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# Herpetofauna inventory of the small islands of the Cres–Lošinj Archipelago (North Adriatic Sea, Croatia)
(Amphibia; Reptilia)

## Herpetofaunistisches Inventar der kleinen Inseln des Cres–Lošinj Archipels in der nördlichen Adria (Kroatien)
(Amphibia; Reptilia)

TAMÁS TÓTH & MIKLÓS HELTAI & ANDREA KESZI & GORAN SUŠIĆ & LEVENTE MOHAROS & BALÁZS FARKAS & CSABA GÉCZY & ORSOLYA TORDA & JÁNOS GÁL

KURFASSUNG

Der vorliegende Überblick über die Herpetofauna der kleinen Inseln des Cres–Lošinj Archipels (Kroatien) basiert auf Literaturdaten und Beobachtungen der Autoren aus den Jahren 2011 bis 2014. Die 16 behandelten Eilande und Inseln, deren Größen zwischen 0,05 km² (Zabodaski) und 16,92 km² (Unije) betragen, sind alle von mindestens einer Art von Mauereidechsen der Gattung *Podarcis* bewohnt. Koludarc, Unije und Veli Osir beherbergen *Podarcis melisellensis fiumana* (WERNER, 1891), während Kormat, Male Srakane, Mali Plavnik, Oruda, Palacol, Unije, Vele Srakane, Visoki und Zabodaski Populationen von *Podarcis siculus campestris* (RAFINESQUE-SCHMALTZ, 1810) aufweisen. Beide Taxa sind auf Plavnik, Susak und Zeča vertreten. *Caretta caretta* (LINNAEUS, 1758) wird erstmalig von Oruda und Unije, und *Hierophis viridiflavus carbonarius* (BONAPARTE, 1833) von Susak und Unije nachgewiesen.

ABSTRACT

The present review of the herpetofauna of the small islands of the Cres–Lošinj Archipelago (Croatia) is based on literature data and observations made by the authors in 2011 to 2014. The 16 islets and islands ranging in size between 0.05 km² (Zabodaski) and 16.92 km² (Unije) are all inhabited by at least one species of wall lizard of the genus *Podarcis*. The islands Koludarc, Unije and Veli Osir harbor *Podarcis melisellensis fiumana* (WERNER, 1891), while Kormat, Male Srakane, Mali Plavnik, Oruda, Palacol, Unije, Vele Srakane, Visoki and Zabodaski hold populations of *Podarcis siculus campestris* (RAFINESQUE-SCHMALTZ, 1810). Both taxa are present on Plavnik, Susak and Zeča. *Caretta caretta* (LINNAEUS, 1758), is reported for the first time from the islands of Oruda and Unije, and *Hierophis viridiflavus carbonarius* (BONAPARTE, 1833) from Susak and Unije.

KEY WORDS

Amphibia: *Bufotes viridis*; Reptilia: *Caretta caretta*, *Emys orbicularis*, *Testudo hermanni*, *Hemidactylus turcicus*, *Podarcis melisellensis*, *Podarcis siculus*, *Pseudopus apodus*, *Hierophis gemonensis*, *Hierophis viridiflavus*, *Telescopus fallax*; herpetofauna, islands of the Cres–Lošinj Archipelago (Koludarc, Kormat, Male Srakane, Mali Osir, Mali Plavnik, Murtar, Oruda, Palacol, Plavnik, Susak, Unije, Vele Srakane, Veli Osir, Visoki, Zabodaski, Zeča), Adriatic Sea, Croatia

## INTRODUCTION

Over the years, the herpetofauna of the Kvarner Region of the Croatian Adriatic was studied by numerous authors including WERNER (1908), KAMMERER (1925, 1926), BRELIH (1963), RADOVANOVIĆ (1953, 1954, 1956), BRUNO (1980, 1988), MRŠIĆ et al. (1989), SEHNAL & SCHUSTER (1999), MAYER & PODNAR (2002), DIECKMANN (2004), and TÓTH et al. (2006, 2009a, 2009b). These works focused nearly exclusively on the distributional aspects of amphibians and reptiles inhabiting this archipelago. In cooperation with Öko-Centar Cres, the Budapest Zoo took an active role in the conservation of natural values and supported basic research in the area since 2002. The herpetofauna assessment of the small islands surrounding Cres and Lošinj was part of the

project. Between 2011 and 2014 the authors gathered a number of noteworthy distributional records that are presented below and compared to previously published data.

