

The semi-aquatic herpetofauna of Serifos (Cyclades, Greece) including conservation aspects

(Amphibia: Reptilia)

Die semiaquatische Herpetofauna von Serifos (Kykladen, Griechenland)
aus Naturschutz-Sicht
(Amphibia: Reptilia)

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KURZFASSUNG

Nach gegenwärtiger Kenntnis umfaßt die Herpetofauna von Serifos zwölf Arten. Die Insel ist wasserreich, die Verbreitung der vier dort vorkommenden semi-aquatischen Arten wurde untersucht. Die Populationen von *Bufo viridis*, *Pelophylax kurtmuelleri* und *Mauremys rivulata* sind als vital anzusprechen, hingegen konnte *Natrix tessellata* nicht mehr nachgewiesen werden. Es werden einige Aspekte des Naturschutzes im Hinblick auf diese Arten behandelt. Auf Serifos verschlechtern zwei Infrastrukturprojekte die Situation der semiaquatischen Herpetofauna zusammen mit Schadeinflüssen durch Tourismus und Landnutzung. Weiters wird auf Austrocknungstendenzen in der Ägäis verwiesen, die für die Insel-Herpetofaunen inskünftig Probleme verursachen werden.

ABSTRACT

According to current knowledge, the herpetofauna of Serifos comprises twelve species. The island is abundant with water. The distribution of the four semi-aquatic species to be found there was investigated. The populations of *Bufo viridis*, *Pelophylax kurtmuelleri* and *Mauremys rivulata* can be considered vital, whereas *Natrix tessellata* (known from earlier reports) was no longer found. The author presents aspects of conservation with reference to these species. Two infrastructural projects on Serifos negatively influenced the island's semi-aquatic herpetofauna, along with adverse effects caused by tourism and modified land use. Reference is also made to the general aridification tendencies to be observed in the Aegean, which will become a problem for the island herpetofauna in the future.

KEYWORDS

Amphibia, Reptilia *Bufo viridis*, *Pelophylax kurtmuelleri*, *Mauremys rivulata*, *Natrix tessellata*; Serifos, Cyclades, Greece, semi-aquatic herpetofauna, ecology, nature conservation, climate change

INTRODUCTION AND FUNDAMENTALS

Many islands of the Aegean suffer from aridification for various reasons, in particular wetland drainage as well as surface and ground water withdrawal for the hotel industry and agricultural purposes (BROGGI 2006a, 2006b, 2007, 2008, 2009, 2010). The author, who is engaged in the conservation of the islands' natural habitats and watchfully observes the fate of the water-associated avian and herpetofauna, visited the Island of Serifos from April 11-20, 2010.

The island.- Serifos is an Aegean island of the northwestern Cyclades, inhabited by about one thousand locals, 73 km² in size and almost circular in shape (9 km wide and 10 km long). Its aspect is barren, wild

and inaccessible, with a rocky relief. A long mountain massif of granite and gneiss extends across the island, reaching its highest point at 582 meters above sea-level in a peak named Troulos. On the western side, the land descends more steeply to the sea than on the eastern side, where a monadnock located halfway down the slope is dotted with the snow-white cubic houses of the attractive Chora, which offers panoramic views of the wide Livadi Bay. Tourism is centered on the port of Livadi, which is still a quiet place except in August. The island has retained its original character, especially in the north, where the landscape is dominated by idyllic farming villages and ter-

enced fields. From the time of the ancient Greeks onwards and especially in the 19th century and up to the end of the Second World War, iron ore and copper were mined in the west of the island, as numerous remains testify.

