The herpetofauna of Folegandros Island (Cyclades, Greece)

The Island of Folegandros (Greek: *Φολέγανδρος*, named after the mythical Folegandros, son of king Minos of Crete and first settler on the island) covers an area of 32.384 km^2 and lies in the south-west part of the Cyclades Archipelago in the Aegean Sea, Greece (36.63° N, 24.90° E**,** WGS84 datum; Fig. 1). It is located between Sikinos in the east, the volcanic island groups of Santorini in the south-east and Milos in the north-west. Folegandros was separated from the neighboring Sikinos by rising sea level approximately 8,000-10,000 years ago (KAPSIMALIS et al. 2009), and remained isolated since. The highest elevation of the island is 416 m above sea level. The permanent population of the island is 667 residents according to the latest census (HELLENIC STATISTICAL AUTHORITY 2011). Compared to the neighboring Santorini and Milos, tourism on Folegandros is small-scale, and mostly peaks during a brief summer season (July-August). A narrow ridge, running from the north-west to the south-east of the island is its main morphological feature. Deep valleys characterize its south-western slopes, steep cliffs the north-east. The island is composed of two main tectono-stratigraphic units (PHOTIADES & KEAY 2003): calcitic marble dominates in the south-east, glaucophane schist with meta-basalt lenses in the north-west. The island is rocky and barren in the south, greener in the north-west where agricultural terraces, both active and abandoned, are common. Grazing by goats and sheep is intense in most parts of the island, thus the vegetation type "phrygana" (low shrub communities) is common. Prevalent anthropogenic element is the island-wide network of dry stone walls that creates numerous microhabitats for reptiles.

Among the islands of the Cyclades Archipelago, the proportion of plants endemic to Greece is highest on Pholegandros (KOUGIOUMOUTZIS et al. 2015). Its flora shows closer affinity to that of the semi-desert and barren, yet geographically more distant, Anafi, than to its neighboring volcanic islands. The impoverished non-volant mammal fauna includes the hedgehog (*Erinaceus roumanicus*), the European rabbit (*Oryctolagus cuniculus*), and the black rat (*Rattus rattus*), domestic cats and farm animals were introduced by humans (MASSETI 2012). Twenty four species of land birds nest on Folegandros (SIMAIAKIS et al. 2012); predatory birds include the little owl *Athene noctua* and the long-legged buzzard *Buteo rufinus* (HANDRINOS & AKRIOTIS 1997). There are no amphibian records from the island (VALAKOS et al. 2008).

The reptile fauna of Folegandros was never in the focus of a targeted investigation and only few records are available in the herpetological literature. The first reptile records from the island were reported by WERNER (1935), with subsequent new records, only some 60 years later, by BUTTLE (1993) and ENTZEROTH (1996; cited as SCHULZ 1996 in several later publications). In total, only four reptilian species were identified to occur the island: *Podarcis erhardii* (BEDRIAGA, 1882) and *Mediodactylus kotschyi* (STEINDACHNER, 1870) by WERNER (1935), *Eryx jaculus* (LINNAEUS, 1758) by BUTTLE (1993) and *Elaphe quatuorlineata* BONNATERRE, 1790, by ENTZEROTH (1996).

The authors visited Folegandros four times: June 13-16, 2013, June 13-16, 2014, May 9-12, 2015 and June 5-6, 2015, and nonsystematically surveyed 12 sites (Fig. 1, Table 1), varying in habitat type (phrygana, agricultural terraces, buildings, a sandy beach and a waste disposal site) for reptiles by day and night. The surveys included flipping rocks and other potential covers, searching on dry stone walls and buildings, and looking for road kills. The authors also visited the small (0.0332 km^2) offshore island of Agios Ioannis (site no. 13, Figs. 1 and 2) on June 14, 2013. This limestone islet located ca. 150 m off the south-east end of Folegandros near the main harbor of Karavostasis is dry, almost barren, and covered with scattered *Atriplex* bushes in addition to low grassy vegetation. It harbors a small sea gull colony (*Larus michahellis*) ensuring the availability of edible residues for the resident lizard population.

