (AH, BX, E, F, FX, IH, IL, RX). Altipiani Maggiori, Aremogna (Roccaraso), Camosciara (Civitella Alfedena), Campo Imperatore, Monte Sirente, Rocca di Mezzo, Val Fondillo (Opi), Valico del Curio (Scanno), Villavallelonga.
29. *Gymnadenia conopsea* (L.) R. Br. in W.T. Aiton – Eurasiatico. (!, AX, B, BX, D, E, FX, GX, H, HF, HX, L, M, NX, OY, Q, QX, QW, RX, SX, SY). Alfedena, Altipiani Maggiori, Ateleta, Barrea, Bisegna, Campo di Giove, Campo Felice, Campo Imperatore, Campotosto, Canistro, Capitignano, Capistrello, Cappadocia, Carsoli, Castel del Monte, Castel di Sangro, Castellafiume, Castelvecchio Calvisio, Fonte Cerreto (Assergi), Gioia dei Marsi, L'Aquila, Lucoli, Monte Prena, Magliano dei Marsi, Monte Sirente, Monte Velino, Monte Zurrone (Roccaraso), Montereale, Morino, Ofena, Ovindoli, Pacentro, Passo del Diavolo, Passo Godi, Pescasseroli, Pettorano sul Gizio, Piani di Pezza (Rocca di Mezzo), Pietransieri, Pizzoli, Rivisondoli, Roccaraso, Santo Stefano di Sessanio, Scontrone, Sella di Monte Aquila, Tagliacozzo, Valle Roveto, Villavallelonga, Villetta Barrea, Villa Santa Lucia
30. *Himantoglossum adriaticum* H. Baumann – Eurimediterraneo. (!, AX, BX, C, D, E, FX, GX, H, HX, I, L, NX, Q, QX, RX, RY, SY, TX, TY). Alba Fucens, Alfedena, Altipiani Maggiori, Assergi, Ateleta, Avezzano, Barrea, Bisegna, Campo di Giove, Campotosto, Canistro, Cansano, Capitignano, Caporciano, Cappadocia, Castel del Monte, Castel di Sangro, Castelvecchio Subequo, Cocullo, Collelongo, Forca d'Acero, Gioia dei Marsi, Introdacqua, L'Aquila, Lucoli, Magliano dei Marsi, Massa d'Albe, Montereale, Monte Sirente, Monte Velino, Ortona dei Marsi, Pacentro, Paganica, Passo del Diavolo, Passo Godi, Pescina, Pescocostanzo, Pettorano sul Gizio, Pietransieri, Pizzoli, Rivisondoli, Roccacinquemiglia, Rocca di Mezzo, Rocca Pia, Roccaraso, Santo Stefano di Sessanio, Scanno, Scontrone, Valle Roveto, Villalago, Villa Santa Lucia, Villetta Barrea.
31. *Limodorum abortivum* (L.) Sw. – Eurimediterraneo. (!, H, M, P, QX, SY). Barrea, Campo di Giove, Campo Felice, Canistro, Capitignano, Lucoli, Magliano dei Marsi, Raiano, Rocca di Mezzo, Valle Roveto.
32. *Listera ovata* (L.) R. Br. – Eurasiatico. (!, AX, B, BX, C, E, GX, HF, HX, M, Q, TX). Alfedena, Altipiani Maggiori, Barrea, Camosciara (Civitella Alfedena), Campo di Giove, Campo Felice, Campotosto, Canistro, Capitignano, Castel di Sangro, Gioia dei Marsi, L'Aquila, Magliano dei Marsi, Monte Velino, Morino, Pietransieri, Pizzoli, Pettorano sul Gizio, Raiano, Rocca di Mezzo, Roccaraso, Valle Roveto, Villetta Barrea.
33. *Neotinea maculata* (Desf.) Stearn – Mediterraneo-Atlantico. (BX, G, Q, QX, RX, RY, SY). Campo Imperatore, Cansano, Capitignano, Castelvecchio Calvisio, Pacentro, Valle Peligna.
34. *Neotinea tridentata* (Scop.) R.M. Bateman, Pridgeon & M.W. Chase – Eurimediterraneo. (!, AX, B, BX, CX, D, E, GX, H, HF, HX, IW, L, M, OX, Q, QX, RX, RY, SX, SY, TX, TY). Aielli, Altipiani Maggiori, Anversa degli Abruzzi, Avezzano, Barisciano, Barrea, Bisegna, Bominaco, Calascio, Campo di Giove, Campo Felice, Campo Imperatore, Campotosto, Cansano, Cappadocia, Capitignano, Carsoli, Castel del Monte, Castel di Ieri, Castelvecchio Subequo, Castellafiume, Cocullo, Collelongo, Collepietro, Fonte Cerreto (Assergi), Forca d'Acero, Gioia dei Marsi, Gole del Sagittario (Anversa degli Abruzzi), Gole di Celano, L'Aquila, Lecce dei Marsi, Lucoli, Magliano dei Marsi, Massa d'Albe, Monte Sirente, Monte Velino, Morino, Ortona dei Marsi, Pacentro, Passo del Diavolo, Pescina, Pescocostanzo, Pietransieri, Pizzoli, Rivisondoli, Rocca di Cambio, Rocca Pia, Roccaraso, San Benedetto in Perillis, Santo Stefano di Sessanio, Scontrone, Sulmona, Tagliacozzo, Tornimparte, Val Fondillo (Opi), Valle Roveto, Villa Santa Lucia, Villalago, Villavallelonga, Villetta Barrea (Fig. 3).
35. *Neotinea ustulata* (L.) R.M. Bateman, Pridgeon & M. W. Chase – Europeo-Caucasico. (!, B, BX, C, D, E, HF, GX, IW, L, M, Q, QX, RX, RY, SY). Aielli, Alfedena, Altipiani Maggiori, Barisciano, Barrea, Campo Felice, Campo Imperatore, Campotosto, Cappadocia, Capitignano, Collarmele, Collelongo, Collepietro, Castelvecchio Subequo, Forca d'Acero, Gioia dei Marsi, L'Aquila, Montereale, Monte Sirente, Monte Velino, Morino, Ortona dei Marsi, Paganica, Passo Godi, Passo del Diavolo, Pescasseroli, Pescocostanzo,

Piani di Pezza (Rocca di Mezzo), Pietransieri, Pizzoli, Rivisondoli, Roccaraso, Santo Stefano di Sessanio, Scontrone, Sulmona, Tagliacozzo, Val Fondillo (Opi), Valle Roveto, Villalago, Villavallelonga, Villetta Barrea.

36. *Neottia nidus-avis* (L.) Rich. – Eurasiatico. (!, BX, C, D, DX, E, FX, GX, HF, HL, HX, LX, P, Q, QX, SX, SY, TX). Alfedena, Altipiani Maggiori, Avezzano, Bosco S. Antonio (Pescocostanzo), Camosciara (Civitella Alfedena), Campo di Giove, Campo Imperatore, Campotosto, Capitignano, Carsoli, Castel del Monte, Collelongo, Fonte Romana (Pacentro), Forca d'Acero, Introdacqua, Lucoli, Monte Sirente, Monti della Meta, Morino, Opi, Pescasseroli, Pettorano sul Gizio, Piani Pezza (Rocca di Mezzo), Roccaraso, Scanno, Valle Roveto, Villavallelonga, Villetta Barrea.
37. *Nigritella rubra* subsp. *widderi* H. Baumann & R. Lorenz – Subendemico. (AH, BX, C, F, FY, I, IN, O, RX). Barrea, Campo Imperatore, Montagna Grande (Scanno), Monte Camicia, Monte Sirente, Monte Velino, Monti della Meta,Villetta Barrea.
38. *Ophrys apifera* Huds. – Eurimediterraneo. (!, C, D, H, M, HF, NX, PX, Q, QX, RX, SY, T, TX). Aielli, Alfedena, Ateleta, Bisegna, Cagnano Amiterno, Calascio, Campo di Giove, Campo Felice, Campotosto, Canistro, Capistrello, Capitignano, Castel di Sangro, Castellafiume, Collelongo, Collepietro, Introdacqua, L'Aquila, Massa d'Albe, Montereale, Morino, Ortona dei Marsi, Pacentro, Pescina, Pietransieri, Pizzoli, Rivisondoli, Rocca di Cambio, Roccaraso, Scontrone, Sulmona, Valle Roveto, Villa Santa Lucia, Villetta Barrea.
39. *Ophrys argolica* subsp. *crabronifera* (Sebast. & Mauri) Faurh. – Endemico. (!, IW, MX, R, RX, QW, S). Collepietro, Navelli, Pizzone, San Benedetto in Perillis.
40. *Ophrys bertolonii* subsp. *bertolonii* Moretti – Appennino-Balcanico. (!, AX, C, CX, D, EX, FX, GX, H, IW, M, NX, PX, Q, QX, RX, RY, RY, S). Aielli, Alfedena, Avezzano, Campo di Giove, Campo Felice, Campo Imperatore, Cansano, Capistrello, Caporciano, Cappadocia, Castel del Monte, Castel di Ieri, Castellafiume, Cocullo, Collepietro, Fonte Cerreto (Assergi), Gole di Celano, L'Aquila, Lecce dei Marsi, Lucoli, Massa d'Albe, Magliano dei Marsi, Monte Sirente, Montereale, Monte Velino, Ortona dei Marsi, Pacentro, Paganica, Passo del Diavolo, Pescina, Pietransieri, Pratola Peligna, Raiano, Rivisondoli, San Benedetto in Perillis, Scontrone, Sulmona, Tagliacozzo, Valle del Tirino, Valle Roveto, Villa Santa Lucia.
41. *Ophrys exaltata* subsp. *archipelagi* (Gölz & H.R. Reinhard) Del Prete – Appennino-Balcanico. (L, R, SH). Capestrano, Collepietro, Navelli, Ofena, Scontrone. Sono state riportate al taxon tutte le segnalazioni di *Ophrys exaltata* subsp. *exaltata* Ten. (Romolini & Souche 2012 e Pezzetta 2015)
42. *Ophrys fusca* subsp. *funerea* (Viv.) Arcang. – Stenomediterraneo. (RY, SY, TX). Bisegna, Cagnano Amiterno, Capitignano, Campotosto, L'Aquila, Lucoli, Massa d'Albe, Montereale, Pescina, Ortona dei Marsi, Scanno, Sulmona.
43. *Ophrys fusca* subsp. *lucana* (P. Delforge, Devillers-Tersch. & Devillers) Kreutz – Endemico. (!, IW, PX, RX, QW, RY, TY). Alfedena, Barrea, Cansano, Collepietro, Pietransieri, Roccaraso, Roccacinquemiglia (Castel di Sangro), San Benedetto in Perillis, Scanno.
44. *Ophrys holosericea* (Burm. f.) Greuter subsp. *appennina (*Romolini & Soca) Kreutz– Endemico. (!, N, PX, RX, RY, SY, TX). Alfedena, Ateleta, Campo di Giove, Canistro, Capistrello, Capitignano, Collepietro, L'Aquila, Lucoli, Magliano dei Marsi, Montereale, Monte Sirente, Monte Velino, Morino, Ortona dei Marsi, Pizzoli, San Benedetto in Perillis, Santo Stefano di Sessanio, Sulmona.
45. *Ophrys holosericea* (Burm. f.) Greuter subsp. *dinarica* (Kranjcev & P. Delforge) Kreutz – Appennino-Balcanico. (!, IW, IZ, L, NX, PX, Q, RX, QW, RY, TX,TY). Aielli, Alfedena, Ateleta, Avezzano, Barrea, Barisciano, Bisegna, Bominaco, Cagnano Amiterno, Calascio, Campo di Giove, Campotosto, Cansano, Canistro, Capistrello, Caporciano, Cappadocia, Castel di Sangro, Collelongo, Collepietro, Gioia dei Marsi, L'Aquila, Lecce dei Marsi, Lucoli, Magliano dei Marsi, Massa d'Albe, Montereale, Monte Velino, Ortona dei Marsi, Pacentro, Pettorano sul Gizio, Pietransieri, Raiano, Rivisondoli, Rocca Pia, Roccaraso, Santo Stefano di Sessanio, Scanno, Scontrone, Sulmona, Tagliacozzo, Villalago, Villa Santa Lucia, Villavallelonga, Villetta Barrea.
46. *Ophrys holosericea* (Burm. f.) Greuter subsp. *gracilis* (Büel, O. Danesch & E. Danesch) Büel, O. Danesch & E. Danesch – Endemico. (!, C,GX, L, NX, Q, RX, SH, TX, TY). Alfedena, Ateleta, Barrea, Campotosto, Capitignano, Passo del Diavolo, Pietransieri, Rivisondoli, Santo Stefano di Sessanio, Scontrone, Villetta Barrea.
47. *Ophrys holosericea* (Burm. f.) Greuter subsp. *pinguis (*Romolini & Soca) Kreutz – Endemico. (!, N, PX, Q, RX, RY, SH, TX). Aielli, Ateleta, Avezzano (Monte Salviano), Campo di Giove, Campotosto, Canistro, Capistrello, L'Aquila, Lucoli, Ortona dei Marsi, Pacentro, Roccacinquemiglia (Castel di Sangro), Santo Stefano di Sessanio.
48. *Ophrys holosericea* (Burm. f.) Greuter subsp. *serotina* (Rolli ex H. F. Paulus) Kreutz – Suben-

demico. (L, RX, S). Alfedena, Castel del Monte, Castel di Sangro, Santo Stefano di Sessanio, Scontrone.

49. *Ophrys holosericea* (Burm. f.) Greuter subsp. *tetraloniae* (W.P. Teschner) Kreutz– Appennino-Balcanico (!, C, F, NX, PX, QX, R, S). Alfedena, Ateleta, Barrea, Cagnano Amiterno, Campo di Giove, Campotosto, Canistro, Capistrello, Castel di Sangro, Collelongo, L'Aquila, Lucoli, Montereale, Scanno, Scontrone, Villetta Barrea.
50. *Ophrys illyrica* S. Hertel & K. Presser – Appennino-Balcanico. (L, NX, QX, R, RX, TX). Ateleta, Avezzano, Barisciano, Campo di Giove Capestrano, Cocullo, Collepietro, L'Aquila, Magliano dei Marsi, Monte Velino, Rosciolo dei Marsi, Santo Stefano di Sessanio, Scontrone, Villetta Barrea.
    Sono state ricondotte al taxon tutte le segnalazioni di *O. ausonia* che secondo Hertel & Presser (2006) è da porre in sinonimia con il primo.
51. *Ophrys incubacea* Bianca subsp. *brutia* (P. Delforge) Kreutz – Endemico. (!, PX, RX, RY, TX). Aielli, Ateleta, Avezzano, Castel di Ieri, Cocullo, Collepietro, Ortona dei Marsi, Pescina, Roccaraso, Rivisondoli, Villetta Barrea.
52. *Ophrys incubacea* Bianca subsp. *incubacea* – Stenomediterraneo. (!, GX, IW, L, PX, Q, QX, RX, RY, SX, TY). Aielli, Alfedena, Avezzano, Barrea, Castel di Ieri, Castelvecchio Subequo, Cocullo, Collarmele, Collepietro, Gioia dei Marsi, Massa d'Albe, Ortona dei Marsi, Pacentro, Passo del Diavolo, Pescina, Raiano, Roccacasale, Roccacinquemiglia (Castel di Sangro), San Benedetto in Perillis, Santo Stefano di Sessanio, Scontrone, Sulmona, Valle Peligna, Villalago, Villa Santa Lucia.
53. *Ophrys insectifera* L. – Europeo. (!, AH, C, F, GX, HX, I, L, PX, T). Alfedena, Avezzano, Barrea, Campotosto, Capistrello, Capitignano, L'Aquila, Pietransieri, Roccaraso, Villetta Barrea.
54. *Ophrys lacaitae* Lojac. – Appennino-Balcanico. (!, L, NX, PX,) Ateleta, Castel di Sangro, Roccaraso.
55. *Ophrys passionis* subsp. *majellensis* (Helga & Herm. Daiss) Romolini & Soca. – Subendemico. (!, GX, H, Q, T, TX). Aielli, Pacentro, Roccaraso, Valle Roveto.
56. *Ophrys passionis* subsp. *passionis* Sennen ex Devillers-Tersch. & Devillers – Mediterraneo-Occidentale. (GX, L). Alfedena, Barrea, Bocca di Pantano (Scanno), Scontrone
57. *Ophrys personata* P. Delforge – Endemico. (Delforge 2015). Ateleta.
58. *Ophrys promontorii* O. Danesch & E. Danesch – Endemico. (!, BX, C, F, GX, IW, L, MX, PX, QX, RX, QW, RY, SX, TX, TY). Alfedena, Avezzano, Barrea, Bisegna, Calascio, Campo di Giove, Campo Imperatore, Capestrano, Castel del Monte, Cocullo, Collepietro, Gioia dei Marsi, Gioia Vecchia, Gole del Sagittario (Anversa degli Abruzzi), Navelli, Ofena, Ortona dei Marsi, Passo Godi, Passo del Diavolo, Pietransieri, Raiano, Rivisondoli, Rocca Calascio, Roccacinquemiglia (Castel di Sangro), Roccaraso, San Benedetto in Perillis, Scanno, Scontrone, Villalago, Villa Santa Lucia, Villetta Barrea.
59. *Ophrys speculum* Link – Stenomediterraneo. (HP, MX, RX, S). Navelli, Pratola Peligna.
60. *Ophrys sphegodes* Mill. subsp. *minipassionis* (Romolini & Soca) Biagioli & Grünanger – Endemico. (!, RX, SH, T). Capestrano, Collepietro
61. *Ophrys sphegodes* Mill. subsp. *riojana* (C.E. Hermos.) Biagioli & Grünanger – Mediterraneo-Occidentale. (IW, PX, R, SH, TY). Aielli, Avezzano, Barisciano, Bominaco, Calascio, Campo di Giove, Cansano, Caporciano, Capistrello, Cappadocia, Castelvecchio Subequo, Cocullo, Collarmele, Collepietro, Gioia dei Marsi, L'Aquila, Lucoli, Magliano dei Marsi, Massa d'Albe, Navelli, Ofena, Ortona dei Marsi, Pescasseroli, Pescocostanzo, Pescina, Pizzoli, Raiano, Roccacinquemiglia (Castel di Sangro), Rocca Pia, San Benedetto in Perillis, Santo Stefano di Sessanio, Tagliacozzo.
62. *Ophrys sphegodes* subsp. *sphegodes* Mill. – Eurimediterraneo. (!, B, BX, C, CX, D, E, EX, FX, GX, IW, L, M, MX, NX, Q, QX,QW, RX, QW, RY, SY, TX). Aielli, Alfedena, Altipiani Maggiori, Assergi, Avezzano, Barisciano, Barrea, Bisegna, Bominaco, Calascio, Campo di Giove, Campo Felice, Campotosto, Cagnano Amiterno, Capestrano, Capitignano, Carsoli, Castel del Monte, Castel di Ieri, Castel di Sangro, Castelvecchio Calvisio, Castelvecchio Subequo, Cocullo, Collepietro, Fonte Cerreto (Assergi), Gioia dei Marsi, Gioia Vecchia, Gole del Sagittario (Anversa degli Abruzzi), Gole di Celano, Introdacqua, Magliano dei Marsi, Massa d'Albe, M. Pettino (L'Aquila), Monte Sirente, Monte Velino, Montereale, Navelli, Ortona dei Marsi, Pacentro, Pescina, Pietransieri, Pizzoli, Raiano, Rivisondoli, Roccaraso, San Benedetto in Perillis, Santo Stefano di Sessanio, Sulmona, Tagliacozzo, Tornimparte, Valle Roveto, Villa Santa Lucia, Villalago, Villetta Barrea.
    Sono state ricondotte al taxon tutte le segnalazioni di *Ophrys aranifera* s. l. e di *O. classica* Devillers-Tersch. & Devillers, un'entità la cui posizione sistematica, secondo M. G. De Simoni (in GIROS 2009) andrebbe ulteriormente studiata e che secondo Hertel & Presser (2006) rientrerebbe nella variabilità di *O. sphegodes*.
63. *Ophrys sphegodes* subsp. *tarquinia* (P. Delforge) Kreutz. – Endemico. (!, IW, PX, RX, SH). Calascio, Collepietro, Ofena.

