

Review of the distribution and conservation status of the terrestrial reptiles of the Cape Verde Islands

RAQUEL VASCONCELOS, JOSÉ CARLOS BRITO, SALVADOR CARRANZA and
D. JAMES HARRIS

Abstract Cape Verde has a higher number of reptile taxa and endemics than any of the five archipelagos in the Macaronesian region. Mapping the precise distributions and assessing the conservation status of reptiles is the first step towards effective conservation. Presence/absence and abundance data were gathered from extensive fieldwork and post-1980 literature. Evaluation of conservation status was considered at specific and subspecific levels, following IUCN Red List criteria and using RAMAS. Fieldwork confirmed the occurrence of 34 of 37 previously recorded taxa (31 native, three exotic). One taxon continues to be considered Extinct. Three broad distribution and rarity patterns were identified: widespread and abundant taxa occurring on ≥ 2 islands/islets, widespread or abundant taxa restricted to one island, and rare or limited range taxa occurring on small areas of islands or islets. More than a third of taxa have areas of occupancy < 20 km² and extents of occurrence < 100 km². Geckos are rarer than skinks because of their high habitat specialization, with 58% occurring on only one island/islet. About half of all taxa are potentially threatened, twice the proportion of those in the Canary Islands, a difference that could be explained by the smaller area and greater aridity of the Cape Verde islands. The criterion used for most threat categorizations is geographical range, and the most pervasive threats are natural disasters, intrinsic factors of the species and introduced species. The importance of applying conservation status at the subspecific level to island endemics is emphasized. Several conservation measures are proposed, including optimized design of protected areas.

Keywords Atlas, *Chioninia*, endemics, *Hemidactylus*, introductions, Macaronesia, Red List, *Tarentola*

RAQUEL VASCONCELOS (Corresponding author), Centro de Investigação em Biodiversidade e Recursos Genéticos da Universidade do Porto (CIBIO-UP), Campus Agrário de Vairão, R. Padre Armando Quintas, 4485-661 Vairão, Portugal, and Institut de Biologia Evolutiva (IBE), Consejo Superior de Investigaciones Científicas–Universitat Pompeu Fabra (CSIC-UPF), Passeig Marítim de la Barceloneta, 37-49, E-08003 Barcelona, Spain.
E-mail raquel.vasconcelos@cibio.up.pt

JOSÉ CARLOS BRITO and D. JAMES HARRIS Centro de Investigação em Biodiversidade e Recursos Genéticos da Universidade do Porto (CIBIO-UP), Vairão, Portugal, and Departamento de Biologia, Faculdade de Ciências da Universidade do Porto, Porto, Portugal

SALVADOR CARRANZA Institut de Biologia Evolutiva (IBE), Consejo Superior de Investigaciones Científicas–Universitat Pompeu Fabra (CSIC-UPF), Barcelona, Spain

Received 21 March 2011. Revision requested 2 June 2011.

Accepted 27 July 2011.

This paper contains supplementary material that can be found online at <http://journals.cambridge.org>

Introduction

Biodiversity loss is one of the top issues of the 21st century. Species with small range size and low gene flow are of particular concern as they have increased probability of extinction by chance alone (Pullin, 2002). For this reason, island populations have a higher risk of extinction than mainland populations (Frankham, 1997). Moreover, even though islands usually have a low number of species, the number of endemics is generally high (Kier et al., 2009), as is their vulnerability to the introduction of exotic species (Case et al., 1992). Thus, it is crucial to increase knowledge about native biodiversity in remote areas such as oceanic islands where species are particularly prone to extinction. One way of fulfilling this goal begins with the production of distribution atlases and updated Red Lists, as these are tools for conservation planning.

The Cape Verde Islands, an oceanic archipelago, lack detailed information on the distribution of biodiversity. Although there are preliminary inventories of the flora (Paiva, 1995), avifauna (Naurois, 1994; Hazevoet, 1995; Clarke, 2006) and herpetofauna (Schleich, 1987), there are no distribution atlases for terrestrial groups. There are no endemic mammals or amphibians. Intra-island distribution data for birds are being collected but accurate distribution data for reptiles are lacking. All native reptiles are endemics and the archipelago has the highest number of endemic reptile taxa in Macaronesia (Schleich, 1987; Pleguezuelos et al., 2002; López-Jurado et al., 2005; Oliveira et al., 2005), within three genera: *Hemidactylus* (Gekkonidae), *Tarentola* (Phyllodactylidae) and *Chioninia* (Scincidae; = *Mabuya* and *Macroscoincus*; Miralles et al., 2010).

After the discovery of this oceanic archipelago by the Portuguese in 1460 several surveys on the fauna of Cape Verde were conducted, leading to the first studies of the taxonomy, systematics and morphology of the Cape Verdean herpetofauna in the 19th century. In the 20th century a preliminary assessment of the reptiles listed 10 endemic terrestrial species (including 23 taxa), and reviewed their distributions at a coarse inter-island scale (Schleich, 1987). Later, taxonomic revisions made by Joger (1993), based on morphological analyses, increased to 12 and 26 the number of species and taxa, respectively. These data were

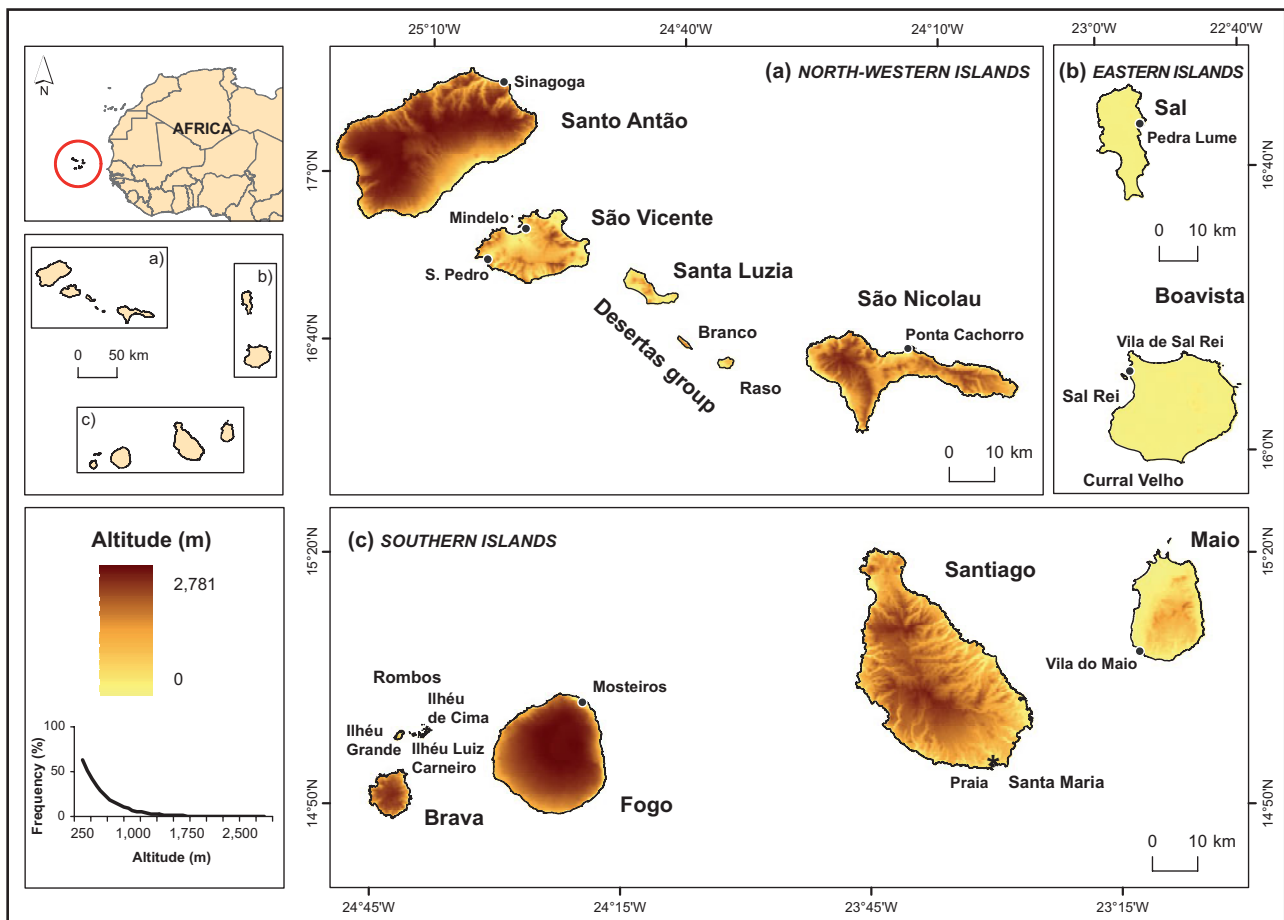


FIG. 1 The Cape Verde Islands, including altitudinal variation, and place names mentioned in the text.

compared with the now outdated (pre-2001) IUCN and German National List criteria to produce the first Red List for Cape Verde (Leyens & Lobin, 1996). The assessment considered 25% of the terrestrial reptiles to be Extinct or threatened (Schleich, 1996), prompting the promulgation of a law for the protection of plant and animal species. This law considered *Hemidactylus bouvieri razoensis* Gruber & Schleich (1982) as Critically Endangered; *Tarentola gigas brancoensis* Schleich (1984) and *Tarentola gigas gigas* (Bocage, 1875) as Endangered; *Hemidactylus bouvieri bouvieri* (Bocourt, 1870) as Rare and *Tarentola rudis* (Boulenger, 1906) and *Chioninia (=Mabuya) vaillanti* (Boulenger, 1887) as Undetermined (Anonymous, 2002).

Genetic studies conducted after 2000 by Brehm et al. (2001), Brown et al. (2001), Carranza et al. (2000, 2001, 2002), Carranza & Arnold (2003, 2006) and Jesus et al. (2001, 2002) for phylogeographical purposes indicated the need for a systematic revision of the reptiles of Cape Verde. An extensive survey of Cape Verde has been carried out since 2006, collecting genetic and morphological data, to review the systematics of endemic reptiles (Arnold et al., 2008; Miralles et al., 2010; Vasconcelos et al., 2010, 2012b). These studies have increased to 22 the number of recognized

endemic reptile species, with 31 taxa. The significant taxonomic revisions, naming previously unnamed populations and describing three new species and three new subspecies, increased the number of species by 83% and the number of taxa by 19% compared to the previous assessment (Schleich, 1996), and indicated the need to revise the distribution maps of all taxa and assess their conservation status using current IUCN criteria (IUCN Standards and Petitions Subcommittee, 2010).

The objectives of this study are to provide distribution data at an intra-island scale and to assess the conservation status of the endemic reptiles of Cape Verde. The fulfilling of these two goals will provide guidance for future management and conservation efforts.

Study area

The Cape Verde Islands belong to the biogeographical region of Macaronesia in the Atlantic Ocean (Fig. 1). They form a volcanic archipelago comprising 10 main islands plus several islets, with a total area of 4,067 km². Island size varies from the 1,004 km² Santiago to the 6 km² Raso. The age of

the islands is 2.6–26 million years, with islands closer to the mainland being the oldest, and consequently the flattest (Torres et al., 2002; Duprat et al., 2007).

The topography of Cape Verde ranges from plains to high mountains, reaching almost 3,000 m on the summit of the active volcano of Fogo. The elevation, steepness and orientation of mountains influence the amount of precipitation that each island receives. Cape Verde is situated just north of the Intertropical Convergence Zone and has a tropical dry climate with a long dry season, frequent long droughts, and an irregular short wet season from July to September (Duarte & Romeiras, 2009). Mean annual temperature is relatively constant (22 °C) because of the moderating influence of the ocean. Annual precipitation is low (< 250 mm) and highly variable both spatially and temporally (Hijmans et al., 2005) and there are almost no permanent water courses.

Methods

Sampling

The 10 islands were surveyed over 2006–2008 during the dry season, from mid May to mid July. Sampling stations (Appendix 1) were randomly chosen and stratified according to habitat availability, based on agro-ecological and vegetation zoning maps (adapted from Diniz & Matos, 1986, 1987, 1988a,b, 1993, 1994, 1999a,b,c; Appendix 2), with the number of stations per habitat proportional to habitat area. Using this approach most of the variability between and within each habitat, in altitude, topography, climate and geographical position, was encompassed by the sampling stations. The sampled area, 440 stations of 1×1 km², corresponds to c. 11% of the country's area. Each station was sampled only by day (because of logistic constraints), along transects, for 35 minutes on average (5–120 minutes, according to the difficulty of the terrain), by two observers walking parallel to each other, totalling nearly 264 hours of sampling. Presence/absence and abundance data of taxa (no. of individuals observed or per km²) were recorded. Abundance data were taken as an indicator of the order of magnitude of the number of mature individuals.

Presence data

A total of 2,139 presence observations were collected from three sources: (1) 1,375 from fieldwork, consisting of indirect evidence (skins, eggs or skeletons) or direct captures of the animals (released afterwards), (2) 610 from the literature, and (3) 154 from *GenBank*. Total presence data (N) corresponds to the total data collected from the three sources. The geographical coordinates of fieldwork observations were recorded with a global positioning system.

Coordinates from literature records (Duméril & Bibron, 1839; Gray, 1845; Bocourt, 1870; Bocage, 1873, 1875, 1896, 1897, 1902; O'Shaughnessy, 1874; Vaillant, 1882; Boulenger, 1885, 1887, 1906; Peracca, 1891; Orlandi, 1894; Serpa-Pinto, 1896; Angel, 1935, 1937; Loveridge, 1947; Dekeyser & Villiers, 1951; Mertens, 1955; Greer, 1976; Schleich, 1980, 1982a,b, 1984, 1987, 1996; Gruber & Schleich, 1982; Schleich & Wutke, 1983; Joger, 1984a,b, 1993; Brygoo, 1985, 1990; Pinheiro, 1990; Hazevoet, 1995; Mateo et al., 1997, 2005, 2009; López-Jurado et al., 1998, 1999, 2005; Andreone, 2000; Carranza et al., 2000, 2001, 2002; Brehm et al., 2001; Brown et al., 2001; Jesus et al., 2001, 2002, 2005; Andreone & Guarino, 2003; Carranza & Arnold, 2003, 2006; González & López-Jurado, 2004; Chadwick & Slater, 2005; Frazen & Glaw, 2007; Köhler & Güsten, 2007; Köhler et al., 2007a, b; Arnold et al., 2008) and *GenBank* data were determined from topographical maps (1:25,000). All coordinates were recorded or determined on the WGS84 datum and mapped using *ArcGIS v. 9.3* (ESRI, Redlands, USA).