The Dalmatian Wall Lizard, *Podarcis melisellensis fiumana* (Werner, 1891), and the Italian Wall Lizard, *Podarcis siculus campestris* (De Betta, 1857), are the dominant saurian species on Kvarner Bay islands. As they are extremely similar in appearance, whole populations have been incorrectly assigned to species (Mayer & Podnar 2002). Whereas for a long time Cres and Lošinj were known to harbor *P. melisellensis* only, most surrounding islands were believed to be occupied by *P. siculus* (Kammerer 1926; Wettstein 1949; Tóth et al. 2006). Just a few islands (e.g., Krk, Unije and Male Srakane) were reported to give home to both taxa. It appears, however, that assisted by humans these wall lizards gradually disperse within the entire region now. As noted by several authors (e.g., Brelih 1963), *P. melisellensis* and *P. siculus* have identical habitat preferences and once their ranges meet, the latter usually drives the former to extinction. The data presented below also serve as a documentation of this process.

## MATERIALS AND METHODS

As a continuation of their earlier investigations on the topic (Tóth et al. 2006, 2009a, 2009b) the authors and colleagues from the Budapest Zoo and fellow herpetologists made numerous field trips to the Kvarner Region between 2011 and 2014. Their primary aim was to gather distributional data. Aided by a small fishing vessel or a power-boat, 16 islands and cliffs of the archipelago were visited, many of which were '*terrae incognitae*' from the herpetofaunistic point of view. The locations of the islands surveyed are shown in Figure 1 and all are defined by their central coordinates in the individual accounts. In case a certain piece of land is known under different names, alternative apellations or spellings are given in parentheses. Distributional records thus collected are compared to literature data to draw a more complete picture of the herpetological relations of the region. The general information relating to each island (e.g., area size, highest peak, number of inhabitants, type of subsoil, etc.) is supplemented by an enumeration of characteristic plants and, wherever applicable, higher vertebrates observed during the surveys. Island coordinates are followed by the date of visit.

## RESULTS AND DISCUSSION

Koludarc (2 in Fig. 1; 44°33'N, 14°25.9'E; June 12, 2014).– This 0.78 km$^2$ island is covered largely by woody vegetation dominated by *Pinus halepensis* and *Quercus ilex*. The highest point lies at 53 m a.s.l. There are several villas on the island surrounded by typical Mediterranean rock walls that offer excellent habitats and refuges for small reptiles. The only reptile observed was *Podarcis melisellensis fiumana* (Werner, 1891), of which the Naturhistorisches Museum Wien possesses voucher material from the island (NMW 35683).

Murtar (7 in Fig. 1; 44°33'N, 14° 25.3'E; June 12, 2014).– This island is situated off Koludarc. No member of the herpetofauna was spotted here but due to its proximity to the previous island, Murtar is likely to harbor *P. melisellensis*.

Kormat (3 in Fig. 1; 44°56.7'N, 14° 34.5'E; September 7, 2011).– This flat piece of land is covered largely by grasses interspersed with alliums. European Shags, *Phalacrocorax aristotelis*, and Yellow-legged Gulls, *Larus michahellis*, were seen on Kormat, which also nest here according to Radovanović (1941, 1956). Radovanović (1941) reported *Podarcis siculus* to occur on the island in March 1938. He found them to be extremely abundant and to exhibit the typical color pattern. The presence of this species on Kormat was also mentioned by Henle & Klaver (1986), and Mršić et al. (1989) listed three vouchers