64. *Ophrys sphegodes* subsp. *tommasinii* (Vis.) Soó – Appennino-Balcanico. (!, HR, L, QX, RX, S). Barisciano, Campo di Giove, Campotosto, Castel del Monte, Cansano, Caporciano, Cocullo, Collepietro, Navelli, Pacentro, Pescina, Pescocostanzo, Pratola Peligna, San Benedetto in Perillis, Santo Stefano di Sessanio, Scontrone, Villa Santa Lucia, Villetta Barrea.
65. *Orchis anthropophora* (L.) All. – Mediterraneo-Atlantico. (!, AX, B, C, FX, GX, H, HF, IW, L, M, MX, OX, Q, QW, RX, RY, SX, SY, TY). Alfedena, Ateleta, Avezzano, Barrea, Bisegna, Campo di Giove, Campo Felice, Canistro, Capistrello, Capitignano, Cappadocia, Castel di Ieri, Castel di Sangro, Castellafiume, Cocullo, Collelongo, Collepietro, Gioia dei Marsi, Gole del Sagittario (Anversa degli Abruzzi), Introdacqua, Lucoli, Magliano dei Marsi, Massa d'Albe, Monte Pettino (L'Aquila), Monte Velino, Morino, Ortona dei Marsi, Pacentro, Passo del Diavolo, Pescina, Pettorano sul Gizio, Pietransieri, Raiano, Rivisondoli, Roccacinquemiglia, Rocca Pia, Roccaraso, San Benedetto in Perillis, Santo Stefano di Sessanio, Scanno, Scontrone, Sulmona, Tagliacozzo, Valle Roveto, Villalago, Villavallelonga, Villetta Barrea.
66. *Orchis italica* Poir. – Stenomediterraneo. (!, EX, H, L, M, MX, NX, RX, RY, SY, TX, TY). Ateleta, Campo di Giove, Campo Felice, Cappadocia, Cocullo, Collepietro, Introdacqua, Montereale, Ortona dei Marsi, Passo del Diavolo, Pettorano sul Gizio, Raiano, Roccacinquemiglia (Castel di Sangro), San Benedetto in Perillis, Scanno, Sulmona, Valle Roveto, Villalago, Villetta Barrea.
67. *Orchis mascula* subsp. *mascula* L. – Europeo-Caucasico. (!, AX, BX, C, D, E, GX, HF, HX, IW, M, Q, RY, TX, TY). Alfedena, Camosciara (Civitella Alfedena), Avezzano, Campotosto, Cappadocia, Gioia dei Marsi, Gioia Vecchia, L'Aquila, Magliano dei Marsi, Massa d'Albe, Monte Sirente, Morino, Passo del Diavolo, Pescasseroli, Pettorano sul Gizio, Pietransieri, Raiano, Rivisondoli, Roccacinquemiglia (Castel di Sangro), Roccaraso, Valico Capo le Serre (Castel del Monte), Villetta Barrea.
68. *Orchis mascula* subsp. *speciosa* (Mutel) Hegi [sin. *O. mascula* subsp. *signifera* (Vest.) Soó] – Centro-Europeo. (GX, L, QX, S). Alfedena, Barrea, Campo di Giove, Capitignano, Cocullo, Pacentro, Passo del Diavolo, Passo Godi, Passo San Leonardo (Pacentro), Rivisondoli, Scanno, Scontrone.
69. *Orchis militaris* L. – Eurasiatico. (!, BX, C, D, FX, HF, L, Q, RX, SY, T, TX). Alfedena, Cagnano Amiterno,Camosciara (Civitella Alfedena), Campo Felice, Campo Imperatore, Capitignano, Montereale, Monte Sirente, Passo Godi, Pizzoli, Roccaraso, Santo Stefano di Sessanio, Scontrone, Villetta Barrea.
70. *Orchis pallens* L. – Europeo-Caucasico. (!, BX, C, D, GX, HF, HX, L, QX, T). Campo Imperatore, Campotosto, Gioia dei Marsi, Gioia Vecchia, Monte Sirente, Morino, Passo Godi, Roccaraso, Scanno, Villavallelonga.
71. *Orchis pauciflora* Ten. – Stenomediterraneo. (!, AX, C, E, EX, FX, GX, H, HF, IW, L, M, MX, OX, Q, QX, QW, RX, RY, SX, SY, TX, TY). Alfedena, Altipiani Maggiori, Avezzano, Barisciano, Calascio, Campo di Giove, Campo Imperatore, Campo Felice, Campotosto, Cansano, Capestrano, Castelvecchio Subequo, Civitaretenga, Cocullo, Collepietro, Gioia dei Marsi, Gole del Sagittario (Anversa degli Abruzzi), Lucoli, Magliano dei Marsi, Monte Pettino (L'Aquila), Monte Velino, Morino, Navelli, Ortona dei Marsi, Pacentro, Passo del Diavolo, Passo Godi, Pescocostanzo, Pietransieri, Rivisondoli, Roccacinquemiglia (Castel di Sangro), Roccaraso, San Benedetto in Perillis, Santo Stefano di Sessanio, Scanno, Scontrone, Valico Capo le Serre (Castel del Monte), Valle Peligna, Valle Roveto, Villalago, Villavallelonga, Villa Santa Lucia, Villetta Barrea.
72. *Orchis provincialis* Balb. Ex Lam. – Stenomediterraneo. (GX, H, RX, S, TY). Camosciara (Civitella Alfedena), Calascio, Forca d'Acero, Monti della Meta, San Benedetto in Perillis, Valle Roveto.
73. *Orchis purpurea* Huds. – Eurasiatico. (!, B, BX, C, CX, D, E, EX, FX, GX, H, HX, IW, L, M, , NX, OY, Q, QX, QW, RX, RY, SX, TX). Alfedena, Altipiani Maggiori, Assergi, Ateleta, Avezzano, Barisciano, Barrea, Bisegna, Cagnano Amiterno, Calascio, Camosciara (Civitella Alfedena), Campo di Giove, Campo Felice, Campo Imperatore, Campotosto, Canistro, Cansano, Capestrano, Capitignano, Cappadocia, Carsoli, Castel di Ieri, Castel di Sangro, Castel del Monte, Castelvecchio Calvisio, Castelvecchio Subequo, Castellafiume, Cocullo, Collepietro, Gioia dei Marsi, Gole di Celano, Introdacqua, L'Aquila, Lecce dei Marsi, Lucoli, Magliano dei Marsi, Massa d'Albe, Monte Pettino (L'Aquila), Montereale, Monte Sirente, Monte Velino, Morino, Navelli, Ocre, Ortona dei Marsi, Pacentro, Passo del Diavolo, Passo Godi, Pescasseroli, Pescina, Pescocostanzo, Pettorano sul Gizio, Pietransieri, Pizzoli, Pratola Peligna, Raiano, Rivisondoli, Roccacinquemiglia, Roccaraso, San Benedetto in Perillis, Santo Stefano di Sessanio, Scanno, Scontrone, Scurcola Marsicana, Sulmona, Tornimparte, Valle Peligna, Valle Roveto, Villalago, Villa Santa Lucia, Villetta Barrea.
74. *Orchis simia* Lam. – Eurimediterraneo. (C, D, GX, H, HF, M, RX, RY, TX). Aielli, Alfedena, Avez-

zano, Campo di Giove, Forca d'Acero, Gioia dei Marsi, Monte Sirente, Morino, Ortona dei Marsi, Passo del Diavolo, Pescina, Valle Roveto, Villetta Barrea.

75. *Orchis spitzelii* Saut. – Europeo-Caucasico. (!, AH, AX, B, BX, C, F, FX, HF, IN, L, M, Q, RX, SX). Campo di Giove, Campo Felice, Campo Imperatore, Capistrello, M. Rotondo (Rocca di Mezzo), Monte Sirente, Monte Velino, Morino, Passo Godi, Pescocostanzo, Scanno, Villetta Barrea.
76. *Platanthera algeriensis* Batt. & Trab. – Mediterraneo-Occidentale. (GX, L, R, SH). Alfedena, Barrea, Castel del Monte, Passo del Diavolo, Villa Santa Lucia.
77. *Platanthera bifolia* (L.) Rchb. subsp. *bifolia* – Paleotemperato. (!, D, E, FX, Pirone & Manzi 2003, Q, RX, TX). Aielli, Altipiani Maggiori, Campo Imperatore, Bisegna, Carsoli, Castel di Sangro, Cocullo, Gioia dei Marsi, Lucoli, Magliano dei Marsi, Monte Sirente, Ortona dei Marsi, Ovindoli, Pescasseroli, Pescina, Rivisondoli, Roccaraso, Tornimparte, Valle Roveto.
78. *Platanthera bifolia* (L.) Rchb subsp. *osca* R. Lorenz, Romolini, V.A. Romano & Soca. – Endemico. (Lorenz *et al*., 2015). Aielli.
79. *Platanthera chlorantha* (Custer) Rchb. – Eurosiberiano. (!, AX, BX, C, FX, H, HX, M, RX, SY, T, TY). Campo di Giove, Campo Felice, Campotosto, Canistro, Capestrano, Capitignano, Caporciano, Carsoli, Castel di Sangro, L'Aquila, Serra Lunga (Collelongo), Monte Sirente, Monte Velino, Valle Roveto, Villa Santa Lucia, Villavallelonga.
80. *Pseudorchis albida* (L.) A. Löve & D. Löve – Artico-Alpino. (AH, B, BX, F, FX, R, RX, Soca T). Camosciara (Civitella Alfedena), Montagna Grande (Scanno), Monte Prena, Monte Velino.
81. *Serapias lingua* L. – Stenomediterraneo. (C, F, I, TX). Aielli, Alfedena.
82. *Serapias parviflora* Parl. – Stenomediterraneo. (!, IW, NX, RX, S). Aielli, Ateleta, Capistrello, Collepietro, Ortona dei Marsi, Roccaraso, Villalago.
83. *Serapias vomeracea* (Burm.f.) Briq. subsp. *longipetala* (Ten.) W. Baumann & Künkele – Mediterraneo-Orientale. (S). Aielli.
84. *Serapias vomeracea* (Burm.f.) Briq. subsp. *vomeracea* – Eurimediterraneo. (!, C, H, IW, L, M, NX, Q, RY, SY). Aielli, Alba Fucens, Alfedena, Ateleta, Avezzano, Campo Felice, Capistrello, Carsoli, Castel di Ieri, Castel di Sangro, Cocullo, Collepietro, Massa d'Albe, Montereale, Ortona dei Marsi, Ovindoli, Pietransieri, Scontrone, Valle Peligna, Valle Roveto.
85. *Spiranthes spiralis* (L.) Chevall. – Europeo-Caucasico. (BX, H, M, SY). Capitignano, Lucoli, Montereale, Morino, Trasacco, Valle Roveto.
86. *Traunsteinera globosa* (L.) Rchb. – Orof. Sud-Europeo. (!, AH, BX, R, RX, SH). Campo di Giove, Campo Imperatore, Castellano (Corno Piccolo), Passo Godi.

Ibridi (1):

1. *Anacamptis* ×*alata* Fleury H. Kretzschmar, Eccarius & H. Dietr. (*A. laxiflora* × *A. morio*) (H, S). Barrea, Capitignano, Ortona dei Marsi, Valle Roveto.
2. *Anacamptis* ×*gennarii* (Rchb. f.) Nazzaro & La Valva (*A. morio* × *A. papilionacea*) (MX, RX). Navelli.
3. *Dactylorhiza* ×*guillaumeae* C.Bernard (*D. incarnata* × *D. sambucina* (T) Gioia dei Marsi.
4. *Dactylorhiza* ×*serbica* (Fleishmann) Soó (D. *incarnata* × *D. saccifera*). (!, SH, T). Campotosto, Passo Godi.
5. *Epipactis* ×*barreana* B.Baumann & H.Baumann. (*Epipactis helleborine* subsp. *latina* × *E. muelleri*). (A). Villetta Barrea.
6. *Epipactis* ×*capellonensis* B.Baumann & H.Baumann (*E. atrorubens* × *E. helleborine* subsp. *latina*. (A). S. Stefano di Sessanio.
7. *Neotinea* ×*dietrichiana* (Bogenh.) H. Kretzschmar, Eccarius & H. Dietr (*N. tridentata* × *N. ustulata*). (!, L, S). Gioia dei Marsi, Lucoli, Passo del Diavolo, Roccaraso, Villetta Barrea.
8. *Ophrys* x*petruccii* Romolini & Soca (*O. apifera* x *O. appennina*). (RX, T). Collepietro.
9. *Ophrys apifera* × *O. dinarica* ((!, R, SH, TX). Barrea, Campotosto, Ortona dei Marsi, Villetta Barrea.
10. *Ophrys apifera* × *O. pinguis* (S). L'Aquila.
11. *Ophrys apifera* × *O. tetraloniae* (T). Canistro.
12. *Ophrys appennina* × *O. bertolonii* (!, RX, S). Collepietro, San Benedetto in Perillis.
13. *Ophrys appennina* × *O. dinarica* (RX, T). Ateleta, Collepietro, Ortona dei Marsi.
14. *Ophrys appennina* × *O. incubacea* (T). Sulmona.
15. *Ophrys appennina* × *O. tetraloniae* (T). Capistrello.
16. *Ophrys bertolonii* × *O. tetraloniae* (L). Scontrone.
17. *Ophrys bertolonii* × *O. riojana* (S). Aielli.
18. *Ophrys brutia* × *O. incubacea* (T). Pescina.
19. *Ophrys dinarica* × *O. gracilis*. (PX, TX). Ateleta, Barrea, Villetta Barrea.
20. *Ophrys dinarica* × *O. promontorii* (T, TX). Alfedena, Barrea, Scanno, Scontrone, Villetta Barrea.

