Short Communication

Reassessing the conservation status of the shrew *Crocidura thomensis*, endemic to São Tomé Island

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Abstract The shrew *Crocidura thomensis* is a little-known species endemic to São Tomé Island. We review its distribution, ecology and conservation status based on nine published and 23 new records. The species has a wide distribution across São Tomé, preferring rugged forested areas with high rainfall. The location of new records coincides with that of historical records but the proportion of records in plantations has declined, possibly as a result of agricultural intensification, increased use of pesticides, and presence of exotic species. The shrew is restricted to a single island, its extent of occurrence is $< 1{,}000$ km² and its habitat is declining in extent and quality, and thus its categorization as Endangered on the IUCN Red List remains appropriate. It is important to gain a better knowledge of population trends, ecological preferences and sensitivity to potential threats, but the effective protection of São Tomé Obô Natural Park and surrounding forests is the most important measure to ensure the long-term survival of this mammal.

Keywords IUCN Red List, São Tomé and Príncipe, São Tomé Obô Natural Park, shrew

The shrew *Crocidura thomensis* is endemic to São Tomé, an 857 km² oceanic island lying just north of the equator and 255 km west of mainland Africa. The island belongs to the Democratic Republic of São Tomé and Príncipe and has a diverse range of unique species across many taxonomic groups (Jones, 1994). The shrew was first described by Bocage (1887) and is the island's only native non-volant mammal. Its endemicity is widely accepted and supported by molecular data (Maloney et al., unpubl. data). It was recorded only nine times in over a century and these records were used by Dutton & Haft (1996) to assess its distribution, ecology and conservation status. Here, we reassess that knowledge based on new observations recorded sporadically by researchers in recent years.

We collated 23 new observations of the shrew, from 15 new locations (Fig. 1, Table 1). The high number of recent observations suggests the species may not be so rare, and the scant historical records are probably attributable to minimal search effort (Atkinson et al., 1994). The shrew is widely distributed across São Tomé, occurring from near sea level to high altitudes. Its extent of occurrence may reach 500 km², if it includes most of the island's forests (Salgueiro & Carvalho, 2001). These data contradict Hutterer (2008), who suggested it was an uncommon to very rare species associated with montane moist forest.

The lack of systematic surveys across the island makes it difficult to assess abundance or identify areas where the shrew may be absent. Nevertheless, the species seems to be associated with areas of high rainfall and rugged terrain (Silva, 1958; Fig. 1). Given that the north-east of São Tomé is one of the most visited areas of the island, the fact that the shrew was recorded only once in this region (in a plantation near riparian gallery forest) suggests the species is less abundant there. The north-east holds the only dry biomes of São Tomé (Silva, 1958), and the most human-dominated landscapes (Jones et al., 1991; INE, 2013); the combined effect of these conditions may be limiting the occurrence of the shrew. The large number of records for the mountainous central area of the island is likely to have resulted from this being the most visited region, with a significant proportion of well-preserved forests.

The São Tomé shrew occupies a variety of habitats, from old-growth mist forest to lowland plantations. However, most observations, and especially those in recent years, have been in rugged forested areas (Table 1). The distribution of new observations coincides with that of previous records but there is an apparent shift in habitat: five of eight of the earlier observations were in plantations, compared to two of the 23 new observations (Table 1). This shift may be attributable to an unbalanced survey effort but plantations have been visited frequently since 2008 (e.g. de Lima et al., 2014); the scarcity of records in plantations is therefore better explained by an effective decrease of the species in this habitat. This decline is corroborated by verbal accounts from local inhabitants.

Introduced species, the use of pesticides, and agricultural intensification have been identified as threats to the survival