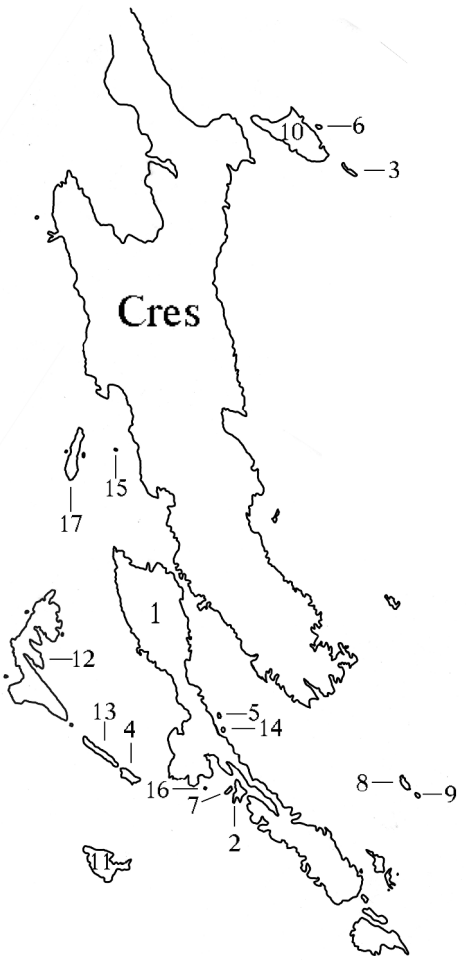


Fig. 1: Representation of the Cres–Lošinj Archipelago in the Adriatic Sea (Croatia).

Abb 1: Die Inseln des Cres–Lošinj Archipels in der Adria (Kroatien).

1 – Lošinj, 2 – Koludarc, 3 – Kormat, 4 – Male Srakane, 5 – Mali Osir, 6 – Mali Plavnik, 7 – Murtar, 8 – Oruda, 9 – Palacol, 10 – Plavnik, 11 – Susak, 12 – Unije, 13 – Vele Srakane, 14 – Veli Osir, 15 – Visoki, 16 – Zabodaski, 17 – Zeča.

available at the Naturhistorisches Museum Wien (NMW 25613: 6-8) [1]. In the spring of 2011, the authors too observed this lizard on the island, whereas BRUNO's (1988) asserted record of *P. melisellensis* could not be confirmed.

Male Srakane (Canidole Piccola) (4 in Fig. 1; 44°33.7'N, 14°20.0'E; June 12, 2014).– This 0.6 km$^2$ island has a single human inhabitant, and similarly to its larger counterpart (Vele Srakane), its chalky lime subsoil is covered by clayey sandstone, indicating that the two Srakane islands form the southern extension of Unije (MAVROVIĆ 1997; ROSANDIĆ 2010). The highest point lies at 40 m a.s.l. Besides grassland vegetation, *Arundo donax* and *Rubus* sp. typify the area. KAMMERER (1926), citing WERNER (1908), claimed the island to give home to *P. siculus* but the authors did not manage to locate any reference in the original account. According to BRELIH (1963), *P. siculus* and *P. melisellensis* are direct competitors and thus rarely co-occur on Adriatic Islands, such as e.g., Male Srakane. He predicted that the first species would unavoidably supersede the latter with time because the smaller and weaker *P. melisellensis* would persist only as long as it was able to find refuge in the high grass. PAVLETIĆ (1962), quoting BRELIH (1963) [2], mentioned the presence of both species on Male Srakane and stated that *P. siculus* inhabited coastal areas, whereas the other species was restricted to the center of the island. On the other hand, TIEDEMANN & HENLE (1986), as well as HENLE & KLAVER (1986) listed only *P. melisellensis* for Male Srakane. Ironically, the authors of the present paper were able to confirm the presence of *P. siculus campestris* only.

Mali Osir (5 in Fig. 1; 44°35.9'N, 14°25.1'E; September 5, 2011).– This desolate little island lies just off Lošinj, and is populated by *P. melisellensis*.

Mali Plavnik (6 in Fig. 1; 44° 58.5'N, 14°32.8'E; September 7, 2011).– The unpopulated island of Mali Plavnik lies

[1] This sample, however, refers to specimens from the Island of Kornat (central Dalmatia). According to a list provided by Heinz GRILLITSCH (Vienna) to the first author, two specimens of *P. siculus* from Kormat (original locality name in the database "Scoglio Cormata near Cherso") bear the registration numbers NMW 16419: 1-2.

[2] PAVLETIĆ (1962) appears to have known BRELIH's paper prior to its actual publication in 1963.

close to Plavnik and is vegetated by *Pistacia* sp., *Ficus carica*, *Rubus* sp., *Helichrysum italicum* and *Clematis* sp. Bruno (1988) reported *P. melisellensis* from this island but the authors only observed specimens of *P. siculus* here.