(1): Nelle sue segnalazioni originali Souche utilizza *Ophrys romolinii* al posto di *O. bertoloni* subsp. *bertolonii*.
(1): V svojih izvirnih poročilih Souche uporablja *Ophrys romolinii* namesto *O. bertoloni* subsp. *bertolonii.*

21. *Ophrys dinarica* × *O. riojana* (T). Ortona dei Marsi.
22. *Ophrys dinarica* × *O. sphegodes*. (Q, RX, RY, TX, TY). Aielli, Alfedena, Barrea, Collepietro, Massa d'Albe, Ortona dei Marsi, Pescina, Pietransieri, Rocca Pia, San Benedetto in Perillis, Villalago.
23. *Ophrys exaltata* susbp. *archipelagi* × *O. promontorii*. (T). Capestrano. Ibrido nuovo per l'Abruzzo.
24. *Ophrys gracilis* × *O. pinguis* (T). Ortona dei Marsi.
25. *Ophrys gracilis* × *O. sphegodes* (T, TY). Roccaraso, Villetta Barrea.
26. *Ophrys lacaitae* × *O. serotina* (L). Castel di Sangro.
27. *Ophrys passionis* subsp. *passionis* × *O. promontorii*. (L). Scontrone.
28. *Ophrys promontorii* × *O. serotina* (L). Scontrone.
29. *Ophrys serotina* × *O. sphegodes* (L, S). Cocullo, Barrea.
30. *Ophrys promontori* × *O. tarquinia* (IW, IX, RX, SH). Ofena.
31. *Ophrys* ×*angelensis* H.Baumann & Künkele (*O. incubacea* × *O. promontorii*) (!, IW, L, RX, SH,). Capestrano, Castel del Monte, Cocullo, Collepietro, Scontrone.
32. *Ophrys* ×*bilineata* Barla (*O. bertolonii* × *O. sphegodes*). (L, QX, RX, R, SH, T). Aielli, Alfedena, Castel del Monte, Massa d'Albe, Pacentro, Pietransieri, Scontrone
33. *Ophrys* ×*brunamontei* Soca (*O. dinarica* × *O. majellensis* (RY, TX). Aielli.
34. *Ophrys* ×*camusii* (*O. argolica* subsp. *crabronifera* × *O. sphegodes*) (QW, TX). San Benedetto in Perillis.
35. *Ophrys* ×*capistrelloi* Soca (*O. dinarica* × *O. tetraloniae*). (QY). Capistrello.
36. *Ophrys* ×*capracottae* Soca (*O. brutia* × *O. dinarica* (PX, Romolini & Soca 2014). Aielli, Pietransieri, Roccaraso.
37. *Ophrys* x*catinii* Soca (O. *bertolonii* × *O. pinguis*). (PX, QY). Aielli, Capistrello.
38. *Ophrys* ×*couloniana* P. Delforge (*O. bertolonii* × *O. promontorii*) (L, RX, SH). Alfedena, Campo di Giove, Calascio, Castel del Monte, Collepietro, San Benedetto in Perillis.
39. *Ophrys* ×*flahaultii* Ladouze (*O. apifera* x *O. sphegodes* (S). Ortona dei Marsi.
40. *Ophrys* ×*hybrida* Pokorny ex Rchb. f. (*O. insectifera* × O. *sphegodes*). (QW). Roccaraso.
41. *Ophrys* ×*impresciae* Soca (*O. dinarica* × *O. pinguis)*. (PX, QY, TX). Ateleta, Avezzano, Capistrello.
42. *Ophrys* ×*lyrata* H. Fleischm. (*O. bertolonii* × *O. incubacea*). (!, IW, L, Q, RX, S). Aielli, Campo di Giove, Castel di Ieri, Collepietro, Pacentro, San Benedetto in Perillis, Scontrone, Sulmona.
43. *Ophrys* ×*pescocanalei* Soca (*O. pinguis* × *O. tetraloniae*). (PX, QY). Capistrello.
44. *Ophrys* ×*piconei* Soca (*O. bertolonii* × *O. dinarica*). (PX, Q, QY, RX S). Aielli, Collepietro, Lecce dei Marsi, Rivisondoli.
45. *Ophrys* ×*recchiae* Soca (*O. dinarica* × *O. incubacea*). (IX, PX, Q, RX, QY, S). Aielli, Collepietro, Pacentro.
46. *Ophrys* ×*terrae-laboris* W. Rossi & F. Minutillo (*O. promontorii* × *O. sphegodes*) (!, L, RX, SH). Barrea, Collepietro, Navelli, Ofena, Pietransieri, Raiano, Roccaraso.
47. *Ophrys* ×*trombettensis* Soca *(O. exaltata* susbp. *archipelagi* × *O. sphegodes*). (T). Navelli. Ibrido nuovo per l'Abruzzo.
48. *Ophrys* ×*vernacchiae* Soca (*O. bertoloni* × *O. brutia*). (!, QY, RX): Aielli, Collepietro, Rivisondoli.
49. *Ophrys* ×*vespertilio* W. Rossi & M. Contorni (*O. apifera* × *O. bertolonii*). (TX). Roccaraso.
50. *Orchis* ×*amsittenii* Hautz (*Orchis mascula* × *O. spitzelii*). (T). Scanno.
51. *Orchis* ×*angusticruris* Franch. ex Rouy (*O. purpurea* × *O. simia*). (H, T). Avezzano, Valle Roveto.
52. *Orchis* ×*bergonii* Nanteuil (*O. anthropophora* × *O. simia*). (L). Cocullo.
53. *Orchis* ×*bivonae* Tod (O. *anthropophora* × *O. italica*). Pettorano sul Gizio, Sulmona.
54. *Orchis* ×*colemanii* Cortesi (*O. mascula* × *O. pauciflora*). (!, GX, HF, L, RX, RY, SH, TY). Barrea, Campo di Giove, Cocullo, Gioia dei Marsi, Magliano dei Marsi, Morino, Pescasseroli, Passo del Diavolo, Passo Godi, Roccaraso, Scanno, Scontrone, Valico Capo le Serre (Castel del Monte).
55. *Orchis* ×*hybrida* (Lindl.) Boenngh. ex Rchb. (*O. militaris* × *O. purpurea*). (!, L, RX, SH). Campo Imperatore, Santo Stefano di Sessanio.
56. *Orchis* ×*klopfensteiniae* P. Delforge (*O. pallens* × *O. spitzelii*). (L, T). Passo Godi, Scanno.
57. *Orchis* ×*loreziana* Brügger (*O. mascula* × *O. pallens*). (T). Scanno.
58. *Orchis* ×*penzigiana* A. Camus *(O. mascula* × *O. provincialis*). (L, TY). Camosciara (Civitella Alfedena), Monti della Meta.
59. *Orchis* ×*spuria* Rchb. f. (*O. anthropophora* × *O. militaris)*. (L). Scontrone.

L'elenco floristico riportato è costituito da 86 entità ripartite in 22 generi. Tale numero costituisce oltre 88 % delle Orchidacee presenti in Abruzzo e il 40 % presente in Italia (Pezzetta 2011, op. cit.). All'insieme delle specie e sottospecie considerate vanno aggiunti 59 ibridi, di cui 13 nuovi per la Regione. Di conseguenza l'ammontare complessivo dei taxa riportati è di 145.

L'elenco comprende molte segnalazioni di località e stazioni inedite che contribuiscono ad allargare l'areale di diffusione dei singoli taxa.

A causa delle numerose segnalazioni, nell'elenco si è deciso di riportare *Ophrys sphegodes* subsp. *riojana* (C.E. Hermos.) Biagioli & Grünanger, un'entità considerata di dubbio valore tassonomico da Delforge (2005). Ad avviso dello scrivente, invece, non sono spiegabili le sue segnalazioni in Italia centrale accompagnate dall'assenza nei territori intermedi rispetto al locus classicus. Probabilmente la sua presenza porterebbe a escludere *O. tommasinii* ma saranno gli studi successivi ad apportare chiarimenti.

L'elenco non comprende le segnalazioni storiche di *Ophrys fusca* Link subsp. *fusca, O. scolopax* Cav., *O. holosericea* (Burm. f.) Greuter subsp *apulica* O. Danesch & E. Danesch e *O. holosericea* (Burm. f.) Greuter subsp. *holosericea* poiché a causa delle recenti revisioni tassonomiche vanno escluse dalla flora abruzzese.

Le entità segnalate in più località e quindi più diffuse sono nell'ordine: *Anacamptis morio*, *Orchis purpurea*, *Neotinea tridentata*, *Ophrys sphegodes*, *Himanthoglossum adriaticum*, *Gymnadenia conopsea*, *Orchis anthropophora*, *Orchis pauciflora*, *Cephalanthera damasonium*, *Anacamptis pyramidalis*, *Ophrys bertolonii*, *Neotinea Ustulata* e *Dactylorhiza sambucina*. Tra gli ibridi, *Orchis ´colemanii* è il più comune ed è segnalato in 12 località diverse.

Dall'elenco si può osservare che il genere *Ophrys* è il più rappresentato con 27 taxa. Le novità tassonomiche descritte recentemente dovrebbero portare ad attribuire molte segnalazioni storiche a qualcuno dei nuovi taxa. Al suo interno il gruppo di *Ophrys exaltata* / *sphegodes /incubacea* è costituito da 12 taxa (*O. archipelagi*, *Ophrys illyrica, O. brutia, O. incubacea*, *O. majellensis*, *O. passionis, O. minipassionis*, *O. riojana, O. sphegodes*, *O. tarquinia* e *O. tommasinii*. A sua volta il gruppo di *Ophrys holosericea* comprende 8 taxa (*O. appennina*, *O. dinarica*, O. *lacaitae, O. gracilis*, *O. pinguis*, *O. personata*, *O. serotina* e *O. tetraloniae*), Alcune entità di entrambi i gruppi potrebbero essere dubbie. Un taxon molto controverso è *O. serotina* che Delforge (2005) considera una buona specie mentre per Romolini & Souche (2012) deve essere posto in sinonimia con *O. holosericea* subsp. *tetraloniae*.

Secondo Faurholdt (2009) *O. dinarica* deve considerarsi una varietà di *O. fuciflora* (*holosericea*). Ad avviso di Delforge (comunicazione personale) tutte le sue segnalazioni per l'Abruzzo vanno riferite a *Ophrys personata* che ha recentemente descritto lui stesso. Tuttavia in attesa di nuovi studi e ricerche, si è deciso di riportare nell'elenco floristico entrambe le specie. Più in generale, come faceva notare Del Prete (1982) si sono descritti nuovi taxa del gruppo in considerazione interpretando come caratteri distintivi piccole differenze morfologiche. Devey *et al.* (2009) hanno dimostrato che tra le popolazioni del gruppo presenti nello stesso territorio avvengono flussi genici che portano alla formazione di piante caratterizzate da piccole differenze morfologiche e caratteri intermedi molto variabili che rendono difficile la classificazione. Si tratta di un dato di fatto che posso confermare con le mie osservazioni dirette sul campo. La loro presenza in natura dovrebbe condurre a una revisione tassonomica e altri studi e ricerche.

Considerazioni analoghe possono essere applicate anche al gruppo *Ophrys exaltata* / *sphegodes*. Ad avviso di Sedeek *et al*. (2014), dal punto di vista genetico *O. sphegodes* e *O. exaltata* sono indistinguibili. In alcuni casi le differenze morfologiche non sono corrisposte da isolamento riproduttivo oppure esemplari simili sono parzialmente isolati dal punto di vista riproduttivo. Queste considerazioni dimostrano che i concetti di specie biologica e di specie filogenetica nei casi esaminati non coincidono e i caratteri morfologici non sono sempre utilizzabili con estrema chiarezza per classificare singoli individui. Nell'ambito del gruppo e per il territorio in considerazione, in particolare, pongono numerosi problemi di classificazione gli esemplari che da Romolini & Souche (2012) e Soca (2015) sono attribuiti a *Ophrys classica*, *O. aranifera* s.l. e *O. riojana*, e dallo scrivente a *O. sphegodes*, *O. tommasinii* e *O. illyrica*.

Altrettanto discusso è lo status di *Ophrys bertolonii*, che sempre secondo Romolini & Souche (2012) per il territorio in esame è da attribuire a *O. romolinii* Soca, un taxon dal rango tassonomico ancora controverso che Quitadamo & Rossini (in GIROS 2009) pongono in sinonimia con la prima entità.

Il genere *Orchis* è rappresentato con 11 taxa e al suo interno *Orchis mascula* subsp. *speciosa* secondo Gulli & Tosi (in GIROS 2009) è di dubbio valore tassonomico.

Il genere *Epipactis*, a sua volta, comprende 11 entità e nel suo ambito, un taxon dal rango tassonomico discusso è *Epipactis helleborine* subsp. *latina* che Bongiorni *et al*. (2014) considerano un ecotipo da ricondurre a *E. helleborine* subsp *helleborine* con caratteri morfologici mutati a causa di una maggiore esposizione alla luce solare.

Il genere *Anacamptis*, a sua volta è costituto da 5 taxa il cui rango tassonomico sinora non è messo in discussione. Anche il genere *Dactylorhiza* è rappresentato da 5 taxa. Al suo interno pongono problemi di classificazione gli individui da attribuire alle due sottospecie che costituiscono il gruppo di *Dactylorhiza maculata*. Secondo Conti & Pellegrini (1990) in Abruzzo s'incontrano popolamenti con caratteri intermedi che rendono difficoltosa l'attribuzione a una delle due sottospecie. Biagioli & Pacifico (in GIROS, 2008), a loro volta sostengono che l'Italia centrale è una zona di contatto tra gli areali di *Dactylorhiza maculata* subsp. *fuchsii* e *D. maculata* subsp. *saccifera* in cui s'incontrano popolazioni in cui possono prevalere i caratteri dell'uno o dell'altro e quindi anche quelli intermedi. Per questo motivo Conti (1995), Pirone (1997) e Conti & Tinti (2008) segnalano in varie parti dell'ambito in esame *Dactylorhiza maculata s. l.*

Il genere *Platanthera* comprende 4 taxa e, allo stato attuale delle conoscenze, in Abruzzo raggiunge la mag-

Tab. 1: Località e Comuni della provincia dell'Aquila con presenza di Orchidaceae. I nomi tra parentesi indicano i Comuni di appartenenza.
Tab. 1: Lokalitete in občine v provinci Aquila s številom taksonov kukovičevk (Orchidaceae). Imena v oklepajih se nanašajo na pripadajoče občine.

Località	Totale Taxa	N° ibridi	Località	Totale Taxa	N° ibridi
Aielli	29	10	Molinia Aterno	1	
Alba Fucens	2		Monte Camicia (Gran Sasso)	3	
Alfedena	47	3	Montereale	21	
Altipiani maggiori	18		Monte Prena (Gran Sasso)	3	
Anversa degli Abruzzi	15		Monte Sirente	30	
Assergi (L'Aquila)	14		Monte Velino	28	
Ateleta	25	3	Monti della Meta	4	1
Avezzano	28	2	Morino	25	1
Barisciano	13		Navelli	14	3
Barrea	43	6	Ocre	2	
Bisegna	13		Ofena	8	2
Bominaco	5		Opi	18	
Cagnano Amiterno	10		Ortona dei Marsi	33	7
Calascio	13	1	Ovindoli	8	
Campo di Giove	44	3	Pacentro	30	3
Campo Felice	23		Paganica (L'Aquila)	3	
Campo Imperatore	26	1	Passo Godi	21	3
Campotosto	34	2	Passo del Diavolo (Gioia dei Marsi)	21	2
Canistro	18	1	Pescina	19	2
Cansano	11		Pescasseroli	12	1
Capestrano	14	2	Pescocostanzo	15	
Capistrello	22	5	Pettorano sul Gizio	18	1
Capitignano	28	1	Pietransieri	25	3
Caporciano	7		Pizzoli	21	
Cappadocia	17		Pratola Peligna	6	
Carsoli	14		Raiano	18	1
Castel del Monte	24	3	Rivisondoli	28	2
Castel di Ieri	9	1	Roccacasale	1	
Castel di Sangro	28	1	Roccacinquemiglia	12	
Castellafiume	7		Rocca di Cambio	4	
Castelvecchio Calvisio	5		Rocca di Mezzo	15	
Castelvecchio Subequo	9		Rocca Pia	8	1

Località	Totale Taxa	N° ibridi	Località	Totale Taxa	N° ibridi
Civitella Alfedena	17	1	Roccaraso	46	9
Cocullo	23	4	San Benedetto in Perillis	22	5
Collarmele	4		Santo Stefano di Sessanio	27	2
Collelongo	16		Scanno	29	5
Collepietro	38	11	Scontrone	37	9
Forca d'Acero (Opi)	10		Scurcola Marsicana	2	
Gioia dei Marsi	28	3	Sulmona	16	2
Gioia Vecchia	4		Tagliacozzo	12	
Gole di Celano	6		Tornimparte	7	
Introdacqua	10		Trasacco	2	
L'Aquila	28	1	Valle Peligna	7	
Lecce dei Marsi	5	1	Valle Roveto	33	2
Massa d'Albe	20	1	Villalago	14	1
Lucoli	22	1	Villa Santa Lucia	20	
Magliano dei Marsi	20	1	Villavallelonga	18	
Monte Aquila (Gran Sasso)	3		Villetta Barrea	43	6

gior biodiversità rispetto alle altre regioni peninsulari. La recente descrizione di *Platanthera bifolia* subsp. *osca* segnalata per ora solo in poche stazioni dovrebbe portare ad altri studi e ricerche per accertare se è più diffusa o se nella Provincia e in tutta la Regione sostiuisce o meno la specie nominale.

Seguono tutti gli altri generi con valori minori il cui rango tassonomico sinora non è in discussione.

Sono discutibili anche le segnalazioni di diversi ibridi del genere *Ophrys*. Alla base del processo d'ibridazione c'è il fatto che le specie parentali condividono lo stesso insetto pronubo. Poiché ciò non è molto comune, si può ritenere che in certi casi entità descritte come ibride, in realtà rappresentino varietà estreme di una specie tipo o dei lusus.

Tra i vari ibridi riportati, in particolare sono molto discutibili quelli formati da specie parentali appartenenti allo stesso gruppo quali: *Ophrys appennina* × *O. dinarica*, *O. appennina* × *O. tetraloniae*, *O. dinarica* × *O. gracilis*, *O. brutia* × *O. incubacea, O. gracilis* × *O. pinguis* e *O. dinarica* × *O. pinguis*. In tutti questi casi gli individui considerati ibridi potrebbero rappresentare delle forme intermedie di transizione tra una specie e l'altra e che quindi ripropongono il problema della corretta definizione di ogni singolo taxon e dell'intervallo di variabilità dei suoi caratteri. Tali aspetti potranno essere chiariti solo con analisi molecolari che possano dimostrare o no l'esistenza nel DNA di parti appartenenti a entrambe le specie parentali.

Sono riportate nella lista rossa della flora italiana (Conti *et al*. 1992) le seguenti specie: *Cypripedium calceolus*, *Epipactis purpurata* e *Platanthera algeriensis*.

Diversi taxa considerati nell'area o nel resto della Regione sono al limite del loro areale. Infatti,

- raggiunge in Abruzzo il limite nord-orientale di distribuzione geografica *Platanthera algeriensis*;
- raggiungono il limite settentrionale di distribuzione geografica: *Epipactis lucana*, *Ophrys exaltata* subsp. *achipelagi*, *Ophrys lacaitae*, *Ophrys promontorii* e *Platanthera bifolia* subsp. *osca*.
- raggiunge il suo limite meridionale di distribuzione geografica in Abruzzo *Traunsteinera globosa*.
- raggiunge il suo limite orientale in Abruzzo *Ophrys pinguis*.

