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Distribution and conservation status of the batracho- and herpetofauna of the Croatian island of Mljet

(Anura; Testudines; Squamata: Sauria, Serpentes)

Verbreitung und Schutzstatus der Amphibien- und Reptilienfauna der kroatischen Insel Mljet

(Anura; Testudines; Squamata: Sauria, Serpentes)

DUŠAN JELIĆ & IVAN BUDINSKI & BORIS LAUŠ

KURZFASSUNG

In den Jahren 2007, 2008 und 2009 untersuchten die Autoren eingehend die Amphibien- und Reptilienfauna der Insel Mljet und stellten dabei das Vorkommen von 12 Arten fest, einer Amphibienform und 11 Reptilientaxa (*Emys orbicularis*, *Testudo hermanni*; *Hemidactylus turcicus*, *Podarcis melisellensis*, *Dalmatolacerta oxycephala*, *Pseudopus apodus*; *Coronella austriaca*, *Hierophis gemonensis*, *Zamenis longissimus*, *Malpolon insignitus*, *Vipera ammodytes*). Darüber hinaus berichten frühere Publikationen über Vorkommen von *Bufo viridis*, *Anguis fragilis*, *Elaphe quatuorlineata* und *Zamenis situla*. *Lacerta agilis* und *Podarcis siculus* wurden in diesem Zusammenhang ganz offensichtlich irrtümlich genannt. Mit insgesamt 16 Arten liegt die Insel Mljet im Mittelfeld was den Artenreichtum auf mediterranen Inseln betrifft, aber weit vorne unter den Inseln der Adria.

Vier der Arten sind in der Roten Liste bedrohter Amphibien und Reptilien Kroatiens angeführt: *Caretta caretta* als gefährdet ('endangered' - EN), *Emys orbicularis* und *Testudo hermanni* als potentiell gefährdet ('near-threatened' - NT) und *Zamenis situla* als wegen Datenmangels nicht einschätzbar ('data deficient' - DD).

ABSTRACT

In 2007, 2008 and 2009 the authors carried out an extensive study of the amphibian and reptile fauna of the island of Mljet resulting in the detection of 12 species. One amphibian and 11 reptile species were recorded (*Emys orbicularis*, *Testudo hermanni*; *Hemidactylus turcicus*, *Podarcis melisellensis*, *Dalmatolacerta oxycephala*, *Pseudopus apodus*; *Coronella austriaca*, *Hierophis gemonensis*, *Zamenis longissimus*, *Malpolon insignitus* and *Vipera ammodytes*). In addition, previous publications reported findings of *Bufo viridis*, *Anguis fragilis*, *Elaphe quatuorlineata* and *Zamenis situla*. *Lacerta agilis* and *Podarcis siculus* were obviously mentioned erroneously. With a total of 16 species, the island of Mljet is of average herpetofaunal richness among Mediterranean islands but one of the richest Adriatic islands.

Four species are listed in the Red Data Book of endangered amphibians and reptiles of Croatia: *Caretta caretta* as endangered (EN), *Emys orbicularis* and *Testudo hermanni* as near threatened (NT), and *Zamenis situla* as data deficient (DD).

KEY WORDS

Amphibia, Reptilia, herpetofauna, Mljet Island, Croatia, Adriatic, conservation, protection

INTRODUCTION

Mljet is the south easternmost of the large Croatian islands, exhibiting a total surface area of about 98 km^2. The island is of elongate shape, and almost 40 km from northwest to southeast, which equals the width of the Dinaric mountain chain. Its climate is characterized by long and dry summers and mild, humid winters (Table 1), and gives rise to a characteristic North Mediterranean flora and fauna.

Mljet is located within the 100 m isobath, demonstrating its erstwhile affiliation with the nearby mainland, as well as all other Croatian islands. Due to large-scale storage of water in the glaciers, the global sea level dropped about 135 m in the average during the last glacial period (BELL & WALKER 2005). This sea level descent dried out the entire northern part of the Adriatic Sea and most of the islands of today merged with the mainland, and remained so during the entire Würm glacial period (RODIĆ 1970). With the subsequent melting of the polar ice caps, the sea level rose to the cur-

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Table 1: Climate data for the city of Dubrovnik (42°39'N, 18°05'E, 52 m a.s.l.), representing the climate conditions of southern Croatia (Croatian Meteorological and Hydrological Service 2010).

Tab 1: Klimadaten von Dubrovnik (42°39'N, 18°05'E, 52 m ü. M.), als repräsentatives Beispiel für die südkroatischen Klimabedingungen (Kroatischer meteorologischer und hydrologischer Dienst 2010).

Month Monat	Average air temperature (°C) Mittlere Lufttemperatur (°C)	Sunshine duration (∑ h) Sonnenscheindauer (∑ h)	Precipitation (mm) Niederschlagsmenge (mm)
January	9.1	131.8	117.4
February	9.3	144.9	105.3
March	11.2	178.6	100.8
April	14.1	212.3	90.3
May	18.5	271.9	64.9
June	22.3	310.8	55.4
July	24.8	349.2	33.6
August	24.9	329.4	68.7
September	21.5	255.6	90.2
October	17.8	199.9	122.4
November	13.7	132	148.7
December	10.4	116.9	137.7
∑; $\bar{x}$	$\bar{x}$ = 16.5	∑ = 2633.3	∑ = 1135.4

rent level, isolating the Adriatic islands, as we see them today, from the mainland in the last 12000 years (Krištufek & Kletečki 2007). The island of Mljet is separated from the mainland by a sea canal, 55 m deep and 6 km wide at its narrowest point. The highest peak of the island is Veliki grad (514 m); elevations somewhat exceeding 300 m are numerous.

