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EIDECHSEN ONLINE



2020

Artikel  
article

3

L@CERTIDAE  
EIDECHSEN ONLINE

2020 № 3- ONLINE VERÖFFENTLICHT / PUBLISHED ONLINE: 2020-02-01



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**Zitat / Citation:**

ZAWADZKI, M. (2020): Success model “island lizard” – or rather a bleak future for the Ibiza wall lizard *Podarcis pityusensis* (Boscá, 1883)? – L@CERTIDAE (Eidechsen Online), 2020[3]: 19–41.



## Success model “island lizard” – or rather a bleak future for the Ibiza wall lizard *Podarcis pityusensis* (Boscá, 1883)?

MIKE ZAWADZKI, 2020

### Abstract

The Ibiza wall lizard, *Podarcis pityusensis* is the only endemic land vertebrate of the Pityusic Islands. It inhabits the two main islands Ibiza and Formentera as well as the vast majority of the offshore small islands. When humans first arrived at the islands, they brought with them a handful of foreign predators, such as genets, beech martens, rats, and feral cats – all lizard predators. *Podarcis pityusensis* is fully protected by national and international legislation and listed in Annex II of the Bern Convention and in Appendix II of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). It is declared as “Near Threatened” by the IUCN (2009). However, some of the populations are very much reduced, endangered or on the verge of extinction as they are threatened by illegal collection, disturbance by visitors, introduction of cats and rats to the islands, and accidental poisoning with bait left for seagulls. The recent introductions of three snake species on Ibiza and Formentera are of particular concern. The Montpellier snake (*Malpolon monspessulanus*) has not been caught on the islands since 2010. The horseshoe whip snake (*Hemorrhois hippocrepis*) has shifted its diet towards lizards, with the native Ibiza wall lizard, representing 55.4 % of the observed prey. A similar dietary shift is probably occurring with the ladder snake (*Rhinechis scalaris*) in Formentera, as a preliminary study shows that more than half of its prey is constituted by *Podarcis pityusensis* (HINCKLEY et al. 2017). The effect of predation may seriously threaten the lizards in the main islands and the arrival of snakes in the surrounding islands may produce a catastrophic and irrecoverable event for lizard populations as they would be the only available prey.

## Zusammenfassung

Die Pityuseneidechse *Podarcis pityusensis* ist das einzige endemische Landwirbeltier der Pityusen und bewohnt neben den beiden Hauptinseln Ibiza und Formentera die allermeisten der vorgelagerten kleinen Felseninseln. Als der Mensch die Inseln besiedelte, brachte er auch fremde Beutegreifer in seinem Gefolge mit, wie z. B. Ginsterkatzen, Steinmarder, Igel, Ratten und Wildkatzen. *Podarcis pityusensis* ist durch nationale und internationale Gesetze geschützt und im Anhang II des Washingtoner Artenschutzübereinkommens (CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora) gelistet. Auf der Roten Liste der IUCN wird die Art derzeit als potenziell gefährdet („Near Threatened“) eingestuft. Einige der Populationen sind jedoch stark rückgängig, gefährdet oder vom Aussterben bedroht. Ursächlich hierfür sind unter anderem Störungen und Nachstellungen durch den Menschen, Einschleppung von Katzen und Ratten sowie auch versehentliche Vergiftung durch Köder zur Bekämpfung von Mäusen. Anfang dieses Jahrtausends wurden drei Schlangenarten mit importierten Olivenbäumen auf die Inseln verschleppt: die Hufeisennatter (*Hemorrhois hippocrepis*), die Treppennatter (*Rhinechis scalaris*) und die Westlichen Eidechsennatter (*Malpolon monspessulanus*). Während letztgenannte Art seit 2010 nicht mehr nachgewiesen wurde, verbreiten sich die beiden anderen Schlangenarten besorgniserregend. *Podarcis pityusensis* macht in der Nahrung von *Hemorrhois hippocrepis* auf Ibiza 55,4 % der beobachteten Beute aus, und die Nahrung von *Rhinechis scalaris* auf Formentera besteht ersten Untersuchungen nach zu mehr als der Hälfte aus Eidechsen (HINCKLEY et al. 2017). Dies stellt für die Eidechsen auf den beiden Hauptinseln eine ernsthafte Bedrohung dar. Sollten die Schlangen auch die umliegenden Inseln erreichen, würde dies katastrophale und unwiederbringliche Folgen für die dort lebenden Eidechsenpopulationen haben, da sie dort die einzige verfügbare Beute wären.

**Keywords:** *Podarcis pityusensis*, island populations, general threats, lizards and men, introductions of snakes, *Hemorrhois hippocrepis*, *Rhinechis scalaris*.