Nella Provincia aquilana, inoltre, secondo Gransingh *et al*. (2012), *Orchis pupurea* raggiunge il suo limite altimetrico in Italia innalzandolo di oltre 200 metri.

Nella Tabella 1 è riportato l'indice delle località in cui sono segnalati i vari taxa. Si può osservare che il loro numero è di 96 e sono comprese in 78 Comuni. Il maggior numero di entità con oltre 40 è segnalato nei territori dei seguenti Comuni: Alfedena, Roccaraso, Campo di Giove e L'Aquila che comprende le frazioni di Assergi, Paganica e parte del massiccio del Gran Sasso. Nel

complesso si può dire che nell'aquilano le Orchidaceae s'incontrano un po' dappertutto.

Le indicazioni per località portano a integrare e accrescere i taxa presenti negli Altipiani Maggiori (Pirone 1997) e, nei massicci del Sirente (Guarrera & Tammaro 1996) e Velino (Petriccione 1993). Esse forniscono anche una prima e generale ripartizione nel territorio di studio di tutti gli ibridi sinora osservati.

Dalla Tabella 2 emerge che le varie entità censite si ripartiscono in 19 diversi corotipi, un dato che conferma che l'Abruzzo è un crocevia di correnti migratorie di diversa origine e distribuzione geografica.

L'analisi corologica evidenzia la dominanza dell'elemento mediterraneo con 25 taxa. Esso è seguito dagli elementi: eurasiatico con 22, endemico ed europeo con 16, nordico con 4 e mediterraneo-atlantico con 3. Questi dati dimostrano che nel comprensorio dominano le *Orchidaceae* tipiche degli ambienti temperati appartenenti ai corotipi euroasiatici, europeo-caucasico, europeo, centro-europeo, subatlantico, ecc. che sono presenti sino a circa 1700-1800 metri d'altitudine.

Tra le entità endemiche, di cui 10 appartenenti al genere *Ophrys*, in base alle conoscenze attuali, è esclusiva della provincia aquilana e quindi anche dell'Abruzzo *Ophrys personata*, mentre tutte le altre sono segnalate anche in altre regioni. In particolare:

- si può considerare un endemita peninsulare presente in modo più o meno continuo dalle regioni settentrionali a quelle meridionali: *Ophrys appennina*;
- si possono considerare endemiche dell'Italia centrale: *Ophrys pinguis* e *O. sphegodes* subsp. *tarquinia*;
- si possono considerare endemiche dell'Italia centro-meridionale: *Ophrys argolica* subsp. *crabronifera*, *O. brutia, O. exaltata* susbp. *archipelagi*, *O. fusca* subsp. *lucana*, *O. holosericea* subsp. *gracilis*, *O. minipassionis O. promontorii* e *Platanthera bifolia* subsp. *osca*.

Nel territorio in esame sono segnalate anche otto specie appennino-balcaniche e una mediterraneo-orientale che rappresentano forme relitte, che documentano processi migratori avvenuti in ere geologiche passate tra le penisole italiane e balcaniche.

CONCLUSIONI

Il territorio esaminato si presenta molto interessante per quanto riguarda la presenza delle *Orchidaceae*, poiché, tenendo conto di quanto riportato in Pezzetta (2011, *op. cit.*) il numero di taxa è superiore rispetto a quello di diverse regioni peninsulari, pur considerando discutibile e/o da confermare lo status tassonomico di alcuni di essi.

Le nuove segnalazioni d'ibridi e gli arrangiamenti tassonomici devono portare anche a un nuovo conteggio delle orchidacee regionali.

Nel complesso la presenza di numerose entità appartenenti a questa importante famiglia conferma l'importanza naturalistica della provincia aquilana e avvalorano le scelte che hanno portato a istituirvi i parchi e le riserve naturali.

Tab. 2: Corotipi delle Orchidacee della provincia dell'Aquila.
Tab. 2: Horotipi kukovičevk (Orchidaceae) v provinci Aquila.

Elementi geografici	Numero taxa	%
Endemico e Subendemico	16	18.6
Endemico	12	
Subendemico	4	
Mediterraneo	25	29.08
Eurimediterraneo	12	
Stenomediterraneo	9	
Mediterraneo-Orientale	1	
Mediterraneo-Occidentale	3	
Eurasiatico	22	25.58
Eurasiatico s. s.	8	
Europeo-Caucasico	7	
Eurosiberiano	4	
Paleotemperato	3	
Nordico	4	4.65
Artico-Alpino	1	
Circumboreale	3	
Europeo	16	18.6
Europeo s. s.	3	
Centro-Europeo	4	
Orofita Sud-Europeo	1	
Appennino-Balcanico	7	
Sud-Est-Europeo	1	
Mediterraneo-Atlantico	3	3.49
Mediterraneo-Atlantico	2	
Subatlantico	1	
Totale	86	100

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Fig.1/Sl. 1: *Cypripedium calceolus* ***(Photo: A. Pezzetta)***

Fig.2/Sl.2: *Dactylorhiza incarnata* ***(Photo: A. Pezzetta)***

KUKAVIČEVKE POKRAJINE L'AQUILA

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POVZETEK

Pokrajina L'Aquila je del dežele Abruci. Za ozemlje te province je značilna izjemna floristična pestrost, ki naj bi štela med 2300 in 2500 taksonov višjih rastlin. Pričujoči prispevek, ki temelji na terenskih raziskavah avtorja in na nekaterih neobjavljenih podatkih drugih strokovnjakov, obravnava prvi seznam kukavičevk in kronološko analizo, ki kaže na rahlo prevladovanje sredozemskih elementov. Avtor poroča o 84 taksonih kukavičevke, od materi je 14 endemičnih ali subendemičnih ter 7 taksonov, ki so na robu njihovega območja razširjenosti. Dobljeni podatki potrjujejo velik floristični pomen province.

Ključne besede: Pokrajina L'Aquila, Orchidaceae, seznam taksonov, floristični elementi

Fig.3/Sl.3: *Neotinea tridentata* ***(Photo: A. Pezzetta)***

BIBLIOGRAFIA

Abbate, G., A. R. Frattaroli, N. Tartaglini, F. G. Corbetta, A. Acosta & L. Filesi (1996): Il paesaggio vegetale lungo il transetto "Imbocco del traforo - Macchia Grande". Analisi floristica ed osservazioni sindinamiche. In: Cicolani B. (cur.): Monitoraggio biologico del Gran Sasso, Vol. I: 75-88. Andromeda editrice, Castelli (TE).

Abbate, G., G. Pirone, G. Ciaschetti, S. Bonacquisti, E. Giovi, D. Luzzi & E. Scassellati (2003): Considerazioni preliminari sui boschi a *Fagus sylvatica* L. e *Taxus baccata* L. dell'Italia peninsulare e della Sicilia. Fitosociologia, 40 (1), 97-108.

Allasia, G. L. (2012): Le stazioni di *Nigritella rubra* subsp. *widderi* (Teppner & E. Klein) H. Baumann & R. Lorenz sulla serra di Rocca Chiarano (Barrea, Abruzzo). GIROS, Notizie 49, 75-76.

Ballelli, S. (1999): Entità di notevole interesse rinvenute sull'Altopiano di Campo Imperatore e zone limitrofe (Gran Sasso d'Italia). Braun-Blanquetia, 16, 33-52.

Baldoni, M., E. Biondi & A. R. Frattaroli (1999): Caratterizzazione bioclimatica del Gran Sasso. Braun-Blanquetia, 16, 7-20.

Bartolucci, F., F. Conti, D. Tinti, E. Scassellati & D. Di Santo (2007): La flora del Parco Nazionale del Gran Sasso e dei Monti della Laga: metodologia e primi risultati. Biogeographia, 27, 39-44.

Baumann, B. & H. Baumann (1988): Ein Beitrag zur Kenntnis der Gattung Epipactis Zinn im Mittelmeergebiet. J. Eur .Orch., 20 (1): 1- 68.

Biagioli, M. P. Grünanger, & K. Kreutz (2015): Nuove combinazioni a rango sottospecifico di alcune *Ophrys*. GIROS Orch. Spont., 58 (1), 5-8.

Biondi, E., S. Ballelli, F. Taffetani, A. R. Frattaroli, J. Guitian & V. Zuccarello (1999): La vegetazione di Campo Imperatore (Gran Sasso d'Italia). Braun-Blanquetia, 16: 53-117.

Betti, S. 1997: Una settimana in Abruzzo. GIROS, Notizie 6, 7-9.

Bongiorni, L., R. De Vivo & S. Fori (2014): *Epipactis tremolsi* C. Pau ed *Epipactis helleborine* subsp. *latina* W. Rossi & E. Klein: considerazioni sul valore di questi taxa. GIROS Notizie 55: 85-88. – GIROS, Notizie 31, 12-15.

Brocchi S., 1822: Osservazioni naturali fatte in alcune parti degli Appennini degli Abruzzi. Bibliot. Itale quattordici, 363.

Brunamonte, A. R., G. Picone, M. Rempicci, A. Gransinigh, M. Antonj, S. Magrini & S. Buono (2015): *Ophrys ×camusii* e *Ophrys ×hybrida*, due ibridi del genere *Ophrys* nuovi per l'Abruzzo (Italia centrale). A. Eur. Orchi, 47 (1), 65.

Colella, A., E. De Santis, G. Frizzi & R. Soldati (2011): Orchidee spontanee d'Abruzzo e chiavi analitiche digitali per il loro riconoscimento. Lucoli (AQ).

Conti, F., A. Manzi & F. Pedrotti (1992): Libro rosso delle piante d'Italia. Tipar litografica, Roma.

Conti, F. (1995): Prodromo della Flora del Parco Nazionale d'Abruzzo. Almadue srl, Roma.

Conti, F. (1998): An annotated checklist of the flora of the Abruzzo. Bocconea, 10, 1-276.

Conti, F. & F. Bartolucci (2015): The Vascular Flora of the National Park of Abruzzo, Lazio and Molise (Central Italy). An Annotated Checklist. Geobotany Studdies (eBook) DOI 10.1007/978-3-319-09701-5

Conti, F. & F. Bartolucci (2016): The vascular flora of Gran Sasso and Monti della Laga National Park (Central Italy. Phytotaxa, 256. Magnolia Press, Auckland.

Conti, F., F. Bartolucci, C. Catonica, G. D'Orazio, I. Londrillo, M. Manzi & D. Tinti (2006): Aggiunte alla Flora d'Abruzzo. I Contributo. Inf. Botan. Ital., 38 (1), 113-116.

Conti, F. & M. Pellegrini (1990): Orchidee spontanee d'Abruzzo. Cogecstre, Penne (PE).

Conti, F. & D. Tinti (2006): I dati di base della flora vascolare del Parco Nazionale della Majella. In: Atti del convegno "La Biodiversità vegetale Nelle Aree Protette in Abruzzo: studi ed esperienze a confronto " (Di Cecco M. & T. Andrisano, *eds*): pp. 183-191. Ente Parco Nazionale della Majella. Litografia Botolini, Rocca San Giovanni (Ch).

Conti, F. & D. Tinti (2008): Il lago di Campotosto e la sua flora. Litografia Brandolini. S. Giovanni Teatino (Ch).

Conti, F. & D. Tinti (2012): Flora vascolare della Riserva Naturale "Gole del Sagittario" (Abruzzo). Bollettino del Museo Civico di Storia Naturale di Verona, 36, Botanica Zoologia, 3-30.

Crugnola, G. (1894): La vegetazione del Gran Sasso d'Italia, Teramo.

Daiss, H. & H. Daiss H. (1996): Orchideen um die Majella (Abruzzen, Italien). J. Eur. Orch., 28 (4), 603-640.

Delforge, P. (2005): Guide des orchidées d'Europe, d'Afrique du Nord et du Proche Orient. 3e e., Delachaux et Niestlé, Paris (F).

Delforge, P. (2015): Nouvelles contributions taxonomiques et nomenclaturales aux Orchidées d'Europe. Les Naturalistes belges, 96 (hors-série), 14-21.

Del Prete, C. (1982): Sintesi dei problemi tassonomici e corologici delle orchidacee dell'Italia peninsulare. Atti Soc. Tosc. Sci. Nat., Mem., Ser. B, 89, 251-268.

Devey, D. S., R. M. Bateman, M. F. Fay & J. A. Hawkins (2009): Genetic structure and systematic relationships within the *Ophrys fuciflora* aggregate (Orchidaceae: Orchidinae): high diversity in Kent and a wind-induced discontinuity bisecting the Adriatic. Ann. Bot. (Oxford), 104 (3), 483-495.

Di Bartolomeo, F. E., D. Febbo, M. Gigante & G. Odoardi (2002): Riserva Zompo Lo Schioppo. Piano di assetto naturalistico. Ed. Cogecstre, Penne (Pe).

Di Pede, A. (2001): *Ophrys sphegodes* Mill. subsp. *majellensis* H. & H. Daiss ed altre *Orchidaceae* della bassa Val Roveto. GIROS, Notizie 18, 14-20.

Falqui, G. (1899): Contributo alla flora del Bacino del Liri. – Atti Accad. Sc. Fis. Nat. di Napoli ser., 2 (9), 1-51.

Faurholdt, N. (2009): Notes on *Ophrys fuciflora* s.l. in Croatia and Central Italy. J. Eur. Orch. 41 (3/4), 635-642.

Galetti, G. (2008): Abruzzo in fiore. Ed. Menabò. Ortona (Ch).

Frizzi, G., F. Tammaro & P. Guarrera (1996): Studio floristico delle Gole di Celano (Abruzzo, Italia) e principali tipologie vegetazionali. Micologia e Vegetazione Mediterranea, 11, 33-52.

GIROS (A cura) (2009): Orchidee d'Italia: guida alle orchidee spontanee. Ed. Il Castello, Cornaredo (MI).

Gransinigh, E., F. R. Brunamonte, M. Rempicci, S. Buono & M. Grelli (2012): Nuovo limite altimetrico di *Orchis purpurea* Huds. In Italia. Giros, Notizie 49, 80-81.

Gravina, P. (1812): Giornale delle peregrinazioni botaniche eseguita nelle Montagne del Circondario di Scanno dal Sig. Pasquale Gravina. Giornale Enciclopedico di Napoli, 6, 3-49.

Griebl, N. (2010): Die Orchideen der Abruzzen. Ber. Arbeitskrs. Heim. Orchid. 27 (2), 123-170.

Groves, H. (1880): Flora del Sirente. Nuovo Giorn. Bot. Ital., 12, 51-68.

Guarrera, P. M. & F. Tammaro (1996): La Flora del M. Sirente e zone limitrofe (Appennino Abruzzese). Tipografia Borgia, Roma.

Gulli, V. & G. Tosi (2009): *Orchis mascula* subsp. *speciosa* (Mutel) Hegi. In: GIROS 2009: Orchidee d'Italia, 106. Ed. Il Castello, Cornaredo (MI).

Gussone, G. (1826): Plantae rariores quas in Itinere per Oras Ionii as Adriatici maris et per regiones Samnii et Aprutii collegit J. Gussone, Regia Tip., Napoli.

Hennecke, G. & M. Hennecke (1999): Neue Orchideen-Funde in den Abruzzen (Italien). J. Eur. Orch., 31 (4), 936-948.

Hertel, S. & H. Presser (2006): Zur Kenntnis der Italienischen Orchideen. J. Eur. Orch., 28 (3), 485-532.

Hertel, S. & H. Presser (2009): Zur Kenntnis der Italienischen Orchideen. Nachtrag. J. Eur. Orch., 41 (1), 195-209.

Hertel, S. & H. Presser (2015): Weitere Erkenntnisse zu *Epipactis*-Arten in Italien. Ber. Arbeitskrs. Heim. Orchid., 32 (2), 79- 109.

Imprescia, U. & G. Picone (2008): Rara Forma teratologica in *Epipogium aphyllum* Sw. Nel Parco Regionale Velino-Sirente (Abruzzo). GIROS, Notizie 37, 36-37.

Lastoria, M. (1988): Orchidee in Abruzzo. Edizioni Deltagrafica, Teramo.

Lorenz, R., M. Akhalkatsi, P.L. Cortis, R. Galesi, G. Giotta, J. Madl, E. Obrist, M. Piccitto, V. A. Romano, R. Romolini & R. Soca (2015): Morphometrische Untersuchungen zur Variabilität und Gliederung der Gattung *Platanthera* in Italien. J. Eur. Orch., 47 (1), 123- 238.

Lucchese, F. & E. Lattanzi (1991): Nuovo contributo alla Flora del Massiccio del Velino. Ann. Bot., 49 (supplemento 1), 137-200.

Marchesetti, C. (1875): Una gita al Gran Sasso d'Italia. Boll. Soc. Adriat. Sc. Nat., 6, 243.

Mauri, E., A. Orsini & M. Tenore (1830): Enumeratio plantarum quas in itinere per Aprutium vel per Pontificiae ditionis finitimas provincias, aestati anni 1829 colligerunt. Atti Accad. Pontam. 1, 185, 326, Napoli.

Nardelli, R. (1883): Climatologia, vegetazione, agronomia della Marsica prima e dopo il prosciugamento del Lago del Fucino. Tip. Marsicana, Avezzano.

Paris, P. & S. Scivola (2011): *Ophrys speculum* Link: un'altra segnalazione per l'Abruzzo. GIROS, Notizie 48, 62-63.

Pedrotti, F., D. Gafta, A. Manzi & R. Canullo (1992): Le associazioni vegetali della Piana di Pescasseroli (Parco Nazionale d'Abruzzo). Documents phytosociologiques, 14, 123-147.