Oruda (8 in Fig. 1; 44°33.0'N, 14° 34.9'E; September 5, 2011).– On this 0.4 km$^2$ island the following characteristic plants were seen: *Ficus carica*, *Juniperus phoenicea*, *Olea europaea*, *Paliurus spina-christi*, *Euphorbia* sp., *Carlina* sp. and *Carex* sp. Of local vertebrates a Dunlin, *Ereunetes alpina*, was spotted. Referring to Werner (1908), Kammerer (1926) stated that the island was home to *P. siculus*, but no information of this kind was found in the quoted work. The same supposition was expressed by Brelih (1963) and, based on his account, by Henle & Klaver (1986). The authors caught numerous individuals of this lizard on Oruda. Carapace fragments of a young Loggerhead Turtle, *Caretta caretta* (Linnaeus, 1758), were recovered on the coast of the island (Fig. 2).

Palacol (Palazzuoli) (9 in Fig. 1; 44° 32.5'N, 14°35.7'E; September 5, 2011).– This 0.3 km$^2$ unsettled private island sporting the ruins of a large fortress or monastery built in the 13th century is populated by *Phalacrocorax aristotelis*. Galvagni collected *P. siculus* in summer 1907 here, and made his material available to Werner (1908). Kammerer (1926), Hirtz (1930), Brelih (1963) and Henle & Klaver (1986) reported this species from Palacol, and also the authors of the present paper observed numerous *P. siculus* on the island.

Plavnik (10 in Fig. 1; 44°58.2'N, 14°31.5'E; September 7, 2011).– The highest point of this 8.64 km$^2$ island lies at 194 m a.s.l. There is a single lodge on Plavnik serving as an accomodation to tourists during summer but there are no permanent inhabitants. No vertebrates were seen in the concrete water basin near the main building. In addition to sheep, Fallow Deer, *Dama dama*, and locally nesting Griffon Vultures, *Gyps fulvus*, were spotted on Plavnik. The largest part of the island is forested; typical plants observed include *Quercus pubescens*, *Q. ilex*, *Ficus carica*, *Juniperus oxycedrus*, *Paliurus spina-christi*, *Rubus* sp., *Helichrysum* sp., *Clematis vitalba*, *Hedera helix*, and *Euphorbia* sp. According to Mršić et al. (1989) there exists an isolated but reproducing population of *Emys orbicularis hellenica* (Valenciennes, 1832) on the island, and Fritz (1992) even listed a voucher specimen in the collection of the Senckenberg Forschungsinstitut und Naturmuseum, Frankfurt (SMF 30002). The occurrence of European Pond Turtles on Plavnik was mentioned also by Fritz (2001). Bruno (1980) reported that he personally encountered an adult female *Testudo hermanni boettgeri* Mojsisovics, 1889, at approximately one km distance from the cottage mentioned above on August 14, 1974. Based on this record, the presence of Hermann's Tortoises on the island was mentioned also by Bruno (1988) as well as Cheylan (2001). Bruno (1980) caught an adult Mediterranean House Gecko, *Hemidatylus turcicus turcicus* (Linnaeus, 1758), on the wall of the country house on August 14, 1974, and in a later account (Bruno 1988) claimed this gecko to be rare on the island. Additionally, he mentioned the find of a piece of molt of a European Glass Lizard, *Pseudopus apodus thracius* (Obst, 1978), on July 19, 1977 (Bruno 1980, 1988). Once Bruno (1980) collected two pairs of *P. melisellensis* on Plavnik, and in his later work (1988) stated this species to be abundant there. Based on this record, the presence of this species on the island was mentioned by Tiedemann & Henle (1986), whereas Henle & Klaver (1986), quoting personal communications with Nemetschkah stated *P. melisellensis* to co-occur with *P. siculus* on Plavnik. Mršić et al. (1989) even referred to two voucher specimens of the latter species kept at the Naturhistorisches Museum Wien (NMW 25613: 4-5). Also, the authors of this paper encountered numerous individuals of both species on the island. Bruno (1980) additionally made mention of an adult Balkan Whip Snake, *Hierophis gemonensis* (Laurenti, 1768), which he caught in the valley between the cottage and the harbor on August 14, 1974, and the same record was repeated by Bruno (1988) as well as Henle (1993). Other than this, also the Naturhistorisches Museum Wien is in the possession of a voucher specimen collected on the island (NMW 27223). In addition, the authors of this paper found a piece of skin shed by a

