

The beauty and the beast: Endemic mutualistic interactions promote community-based conservation on Socotra Island (Yemen)



Cristina García^a, Raquel Vasconcelos^{b,c,*}

^a Plant Biology, CIBIO/InBio, Centro de Investigação em Biodiversidade e Recursos Genéticos, Laboratório Associado, Universidade do Porto, Campus Agrário de Vairão, 4485-661 Vairão, Portugal

^b Conservation Genetics and Wildlife Management, CIBIO/InBio, Centro de Investigação em Biodiversidade e Recursos Genéticos, Laboratório Associado, Universidade do Porto, Campus Agrário de Vairão, 4485-661 Vairão, Portugal

^c Systematics, Biogeography and Evolution of Reptiles and Amphibians, IBE, Institute of Evolutionary Biology (CSIC-UPF, Consejo Superior de Investigaciones Científicas – Universitat Pompeu Fabra), Passeig Marítim de la Barceloneta 37, 08003 Barcelona, Spain

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ABSTRACT

The understanding that biodiversity is supported by an entangled network of interactions is fundamental if we are to guarantee the persistence of endemic and restricted-range taxa. When it comes to remote, isolated and rural areas, local human communities play a pivotal role in preserving their native flora and fauna. Locals typically show contrasting aesthetic appreciation for different species, unaware that the fate of highly valued species might be closely linked to the activity of non-charismatic and disregarded species. Therefore, conveying the importance of biotic interactions in sustaining biodiversity is important to incentivise environmental awareness in those areas. The remote Socotra Archipelago (Yemen), a Natural World Heritage, hosts one of the oldest forest ecosystems on Earth and 31 endemic reptile species. The relic dragon's blood tree *Dracaena cinnabari* is classified as Vulnerable and it is highly valued among locals. On the contrary, reptiles are typically persecuted and feared by them, in spite of the fact that they might provide services to *D. cinnabari*. In order to document the role of nocturnal lizards as pollinators of *D. cinnabari*, we conducted a trip to Socotra Island and we examined 11 tree populations at night for the presence of reptiles and whether they carry pollen in their snouts. Our results confirmed that three species of geckos carried pollen grains of *D. cinnabari* and at least seven other unidentified species. This result indicates that these geckos visit *D. cinnabari* flowers, likely to feed upon pollen or nectar, suggesting that they may pollinate this relic tree. We point out that by focusing on the need of preserving mutualistic biotic interactions, instead of individual species, environmental awareness would increase and Socotri people would steadily shift their attitude towards an holistic preservation of *D. cinnabari*.

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Conservation studies have steadily moved from preserving flagship species to maintaining biotic interactions and the ecosystem services that support high levels of biodiversity (Thompson, 2005). This view of biodiversity as an entangled network of interactions, that support the coexistence of interacting species, is fundamental if we are to guarantee the persistence of endemic and restricted-range taxa. Remote oceanic islands typically host high levels of biodiversity but some of them are still poorly known by researchers who continue to discover and describe new endemic species that

inhabit these hotspots of biodiversity (Vasconcelos et al., 2016). At these locations, local human communities play a pivotal role in guaranteeing the persistence of their native flora and fauna (Berkes, 2007). Therefore, conveying key ecological concepts, such as biotic interactions, is important to incentivise the environmental awareness among locals to preserve a myriad of species that interact with flagship species.

The Socotra Archipelago (Yemen) hosts one of the richest endemic flora worldwide that includes a high number of threatened species and, therefore, it was declared a Natural World Heritage site by UNESCO in 2008. Among its unique plant communities we find arboreal relic forests from the Mio-Pliocene, almost extinct due to Pliocenic climate changes, such as dragon's blood trees *Dracaena cinnabari* (Fig. 1A–C). This is an evergreen monocotyledonous tree with a typical umbrella shaped crown due to a 'dracoid' ramification of its branches (Fig. 1A). According to Miller and Cope (1996)

* Corresponding author at: Conservation Genetics and Wildlife Management, CIBIO/InBio, Centro de Investigação em Biodiversidade e Recursos Genéticos, Laboratório Associado, Universidade do Porto, Campus Agrário de Vairão, 4485-661 Vairão, Portugal.