## Introduction

Anyone who has ever spent their summer vacation on Ibiza or its little sister island Formentera has most likely already encountered it: the Ibiza wall lizard or Pityusic lizard, *Podarcis pityusensis*. This lizard is actually unmistakable, and anyone who is willing to leave the pool area of their holiday hotel and takes a look to the right and left of the beach promenade will spot the pretty and nimble reptiles. The Ibiza wall lizard lives all over Ibiza and Formentera and can be found in large numbers in many places as well as on most of the surrounding offshore islands and small rocky islets. *Podarcis pityusensis* is the only endemic land vertebrate living in the archipelago. In total, the herpetofauna of the islands is quite poor in species. The Moorish Gecko (*Tarentola mauritanica*) and the Mediterranean House Gecko or Turkish Gecko (*Hemidactylus turcicus*) have been introduced by men as well as the specimens of the North American red-eared slider (*Trachemys scripta elegans*) that you can come across at some places on Ibiza. The Mediterranean Spur-thighed Tortoise

(*Testudo graeca*), which had been reported from time to time in the literature and which can be traced back to released specimens from the pet trade, have meanwhile disappeared – at least on Ibiza. A few years ago an attempt was made to reintroduce a small number of specimens on Formentera. The amphibians are represented on the Pityusic islands only with two species: the Iberian water frog (*Pelophylax perezi*) and the Balearic green toad (*Bufo balearicus*), which also arrived at the archipelago with the help of men. Depending on the authors' opinion, six (CIRER 1987) respectively 23 subspecies (SALVADOR 2015) of *Podarcis pityusensis* are currently recognized, some of which differ considerably in terms of coloration and pattern, but also in size. The nominate form *Podarcis pityusensis pityusensis*, which lives on Ibiza and some nearby islets, usually shows a green back in the males (Fig. 1) with three more or less continuous, jagged black longitudinal stripes. The females are usually rather inconspicuously brown colored, although in many places they also show green colors on the back. On Formentera, on the other hand, *Podarcis pityusensis formenterae* is a particularly colorful subspecies that is

characterized by bluish to greenish colors (Fig. 2). Only on Formentera’s northernmost promontory Trocadors the lizards show light brown to light gray colors as a special adaptation to the sandy habitat (Fig. 3). You can find the lizards almost everywhere on the two main islands. They prefer sunny habitats like wild vegetated areas, gardens, rock piles and stone walls. You can even find them in the pine forests, although the population density is lower there. The Ibiza wall lizard has long since become a popular animal and even a symbol of the archipelago. Nowadays its image decorates countless bath towels, t-shirts, bags, jewelry tags, postcards and stickers.

In addition to Ibiza and Formentera, *Podarcis pityusensis* also inhabits 46 offshore islands in the archipelago as well as seven former islands, each of which had been connected to either one of the two main islands. Although the lizards seem to be missing on some small barren rocky islets, new island

populations have been discovered even more recently (VAN DEN BERG 2010, VAN DEN BERG & ZAWADZKI 2010, ROMERO 2012, VAN DEN BERG & ZAWADZKI 2017, ZAWADZKI & VAN DEN BERG 2017).

Some populations of *Podarcis pityusensis* have been reported from outside its actual range, which are due to human introductions. Such thriving populations can be found on Mallorca in the island capital Palma (MÜLLER 1927, EISENTRAUT 1949, ZAWADZKI 2012) as well as on the Illetas Islands in the western part of the large bay of Palma (EISENTRAUT 1949, ZAWADZKI et al. 2018), and in Cala Ratjada (FRITZ 1992, ZAWADZKI 2005). In addition, the species has been able to establish itself on mainland Spain in Barcelona (CARRETEO et al. 1991, BRUEKERS 2007), San Juan de Gaztelugatxe (SOCIETAT CATALANA D’HERPETOLOGIA 2001, GARCIA-PORTA 2001) and on Monte Urgul in San Sebastian (SANZ-AZKUE et al. 2005).



Fig. 1. *Podarcis pityusensis pityusensis* male, Ibiza.



Fig. 3. *Podarcis pityusensis formenterae*, Trocadors, N-Formentera.



Fig. 2. *Podarcis pityusensis formenterae*, Formentera.



Fig. 4. Barren habitat of *Podarcis pityusensis formenterae* on Trocadors, in the north of Formentera.



Fig. 6. Pityusic lizard licking nectar from a flower, Illa Alga.



Fig. 5. Male *Podarcis pityusensis formenterae* eating a yellow petal of a flower.

### Islands as habitat

Many of the smaller islands off the coasts of Ibiza and Formentera make a rather poor impression (Fig. 4), and sometimes you can only find two or three plant species on the smallest of them. The quantity of invertebrates on such a barren island is accordingly low. The lizards have adapted extremely well to this scarce food supply and, in addition to ants, black beetles, woodlice and snails, they also eat small crustaceans, which they prey near the water at the shores of their home islet. *Podarcis pityusensis* also consumes plant matters like nectar and pollen, fruits, berries, and flower petals (Fig. 5 & 6). Flying insects that are attracted by plants also expand the menu of the lizards. However, the often poor environmental conditions also have an advantage, because on such less hospitable islands predators are rare or completely absent. In an environment without enemies and food competitors, the lizard populations can reach

enormous densities.

In spring during the blooming season, when the lizards find plenty of food, they store fat in their tails, which helps them to survive the time when food is scarce. During the hot summer months, when most of the plants have long since faded and the invertebrates hide in deep crevices or under stones during the day, many of the lizards have literally collapsed on the flanks and exhibit corresponding skin folds. But from the end of June to the beginning of July, when the first young lizards hatch, the table is set to a certain extent for the adult lizards, because they do not stop at their own offspring (Fig. 7). The small juveniles therefore have to be careful to stay off the menu of the adult lizards. When they run across an adult lizard, they immediately flee into the nearest bush or a nearby crevice. Cannibalism by adult lizards may be a major cause of death in juveniles. Sometimes natural predators like Eleonora's falcon (*Falco eleonora*) or the European kestrel (*Falco tinnunculus*) prey

on the lizards, and also seagulls sometimes prey on them, but they are unlikely to have any or only little impact on the population sizes (Fig. 8). However, the presence of breeding gulls on some islands affects the

behavior of the lizards, which are much shyer and are only rarely seen outside of their shelter during this time (ZAWADZKI & KRONIGER 2003). However, man is the greatest threat to the Pityusic wall lizard.