When an endemic taxon was found outside its previously known range within the archipelago it was considered a probable recent anthropogenic introduction if it was genetically close to individuals found on the island of origin of the taxon (Miralles et al., 2010; Vasconcelos et al., 2010) and if, after extensive sampling, only a small number of individuals was found mainly on the coast rather than inland.

Conservation status

Conservation status was evaluated at specific and subspecific levels, following the methodology and criteria of the IUCN Red List guidelines (IUCN Standards and Petitions Subcommittee, 2010). A taxon was considered threatened when it qualified as Vulnerable (VU), Endangered (EN) or Critically Endangered (CR), according to the criteria of population reduction (A), geographical range (B), small population size and decline (C), or very small or restricted population (D; IUCN Standards and Petitions Subcommittee, 2010). Non-indigenous and fossil taxa were listed as Not Evaluated (NE).

Criteria were applied with *RAMAS Red List v. 2.0* (Akçakaya & Ferson, 2001). Parameters for categorization were (1) population number, estimated from the number of mature individuals using abundance data, (2) population reduction, estimated from subfossil and published data, (3) area of occupancy (AOO), calculated from the number of occupied cells \times area of an individual cell (1×1 km²) considering only observations after 1980, (4) extent of occurrence (EOO), estimated by the minimum convex polygon method, which determines the area contained within the shortest continuous imaginary boundary that can be drawn to encompass all the occurrences of a taxon

(calculations made with *Hawth's Tools* extension for *ArcGIS*, Beyer, 2004), and (5) population fragmentation, based on the number of locations (corresponding to the number of habitats where occurrence was registered; see Sampling above and Appendix 2), and number of subpopulations (quantified by the number of islands or islets of occurrence of a taxon). The only exceptions to (5) were applied to *Tarentola darwini* and *Chioninia spinalis santiagoensis*, which each presented two evolutionarily significant units on the same island and thus the number of subpopulations did not coincide with the number of islands or islets of their occurrence (Miralles et al., 2010; Vasconcelos, et al. 2010).

Taxa were considered to have a restricted range (RR) if AOO was $< 20 \text{ km}^2$ or the number of locations of occurrence was ≤ 5 (Akçakaya & Ferson, 2001). An exception was made for *Chioninia spinalis spinalis*, which was not considered to be RR because, even though its value of AOO was $< 20 \text{ km}^2$, this was assumed to be the result of an underestimation of presences. Sampling occurred during the dry season and this, together with the steep slopes of Fogo Island, made detection difficult. Major threats for each taxon were assessed using a standardized list (IUCN, 2010; Appendix 3) implemented in RAMAS and were evaluated based on information gathered from fieldwork and published data.

Results

Presence data

During the fieldwork we made 50 observations of exotic taxa and 1,325 of native taxa, and the literature and *GenBank* data together contributed 21 and 743 observations of exotic and native taxa, respectively. A total of 38 taxa were recorded, of which 31 were native (not counting fossil species) and six exotic (Table 1). Of these, only 34 taxa (31 native and three exotic) were confirmed by fieldwork. The distributions of observations are given in Appendices 4–7. Detailed information about doubtful and historical records is given in Appendix 8.

Three exotic reptile species were confirmed to be present (Appendix 4). The most abundant and widespread species is *Hemidactylus angulatus*, which occurs on at least six islands and one islet. The most recent introduction recorded is *Agama agama* on Santo Antão, São Vicente and Santiago. Fieldwork produced first records of *Hemidactylus mercatorius* (referred as *Hemidactylus mabouia* by previous authors) on Santo Antão and Brava and confirmed the occurrence of the species on São Vicente.

Fieldwork confirmed the following introductions of endemic taxa: (1) *Chioninia delalandii* in Vila do Maio, Maio (originally present on all other southern islands) and

Mindelo, São Vicente, (2) *Tarentola maioensis* (originally from Maio) at Ponta Cachorro, São Nicolau, and (3) *Tarentola substituta* (originally from São Vicente) in Sinagoga, Santo Antão (Table 1).

Of the 31 endemic taxa five belong to the genus *Hemidactylus*, 14 to *Tarentola* and 12 to *Chioninia* (Table 1). Unsuccessful searches were conducted for *Chioninia* (= *Macrosцинus*) *coctei* by three observers on Santa Luzia Island during 5 days. Three broad distribution and rarity patterns were identified for extant taxa: (1) widespread and abundant taxa, occurring on two or more islands or one island and distant islets (e.g. *Hemidactylus boavistensis*, *Tarentola raziana* and *C. delalandii*), (2) widespread or abundant taxa, restricted to one island and its neighbouring islets (*Tarentola boavistensis*, *T. darwini* and *Chioninia spinalis maioensis*), and (3) rare or limited range taxa, occurring on an islet or a small part of an island (*H. bouvieri* spp., *Hemidactylus lopezjuradoi*, *Tarentola bocagei*, *T. gigas* spp., *T. rudis*, *Tarentola protogigas* and *C. vaillanti* spp.; Table 1; Appendices 5–7).

The native *C. delalandii* and *T. darwini* have the largest EOO and AOO, *T. g. brancoensis* and *T. g. gigas* have the smallest EOO, and *H. lopezjuradoi* and *H. b. bouvieri* the smallest AOO (Table 1, Appendices 5–7). *C. delalandii* is the taxon with the highest number of confirmed subpopulations, followed by *H. bouvieri*, *Chioninia stangeri* and *H. boavistensis*. About 40% of the reptile taxa have an AOO $< 20 \text{ km}^2$, geckos 1.5 times more than skinks (47% of geckos vs 33% of skinks). About a third (36%) of all taxa have an EOO $< 100 \text{ km}^2$, especially geckos (53% of geckos vs 8% of skinks).

About 30% of the taxa occur in < 5 locations, and 58% occur on only one island or islet, with a similar pattern for geckos and skinks (Table 1). Thirteen of the reptile taxa (42%) have a restricted range, with higher values for geckos than for skinks.

Most (71%) of the taxa were recorded below 250 m altitude but 24% occur at 250–1,000 m (Appendices 4–7). Examples of taxa occurring at altitudes above 1,000 m are *C. delalandii*, *Chioninia fogoensis*, *C. s. spinalis*, *Chioninia vaillanti vaillanti* and *Tarentola caboverdiana*.

Conservation status

A summary of the current conservation status of the endemic taxa is presented in Table 1. About half of the reptiles are threatened (Table 1). One taxon is categorized as Extinct, c. 16% of the taxa as Critically Endangered or Endangered, and 19% as Vulnerable. Geckos have twice (63%) the percentage of threatened taxa as skinks (33%), with 80% of *Hemidactylus* categorized as Critically Endangered.

The most frequently used criterion for categorization of threat was geographical range (B; 56%). The most pervasive

threats were natural disasters (74%), specifically droughts and volcanoes, and intrinsic factors of taxa (42%), specifically restricted range and low densities (Table 1; Appendix 3).

Discussion

This research presents for the first time accurate within-island information on the distribution of the terrestrial reptiles of Cape Verde, including newly described and revised taxa, and a revised conservation assessment using the IUCN criteria for all taxa, many of them previously categorized as Data Deficient or Undetermined (*T. boavistensis*, *T. substituta*, *T. rudis* and *C. vaillanti*; Schleich, 1996).

The considerable extent of occurrence of two introduced and invasive *Hemidactylus* species, *H. angulatus* and *H. mercatorius*, is alarming, with *H. angulatus* widespread on Santiago and Boavista Islands, and *H. mercatorius* having spread to other islands. It is known that introduced *Hemidactylus* can cause catastrophic declines and extinctions of endemic geckos, as *H. frenatus* did with *Nactus* species on the Mascarene Islands (Cole et al., 2005). In addition, island invasions can be fast and human-mediated and recent reptile extinctions have occurred exclusively on islands (Case et al., 1992). Given that some endemic forms, such as *H. bouvieri* and *H. lopezjuradoi*, Critically Endangered, and that *H. angulatus* is probably already displacing some populations of the endemic *H. boavistensis* (López-Jurado et al., 1999) information regarding the extent of this threat is vital and monitoring is required. New taxa are being introduced in the archipelago, such as *A. agama* on Santo Antão (Vasconcelos et al., 2009), and recently also on São Vicente (E. Lopes, B. Martins & R. Vasconcelos, pers. obs) and Santiago (A. Rendall, G. Semedo, J. Semedo & R. Vasconcelos, pers. obs), and measures are required to prevent the entry of further exotic taxa to this vulnerable ecosystem.

Our extensive sampling did not confirm the introduction of the endemics *T. nicolauensis* to Mindelo, São Vicente (Jesus et al., 2002) or *C. delalandii* to Sal Rei, Boavista (Schleich, 1987). This may be because of low population sizes, or the extinction of the populations, as suggested by López-Jurado et al. (1999) in the latter case. However, our sampling detected new introductions of *T. substituta* on Santo Antão and *C. delalandii* on São Vicente.

Our searches and those of previous expeditions since 1912 for the native *Chioninia coctei* have been unsuccessful. Some authors considered *C. coctei* to be Extinct by the beginning or second half of the 20th century (Chevalier, 1935; Schleich, 1982a, 1984; Hazevoet, 1995) and it has been categorized Extinct by IUCN since 1986 (Schleich, 1996). Extinction was because of over-collection, prolonged droughts and

predation by feral cats (Andreone, 2000). Bocage (1896) also noted the unsustainable collection of specimens by naturalists. Nevertheless, there is still the possibility that a few individuals survive on Santa Luzia or other islands or islets (Appendix 8). Several threatened Cape Verde taxa have restricted ranges, with particular habitat associations or a low number of records (Appendix 9) and may be at risk of extinction.

The major threats to the biodiversity of this archipelago are habitat fragmentation for agriculture and cattle, introduced species, direct exploitation by hunting, collection and logging (Leyens & Lobin, 1996), and severe droughts (MAAP-DGA, 2004). For reptiles, the major threats are natural disasters such as droughts and volcanic activity, intrinsic factors of the species such as low densities and restricted ranges, and exotic species (Appendix 3). The endemic *Hemidactylus* and *T. p. protogigas* are potentially the most threatened taxa.

IUCN criteria were applied at the subspecific level as Cape Verde is an insular system and reptile populations face conservation problems that need to be addressed at that level. For example, *T. protogigas* is Critically Endangered on Fogo because of supposed continuing decline and restricted range but on Brava and Rombos the species is Vulnerable.

The frequent classification of threatened taxa based on the IUCN Red List criterion B, related to geographical range, is a common pattern in reptile assessments (Pleguezuelos et al., 2002, 2010; Oliveira et al., 2005), associated with the lack of data concerning population trends and probability of extinction related to criteria A and E, respectively. Use of criterion D, related to population size or restricted range, was unusually frequent compared to other reptile assessments in the Mediterranean basin because these reptile taxa often occur on small islands and are sometimes even restricted to islets. However, if comparisons were limited to the assessments of other insular reptiles of that hotspot, criterion D would turn up more frequently (Pleguezuelos et al., 2002; Oliveira et al., 2005), as is the case for *T. bischoffi* from Selvagens (Madeira archipelago) and *Gallotia bravoana* from La Gomera (Canaries).

In Macaronesia Cape Verde may have the highest percentage of threatened taxa (52%), followed by Madeira (50%; Oliveira et al., 2005) and the Canary Islands (25%; Pleguezuelos et al., 2002). Without considering the reptiles of Madeira, as it hosts a maximum of only five taxa, the high percentage of threatened taxa compared to the Canaries is alarming. It could be explained by the small total area of the Cape Verde archipelago (c. 50% less than the Canary Islands), which restricts ranges of taxa, and by the increasing aridity that is affecting the islands, especially at lower altitudes (Langworthy & Finan, 1997), which could have led to population reductions and extinctions. In the previous century cyclic droughts were caused by climate changes in Cape Verde but projections of rainfall changes for the region

TABLE 1 Cape Verde reptile taxa, total presence data (N, see text for details), data used for assessment of conservation status (extent of occurrence, EOO; area of occupancy, AOO; number of localities in which a taxon was found; number of subpopulations, the latter two with number of doubtful occurrences in parentheses: see Appendix 8 for further details), Red List category, criteria used for Red List categorization (IUCN Standards and Petitions Subcommittee, 2010), and major threats (IUCN, 2010; Appendix 3).