The island's lithological body is made of Mesozoic limestone and dolomite. The geologically oldest parts, upper Jurassic sediments, are located at a relatively narrow zone in the center of the south coast. Mljet's coast is well structured, northwest shores (the "lakes" - actually lagoons - Veliko and Malo jezero, the bays Lastovo and Pomena and the gulf Polače) and southeast shores (the bay Saplunara) in particular.

The island of Mljet belongs to the Mediterranean phytogeographic region, and includes two vegetation belts arranged according to altitude: Mediterranean-littoral (from the sea level up to about 500 m above sea level in some areas) and Mediterranean-alpine (only the highest parts of the island) (Trinajstić 1995). A detailed floristic overview of Mljet and its threat status is presented by Boršić et al. (2009).

The values of Mljet's nature were noted as early as the beginning of the 20th century, and the idea to officially protect this area came up very early (Mader 2010). This protection initiative is one of the oldest in the world, only approximately 30 years later than the foundation of the first protected area in the World – Yosemite National Park, USA.

Mader (2010) reported the following: Within the years 1910 and 1915, a number of Australian intellectuals initiated the idea to set up 'Mljet's protected Nature Park'. One of the main obstacles for implementing this plan was the extremely high number of Nose-horned Vipers living on the island. In autumn 1913, the Archduke Ludwig Salvator wrote in the Adria magazine: "I remember that there was a talk about it in previous years and a large number of snakes was mentioned as an obstacle", writing about a problem pointed out also by professor Max Kleiber from Munich, another intercessor of the Nature Park idea, during his first visit to Mljet in the summer of 1903. He noted that Polače "with its surroundings would be the most interesting point of the island which is, for its many snakes, more feared than visited". In a footnote Kleiber appended: "Last autumn (1910) I learned from ranger commissioner Nejedly in Korčula that not so long time ago a number of mongooses has been set free on the island, and that the citizens have instantly named them 'snake-eaters'". Carrara (1846), Kolombatović (1882) and Werner (1908) all mention an extremely large number of Nose-horned Vipers on Mljet, whereas already Hirtz (1927) states that it has become extremely rare, the reason for that being the Small Indian

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Fig. 1: Record localities on the Croatian island of Mljet.

Abb. 1: Die kroatische Insel Mljet und die im Text angeführten Fundorte.

Mongoose introduced only several years earlier.

The Small Indian Mongoose *Herpestes auropunctatus* (HODGSON, 1836), was introduced on Mljet on 26th of August 1910, when 11 specimens of this species, imported from India, were released at the location of Vilina vodica (MADER 2010). Since then the mongooses dispersed across the whole island and made a serious impact on its sensitive eco-system (BARUN et al. 2010).

This study summarizes the current knowledge of the batrachofauna and herpetofauna of the island of Mljet. Previous literature data as well as recent unpublished finds of the authors and their associates are presented in this paper. The findings of two amphibian and 14 reptile species are presented on separate maps, and the authors propose guidelines for the species' protection.

MATERIALS AND METHODS

In simply referring to 'Mljet', most of the previous publications (CARRARA 1846; KOLOMBATOVIĆ 1882; 1904; RÖSSLER 1904; WERNER 1897, 1902, 1908; BOULENGER 1905; BOLKAY 1924; HIRTZ 1930; PAVLETIĆ 1964; FRITZ 1992) quoted findings from this island without stating an accurate site. With this study, the authors remedy this deficiency by gathering information about precise record localities, to understand the distribution of amphibians and reptiles on the island.

For this purpose, field surveys in the form of active searching in promising places, was conducted on several occasions during 2007 (30 days from April to September; two persons on average), 2008 (seven days in July; one person) and 2009 (five days in June; one person) on a number of sites on the island (Fig. 1).

Targets of focused research were the rare species (amphibians, snakes) and the effect of the introduced mongooses on their survival.

The faunal diversity on the island of Mljet was compared with other larger Adriatic and Mediterranean islands, provided that published herpetological data existed. Cited literature data are used without critical review, although authors suspect that for some islands (e.g. Krk, Cres) species numbers are overestimated.

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SPECIES ACCOUNT

During the surveys on Mljet, one amphibian (*Pelophylax ridibundus*) and 11 reptile species were detected (*Emys orbicularis*, *Testudo hermanni*; *Hemidactylus turcicus*, *Podarcis melisellensis*, *Dalmatolacerta oxycephala*, *Pseudopus apodus*; *Coronella austriaca*, *Hierophis gemonensis*, *Zamenis longissimus*, *Malpolon insignitus*, *Vipera ammodytes*). The status of seven more species (*Bufo viridis*; *Caretta caretta*; *Anguis fragilis*, *Podarcis siculus*, *Lacerta agilis*, *Elaphe quatuorlineata* and *Zamenis situla*) reported from Mljet in the literature, is discussed.