Like many islands of the Cyclades, Serifos is largely treeless, and a pronounced rural exodus has left it partly covered with phrygana. LIVANIOU-TINIAKOU et al. (2003) published a study on Serifos' "floristic dynamics in correlation with the type of substrate and human activities" Accordingly, some 680 vascular plants have been recorded on Serifos, 22 of which are considered endemic to Greece; this paper offers an overview of the natural history of the island. There is also a GPS-compatible map of Serifos (Anavasi map no. 10.25; 1:25 000), which shows minor footpaths and mule tracks, as well as springs and watercourses. Many of the paths on the island have red and white markings with numbers HAUGLI (1997-2009).

The water supply.- Serifos is located in the Attic-Cycladic zone with its main substrate of crystalline gneiss. At 600 mm, annual precipitation is one of the highest in the Cyclades. In this constellation, the island has many springs and also running water in the numerous hollows and gorges. Such sites often support oleander trees, which can be seen in the aerial photographs available on Google Earth[®]. There are also numerous man-made water retention structures in the form of cisterns and open collection tanks. Especially in the north of the island, there is a surprising number of deep gorges with running water. The fertile plain around Livadi is highly abundant with water; in spring, the groundwater is just a

few decimeters below the surface of the flood plain.

For their "Inventory of the wetlands of the Aegean Islands", CATSADORAKIS & PARAGAMIAN (2007, p. 41) mapped four locations on Serifos: two gorges in the north, a small formerly marshy plain to the north of Livadi, which is now the site of a big retention dam and reservoir, and the only larger wetland area with a small lagoon on Tsilizaki Bay near Livadi.

History of the herpetofaunal exploration.- For Serifos, BEDRIAGA (1881) mentioned (according to his nomenclature) the occurrence of *Rana esculenta*, *Bufo variabilis*, *Clemmys caspica*, *Lacerta viridis*, *Lacerta muralis erhardii* and *Zamenis gemonensis*. In his study of the herpetology and area geography, BIRD (1935) reported from Serifos all the species later mentioned by WERNER (1938), except *Bufo viridis*. He considered Serifos as a natural continuation of the Attica Peninsula via the islands of Zea (Kea) and Kythnos, and noticed herpetofaunal similarities among the islands of this island chain. In his standard work on the amphibians and reptiles of Greece, WERNER (1938) listed two amphibian and seven reptile species for Serifos, namely (in the spelling of his day): *Bufo viridis*, *Rana ridibunda*, *Clemmys caspica rivulata*, *Gymnodactylus kotschyi*, *Lacerta ehrhardi*, *Lacerta strigata major*, *Ablepharus kitaibelii*, *Coluber jugularis caspius* and *Natrix tessellata*. BUCHHOLZ (1955) added *Telescopus fallax*, CLARK (1968) *Elaphe situla* and CATTANEO (1989) *Hemidactylus turcicus*, the latter, however, being not included in the map by VALAKOS et al. (2008). That makes a total of twelve herpetofauna species recorded from this relatively small island.

RESULTS AND DISCUSSION

The herpetofauna in general

David BUTTLE (Norwich, UK, in litt.) kindly made his notes from two excursions to Serifos (2-6 November 1995 and 11-14 May 1997) available to the author, in which he confirms the above list of species with the exception of *Natrix tessellata* LAURENTI, 1768 and *Telescopus fallax* (FLEISCHMANN,

1831). The author's own excursion, from 11-20 April 2010, confirmed all the species mentioned except *Zamenis situla* (LINNAEUS, 1758) and *N. tessellata*. With fifteen sightings, *Dolichophis caspius* (GMELIN, 1789) was a frequently observed snake species. *Telescopus fallax* was found as a road-kill above the Chora on 12 April 2010. Frequent sightings were made of *Ablepha-*

rus kitaibelii (BIBRON & BORY, 1833), while *Hemidactylus turcicus* (LINNAEUS, 1758) was found only once in the chapel of Agia Anastasia in the north. Numerous specimens of *Cyrtopodion kotschy* (STEINDACHNER, 1870) were seen, too, especially in the many stone walls. In some places *Lacerta trilineata* BEDRIAGA, 1886 was also found in and around such walls. As there was little traffic on the island at that time of the year, the Balkan Green Lizard was sometimes to be seen warming up in the morning on tarmac. *Podarcis erhardii* (BEDRIAGA, 1882) was also a frequent and widespread sighting on the island.