Petriccione, B. (1993): Flora e vegetazione del Monte Velino (Appennino Centrale). Ministero delle Risorse Agricole, Alimentari e Forestali.Collana Verde, 92, Roma.

Petrucci, F. (2013): Gioielli della natura tra il Parco Nazionale d'Abruzzo e il Monte Vettore. GIROS, Notizie 53, 97-102.

Pezzetta, A. (2011): Fitogeografia delle orchidee italiane. GIROS, Notizie 47, 36-53.

Pezzetta, A. (2013): Le *Orchidaceae* della Majella. GIROS, Notizie 53, 44-60.

Pezzetta, A. (2015): Le *Orchidaceae* del Gran Sasso d'Italia (Abruzzo). GIROS, Orch. Spont. Eur., 58 (2), 197-213.

Pignatti, S., (1982): Flora d'Italia, voll. I-III. Edagricole, Bologna.

Pirone, G. (1997): Il paesaggio vegetale di Rivisondoli. Edigrafital S. p. A., S. Atto, Teramo.

Pirone, G., F. Corbetta, A. R. Frattaroli & F. Tammaro (1997): Ricerche sulla Valle Peligna (Italia centrale, Abruzzo : La copertura vegetale. In Osella, B. G., M. Biondi, C. Di Marco & M. Riti: Ricerche sulla Valle Peligna (Italia Centrale, Abruzzo), Vol I, 81-112. Amministrazione provinciale, L'Aquila.

Pirone, G., A. R. Frattaroli, E. Biondi, S. Casavecchia & S. Pesaresi (2010): La vegetazione forestale del Parco Nazionale del Gran Sasso e dei Monti della Laga. It. For. Mont., 65 (6), 699-735.

Pirone, G., A.R. Frattaroli, F. Conti, G. Ciaschetti & F. Di Martino (2007): Aspetti fitogeografici del Parco Naturale Regionale Sirente - Velino. Biogeographia, 27, 199-148.

Pirone, G. & A. Manzi (2003): Un bosco residuo a cerro, rovere, farnia e carpino bianco nei dintorni dell'Aquila (Abruzzo, Italia centrale). Inform. Bot. Ital., 35 (2), 321-327.

Rempicci, M., E. Gransinigh & S. Buono, F. R. Brunamonte & S. Magrini (2012): Duplicazione del viscidio in *Epipogium Aphyllum* SW. GIROS, Notizie 50, 62-63.

Romolini, R. & R. Soca (2011a): New species in *Ophrys* (*Orchidaceae*) to the Italian and French Florae. J. Eur. Orch., 43 (4), 750-784.

Romolini, R. & R. Soca (2011b): Una stazione di *Ophrys lacaitae* Lojac., nuovo limite Nord per la specie in Italia. GIROS, Notizie 46, 48-49.

Romolini, R. & R. Soca (2014): Descrizione di dieci nuovi ibridi di *Ophrys* italiane. GIROS, Notizie 55, 48-68.

Romolini, R. & R. Souche (2012): *Ophrys* d'Italia. Éd. Sococor, Saint Martin de Londres (F).

Rossi, W., G. Pirone, A. R. Frattaroli & L. Di Martino (2008): Fiori del Gran Sasso d'Italia. Edizioni L'Una, L'Aquila.

Sedeek, K. E. M., G. Scopece, A.M., Staedler, J. Schönenberger, S. Cozzolino, F. P. Schiestl & P. M. Schlüter (2014): Genic rather than genome-wide between sexually deceptive *Ophrys* orchids with different pollinators. Mol. Ecol., 23, 6192-6205.

Soca, R. (2008): Presenza di *Ophrys riojana* Hermosilla in Italia. GIROS, Notizie 38, 41-43.

Soca, R. (2014): Description of ten new Ophrys-hybrids (Orchidaceae) of the Abruzzo (Italy) J. Eur. Orch., 46 (3/4), 661 - 678.

Soca, R. (2015): Aggiornamento della presenza di *Ophrys riojana* in Italia. GIROS, Orch. Spont. Eur. 58 (1),: 88-97.

Souche, R. (2008): Hybrides d'*Ophrys* du bassin méditerranèen occidental. Éd. Sococor, Saint Martin de Londres (F).

Tammaro, F. (1998): Il paesaggio vegetale d'Abruzzo. Cogecstre Edizioni, Penne (PE).

Tenore, M. (1811-1838): Flora Napolitana ossia descrizione delle piante indigene del Regno di Napoli e delle più rare specie di piante esotiche coltivte nei giardini, 1-5. Stamperia Reale, Tipografia del Giornale Enciclopedico e Stamperia Francese, Napoli.

Tenore, M. & G. Gussone (1842): Memorie sulle peregrinazioni eseguite dai soci ordinari Singori M. Tenore e G. Gussone. Stamperia Reale, Napoli.

Tomaselli, R., A. Balduzzi, S. Filipello (1973): Carta bioclimatica d'Italia. Collana verde n°33. Ministero Agricoltura e Foreste, Roma.

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OPHRYS ILLYRICA S.HERTEL & K.HERTEL (ORCHIDACEAE), A NEW SPECIES IN THE SLOVENIAN FLORA

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ABSTRACT

Two late flowering specimens from the Ophrys incubacea *group were observed, the first specimen on 11th May 2016 and the second on 19th May 2016 on limestone in the area of Veli Badin above Sočerga, SW Slovenia. Floral macro-morphological characteristics were as follows: very lax inflorescence with small flowers, dark reddish-brown, horizontally aligned lip. The lip was slightly convex, without basal swellings, and with hairless, orange-brown border of the lip (rim) curved upwards. Stigmatic cavity was concolourous with the lip, higher than broader, strongly constricted at the base. Speculum was glossy, dark bluish, edged whitish, π shaped, not branched. Due to the macro-morphological characteristics and late beginning of flowering phase, two specimens were determined as* Ophrys illyrica *S.Hertel & K.Hertel (Orchidaceae), a new bee orchid species in the Slovenian flora.*

Keywords: Orchidaceae*, Ophrys illyrica,* Veli Badin, Istria, SW Slovenia

OPHRYS ILLYRICA S.HERTEL & K.HERTEL (ORCHIDACEAE), NUOVA SPECIE NELLA FLORA SLOVENA

SINTESI

Due esemplari in fioritura tardiva, appartenenti al gruppo Ophrys incubacea*, sono stati osservati l'11 maggio e 19 maggio 2016, sulla pietra calcarea nella zona di Veli Badin, sopra Sočerga (Slovenia SO). Le caratteristiche macro-morfologiche floreali comprendevano un'infiorescenza molto molle con piccoli fiori, di colore rosso-marrone scuro, con il labello allineato orizzontalmente. Il labello era leggermente convesso, senza rigonfiamenti basali, senza peli, con il bordo arancio-marrone e ricurvo verso l'alto. La cavità stigmatica era più alta che larga e fortemente ristretta alla base. La macula era lucida, di colore bluastro scuro, con gli orli biancastri, a forma di π, non ramificata. Viste le caratteristiche macro-morfologiche e il tardo inizio della fase di fioritura, i due campioni sono stati determinati come* Ophrys illyrica *S.Hertel & K.Hertel (Orchidaceae), una nuova specie di orchidee nella flora slovena.*

Parole chiave: Orchidaceae*, Ophrys illyrica,* Veli Badin, Istria, Slovenia SO

INTRODUCTION

The orchid genus *Ophrys* is known for its distinctive floral morphology and remarkable pseudocopulatory reproductive strategy (Cozzolino & Scopece, 2008; Devey *et al.*, 2008; Schiestl & Cozzolino, 2008; Cortis *et al.*, 2009).

Ophrys incubacea s.l. (*sensu lato*) is, according to Delforge (2006) a group of ten western species, and some varieties, distributed from Spain to Italy, Slovenia and Croatia, Montenegro and Albania to the southeast. Some of them are very localized, like *Ophrys sipontensis* R. Lorenz & Gembardt which is endemic to the south of mount Gargano (Siponto plain) in Italy and *Ophrys aveyronensis* (J. J. Wood) P. Delforge, endemic to the south of the French Massif Central, mainly on the Causse du Larzac (Delforge, 2006). All species of this group tend to have broad petals, their stigmatic cavities of the same dark colour as the central part of their lip, which tells them apart from those of the closely related, *Ophrys sphegodes s.l.* group which always have the stigmatic cavity lighter than the central part of the lip (Delforge, 2006).

According to Martinčič *et al.* (2007), 8 species from the genus *Ophrys* are present within the Slovenian territory, 2 of them belonging to the *Ophrys incubacea* group: *Ophrys incubacea s.s.* (*sensu stricto*) and *Ophrys tommasinii* Visiani. *Ophrys incubacea* Bianca is restricted to Istria with less than five known localities in Slovenia. For Slovenian coast (Piran and Koper) this species was already mentioned by Marchesetti (1896-1897) using the synonym *Ophrys atrata* Lindl. *Ophrys incubacea s.s.* was/is often confused with *Ophrys sphegodes s.s.* for different reasons. Its actual distribution in Slovenia is much more localized than many authors assume or claim. In Slovenia, the occurrence of the second taxa, *Ophrys tommasinii*, syn. *Ophrys aranifera* subsp. *tommasinii* (Visiani) E.G. Camus, still remains questionable.

Hertel and Hertel (2002) have presented a paper in Journal Europäischer Orchideen devoted to orchids from Croatian Istria. They report on late flowering group of *Ophrys sphegodes*-like species with relatively small flowers, but belonging to the *Ophrys incubacea* group. They flower successively and are quite easily distinguished by the numerous morphological features (Tab. 1). They consider the early, in April flowering species, as *Ophrys tommasinii*, and name the other one, flowering from early May to mid-June as *Ophrys illyrica* S. Hertel & K. Hertel, synonym *Ophrys araneola* subsp. *illyrica* (S.Hertel & K. Hertel) Kreutz. It is possible to distinguish both species according to the following morphological features (see also Tab. 1):

- The stigmatic cavity is always significantly higher for an equivalent breadth at *Ophrys illyrica* and the stigmatic head is laced stronger than that of *Ophrys tommasinii*.
- The column (gynostemium) always makes a larger angle with the lip in the case of *Ophrys illyrica*, as it does by *Ophrys tommasinii* where they are roughly parallel.
- The lip of *Ophrys tommasinii* frequently shows small round gibbosities (swellings) usually absent in *Ophrys illyrica*, the flowers of which don't quickly fade after anthesis.
- *Ophrys illyrica* flowers almost a month later than the *Ophrys tommasinii* in the same altitudes.

According to Ravnik (2002) and Dolinar (2015), *Ophrys tommasinii* grows in Slovenian Istria (Krkavče, Marezige, Sočerga). *Ophrys illyrica* on the other hand was thought to be a Croatian endemic (Delforge, 2006). *Ophrys illyrica* is the third and last flowering species of small flowered *Ophrys sphegodes*-like species in southern Istria and Kvarner archipelago. Its locus typicus being on the island of Cres. The species was already recorded from the Rijeka area, southern part of Istrian peninsula, island of Krk, Cres and Lošinj islands (Rottensteiner *et al.*, 2014). Central Istria was thought to be the northernmost border of its areal (Rottensteiner *et al.*, 2014). The other two species referred to, are *Ophrys tommasinii* and, controversial *Ophrys incantata* Devillers & Devillers-Tersch. (probably the *Ophrys tommasinii* in the Northern Adriatic). In Croatia, the flowering period of three *Ophrys* species with small flowers follow each other. It begins in central and southern Dalmatia with *Ophrys incantata* in March and early April. According to Delforge (Delforge, 2006), *Ophrys incantata* belongs to the *Ophrys axaltata* group. According to the Flora Croatica Database (Nikolić, 2015), this species is restricted to the central Dalmatia (Dalmatinska zagora, Primošten). On the other hand, Kranjčev (2005) doesn't mention the species *Ophrys incantata* for Croatia at all. The species *Ophrys tommasinii* follows in April and *Ophrys illyrica* is the last one, flowering from May to mid-June.

To summarize, Hertel and Hertel (2002) describe a small flowered species from Croatia as *Ophrys illyrica*, which is in flower in May and June, about a month later than *Ophrys tommasinii*. Its stigmatic cavity is higher and the stigmatic head is laced stronger than that of *Ophrys tommasinii*. The horizontally aligned lip is a characteristic feature of *Ophrys illyrica* (in addition to the late flowering). The colour of the labellum is a dark reddish brown, while the labellum of *Ophrys tommasinii* has a lighter yellowish brown colour.

MATERIAL AND METHODS

Two late flowering specimens from the *Ophrys incubacea s.l.* group were observed on 11th May and 19th May 2016 on limestone in the area of Veli Badin above Sočerga (Figs. 1 and 2D) in the altitude of about 330 m in dry grassland belonging to the *Satureion subspicatea* alliance. Its floral macro-morphological characteristics were compared with those of the *Ophrys incubacea* group members: *Ophrys illyrica*, *Ophrys incubacea s.s.* and *Ophrys tommasinii*, but also with *Ophrys sphegodes*

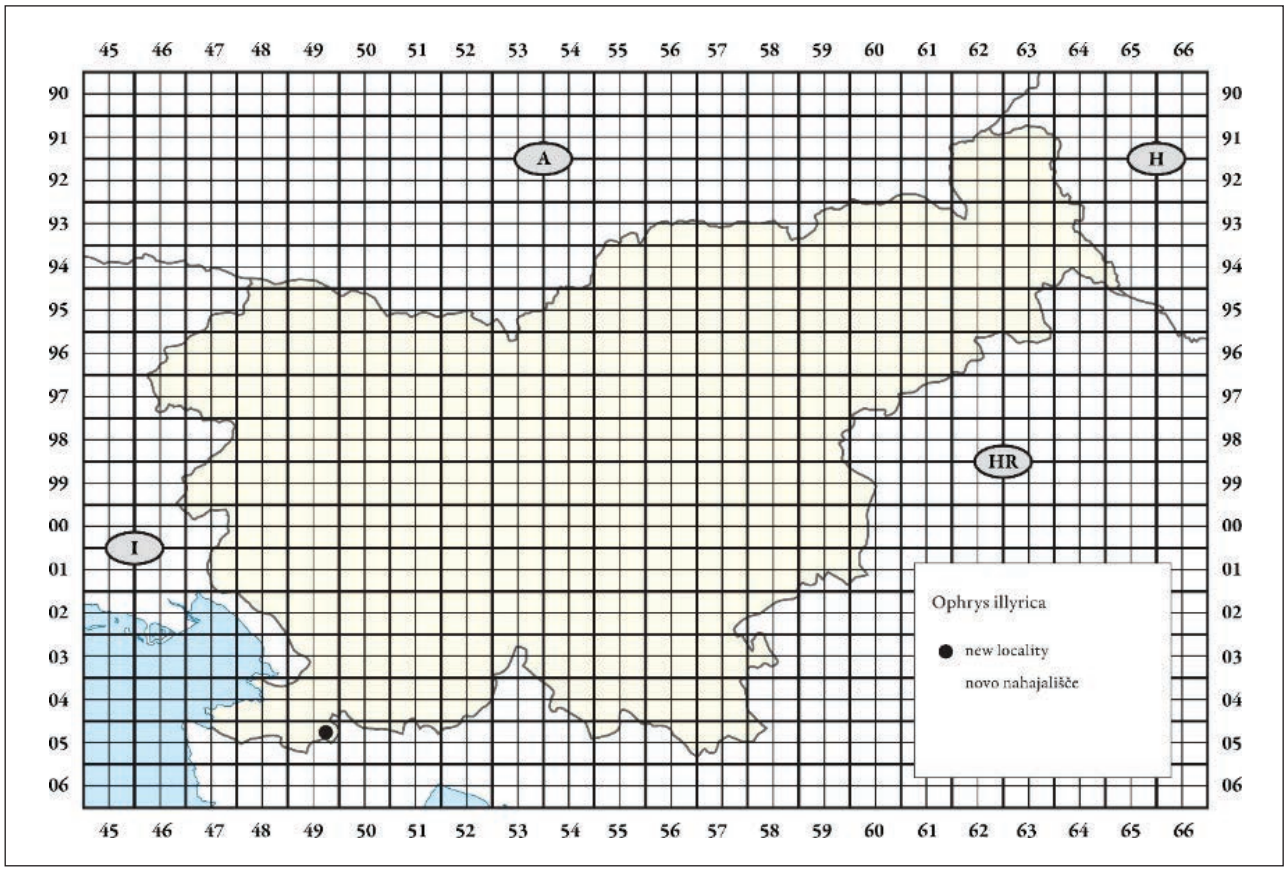

Fig. 1: Map of Slovenia with the** Ophrys illyrica **locality in Slovenian Istria.
Sl. 1: Karta Slovenije in lokacija rastišča Ilirskega mačjega ušesa (**Ophrys illyrica**) v slovenski Istri.

s.s. (*Ophrys sphegodes* group) in order to determine its taxonomic status. All photographs and measurements were done in the field.

RESULTS

The plants were 27 cm and 30.8 cm tall, with 7 flowers and 5 flowers. Only two of the flowers per each plant were fully opened at the time of observation (Figures 2A and 2C). Both inflorescences were very lax. The lip was horizontally aligned (Fig. 2B), entire, small, in average 9.8 mm long, dark reddish-brown, flat, slightly convex and without basal swellings. The border of the lip (rim) was hairless, orange-brown curved upwards. Speculum was glossy, dark bluish, edged whitish, π shaped, not branched. Stigmatic cavity was concolorous with lip, strongly constricted at its base, bluish specular stage was clearly visible. Pseudo eyes were blackish, encircled pale bluish with a whitish bridle. Petals were broadly lanceolate with the undulated rim (Fig. 2A). The column was not parallel with the lip (Fig. 2B). Due to the morphological features (Tab. 1) in addition to the late flowering, both observed specimens were determined as the *Ophrys illyrica*.