Pelophylax ridibundus (Pallas, 1771)
Marsh Frog (Fig. 2)

The Marsh Frog is present in almost all freshwater locations and even in some brackish water bodies on the island [freshwater ponds, three brackish lakes ("blatina" in the local vernacular)]. Sites known from the literature are: Blatina near Blato (Partsch 1826; Pavletić 1964), Sobra (Werner 1908), "Mljet" (Kolombatović 1904). During our research, the Marsh Frog was observed in various puddles: Vodice near Kneže polje, near Ivanje polje, Blatina near Blato and Slatina near Kozarica.

Bufo viridis viridis Laurenti, 1768
Green Toad (Fig. 2)

This species is the most common amphibian on Adriatic islands, due to its adaptability and ability to reproduce in brackish water. It was, however, not encountered during the present surveys. The only older published site for this species on Mljet is environs of Sobra (Werner 1908). According to Tvrtković et al. (2009), this species is almost extinct on Mljet, found only on Slatina near Kozarica, although there are clues that it is also still present at Blatina near Sobra.

Caretta caretta caretta (Linnaeus, 1758)
Loggerhead Sea Turtle (Fig. 3)

The Loggerhead, which is by far the most common species in the Adriatic, is the only sea turtle species recorded from Mljet and the surrounding waters. Lazar & Tvrtković (2000) mention an earlier report on a juvenile specimen found on the coast near Kozarica in 1987, as well as findings of undetermined specimens of the Family Cheloniidae in the sea between the islands of Mljet and Vis, in the Mljet canal and on the shore near Pomena. These latter observations do not refer to records verified by experts, and there is no certainty about the species they refer to.

Emys orbicularis hellenica (Valenciennes, 1832)
European Pond Turtle (Fig. 3)

The Pond Turtle was first mentioned from Mljet by Kolombatović (1904) in his paper about the vertebrates of Dalmatia, which is also the earliest report of this species for Adriatic islands. However, the author does not state the exact site, just "Meleda" (Mljet). Later on, the Pond Turtle was found on the islands of Krk, Cres, Plavnik, Rab, Pag, and Veliki Kornat (Hirtz 1930; Fritz 1992), but may be in steep decline, as on many of these (Plavnik, Rab, Veliki Kornat) it has not been recently confirmed. There is a specimen from Ivanje polje in the Croatian Natural History Museum's collection (obtained by Hajdić in 1905) (Lončar 2005). The authors found Pond Turtles in large numbers in the brackish lake Blatina near Blato, and several specimens in wells in Blatsko polje. At the Ivanje polje locality, several small ponds were found, but not Pond Turtles.

Testudo hermanni boettgeri Mojsisovics, 1889
Hermann's Tortoise (Fig. 3)

Werner (1908) was the first to report the presence of Hermann's Tortoise (under the name *Testudo graeca* L.) on the island of Mljet, although he himself did not find any. In their study, the authors found tortoises in fair numbers in the surroundings of Solin, near Goveđari, in Ivanje polje and in Saplunara bay. The local inhabitants often keep them as pets in their gardens, making

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Hermann's Tortoise a quite common animal around villages. Since a considerable number of specimens showed shell lesions (similar to bite marks), the authors believe that these injuries are the consequences of wild boar attacks. The wild boar has extremely strong jaws with which it can crack the turtle's hard shell and get to the nutritive interior.

Hemidactylus turcicus turcicus
(Linnaeus, 1758)
Turkish Gecko (Fig. 2)

This species was reported by Partsch (1826) along with the Marsh Frog, and thus, belongs to the earliest records of herpetological species on Mljet. Later it was mentioned by Bolkay (1924) in his review of the herpetological collection stored in the Bosnia-Herzegovina museum in Sarajevo. The only precise site known from the literature is presented by Werner (1908), who mentioned one specimen caught on the wall of an old house in Babino polje. The authors caught several Turkish Geckos in the little bay Saplunara, in the village Korita, in Polače and Soline, and found one specimen killed by a cat in Goveđari. According to reports by the local inhabitants, this species is very common and can be found all over the island. It is most numerous in villages, and quite numerous on crag, dry stone walls, pathway incisions, water tanks and cave entrances. Local people kill them because of the popular myth that they are poisonous and can erase the whole family if they fall into their food or water.

Dalmatolacerta oxycephala
(Duméril & Bibron, 1839)
Sharp-snouted Rock Lizard (Fig. 2)

In literature, this species was mentioned for Mljet very early, however, none of the authors (Werner 1891, 1908; Kolombatović 1904; Rössler 1919a, 1919b; Kammerer 1926; Koch 1926; Karaman 1939; Radovanović 1956; Pavletić 1964; Pozzi 1966) gave any precise localities; the species is mostly characterized just as a very common one. Our research confirmed the presence of this species in the environs of Solin, Saplunara bay, near Babine kuće and on Montokuc hill. It is apparent from the findings at sea level near Solin and Saplunara bay (~10 m a.s.l.) to Montokuc (258 m a.s.l.) that the species is most probably widely distributed all over the island.