Taxa ¹	N ²	EOO ³ (km ²)	AOO ⁴ (km ²)	No. of localities ⁴	No. of subpopulations	Red List category ⁵	Criteria	Threats ⁶
Endemic species								
<i>Geochelone atlantica</i> † López-Jurado et al. (1998)	NO	?	0	0	0 (2)	NE		
Genus <i>Hemidactylus</i> Oken, 1817								
<i>H. bouvieri</i> (Bocourt, 1870)	34	?	7	8 (10)	5 (7)	CR	B1ab(i,ii,iii,iv,v)c(iii,iv)+2ab(i,ii,iii,iv,v)c(iii,iv)	1,2,7,9,12
<i>H. bouvieri bouvieri</i> (Bocourt, 1870)	7	?	1*	2 (4)*	2 (4)	CR	B1ab(i,ii,iii,iv,v)c(iii)+2ab(i,ii,iii,iv,v)c(iii); C1+2a(ii)	1,2,7,9,12
<i>H. bouvieri</i> ssp., São Nicolau	5	?	2*	2*	1	CR	B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v); C1+2a(ii)	1,2,7,9,12
<i>H. bouvieri rasoensis</i> Gruber & Schleich (1982)	22	?	4*	4*	2	CR	B1ab(i,ii,iii,iv,v)c(i,ii,iii,iv)+2ab(i,ii,iii,iv,v)c(i,ii,iii,iv); C1+2a(i,ii)b; D	1,2,7,9,12
<i>H. boavistensis</i> Boulenger (1906)	91	723	47	14	4	LC		1,2,7
<i>H. lopezjuradoi</i> Arnold et al. (2008)	3	?	1*	1*	1	CR	B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v); C1+2a(ii)	1,2,7,9,12
Genus <i>Tarentola</i> Gray, 1825								
<i>T. boavistensis</i> Joger (1993)	39	458	27	7	2	VU	C1; D1	7,9
<i>T. bocagei</i> Vasconcelos et al. (2012)	20	43	9*	7	1	VU	D2	9
<i>T. fogoensis</i> Vasconcelos et al. (2012)	44	341	20	8	1	LC		7
<i>T. darwini</i> Joger (1984b)	152	839	65	9	2	LC		0
<i>T. substituta</i> Joger (1984b)	160	151	45	8	1 ⁷	LC		7
<i>T. raziana</i> Schleich (1984)	84	28	22	8	3	VU	B1ab(v)+2ab(v); C1	1,2,7
<i>T. caboverdiana</i> Schleich (1984)	89	545	37	7	1	LC		0
<i>T. nicolauensis</i> Schleich (1984)	111	198	41	10	1 ⁷	LC		0
<i>T. gigas</i> (Bocage, 1875)	74	<10	6*	4*	2	EN	B1ac(iv)+2ac(iv)	7,8,9,10
<i>T. gigas gigas</i> (Bocage, 1875)	39	<3	3*	2*	1	EN	B1ac(iv)+2ac(iv)	7,8,9,10
<i>T. gigas brancoensis</i> Schleich (1984)	35	<6	3*	2*	1	EN	B1ac(iv)+2ac(iv)	7,8,9,10
<i>T. rudis</i> Boulenger (1906)	43	254	22	7	2	VU	D1	8
<i>T. protogigas</i> Joger (1984b)	75	75	22	11	4			7,9,12
<i>T. protogigas protogigas</i> Joger (1984b)	13	31	4*	3*	1	CR	B1ab(i,ii,v)+2ab(i,ii,v); C2a(ii)	7,9,12
<i>T. protogigas hartogi</i> Joger (1993)	62	45	18*	8	3	VU	D2	7
<i>T. maioensis</i> Schleich (1984)	57	195	22	6	1	LC		7
Genus <i>Chioninia</i> (Gray, 1845)								
<i>C. vaillanti</i> (Boulenger, 1887)	43	446	20	11	3	EN	D2	7,9
<i>C. vaillanti vaillanti</i> (Boulenger, 1887)	19	317	12*	5*	1	EN	D1+2	9
<i>C. vaillanti xanthotis</i> Miralles et al. (2010)	24	129	8*	6	2	EN	D1+2	7,9
<i>C. delalandii</i> (Duméril & Bibron, 1839)	341	1,134	141	37	7 ⁷	LC		7
<i>C. nicolauensis</i> (Schleich, 1987)	43	183	21	9	1	LC		7
<i>C. fogoensis</i> (O'Shaughnessy, 1874)	95	344	46	9	1	LC		2
<i>C. stangeri</i> (Gray, 1845)	122	101	28	23	4	EN	B1ab(i,ii,iii,v)+2ab(i,ii,iii,v); C1+2a(ii)	2,7
<i>C. coctei</i> (Duméril & Bibron, 1839)	49	6	7*	3*	3 (5)	EX		1,2,3,7,9
<i>C. spinalis</i> (Boulenger, 1906)	297	2,035	129	34	9	LC		0,7,9
<i>C. spinalis salensis</i> (Angel, 1935)	39	142	17*	6	1	VU	D2	7,9
<i>C. spinalis santiagoensis</i> Miralles et al. (2010)	67	790	31	6	3	LC		0
<i>C. spinalis spinalis</i> (Boulenger, 1906)	37	295	14 ⁸	8	1	LC		7

TABLE 1 (Continued)

Taxa ¹	N ²	EOO ³ (km ²)	AOO ⁴ (km ²)	No. of localities ⁴	No. of subpopulations	Red List category ⁵	Criteria	Threats ⁶
<i>C. spinalis maioensis</i> (Mertens, 1955)	57	210	29	7	1	LC		7
<i>C. spinalis boavistensis</i> Miralles et al. (2010)	97	598	52	7	3	LC		7
Exotic								
<i>Pelusios</i> sp. Wagler, 1830	NO	?	0	0	0 (2)	NE		
<i>Lygodactylus</i> sp. Gray, 1864	NO	?	0	0	0 (1)	NE		
<i>Hemidactylus angulatus</i> Hallowell, 1852	60	1,140	41	>6	8 (10)	NE		
<i>Hemidactylus mercatorius</i> (Gray, 1842)	12	8	7	3	3	NE		
<i>Agama agama</i> (Linnaeus, 1758)	4	?	4	4	3	NE		
<i>Psammophis sibilans</i> (Linnaeus, 1758)	NO	?	0	0	0 (1)	NE		

¹†, Fossil²NO, Not observed³?, Unknown⁴Endemic taxa with a restricted range (i.e. AOO < 20 km² or number of localities of occurrence ≤ 5) are indicated with an *⁵CR, Critically Endangered; VU, Vulnerable; EN, Endangered; LC, Least Concern; EX, Extinct; NE, Not Evaluated⁶0, None; 1, Habitat loss; 2, Invasive alien species; 3, Harvesting; 7, Natural disasters; 8, Changes in native species dynamics; 9, Intrinsic factors; 10, Human disturbance; 11, Other; 12, Unknown⁷See Presence data section in Results for further details⁸See Methods for further details

in response to global warming are highly uncertain (Biasutti et al., 2008). If droughts become more pronounced this could compromise the viability of some reptile populations, and thus increased conservation efforts are needed to ensure a secure future for the herpetofauna of Cape Verde.

National laws to protect all threatened taxa are needed as current legislation is inadequate in the face of recent taxonomic changes and new distribution data. In addition, education campaigns are required to increase awareness and capacity-building so that Cape Verdeans can protect the endemic reptiles of the archipelago better. Particular attention should be paid to new legislation to protect *H. bouvieri*, *H. lopezjuradoi* and *T. p. protogigas*, which have restricted AOO, are Critically Endangered and for which there are few records. Management plans are required to prevent the extinction of these taxa. Research and policy-based action, accompanied by species-based actions, such as control and eradication of invasive and potential competing species, are imperative to ensure the viability of the endemic *Hemidactylus*. This also applies to the subspecies of *T. gigas*, for which improved annual estimates of the abundance of mature individuals are needed because demographic fluctuations are likely to occur within their extremely restricted ranges (both occur on small islets) as a result of cyclic droughts and variation in the numbers of birds with which both subspecies have trophic relationships. The Endangered *C. vaillanti* also requires a management plan as its range has probably already been reduced by increasing aridity, as suggested by the finding of subfossil records on Boavista and Maio, where the species is no longer found (Carranza et al., 2001). In addition, *C. stangeri* on São Vicente deserves particular attention because of its small range. Removal of introduced mammals from Santa Luzia is needed to conserve the threatened *C. stangeri* and *T. raziana*.

Currently, only four of the 46 terrestrial protected areas on Cape Verde have been legally gazetted, and it is important to guarantee that protected areas will encompass all reptile taxa and evolutionarily significant units (Miralles et al., 2010; Vasconcelos et al., 2010). At present this is not the case because, for example, there are no protected areas planned for Brava, where the largest population of *T. p. hartogi* occurs. The opportunity to optimize the design and location of such areas for reptiles needs to be taken, following the recommendations of Vasconcelos et al. (2012a).

In general little is known about the biology and demography of the threatened reptiles of Cape Verde; further ecological studies and quantification of the major threats affecting these taxa are required. The new data on distribution and conservation status presented here may improve the options for assessing conservation priorities for this group. The findings of this research will be passed to the Cape Verde governmental authorities, which have shown

great interest in this work and, considering their budgetary constraints, have provided considerable assistance and support. Ultimately, the effective protection of the biodiversity of Cape Verde is dependent on the necessary funds becoming available to support the implementation and management of the protected area network and future conservation action plans.

Acknowledgements

RV is grateful to S. Rocha, M. Fonseca and A. Perera from Centro de Investigação em Biodiversidade e Recursos Genéticos, S. Martins, J. Motta, H. Abella and A. Nevsky for help during fieldwork, R. Freitas, J. César, Dr Domingos, Eng. Orlando, J. Gonçalves, L. Carvalho, C. Dias, I. Gomes and staff from the former Ministério do Ambiente Agricultura e Pescas and Instituto Nacional de Investigação e Desenvolvimento Agrário for logistical aid, and J. Roca for lab assistance. Research was supported by Fundação para a Ciência e Tecnologia (FCT) (SFRH/BD/25012/2005 and SFRH/BPD/79913/2011, to RV), PTDC/BIA-BDE/74288/2006. JCB and DJH have contracts with FCT (Programa Ciência 2007/2008 Fundo Social Europeu) and Ministerio de Educación y Ciencia, Spain (CGL2009-11663/BOS). Samples were obtained under licence 07/2008 from the Direcção Geral do Ambiente, Cape Verdean Government.

References

- AKÇAKAYA, H.R. & FERSON, S. (2001) *RAMAS® Red List: Threatened Species Classifications under Uncertainty. Version 2.0*. Applied Biomathematics, Setauket, USA.
- ANDREONE, F. (2000) Herpetological observations on Cape Verde: a tribute to the Italian naturalist Leonardo Fea, with complementary notes on *Macrosцинus coctei* (Duméril & Bibron, 1839) (Squamata: Scincidae). *Herpetozoa*, 13, 15–26.
- ANDREONE, F. & GUARINO, F.M. (2003) Giant or long-lived? Age structure in *Macrosцинus coctei*, an extinct skink from Cape Verde. *Amphibia-Reptilia*, 24, 459–470.
- ANGEL, F. (1935) Lézards des Îles du Cap Vert, rapportés par M. le Professeur Chevalier. Description de espèces nouvelles. *Bulletin du Muséum d'Histoire Naturelle, Paris*, 2, 165–169.
- ANGEL, F. (1937) Sur la faune herpétologique de l'Archipel du Cap Vert. *XII. Congrès International Zoologie, Lisbonne, 1935*, 1693–1700.
- ANONYMOUS (2002) *Boletim Oficial da República de Cabo Verde 2002*. Artigo no. 37. Ministério da Justiça, Praia, Cape Verde.
- ARNOLD, E.N., VASCONCELOS, R., HARRIS, D.J., MATEO, J.A. & CARRANZA, S. (2008) Systematics, biogeography and evolution of the endemic *Hemidactylus* geckos (Reptilia, Squamata, Gekkonidae) of the Cape Verde Islands based on morphology and mitochondrial and nuclear DNA sequences. *Zoologica Scripta*, 37, 619–636.
- BEYER, H.L. (2004) *Hawth's Analysis Tools for ArcGIS*. <http://www.spatalecolology.com/htools> [accessed 10 January 2010].
- BIASUTTI, M., HELD, I.M., SOBEL, A.H. & GIANNINI, A. (2008) SST forcings and Sahel rainfall variability in simulations of the twentieth and twenty-first centuries. *Journal of Climate*, 21, 3471–3486.
- BOCAGE, J.V. (1873) Melanges ertologiques. II. Sur quelques reptiles et batraciens nouveaux rares ou peu connus d'Afrique occident. *Jornal de Ciencias Mathematicas, Physicas e Naturaes, Academia Real das Ciencias de Lisboa*, 4, 209–227.
- BOCAGE, J.V. (1875) Sur deux reptiles nouveaux de l'Archipel du Cap-Vert. *Jornal de Ciencias Mathematicas, Physicas e Naturaes, Academia Real das Ciencias de Lisboa*, 5, 287–290.
- BOCAGE, J.V. (1896) Reptis de algumas possessões portuguesas d'Africa que existem no museu de Lisboa. *Jornal de Ciencias Mathematicas, Physicas e Naturaes, Segunda Série, IV*, 65–104, estampas I e II.
- BOCAGE, J.V. (1897) Mammiferos, repteis e batrachios d'Africa de que existem exemplares typicos no Museu de Lisboa. *Jornal de Ciencias Mathematicas, Physicas e Naturaes, Academia Real das Ciencias de Lisboa*, 4, 187–206.
- BOCAGE, J.V. (1902) Aves e reptis de Cabo Verde. *Jornal de Ciencias Mathematicas, Physicas e Naturaes, Academia Real das Ciencias de Lisboa*, 14, 206–210.
- BOCOURT, F. (1870) Description des quelques sauriens nouveaux originaires de l'Amerique meridionale. *Archives du Muséum d'Histoire Naturelle, Paris*, 6, 11–18.
- BOULENGER, G.A. (1885) *Catalogue of the lizards in the British Museum (Natural History), Volume I*, 2nd edition. Trustees of the British Museum, Taylor and Francis, London, UK.
- BOULENGER, G.A. (1887) *Catalogue of the lizards in the British Museum (Natural History), Volume III*, 2nd edition. Trustees of the British Museum, Taylor and Francis, London, UK.
- BOULENGER, G.A. (1906) Report on the reptiles collected by the late L. Fea in West Africa. *Annali del Museo Civico di Storia Naturale di Genova*, 3, 196–216.
- BREHM, A., JESUS, J., PINHEIRO, M. & HARRIS, D.J. (2001) Relationships of scincid lizards *Mabuya* (Reptilia: Scincidae) from the Cape Verde Islands based on mitochondrial and nuclear DNA sequences. *Molecular Phylogenetics and Evolution*, 19, 311–316.
- BROWN, R.P., SUAREZ, N.M., SMITH, A. & PESTANO, J. (2001) Phylogeography of Cape Verde Islands skinks (*Mabuya*). *Molecular Ecology*, 10, 1593–1597.
- BRYGOO, É. (1985) Les types de Scincidés (Reptiles, Sauriens) du Muséum National d'Histoire Naturelle. Catalogue critique. *Bulletin du Muséum National d'Histoire Naturelle (serie 4)*, 7, 1–126.
- BRYGOO, É. (1990) Les types de Gekkonidés (Reptiles, Sauriens) du Muséum National d'Histoire Naturelle. Catalogue critique. *Bulletin du Muséum National d'Histoire Naturelle (serie 4)*, 12, 19–141.
- CARRANZA, S. & ARNOLD, E.N. (2003) Investigating the origin of transoceanic distributions: mtDNA shows *Mabuya* lizards (Reptilia, Scincidae) crossed the Atlantic twice. *Systematics and Biodiversity*, 1, 275–282.
- CARRANZA, S. & ARNOLD, E.N. (2006) Systematics, biogeography, and evolution of *Hemidactylus* geckos (Reptilia: Gekkonidae) elucidated using mitochondrial DNA sequences. *Molecular Phylogenetics and Evolution*, 38, 531–545.
- CARRANZA, S., ARNOLD, E.N., MATEO, J.A. & GENIEZ, P. (2002) Relationships and evolution of the North African geckos, *Gekkonina* and *Tarentola* (Reptilia: Gekkonidae), based on mitochondrial and nuclear DNA sequences. *Molecular Phylogenetics and Evolution*, 23, 244–256.
- CARRANZA, S., ARNOLD, E.N., MATEO, J.A. & LÓPEZ-JURADO, L.F. (2000) Long-distance colonization and radiation in gekkonid lizards, *Tarentola* (Reptilia: Gekkonidae), revealed by mitochondrial DNA sequences. *Proceedings of the Royal Society of London Series B*, 267, 637–649.
- CARRANZA, S., ARNOLD, E.N., MATEO, J.A. & LÓPEZ-JURADO, L.F. (2001) Parallel gigantism and complex colonization patterns in the

