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DISEASE IMPLICATED IN DECLINE OF THE THREATENED OBÔ GIANT LAND SNAIL *ARCHACHATINA BICARINATA* IN SÃO TOMÉ AND PRÍNCIPE

By Martina Panisi & Ricardo F. de Lima

The rapid decline of the Obô giant land snail *Archachatina bicarinata* (Bruguière, 1792; Fig. 1) has long been identified (Gascoigne, 1994; Dallimer & Melo, 2010; Panisi *et al*., 2020) in the oceanic islands of Príncipe and São Tomé (Democratic Republic of São Tomé and Príncipe, Central Africa), where it is endemic. The species was abundant and widespread until the mid-20th century, but it is now restricted to the most remote forests of both islands (Panisi *et al*., in press). Overharvesting, habitat loss and the introduction of the West African giant land snail *Archachatina marginata* (Swainson, 1821; Fig.1) are all possible causes for its decline, and a potential disease has also been implicated since 1994 (Gascoigne, 1994; Panisi *et al*., in press). The Obô giant land snail is listed by IUCN (Clarke & Naggs, 1996) as "Vulnerable" but a new assessment suggests an upgrade to "Endangered". The suspicion around an unidentified disease is particularly concerning, as it would have the potential to push it towards extinctions in the near future.

Apparently sick individuals have been recorded on both islands and mass mortality events have been recorded on São Tomé in recent years. In March 2021, we failed to find live Obô giant land snails at Zagaia, a remote peak covered in native forest in the São Tomé Obô Natural Park, where it used to be abundant until recently, according to monitoring reports and interviews (Fig. 2). We found nine intact dead snail shells and several fragments of old shells belonging to both juveniles and adults of the threatened species, and evidence that the introduced giant land snail had reached this location. A similar

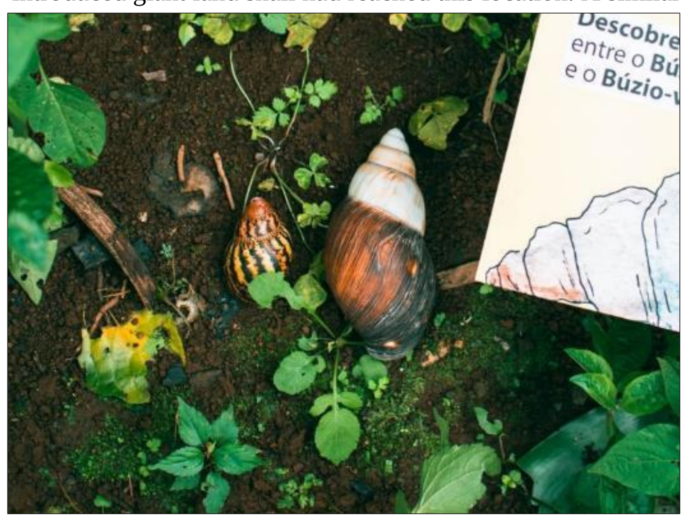

Fig. 1. Part of an educational display at the Obô giant land snail ex-situ centre in São Tomé. On the left, the invasive West African giant land snail *Archachatina marginata* (shell length ~75 mm, individuals in São Tomé and Príncipe can reach up to ~125 mm). On the right, the threatened Obô giant land snail, *Archachatina bicarinata* (sinistral, shell length ~ 160 mm). (Photo: Vasco Pissarra, Forest Giants Project/Alisei NGO).

event had been recorded in 2017, when we visited another remote location near the Cabumbé peak, where the species was also long known to occur, according to local hunters. There, we also recorded no live Obô giant land snails, but 22 freshly dead adult or near adult specimens in just 400 m^2, three of which containing eggs that were still visible (Panisi, 2017; Fig. 2). No dramatic climatic event was reported during these periods and the areas are seldom visited.

In 2019, an ex-situ breeding programme was created for the species in São Tomé to obtain information on its ecology (Panisi *et al.*, 2020), but three separate events between February and June 2020 affected the population, which was being kept in open-air cages. Fifty-eight percent of the individuals showed symptoms of a disease and most of them, including some juveniles that had been born ex-situ, eventually died.

