

Distribution, ecology and status of an endemic shrew, *Crocidura thomensis*, from São Tomé

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The São Tomé white-toothed shrew Crocidura thomensis is endemic to the island of São Tomé in the Gulf of Guinea. This species was discovered in 1886 and since then has been recorded from fewer than 10 locations. This paper summarizes all published and unpublished information on C. thomensis. The species is currently listed by the IUCN as 'Insufficiently Known', but using the new IUCN Red List Categories is re-classified as 'Vulnerable B1 + 2c'. Threats to the survival of C. thomensis include deforestation, plantation redevelopment and predation by introduced mammals.

Introduction

São Tomé, with an area of 857 sq km, is the larger of the two islands that make up the Democratic Republic of São Tomé and Príncipe. It lies 255 km off the coast of Gabon in the Gulf of Guinea and the nearest land is Príncipe, 150 km to the N-NE (Figure 1). Geological evidence indicates that São Tomé has never been connected to Príncipe nor to mainland Africa (Exell, 1944; Heim de Balsac and Hutterer, 1982; Jones and Tye, 1988; Brühl, 1993; Jones, 1994), allowing the biota to evolve in isolation. This is shown by the large number of endemic taxa present, especially birds (Collar and Stuart, 1985; Günther and Feiler, 1985; Jones and Tye, 1988; Atkinson *et al.*, 1991, 1994; Jones *et al.*, 1991; Nadler, 1993; Peet and Atkinson, 1994) and plants (Exell, 1944, 1956; Brühl, 1993; Figueiredo, 1994).

When discovered in 1479, São Tomé was reported to be completely covered in rain forest (Exell, 1944; Hodges and Newitt, 1988). Much of this was cleared for plantation development, with the remaining primary forest restricted to higher altitudes and steep slopes (Exell, 1944). A survey in 1989 found that total forest cover was 91.1 per cent: 28.5 per cent primary, 30.2 per cent secondary and 32.4 per cent shade forest over cocoa plantations

(Interforest AB, 1990). Apart from nine bat species (Juste and Ibañez, 1994), the island was believed to be devoid of mammals when it was discovered (Exell, 1944), although subsequently 14 species were introduced (Dutton, 1994) and in 1886 a species of Soricidae was discovered (Bocage, 1887). Quite how this species became established on São Tomé remains a zoogeographical mystery (Heim de Balsac and Hutterer, 1982; Jones and Tye, 1988; Jones, 1994; Juste and Fa, 1994).

Discovery and classification

The São Tomé white-toothed shrew *Crocidura thomensis* was first collected by Francisco Newton in 1886 (Bocage, 1887; Figure 2; Table 1). Newton had written 'that this species must be truly rare for it had escaped the researches of his [Newton's] predecessors and he was only able to obtain this single individual taken by chance' (Bocage, 1887). Newton collected his last specimen in 1896 (Bocage, 1904b; Figure 2; Table 1). Bocage (1887) described the species and wrongly recorded that it also occurred on Príncipe (Bocage, 1904a; Heim de Balsac and Hutterer, 1982; Jones and Tye, 1988). The specimens described by Bocage were preserved in the Bocage Museum,

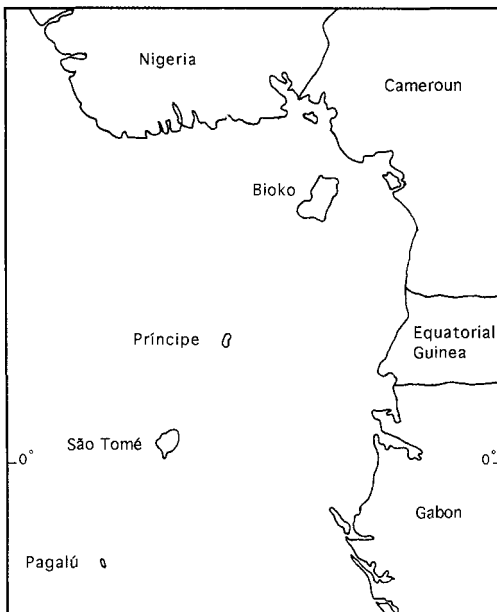


Figure 1. São Tomé in relation to the African mainland and the other Gulf of Guinea islands.