The semi-aquatic herpetofauna

The semi-aquatic herpetofauna comprises two amphibian species, the Green Toad and the Greek Marsh Frog, and two reptile species, the Balkan Terrapin and the Dice Snake.

Bufo viridis LAURENTI, 1768 - Green Toad.- In his most recent herpetological work, CATTANEO (1989) speaks of a "vital population" on Serifos. During his visit to the island from 9-22 May 1985 he observed adult and larval Green Toads in wet gorges and in brackish water. During our visit, we found *B. viridis* to be widespread throughout the island. It was a particularly regular sighting on the flood plain near Livadi, where we heard them near the sea by Aviomonas on 16 April 2010 and in the following nights, and where we also observed a "frog rain", i.e., a huge number of freshly metamorphosed juveniles. The tadpoles were regularly found in wet gorges in the north of the island and also in other residual waters in ditches and artificial water sites. The Green Toad cannot be considered to be at risk on Serifos at the present time.

Pelophylax kurtmuelleri (GAYDA, 1940) - Greek Marsh Frog.- The Greek Marsh Frog is also rightly stated by CATTANEO (1989) to have a "vital population" on Serifos. During our visit to the island, it was observed at altitudes from sea-level to 360 m near Agios Pandaleimon, the highest point of occurrence in the island's interior. Hardly a valley was explored in which its croaking was not to be heard, ema-

nating from biotopes along water courses, in the quagmires of otherwise dry stream beds, and in and around wells and cisterns (Figs. 1, 2). The green frog thus has a widespread presence on the island. All locations of frogs observed or heard were plotted on a map (Fig. 3) as a record of the dispersal found.

At the time of the ancient Greeks, Serifos' green frogs were said to have been famous for not croaking (PAFILIS 2010), and the term "Seriphian frog" was formerly used to denote a person who refused to speak. Be that as it may, the Green frogs living in 2010 made plenty of noise.

Mauremys rivulata (VALENCIENNES, 1833) - Balkan Terrapin.- CATTANEO (1989) said the Balkan Terrapin is "not rare" on Serifos and described wide, stepped streams with impounded water as typical biotopes. In response to a personal enquiry made on 8 June 2010, CATTANEO (in litt.) specified two sites, one on a stream passing through Livadi and the other on the Potamia stream below the village of Potamia in the north of the island. The following additional finds were made by the author:

* Steno reservoir north of Livadi (Fig. 4), in the upstream pondage area, with several sturdy specimens seen basking in the sun.

* Kalamos stream in the north, which flows into the sea at Sikamia Bay. The lowest section of the stream had seeped away in the alluvial material, but where the bedrock emerges we found a number of large puddles where there were terrapins, including several juveniles measuring approx. 3.5 cm in carapax length.

* The terrapin site in the Kalamos stream extends beyond the village of Ghilani, where it continues in the lateral branch of the Potamia as far as the track by the chapel of Agios Polikarpos at almost 200 m above sea-level.

* Terrapins were also found in the little parallel valley to the east, which originates below the village of Panaghia, in the area of the old watermills near Kato Dhipotamata at approx. 140 m above sea-level (Fig. 5).

The wet gorge habitats of these northern populations are mostly difficult to access and often protected by beds of *Arundo*



Fig. 1: Greek Marsh Frogs at a well near Sikamia in the catchment of Lakos brook, Serifos.
Photo: Mario F. BROGGI.

Abb. 1: Balkan-Wasserfrösche in offenem Brunnen nahe Sikamia im Einzugsgebiet des Lakos-Baches, Serifos.



Fig. 2: Wet gorges with puddles above the reservoir of Steno, Serifos, where Greek Marsh Frogs and Green Toads spawn. Photo: Mario F. BROGGI.