- Cape Verde scincid lizards *Mabuya* and *Macroscincus* (Reptilia: Scincidae) revealed by mitochondrial DNA sequences. *Proceedings of the Royal Society of London Series B*, 268, 1595–1603.
- CASE, T.J., BOLGER, D.T. & RICHMAN, A.D. (1992) Reptilian extinctions: the last ten thousand years. In *Conservation Biology: The Theory and Practice of Conservation, Preservation, and Management* (eds P.L. Fiedler & S.K. Jain), pp. 91–125. Chapman & Hall, New York, USA.
- CHADWICK, E. & SLATER, F. (2005) A population of skinks (*Mabuya* spp.) and the gecko *Hemidactylus bouvieri boavistensis* behind coastal dunes on Boa Vista, Cape Verde Islands. *Herpetological Bulletin*, 92, 14–18.
- CHEVALIER, A. (1935) Les îles du Cape Vert: géographie, agriculture, flore de l'archipel. *Revue de Botanique Appliquée et d'Agriculture Tropicale*, 15, 733–1090.
- CLARKE, T. (2006) *Field Guide to the Birds of the Atlantic Islands*. Christopher Helm, London, UK.
- COLE, N.C., JONES, C.G. & HARRIS, S. (2005) The need for enemy-free space: the impact of an invasive gecko on island endemics. *Biological Conservation*, 125, 467–474.
- DEKEYSER, P.L. & VILLIERS, A. (1951) Mission J. Cadenet aux Iles du Cap Vert. *Bulletin de L'Institut français d'Afrique noire*, 13, 1152–1158.
- DINIZ, A.C. & MATOS, G.C. (1986) Carta de Zonação Agro-Ecológica e da Vegetação de Cabo Verde I—Ilha de Santiago. *Garcia da Horta, Série de Botânica, Instituto de Investigação Científica Tropical*, 8, 39–82.
- DINIZ, A.C. & MATOS, G.C. (1987) Carta de Zonação Agro-Ecológica e da Vegetação de Cabo Verde II—Ilha do Fogo. *Garcia da Horta, Série de Botânica, Instituto de Investigação Científica Tropical*, 9, 35–69.
- DINIZ, A.C. & MATOS, G.C. (1988a) Carta de Zonação Agro-Ecológica e da Vegetação de Cabo Verde III—Ilha do Maio. *Garcia da Horta, Série de Botânica, Instituto de Investigação Científica Tropical*, 10, 19–48.
- DINIZ, A.C. & MATOS, G.C. (1988b) Carta de Zonação Agro-Ecológica e da Vegetação de Cabo Verde IV—Ilha da Boavista. *Garcia da Horta, Série de Botânica, Instituto de Investigação Científica Tropical*, 10, 49–72.
- DINIZ, A.C. & MATOS, G.C. (1993) Carta de Zonação Agro-Ecológica e da Vegetação de Cabo Verde V—Ilha do Sal. *Garcia da Horta, Série de Botânica, Instituto de Investigação Científica Tropical*, 11, 9–30.
- DINIZ, A.C. & MATOS, G.C. (1994) Carta de Zonação Agro-Ecológica e da Vegetação de Cabo Verde VI e VII—Ilha de S. Vicente—Ilha Sta. Luzia. *Garcia da Horta, Série de Botânica, Instituto de Investigação Científica Tropical*, 12, 69–100.
- DINIZ, A.C. & MATOS, G.C. (1999a) Carta de Zonação Agro-Ecológica e da Vegetação de Cabo Verde VIII—Ilha de S. Nicolau. *Garcia da Horta, Série de Botânica, Instituto de Investigação Científica Tropical*, 14, 1–54.
- DINIZ, A.C. & MATOS, G.C. (1999b) Carta de Zonação Agro-Ecológica e da Vegetação de Cabo Verde IX—Ilha Brava. *Garcia da Horta, Série de Botânica, Instituto de Investigação Científica Tropical*, 14, 55–82.
- DINIZ, A.C. & MATOS, G.C. (1999c) Carta de Zonação Agro-Ecológica e da Vegetação de Cabo Verde X—Ilha de Santo Antão. *Garcia da Horta, Série de Botânica, Instituto de Investigação Científica Tropical*, 14, 1–34.
- DUARTE, M.C. & ROMEIRAS, M.M. (2009) Cape Verde Islands. In *Encyclopedias of Islands* (eds R.G. Gillespie & D.A. Clague), pp. 143–148. University of California Press, Berkeley, USA.
- DUMÉRIL, A.M.C. & BIBRON, G. (1839) *Erpétologie générale ou Histoire naturelle complète des Reptiles. Tome V*. Librairie Encyclopédique de Roret, Paris, France.
- DUPRAT, H.I., FRIIS, J., HOLM, P.M., GRANDVUINET, T. & SØRENSEN, R.V. (2007) The volcanic and geochemical development of São Nicolau, Cape Verde Islands: constraints from field and ⁴⁰Ar/³⁹Ar evidence. *Journal of Volcanology and Geothermal Research*, 162, 1–19.
- FRANKHAM, R. (1997) Do island populations have less genetic variation than mainland populations? *Heredity*, 78, 311–327.
- FRAZEN, M. & GLAW, F. (2007) Type catalogue of reptiles in the Zoologische Staatssammlung München. *Spixiana*, 30, 201–276.
- GONZÁLEZ, M.E. & LÓPEZ-JURADO, L.F. (2004) Referencia de experto. Cambios taxonómicos y corológicos de reptiles y mamíferos. Justificación de sinonimias de vertebrados. In *Banco de Datos de Biodiversidad de Cabo Verde—Archivo Documental*. Unpublished Report. Atlántico Cabo Verde (PELCRIN V00008)—INTERREG IIIB.
- GRAY, J.E. (1845) *Catalogue of the Specimens of Lizards in the Collection of the British Museum*. Edward Newman Trustees of the British Museum, London, UK.
- GREER, A.E. (1976) On the evolution of the giant Cape Verde scincid lizard *Macroscincus coctei*. *Journal of Natural History*, 10, 691–712.
- GRUBER, H.J. & SCHLEICH, H.-H. (1982) *Hemidactylus bouvieri razoensis* nov. ssp. von den Kapverdischen Inseln (Reptilia: Sauria: Gekkonidae). *Spixiana*, 5, 303–310.
- HAZEVOET, C.J. (1995) *The Birds of the Cape Verde Islands. B.O.U. Check-list no. 13*. British Ornithologists' Union, Tring, UK.
- HIJMANS, R.J., CAMERON, S.E., PARRA, J.L., JONES, P.G. & JARVIS, A. (2005) Very high resolution interpolated climate surfaces for global land areas. *International Journal of Climatology*, 25, 1965–1978. [Http://www.worldclim.org](http://www.worldclim.org) [accessed 1 March 2010].
- IUCN (2010) *The Habitats Authority File and the Threats Type Authority File*. [Http://www.iucn.org/about/work/programmes/species/red_list/resources/technical_documents/authority_files/](http://www.iucn.org/about/work/programmes/species/red_list/resources/technical_documents/authority_files/) [accessed 10 January 2010].
- IUCN STANDARDS AND PETITIONS SUBCOMMITTEE (2010) *Guidelines for Using the IUCN Red List Categories and Criteria: Version 8.0*. IUCN, Gland, Switzerland. [Http://intranet.iucn.org/webfiles/doc/SSC/RedList/RedListGuidelines.pdf](http://intranet.iucn.org/webfiles/doc/SSC/RedList/RedListGuidelines.pdf) [accessed 10 January 2010].
- JESUS, J., BREHM, A. & HARRIS, D.J. (2002) Relationships of *Tarentola* (Reptilia: Gekkonidae) from the Cape Verde islands estimated from DNA sequence data. *Amphibia-Reptilia*, 22, 235–242.
- JESUS, J., BREHM, A. & HARRIS, D.J. (2005) Phylogenetic relationships of *Hemidactylus* geckos from the Gulf of Guinea islands: patterns of natural colonizations and anthropogenic introductions estimated from mitochondrial and nuclear DNA sequences. *Molecular Phylogenetics and Evolution*, 34, 480–485.
- JESUS, J., BREHM, A., PINHEIRO, M. & HARRIS, D.J. (2001) Relationships of *Hemidactylus* (Reptilia: Gekkonidae) from the Cape Verde Islands: what mitochondrial DNA data indicate. *Journal of Herpetology*, 35, 672–675.
- JÖGER, U. (1984a) Taxonomische revision der gattung *Tarentola* (Reptilia, Gekkonidae). *Bonner zoologische Beiträge*, 35, 129–174.
- JÖGER, U. (1984b) Die Radiation der gattung *Tarentola* in Makaronesien (Reptilia: Sauria: Gekkonidae). *Courier Forschungsinstitut Senckenberg*, 71, 91–111.
- JÖGER, U. (1993) On two collections of reptiles and amphibians from the Cape Verde Islands, with descriptions of three new taxa. *Courier Forschungsinstitut Senckenberg*, 159, 437–444.
- KIER, G., KREFT, H., LEE, T.M., JETZ, W., IBISCH, P.L., NOWICKI, C. et al. (2009) A global assessment of endemism and species richness across island and mainland regions. *Proceedings of the National Academy of Sciences of the USA*, 106, 9322–9327.
- KÖHLER, J. & GÜSTEN, R. (2007) Herpetological type specimens in the natural history collections of the museums in Darmstadt and Wiesbaden, Germany. *Spixiana*, 30, 275–288.