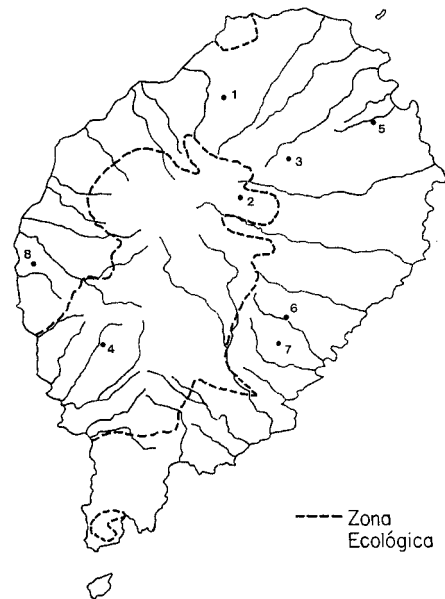


Figure 2. Successful trap sites and sightings of *Crocidura thomensis*. Numbers relate to the sites listed in Table 1.

Lisbon, until 1910 when all but one specimen, attributed to Príncipe, were destroyed by fire (Heim de Balsac and Hutterer, 1982).

No other specimens of *C. thomensis* were collected until the early 1970s when R. de Naurois carried out a field search (Heim de Balsac and Hutterer, 1982). An initial examination of owl pellets revealed only bones of ship rats *Rattus rattus*, a bird and a mouse. Direct habitat searches were unsuccessful on the eastern coast between 200 and 300 m but searches between 700 and 800 m towards the centre of the island produced a series of specimens of *C. thomensis* (Figure 2; Table 1). Specimens of the shrew on Príncipe were also collected, allowing a re-examination of the Soricidae of the two islands. It was found that the species occurring on Príncipe was a subspecies of *C. poensis*, a widely distributed West African species, and that *C. thomensis* was endemic to São Tomé (Heim de Balsac and Hutterer, 1982). It should be noted that Nowak (1991) wrongly attributes *C. thomensis* to Príncipe and *C. poensis* to São Tomé.

C. thomensis is dark brown in colour and has a very long snout (R. Hutterer, pers. comm.),

unusually long hind feet and large ears (Heim de Balsac and Hutterer, 1982). The male neotype has a body length of 84 mm, a tail length of 88 mm and feet (excluding claws) of 18.7 mm (Heim de Balsac and Hutterer, 1982). The specimen described by Bocage (1887) measured 16 mm from snout tip to eye and the female captured in 1991 weighed 12.5 g (Feiler *et al.*, 1993). More detailed descriptions of the morphology of *C. thomensis* were given by Heim de Balsac and Hutterer (1982), with Bocage (1887, 1904b) and Feiler *et al.* (1993) also giving morphometric information. Heim de Balsac and Hutterer (1982) also explored the systematic position of *C. thomensis* in the *Crocidura* genus and suggested that São Tomé and Príncipe were colonized at different periods.

Recent research

No further efforts to catch and study *C. thomensis* occurred until 1989–91. In 1989 and 1990, 13 sites were unsuccessfully trapped using various sizes of Sherman trap, and 95 × 48 mm

break-back traps (two sites) and Longworth traps (11 sites), respectively (Atkinson *et al.*, 1994). However, in 1990 one individual of *C. thomensis* was observed near the source of the Rio Xufexufe (Atkinson *et al.*, 1994; Figure 2; Table 1). In 1991 a further eight sites were trapped, again using various sizes of Sherman trap and 95 × 48 mm break-back traps, but only one male specimen was caught in a break-back trap on the Rio Angra Toldo (Feiler *et al.*, 1993; Atkinson *et al.*, 1994; Figure 2; Table 1). A live female was captured in a butterfly net as it ran across the bridge at Blublu waterfall and two other individuals were observed at Pico Maria Fernandez (Atkinson *et al.*, 1994, H. Read, pers. comm; Figure 2; Table 1).

In 1992 a skull and some vertebrae of *C. thomensis* were found near Ponta Furada (Figure 2; Table 1). Examination of these suggested that they could have originated from a barn owl *Tyto alba* pellet.

Distribution and habitat occurrence

When Heim de Balsac and Hutterer (1982) published their paper on the Soricidae of the Gulf of Guinea islands, *C. thomensis* was only known from four mid-altitude sites between 700 and 1200 m (the fifth site on São Tomé is



Crocidura thomensis (Jacob Fahr).

unknown). They said that this species inhabited plantations at medium altitudes and suggested that it had not adapted to plantations at lower altitudes due to the 'swarming' of the rat.