E-mail address: raquel.vasconcelos@cibio.up.pt (R. Vasconcelos).

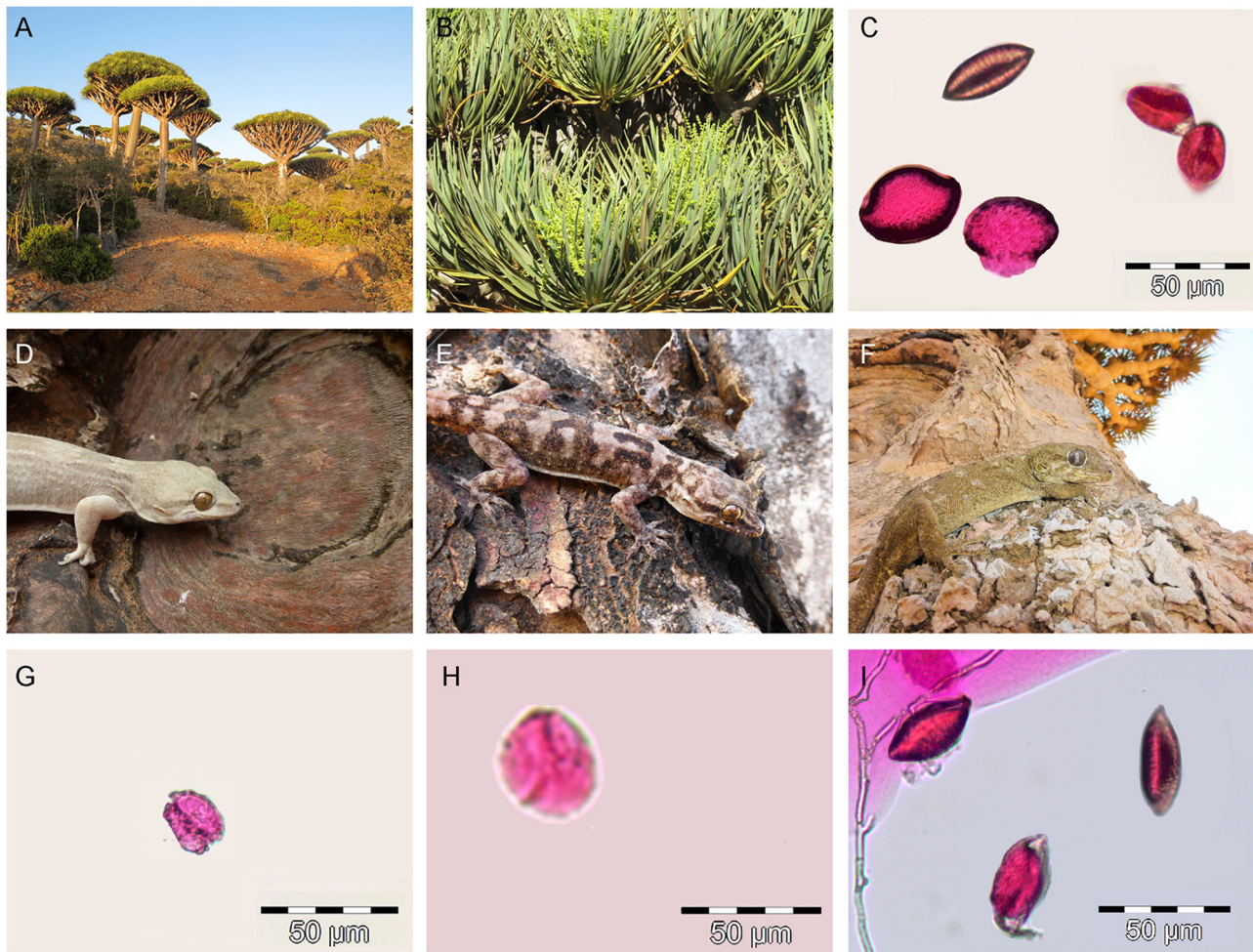


Fig. 1. Evidence of the potential mutualistic pollen dispersal interaction between *Dracaena cinnabari* trees and Socotran geckos. *Dracaena cinnabari* forest at Diksam (N12.57193, E54.04967), Socotra Island, Yemen (A). Detail of the flowering tree used for reference (B). Reference sample of pollen collected directed from open flowers (C). The *Hemidactylus dracaenacolus*, a Critically Endangered gecko endemic to Socotra which lives exclusively on *D. cinnabari* trees (D). The Grant's leaf-toed gecko *Hemidactylus granti* (E) frequently seen on the stems of *D. cinnabari* and also on cliffs (E). The Socotra giant gecko *Haemodracon riebeckii*, frequently seen on the canopy of *D. cinnabari*, as well as on cliffs (F). Pollen collected from the snout of *H. dracaenacolus*' (G), *H. granti*' (H) and *Haemodracon riebeckii*' (I), respectively.

D. cinnabari forests inhabiting Socotra Island represent one of the oldest forest ecosystems on Earth. *D. cinnabari* is classified as Vulnerable by IUCN and it is now threatened by goat grazing (Miller, 2004), soil erosion, and increased aridity (Attorre et al., 2007).

The island was named *Suq-al-qatr*, meaning the market of dragon's blood, in reference to the characteristic red sap of *D. cinnabari*. Its sacred value is widely referred in the Greek mythology, the Bible, and the Quran. The influence of these cultures, along with a profitable trade of dragon's blood until the 18th century, made *D. cinnabari* a flagship species deeply rooted in Socotri culture (Cheung & Devantier, 2006). Nowadays, even though its economic value has sharply decreased, locals still use it for dyeing, gluing, cosmetic, medicine and rituals (Miller & Morris, 2004). On the contrary, as on many other places including our Western countries (Cerfaco, 2012), reptiles are poorly known and much feared by the Socotri. Reptiles also typically receive poor attention from the scientific community, even in biodiversity hotspot areas such as Socotra, where they represent the most important and diverse group of vertebrates with 31 endemic species of nine different genera. Yet, the fate of despised lizards and their native trees become closely linked when lizards provide pollination services.