- KÖHLER, G., HERTZ, A., SUNYER, J. & MONTEIRO, A. (2007a) Geographic distribution. *Hemidactylus bouvieri*. *Herpetological Review*, 38, 483.
- KÖHLER, G., HERTZ, A., SUNYER, J., SEIPP, R. & MONTEIRO, A. (2007b) Herpetologische forschungen auf den Kapverden unter besonderer berücksichtigung des Kapverdischen Riesenskinks, *Macrosцинcus coctei*. *Elaphe*, 15, 75–79.
- LANGWORTHY, M. & FINAN, T.J. (1997) *Waiting for Rain—Agriculture and Ecological Imbalance in Cape Verde*. Lynne Rienner Publishers, Boulder, USA.
- LEYENS, T. & LOBIN, W. (eds) (1996) *Primeira Lista Vermelha de Cabo Verde*. Courier Forschungsinstitut Senckenber, Frankfurt, Germany.
- LÓPEZ-JURADO, L.F., MATEO, J.A. & FAZERES, A.I. (2005) Chordata. In *Lista Preliminar de Espécies Silvestres de Cabo Verde*. *Hongos, Plantas Y Animales Terrestres* (eds M. Arechavaleta, N. Zurita, M.C. Marrero & J.L. Martín), p. 101. Gobierno de Canarias, Consejería de Médio Ambiente, Canary Islands.
- LÓPEZ-JURADO, L.F., MATEO, J.A. & GARCÍA-MÁRQUEZ, M. (1998) La tortuga fósil de la isla de Sal (Archipiélago de Cabo Verde). *Revista Española de Herpetología*, 12, 111–114.
- LÓPEZ-JURADO, L.F., MATEO, J.A. & GENIEZ, P. (1999) Los Reptiles de La Isla de Boavista (Archipiélago de Cabo Verde). *Boletín de la Asociación Herpetológica Española*, 10, 10–13.
- LOVERIDGE, A. (1947) Revision of the African lizards of the family Gekkonidae. *Bulletin of the Museum of Comparative Zoology at Harvard College*, 98, 3–469.
- MAAP-DGA (MINISTÉRIO DO AMBIENTE AGRICULTURA E PISCAS—DIRECÇÃO GERAL DO AMBIENTE) (ed.) (2004) *Livro Branco sobre o Estado do Ambiente em Cabo Verde*. Praia, Santiago, Cape Verde.
- MATEO, J.A., GARCÍA-MÁRQUEZ, M., LÓPEZ-JURADO, L.F. & PETHER, J. (1997) Nuevas observaciones herpetológicas en las Islas Desertas (Archipelago de Cabo Verde). *Boletín de la Asociación Herpetológica Española*, 8, 8–11.
- MATEO, J.A., LÓPEZ-JURADO, L.F. & GARCÍA-MÁRQUEZ, M. (2005) Primeras evidencias de la supervivencia del Escinco Gigante de Cabo Verde *Macrosцинcus coctei* (Duméril & Bibron, 1839). *Boletín de la Asociación Herpetológica Española*, 15, 73–75.
- MATEO, J.A., LÓPEZ-JURADO, L.F. & GENIEZ, P. (2009) Historical distribution of Razo lark *Alauda razae* in the Cape Verde archipelago. *Alauda*, 77, 309–312.
- MERTENS, R. (1955) Die Eidechsen des Kapverden. *Societas Scientiarum Fennica. Commentationes Biologicae*, 15, 1–17.
- MIRALLES, A., VASCONCELOS, R., HARRIS, D.J., PERERA, A. & CARRANZA, S. (2010) An integrative taxonomic revision of the Cape Verdean skinks (Squamata, Scincidae). *Zoologica Scripta*, 40, 16–44.
- NAUROIS, R. (1994) *Les Oiseaux de L'archipel du Cap Vert. As aves do Arquipélago de Cabo Verde*. Instituto de Investigação Científica Tropical, Lisboa, Portugal.
- OLIVEIRA, M.E. (coord.), BRITO, J.C., DELINGUER, T., FERRAND DE ALMEIDA, N., LOUREIRO, A., MARTINS, H.R. et al. (2005) Répteis. In *Livro Vermelho dos Vertebrados de Portugal* (eds J. Almeida, P.R. Almada, T. Dellinger, N. Ferrand de Almeida, M.E. Oliveira, J.M. Palmeirim et al.), pp. 125–144. Instituto de Conservação da Natureza, Lisboa, Portugal.
- ORLANDI, S. (1894) Note anatomiche sul *Macrosцинcus coctei* (Barb. du Boc.). *Atti della Società Linguistica di Scienze Naturali e Geografiche, Genova*, 5, 175–204.
- O'SHAUGHNESSY, A.W.E. (1874) Descriptions of new species of Scincidae in the collection of the British Museum. *The Annals and Magazine of the Natural History*, 4, 298–301.
- PAIVA, J. (ed.) (1995) *Flora de Cabo Verde. Plantas Vasculares*. Instituto de Investigação Científica Tropical, and Instituto Nacional de Investigação e Desenvolvimento Agrário, Lisboa, Portugal and Praia, Cape Verde.
- PERACCA, M.G. (1891) Sulla oviparità del *Macrosцинcus coctaei* Dum. c Bibr.. *Bollettino dei Musei di Zoologia ed Anatomia comparata della R. Università di Torino*, 6, 1–5.
- PINHEIRO, M. (1990) *Mabuya fogoensis* O' Shaughnessy (Sauria, Scincidae) e *Mabuya stangeri* (Gray) de algumas ilhas do arquipélago de Cabo Verde. *Garcia de Horta, Série Zoológica*, 15, 49–56.
- PLEGUEZUELOS, J.M., BRITO, J.C., FAHD, S., FERICHE, M., MATEO, J. A., MORENO-RUEDA, G. et al. (2010) Setting conservation priorities for the Moroccan herpetofauna: the utility of regional red listing. *Oryx*, 44, 501–508.
- PLEGUEZUELOS, J.M., MÁRQUEZ, R. & LIZANA, M. (2002) *Atlas y libro rojo de los anfibios y reptiles de España*. Dirección General de Conservación de la Naturaleza, Asociación Herpetologica Española, Madrid, Spain.
- PULLIN, A.S. (2002) *Conservation Biology*. Cambridge University Press, Cambridge, UK.
- SCHLEICH, H.-H. (1980) Der kapverdische Riesengecko, *Tarentola delalandii gigas* (Bocage, 1896). *Spixiana*, 3, 147–155.
- SCHLEICH, H.-H. (1982a) Letzte nachforschungen zum Kapverdischen Riesenskinks, *Macrosцинcus coctei* (Duméril & Bibron 1839) (Reptilia: Sauria: Scincidae). *Salamandra*, 18, 78–85.
- SCHLEICH, H.-H. (1982b) Vorläufige mitteilung zur herpetofauna der Kapverden. *Courier Forschungsinstitut Senckenberg*, 52, 245–248.
- SCHLEICH, H.-H. (1984) Die geckos der gattung *Tarentola* der Kapverden (Reptilia: Sauria: Gekkonidae). *Courier Forschungsinstitut Senckenberg*, 71, 95–106.
- SCHLEICH, H.-H. (1987) Herpetofauna Caboverdiana. *Spixiana*, 12, 1–75.
- SCHLEICH, H.-H. (1996) *Lista Vermelha para os Répteis* (Reptilia). In *Primeira Lista Vermelha de Cabo Verde* (eds T. Leyens & W. Lobin), pp. 122–125. Courier Forschungsinstitut Senckenberg, 193, Frankfurt, Germany.
- SCHLEICH, H.-H. & WUTKE, M. (1983) Die Kapverdische eilande Santa Luzia, Branco und Razo – ein reisebericht. *Natur und Museum* 113, 33–45.
- SERPA-PINTO (1896) *Carta de Serpa Pinto a Bocage de 6 Fevereiro de 1896*. Arquivo Histórico de Correspondência Nacional do Museu Bocage CN/P-23, Lisboa, Portugal.
- TORRES, P.C., SILVA, L.C., SERRALHEIRO, A., TASSINARI, C. & MUNHÁ, J. (2002) Enquadramento geocronológico pelo método K/Ar das principais sequências vulcano-estratigráficas da ilha do Sal—Cabo Verde. *Garcia de Orta, Série Geológica*, 18, 9–13.
- VAILLANT, M.L. (1882) Sur les *Macrosцинcus coctei*, D., B., récemment arrivés à la ménagerie du Muséum d'Histoire Naturelle. *Comptes Rendus hebdomadaires des Séances de L'Académie des Sciences*, 94, 811–812.
- VASCONCELOS, R., BRITO, J.C., CARVALHO, S., CARRANZA, S. & HARRIS, D.J. (2012a) Identifying priority areas for island endemics using genetic versus specific diversity—the case of the terrestrial reptiles of the Cape Verde Islands. *Biological Conservation*, 153, 276–286.
- VASCONCELOS, R., CARRANZA, S. & HARRIS, D.J. (2010) Insight into an island radiation: the *Tarentola* geckos of the Cape Verde archipelago. *Journal of Biogeography*, 37, 1047–1060.
- VASCONCELOS, R., PERERA, A., GENIEZ, P., CARRANZA, S. & HARRIS, D.J. (2012b) An integrative taxonomic revision of the *Tarentola* geckos (Squamata, Phyllodactylidae) of the Cape

Verde Islands. *Zoological Journal of the Linnean Society*, 164, 328–360.

VASCONCELOS, R., ROCHA, S., BRITO, J.C., HARRIS, D.J. & CARRANZA, S. (2009) First report of introduced African rainbow lizard *Agama agama* (Linnaeus, 1758) in the Cape Verde Islands. *Herpetozoa*, 21, 183–186.

Appendices 1–9

The appendices for this article are available online at <http://journals.cambridge.org>

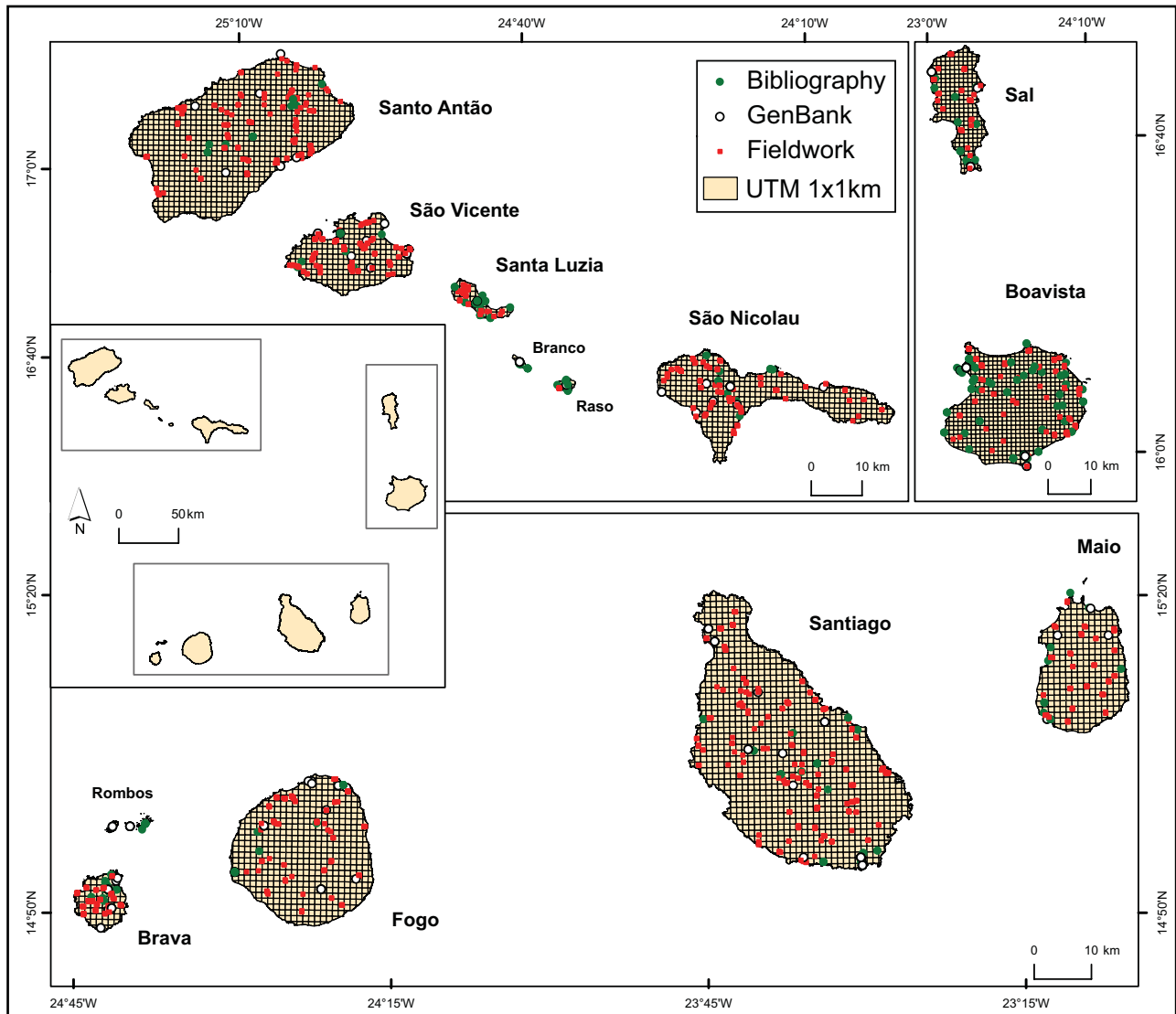
Biographical sketches

RAQUEL VASCONCELOS studied the herpetofauna of the Cape Verde Islands, combining geographical information systems and molecular tools, and is now studying the reptiles of the Socotra archipelago. JOSÉ CARLOS BRITO is interested in geographical patterns of biodiversity and is the principal investigator of the BIODESERTS (Biodiversity of Deserts and Arid Regions) group. SALVADOR CARRANZA has a long-standing interest in the herpetofauna of the Mediterranean Basin, Old World deserts and oceanic islands. D. JAMES HARRIS is interested in phylogenetics, especially of reptiles, and leads several projects on the genetic and morphological variation of reptiles of the Mediterranean Basin and other areas.

Review of the distribution and conservation status of the terrestrial reptiles of the Cape Verde Islands

RAQUEL VASCONCELOS, JOSÉ CARLOS BRITO, SALVADOR CARRANZA and
D. JAMES HARRIS

APPENDIX 1 Distribution of stations sampled during fieldwork and localities for which data were obtained from *GenBank* or the literature. The UTM sampling grid is in 1x1 km² cells.



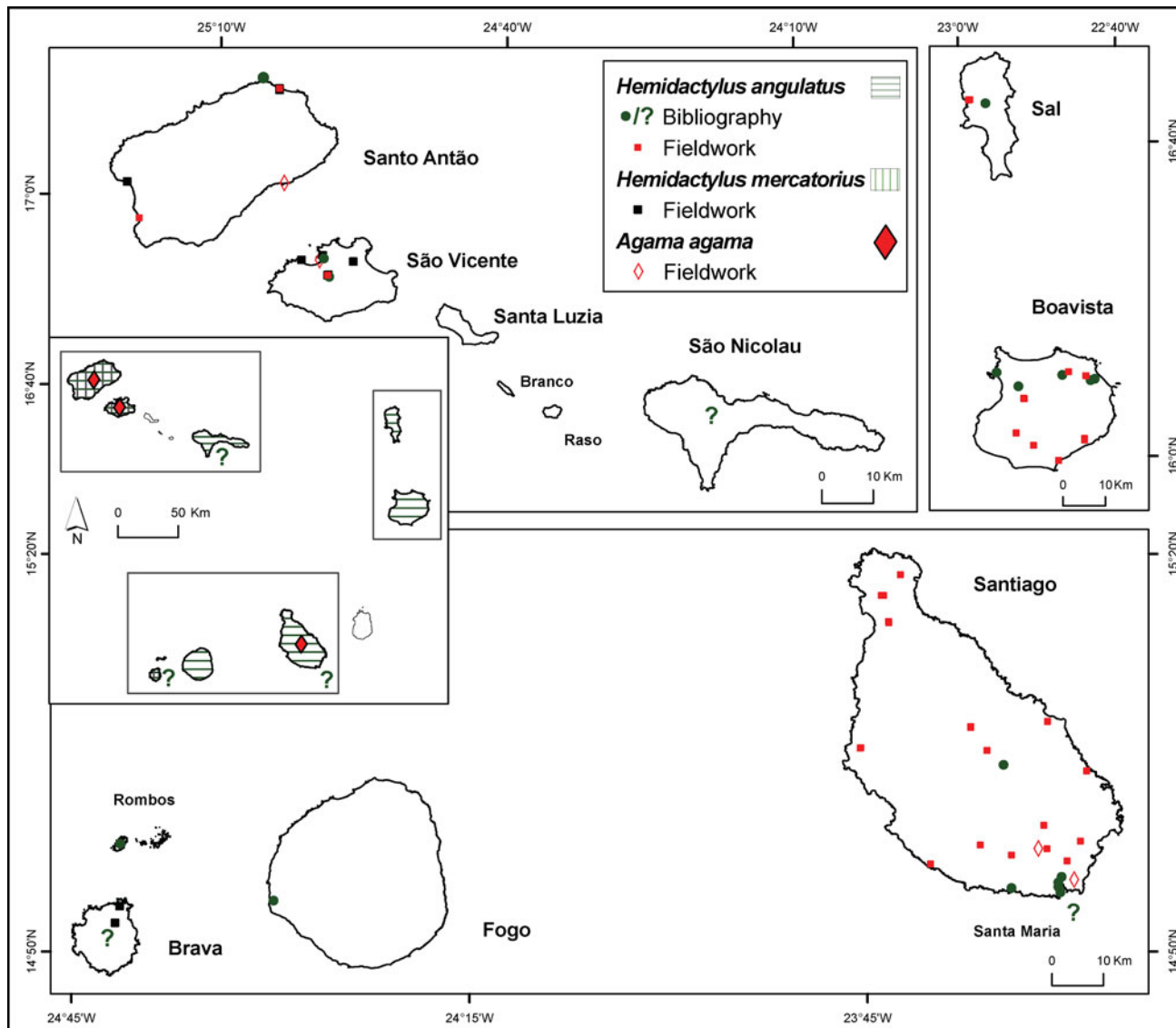
APPENDIX 2 Types and total number of habitats present (●) on each island or islet in the Cape Verde archipelago (Fig. 1; adapted from Diniz & Matos, 1986, 1987, 1988 a,b, 1993, 1994, 1999 a,b,c).