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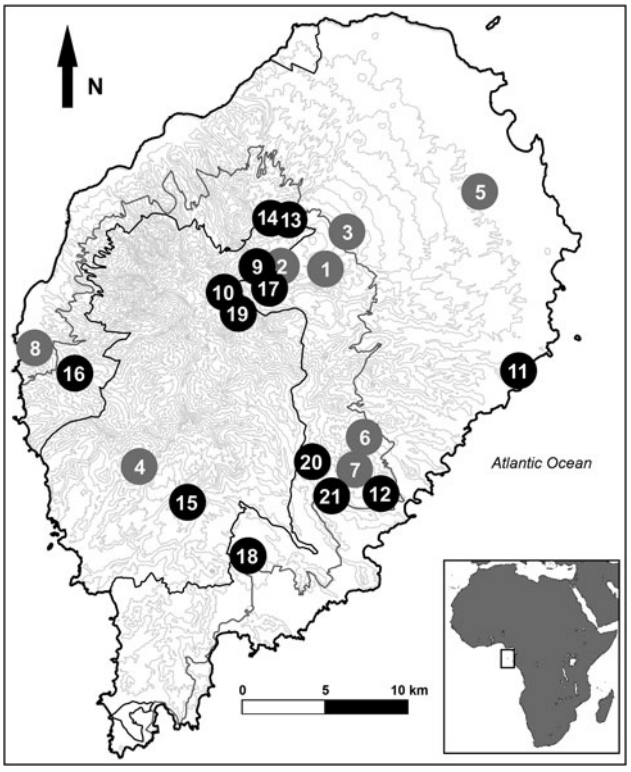

FIG. 1 Locations where the endemic shrew *Crocidura thomensis* was recorded on the island of São Tomé. Grey dots mark the location of records compiled by Dutton & Haft (1996; point 1 has been reassigned to its correct location); black circles mark new locations. Numbers correspond to Table 1. The pale grey lines in the background mark 100 m altitudinal isohyets. The São Tomé Obô Natural Park and its buffer zone are delimited by black and dark grey lines, respectively. The rectangle on the inset shows the location of the island off the west coast of Africa. Shapefiles were adapted from the Natural Park Management Plan (Albuquerque et al., 2008).

of the shrew (Atkinson et al., 1994; Dutton & Haft, 1996), and provide reasonable causality for its decline in the agricultural matrix. Many species have been introduced to São Tomé, some of which have been identified as potential predators or competitors of the shrew (Atkinson et al., 1994; Dutton, 1994) or are contributing to overall habitat degradation (de Lima et al., 2014). Few people can afford to use pesticides on a regular basis but the potential impact of pesticide use on the shrew should not be ignored as it has been implicated in the decline of the endemic insectivorous São Tomé paradise flycatcher *Terpsiphone atrochalybeia* (Jones et al., 1991). There is little information available on forestry or agricultural practices in São Tomé but there are signs of deforestation, forest degradation and agricultural intensification (Salgueiro & Carvalho, 2001; GeoVille, 2013). The human population increased from 100,000 in the mid 1980s to almost 170,000 in 2012 and is projected to continue growing rapidly (INE, 2013). In this context the demand for agricultural and forest resources is likely to increase and contribute to continuing degradation of the shrew's habitat.

Little is known about the diet of this shrew. Dutton & Haft (1996) reported a captive specimen consuming freshwater shrimp, crab, moths, earthworms and grasshoppers. We observed it feeding on earthworms, cockroaches, moths, crickets and a centipede (*Scolopendra* sp.). Field observations associate the shrew with wet environments, where many of the above-mentioned and other potential food items are particularly abundant (e.g. spider crickets, Phalangopsinae). We hypothesize that the shrew's association with wet environments is linked to the abundance of food in these locations, which is needed to satisfy the species' high metabolic rate.

Hutterer (2008) categorized the species as Endangered on the IUCN Red List, based on an extent of occurrence $< 1{,}000$ km^2, with all individuals in a single location and a sustained decline of habitat extent and quality (B1ab(iii); IUCN, 2001). Despite the new information provided here, these criteria still apply and the species should therefore retain its Endangered status.

The São Tomé Obô Natural Park was created in 2006 and protects the island's main forest block (DGA, 2006; Fig. 1). Its establishment was a major step towards recognizing the conservation value of São Tomé's forests and demonstrated the willingness of the Santomean government to protect them. Effective protection of the Park is the most important measure to ensure the survival of the shrew, but enforcement remains almost non-existent. It is necessary to gain better knowledge of the shrew's distribution, abundance, ecology and threats (Nicoll & Rathbun, 1990), especially concerning the impact of introduced species (Atkinson et al., 1994). Testing the food-limitation hypothesis and the association with wet environments is also important, to evaluate the species' vulnerability to climate change. In recent years there have been several long and intense dry seasons, which could pose an additional threat to the long-term subsistence of this unique mammal.