Fig. 7. The pressure on young lizards is particularly great because the adult lizards do not stop at their own offspring. This specimen has already lost its tail.



Fig. 8. On some islands the number of gulls is quite high.

## Man as a threat

Since humans reached the islands about 4,000 years ago, the lizards have been subjected to new threats. When humans arrived, they brought along foreign predators, such as genets, stone martens, hedgehogs, rats and feral cats. On the neighboring Balearic Islands of Mallorca and Menorca the sister species *Podarcis lilfordi* has become extinct on the main islands because



Fig. 9. Rats have been introduced on some of the islets.



Fig. 10. Poison is used to fight the introduced rats.



Fig. 11. Rabbits have been released on S'Espartar and compete with the lizards for the scarce food resources.

of the introduction of predators. Today you can find this lizard only on the offshore islands. Rats have been introduced to some islands in the Pityusic archipelago, such as Sa Conillera, Illa de Na Bosc, Es Vedrá, Vedranell, Tagomago and S'Espalmador (McMINN GRIVÉ & RODRÍGUEZ MOLINA 2010). Even if the rats may not prey on the lizards, they compete for the scarce food resources in these small ecosystems (Fig. 9). The same is true for goats that have been located on Es Vedrá and rabbits that have been released on S'Espartar. These animals are now being fought by the local nature conservation authority (Fig. 10 & 11).

## Lizard capture and translocations

Especially in the 1920s and 1930s professional collectors caught thousands of lizards for herpetological collections in museums or for the pet trade – not only on Ibiza and Formentera, but also on the offshore islands. For example, the Berlin based pet wholesaler SCHOLZE & PÖTSCHKE already offered 18 different subspecies of *Podarcis pityusensis* for sale in its 1930 catalog. The demand for lizards as pets for the terrarium then continued to increase in the 1950s, 60s and 70s, which put enormous pressure on some of the small island populations. Especially the most colorful subspecies were very popular in terrarium circles. In some cases, up to several hundred specimens were caught from one location. MARTINEZ-RICA & CIRER (1982) report that in 1979 more than hundred specimens of *Podarcis pityusensis maluquerorum* were caught in one day alone.

But even in the 1980s, when *Podarcis pityusensis* was already protected by Spanish national law and its trade was regulated by the Bern Convention, random custom searches in the UK resulted in one suitcase that contained 500 lizards, 420 of them had already died. The remaining 80 surviving animals were brought back to Ibiza. In 1988 a total of 400 *Podarcis pityusensis* specimens were found in another suitcase, all of which were brought back to Ibiza. Another 2,000 lizards were discovered in the same year at Schiphol Airport in Amsterdam (KORBETT 1989). And in Germany more than 100 illegally imported *Podarcis pityusensis* were confiscated in 2001 (unpubl. data).

Another problem arose from the great demand for particularly rare island forms, since these forms live on the most remote islands where access was difficult. Local fishermen earned extra money by bringing lizards from islands with large populations to smaller

islands with few or no specimens. In some cases, such transported lizards are said to have even been described as new subspecies according to MARTINEZ-RICA & CIRER (1982)! Likewise, lizards from very colorful subspecies or the coveted black lizards from the most distant islands were released on other islands more close to Ibiza, in order to have easier access to these lizards and to avoid long and sometimes difficult and risky boat trips (e. g. WETTSTEIN 1937). LILGE (1975), for example, reports that in the fall of 1971 about 50 lizards from S’Espartar, perhaps also from Illa des Freres and from the Bledas Islands, were released at Cala Comte in western Ibiza by professional lizard catchers that supplied the pet trade market to make lizards of these subspecies more accessible. In the 1960s and 1970s, lizard catchers released the surplus of their catch from various subspecies on other islands, in one case on the island Sa Conillera (unpubl. data). Pityusic wall lizards had also been released far from their native range, for example this happened in the 1970s in Germany near Mettmann / Neandertal, where 100–200 *Podarcis pityusensis formenterae* and another 100–200 specimens of the same subspecies were released at Remscheid (ECKSTEIN & MEINIG 1989). A number of terrarium keepers also released specimens from *Podarcis pityusensis* in their home

gardens in Central Europe, where the lizards lived until they were discovered by cats or fell victim to winter temperatures. Obviously there was such a surplus of animals during the heyday of the “island lizards” pet trade that older terrarium keepers often got to know *Podarcis pityusensis* as “colorful feeding lizards” for snakes.

But not only lizard catchers were involved in such translocations, because translocation experiments had also been carried out in the name of science: In order to obtain information about the causes of island melanism, EISENTRAUT released lizards on various lizard-free islands in spring 1930 (EISENTRAUT 1930, 1949). Unfortunately, however, he overlooked the lizards already living there on at least two of these islands, so that today we can find hybrids between the resident and the translocated lizards (ZAWADZKI 2001, PEREZ-MELLADO et al. 2017).

At the beginning of the 1970s, melanistic lizards from the Bledas Islands were released in several places on Formentera by “nature lovers” in order to give these lizards a refuge there, since they were threatened by commercial catch (ZAWADZKI 2001).

Lizards from Formentera, S’Espartar, Es Vedrá and the Bledas Islands have been released in gardens in Ibiza several times, because the house owners were



Fig. 12. Lizards were often translocated to other islands by boats.



Fig. 13. Ready for the trip: A Pityusic lizard on a fishing net.