Lacerta agilis Linnaeus, 1758
Sand Lizard (Fig. 2)

According to Rössler (1904) the voucher collected by A. Langhoffer in 1894 near Polače, was stored in the Croatian Natural History Museum (Zagreb). However, Pavletić (1964) and Lončar (2005), in their collection catalogs, do not refer to the above mentioned sample at all and we must assume that it is no longer available. We consider the affair a matter of locality mistake or erroneous determination, which was corrected after Rössler's (1904) publication, maybe even a printing error in the first paper. In Dalmatia it can only be found on higher mainland mountains (Promina, Svilaja, Dinara, Kamešnica) (Jelić 2010b). There is, however, a mention of this lizard species for the island of Lastovo, about 40 km southwest of Mljet by Bolkay (1924), who indicated "Dalmatia, Ubli nearby church, 1910" as the site and time. It is difficult to believe that *L. agilis*, which is adapted to temperate and continental climate, could live on Adriatic islands. However, one should bear in mind that the islands were mountains connected to the mainland until about 12000 years ago (Kryštufek & Kletečki 2007) and this species may have survived here from that time. Neither our studies nor the research by Tvrtković et al. (2009) could confirm the presence of this species on Mljet. Thus, it was excluded from species list in our further analysis.

Podarcis melisellensis fiumanus
(Werner, 1891)
Dalmatian Wall Lizard (Fig. 2)

The island is inhabited by the subspecies which also lives on the mainland and most other Adriatic islands, except the archipelago of Lastovo and Vis (Podnar et al. 2004). This most common lizard species is present in almost all habitats. It can be

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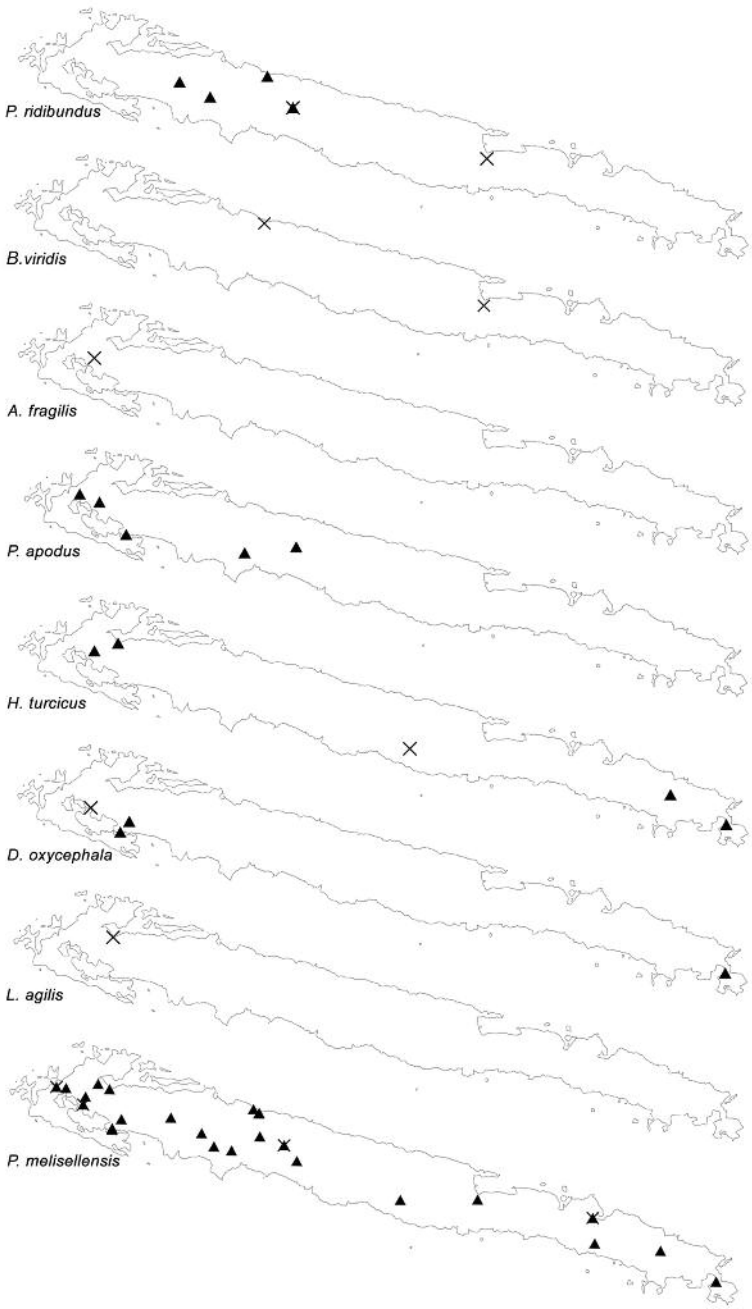

Fig. 2: Amphibian and reptilian records on the Croatian Island of Mljet available from the literature (×) and the authors' field observations (▲).

Abb. 2: Amphibien- und Reptilienfunde auf der kroatischen Insel Mljet nach Literaturangaben (×) und Beobachtungen der Autoren (▲).