Habitat type	São Vicente	Santa Luzia	Raso	Branco	Santo Antão	São Nicolau	Brava	Rombos	Maio	Fogo	Santiago	Santa Maria	Sal	Boavista
Beaches	●	●			●	●			●	●	●		●	●
Dunes & sandy areas	●	●							●				●	●
Recent lavas										●				
Very arid flat areas	●	●	●		●	●			●	●			●	●
Very arid & hilly areas	●	●	●	●	●	●							●	●
Very arid & mountain areas	●	●	●	●		●								
Arid & flat areas						●	●	●		●	●	●		
Arid & hilly areas	●				●	●	●	●	●		●			
Arid & mountain areas	●				●						●			
Semi-arid & flat areas						●	●			●	●			
Semi-arid & hilly areas					●	●	●			●	●			
Semi-arid & mountain areas	●				●	●					●			
Sub-humid & flat areas										●				
Sub-humid & hilly areas					●		●			●	●			
Sub-humid & mountain areas	●				●	●	●			●	●			
Humid & mountain areas					●	●	●			●	●			
Water lines & floodplain areas	●	●			●	●	●		●		●		●	●
Coastal-salty lowland areas	●								●				●	●
Cliffs										●	●			
Urban areas	●				●	●	●		●	●	●		●	●
<i>Total number</i>	12	6	3	2	12	13	9	2	7	12	13	1	7	7

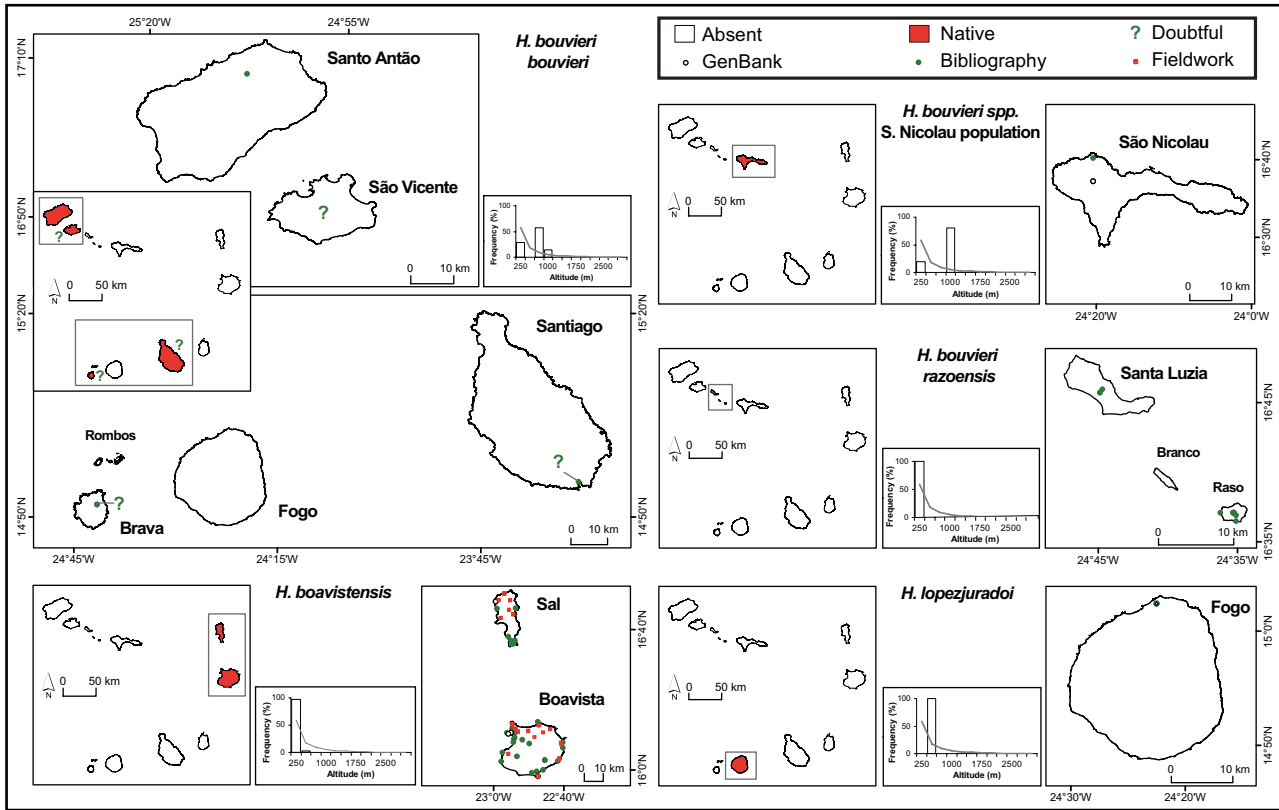
APPENDIX 3 Major threats affecting the reptiles of Cape Verde (Fig. 1), assessed using the categorization of threats in IUCN Standards and Petitions Subcommittee (2010), where further details of the subcategories of each threat can be found.

Taxa	0. None	1. Habitat loss	2. Invasive alien species	3. Harvesting	7. Natural disasters	8. Changes in native species dynamics	9. Intrinsic factors	10. Human disturbance	11/12. Other/Unknown
<i>H. bouvieri bouvieri</i>		1.1.1.2, 1.5	2.1, 2.2		7.1		9.5, 9.9		12
<i>H. b. spp.</i> , São Nicolau		1.1.1.2, 1.5	2.1, 2.2		7.1		9.5, 9.9		12
<i>H. b. razoensis</i>		1.5	2.1, 2.2		7.1		9.5, 9.9		12
<i>H. boavistensis</i>		1.4, 1.5	2.1		7.1				
<i>H. lopezjuradoi</i>		1.1.1.2, 1.5	2.1, 2.2		7.1, 7.5		9.5, 9.9		12
<i>T. boavistensis</i>					7.1		9.5		
<i>T. bocagei</i>							9.9		
<i>T. fogoensis</i>					7.5				
<i>T. darwini</i>	0								
<i>T. substituta</i>					7.1				
<i>T. raziana</i>		1.5	2.1, 2.2		7.1				
<i>T. caboverdiana</i>	0								
<i>T. nicolauensis</i>	0								
<i>T. gigas gigas</i>					7.1	8.3	9.9	10.6	
<i>T. g. brancoensis</i>					7.1	8.3	9.9	10.6	
<i>T. rudis</i>						8.4			
<i>T. protogigas protogigas</i>					7.5		9.5, 9.9		12
<i>T. p. hartogi</i>					7.1, 7.7				
<i>T. maioensis</i>					7.1				
<i>C. vaillanti vaillanti</i>							9.5, 9.7, 9.9		
<i>C. v. xanthotis</i>					7.5		9.5, 9.7, 9.9		
<i>C. delalandii</i>					7.1				
<i>C. nicolauensis</i>					7.1				
<i>C. fogoensis</i>			2.5						
<i>C. stangeri</i>			2.2		7.1				
<i>C. coctei</i>		1.5	2.2	3.1.1, 3.2.1, 3.4.1, 3.5.3	7.1		9.2, 9.7, 9.9		
<i>C. spinalis salensis</i>					7.1		9.9		
<i>C. s. santiagoensis</i>	0								
<i>C. s. spinalis</i>					7.5				
<i>C. s. maioensis</i>					7.1				
<i>C. s. boavistensis</i>					7.1				
Total	2	7	9	1	23	3	13	2	5

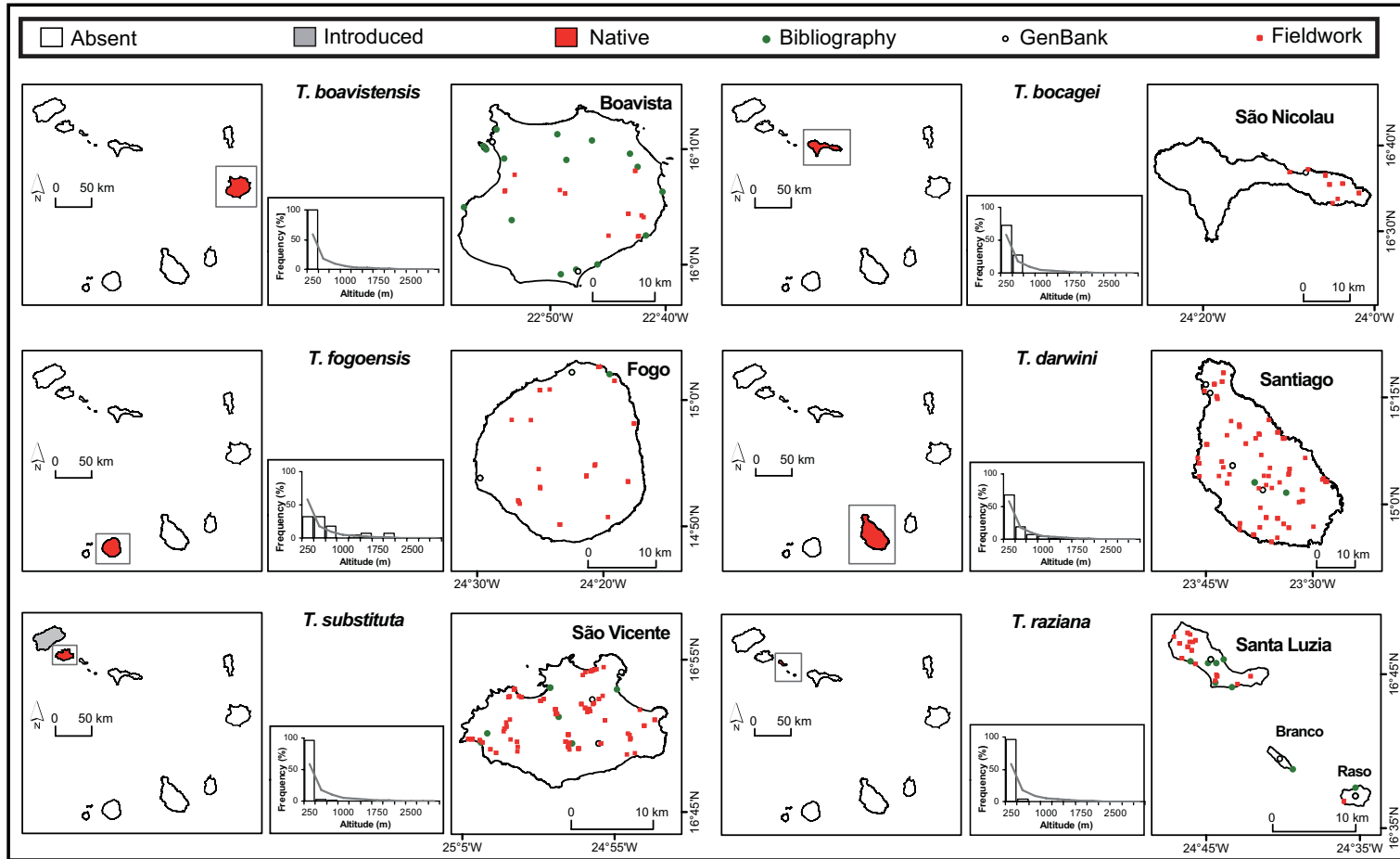
APPENDIX 4 Distribution of introduced reptiles in the Cape Verde Islands. Islands of occurrence of each taxon are highlighted with taxon-specific shading. Doubtful records are indicated by question marks (a single question mark within an island indicates the locality of occurrence is unknown).