Fig. 15. Dead lizards in a beverage can.



Fig. 14. Rubbish often becomes a deadly trap for the curious lizards.



Fig. 16. Unfortunately not an isolated case.

obviously more fond of the blue and black lizards than of the ones from the nominate form that actually live there. But even before this time, lizards – mostly unintentionally – had been transported from one island to another with the help of humans. This was done either by boats, which brought supplies for the lighthouse keepers that lived on some of the islands, by fishing boats or by regular shipping traffic between Ibiza and Formentera. Whenever people transport food or materials by boat, there is a risk that lizards will be transported from one island to another (Fig. 12 & 13). For this very reason, excursion boats can also pose a danger to the lizards of the island's population. In the 1990s, for example, during the summer months hundreds of tourists were taken daily by excursion boats from Ibiza to Formentera where they went ashore the small island of Pouet and usually had a picnic there and then often left plenty of rubbish behind

(Fig. 14). On this island I found several lizards inside the garbage that had died in half-empty beverage cans and bottles as well as inside plastic bags (Fig. 15). Unfortunately this was not an isolated case, because I also found dead lizards in the rubbish left behind on other islands, too (Fig. 16.). Forgotten or left behind illegal lizard traps in which I found repeatedly live or dead lizards, represent a similar danger (Fig. 17 & 18) (PEREZ-MELLADO 2002, and own observations).

In the past, the genetic isolation of some island populations has been broken by translocated lizards. By this mixing of local lizards with alien lizards, unique traits can be lost by the mixing of their genes. In the course of evolution, each population has developed special adaptation mechanisms that enable it to survive under the unique conditions of its habitat. There is also a risk that translocated lizards may introduce diseases or alien parasites.



Fig. 17. Illegal trap found on an island.



Fig. 18. Dead lizards inside an illegal trap.

### Bombs, poison and building mania

The lizard populations of some islands off Ibiza's west coast, e. g. S'Espartar and Illa de Na Bosc experienced further threats by humans as they served as targets for warship firing practice of the Spanish Navy (Fig. 19 & 20). On Bleda Plana, the lighthouse keepers have tried several times to poison the lizard population, but have not succeeded in exterminating it. The population of the small island of Pouet near Formentera had also been exposed to poison (CIRER 1981). A significant mortality in *Podarcis pityusensis* has been identified on some islands from the use of poisoned baits to control seagulls (*Larus cachinnans*) (PEREZ-MELLADO 2002).

In the 1960s the surface of the Illa de Ses Rates was entirely levelled to build a hotel and a wide road was planned to join the island with Ibiza. Fortunately, conservation efforts had been successful and stopped the building project before the hotel was finished. Today, only debris and remnants remind of this

construction sin. But with the transport of building materials, lizards from Ibiza were transported to the offshore island, so that the genetic isolation of the native *P. p. ratae* has been broken (MARTINEZ-RICA & CIRER 1982). Fortunately, similar construction projects have not been implemented, such as the plans to build a pleasure harbor on the island of Murada and to join it to Ibiza.

Previously, former islands that host their own lizard populations with their special characteristics have been artificially connected to Ibiza (Illa Plana, Illa Grossa, and Illa Botafoc) and to Formentera (La Sabina). These constructural measures paved the way for the lizards to be able to mix with each other. In the harbor of Ibiza town the three islands of Illa Botafoc, Illa Grossa and Illa Plana now build a concatenation of former islands that are connected to Ibiza. In case of the small former island of Botafoc, even parts of its surface have been removed to build a huge landing place for cruise ships (Fig. 21 & 22).



Fig. 19. In the past, some islands served as training targets for the Spanish Navy and were heavily attacked.



Fig. 20. The Illa de Na Bosc is located in the immediate vicinity of a busy beach. As a result, lizards no longer have to fear bombardments by the navy.



Fig. 21. The small island of Botafoc, on which a small population of lizards lives, was first equipped with a lighthouse, then artificially connected to Ibiza's coast.



Fig. 22. A few years ago, part of the island of Botafoc had to make way to make room for a giant cruise ship dock. In the background of the island of Botafoc is the island of Grossa, which is also connected to Ibiza.

### Protected and yet endangered?

*Podarcis pityusensis* is fully protected by national and international legislation and listed in Annex II of the Bern Convention and in Appendix II of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). It is also listed in Annexes II and IV of the Habitats Directive and is therefore considered to be a strictly protected type of common interest. In addition, many islands around Ibiza and Formentera are part of the Natura 2000 network of the European Union and, as part of nature parks, are under special protection and may not be entered. *Podarcis pityusensis* is declared as "Near Threatened" by the IUCN (2009).

Fortunately, the lizards on the two main islands of Ibiza and Formentera are still very abundant. However, some of the island's populations consist of no more than a few hundred animals. Sometimes only a few dozen specimens live on some of the smallest islands, in some cases less than 20 animals (VAN DEN BERG & ZAWADZKI 2010).

MARTINEZ-RICA & CIRER (1982) summarize in their work that abundant and well-maintained lizard populations are only found on ten islands (= 18 %). On 13 islands (= 23 %) the geographical isolation between populations is no longer given or only poor or incomplete. The high probability of populations mixing – in some cases the authors have already observed this – is indicated in 19 islands (= 34 %). Human pressure on lizard populations is strong in 14 cases (= 25 %). And finally, 18 populations (about a third) may be considered highly endangered or

already extinct by elimination or genetic mixing with other populations.