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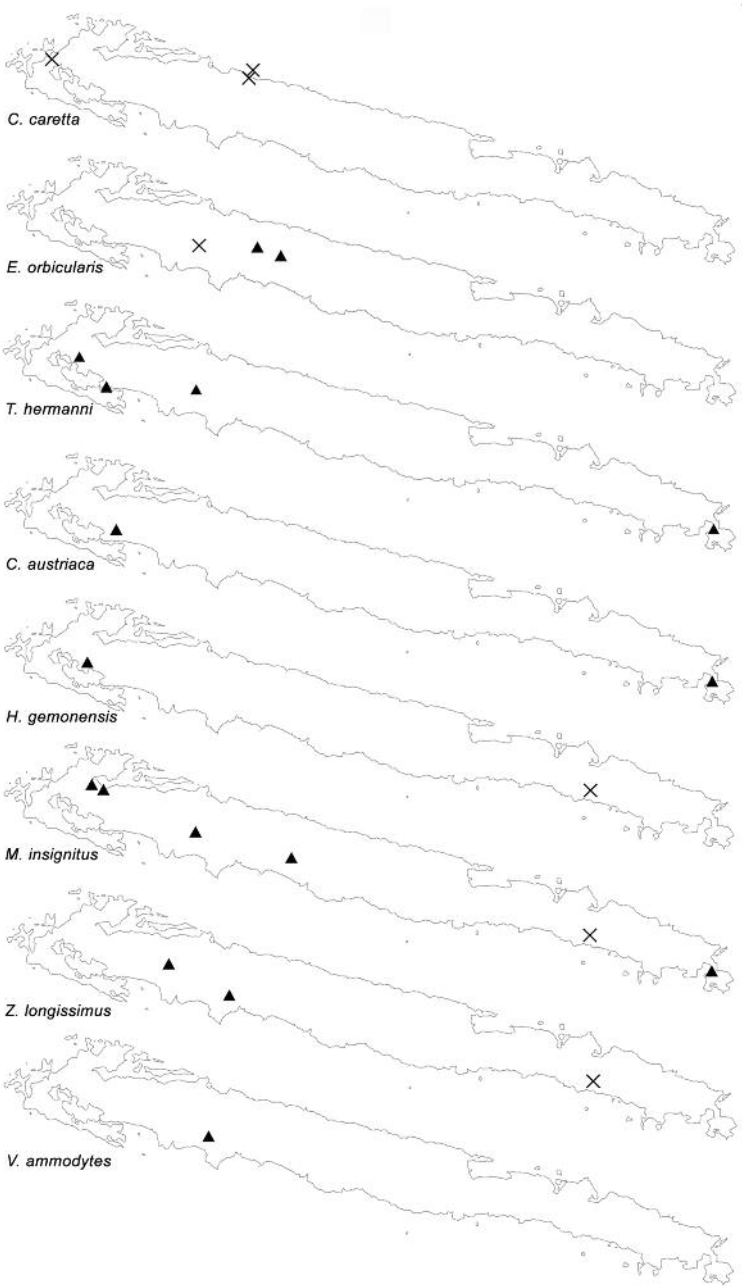

Fig. 3: Reptilian records on the Croatian Island of Mljet available from the literature (×) and the authors' field observations (▲).

Abb. 3: Reptilienfunde auf der kroatischen Insel Mljet nach Literaturangaben (×) und Beobachtungen der Autoren (▲).

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extremely numerous in places and, as such, form the prey for various birds, mammals and snakes.

Along with normally colored *P. melisellensis fiumanus*, the inconspicuous color morph "modesta" occurs on Mljet, with approximately 20% frequency. Both forms were recorded by Werner (1908), which was the first finding of this species for Mljet. The sites mentioned in literature are: the island of Mljet (Kolombatović 1904; Werner 1908; Rössler 1919a, 1919b; Kammerer 1926; Radovanović 1956; Pavletić 1964), Pomena (Podnar-Lešić 2005; Važić 2006), and Blato (Važić 2006). The authors recorded the Dalmatian Wall Lizard on all visited sites: Babina Kuća, Babino polje, Blatina kod Blata, Blatsko polje, road between Polača and Goveđari, road under Bugari, Dugo polje, Goveđari, Ivanje polje, Korita, Kozarica, pond in Ivanje polje, Mala Poma, Maranovići, Montokuc, Nerezine dol, Okuklje, Polaće, Pomena, Saplunara, Slatina near Kozarice, Sobra, Soline and Vodice.

Podarcis siculus siculus
(Rafinesque-Schmaltz, 1810)
Italian Wall Lizard

Rössler (1919a; 1919b; 1920) stated that *Lacerta serpa* var. *olivacea* (synonym of *P. siculus*) is found on the island. This reference is most probably the result of a mistake or wrong identification, as was later concluded by Karaman (1939) and Pavletić (1964). There is no exact site given for this find, just generally "Mljet". Moreover, this taxon was never again mentioned from Mljet since that time. Thus, this species was excluded from the list of species in our further analysis.