The 1990–92 research showed that *C. thomensis* has a far wider distribution (Figure 2) and a far greater altitudinal range (75–1200 m; Table 1) than previously believed, even if the site of the skull and vertebrae is discounted owing to the possibility of long-distance transport from the point of capture by an owl. Previously it had been written that this species relied on the forests of São Tomé for its continued survival (Nicoll and Rathbun, 1990). However, *C. thomensis* has been recorded in

Table 1. Site locations and descriptions of all captures and sightings of *Crocidura thomensis*

Year	No. ind.	Site	Long./Lat.	Altitude (m)	Habitat†
1886 ^a	1	Roça Minho (1)*	0°16'N 6°31'E	800	Plantation
1896 ^b	1	Santa Maria (2)	0°20'N 6°36'E	1200	Plantation
1971 ^c	4	Monte Café (3)	0°18'N 6°31'E	700	Plantation
1971 ^c	2	Monte Café (3)	0°18'N 6°31'E	800	Plantation
1990 ^d	1	Rio Xufexufe (4)	0°11'N 6°32'E	300	Primary forest
1991 ^e	1	Blublu Waterfall (5)	0°19'N 6°43'E	75	Plantation
1991 ^e	1	Rio Angra Toldo (6)	0°11'N 6°38'E	100	Secondary forest and bamboo
1991 ^e	2	Pico Maria Fernandez (7)	0°10'N 6°38'E	400	Primary forest
1992 ^f	1	Ponta Furada (8)	0°14'N 6°29'E	90	Secondary forest

* Numbers in parentheses relate to site locations shown in Figure 2.

† Site habitats are those at the time of capture/sighting and may no longer be current.

Sources: a, Bocage, 1887; b, Bocage, 1904b; c, Heim de Balsac and Hutterer, 1982; d, Atkinson *et al.*, 1994; e, Atkinson *et al.*, 1994 and Feiler *et al.*, 1993; f, Atkinson *et al.*, 1994 and H. Read, pers. comm.

plantations, and in primary and secondary forest (Bocage, 1887, 1904b; Heim de Balsac and Hutterer, 1982; Atkinson *et al.*, 1994; Table 1), but no sightings or captures have been made in the savannah area in the north-east of the island.

Ecology and behaviour

Little is known about *C. thomensis* but the sparse information available permits some speculation on its ecology and behaviour. Most captures have been of single individuals (Bocage, 1887, 1904b; Feiler *et al.*, 1993; Atkinson *et al.*, 1994), matching the understanding that most shrew species are solitary for much of their lives (Churchfield, 1990), although some *Crociodura* species show social tolerance (Nowak, 1991). R. de Naurois collected several individuals of *C. thomensis* at one site (Heim de Balsac and Hutterer, 1982) and in 1991 two shrews were observed chasing one another (Atkinson *et al.*, 1994). These records could indicate that *C. thomensis* is one of the more socially tolerant *Crociodura* species or that the captures and observations were made during the breeding season and/or during territorial defence.

Most shrew species have a well-defined breeding season (Churchfield, 1990), although some tropical species of *Crociodura* breed throughout the year (Sheppe, 1972; Medway, 1978). The only indication of the breeding season of *C. thomensis* is de Naurois finding several juveniles in a nest of dead leaves, twigs and debris in December 1971 (Heim de Balsac and Hutterer, 1982; R. Hutterer, pers. comm.), in one of the dry periods separating the two wet seasons (approximately March–May and October–November; Jones and Tye, 1988; Juste and Fa, 1994).

Shrews are opportunistic predators of invertebrates, with their diet showing a wide diversity (Churchfield, 1990). The live specimen of *C. thomensis* captured in 1991 by J.H. ate most of two freshwater crustaceans (shrimp and crab) and some invertebrates (moths, earthworms and grasshoppers) that were offered. The long snout of *C. thomensis* is likely to

facilitate access to worms and insects in fissures and holes (R. Hutterer, pers. comm.).

Heim de Balsac and Hutterer (1982) speculated that *C. thomensis* was probably a jumping species because the hind feet are exceptionally long. However, none of the four individuals observed in 1990 and 1991 was seen to jump. The long limbs and long tail may facilitate climbing (R. Hutterer, pers. comm.), as with *Sylvisorex megalura* (Vogel, 1974) on mainland Africa, especially in the rugged terrain of São Tomé (Juste and Fa, 1994). Heim de Balsac and Hutterer (1982) also noted that this shrew must be tolerant of humans because the specimens collected by de Naurois in the early 1970s were discovered in immediate proximity to human activity; this is in common with many *Crociodura* species (Churchfield, 1990).