According to PEREZ-MELLADO (2002), the lizard populations on the islands in the east of Ibiza have satisfying or even high densities, while on other islands, such as Illa Murada or some of the most distant islands off the bay of San Antonio, a serious decrease in population density has been observed in the past 10–15 years.

According to MARTINEZ-RICA (1981) the lizard populations of the following islands are very much reduced, endangered or at the verge of extinction: Es Malví Pla, En Caragoler, Illa des Frares, Trocadors, Illa des Porcs, s'Illeta d'en Purroig, Illa de Ses Rates and Sa Torreta. BLANCO & GONZÁLEZ (1992) state that the lizard populations of the islands Ses Margalides and s'Illeta den Purroig are endangered, and those of Illa des Frares, Illot de s'Hort, Illa des Porcs, Illa de Ses Rates, Sa Torreta and Escull de S'Espartar were classified as vulnerable. CIRER & MARTÍNEZ-RICA (1997) cite the lizards of Gastabí, Alga, Sa Torreta, En Caragoler, Sal Rosa, S'Hort, Sa Mesquida and Ses Margalides as the most endangered populations. According to PÉREZ-MELLADO (2002) the populations from the islands Murada, Ses Margalides, s'Illeta d'en Purroig and Alga are at a high risk, and the ones of Illa des Frares, Illot de s'Hort, Illa des Porcs, Illa de Ses Rates, Sa Torreta, S'Espartar and S'Espardell are endangered, while SALVADOR & PLEGUEZUELOS (2002) state that the small islands of S'Hort, Calders, Murada, Ses Margalides, s'Illeta d'en Purroig and Escull Vermell harbor only very small lizard populations and are at a high risk for extinction.

According to the IUCN Red List (PÉREZ-MELLADO & MARTÍNEZ-SOLANO 2009), *Podarcis pityusensis* is currently only classified as “Near Threatened” because the species as a whole is not considered to be declining and there are generally no major threats to the species. Only a number of island populations are threatened by human interference, the introduction of cats and rats and accidental poisoning by bait designed to combat seagulls. This rather trivializing assessment does not longer do justice to the seriousness of the situation and the real need for protection, especially that of the populations of smaller islands.

In addition to the destruction of natural habitats, especially through urbanization and development for tourism, *Podarcis pityusensis* is facing further threats on Ibiza and Formentera. Although the lizards are abundant in many places in Ibiza, MARTINEZ-RICA & CIRER (1982) noted a significant decrease between 1962 and 1978 in some places. This decrease is likely to be seen in connection with the use of insecticides and pesticides, especially in areas where agriculture is practiced.

Unfortunately, some people consider the lizards as annoying pests, as can be seen, for example, from the report by MEYER (1951): “*The most dangerous time for them [the lizards] is when the grapes ripen. Because of their large quantity the lizards can do some damage to the fruits. Clay pots with sliced prickly pears or bread moistened with oil or wine are used as bait. These pots are placed at the walls or dug into the ground, and the lizards are caught in large quantities and killed with hot water, in one day up to 50 or more in a pot.*”

Unfortunately, this procedure is still common in some places to this day, although the lizards are legally protected. On many trips on Ibiza and Formentera I found empty plastic containers used as traps for the lizards. Sometimes I could save many lizards, some of which were already very weak, but sometimes many of them were already dead (Fig. 23). Most recently, this was the case on Formentera in October 2018, where I was able to count more than 20 containers that had been used as lizard traps in a field with grapevines (Fig. 24). At least I was able to save many lizards from these traps alive and release them back to the wild after I had destroyed all of the traps (Fig. 25 & 26). Many lizards, however, suffered death in these traps. They died due to thirst or hunger or perished heat stroke or drowning after rain (Fig. 27).



Fig. 23. Even today people fight lizards and set up traps.



Fig. 24. On Formentera I found more than 20 containers in a field with grapevines that had been used as lizard traps.



Fig. 25. Exhausted, but rescued lizard.



Fig. 26. Even this lizard, which at first glance appears dead, recovered after a short time and was released into freedom.



Fig. 27. Rainwater inside the traps caused many lizards to drown.



Fig. 29. "The end of the road": many lizards die on the streets of Ibiza and Formentera.



Fig. 28. Stray cats are skillful and persistent lizard predators.



Fig. 30. A Bottle as a deadly trap for lizards.

At least in Ibiza and Formentera, countless lizards are run over on roads and paths by cars and bicycles (Fig. 28). In addition, stray domestic cats hunt the lizards (Fig. 29). Empty bottles that are carelessly thrown away into nature by humans are a deadly trap for lizards, too (Fig. 30 & 31). Fortunately, the lizard populations on the two main islands still seem to be more or less stable, but, as reported above, especially the lizards on the smallest of the islands are critically endangered because of their low population density and small habitat.



Fig. 31. A bottle again! At least the male lizard was still alive.



Fig. 32. On Trocadores tourists have made a habit of building towers by stacking up stones. Unfortunately, the lizards living here find less and less hiding places in the barren habitat, as tons of stones that were originally scattered over a wide area have been collected for this bad habit.