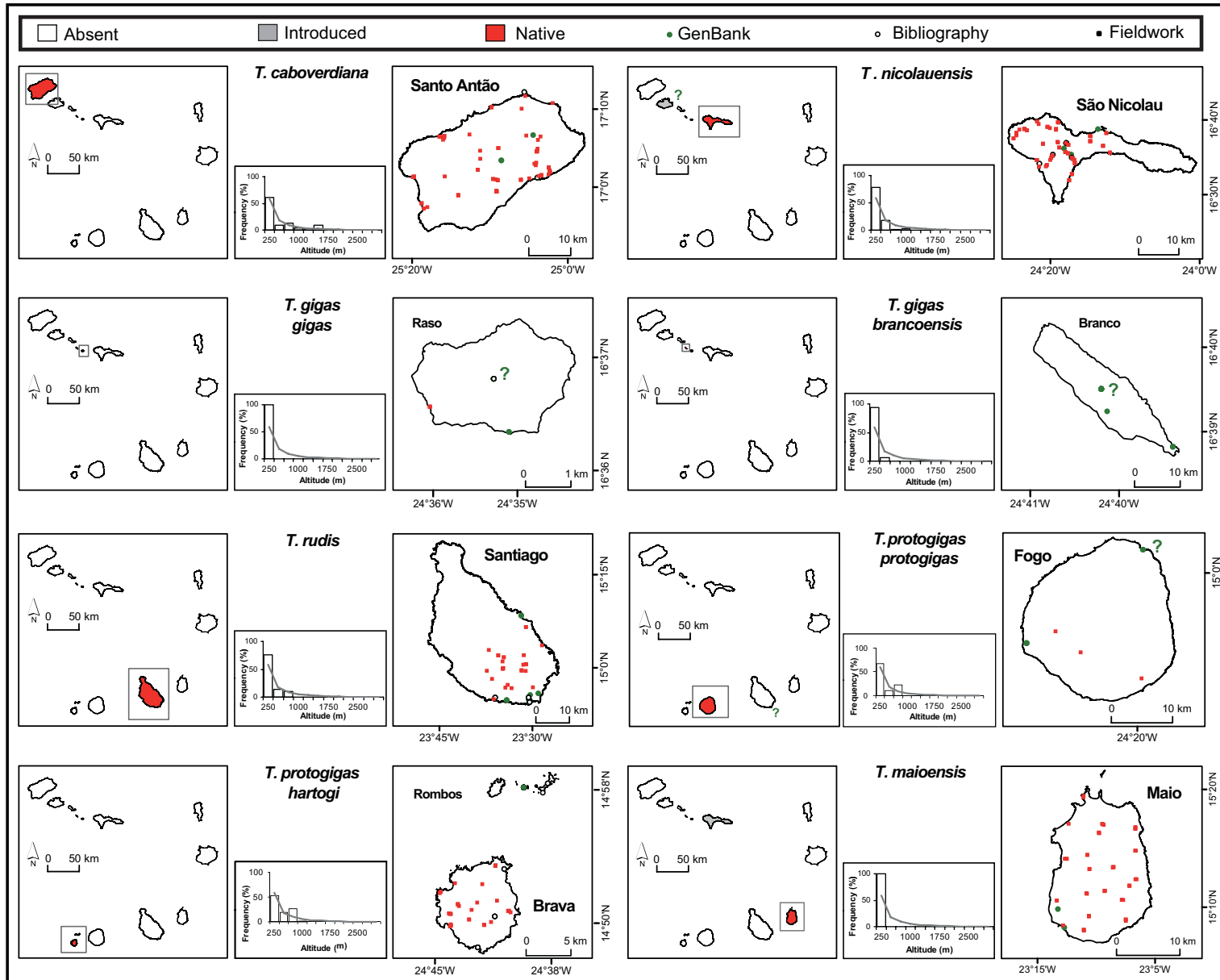
APPENDIX 5 Distribution of *Hemidactylus* reptiles in the Cape Verde Islands. Islands of occurrence of each taxon are highlighted in red. Doubtful records are indicated by question marks (a single question mark within an island indicates the locality of occurrence is unknown). The histograms represent the altitudinal distribution of each taxon.



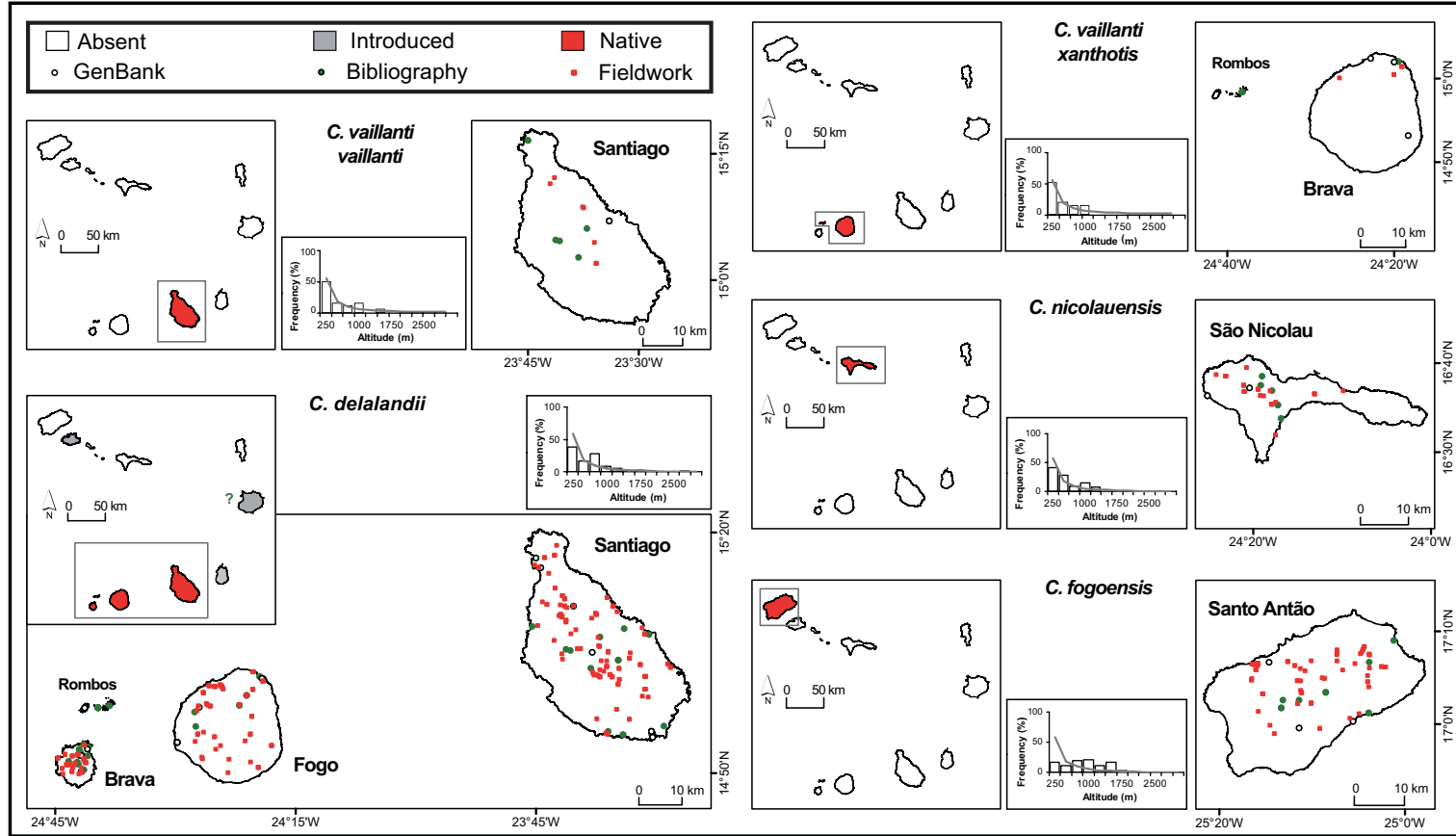
APPENDIX 6 Distribution of *Tarentola* reptiles in the Cape Verde Islands. Islands of occurrence of each taxon are highlighted in light grey if they result from an introduction and in red if native. Doubtful records are indicated by question marks (a single question mark within an island indicates the locality of occurrence is unknown). The histograms represent the altitudinal distribution of each taxon.



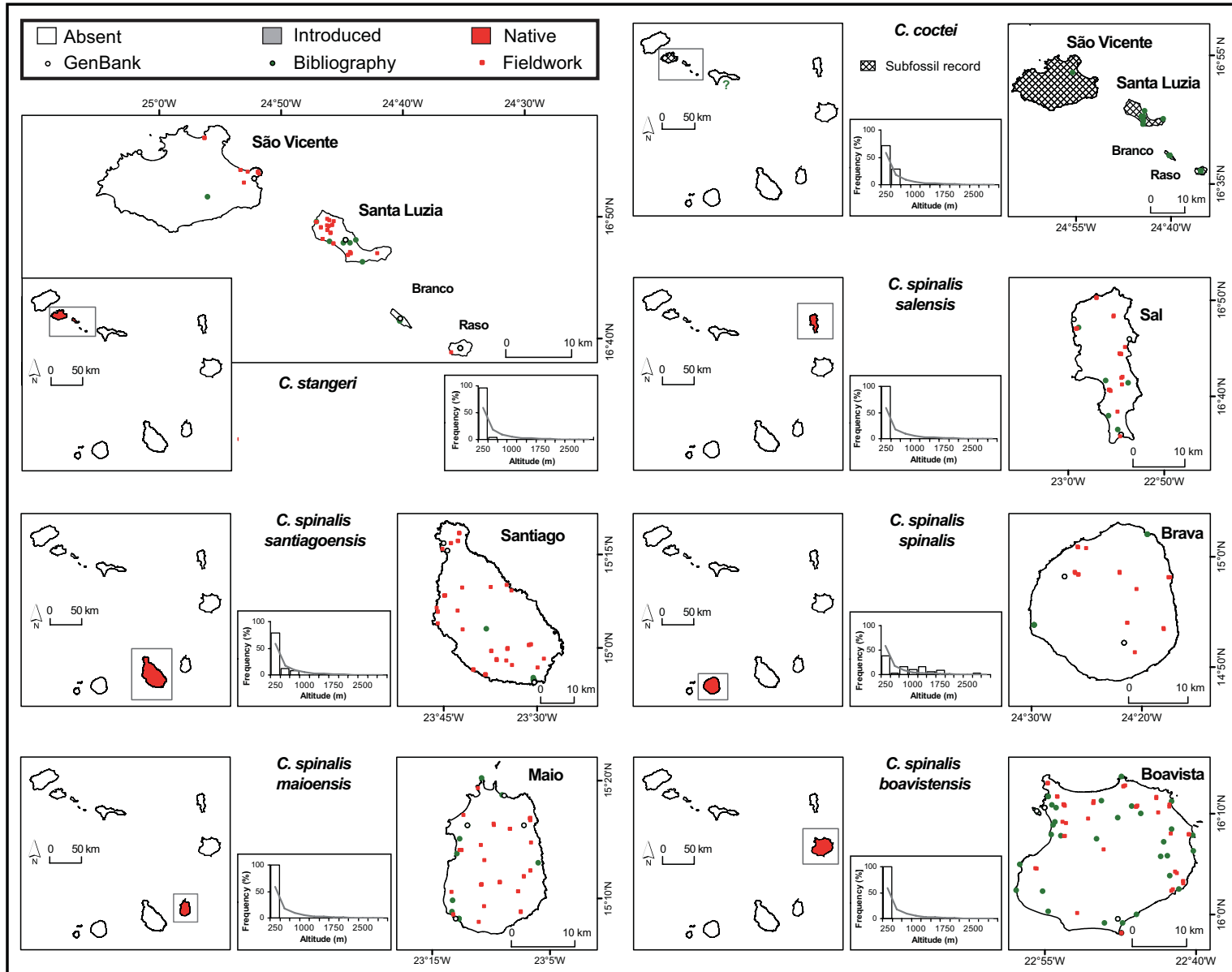
APPENDIX 6 (Continued)



APPENDIX 7 Distribution of *Chioninia* reptiles in the Cape Verde Islands. Islands of occurrence of each taxon are highlighted in light grey if they result from an introduction and in red if native. Doubtful records are indicated by question marks (a single question mark within an island indicates the locality of occurrence is unknown). The histograms represent the altitudinal distribution of each taxon.



APPENDIX 7 (Continued)



APPENDIX 8 Uncertain occurrences of endemic and exotic taxa in the Cape Verde Islands.

Exotic taxa

Serpa Pinto (1896) mentioned a ‘tortoise’ on São Vicente. Nevertheless, Bocage (1896) doubted the presence of a terrestrial chelonian in the archipelago. Given that the common name in Creole (cágado) is applied to the marine turtle *Eretmochelys imbricata*, common in the archipelago, it is probable that a misunderstanding of common names occurred. The old references for *Pelusios* on Santa Maria islet (Angel, 1935, 1937) were never confirmed.

An unknown species of *Lygodactylus* gecko was observed on Santiago and mentioned on the National Red List (Schleich, 1996) as Data Deficient but has not been recorded since. The presence of *H. angulatus* on Maio is referred to by Schleich (1982b), citing Angel (1935, 1937), but no such reference exists in the original papers. Schleich (1987) cites *H. angulatus* on Santa Maria islet but with uncertainty. The presence of *H. angulatus* on Brava, at an unknown location, was referred to first by Mertens (1955) and cited later by others (Naurois, 1994; Schleich, 1982b, 1987, 1996). On São Nicolau specimens were collected by Jesus et al. (2001) at an unknown location. However, no other individuals have been observed on either island since then, including during our surveys. Later authors doubted the occurrence of *H. angulatus* on São Nicolau (González & López-Jurado, 2004) and excluded it from the preliminary list of species of Cape Verde (López-Jurado et al., 2005). Hence, the present occurrence of the taxon on those two islands is doubtful.

Regarding the *A. agama* specimen seen on São Antão, after intensive sampling throughout the island at 71 sites with at least two observers, no other agamids were found. However, it is possible that some individuals remain in the wild (for details see Vasconcelos et al., 2009).

There is an old reference to the snake *Psammodromus sibilans* on Sal by Deykeyser & Villiers (1951) that, according to the author was an accidental introduction from Guinea-Bissau that has never been recorded again.

Endemic taxa

Chevalier, in the 1930s, referred to fossil records of *Testudo calcarata* in Pedra Lume crater, on Sal (in López-Jurado, 1998). Later on, it was described as *Geochelone atlantica* López-Jurado 1998. Also Bebiano (1932) referred subfossil eggs from Maio to this terrestrial turtle but their identification has been questioned (Hazevoet, 1995). Nevertheless, this species probably went extinct after the end of the humid phase of the Quaternary, as ecological conditions no longer could sustain its presence, as

confirmed by its absence from more recent historical records (López-Jurado, 1998).