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TABLE 1 Known records of the shrew *Crocidura thomensis*, endemic to São Tomé (Fig. 1), with date recorded, number of individuals, location, altitude, habitat, and data source.

No.[1]	Date	No. of individuals	Location	Altitude (m)	Habitat	Source
1	1886	1	Minho	800	Plantation	Dutton & Haft (1996)
2	1896	1	Santa Maria	1,200	Plantation	Dutton & Haft (1996)
3	Dec. 1971	4	Monte Café	700	Plantation	Dutton & Haft (1996)
3	1971	2	Monte Café	800	Plantation	Dutton & Haft (1996)
4	End of July 1990	1	Rio Xufexufe	300	Primary forest	Dutton & Haft (1996)
5	1991	1	Cascata Blublu	75	Plantation	Dutton & Haft (1996)
6	1991	1	Rio Angra Toldo	100	Secondary forest/Bamboo	Dutton & Haft (1996)
7	1991	2	Maria Fernandes	400	Primary forest	Dutton & Haft (1996)
8	1992	1	Ponta Furada	90	Secondary forest	Dutton & Haft (1996)
9[2]	2002 or 2003	1	Path to Lagoa Amélia	1,300	Primary forest	Covas & Melo (pers. comm.)
10[2]	2008	1	Esponja	> 1,400	Primary forest	Olmos (pers. comm.)
11[2]	2008	1	Água Izé	< 100	Plantation	Carvalho (pers. comm.)
12[2]	2008	1	Angra Toldo	< 250	Secondary forest	Rocha & Carvalho (pers. comm.)
13	9 May 2009	1	São Luís	950	Secondary forest	Authors, pers. obs.
14	12 June 2009	1	Rio do Ouro	900	Secondary forest	Authors, pers. obs.
15	1 July 2009	1	Rio Quija/Água Lemos	650	Secondary forest	Authors, pers. obs.
16	19 June 2009	1	Santa Clotilde	100	Secondary forest	Monteiro & Carvalho (pers. comm.)
17	25 Aug. 2009	1	Nova Ceilão	1,000	Secondary forest	Monteiro & Oquiongo (pers. comm.)
18	29 Aug. 2009	1	Rio Martim Mendes	150	Secondary forest	Monteiro (pers. comm.)
16	23 Sep. 2009	1	Santa Clotilde	100	Secondary forest	Monteiro & Oquiongo (pers. comm.)
16	23 Oct. 2009	1	Santa Clotilde	100	Shade plantation	Monteiro & Oquiongo (pers. comm.)
17	21 Mar. 2010	1	Nova Ceilão	850	Secondary forest	Monteiro (pers. comm.)
17	21 Mar. 2010	1	Nova Ceilão	1,000	Secondary forest	Monteiro (pers. comm.)
17	27 Apr. 2010	1	Água Pinhão	1,000	Secondary forest	Oquiongo (pers. comm.)
13	5 June 2010	1	São Luís	1,050	Secondary forest	Authors, pers. obs.
19[2]	29 Oct. 2012	1	Ana Chaves	900	Primary forest	Faustino (pers. comm.)
13	30 Oct. 2012	1	São Luís	900	Secondary forest	Oquiongo (pers. comm.)
20	20 Aug. 2013	1	Santa Maria/Nova Ceilão	1,400	Secondary forest	Authors, pers. obs.
21	11 Sep. 2013	1	Rosário	200	Secondary forest	Monteiro (pers. comm.)
12	5 Feb. 2014	1	Maria Fernandes	390	Primary forest	Authors, pers. obs.
22	10 Feb. 2014	1	Vale Carmo	270	Secondary forest	Authors, pers. obs.
23	19 Feb. 2014	1	Rio Quija/Água Lemos	670	Primary forest	Monteiro & Fonseca (pers. comm.)

[1]Numbers correspond to those in Fig. 1
[2]Approximate locations

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Biographical sketches

Ricardo Faustino de Lima is researching the effects of human activities on the biodiversity of the endemic-rich islands of São Tomé and Príncipe. Eden Maloney has studied the phylogenetics of the shrews of São Tomé and Príncipe. W. Brian Simison's research focuses on the global phylogeography of limpets. Robert Drewes has extensive research experience in Africa and has been leading multidisciplinary expeditions to São Tomé and Príncipe since 2001.