On Trocadores, a peninsula building the northernmost tip of Formentera, holidaymakers have made a habit of building towers by stacking up stones (Fig. 32). While building such a stone tower people express a wish, and when the tower falls down, their wish will come true. Unfortunately, the lizards living here find less and less hiding places in the barren habitat, as tons of the stones that were originally scattered over a wide area have been collected for this bad habit. At many

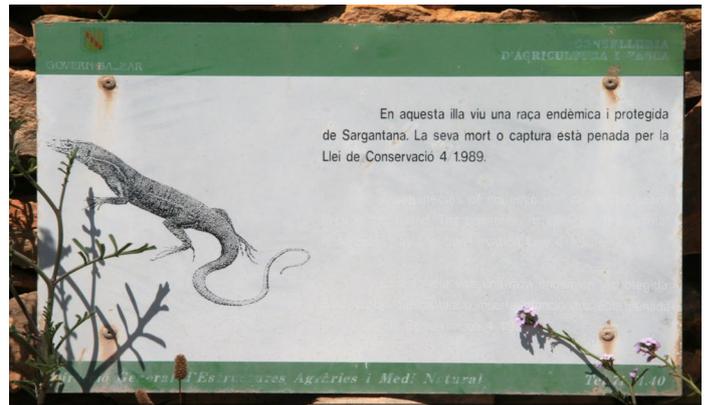


Fig. 33.



Fig. 34.



Fig. 35.



Fig. 33–36. Boards provide information on the wild life of the Pityusic Islands and the protection status of the lizards.

places on Ibiza and Formentera you can find information boards from the Balearic government that provide information on the wild life of the Pityusic islands and the protection status of the lizards (Fig. 33–36).

### The new threat: the invasion of snakes

As if *Podarcis pityusensis* had not already struggled enough with all the dangers mentioned above, there has been a new threat for several years now: snakes! They came to Ibiza and Formentera as blind passengers in imported olive trees (Fig. 37) from Andalusia and the region around Valencia: the horseshoe whip snake (*Hemorrhoids hippocrepis*, Fig. 38), the ladder snake (*Rhinechis scalaris*, Fig. 39) and the Montpellier snake (*Malpolon monspessulanus*).

After Spain's entry into the European Union in 1986, traditional agriculture changed in many places to a more competitive, mechanized one. Between 1996 and 2005, more than 900,000 olive trees were removed from the fields in order to gain more agricultural fields for other products (FORTUNY SANTOS 2002). The olive trees ended up as firewood or were sold as garden trees. The intensive trade of these olive trees between the south of the Iberian Peninsula and the Pityusic Islands led to the introduction of the first specimens of the three snake species being reported in Ibiza in

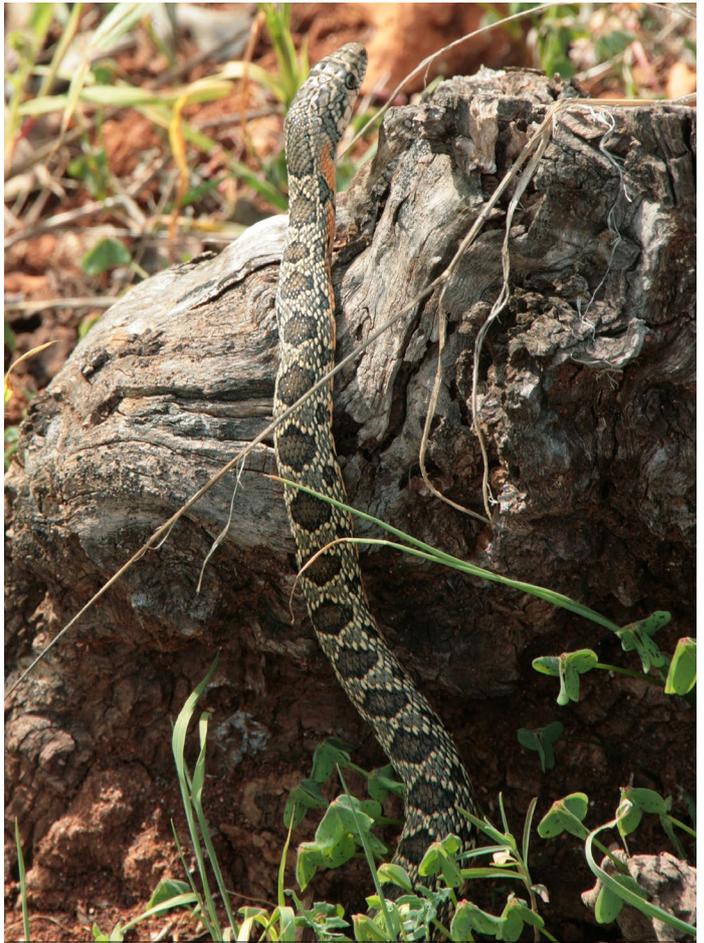


Fig. 38. *Hemorrhoids hippocrepis* finds plenty of prey with the lizards in Ibiza.



Fig. 39. Dead on road *Rhinechis scalaris*.



Fig. 37. Olive trees are imported in large quantities from mainland Spain to the Pityusic Islands. Unfortunately, snakes came to the island with the trees.

2003. *Rhinechis scalaris* was sighted for the first time on Formentera in 2006. However, several locals told me that snakes were already released on Ibiza as early as in the 1970s. Since the island was known to have no snakes and no venomous animals, members of the hippie scene attributed “magical powers” to their adopted home island. As a result, some skeptics have

repeatedly released snakes on the island, including poisonous snakes. Unfortunately, no details about the number of snakes being released or their species affiliation are known (unpubl. data).