Abb. 2: Wasserläufe mit kleinen Wasserflächen oberhalb des Steno-Reservoirs, Serifos, worin der Balkan-Wasserfrosch und die Wechselkröte laichen.

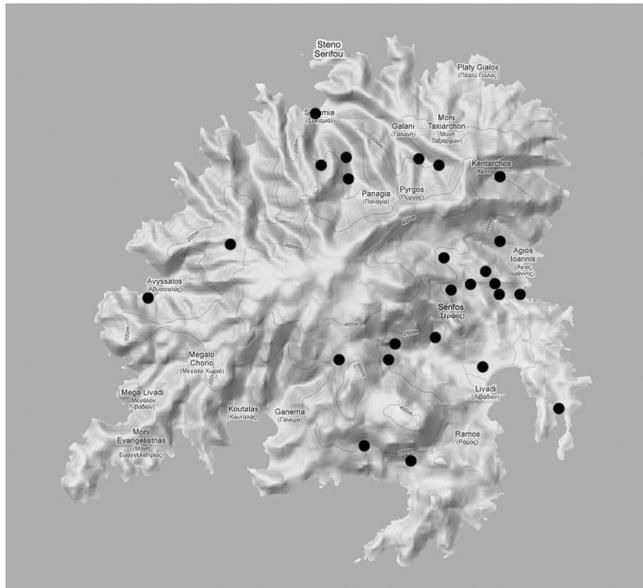


Fig. 3: Locations on the island of Serifos where the Greek Marsh Frog *Pelophylax kurtmuelleri* (GAYDA, 1940) was observed by the author. Basemap: Google maps.
 Abb. 3: Fundorte auf der Insel Serifos, an denen der Autor den Balkan-Wasserfrosch *Pelophylax kurtmuelleri* (GAYDA, 1940) beobachtete. Kartengrundlage: Google Maps.



Fig. 4: A few years ago, a reservoir was created north of Livadi, Serifos. The system has never been functional. Photo: Mario F. BROGGI.
 Abb. 4: Bau eines Wasserrückhaltebeckens oberhalb der Bucht von Livadi, Serifos, allerdings ohne Funktion.

donax. But the stream continuum includes numerous sunny water-filled puddles, where the terrapins feel at home. The terrapin population seems to be stable in the north of the island and includes all age groups. In the south of the island, only one location was found, namely the reservoir above Livadi (Fig. 4). No specimens were detected, on the other hand, at the site mentioned by CATTANEO (1989) on the stream that flows through Livadi and down into the sea. And no terrapins were seen in Tsilizaki Lagoon, which would theoretically constitute a suitable biotope. Nor were any of the typical linear tracks discovered in the lagoon's carpet of algae, which are a sign of their presence.

Natrix tessellata LAURENTI, 1768 - Dice Snake.- The Dice snake was first reported on Serifos by WERNER (1933), who found it "not infrequently in the coastal marshes". In the light of this information, BIRD (1935) searched for the Dice Snake on Serifos but failed to find it. The second reference to Dice Snake sightings is to be found in BUCHHOLZ (1955), who said he "caught them all in a stream near the coast where they were hunting the larvae of *Rana ridibunda*". And he continued: "I consider *tessellata* to be common on Serifos." According to BUCHHOLZ, *N. tessellata* does not grow to a large size on Serifos. His biggest was 69 cm long, and the three smaller specimens 41-44 cm. His visit to the island lasted from 31 May to 2 June 1953. His observations on the location seem to be consistent with the later description in CATTANEO (1989).

CATTANEO (1989) visited Serifos from 9-22 May 1985. He collected five specimens and said the species "was feeding on *Bufo viridis* and *Rana ridibunda*". His biggest catch was 83.5 cm long. In response to my enquiry concerning the location of the find, CATTANEO (in litt.) spoke of a stream that flows from Nochta, the big valley southwest of Chora, towards Livadi (same site as for the Balkan Terrapin according to CATTANEO). CATTANEO (1989) is the last person to have reported the Dice Snake on Serifos.