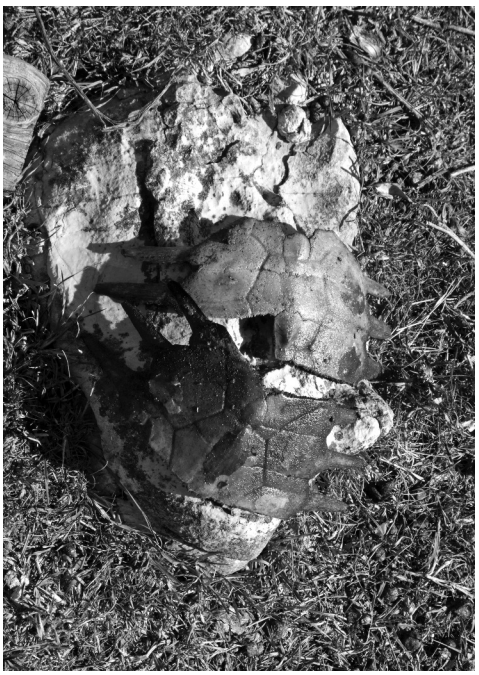

Fig. 2: Carapace fragments of a young *Caretta caretta* (LINNAEUS, 1758) found on Oruda (8 in Fig. 1).

Abb. 2: Rückenschildfragmente einer jungen *Caretta caretta* (LINNAEUS, 1758), gefunden auf Oruda (8 in Abb. 1).

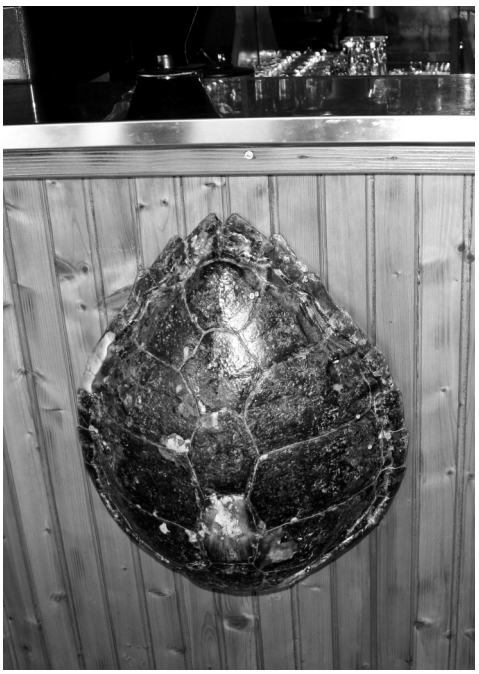

Fig. 3: Carapace of *Caretta caretta* (LINNAEUS, 1758) put on display in a pub on Unije Island (12 in Fig. 1).

Abb. 3: Rückenschild von *Caretta caretta* (LINNAEUS, 1758), ausgestellt in einem Gasthaus auf der Insel Unije (12 in Abb. 1).

member of this species on Plavnik. TÓTH et al. (2006), based on an earlier observation made by FARKAS, reported the presence of the European Cat Snake, *Telescopus fallax* FLEISCHMANN, 1831, on the island.

Susak (Sansig, Sansego) (11 in Fig. 1; 44°30.5'N, 14°18.0'E; June 11, 2014).– Inhabitants of this 3.76 km² island numbered 188 at a 2001 census (MAVROVIĆ 1997; BALON et al. 2005; ROSANDIĆ 2010). The chalky lime subsoil is covered with clayey sandstone, the thickness of which locally approaches one hundred meters. The sand originating from river sediments is believed to have been deposited by winds before the rise of sea levels. The highest peak of the island is named Garba (96 m a.s.l.). KAMMERER (1925, 1926) noted that due to soil characteristics it would be a time consuming and dubious enterprise to dig out lizards on Susak. Unlike most islands in the Croatian Adriatic Susak has a predominantly loess soil covered by, among others, *Arundo donax* and *Rubus* sp. Vineyards are also abundant here due to favorable conditions. WERNER (1908), referring to experiences made and material collected in 1907 by GALVAGNI, stated that the island was inhabited by 'true' *P. siculus* (*Lacerta serpa campestris* in his notation) but also by the uniformly colored variety *olivacea*, i.e., by lizards similar to *Podarcis melisellensis* (*olivacea* form of *Lacerta fiumana* in his notation) in having an unmarked olive green back but with males lacking the red underside of *P. melisellensis*. As the two *olivacea* varieties, as recognized at that time, differed in head shape and snout-vent-length, he intended to name this form *Lacerta fiumana* var. *imitans* (a nomen nudum currently relegated to the synonymy of *P. melisellensis fiumanus*). Later KAMMERER (1926) reported to have seen white-bellied specimens of both sexes representing this species, with