Status and threats

Of all captures and sightings of *C. thomensis*, only three have been in primary forest, all others occurring in plantation or secondary growth. This suggests that this shrew can survive in modified habitats and this, coupled with the fact that forest cover on São Tomé is 91.1 per cent (Interforest AB, 1990), indicates that it may not be under immediate threat from forest destruction. However, further forest clearance could have a detrimental impact. Many plantations have reverted to secondary forest, but the government's current land privatization programme may lead to the revitalization of these plantations (Atkinson *et al.*, 1994). Untouched primary forest is now restricted to the mountainous regions, with a small remaining area of lowland rain forest in the south-western and central parts of the island (Jones, 1994), and the plantations and secondary forest are probably important for the survival of *C. thomensis*.

If redevelopment of plantations occurs, a decline in habitat suitability could lead to populations becoming fragmented and isolated, perhaps causing a decline in the viability of the remaining populations and possibly leading to local extinctions. The redevelopment of plantations would inevitably lead to an

increase in pesticide use and insectivores are highly susceptible to many of the chemicals involved (Jefferies, 1972; Rudd *et al.*, 1981; Churchfield, 1990; Osborn *et al.*, 1991; Forsyth and Westcott, 1994). The use of pesticides was implicated in the decline of the São Tomé paradise flycatcher *Terpsiphone atrochalybeia* and the São Tomé oriole *Oriolus crassirostris* in the early 1970s (de Naurois, 1984a, b; these species are believed to have since recovered, Atkinson *et al.*, 1994) and may be the reason that searches for *C. thomensis* at lower altitudes were unsuccessful during this period.

Predation by introduced mammals is also a threat. Human colonization led to the accidental introduction of ship rats and brown rats *Rattus norvegicus*. The African civet *Civettictis civetta* and the weasel *Mustela nivalis* may have been introduced deliberately to control the rats (Bocage, 1904b; Frade, 1958; Dutton, 1994). Domestic cats *Felis catus* are also present (Jones and Tye, 1988; Atkinson *et al.*, 1994; Dutton, 1994).

Shrews are normally regarded as unpalatable to mammalian predators because of their distasteful odour (Churchfield, 1990). However, they form part of the diet of weasels (Erlinge, 1975; Moors, 1975; Tapper, 1976), and two viverrids – the large Indian civet *Viverra zibetha* (Medway, 1969) and banded mongoose *Mungos mungo* (Baxter, 1993) have been recorded to prey on shrews – indicating that the African civet could take *C. thomensis*. Domestic cats are also known to kill (but seldom eat) shrews (Churchfield, 1990), and rats are recorded as preying on small mammals (Brosset, 1963; Davies, 1979). Bearing in mind their probable long association on São Tomé (Dutton, 1994), it seems unlikely that these predators would be the sole cause of any extinctions, but coupled with other threats such as predation could tip the balance against the survival of the shrew.

Nicoll and Rathbun (1990) considered *C. thomensis* to be 'very rare' and the species is currently listed as 'Insufficiently Known' by the IUCN (Groombridge, 1993). Using the criteria for the new IUCN Red List Categories (IUCN, 1994) *C. thomensis* should be categorized as 'Vulnerable: B1 + 2c'. Both the extent

of occurrence and area of occupancy of this shrew are less than the minimum limits of 20,000 and 2000 sq km, respectively. In addition, it has been recorded from fewer than 10 locations and both the extent and quality of habitat is projected to decline with land privatization and plantation regeneration.

Conservation action

Nicoll and Rathbun (1990) recommended that São Tomé's forests needed protection to conserve *C. thomensis*. These forests have also attracted conservation interest because of their ornithological endemism and were ranked second out of 75 African forests by Collar and Stuart (1988).

A Zona Ecológica (national park; Figure 2) was gazetted in 1993 (Jones, 1994), the main part encompassing forest in the lowland south-west and central highlands of São Tomé, including the untouched primary forest and the majority of the remaining lowland rain forest. It was first delineated by BDPA (1985) and was reaffirmed by Jones and Tye (1988), Interforest AB (1990) and Jones *et al.*, (1991). Atkinson *et al.*, (1994) suggested minor but important extensions for further avifaunal protection. It is likely that the zona will provide significant protection for *C. thomensis*, even though it includes only two sites where the species has been recorded.

Further protection should be provided in other parts of the island and every effort should be made to minimize the impact of plantation redevelopment on *C. thomensis*. Pesticide application techniques, in particular, should be reviewed to minimize any environmental contamination.

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