Animals were caught by hand or noose, under a permit issued by the Greek Ministry of Environment, Energy, and Climate Change (permit number 111165/1558). Collecting on Folegandros included

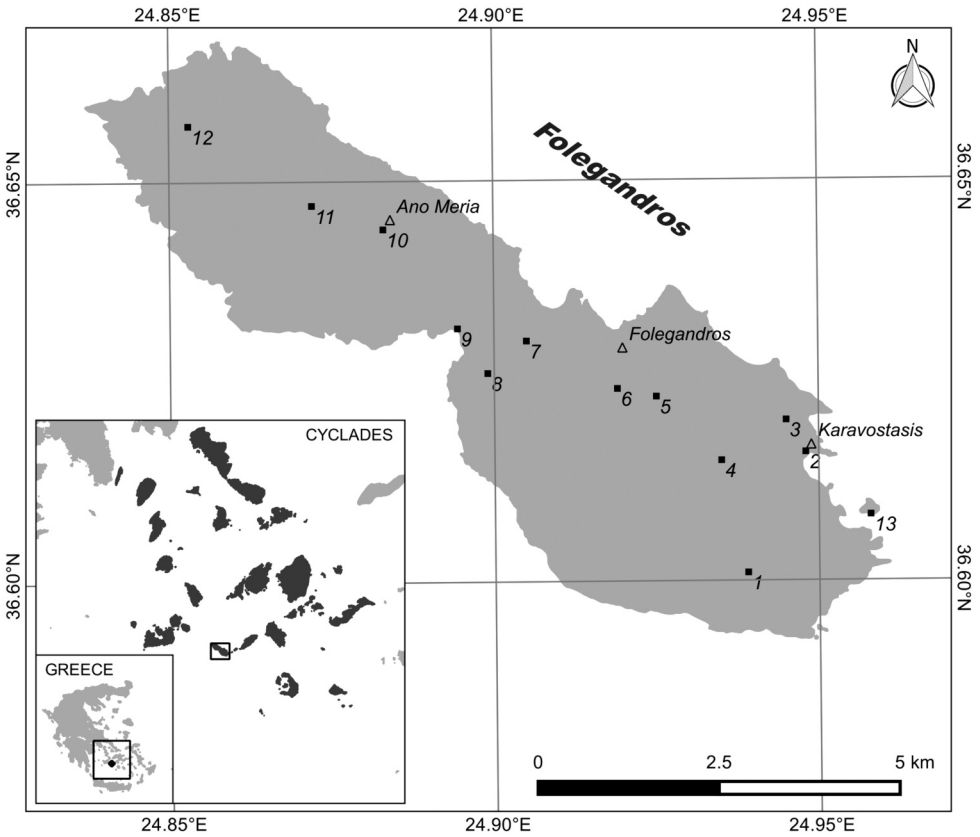

Fig. 1: Map of Folegandros showing the localities surveyed: 1 – Livadi, 2 – Karavostasis village, 3 – Karavostasis hills, 4 – north-east of Tourlos, 5 – Chora junction, 6 – Chora (Folegandros), 7 – Lithia (three windmills), 8 – Agios Christos, 9 – Agkali, 10 – Ano Meria, 11 – Merovigli, 12 – Chrisopigi, 13 – Islet Agios Ioannis.

12 individuals of Erhard's Wall Lizard, 2 *Mediodactylus* and 2 *Eryx*; all of them were deposited at the Zoological Museum of the University of Athens (ZMUA). All other specimens were released immediately after being caught and measured. Additionally, specimens from Folegandros deposited at the Zoologisches Forschungsmuseum Alexander Koenig in Bonn, were examined and catalogues of other collections as well as online databases (including the meta-repositories GBIF: < http://www.gbif.org >, and VertNet: < http://www.vertnet.org >) queried for reptile and amphibian records. Data acquisition included information on age (adult\sub-adult\ juvenile) and sex, snout-vent length (SVL), tail length (TL) and body mass (except for animals on Ag. Ioannis). Selected species representatives were photographed. The known herpetofauna of Folegandros consists of the following species:

Mediodactylus kotschyi (Steindachner, 1870) (Fig. 3) — Folegandros: First record by Buttle (1993); other published original records – none; museum records – none; records of the present study: sites no. 7 and 8 (five individuals, June 5, 2015, 8:30-13:00 h). For measurements of two adult males (ZMUA 4170-4171). Ag. Ioannis: First record by Beutler & Gruber

Table 1: Description of the study sites on Folegandros including the reptile species observed.