the young being of a light sand color and the adults uniquely vivid green. The occurrence of *Podarcis siculus* on the island was reported by Karaman (1921, 1939), Kammerer (1925, 1926), Hirtz (1930), Radovanović (1953, 1954, 1956) and Henle & Klaver (1986). The Naturhistorisches Museum Wien possesses vouchers of both species from Susak (NMW 11212 and 35689, and NMW 11309, respectively). Radovanović (1954, 1956) claimed that *P. siculus* from Susak had especially long tails. The total length of the animals was similar to those inhabiting the mainland or other islands but their tails greatly exceeded two-thirds of the total length. The authors of this note observed normal-colored *P. siculus* and unpatterned *P. melisellensis* on the island and twice spotted a Dark Green Whip Snake, *Hierophis viridiflavus carbonarius* (Bonaparte, 1833), crossing the tourist trail in the eastern part of Susak, in an area covered by reeds and bushes. According to locals, *H. turcicus* are frequently seen climbing the house walls of Susak city.

Unije (12 in Fig. 1; 44°38.2'N, 14° 14.8'E; June 12-14, 2014).– There is a single settlement on this 16.92 km$^2$ island inhabited by 90 people (2001 survey; Mavrović 1997; Balon et al. 2005; Rosandić 2010). The subsoil in the southwestern part of Unije (Unijskog Polje) is similar to that of Susak, i.e., consists of limestone covered by a thick layer of sand. The highest peak is Pečurvište (138 m a.s.l.), located in the south. The island offers a great variety of habitats: the southeastern part is dominated by evergreen shrubs while the north is characterized by Holm Oak, *Quercus ilex* stands; wetlands are also present on Unije. According to Rosandić (2010) 629 species of plants have so far been identified on the island, of which the authors of this paper noted the abundance of the following species in the island center: *Ficus carica*, *Cupressus sempervirens*, *Pistacia lentiscus*, *Ulmus* sp., *Juniperus oxycedrus*, *J. phoenicea*, *Phragmites communis*, *Helichrysum italicum* and *Aristolochia clematitis*. The only birds observed in the present survey were Mallards, *Anas platyrhynchos*. Brelih (1963) claimed that most islands in the Croatian Adriatic harbor *P. siculus* only, whereas Unije is one of the exceptions having a *P. melisellensis* population as well. Since the two species are competitors that normally co-occur only on the mainland and some larger islands it was a surprise to find them in sympatry here. Pavletić (1962), referring to Brelih (1963), believed that while *P. siculus* inhabited the coastal zone, the other species was distributed mainly in the center of the island. Tiedemann & Henle (1986) and Henle & Klaver (1986) also cited Brelih (1963) for records. In the present study, both species were found in high numbers throughout the island in a great variety of colors and patterns. The *P. melisellensis* observed on Unije included patternless specimens with a green back as well as individuals having a brown dorsum. Additionally, a *H. viridiflavus carbonarius* was detected on the way to Maračol Bay on an open trail leading between rock walls surrounded by bushes and young trees. This species is well-known to locals, similarly to the European Green Toad, *Bufotes viridis* (Laurenti, 1768). The pub in the coastal town is noteworthy for having the shell of a *Caretta caretta* on display above the bar (Fig. 3). According to the owner, the animal was caught four to five years earlier but another sea turtle was seen in the bay approximately one month prior the authors' visit.