DISCUSSION

The potential occurrence of the late flowering, *Ophrys sphegodes*-like specimens from the *Ophrys incubacea s.l.* group in the Slovenian Istria was already speculated (Dolinar, 2015; Kaligarič, 1991; Ravnik, 2002). Dolinar (2015) mentions the occurrence of the *Ophrys tommasinii* in Slovenian Istria. Pospichal (1897) mentions the occurrence of the *Ophrys tommasinii* (syn. *Ophrys aranifera* Huds. Fl.), but only for central and southern Istria (Svetvinčenat, Barban, Bršica). Also Pospichal (1897) mentions the occurrence of the *Ophrys fucifera* Sm. Brit. (*Ophrys fucifera* is a synonym of *Ophrys sphegodes* Mill.). The author distinguishes between three types: α- forma typica (*Ophrys sphegodes s.s.*), species is common in flysch (Koper, Izola), ß- atrata (*Ophrys incubacea s.s.*), species restricted to limestone, terra rossa and γ- pseudospeculum (Volovica, Pazin). The pseudospeculum form flowers till June. It seem quite possible that, according to Pospichal (1897), the pseudospeculum term refers to *Ophrys illyrica* due to its late flowering. *Ophrys illyrica* specimens from Veli Badin only started flowering at the time of the observation, according to Dolinar (2015) *Ophrys tommasinii*

Tab. 1: Floral macro- morphological and other differences between members of the** Ophrys incubacea **group, native to Slovenia and** Ophrys sphegodes s.s. **according to Delforge (2006) and Rottensteiner** et al. **(2014).
Tab. 1: Makro- morfološke razlike cvetov ter druge razlike med, v Sloveniji samoniklimi vrstami mačjih ušes iz oblikovnega kroga** Ophrys incubacea **in** Ophrys sphegodes**. Povzeto po Delforge (2006) in Rottensteiner s sod. (2014).

	Ophrys incubacea group				***Ophrys sphegodes*** *group*
	Ophrys tommasinii	***Ophrys incubacea*** *s.s.*	***Ophrys illyrica***	**specimens from Veli Badin**	***Ophrys sphegodes*** *s.s.*
Inflorescence	rather dense (2-11 small flowers)	lax (3-8 relatively large flowers)	very lax (2-10 small flowers)	very lax with 7 flowers and 5 flowers	lax (3-12 flowers)
Sepals	spreading, whitish-green, lanceolate	green (slightly whitish), rarely pinkish, spreading, oval-lanceolate	spreading, greenish, lanceolate	spreading, greenish, lanceolate	broadly oval-lanceolate, bright green, whitish green, yellowish or olive-green
Petals	narrowly lanceolate, entire, chestnut-brown to yellowish-brown	green to brown, sometimes pink, darker than sepals, narrowly to broadly lanceolate	broadly lanceolate, margins undulate yellowish-brown	broadly lanceolate, margins undulate, yellowish-brown	spreading, greenish-yellow to olive-green, of various shape: oblong, lanceolate, oval, margins strongly undulate
Lip	light yellowish brown , pronounced convex, with rounded basal swellings, not longer than 9 mm	entire or obscurely 3 lobed, up to 14 mm long, dark brown to blackish, margins turned down	dark reddish-brown, slightly convex without basal swellings, 9.5-10 mm long	horizontally aligned, dark reddish-brown, slightly convex without basal, 9.6- 10 mm long	chestnut brown, reddish-brown, entire rarely 3 lobed, up to 15 mm long, convex, margins turned down
Basal swellings	more or less marked	prominent triangular basal swellings, up to 4 mm high, hairless on inner side	absent	absent	more or less well marked
Speculum	basal, drab, dark greyish, edged whitish	central, rather simple forming H shape, blue, glossy, rarely edged whitish	basal, slightly glossy, dark bluish, often edged whitish	π shaped, glossy, dark bluish, edged whitish	greyish to bluish, glossy, often simply forming a thickened H shape
Stigmatic cavity	paler, greenish-grey, with a blurred bluish to whitish specular stage, not obvious	concolourous with the centre of the lip, contrasting with their whitish edges, floor with a strongly contrasting white or pale bluish specular stage	concolourous with lip, higher than broad, strongly constricted at the base	concolourous with lip, higher than broad, strongly constricted at the base	and basal field rather reduced, coloration paler than centre of the lip, stigmatic cavity rounded
Pseudo-eyes	greenish-grey, iridescent, rather large and globular	circular, spotted black or blue in centre, edged pale blue	blackish, contrastingly encircled pale bluish	blackish, contrastingly encircled whitish-pale bluish	iridescent greenish-grey, sometimes encircled with pale greenish

Flowering season	end III, IV, early V	III-V	late flowering: a month later than *O. tommasinii* V, mid VI	mid V (beginning of the flowering phase)	mid III to late IV in Istria (late III-mid V in continental Slovenia)
Pollinator	*Andrena vulpecula* (Hymenoptera: Andrenidae)	*Andrena morio* (Hymenoptera: Andrenidae)	*Andrena pandellei* (Hymenoptera: Andrenidae)	Pollinator was not observed in the field	*Andrena nigroaenea*, *A. barbilabris*, *A. cineraria*, *A. limata* (Hymenoptera: Andrenidae)

ends with flowering phases in Slovenian Istria already in the mid-April. The flowering period of the *Ophrys sphegodes s.s.* in Slovenian Istria extends from mid-March till the end of April. Because of the poorly known distribution of *Ophrys illyrica* in Slovenia, this taxon should definitely belong to the Slovenian Red List as a vulnerable taxon (V). The reason for this lack of data for Slovenia is mainly due to morphological similarity with the *Ophrys sphegodes s.s.* It is of great importance to closely observe late flowering specimens from the *Ophrys incubacea* group which are flowering from May till June and resemble *Ophrys sphegodes s.s.* On the other hand, closer inspection of the inflorescence and floral elements reveals quite sufficient and reliable morphological dissimilarities between *Ophrys sphegodes s.s.* and *Ophrys illyrica*, but also *Ophrys tommasinii* and *Ophrys illyrica*. The occurrence of this taxon in Slovenia is not surprising, and it is likely to have more localities elsewhere in the Slovenian Istria.

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Sincere thanks to dr. Matej Lipovšek, Branko Dolinar and Jože Kosec for the confirmation of the *Ophrys illyrica* locality at Veli Badin, Sočerga. Sincere thanks to Dietmar Jakely and prof. Helmut Presser for their help in the determination of *Ophrys illyrica*. Thanks to Mihael J. Kocjan for providing Fig. 1.

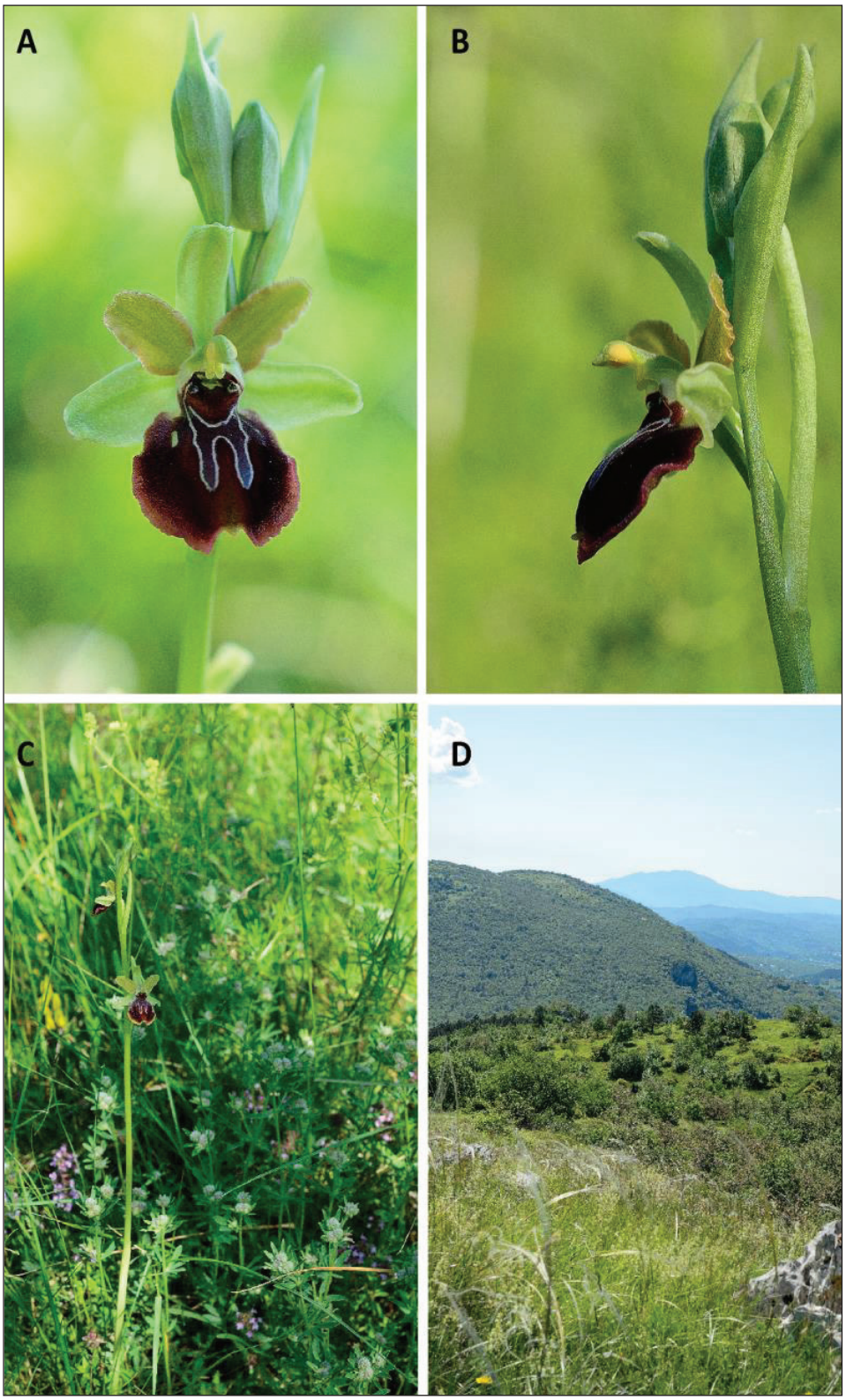

Fig. 2: *Ophrys illyrica* ***at Veli Badin, Istria, SW Slovenia; A- frontal view of the flower, B- lateral view, C- habitus, D- habitat (Photo: I. Paušič, 19.5.2016).***
Sl. 2: Ilirsko mačje uho *(Ophrys illyrica)* ***z rastišča Veli Badin, Istra, JZ Slovenija; A- sprednji pogled na cvet, B- stranski pogled, C- celotna rastlina, D- habitat (Photo: I. Paušič, 19.5.2016).***

OPHRYS ILLYRICA S.HERTEL & K.HERTEL (ORCHIDACEAE), NOVA VRSTA V FLORI SLOVENIJE

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POVZETEK

Na območju spodmolov Veli Badin nad Sočergo (Istra, JZ Slovenija) smo 11. in 19. maja 2016 naleteli na dva, kasno cvetoča primerka mačjih ušes (rod Ophrys*) iz oblikovnega kroga* Ophrys incubacea. *Primerka sta imela majhne cvetove in rahlo socvetje. Vodoravno nastavljena medena ustna je bila temno, rdečerjavo obarvana in le rahlo konveksna, brez lateralnih grbin. Rob medene ustne je bil svetlejšega odtenka, oranžno rjav, z rahlo navzgor uvihanim robom. Brazdna votlina je bila pri obeh primerkih višja kot široka, na bazi močno zažeta. Risba (lat.* macula*) je bila bleščeča, modro obarvana s kontrastno, belo obrobo, ne razvejana. Zaradi omenjenih makro morfoloških znakov cvetov in kasnega začetka cvetenja smo najdena primerka mačjih ušes determinirali kot Ilirsko mačje uho,* Ophrys illyrica *S.Hertel & K.Hertel (Orchidaceae), novo vrsto v flori Slovenije.*

Ključne besede: Orchidaceae, *Ophrys illyrica*, Veli Badin, Istra, JZ Slovenija

REFERENCES

Cortis, P, N.J. Vereecken, F.P. Schiestl, M.R. Barone Lumaga, A. Scrugli & S. Cozzolino (2009): Pollinator convergence and the nature of species' boundaries in sympatric Sardinian *Ophrys* (Orchidaceae). Annals of Botany, 104, 497–506.

Cozzolino, S. & G. Scopece (2008): Specificity in pollination and consequences for postmating reproductive isolation in deceptive Mediterranean orchids. Philosophical Transactions of the Royal Society of London B 363, 3037–3046.

Delforge, P. (2006): Orchids of Europe, North Africa and the Middle East. A&C Black publishing, London, 640 pp.

Devey, D.S., R.M. Bateman, M.F. Fay & J.A. Hawkins (2008): Friends or relatives? Phylogenetics and species delimitation in the controversial European orchid genus *Ophrys*. Annals of Botany, 101, 385–402.

Dolinar, B. (2015): Kukavičevke v Sloveniji. Pipinova knjiga, Ljubljana, 183 p.

Dolinar, B. (2015): Contribution to the knowledge of the taxa from the groups *Ophrys sphegodes s.lat*. and *Ophrys holosericea s.lat*. in Slovenia. Folia biologica et geologica, 56/3, 37–49.

Hertel S. & K. Hertel (2002): Beobachtungen zu den Orchideen Istriens. Jour.Europ.Orchid., 34/ 3, 493–542.

Kaligarič, M. (1991): Prispevek k poznavanju razširjenosti orhidej (Orchidaceae) Slovenske Istre, Annales, Series historia naturalis (Koper), 1/1, 33–40.

Kranjčev, R. (2005): Hrvatske orhideje. Agencija za komercialnu djelatnost d.o.o., Zagreb, 517 pp.

Marchesetti, C. (1896-97): Flora di Trieste e de' suoi dintorni. Trieste, 1896-97.

Martinčič, A., T. Wraber, N. Jogan, A. Podobnik, B. Turk, B. Vreš, V. Ravnik, B. Frajman, S. Strgulc Krajšek, B. Trčak, T. Bačič, M. A. Fischer, K. Eler & B. Surina (2007): Mala flora Slovenije: ključ za določanje praprotnic in semenk. Tehniška založba Slovenije, Ljubljana, 967 pp.

Pospichal, E. (1897): Flora des Oesterreichischen Küstenlandes 1-2, Leipzig und Wien, 1897-99.

Ravnik, V. (2002): Orhideje Slovenije. Tehniška založba Slovenije, Ljubljana, 192 p.

Rottensteiner, W.K., K.G. Bernhardt, H.P. Comes, G. Dietrich, A. Drescher, H. Duistermaat, U. Eggli, F. Ehrendorfer, P Englmaier, M. Erben, D. Ernet, M.A. Fischer, B. Frajman, W. Franz, G. Gottschlich, W. Gutermann, K.B. von Hagen, R. Hand, D. Jakely, N. Jogan, J.W. Kadereit, N. Killian, M. Klemun, F. Krahulec, G. Krebs, B.P Kremer, K. Kreutz, M. Kropf, J. Kučera, E. Landolt, G.H. Loos, M. Magnes, M. Martinez- Azorin, V. Melzheimer, V. Mikoláš, M. Münch, I.M. Munda, C. Neinhuis, K. Oswald, H. Paulus, M. Pinter, A. Podobnik, A. Polatschek, J.P. Reduron, D. Schantl, U. Starmühler, I. Uhlemann, H. Uhlich, E. Vitek, R. Vogt, G. Wagenitz, H.G. Wagner, J. Walter, S.J.U. Wanke, H.E. Weber, F.H.E. Weberling & G. Wiegleb (2014): Exkursionsflora für Istrien. Verlag des Naturwissenschaftlichen vereins für Kärnten, Klagenfurt, 1014 pp.

Schiestl, F. & S. Cozzolino (2008): Evolution of sexual mimicry in the orchid subtribe Orchidinae: the role of preadaptations in the attraction of male bees as pollinators. BMC Evolutionary Biology, 8, 27.