Site	Latitude (° N)	Longitude (° E)	Habitat	*Mediodactylus kotschyi*	*Hemidactylus turcicus*	*Podarcis erhardii*	*Eryx jaculus*	*Elaphe quatuorlineata*
1	36.601	24.939	Sparse shrub land	-	-	+	-	-
2	36.616	24.948	Human settlement	-	+	+	-	-
3	36.620	24.945	Barren rocky hill	-	-	+	-	-
4	36.615	24.935	Waste disposal site	-	-	-	-	-
5	36.623	24.925	Dense shrub land with stone walls	-	-	+	+	-
6	36.624	24.919	Human settlement	-	+	+	-	-
7	36.630	24.905	Agricultural fields and terraces with stone walls	+	+	+	+	+
8	36.626	24.899	Dense rocky shrub land	+	-	+	-	+
9	36.631	24.894	Sandy beach in human settlement	-	-	+	-	-
10	36.644	24.883	Road side stone walls	-	-	+	-	-
11	36.647	24.872	Abandoned terraces next to a human settlement	-	+	+	+	-
12	36.657	24.853	Rocky hill side	-	-	+	-	-
13	36.608	24.958	Sparse shrub land	+	-	+	-	-

(1978); other published original records – none; museum records – one specimen at Zoologisches Forschungsmuseum Alexander Koenig in Bonn (ZFMK); records of the present study: site no. 13 (two individuals, June 14, 2013).

This most common reptile on the Aegean islands (VALAKOS et al. 2008) appears to be quite rare. Three individuals were found in the day light on dry stone walls (site no. 7), and two under rocks (sites no. 7 and 8).

Hemidactylus turcicus (LINNAEUS, 1758) — Folegandros: First record – this study; other published original records – none; museum records – Natural History Museum Crete (NHMC) 80.3.87.244-245 (collected by N. POULAKAKIS, locality: near Karavostasis, Folegandros); records of the present study – sites no. 2, 6, 7, 11. Ag. Ioannis: no records available.

Although fairly common in human settlements, this species was not reported from Folegandros to date. It was found active on walls (Fig. 4) by night and under rocks by day. The adult females were gravid bearing two eggs each (determined by visual inspection of the abdomen, see SLAVENKO et al. 2015). On May 10, 2015, an active adult male was found at an unusually low ambient temperature (17.2 C°), on an even colder wall (13.4 C°) at site no. 6. Its body temperature (18.1 C°) was by far the coldest measured among hundreds of individuals of this species on the Aegean islands during three years of research (ITESCU, SCHWARZ, SLAVENKO, PAFILIS & MEIRI unpublished); the second coldest was 21.0 C° for an individual from the island of Iraklia.

Podarcis erhardii (BEDRIAGA, 1882) — Folegandros: First record – WERNER (1935); other published original records – WETTSTEIN (1953), BUTTLE (1993), MARSHALL & STEVENS (2014), MARSHALL et al. (2015); museum records – Museum of Comparative Zoology in Harvard University (MCZ) R-38478-38482 (collected by F. WERNER, 5. 1934, locality: "Folegandros"), Naturhistorisches Museum Wien (NHMW) 7294: 1-27 (collected by F. WERNER & O. WETTSTEIN, 5.1934, locality: "Folegandros"), NHMW 26394: 1-23 (Pholegandros, F. TIEDEMANN leg. 12.IV.1981), ZFMK 621-645 (collected by K. F. BUCHHOLZ, 5-6.6.1953, locality: "Folegandros"), ZFMK 670-693 (collected by K. F. BUCHHOLZ, 7.6.1953, locality: Karavostasis, Folegandros), NHMC 80.3.51. 2604-2610 (collected by N. POULAKAKIS, locality: near Karavostasis, Folegandros); records of the present study – sites no. 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12 (ZMUA 4158-4169). Ag. Ioannis: First record by the present study – site no. 13.

This lizard is by far the most common reptile species on Folegandros, as already

Fig. 2: The small islet of Agios Ioannis. Photo by J. Foufopoulos.

mentioned by WERNER (1935) and BUTTLE (1993). Overall, the authors observed and caught more than twice as many males as females. During the summer, the lizards followed a bimodal activity pattern with peak activity periods in the morning and late in the afternoon. On Ag. Ioannis, *P. erhardii* was also the dominant reptile (up to six individuals per 100 m transect). The lizards ranged widely across the islet and made extensive use of the *Atriplex* bushes for shelter. Lizards from Folegandros and Ag. Ioannis were similar in size but those from the latter were less fearful (i.e., allowed closer approach) and were frequently engaged in intense agonistic interactions. In line with this observation, 73 % of the animals on Ag. Ioannis had regenerated tails, whereas this proportion was only 34 % on Folegandros. This difference is statistically significant ($\chi^2 = 24.08$, $p < 0.01$).

Eryx jaculus (LINNAEUS, 1758) — Folegandros: First record – BUTTLE (1993); other published original records – none; museum records – none; records of the present study – sites no. 5, 7, 11 (ZMUA 4172-4173). Ag. Ioannis: no records available.