Anguis fragilis Linnaeus, 1758
Slow Worm (Fig. 2)

The only record is presented by Džukić (1987) in his paper on the taxonomy of *Anguis fragilis* in Yugoslavia in which he mentions the finding of *A. f. colchicus* (Nordmann, 1840) nearby a dry stone wall next to Goveđari. In the present study and the research by Tvrtković et al. (2009), this species was not found. The Slow Worm is very rare in Dalmatia, only recorded from three North Adriatic islands: Krk, Cres and Košljun (Tóth et al. 2006). It prefers humid and wooded habitats; thus, it should be looked for in such places, e.g., Mediterranean primeval forest remains, such as the native holm oak forest in the area of Velika dolina.

Pseudopus apodus thracius (Obst, 1978)
European Glass Lizard (Fig. 2)

Only Werner (1908) mentioned the European Glass Lizard for the island of Mljet, based on testimonies of local inhabitants, although he did not find it himself. This poorly supported information is very surprising because the European Glass Lizard is very common on Mljet in fields and around villages. Scrunched specimens are often found on the road since the Glass Lizard is extremely slow moving on smooth surfaces such as asphalt. During the research, it was observed in Mala Poma, Goveđari, Soline, Blato and Dugo polje.

Coronella austriaca austriaca
Laurenti, 1768 Smooth Snake (Fig. 3)

This species is very rare on Adriatic islands and is previously known only from Cres (Hill 2008), Krk and Brač (Werner 1891; Bruno 1980; Engelmann 1993). For Mljet, the Smooth Snake was first mentioned from a student field trip report by Lipej et al. (1987). Our research during 2008 confirmed this species record for Mljet (Jelić 2010a). There was one adult specimen observed on Montokuc hill (258 m a.s.l.) and one shed skin in Saplunara bay.

Hierophis gemonensis (Laurenti, 1768)
Balkan Whip Snake (Fig. 3)

Werner (1902) and Kolombatović (1904) mentioned the Balkan Whip Snake for Mljet based on Ginzberger's finding, and it was later reported by Karaman (1939), Radovanović (1964) and Tortonese & Lanza (1968). The site known from the literature is Maranovići (Werner 1908). During our research, this species was encountered only once, in Pomijenta, where an adult specimen was observed basking on a dry stone wall. This species is very com-

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Table 2: Diversity of the herpetofauna. Island size and number of taxa on Mljet compared with other Adriatic and Mediterranean islands. * - Numbers used in KRYŠTUFEK & KLETEČKI (2007) for Krk and Cres contain some very doubtful findings that were not reconfirmed recently.

Tab. 2: Der Artenreichtum der Herpetofaunen. Ein Vegleich von Mljet und anderen Inseln der Adria und des Mittelmeeres hinsichtlich Inselfläche und Anzahl der Taxa. * - Zahlenangaben in KRYŠTUFEK & KLETEČKI (2007) für Krk und Cres beinhalten zweifelhafte Funde, die in jüngerer Zeit nicht mehr bestätigt wurden.

Country Land	Island Insel	Number of species Anzahl der Arten	Surface area (km^2) Inselfläche (km^2)	Reference Datenquelle
Greece	Corfu	34	585	TOTH et al. (2002)
Croatia	Krk*	29	405	KRYŠTUFEK & KLETEČKI (2007)
Croatia	Cres*	27	406	KRYŠTUFEK & KLETEČKI (2007)
Italy	Sardinia	27	23813	SALVI & BOMBI (2010)
Italy	Sicily	27	25460	CORTI et al. (1999)
Cyprus	Cyprus	24	9251	CORTI et al. (1999)
Greece	Lesbos	24	1630	CORTI et al. (1999)
Greece	Chios	22	842	CORTI et al. (1999)
France	Corsica	21	8681	CORTI et al. (1999)
Croatia	Hvar	21	300	KRYŠTUFEK & KLETEČKI (2007)
Greece	Rhodes	20	1398	CORTI et al. (1999)
Croatia	Mljet	16	100	this study
Greece	Crete	16	8312	CORTI et al. (1999)
Croatia	Brač	16	395	KRYŠTUFEK & KLETEČKI (2007)
Croatia	Pag	16	285	KRYŠTUFEK & KLETEČKI (2007)
Croatia	Rab	16	94	KRYŠTUFEK & KLETEČKI (2007)
Croatia	Korčula	14	279	KRYŠTUFEK & KLETEČKI (2007)
Croatia	Lošinj	14	74	TOTH et al. (2002)
Croatia	Dugi otok	12	124	KRYŠTUFEK & KLETEČKI (2007)

mon on other islands; so it is surprising that it was so poorly represented on Mljet.

Elaphe quatuorlineata quatuorlineata (LACÉPÈDE, 1789) Four-lined Snake

The presence of this species on Mljet was repeatedly mentioned in the older literature (WERNER 1987, 1902, 1908; KARAMAN 1939), but all reports are based on an indication by WERNER (1897) who writes that he has, in his collection, one specimen of this species, caught on Mljet by GINZBERGER. This finding's more precise location is not given. Our research did not confirm the occurrence of this species.

Zamenis situla (LINNAEUS, 1758) Leopard Snake

Without giving a specific site, a record from Mljet is mentioned in a paper by FARKAS & TÓTH (1999) who refer to OBST et al. (1993). However, in OBST et al. (1993) there is no record for Mljet. Thus, the Leopard Snake was excluded from the list of species in our further analysis.