Vele Srakane (13 on Fig. 1; 44° 34.9'N, 14°18.6'E; June 12, 2014).– According to a 2001 census this 1.17 km$^2$ island has nine inhabitants. Vele Srakane, similarly to its smaller counterpart (Male Srakane), has a chalky lime subsoil blanketed with clayey sandstone (Mavrović 1997; Balon et al. 2005; Rosandić 2010). The highest point at 60 m a.s.l. is named Vela Straža. The authors observed the following characteristic plants: *Arundo donax*, *Rubus* sp., *Hordeum murinum*, and *Malva neglecta*. Brelih (1963) documented the occurrence of both, *P. siculus* as well as *P. melisellensis* on Vele Srakane, and Tiedemann & Henle (1986) and Henle & Klaver (1986) referred to vouchers of both species in the Ljubljana Museum (registration numbers not mentioned). In the present survey, the authors saw several *P. siculus* individuals, primarily around the small settlement on the island.

Veli Osir (14 on Fig. 1; 44°35.4'N, 14°25.1'E; September 5, 2011).– The authors

observed marked as well as patternless specimens of *P. melisellensis* on this small, uninhabited cliff situated just off Lošinj.

Visoki (15 in Fig. 1; 44°46.6'N, 14° 20.9'E; June 12, 2014).– This islet is nesting ground of *Larus michahellis* and the type locality of *Lacerta sicula fiumanoidea* Brelih, 1963, which also occurs on nearby Misar (Brelih & Džukić 1974). Interestingly, Bruno (1988) mapped the presence of this species on Visoki but did not mention its occurrence in the text. Additionally, Henle & Klaver (1986), referring to Brelih (1963), documented this lizard from the island and claimed that specimens had no markings here. The authors of this paper observed numerous individuals during their visit.

Zabodaski (Zabodacki) (16 in Fig. 1; 44°33.1'N, 14°24.1'E; June 12, 2014).– According to Brelih (1963) the individuals of *P. siculus* occurring on this small, just 0.05 km$^2$ uninhabited islet are somewhat distinct from 'true' *P. siculus campestris* (De Betta, 1857) but still represent this form. On account of Brelih (1963), Henle & Klaver (1986) did also list this species from Zabodaski. The authors of this paper found several specimens on the island. Interestingly, the Naturhistorisches Museum Wien holds a voucher of *P. melisellensis* from Zabodaski (NMW 35688).

Zeča (17 in Fig. 1; 44°46.5'N, 14° 18.6'E; June 12, 2014).– The highest point of this 2.55 km$^2$ uninhabited island lies at 65 m a.s.l. The rocky, bushy terrain also harbors a small lake filled with sea water, the shores of which are the nesting grounds of *Larus michahellis*. The following plants characterize the island's vegetation: *Pistacia lentiscus*, *Cupressus sempervirens*, *Phyllirea latifolia*, *Glaucium flavum*, and *Euphorbia palarias*. According to Brelih (1963) Zeča is occupied by *P. melisellensis.* Bruno (1988) lists *P. apodus* and *H. gemonensis* in addition to *P. melisellensis*. Surprisingly, he stated *H. gemonensis* to occur in reed beds. The authors of this paper observed several *P. melisellensis* on the island, among them an unmarked specimen, but also some *P. siculus* with species-typical pattern.

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AUTHORS: Tamás Tóth [1] (corresponding author < truffoi@gmail.com >), Miklós Heltai [2], Andrea Keszi [1], Goran Sušić [3], Levente Moharos [4], Balázs Farkas [5], Csaba Géczy [6], Orsolya Torda [7] & János Gál [8]

[1] Zoological and Botanical Garden of the City of Budapest, P.O. Box 469, 1371 Budapest, Hungary.
[2] Institute for Wildlife Conservation, Szent István University, Páter Károly u. 1, 2103 Gödöllő, Hungary.
[3] Birds of Prey Conservation Centre, Crnika bb, Selo 9, Pp. 24, 53284 Senj, Croatia.
[4] Csiki-hegyek u. 10, 1118 Budapest, Hungary.
[5] Bercsényi u. 21, 2464 Gyúró, Hungary.
[6] Gyöngyvirág u. 3/a, 1125 Budapest, Hungary.
[7] Eötvös Loránd University (ELTE), Department of Ethology, Pázmány Péter sétány 1/c, 1117 Budapest, Hungary.
[8] Department of Pathology, Division of Exotic and Wild Animal Medicine, Faculty of Veterinary Science, Szent István University, István u. 2, 1078 Budapest, Hungary.