FRANZ WERNER (1935) was the first to think about the presence of this species on Folegandros, yet he did not actually find it. Later, TOKAR & OBST (1993) cited Werner's speculation as an actual record, however it was BUTTLE (1993) who first documented the presence of boas on Folegandros, finding two individuals under rocks in olive groves. In the present study three individuals (two juveniles and a large adult female) were encountered: a fairly complete, recently deceased juvenile on the road near Merovigli (site no. 11) on June 15, 2014; a large adult female (54.7 cm in total length) found under an old telephone booth in a shrubland by the road close to Chora junction (site no. 5) and a juvenile under sandstone on a dirt path near Lithia (site no. 7).

Figs. 3-5 (opposite page).

Fig. 3: Adult male *Mediodactylus kotschyi* (STEINDACHNER, 1870) on a dry stone wall in an abandoned agricultural field near Lithia (site no. 7). Photo by S. Jamison.

Fig. 4: An adult female *Hemidactylus turcicus* (LINNAEUS, 1758) on a wall in the village of Karavostasis (site no. 2). Photo by A. Slavenko.

Fig. 5: Adult male *Elaphe quatuorlineata* (BONNATERRE, 1790) in Agios Christos (site no. 8). Photo by S. Jamison.

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Table 2: Number of reptile species known from such Aegean islands which are similar in size to Folegandros. * - Number of species recorded prior to this study.

Island	Area (km^2)	Lizard species	Snake species	Turtle species	Total reptile species	Source
Fourni	30.5	4	2	0	6	Dimaki & Legakis 1999
Folegandros	32.4	3 (2*)	2	0	5 (4*)	This study
Gavdos	33.0	3	2	2	7	Broggi 2014b; Author's unpublished data
Patmos	34.1	3	6	0	9	Cattaneo 2008
Antiparos	35.1	6	4	0	10	Gruber & Fuchs 1977; Cattaneo 1984
Kimolos	37.4	5	5	2	12	Broggi 2014a
Anafi	38.6	3	0	0	3	Wettstein 1953; Author's unpublished data

The total length of the largest individuals reported from the Cyclades were 57.3 cm (Antiparos, Cattaneo 2010), 58 cm (Amorgos, Buttle 1993), 58.7 cm (Iraklia, Cattaneo 2010) and 60 cm (Amorgos, Lieftinck 1974).

Elaphe quatuorlineata (Bonnaterre, 1790) — Folegandros: First record – Entzeroth (1996); other published original records – none; museum records – none; records of the present study – sites no. 7, 8. Ag. Ioannis: no records available.

An adult male (Fig. 5) was found in Agios Christos on the floor of an abandoned building surrounded by typical dense low shrub land (site no. 8) where the snake was active at 10:30 h in the morning. Another adult male (only the rear part of the body, about 50 cm long, with exposed hemipenis) was detected in an abandoned agricultural field near Lithia (site 7).

The present surveys confirm previous observations that the herpetofauna of Folegandros is fairly depauperate (Werner 1935**;** Buttle 1993). Only five reptile species were detected to occur on the island, fewer than on most other Aegean islands of similar size (Table 2). Amphibians were not observed and their absence from the island is highly probable due to the scarcity of surface fresh water.

Considerable differences in species richness were observed between different sites on the island (Table 1); they are worth a more in depth investigation of the reasons.

Increased intraspecific aggressiveness of *P. erhardii* on the small islet of Ag. Ioannis, which is free of terrestrial predators, was derived from the comparatively high proportion of regenerated tails. This finding supports recent results reporting harsh intraspecific competition in insular lizards, and *P. erhardii* specifically (Cooper et al. 2015; Donihue et al. 2016; Itescu et al. in press). The relative rarity of *M. kotschyi*, the otherwise most common Cycladic reptile species (Valakos et al. 2008 and authors' pers. obs.) is surprising and remains unexplained for now.

The presence of *E. quatuorlineata* on Folegandros is noteworthy as there is no record from any of the surrounding islands (Kornilios et al. 2014) between Ios and Antimilos.

The present study confirms that the reptile fauna of Folegandros is among the poorest in species of all Aegean islands of similar size. Among larger islands, only the south Cycladic Anafi and Astypalea, which are isolated for >100,000 years, harbor fewer reptilian species (Table 1). Several traits of Folegandros explain its depauperate herpetofauna: the island is barren, with little surface water and sparse vegetation; it is isolated for a long period of time (about 8,000 years); its herpetofauna may have been subject to community relaxation (the progressive extinction of species isolated on a habitat fragment for long periods of time *sensu* Foufopoulos & Ives 1999), possibly leading to the disappearance of common Cycladic taxa; and the proximity of Folegandros to the south Aegean volcanic arc, and especially the Minoan eruption (of

Santorini) ca. 3,650 years ago, may have contributed to the impoverishment

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