*Hemorrhoids hippocrepis* has been introduced to both Ibiza and Formentera, but seems to have disappeared from the latter, given that no specimen of the species was captured here in 2016. *Hemorrhoids hippocrepis* is the most common snake on Ibiza and has expanded its

distribution area rapidly since its arrival. In 2015 this area was already 148 km<sup>2</sup> (= 27 % of the island area). *Rhinechis scalaris* has a low capture rate in Ibiza, but is extremely abundant in Formentera. Here the species has invaded an area of around 350 hectares, which corresponds to 4.2 % of the island area by 2016 (SILVA-ROCHA et al. 2018; unpublished data GOVERNMENT BALEAR).

These data show that *Hemorrhoids hippocrepis* and *Rhinechis scalaris* have successfully naturalized on the Pityusic islands. Fortunately, *Malpolon monspessulanus* does not seem to have established itself on Ibiza, since no specimen of the species has been caught here since 2010 (ÁLVAREZ et al. 2010; MATEO et al. 2011).

What does this snake invasion mean for *Podarcis pityusensis*, which, in contrast to other lacertids in the Mediterranean, has never had contact with such a

half of the prey of *Rhinechis scalaris* in Formentera is constituted by *Podarcis pityusensis* (SILVA-ROCHA et al. 2018). And *Hemorrhoids hippocrepis* also seems to have adapted to the abundant prey: While in the south of the Iberian Peninsula (the source area of introduced populations) lizards represent only 24.2 % of prey items (PLEGUEZUELOS & MORENO 1990), *Podarcis pityusensis* represents 55.4 % of the observed prey in Ibiza (HINCKLEY et al. 2017).

Remarkably, the specimens of *Hemorrhoids hippocrepis* are larger in Ibiza than in their southern continental range. The length and weight record for this species for the area of the Iberian Peninsula and the Balearic Islands was reached by a specimen captured in Ibiza. It was 183 cm long and weighed 1,440 g, exceeding the previous record by 105 % and 213 % respectively (HINCKLEY et al. 2017).

Year	<i>Hemorrhoids hippocrepis</i>	<i>Rhinechis scalaris</i>	<i>Malpolon monspessulanus</i>	Not identified
2003	2	2	1	0
2004	1	0	0	1
2005	1	1	0	0
2006	0	0	0	0
2007	1	19	4	3
2008	1	7	1	6
2009	6	12	0	7
2010*	?*	?*	?*	?*
2011	12	7	0	-
2012	15	5	0	-
2013	38	10	0	-
2014	95	8	0	-
2015	302	10	0	-
2016	317	10	0	-
2017	→→→	1.950**	←←←	

Table 1. Number of snakes caught on Ibiza. \* = No corresponding data could be determined for 2010. \*\* = Total number for both species (adapted from ALVAREZ et al. 2010, SILVA-ROCHA et al. 2018)

predator? *Rhinechis scalaris* was thought to be less of a threat to the lizards, since it feeds mostly on birds and mammals, and reptiles usually only constitute a small percentage of its diet (PLEGUEZUELOS et al. 2007). However, a preliminary study has shown that more than

*Hemorrhoids hippocrepis* thrives perfectly in Ibiza, as it finds easily available food with the lizards. In addition, the species has a low mortality rate because there are almost no natural predators, which favors its rapid expansion.



Fig. 40. A PVC double funnel trap for snakes covered with plywood panels.



Fig. 41. Entrance funnel of the trap.



Fig. 42. Wooden box traps gave better results in capturing snakes.

### The fighting against the snakes

Due to the potential risk to native fauna, the island government launched an eradication campaign in 2014, which is mainly based on snake capture (MONTES et al. 2015). This pilot project was carried out in 2014 and 2015 under the scientific advice and participation of the Spanish Herpetological Society (AHE). The first useful information regarding the distribution and density of the snakes was obtained, and it was also tested which



Fig. 43. In the right-hand chamber of the wooden box trap a mouse is placed as a bait.



Fig. 44. Unfortunately, lizards often find their way into the traps in search of food.



Fig. 45. If the traps are not checked regularly and are not supplied with drinking water, they become a deadly trap for the lizards.

capture methods were the most successful. In order to inform the population about the snake plague and the associated danger to the local fauna, corresponding trilingual brochures were also distributed. When capturing snakes, wooden box traps gave better results than PVC double funnel traps covered with plywood panels (Fig. 40 & 41). Specially trained dogs were also used and proved to be quite effective in tracking down snakes. However, the reptiles mostly hide deep inside one of the countless stone walls,

which made catching the snakes almost impossible. From the trap models used up to this point, however, the snakes often managed to escape, as observed scales and snake feces in empty traps showed. From 2016, the Balearic government took control of the project and upgraded the traps that were used (Fig. 42 & 43). In addition, 400 subsidized traps were sold to the local people. The data listed in table 1 clearly show that the number of captured snakes has increased significantly in recent years. In addition, there is an unknown number of snakes caught by private local people. I found snakes in Ibiza several times myself. The actual number of snakes living in Ibiza and Formentera is likely to be many times higher, so that the data given in the statistics only represent the “tip of the iceberg”. Unfortunately, although the traps should be checked regularly, this does not happen on a regular basis everywhere. In October 2018 I found a trap on the La Mola plateau in the south of Formentera that had not been checked for a long time (Fig. 44). The right-hand chamber of the wooden box trap, in which the bait mouse is normally located, was already empty, as



Fig. 46. Some of the rescued lizards that had not had water or food inside the snake trap for a long time.