Zamenis longissimus LAURENTI, 1768 Aesculapian Snake (Fig. 3)

This species lives in various habitat types, but avoids open areas where shelter (mostly trees and shrubs) is rare. It is quite common on cultivated land, as well as near villages or farm objects. KOLOMBATOVIĆ (1904) reports this species to be present on Mljet according to GINZBERGER's findings, but does not provide any more detailed information. WERNER (1908) brings up LISIČAR's finding of two adult males near Maranovići. During the present research, the Aesculapian Snake was recorded near Vodice (one juvenile specimen run over) and in Dugo polje (adult).

Malpolon insignitus (GEOFFROY SAINT-HILAIRE, 1827) Montpellier Snake (Fig. 3)

In spite of being very common on Mljet, this species was only mentioned by WERNER (1908), who reported it from near the village Maranović and also referred to two specimens caught by LISIČAR in the same

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location. During our research we found Montpellier Snakes on most of the sites visited: Ivanje polje, Blatsko polje, Soline, the road between Polače and Goveđari, Polače, the road below Bugari hill, as well as Saplunara bay and its surroundings. During the studies, about 10 specimens were seen run over on the road. Interestingly, four specimens caught in Saplunara bay had extremely severe injuries, which were clearly inflicted by a predator. Two of the specimens were hurt so badly that the authors think that they could not have survived. The producer of these injuries was most likely the Small Indian Mongoose.

Vipera ammodytes ammodytes
(LINNAEUS, 1758)
Nose-horned Viper (Fig. 3)

CARRARA (1846), KOLOMBATOVIĆ (1882) and WERNER (1897, 1902, 1908) mention the occurrence of extremely large numbers of Nose-horned Vipers on Mljet. Later, HIRTZ (1927) who could not find any vipers on Mljet, stated that, according to local inhabitants, the viper had become exceptionally rare, due to the predatory activity of the Small Indian Mongoose (*Herpestes auropunctatus*) introduced on Mljet in 1910.

The only recent find of this species was made by members of the Croatian Biospeleological Society (CBSS), who recorded one specimen near Nerezni dol in 2008 (PREDRAG Rade, pers. comm.). Despite great efforts and tactic searching at favorable sites, we were not able to reconfirm the presence of *V. ammodytes* on this island. On Mljet, the Small Indian Mongoose mostly prefers lower altitudes, fields and the environs of villages. From this we believe that the Nose-horned Viper should be searched for in more inaccessible parts in higher elevations of the island where populations might have survived.

DISCUSSION

During their studies on the island of Mljet, the authors found one amphibian and 11 reptile species. The occurrence of four more species is known only from the literature (*Bufo viridis*, *Caretta caretta*, *Anguis fragilis*, and *Elaphe quatuorlineata*). In total 16 herpetological species were recorded from that island, two species of amphibians, three of turtles, five of lizards and six of snakes.

The low number of amphibian taxa is characteristic for East Mediterranean islands (CORTI et al. 1999) and a consequence of dry climate, lack of fresh water for reproduction and the limited sea water tolerance of amphibians, which impedes island hopping. On the other hand, travelling by "sea current drift" is quite common with reptiles which may arrive at nearby islands using driftwood. This phenomenon was observed during December 2010 when the currents of the Neretva river floods brought Pond Turtles (*E. o. hellenica*) to the island of Korčula. The authors assume that the Neretva river washed sedge clusters containing turtles into the sea, and that the clusters made their way to Korčula by currents. On the beach near the town of Korčula, 21 specimens of *E. o. hellenica* were detected, 14 of which had survived this incredible 65 kilometers journey from the Neretva estuary. The turtles were found partly entangled in floating sedge, partly walking around (S. VILOVIĆ, pers. comm.). This event shows that, in the past, such kind of transport may have happened quite often. It can be expected that the closer an island is to a mainland river estuary, the bigger are the similarities between both island and mainland faunas. It is unrealistic to expect that Pond Turtles could survive on Korčula because there are no larger fresh water ecosystems here. However, if this species arrived at the shores of Mljet the same way in the past, the turtles would have found appropriate habitats in the lakes there (near Blato, Sobra and Kozarica). Thus, the Pond Turtle population of Mljet is not necessarily isolated since the end of the Pleistocene (12000 years BP), as we would suppose.

During the assessment, *E. quatuorlineata*, were not found, although it was mentioned in older literature, and the authors are convinced that it has or still is present on the

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island. Since the introduction of the Small Indian Mongoose considerably reduced the population of snakes on Mljet, it is possible that these species became extinct under this influence. However, we must leave the question unanswered if prolonged, focused search could verify its presence.

Anguis fragilis was reported only once (from near Goveđari) and it is unknown whether or not a population is still present. There are habitats on Mljet that could be favorable for *Anguis* such as the Mediterranean primeval forest remains (native oak forest) in the area of Velika dolina.

The record of *Lacerta agilis* on Mljet seems most questionable, and unlikely, because this lizard species has a clear preference for higher continental habitats and is consistently absent from the Adriatic coastal regions and islands. Also RÖSSLER's (1904) finding of *Podarcis siculus* was most likely the result of an erroneous determination. The record of *Zamenis situla* by FARKAS & TÓTH (1999) was found to be the result of incorrect citation of OBST et al. (1993). We do not consider these last three species valid for Mljet.