Although there is no proof that the wild and ex-situ events are related, the snails showed similar symptoms: the individuals weigh less and present leucodermic lesions, weakened epidermis, low mobility and occasionally tuberculations in the foot. Leucodermic lesions have been described in the giant African land snail *Lissachatina fulica* (Bowdich, 1822) in their native range (Mead, 1979), and in wild and captive populations introduced in India (Raut, 1983) and on islands in the Pacific (Gerlach, 2001). A presumed disease has been attributed to *Aeromonas* spp. bacteria (Mead, 1979), and it was observed to spread easily when snail populations are dense (Raut, 1983). This may explain the mass mortality events recorded for the Obô giant land snail, which can occur at high densities in isolated forested patches (Panisi, 2017; Panisi *et al*., 2020), and help provide a possible explanation for its spectacular decline.

The spread of this disease has already been linked to the introduction of molluscs in some islands of the Pacific, where it has been suggested to help reducing the population growth of the introduced molluscs, but not necessarily affect native species (Gerlach, 2001). In São Tomé, it has been hypothesised that a disease may have been introduced in the islands together with the West African Giant Snail *Archachatina marginata* (Gascoigne, 1994), but the exact mechanisms of interaction between these two giant snail species is not well understood. Anecdotal reports of local inhabitants are consistent and seem to match our observations as well as the few written accounts regarding the reduction in the distribution of the Obô giant land snail following the spread of the introduced one (Fig. 2). Nowadays, the species are almost completely segregated in space, sometimes separated by natural barriers, such as streams (Panisi, 2017). We did not find evidence of the presence of the invasive snail in the surroundings of the freshly dead Obô giant land snail in 2017. Nonetheless, the introduced snails have also been seen showing signs of disease, such as leucodermic lesions, on both islands.

The Obô giant land snail is an iconic terrestrial mollusc that, in recent years, has been widely used as flagship for the protection of the unique malacofauna of São Tomé and Príncipe, and even for the conservation of their endemic-rich

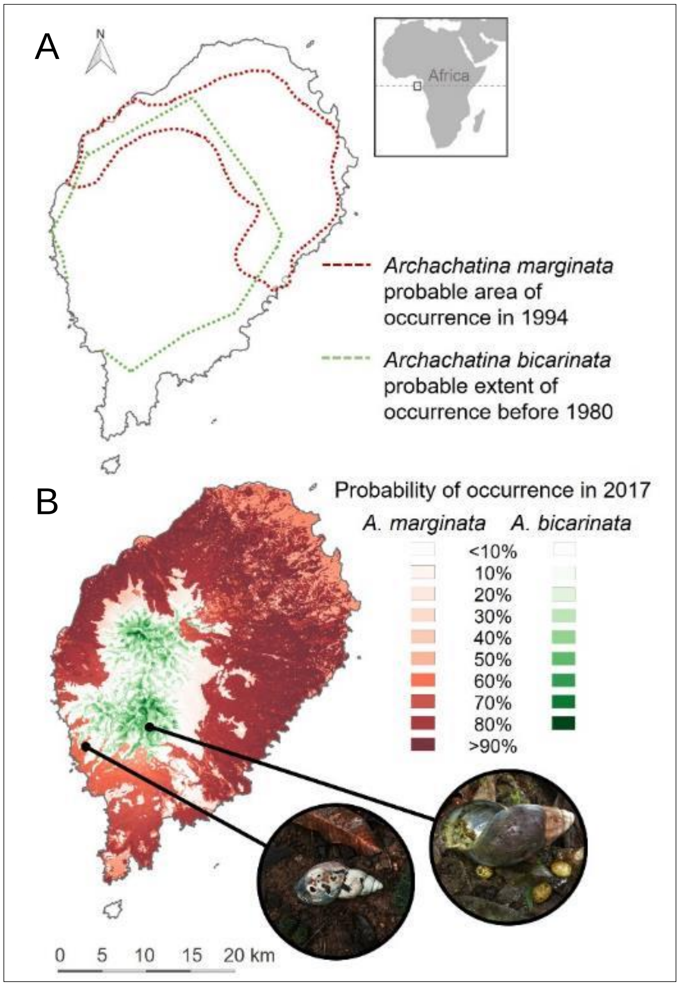

Fig. 2. Changes in the potential distribution of the Obô giant land snail *Archachatina bicarinata* and the West African giant land snail *Archachatina marginata* on São Tomé Island. A - The dotted black lines represent the probable extent of occurrence of A. *bicarinata* before 1980, based on 38 interviews of relevant stakeholders, such as eco-guides and snail harvesters (Panisi, 2017). The dotted red lines represent the estimated distribution of *A. marginata* in 1994 (Gascoigne, 1994). B - The island-wide distribution in 2017 was modelled by Panisi (2017) for both species. The black dots represent the location of Zagaia, surveyed in 2021 (left) and the area near Cabumbé peak, surveyed in 2017 (right). The inset at the top shows the location of São Tomé Island in relation to mainland Africa.

forests (Forest Giants Project, 2019; Rebelo, 2020). However, efforts have focused mostly on stopping habitat loss and harvesting, which this potential disease might prove fruitless. Thus, we urge for the need of a specialised intervention to identify the exact cause(s) of death, and assess how to prevent future declines, which probably will involve further ex-situ conservation efforts.