Fig. 47. Juvenile *Hemorrhois hippocrepis*.

were the containers for food and drinking water for the mouse. In the left chamber, which is provided with an entrance hole through which the snake should find its way into the trap, I found nearly 20 *Podarcis pityusensis formenterae*. Among them was a dead specimen (Fig. 45) as well as many heavily emaciated specimens that had not gotten water or food for a longer period of time. Without this coincidentally rescue all these lizards would have died in the trap, which was actually intended for their predator (Fig. 46). This observation is certainly not a solitary case, since the curious lizards do not stop at a snake trap when looking for food.

### Future prospects

The recent studies that investigated the spread of the alien snakes as well as the composition of their prey in the Pityusic islands show that these snakes are a serious threat to the endemic *Podarcis pityusensis*.

MENCIA et al. (2016) and ORTEGA et al. (2016) studied whether *Podarcis pityusensis* is able to distinguish between the two snake species introduced in Ibiza, *Hemorrhois hippocrepis*, which is known to prey on lizards in its native distribution area, and *Rhinechis scalaris*, which does not prey on lizards. Two test groups of lizards were chosen. The first group of lizards came from the main island of Ibiza, which now live together with the two introduced snake species, and the second group of lizards originated from the island of Sal Rossa, which is close to Ibiza but is free of snakes. Ibiza lizards recognized the scent of *H. hippocrepis* and responded with clear antipredatory behaviors. However, they reacted to the scent of *R. scalaris* in a similar way to that of the controls (odourless and pungent scent). The Sal Rossa lizards, however, did not respond to any of the snake species or the controls. From this, MENCIA et al. (2016) conclude that the lizards can very quickly acquire the ability to react to a new predator. Since only a few generations of lizards have been confronted with the introduced snakes, the authors suspect that the lizards have learned to associate the scent of the predatory snake with a threat.

Even if the results of this study may give reasons to hope for the endangered *Podarcis pityusensis*, it is necessary to point out to that the statement that *Rhinechis scalaris* usually does not prey on lizards, is not true, at least for the situation on Formentera. As already reported above, over 50 % of the prey of this snake species on this island is constituted of *Podarcis pityusensis*.

## Conclusion

It is probably not possible to exterminate the snakes on Ibiza completely, especially since they reproduce vigorously, as juvenile specimens indicate (Fig. 47). But at least you can successfully decimate them. According to statistics, the number of snakes captured has tripled from 2016 to 2017. This does not necessarily mean that there are more and more snakes, on the contrary, it is because in 2017 there were three and a half times more traps, which were also set up for a longer period than in the previous year. In comparison with the effort, the capture quote decreased by almost 15 % within one year. It is concluded that fewer snakes have gone into the traps because the number of snakes has already decreased overall (KRAMER 2018).

In Ibiza and Formentera, every effort should still be made to fight the snakes. Residents from rural areas with high snake densities already report with a mixture of sadness and anger that they no longer encounter lizards in their surroundings.

Being the only endemic terrestrial vertebrate of the Pityusic islands, *Podarcis pityusensis* represents a true specialty of the fauna there and deserves the greatest possible protection. Similarly, the populations

of the species on the offshore islands, regardless their taxonomic status, most of these micro-insular populations represent unique adaptations resulting from local ecological conditions. The populations of the smallest islands in particular often consist of only a small number of specimens and are also subject to strong demographic fluctuations. The arrival of snakes in these islands would have catastrophic and irreversible consequences for the lizard populations, as they would be the only prey available. Such a horror scenario must be avoided by all means, because the danger is not an abstract one: many islands are located near the coast of the main islands, and at least six *Hemorrhois hippocrepis* have been observed swimming in the sea. A shed skin of a *Hemorrhois hippocrepis* has also been found on the island of S'Espartar recently (HINCKLEY et al. 2017, SILVA-ROCHA et al. 2018). People are desperately hoping that this skin may have been carried to the island by the wind ...

I would like to close this article with a quotation from the Ibiza resident scientist ELBA MONTES, whose doctoral thesis deals with the fight against invasive snake species on islands: "Ibiza has lost its innocence. The lizards will disappear."



Fig. 48. Is *Podarcis pityusensis* facing a dark future?

## Acknowledgements

My special thanks go to my wife GITTA ZAWADZKI and to my friends and herpetological colleagues MARTEN VAN DEN BERG and MICHAEL KRONIGER. Moreover I would like to thank ANGELA REIJNDERS and HANS „KITCHEN PRINCESS“ STEENKAMP, as well as SABINE GRÄPER for her reliable and conscientious care of my animals during my trips.

I would also like to thank the following people, without whom our investigations on *Podarcis pityusensis* on Ibiza would not have been possible: IVAN RAMOS, JOAN MAYOL and CATERINA AMENGUAL (Servei de Protecció d'Espècies/Govern de les Illes Balears); DENNIS RÖDDER, URSULA BOTT and WOLFGANG BÖHME (Museum Alexander Koenig, Bonn); VIRGINIA PICORELLI, NÚRIA VALVERDE, MARIANA VIÑAS, HELENA RIBAS, PAULA GOBERNA; JOSÉ RIPOLL, ABEL O'FERRAL and PACO (Espais Naturals Protegits d'Eivissa i Formentera). Furthermore I would also like to thank the following people: CHEMA RAMON and his family; MARTINA GREEF, PAOLO and GIOVANNA DELL; ALEJANDRO BONET; Diving Center SOMNI BLAU IBIZA; ALAIN, ULLA and GWEN (Santa Gertudis), RAFAÉL, BEATRICE GALBAS, CHRISTINE, PACO, JULIETTE and MARIA. Once again I would like to thank MARTEN VAN DEN BERG for revising the manuscript.

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