David BUTTLE visited Serifos in 1995 and 1997. According to his mail sent on 14 May 2010, his efforts to find the Dice Snake

failed. BUTTLE (in litt.) wrote that if the species is still present on the island at all, it must be very rare and extremely localized.

Our intensive investigations throughout the island were also in vain. The streams in the north of the island, with their abundant sources of nutrition, have the characteristics of potential habitats, and the author spent hours searching there.

At the time of our visit to Serifos, the stream in Livadi mentioned by CATTANEO was dry, but the groundwater level of the sparsely inhabited grassland in and around Livadi was high, with water standing in several ditches and hollows. The many flowering specimens of *Orchis laxiflora* in marshy meadows were also an indicator of the wet state of the land.

It must be considered questionable whether the Dice Snake is still present on Serifos today. If it is, it is most likely to be found in the village of Livadi with its loose accumulation of buildings.

Observations relevant for conservation

Endangered wetlands.- The "coastal marshes" mentioned by WERNER (1933) no longer exist on Serifos. Similarly, CATTANEO (1989) spoke of the brackish water on the island where *Bufo viridis* is to be found, but such a description now only applies to the wetland and small lagoon on Tsilizaki Bay west of Livadi (Fig. 6). This site can still be considered a "coastal marsh". Only a few decades ago, there were very few buildings on Livadi Bay. Parts of the hinterland there are still marshy almost down to the sea. As mentioned above, water-filled ditches and pools were seen here in April 2010, and two streams flow into the bay. Wetlands are under threat in general on the Aegean islands, all the more so as they naturally occupy only a small area. Moreover, the hygrophilous populations living there are usually small and isolated. These sites are being destroyed in the interests of tourism (cf. on Skyros, BROGGI 2006); the water resources are utilized for agricultural purposes so that the wetlands dry out (cf. on Lipsi, BROGGI 2008); the springs are usually tapped (e.g. Ithaki, BROGGI 2009), and the water supply and

storage systems once built for agricultural purposes (cisterns, wells) are increasingly being covered up or losing their function with the discontinuation of agricultural activity or their replacement with ground-water pumps (cf. Tilos, BROGGI 2006b).

Environmental degradation.- The authors of earlier herpetological papers pointed out that regional projects can be highly detrimental to the environment and the landscape on Greek islands. This applies to the frequently observed problem of oversized new roads (cf. photographs in BROGGI 2008 for Lipsi) and other infrastructure measures. This verdict can be underlined for Serifos with the following examples.

Reservoir at Steno above Livadi (Fig. 4). A few years ago, a reservoir covering an area of approx. 4-5 ha was created north of Livadi with two dams on the south and west sides built with EU funds. The 2007 Anavasi map still shows a wetland in the area, although the high dam on the south side is already to be found on the map. The reservoir on the small plateau of Steno interrupts the stream there. At the time of our visit to the island, the reservoir was full. However, it is said that the system has never been put to its intended use because there was no money to install the pumps needed to distribute the water.

Ineffective waste water treatment plant. To the west of Livadi, on a stretch of level ground, stands a group of buildings behind a fence: a waste water treatment plant. The incoming waste water pipes seem to be in place. Below the plant, large amounts of foaming stinking water flow towards Tsilizaki Bay (Fig. 7). It would seem that the biological treatment stage at least is not working. Before it reaches the bay, this nutrient-rich water flows into a wetland covering an area of about 8 ha, which ends in a lagoon dammed by a barrier beach. In this heavily overloaded water with its carpet of algae, migratory water birds were seen resting, whereas the herpetofauna was represented solely by the Greek Marsh Frog. This last remaining large wetland area on Serifos can be assumed to be of great importance for migratory birds. It must also be assumed, however, that fish – as a potential source of food

for the birds – cannot survive in this open sewer.