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IMPORTANCE OF AUTHORS' LABELS AND OTHER COLLECTION INFORMATION IN EX SITU CONSERVATION OF BIODIVERSITY

By Basudev Tripathy, Amit Mukhopadhyay & Sheikh Sajan

Ex situ conservation and preservation of biological diversity (especially endangered species) is always a challenge for conservationists and policymakers regarding development of proper management strategies (Lane, 1996; Soberón *et al*., 2000). Most of the ex situ efforts, such as in vitro tissue culture, museum collections, captive breeding, aquariums, botanical gardens and genomic databases (e.g. GenBank) render complementary services for in situ conservation and preservation and represent an insurance against extinction of endangered species. Meanwhile, ex situ conservation provides ample opportunities for governments and non-governmental

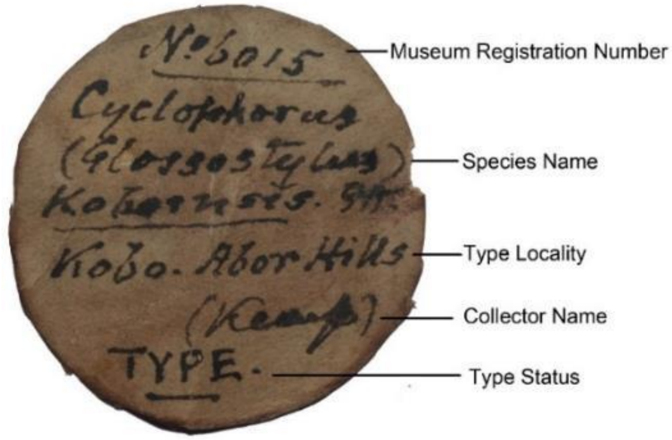

Fig 1. Label of Henry Haversham Godwin-Austen with "type" indication, registration number and other relevant information.

organisations, research and educational institutions, individual researchers and students to contribute to the preservation of biological diversity.

Taxonomy is the science of naming, describing and classifying the world's biodiversity, providing a crucial link between other branches of science. A taxonomist who describes a particular species and places it in a systematic arrangement is also actively involved in both in situ and ex situ preservation and conservation of the species as well as the specimens on which the species is described. The original labels and other information provided by the author associated with the museum specimen may include information on the species, including name, higher taxa, locality, date, habitat and other relevant information that could be used by future workers (not only taxonomists but also ecologists, climatologists and others) to study the species in situ (Tripathy & Venkitesan, 2011; Tripathy *et al*., 2019; Breure & Páll-Gergely, 2019; Sajan *et al*., 2019). Authors' labels and other documentation such as field notes (particularly for type specimens) may provide detailed information about type and other localities and could be useful for ecologists and conservationists in formulating species-specific conservation plans and preserving biological resources (Fig. 1). Such documentation could also be useful for resolving taxonomic problems, helping to pursue the history of the species and the previous and current status of the species (Naggs, 1997; Anistratenko, 2015; Sutcharit *et al*., 2015; Oliver *et al*., 2017; Tripathy *et al*., 2019; Sajan *et al*., 2019). Ex situ preservation and conservation will be hindered without the original documentation of the taxonomist(s) who described and named the species (Tripathy *et al*., 2019; Sajan *et al*., 2019). Hence, natural history museums and other national and international institutions and biodiversity repositories involved in taxonomy can play a vital role in the maintenance and preservation of the hard work of taxonomists in support of ex situ preservation (Hooper-Greenhill, 1992; Lane, 1996; Drew, 2011; Sutcharit *et al*., 2015; Ballard *et al*., 2017; Tripathy & Sajan, 2019).

The shrinkage of habitats due to anthropogenic activities, including modernisation, habitat fragmentation, urbanisation and climate change may cause rapid extinction (Fahrig, 2003;