Among other biotic interactions, those entailing pollen and seed dispersal are crucial to fulfil the demographic cycle of plant species. Pollination by lizards is a characteristic island syndrome where

lizards feed upon flowers, fruits, nectar, and pollen (Olesen & Valido, 2003; Whitaker, 1987). They act as pollinators when they visit open flowers to feed on their pollen grains that become attached to their snout and they are carried to the stigma of the same or a different flower facilitating its pollination. In Socotra Island, the role of insects as pollinators in the reproductive biology of *D. cinnabari* is unknown to date (Brown & Mies, 2012). Bird species such as *Onychognatus* sp. have been observed feeding on fleshy berries produced by *D. cinnabari* (Adolt & Pavlis, 2004) but understanding is incomplete on whether this tree has pollen vectors among vertebrates.

Fascinated by the cultural and natural history value of the *D. cinnabari* and motivated by the deeply unknown function of endemic lizards on this island, we conducted a trip to Socotra Island in 2014 to register the interaction between two endemic and threatened taxa with contrasting aesthetic appreciation by the local population: the venerated trees and feared geckos. We conducted our expedition from 26 th of February to 15th of March to overlap with the flowering period of *D. cinnabari* (Fig. 1B) and we visited eleven populations covering the species' entire distribution on the island, including intact forests (two sites), sparse woodlands (three sites), mountainous areas (three sites), and major isolated *D. cinnabari* remnants (three sites). Overall, we sampled 111 individual trees (94 flowering trees). A population was defined as a

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