The present occurrence of *Hemidactylus bouvieri* on Santiago and Brava is doubtful, since the most recent records are 50 and 110 years ago, respectively (Mertens, 1954; Andreone, 2000). It is unknown if these records are of this species or another as no molecular studies could be performed. For the accepted current distribution for the *Hemidactylus* species see Arnold et al. (2008).

The occurrence of *Tarentola* on Sal (Angel, 1935, 1937) is uncertain. Its possible presence is based on only one specimen sent by Professor Chevalier in 1934 that might have been incorrectly assigned to Sal. All the following authors refer to this record based on Angel (Mertens, 1955; Schleich, 1982b). Sal is a relatively small and almost flat island where the species’ presence should be relatively easy to detect but subsequent expeditions failed to record it, including ours. For this reason Carranza et al. (2000) consider that Sal apparently has no *Tarentola* at the moment. Therefore we considered that occurrence to be doubtful.

The presence of *T. substituta* on Santa Luzia and Branco islet is mentioned by López-Jurado et al. (2005). This was the first record for the species on those islands and it is strange that there was no reference to this fact. Even more so considering that references for that study were based on earlier literature. Possibly it is a typographical error, as it is missing the reference for the same islands for *T. raziana* in the table where this doubtful record occurs. Thus, the presence of *T. substituta* on those islands is considered in this study as erroneous.

There is a reference for the occurrence of *T. nicolauensis* in Mindelo, São Vicente Island (Jesus et al., 2002) that could be interpreted as a recent introduction because of high genetic similarity to the samples from São Nicolau Island. However, its presence has been doubted (González & López-Jurado, 2004) and the record excluded from the preliminary list of species of Cape Verde (López-Jurado et al., 2005). Unless its presence is confirmed we consider it doubtful.

The possible presence of *T. darwini* on Sal Island (Joger, 1984a) was criticised by Schleich (1987) who stated that it was speculative, and mentioned the poorly preserved state of the specimen and that the identification was based only on the high number of dorsal tubercles. Later, in 1993, Joger assumed its presence on São Nicolau and not on Sal and thus we do not consider the occurrence of *T. darwini* on the latter island valid.

Some subfossil bones of an undetermined subspecies of *T. gigas* were recently found on Santa Luzia and São Vicente (Mateo et al., 2009) but without genetic confirmation it is difficult to assign them to subspecies. Therefore, we consider that the species had a wider range in the past, although this was not represented on either of the current distribution maps of the subspecies.

A specimen of *T. protogigas* (Museo Civico “G. Doria” di storia Naturale de Genova 28248) is recorded to have been found in Igreja (same as Mosteiros) on the northern part of Fogo in 1899 (Andreone, 2000) based on data collected by Fea. However, the much more abundant *T. fogoensis*, previously referred to *T. darwini* (Vasconcelos et al., 2012b) and also present on the island, was not described at the time. In this way, without genetic confirmation, this unique northern record is doubtful as it could represent *T. fogoensis*. Also, the fact that Joger (1984a) used this same specimen to describe the new subspecies of *T. ‘rudis’ protogigas* but stating its origin as São Filipe, Fogo Island, indicates that an error occurred in the capture locality. ‘*T. rudis* cf. *protogigas*’ was also reported to occur on Santa Maria islet by Schleich (1987). However, no genetic analysis was performed and no vouchers were collected. It is possible that these animals could be *T. rudis* with some morphological variation from those from Santiago. The reference by the same author to the occurrence of *T. rudis* on Fogo (Schleich, 1984) is explained by the fact that when Boulenger (1906) described *T. rudis* (at the time *T. delalandii* var. *rudis*) he recognised Santiago and Fogo as its terra typica. Knowing that *T. ‘rudis’ protogigas* Joger, 1984 had not yet been described, this confusion is resolved. That is why the same specimen identified as *T. rudis* from Fogo in Schleich (1984) was used in the *T. protogigas* section in Schleich (1987). However, the error was later propagated (Schleich, 1987), probably due to a typographical error as the author does not refer to its occurrence on Fogo in the article, either in the table or in the subspecies description, but only in the ‘Island by Island’ section. In a later publication (Schleich, 1996) the occurrence of *T. rudis* on Fogo or *T. p. protogigas* on Santa Maria was not mentioned. Thus, the references until 1984 for *T. rudis* on Fogo were interpreted as referring to *T. p. protogigas*. This interpretation is also based on our intensive surveys and on the fact that after that date no other author referred to the occurrence of both taxa on the same island and this is supported by others (González & López-Jurado, 2004). For analogous reasons, all references to *Tarentola* on Brava and Maio until 1984 were referred to *T. p. hartogi* and *T. maioensis* Schleich, 1984, respectively, the only *Tarentola* proven to occur respectively on each of the islands.

T. gigas referred by Jesus et al. (2001) to occur on São Nicolau Island is actually *T. maioensis*, probably introduced on this island (Vasconcelos et al., 2010). Regarding *T. protogigas hartogi* (sensu Joger, 1993), it is genetically nearly identical to *T. protogigas* from Brava (Carranza et al., 2000). Moreover, differences in morphology are questionable as Joger’s (1993) study did not present statistical support, being based on only five and nine specimens of each subspecies. Thus, in this study, *T. p. hartogi* was considered to occur on Brava and Rombos, following Vasconcelos et al. (2012b).

The past presence of *C. coctei* on other islands apart from the Desertas group is defended by some authors as possible on São Nicolau because of Pleistocene sea level falls and based on reports by fishermen (Greer, 1976; Schleich, 1982a). Also, on São Vicente, a fisherman (Schleich, 1982a), subfossil records (Mateo et al., 2005, 2009) and old museum specimens (Andreone, 2000) might indicate its presence, even though the localities of specimens can be considered doubtful (see also Miralles et al., 2010). The possible current presence on Santa Luzia Island is supported by the finding of an alleged mandible of a juvenile of this species in the faecal pellets of a cat (Mateo et al., 2005).

The presence of a subfossil record from Boavista and Maio, apparently conspecific with *C. vaillanti* (in Carranza et al., 2001), might indicate a larger species range in the past, although without genetic data or a detailed study of the subfossil material it is not possible to assign them to any subspecies. Considering that these fossils were much larger than the individuals from Fogo and Santiago, reaching 240 mm from snout to vent, it is possible that this would be a different and extinct form. The presence of *C. vaillanti* and *T. p. hartogi* on Brava Island, noted by Brehm et al. (2001) and López-Jurado et al. (2005), respectively, was interpreted as referring to the Rombos Islets, which lie north of this island, as both taxa were considered to be found exclusively on Rombos Islets before the taxonomical revision of Vasconcelos et al. (2012b). Moreover, López-Jurado et al. (2005) mentions in his introductory text the assignment of the presence records on islets to the island nearby. This study confirmed the introduction of *C. delalandii* on Maio, first referred to by Carranza et al. (2001) and López-Jurado et al. (2005) and refers its first occurrence on S. Vicente, Mindelo. This species is also recorded from São Nicolau by Fea in 1899 (Andreone, 2000) and Bocage (1902) but this is probably a error perpetuated from mislabelling (Andreone, 2000). The introduction of this species on Boavista, in Vila de Sal Rei (Schleich, 1987), occurred in the 1970s but its current presence is uncertain as some authors claim it is now extinct (López-Jurado et al., 1999) or has not been found after intensive survey (Brown et al., 2001). Others have referred to its presence after the 1970s (Chadwick & Slater, 2005), although the photograph of the individual raises doubts. The current presence of this species on Boavista, also not confirmed during our surveys, is hence considered doubtful.

Chioninia geisthardtii (Joger, 1993) and *C. fogoensis fogoensis* (O’ Shaughnessy, 1874) were not considered valid taxa, following some authors (Carranza et al., 2001; González & López-Jurado, 2004; Naurois, 1994), and both are presently considered as synonyms of *C. fogoensis* from Santo Antão (Miralles et al., 2010). The record of *C. fogoensis* on São Vicente is also doubtful (Miralles et al., 2010).

Chioninia spinalis spinalis is referred to São Nicolau by Fea in 1899 but it is again probably an error originating from

a mislabelling (Andreone, 2000). Its presence on Sal is also mentioned by Angel (1935, 1937) even though he is the author responsible for the description of the new taxa *C. salensis* (Angel, 1935), now *C. spinalis salensis* following Miralles et al. (2010). This can be explained by the fact that *C. spinalis* was described by Boulenger (1905) as being present on Fogo and Sal. When Angel found differences in the few specimens analysed from Sal, he assumed the existence of the two taxa (*C. spinalis* and *C. salensis*) on the island. Only later, Mertens (1955) divided them into *C. stangeri spinalis* and *C. stangeri salensis*, which was confirmed by Schleich (1987) and by Joger (1993), who changed the taxonomy to *C. spinalis spinalis* and *C. spinalis salensis*, respectively. For this same reason, Angel (1937) referred to the presence of *C. stangeri* on Boavista as some authors referred to *C. spinalis* as *C. stangeri*, omitting the subspecific name, for example Bocage (1902), because the description of *C. spinalis* occurred only in 1906 by Boulenger. The reference for *C. stangeri* on São Nicolau (Bocage, 1902) is again an old error (González & López-Jurado, 2004), repeated in later citations. However, Pinheiro (1990) indicated it was recently introduced on this island and on Santiago, but there is no confirmation by any of the further surveys, including ours. Reference to this species on Brava and Sal is also made by Schleich (1982b) based on old references. Later, the same author considered those records and the presence of this taxon on Boavista as doubtful (Schleich, 1996). In this way, the presence of *C. stangeri* in these three islands is considered as probably erroneous. The hypothesis that they could be referring to *C. spinalis* in the case of Sal and Boavista islands, as mentioned above, is more plausible.

APPENDIX 9 Supplementary data on the distribution of native taxa

Several threatened Cape Verde taxa have restricted ranges, particular habitat associations or a very low number of records. For example, there are few presences of *H. bouvieri* on São Vicente, Santo Antão, São Nicolau, Santiago and possibly Brava, and of *H. lopezjuradoi*, known only from one site in the north of Fogo Island (Arnold et al., 2008). Rarity could be related to low population sizes and habitat specialization. Observations of endemic *Hemidactylus* were restricted to relatively humid places such as mountain tops and humid deep valleys (Arnold et al., 2008; Köhler et al., 2007a,b). Some individuals were found at 600–700 m, on Santo Antão on mountain tops, and on São Nicolau and Santa Luzia under bushes of the endemic *Euphorbia tuckeyana* (Arnold et al., 2008; R. Vasconcelos pers. obs.). Other specimens on São Nicolau and Fogo were found at 250–300 m under stones in humid deep valleys, under large rocks near water (Köhler et al., 2007b) and under stones with lots of vegetation (Arnold et al., 2008).

H. b. razoensis is also uncommon, occurring on Raso islet (Arnold et al., 2008) on dry inland streams with high vegetation density, or inside cavities in volcanic rock and holes made by roots and never on rocks or on the ground (Gruber & Schleich, 1982), and on Santa Luzia in mountain areas. Only five individuals of this subspecies were collected by Gruber & Schleich (1982), further four by Mateo et al. (1997) and one more was found by R. Vasconcelos and J. Oliveira in 2012. All these *Hemidactylus* are hence Critically Endangered.

Although not with a restricted range, the same sort of habitat associations are seen for other threatened taxa. The threatened *T. boavistensis* seems to avoid the dune areas that cross from north to south on western Boavista Island and is rare on the hyperarid flat areas on the south and northern coasts (López-Jurado et al., 1999), and the threatened *T. raziana* occurs only in the small and very arid Desertas group. Also threatened, *T. rudis* was only detected on the southern part of Santiago Island and on Santa Maria Islet (Schleich, 1987; Vasconcelos et al., 2012b), preferentially on rocky barren areas and dry woody shrubland (R. Vasconcelos, pers. obs.). Furthermore, it was confirmed that the Endangered *C. stangeri* mainly occurs, apart from Desertas, on eastern São Vicente and is absent between São Pedro and Mindelo (Schleich, 1987).

Most restricted range and threatened taxa occurred only on one island, such as *T. p. protogigas* with only four recent records (after 1980) on the southern part of Fogo Island (but see Appendix 8). Although more common, *T. bocagei* is also restricted to eastern São Nicolau Island. Individuals were found under rocks on rocky barren plain and arid areas and were less abundant in more humid or high areas. Concerning the skinks, the three extant taxa with restricted range are uncommon: *C. v. vaillanti* and *C. v. xanthotis* are restricted to inland Santiago, to the northern side of Fogo Island and Cima Islet, respectively, mainly on remains of agricultural stone walls and other rock walls with vegetation cover in sub-humid and humid areas such as in conifer and moist eucalyptus forests and near water tanks (R. Vasconcelos, pers. obs.). Similarly, *C. s. salensis* occurs only on Sal, generally under fallen palm trees, rock piles and calcareous plates in dunes and sandy areas (Schleich, 1987, 1996).

Some taxa are presently restricted to very small islets, such as *T. g. gigas* and *T. g. brancoensis* on Branco and Raso, respectively. The latter is more abundant on the lower parts of the islet near the coast (Schleich, 1982a), such as in the southern dunes (Schleich & Wuttke, 1983) and on high parts and small ravines on the southern side (Schleich, 1980) or in flat areas in the interior of the islet (Andreone, 2000). It is rare on the south-east peninsula because of the strong wind exposure (Schleich, 1982a). Wind-exposed vertical slopes and rough and fissured stone are usually avoided by these geckos (Schleich, 1980) as they are unable to use vertical

surfaces (Schleich, 1987) because of their high body mass. Both subspecies are usually found on rocky shores under sandstone blocks and are commensal with sea birds, using them as a food source (dead young, eggs, regurgitations) and inhabiting the same crevices birds use to nest (Schleich, 1982a; Hazevoet, 1995). This species probably had a wider range in the past, occupying Santa Luzia Island and São

Vicente, where subfossil bones have been found (Mateo et al., 2009). Thus, the present range of the species results from the natural fragmentation of the habitat after the Pleistocene sea-level fluctuations that joined São Vicente and the Desertas group, followed by the effect of human colonization and associated mammalian predators (Mateo et al., 2009; Appendix 8).