Natura 2000 area.- Serifos harbors Natura 2000 area no. GR 4220009, covering 4531 ha of land. The site includes the southern half of the island with the four bays Kalo Ampeli, Koytala, Maliadhiko and Dyo Gialloudia. It begins at coast level and rises up to the highest point on the island (Troulos 582 m). The official text on the site lists 24 springs and 14 km of waterways. Its main characteristics are described as a combination of geomorphological and hydrogeological phenomena offering a varied habitat structure. It is these morphological structures, with the addition of the ancient monuments and abandoned mines, that constitute the outstanding value of the site (HELLENIC MINISTRY FOR THE ENVIRONMENT without year). The boundary of the area may have been selected for geomorphological reasons or because of the maritime portion of the site with its *Posidonia* grass communities. With regard to the general fauna, however, it might have been more appropriate to focus on the northern part of the island, where the wet areas support much greater diversity. Although listed in Annex II of EU Directive 92/43/EEC, *Mauremys rivulata* is unlikely to be present on the Natura 2000 site, although – as discussed above – it is to be found in other parts of the island. This applies to other important species mentioned in the annex, too, like *N. tessellata*. Reference is also made to an “important bird area” (GR 150 Serifos Island) occupying 7400 ha. That, presumably, is the site of the severely degraded lagoon.

Regional planning management.- Greek regional planning instruments do not successfully prevent land owners from uncontrolled building for tourism purposes. Lack of a land register and house builder friendly regulations, along with a multitude of new access roads constructed, promote this building activity. Even in the Natura 2000 area on Serifos, this kind of building activity is to be found around Sotiras at Kalo Ambeli, well away from any other housing. The tourist facilities present in Maliadhiko Bay demonstrate clearly that Natura 2000 status does not offer protection from substantial degradation of the countryside.

The influence of climate change with resulting aridification tendencies.- In addition to the direct impacts of anthropogenic activity, increasing aridification must be expected in the eastern Mediterranean in general in the wake of climate change. Over the last twenty years, the author noted a continual reduction in total surface water. For example, running water was no longer to be seen in April on Lipsi in 2007, Ithaki in 2008 and Alonnisos in 2009 (BROGGI 2008, 2009, 2010), and on the little Dodecanese island of Lipsi water had to be shipped to the island in April already. This observation is confirmed by a recent investigation. Data analyzed for the

eastern Mediterranean indicate a reduction in precipitation accompanied by an increase in summer temperatures (SARRIS et al. 2007). Further evidence is available in the form of dendrochronological investigations of *Pinus halepensis* (SARRIS et al. 2007), which show that conditions for growth for this species of pine deteriorated in the second half of the 20th century. Aridification is also becoming increasingly problematic for the semi-aquatic herpetofauna in what are already small threatened refuge units. The future of the semi-aquatic herpetofauna of the Aegean islands is uncertain; the extinction of species on the various islands is to be feared.

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Fig. 5. Balkan Terrapin nearby the old watermill of Kato Dhipotamata, in the vicinity of the village of Panaghia. Photo: Peter GOOP.

Abb. 5: Bachschildkröten nahe der alten Wassermühle von Kato Dhipotamata in der Nähe der Ortschaft Panaghia.



Fig. 6: Wetland and nutrient-rich lagoon in the Tsilizaki Bay, Serifos. Photo: Mario F. BROGGI.

Abb. 6: Feuchtgebiet mit überdüngter Lagune in der Tsilizakibucht, Serifos.



Fig. 7: Below the plant, uncleaned, foaming water flows towards Tsilizaki Bay, Serifos.

Photo: Mario F. BROGGI.

Abb. 7: Ungereinigtes, schäumendes Wasser aus der Kläranlage fließt in die Tsilizakibucht, Serifos.

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