Based on personal data of the authors and available published data from other Adriatic islands mentioned in Table 2, we find it very surprising that *Lacerta trilineata* BEDRIAGA, 1886 and *Natrix natrix* (LINNAEUS, 1758) were not registered on Mljet. But according to BARUN et al. (2010) both species tend to be more rare or absent from islands inhabited by Small Indian Mongoose (Korčula, Hvar, Mljet) then on islands where mongooses are not present (Brač, Dugi otok, Lastovo).

With a total of 16 recorded species of the herpetofauna, the island of Mljet belongs to the Mediterranean islands of average species-richness (CORTI et al. 1999) and to the richest among the Adriatic islands (Table 2). It is interesting to see that the large Mediterranean islands, Sicily, Sardinia, Corsica, Cyprus, Crete and Rhodes, do not belong to the species-richest ones. Several times smaller islands like Corfu, Krk and Cres made it to the very high ranks (* note the remark made in 'Materials and Methods' and Table 2). On the other hand, the herpetofauna of Mljet is as rich as that of the many times larger Adriatic islands Brač, Pag and Korčula.

Out of 16 herpetofaunal species occurring on Mljet, four reptile species are quoted in the Red Data Book of Amphibians and Reptiles of Croatia (JANEV-HUTINEC et al. 2006), from which *Caretta caretta* is classified 'Endangered' (EN). *Emys orbicularis* and *Testudo hermanni* are 'Near Threatened' (NT), whereas *Zamenis situla* is a 'Data Deficient' (DD) species. Particularly for Mljet, we identified *Bufo viridis*, *Emys orbicularis* and *Vipera ammodytes* as highly threatened, and *Coronella austriaca*, *Testudo hermanni* and *Hierophis gemonensis* as endangered. *Anguis fragilis*, *Elaphe quatuorlineata* and *Zamenis situla* should be addressed as data deficient species.

PROTECTION GUIDELINES FOR THE AMPHIBIAN AND REPTILIAN FAUNA OF MLJET

Allochthonous species regulation.- Most of the protection-related problems on Mljet are based on introduced invasive species which alter this sensitive island ecosystem considerably. Firstly, there is the Small Indian Mongoose which exterminated *Vipera ammodytes* almost completely during the last 100 years. This small carnivore is most probably the reason for the low densities of *Hierophis gemonensis*, *Elaphe quatuorlineata* and possibly *Zamenis situla*. It is absolutely essential to set up an eradication plan as soon as possible, or at least a plan for the reduction of the number of Small Indian Mongooses on the island to reduce the pressure on the indigenous fauna.

The wild boar is also causing extreme problems to the island fauna, because wild boars are voracious omnivores which can easily crack the turtle shell (especially of smaller specimens). Due to their bulky build, turtles are a perfect prey and are often found with bitten and broken shells. This mammal has extremely negative influence on the abundance of snakes, slow worms and glass lizards, and will eat them if there

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is the opportunity (MARIÁN 1957; SCHIEMENZ 1985). We feel that it is necessary to come up with a plan to remove wild boars from Mljet in cooperation with official hunting organizations, as it was done for the islands of Krk and Cres.

There is another widely spread invasive species on the island, the Eastern Mosquitofish, *Gambusia holbrooki* GIRARD, 1859. This species inhabits all mud-swamps on Mljet and some ponds. With its extremely aggressive behavior it adversely affects the survival of frog eggs and tadpoles. The Mosquitofish was originally introduced to Europe to control the populations of mosquitoes during the malaria outbreaks, but today it is frequently spread unintentionally by a variety of vectors (water transport in agriculture; together with economically important fish species etc.). Controlling this species is very difficult and expensive, so the least one can do is try to prevent further spreading to new ponds. Convincing and instructing local inhabitants is the most important factor doing that.

Destroying habitats.- On the Adriatic islands, habitat destruction refers chiefly to aquatic biota and is mainly a threat to amphibians, Marsh Frog and Green Toad in particular. Natural water surfaces are in danger of being subject to the deposition of waste and poisons. The poisons used in agriculture are highly effective dangerous chemicals, and it is necessary to regulate their application and reduce their concentration in edge of field water bodies and water basins.

Setting up monitoring for especially sensitive and endangered species as well as their habitats. It is necessary to come up with the monitoring of the *Emys orbicularis* population in Blatina near Blato. Specific research strategies should be applied to detect, monitor and support possibly extant micro-populations of *Bufo viridis* and *Vipera ammodytes*.

CONCLUSION

The research of the amphibian and reptile fauna of Mljet began over 100 years ago, and during this period of time a significant change in the number of certain species can be noticed. Populations of various species declined, so that some of them can be considered extremely rare or even extinct. The main reason for this drastic change seems to be the introduction of invasive alien species which, with their presence and interaction with native species, significantly changed the island's ecosystems. Considerable progress in island fauna protection could be effectuated by establishing a plan to regulate the number of alieninvasive species. Further research efforts are needed to investigate the lesser known and endangered species, and set up monitoring systems, to ensure long-term survival of these species.

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