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PRISPEVEK K POZNAVANJU RAZŠIRJENOSTI METULJASTE KUKAVICE *ANACAMPTIS PAPILIONACEA* (L.) R.M.BATEMAN, PRIDGEON & M.W.CHASE, 1997 (ORCHIDACEAE) NA SEVERNI MEJI AREALA VRSTE

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IZVLEČEK

Metuljasta kukavica (Anacamptis papilionacea) *je vrsta, ki se široko pojavlja predvsem v zahodnem in osrednjem delu Sredozemlja. Poročamo o odkritju dveh novih nahajališč te mediteranske vrste (Sv. Anton, Istra) in Fokovci (Goričko); slednje nahajališče je zelo oddaljeno od njenega sredozemskega areala. Razpravljamo o razširjenosti in širjenju vrste proti severu in vzhodu, vse od najdbe Wraberja iz leta 1975. Goričko je morda najsevernejše znano nahajališče te vrste sploh. Prav to, pa tudi nahajališča na Dolenjskem in v Vipavski dolini, nakazuje širjenje vrste proti celini z disperzijo na dolge razdalje, prav mogoče tudi zaradi globalnega segrevanja.*

Ključne besede: Orchidaceae, *Anacamptis papilionacea*, razširjenost, novi lokaciji, Slovenija

CONTRIBUTO ALLA CONOSCENZA DELLA DISTRIBUZIONE DELL'ORCHIDEA FARFALLA *ANACAMPTIS PAPILIONACEA* (L.) R.M.BATEMAN, PRIDGEON & M.W.CHASE, 1997 (ORCHIDACEAE) SUL CONFINE SETTENTRIONALE DELL'AREALE DELLA SPECIE

SINTESI

L'orchidea farfalla (Anacamptis papilionacea) *è una specie largamente distribuita, in particolare nella parte occidentale e centrale del Mediterraneo. Gli autori riportano due nuove località di ritrovamento di questa specie, la prima è Sant'Antonio (Istria), la seconda è Fokovci (Goričko), che è molto distante dall'areale mediterraneo della specie. Gli autori discutono la distribuzione e la diffusione della specie verso nord e verso est, dal suo primo ritrovamento da parte di Wraber nel 1975. Goričko* è forse la *località più settentrionale conosciuta nell'intero areale di distribuzione della specie. I ritrovamenti di* A. papilionacea *nella Bassa Carniola e nella Valle del Vipacco suggeriscono la diffusione della specie verso la zona continentale con una dispersione su lunghe distanze, probabilmente anche a causa del riscaldamento globale.*

Parole chiave: Orchidaceae, *Anacamptis papilionacea*, distribuzione, nuove località, Slovenia

UVOD

Metuljasto kukavico, *Anacamptis papilionacea* (L.) R.M.Bateman, Pridgeon & M.W.Chase, 1997 (Orchidaceae) razlikujemo od preostalih naših samoniklih vrst kukavičevk (Orchidaceae) predvsem zaradi značilnega videza, oblike medene ustne ter po velikih rdečerožnatih cvetovih. Glede morfoloških lastnosti cvetov je vrsta izredno variabilna. Predvsem medena ustna se pojavlja v različnih barvnih odtenkih in z vzorci, zaradi katerih številni avtorji prepoznajo posamezne podvrste, ekotipe (Delforge, 2005). Metuljasta kukavica je južnoevropsko-mediteranska vrsta (Aeschimann *s sod.*, 2004), njena razširjenost obsega območje večjega dela Mediteranskega bazena južno od Alp. Vrsta se pojavlja v severni Afriki, na Iberskem, Apeninskem in Balkanskem polotoku ter na vzhodu do Anatolije in Kavkaza (Delforge, 2005). Zahodna Romunija (pokrajina Banat) (Delforge, 2005) je veljala do sedaj kot območje kjer doseže areal vrste severno mejo. Flora Helvetica (Lauber & Wagner, 2001) za Švico navaja enkratno najdbo metuljaste kukavice v južnem predelu kantona Tessin, južnoalpsko področje, prav tako na severni meji areala vrste. V Sloveniji je metuljasta kukavica zavarovana kot tudi vse druge kukavice (Anonymus, 2004) in na Rdeči seznam uvrščena kot ranljiva vrsta (V) (Wraber & Skoberne, 1989; Anonymus, 2002). V sosednji Hrvaški je prav tako uvrščena na rdeči seznam kot ranljiva vrsta (Nikolić & Topić, 2005). Največ njenih nahajališč je znanih v Istri, redkejša je na področju Kvarnerja in Dalmacije (Kranjčev, 2005; Rottensteiner *s sod.*, 2014). V notranjosti Hrvaške pa njeno pojavljanje ni znano (Nikolić, 2011; Kranjčev, 2005).

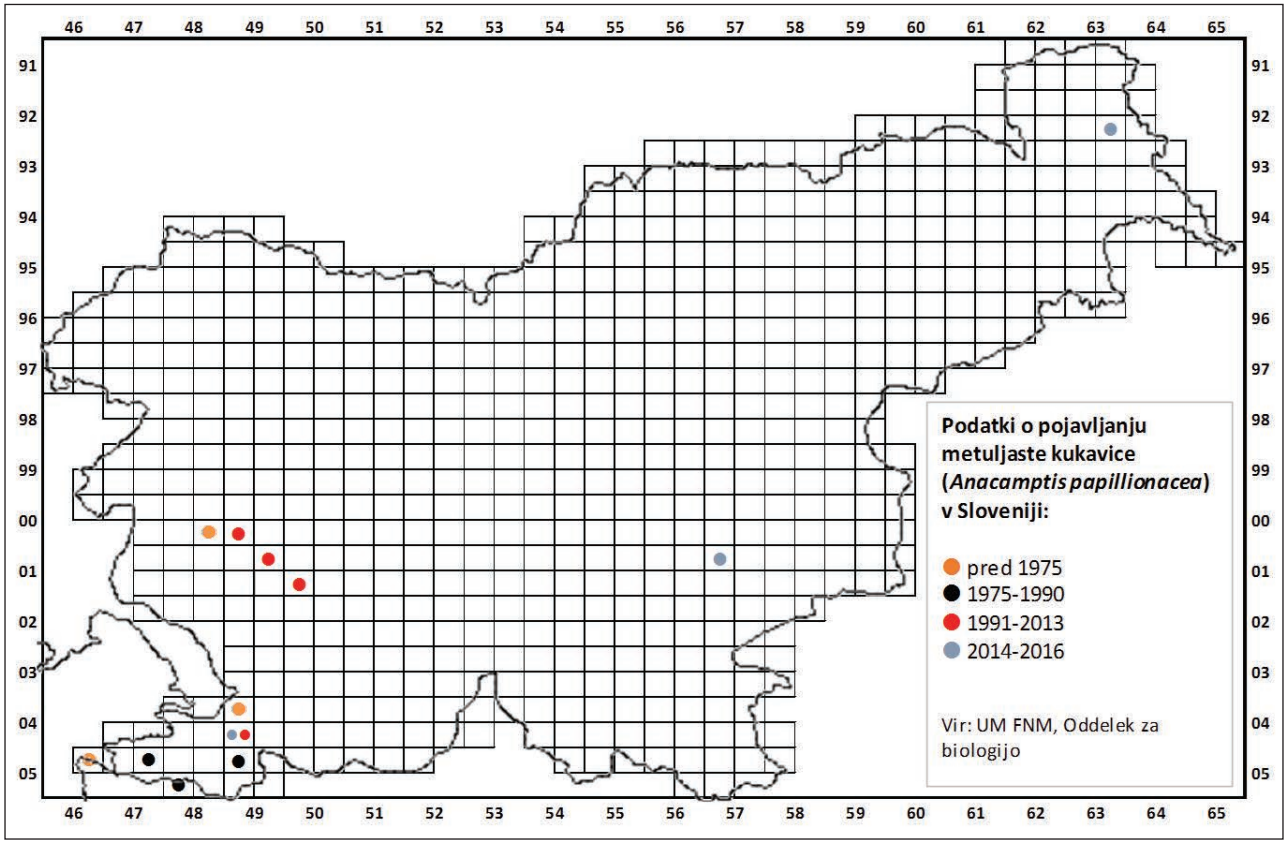
METODE

V prispevku obravnavamo pregled literaturnih virov o pojavljanju vrste v Sloveniji ter predstavljamo dve novi rastišči metuljaste kukavice (*Anacamptis papilionacea*) v slovenski Istri ter v Prekmurju.

REZULTATI IN RAZPRAVA

Pregled rastišč metuljaste kukavice v Sloveniji

Prve omembe pojavljanja metuljaste kukavice za širše območje Slovenije izhajajo še iz časa Scopolija,



Sl. 1: Razširjenost metuljaste kukavice** (Anacamptis papilionacea) **v Sloveniji. Vključeni so arhaični podatki o rastiščih kjer se vrsta danes ne pojavlja več, kot tudi na novo odkrite lokacije.
Fig. 1: Distribution of the Butterfly orchid** (Anacamptis papilionacea) **in Slovenia. The map is representing recent distribution of the species but also showing locations where the orchid is believed to be extinct.

ki v 2. izdaji »Kranjske flore« (Flora Carniolica, 1772) omenja metuljasto kukavico v toplejših predelih Kranjske (»Habitat in Carniolia calidiore«, mišljeno je območje Istre), vendar točnih lokacij ne navaja (Wraber, 1975). O tej kukavici sta v tistem času za »toplejšo Kranjsko« pisala tudi Fleischman in Tommasini (Wraber, 1975), čeprav sta Marchesetti in Pospichal (1897) »toplejšo Kranjsko« opredelila kot območje Istre južneje od Savudrije. V Furlaniji-Julijski krajini Poldini navaja lokaliteto na apnenčastem osamelcu pri kraju Medea in v Tržaškem zalivu pri kraju Stramare, tik ob meji s Slovenijo (Poldini, 2009). Metuljasta kukavica je v Sloveniji redka vrsta, ki jo je T. Wraber 29.4.1975 našel na Steni v dolini Dragonje ter istega dne še pri razvalini Štefanove cerkve (Sv. Štefan) v dolini Dragonje (Wraber, 1975). 11. maja 1975 je takratna študentka biologije Danica Erjavec našla metuljasto kukavico na zahodnem grebenu hriba Grad nad vasjo Sočerga v slovenski Istri (Wraber, 1975). Wraber je že leta 1975 domneval, da se vrsta pojavlja tudi v Vipavski dolini. Fleischmann omenja pojavljanje vrste v Vipavski dolini pri Vipavi (Fleischmann, 1844), navaja kvadrant 0149/4, vendar kasneje botaniki vrste tu niso več našli. 28.4.2011 sta Figelj in Slameršek vrsto našla tudi v Vipavski dolini na travnikih, ki ležijo med vasjo Poreče ter Mlakami pri Vipavi, prvič po letu 1844 (Figelj & Slameršek, 2011). Danes so znana rastišča v Vipavski dolini pri vasi Poreče pri Podnanosu (Figelj & Slameršek, 2011), vasi Cesta (Dakskobler, Anderle, Zupan & Vreš, 2013) in vasi Stomaž (Dakskobler, Anderle, Zupan & Vreš, 2013). Na kraškem robu nad vasjo Podpeč je vrsto odkril Kaligarič (Kaligarič, 1991).

Metuljasta kukavica je bila do nedavnega v Sloveniji znana le iz submediteranskega fitogeografskega območja. Leta 2014 je bila prvič popisana na Dolenjskem (Jerin & Jogan, 2014), leto zatem pa še na Goričkem (Sl. 1).

Nova rastišča metuljaste kukavice v Sloveniji

0449/3 Slovenija: Primorska, Istra, vzhodno od naselja Sv. Anton, suh travnik na flišu, 342 m. Det. I. Paušič & Ž. Cenc, 10.5.2016.

Sl. 2: Metuljasta kukavica** (Anacamptis papilionacea)**: A- Primorska, Istra, vzhodno od naselja Sv. Anton, B- Prekmurje, Goričko, Fokovci. Fotografija A - Igor Paušič, fotografija B - Kristjan Malačič.
Fig. 2: Butterfly orchid** (Anacamptis papilionacea)**: A- Primorska, Istria, east of the settlement Sv. Anton, B- Prekmurje, Goričko, Fokovci. Photos by: A- Igor Paušič, B- Kristjan Malačič.

10.5.2016 smo zabeležili metuljasto kukavico na suhem travniku, na flišu, vzhodno od naselja Sv. Anton v slovenski Istri, na nadmorski višini 340 m. Lokacija se nahaja ob cesti, na poti od Sv. Antona proti Kubedu, blizu gostilne Mohoreč. Za travnik je značilna zaraščajoča se submediteransko-ilirska združba *Danthonio-Scorzoneretum villosae*. Na flišu v slovenski Istri metuljasta kukavica še ni bila zabeležena. Na rastišču smo zabeležili en cvetoč primerek (Sl. 2A), v neposredni bližini pa še 2 primerka *Orchis x gennarii*, križanca med *Anacamptis papilionacea* in *Anacamptis morio*. V neposredni bližini je bilo prisotnih več še cvetočih primerkov *A. morio*, sicer pa sta bila v združbi prisotni tudi vrsti *Serapias vomeracea* in *Neotinea tridentata*. Travnik na južni strani meji na cesto, na severni pa na grmiščno združbo puhastega hrasta in črnega gabra (*Ostryo carpinifoliae-Quercetum pubescentis*). Traviščna združba izkazuje znake ruderalizacije, kar je verjetno posledica kmetijske rabe v preteklosti. Paše ali drugih motečih dejavnikov nismo opazili, morda določeno stopnjo zaraščanja z le nekaterimi grmovnimi vrstami. Obstoj tega majhnega rastišča je dolgoročno vprašljiv in vreden nadaljnjih opazovanj.

9263/4 Slovenija: Prekmurje, Goričko, Fokovci, suh travnik na peščenjaku, 311 m. Leg. Gordana Bači, Det. Branko Bakan.

Metuljasto kukavico so leta 2015 na svojem zemljišču opazili lastniki, člani družine Bači iz Fokovcev, ki so na rastlino opozorili zaposlene Krajinskega Parka Goričko. Fotografirala sta jo Gregor Domajnko in Kristjan Malačič (Sl. 2B). Rastišče je ruderaliziran suh travnik, ki pripada asociaciji *Hypocherido-Festucetum rupicolae*. Primerek je ponovno cvetel tudi v sezoni 2016.

V prispevku navajamo lokacije trenutne razširjenosti metuljaste kukavice (*A. papilionacea*) v Sloveniji in podajamo dve novi lokaciji, in sicer na Goričkem (Fokovci), ki je po trenutno znanih podatkih najbolj severna lokacija na celotnem arealu razširjenosti vrste, in pri kraju Sv. Anton v slovenski Istri, kjer se vrsta pojavlja na flišu. V Prekmurju je najbolj severno popisano nahajališče te vrste pri nas, pri Sv. Antonu pa njeno najbolj južno. Wraber (1975) pri opisu vrste navaja: »Po svoji razširjenosti je metuljasta kukavica tipična mediteranka, ena od orhidej, s katerimi je sredozemska flora tako zelo bogata«. Hkrati opaža, da se vrsta na mikroklimatsko ugodnih rastiščih pojavlja daleč od obmorskih predelov, saj se pojavlja na južnem vznožju Alp (Aosta, Komsko jezero, Goriško) in v južnem Podonavju (Banat, Romunija) (Wraber, 1975). Po do sedaj znanih podatkih, se vrsta v Sloveniji pojavlja v Istri pri Sv. Antonu in na kraškem robu nad vasjo Podpeč, na treh lokacijah v Vipavski dolini, na Dolenjskem ter na Goričkem. Na novo odkrito rastišče metuljaste kukavice na Goričkem se nahaja na sami severni meji areala vrste. Nad vasjo Podpeč ter pri Sv. Antonu se poleg križancev z navadno kukavico (*A. morio*) pojavljajo primerki z vzorcem vzporednih črt na medeni ustni (Dolinar, 2015). Taki primerki so značilni za populacije v Istri, npr. na polotoku Kamenjaku. Na rastiščih v Vipavski dolini srečamo primerke z žlebasto oblikovano, enobarvno, temno rožnato barvo, kot je značilno za primerke iz severne Dalmacije. Tak je bil tudi primerek, ki smo ga zabeležili na novi lokaciji pri Sv. Antonu. Na vseh lokacijah v Sloveniji se vrsta pojavlja prehodno, maloštevilno, kvečjemu z nekaj primerki. Zaradi bližine navadne kukavice (*A. morio*) na istih rastiščih, je vrsta v Sloveniji pogosto podvržena križanju, kar dodatno otežuje disperzijo genetsko čistih primerkov (Podpeč, Sv. Anton). V nekaj letih (2011-2016) je bilo popisanih šest novih lokalitet te vrste pri nas. Ena od možnih razlag je ta, da se vrsta širi tudi v notranjost države. Prekmurje je, takoj za Primorsko, pokrajina z letno najnižjo količino padavin v Sloveniji. Na območju Goričkega, kjer je po večini matična podlaga suhi peščenjak in lapor, se tako pojavljajo nekatere termofilne (sub-mediteranske) rastlinske vrste, kot so *Verbascum phoeniceum, Muscari comosum, Petrorhagia prolifera, Papaver argemone, Rosa gallica, Geranium purpureum* in druge (Bakan, 2006), mednje pa lahko prištejemo tudi metuljasto kukavico. Morda so prav talne razmere, ugodna mikroklima in nenazadnje tudi globalno segrevanje kot posledica podnebnih sprememb botrovale k širjenju metuljaste kukavice krepko čez mejo njenega strnjenega areala v Mediteranu. Res pa je, da primer ni čisto osamljen, saj so v literaturi že bile opisane takšne nepričakovane najdbe mediteranskih vrst orhidej v popolnoma »kontinentalnem« delu Evrope, več sto kilometrov stran od strnjenega areala. Gre za primer vrste *Ophrys bertolonii*, najdene leta 2010 na osrednjem Madžarskem (Molnar *s sod*., 2010). Avtorji menijo, da gre za enkratno disperzijo, ki ne pomeni nujno, da se bo vrsta tam obdržala. Po drugi strani pa je npr. južnoevropska vrsta orhideje *Ophrys scolopax* subsp. *cornuta* redno prisotna razen v Mediteranu tudi v kontinentalnih predelih, vse do Madžarske (Nemeth & Ivany, 1986).

ZAHVALA

Iskreno se zahvaljujeva kolegu Branku Bakanu za sliko 1. Zahvaljujeva se Kristjanu Malačiču za fotografije metuljaste kukavice z Goričkega.

CONTRIBUTION TO THE KNOWLEDGE OF THE DISTRIBUTION OF BUTTERFLY ORCHID *ANACAMPTIS PAPILIONACEA* (L.) R.M.BATEMAN, PRIDGEON & M.W.CHASE, 1997 (ORCHIDACEAE) AT THE NORTHERN BORDER OF THE SPECIES' DISTRIBUTION

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SUMMARY

*In the paper authors present the distribution of the Butterfly orchid (*Anacamptis papilionacea*) in Slovenia. For Slovenia and the neighboring regions, this species was already mentioned by Fleischmann (1844), Marchesetti (1896) and Pospichal (1897). Since the species discovery in the 20th century (1975 by prof. T. Wraber), this orchid species was observed on few locations in Istria and Vipavska dolina. Two new localities are presented, the first near the settlement of Sv. Anton in Istria on flysch, and the second in the continental, NE Slovenia in the Goričko region (Fokovci). According to the available data, the locality in Goričko is the northernmost point in the species distribution range. The Goričko area has the lowest precipitation rate in Slovenia with hot summers. Bedrock consists mainly of sand and sandstone. The following thermophilous plant species were already recorded for Goričko:* Verbascum phoeniceum, Muscari comosum, Petrorhagia prolifera, Papaver argemone, Rosa galica, Geranium purpureum. Anacamptis papilionacea*, typical Mediterranean species that seem to be spreading northward, into continental areas due to change of different gradients (climate etc.). Suitable microclimate and dry, sandy substratum together with the climate changes may have pushed the species far into continental Slovenia. In Slovenia the species remains rare; the orchid is present with only a few plants per each locality and usually growing in the vicinity of Green winged orchid specimens (Anacamptis morio) which enable hybridization of two species.*

Key words: Orchidaceae, *Anacamptis papilionacea*, distribution, new localities, Slovenia

LITERATURA

Aeschimann, D., K. Lauber, D. M. Moser & J. -P. Theurillat (2004): Flora alpina. Bd. 2: Gentianaceae–Orchidaceae. Haupt Verlag, Bern, Stuttgart, Wien. 1124 pp.

Anonymus (2002): Pravilnik o uvrstitvi ogroženih rastlinskih in živalskih vrst v rdeči seznam. Ur. L. RS št. 82/2002.

Anonymus (2004): Uredba o zavarovanih prosto živečih rastlinskih vrstah. 2004. Ur. l. RS št. 46/2004: 5933–5962.

Bačič, T., V. Jerin & N. Jogan (2015): Notulae ad floram Sloveniae. *Orchis papilionacea L.* Hladnikia, 36, 53-54.

Bakan, B. (2006): Slikovni pregled višjih rastlin Prekmurja. Prispevek k poznavanju flore Prekmurja. S-Tisk d.o.o., 245 pp.

Dakskobler, I., B. Anderle, B. Zupan & B. Vreš (2014): Novelties in the flora of Slovenia. *Orchis papilionacea L.* Hladnikia, 33, 3-30.

Delforge, P. (2005): Orchids of Europe, North Africa and the Middle East. A&C Black publishing, London, pp. 295–300.

Dolinar, B. (2015): Kukavičevke v Sloveniji. Pipinova knjiga, Ljubljana, pp. 22–23.

Figelj, J. & A. Slameršek (2011): Notulae ad floram Sloveniae. *Orchis papilionacea L.* Hladnikia, 28, 51–52.

Fleischmann, A. (1844): Übersicht der Flora Krain's. – Annalen der k.k. Landwir tschaftsGesellschaft in Krain 6: 27. (URN:NBN:SI:DOC-IUPWFQG3 from htt p:// www.dlib.si).

Kaligarič, M. (1991): Prispevek k poznavanju razširjenosti orhidej (Orchidaceae) Slovenske Istre. Annales, 1(1), 33–40.

Kranjčev, R. (2005): Hrvatske orhideje: prilozi za hrvatsku floru: staništa, svojte, hibridi, zaštita, Agencija za komercijalnu dejavnost, Zagreb, pp. 338-341.

Lauber, K. & G. Wagner (2001): Flora Helvetica. Verlag Bern Haupt; Bern, Stuttgart, Wien, pp. 1528

Marchesetti, C. (1896/97): Flora di Trieste e de'suoi dintorni. Trieste, 1896-97.

Molnár, A., M. András, & S. Gábor (2010): An unexpected new record of the Mediterranean orchid, *Ophrys bertolonii* (Orchidaceae) in Central Europe. Biologia 66/5, pp. 778-782.

Németh, F. & E. Iványi (1986): Morphometrical studies on the Hungarian representatives of *Ophrys scolopax* Cav. agg. (Orchidaceae). Studia Botanica Hungarica, XIX, pp. 99-113.

Nikolić, T. (2011): Flora Croatica Database, On-Line (http://hirc.botanic.hr/fcd). Department of Botany, Faculty of Science, University of Zagreb.

Nikolić, T. & J. Topić (2005): Crvena knjiga vaskularne flore Republike Hrvatske. Kategorije EX, RE, CR, EN i VU. Ministarstvo kulture, Državni zavod za zaštitu prirode, Zagreb, pp. 693.

Poldini, L. (2009): La diversità vegetale del Carso fra Trieste e Gorizia. Lo stato dell'ambiente.Edizione Goliardiche, Trieste. 391 pp.

Pospichal, E. (1897): Flora des Oesterreichischen Küstenlandes 1-2, Leipzig und Wien, 1897-99.

Ravnik, V. (2002): Orhideje Slovenije. Tehniška založba Slovenije, Ljubljana. pp. 70–71.

Rottensteiner, W.K., K.G. Bernhardt, H.P. Comes, G. Dietrich, A. Drescher, H. Duistermaat, U. Eggli, F. Ehrendorfer, P Englmaier, M. Erben, D. Ernet, M.A. Fischer, B. Frajman, W. Franz, G. Gottschlich, W. Gutermann, K.B. von Hagen, R. Hand, D. Jakely, N. Jogan, J.W. Kadereit, N. Killian, M. Klemun, F. Krahulec, G. Krebs, B.P Kremer, K. Kreutz, M. Kropf, J. Kučera, E. Landolt, G.H. Loos, M. Magnes, M. Martinez- Azorin, V. Melzheimer, V. Mikoláš, M. Münch, I.M. Munda, C. Neinhuis, K. Oswald, H. Paulus, M. Pinter, A. Podobnik, A. Polatschek, J.P. Reduron, D. Schantl, U. Starmühler, I. Uhlemann, H. Uhlich, E. Vitek, R. Vogt, G. Wagenitz, H.G. Wagner, J. Walter, S.J.U. Wanke, H.E. Weber, F.H.E. Weberling & G. Wiegleb (2014): Exkursionsflora für Istrien. Verlag des Naturwissenschaftlichen vereins für Kärnten, Klagenfurt, 1014 pp.

Scopoli, G.A. (1772): Flora Carniolica, Ed. 2., vol. 1, pp. 186-187

Wraber, T. (1975): Na obisku pri metuljasti kukavici. Proteus (Ljubljana), 38, 10–12.

Wraber, T. & P. Skoberne (1989): Rdeči seznam ogroženih praprotnic in semenk SR Slovenije. Varstvo narave (Ljubljana), 14–15, 1–429.

IN MEMORIAM

IN MEMORY OF FRANCESCO MARIA TAMBERLICH (1965-2016)

On 08th April, Francesco passed away after a difficult fight with a terrible illness. But throughout that tragic period Francesco had always remained optimistic, smiling with colleagues and friends. He was a noble and selfless soul, always ready to help people. We lost a great colleague and overall a true Friend.

Born in Rome on 25th September 1965, he was a big fan of the Juventus Football Club and an expert in wine tasting. He was also an enthusiastic tennis player. We met Francesco in 1998 when we worked at the Marine Biology Laboratory of Trieste (LBM), and since then we spent almost 20 years together, sharing the same room.

Francesco studied at the Faculty of Biology at the University of Pisa. After his graduation on 3rd November 1993, he was employed in LBM of Trieste for CHN, Total Suspended Matter, microalgal culture and sedimentological analyses. There he discovered his love of the sea and participated in several oceanographic expeditions. Francesco was also a diver and an instructor in marine biology for scuba divers.

In 2005, we worked at the Regional Agency for the Protection of the Environment of Friuli Venezia Giulia (ARPA FVG) and he was assigned the referent position for ecotoxicological assay and elemental analyses. Francesco adopted an innovative application for the monitoring of sediment quality called the Sediment Quality Triad (SQT). This approach was applied in the Lagoons of Marano and Grado and nearby underwater sewage discharges as an assessment tool for evaluating the extent of sediment degradation resulting from contaminants released due to human activity. The evaluation focuses on three main components: sediment chemistry, sediment toxicity tests using aquatic organisms, and macrozoobenthic communities. Although the SQT approach does not provide a cause-and-effect relationship linking concentrations of individual chemicals to adverse biological effects, it does provide an assessment of sediment quality commonly used to explain sediment characteristics quantitatively.

Anyway, Francesco's greatest passion was wine, and in 2008 he even obtained a certified sommelier qualification from the Italian Sommelier Association. We remember that time very well, for thanks to him we discovered the world of wine.

In 2014, our work focused on the environmental monitoring connected to channel dredging in the lagoon. We coordinated in particular the monitoring on the bivalve *Ensis minor*, a very important commercial stock influenced by dredging activity off the tourism plant in Lignano Sabbiadoro. In this occasion, Francesco proposed to test the condition index and air survival time of the mollusks in order to assess any stress condition for these organisms due to dredging activity in the surrounding area.

The last time we worked together it was in the laboratory, measuring these bivalve samples. The room was hot, and adding to that the noise of the equipment inside, the smell of the samples, the repetitive work of measuring a lot of specimens… We were so tired of that boring work, but suddenly Francesco said: who knows, maybe one day we will remember this moment as a happy time!

You were a wise man, Francesco, now we understand the meaning of that statement: whenever we are tired or bored while on the job, we should be nevertheless happy and grateful of the opportunity!

Grazie Maestro

Nicola Bettoso & Alessandro Acquavita

Topic scientific contributions of F. M. Tamberlich

Tamberlich, F., C.M. Salvi & B. Martinčić (2000): Filtration, assimilation and biodeposition of the clams *Tapes philippinarum* (Adams & Reeve) and *Tapes decussatus* L. (Jeffreys). Oebalia, 26, 63-74.

Martinčić, B., C. Salvi & **F. Tamberlich** (2000): Modello di carrying capacity applicato alle mitilicolture in sospensione nel Golfo di Trieste. Hydrores, 16, 7-23.

Fonda Umani S., R. Amodio, V. Barbariol, E. Sdrigotti, C. Welker, P. Del Negro, **F. Tamberlich**, R. Long & F. Azam (2000): Spatial and temporal dynamics of transparent particles in the Gulf of Trieste (northern Adriatic Sea) and their relationship to bacterial ectohydrolase activities. Eos. Trans. AGU, 80(4), 192 p.

Del Negro, P., C. De Vittor, S. Predonzani, **F. Tamberlich**, R. Piani, F. Finocchiaro, P. Fanzutti & S. Fonda Umani (2001): Utilizzazione batterica dei solfati in sedimenti di ambiente salmastro (Lago di Sabaudia o di Paola – LT). Biol. Mar. Medit., 8(1), 309-315.

De Vittor, C., E. Sdrigotti, P. Del Negro, F. Aleffi, **F. Tamberlich** & S. Fonda Umani (2002): Organic carbon cycling in diatom-inhabited muddy sediments. Eos. Trans. AGU, 83(4), 213 p.

Pecchiar, I., A. Bussani, M. Cabrini, M. Celio, S. Comisso, C. Falconi, **F. Tamberlich** & S. Fonda Umani (2003): Variazioni della produttività primaria e della biomassa autotrofa in relazione alle caratteristiche idrologiche delle masse d'acqua in due stazioni del Golfo di Trieste nel 2001. Biol. Mar. Medit., 10(2), 1026-1031.

Monti, M., A. Zrimec, A. Beran, M. Berden Zrimec, L. Drinovec, G. Kosi & **F. Tamberlich** (2005): Delayed luminescence of *Prorocentrum minimum* under controlled conditions. Harmful Algae, 4, 643-650.

Tamberlich, F., M. Celio, A. Bussani, C. Comici, F. Voltolina & N. Burba (2006): Analisi della distribuzione temporale del carbonio organico e dell'azoto in fase particellata in acque influenzate da input fluviale. Biol. Mar. Medit., 13(1), 185-191.

Monti, M., P. Frisenda, **F. Tamberlich** & L. Talarico (2006): Influence of salinity on growth and fine structure of Prorocentrum minimum (Pavillard) Schiller 1933 under culture: preliminary results. Biol. Mar. Medit., 13(1), 1029-1031.

Aleffi, I.F., N. Bettoso, M. Celio, **F. Tamberlich**, S. Predonzani & V. Solis-Weiss (2006): Effects of suspended mussel culture on the macrozoobenthos in the Gulf of Trieste (northern Adriatic Sea, Italy). Annales Ser. hist. nat., 16(2), 135-146.

Fonda Umani, S., P. Del Negro, C. Larato, C. De Vittor, M. Cabrini, M. Celio, C. Falconi, **F. Tamberlich** & F. Azam (2007): Major inter-annual variations in microbial dynamics in the Gulf of Trieste (northern Adriatic Sea) and their ecosystem implications. Aquat. Microb. Ecol., 46, 163-175.

Tamberlich, F., A. Acquavita, L. Milani, I. Aleffi, S. Predonzani, L. Faresi & G. Mattassi (2007): Saggi biologici sui sedimenti marino costieri della regione Friuli Venezia Giulia: analisi dei risultati e criticità. Biol. Mar. Medit., 14(1), 238-241.

Onorati, F., G. Ruggiero, M.S. Sanguinetti, M. Ferrara, V. Belluria, P. Martini,F. Bandini, L. Facchin, T. Leoni, A.M. Celletti, M. Molina, S. Trichilo, E. Rossi, L. Brilli, S. Dilani, S. Comin, S. Manzo, S. Fabbri, G. Mascilongo, R. Lo Re, R. Guerra, E. Di Gioia, F. Castiglioni, **F. Tamberlich**, D. Traldi, A. Pasteris & C. Grillo (2007): Interconfronto Nazionale sul test di inibizione della bioluminescenza di *Vibrio fischeri*. Biol. Mar. Medit., 14(1), 86-90.

Cibic, T., A. Acquavita, I.F. Aleffi, N. Bettoso, O. Blasutto, C. De Vittor, C. Falconi, J. Falomo, L. Faresi, S. Predonzani, **F. Tamberlich** & S. Fonda Umani (2008): Integrated approach to sediment pollution: a case study in the Gulf of Trieste. Mar. Poll. Bull., 56(9), 1650-1657.

Acquavita, A., S. Predonzani, G. Mattassi, P. Rossin, **F. Tamberlich**, J. Falomo & I. Valic (2010): Heavy metal contents and distributions in coastal sediments of the Gulf of Trieste (northern Adriatic Sea, Italy). Water Air Soil Pollut., 211, 95-111.

Sladonja, B, N. Bettoso, A. Zentilin, **F. Tamberlich** & A. Acquavita (2011): Manila Clam (*Tapes philippinarum* Adams & Reeve, 1852) in the Lagoon of Marano and Grado (northern Adriatic Sea, Italy): socio economic and environmental pathway of a shell farm. In: Sladonja, B. (eds.): Acquaculture and the Enviroment - A Shared Destiny, INTECH open access publisher, 51-78.

Lipizer, M., C. De Vittor, C. Falconi, C. Comici, **F. Tamberlich** & M. Giani (2012): Effects of intense physical and biological forcing factors on CNP pools in coastal waters (Gulf of Trieste, northern Adriatic Sea). Estuar. Coast. Shelf S., 115, 40-50.

Mattassi, G., I.F. Aleffi, N. Bettoso, L. Milani & **F. Tamberlich** (2012): Applicazione di indici biotici negli ambienti di transizione e marino costieri del Friuli Venezia Giulia. Biologia Ambientale, 26(1), 3-14.

Acquavita, A., J. Falomo, S. Predonzani, **F. Tamberlich**, N. Bettoso & G. Mattassi (2014): The PAH level, distribution and composition in surface sediments from a Mediterranean Lagoon: the Marano and Grado Lagoon (northern Adriatic Sea, Italy). Mar. Poll. Bull., 81, 234-241.

Acquavita, A., I.F. Aleffi, C. Benci, N. Bettoso, E. Crevatin, L. Milani, **F. Tamberlich**, L. Toniatti, P.L. Barbieri, S. Licen & G. Mattassi (2015): Annual characterization of the nutrients and trophic state in a Mediterranean coastal lagoon: the Marano and Grado Lagoon (northern Adriatic Sea). Reg. Stud. Mar. Sci., 2, 132-144.

Boscutti, F., I. Marcorin, M. Sigura, E. Bressan, **F. Tamberlich**, A. Vianello & V. Casolo (2015): Distribution modeling of seagrasses in brackish waters of Grado-Marano Lagoon (northern Adriatic Sea). Estuar. Coast. Shelf S., 164, 183-193.

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.

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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).

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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.

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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.

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

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

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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.

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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).

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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).

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SLIKA NA NASLOVNICI:
Rjavi srakoper (*Lanius collurio*) je ena od ogroženih vrst v evropskem merilu, ki ga še posebej ogrožajo spremembe v kulturni krajini. Razveseljujoče je dejstvo, da se v dolini Dragonje še vedno pojavlja v velikem številu, kar kaže na trajnostno izrabo prostora. (Foto: D. Šere)
Sl. 1: Ilirsko mačje uho (*Ophrys illyrica*) je bilo pred kratkim prvič odkrito v Sloveniji. Našli so ga na območju Velikega Badina iznad vasi Sočerga (Foto: I. Paušič)
Sl. 2: Metuljasto kukavico (*Anacamptis papilionacea*) prepoznamo predvsem po značilni obliki medene ustne ter po velikih, rdeče-rožnatih cvetovih. (Foto: I. Paušič)
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Sl. 5: Čebeljeliko mačje uho *Ophrys apifera* je evrimediteranska vrsta kukavičevk, ki jo najdemo predvsem na revnih tleh. (Foto: I. Paušič)
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The red-backed shrike (*Lanius collurio*) is an endangered species on European scale, particularly vulnerable to changes in the cultural landscape. Happily, in the Dragonja Valley it is still present in high numbers, which shows that sustainable land use practices are still being implemented. (Photo: D. Šere)
Fig. 1: Recently, the orchid *Ophrys illyrica* was recorded in Slovenia for the very first time. It was discovered in the area of Veli Badin above the village of Sočerga. (Photo: I. Paušič)
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