forests

Article

Micro-Hotspots for Conservation: An Umbrella Tree Species for the Unique Socotran Reptile Fauna

Raquel Vasconcelos [1,2,*], Eudald Pujol-Buxó [3], Gustavo A. Llorente [3], Ahmed Saeed [4] and Salvador Carranza [2]

1 CIBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, InBIO Laboratório Associado, Universidade do Porto, Campus Agrário de Vairão, R. Pe. Armando Quintas, 4485–661 Vairão, Portugal
2 Institute of Evolutionary Biology (CSIC-Universitat Pompeu Fabra), Passeig Marítim de la Barceloneta 37–49, E-08003 Barcelona, Spain; salvador.carranza@ibe.upf-csic.es
3 Departament de Biologia Evolutiva, Ecologia i Ciències Ambientals and Institut de Recerca de la Biodiversitat (IRBio), Universitat de Barcelona, Avinguda Diagonal, 643–645, 08028 Barcelona, Spain; epujolbuxo@ub.edu (E.P.-B.); gllorente@ub.edu (G.A.L.)
4 Environment Protection Authority, Socotra Branch, Hadibo, Socotra, Yemen; qamhem@yahoo.com
* Correspondence: raquel.vasconcelos@cibio.up.pt

Received: 4 March 2020; Accepted: 19 March 2020; Published: 21 March 2020

Abstract: Umbrella species are defined as species that can be rare and sensitive to human disturbance, whose protection may confer the protection of other co-occurring species. The dragon's blood tree *Dracaena cinnabari* Balf.f. was already considered an umbrella species on Socotra Island (Indic Ocean, Yemen) due to its ecological importance for some native biota. We studied the reptile community living on *D. cinnabari* from Socotra Island. We sampled reptiles on trees across most *D. cinnabari* populations and applied co-occurrence and network partition analyses to check if the presence of reptiles on *D. cinnabari* populations was random or structured. Regardless of its patched and scarce actual distribution, we report the use of this tree as a habitat by more than half of the reptile community (12 endemic reptiles). Co-occurrence and network partition analyses demonstrate that this community is structured across the distribution of dragon's blood trees, reflecting complex allopatric, vicariant, and biotic interaction processes. Hence, these trees act as micro-hotspots for reptiles, that is, as areas where endemic and rare species that are under threat at the landscape scale co-occur. This Socotra endemic tree is currently threatened by overgrazing, overmaturity, and climate change. Its protection and declaration as an umbrella species are expected to benefit the reptile community and to protect evolutionary processes that are partially driven by the ecological links between reptiles and this tree. To our knowledge, no tree species has been proposed as an umbrella species for island vertebrate endemics so far, highlighting the ecological uniqueness of Socotra Island.

Keywords: ecological network; evolutionary processes; co-occurrence analysis; reptile community; Socotra Island

1. Introduction

An umbrella species is defined as a species that can be rare and sensitive to human disturbance, whose protection may confer the protection of other co-occurring species [1,2]. This concept is appealing and offers a simple ecologically-based shortcut for the conservation management of communities [3]. The umbrella species concept was first described to refer to species with wide ranges under the assumption that by protecting them, a suite of species with more modest spatial needs would be protected. Because organisms with large body sizes tend to have large home ranges, large mammals and birds have typically been proposed as umbrella species (see a review in [3]).

On a few occasions, umbrella species have been proposed for the protection of island endemics, even though some islands are prominent biodiversity hotspots [4] and are considered to be among the most threatened terrestrial ecosystems [5]. Island ecosystems are characterized by high endemicity, low species richness, short trophic webs, and reduced antagonistic interactions [6,7]. The absence of large vertebrates and the apparent simplicity of the trophic webs and ecological networks [6,7] have likely limited the description of umbrella species on islands.

The Socotra Archipelago is a fragment of the Gondwana Supercontinent, which was isolated from the Indian Ocean around 20 My ago when the Arabian and African plates separated, resulting in the formation of the Gulf of Aden [8]. The Archipelago is composed of a large main island, Socotra, and three islets. It is characterized by highly endemic flora, i.e., 37% of plants [9], and fauna [10]. Within vertebrates, 93.5% of reptiles are endemic, 29 native, and two introduced [11–13]. Phylogenetic studies including Socotran reptiles have demonstrated their historical relatedness to Arabian and Madagascan reptiles, therefore suggesting a Gondwanan origin from ancient ancestors [14,15]. Other studies have detected that some Socotran reptiles are sister species to more recent relatives occurring on the mainland [12], with spectacular cases of intra-island speciation [16].

A relevant endemism of the island is the dragon's blood tree *Dracaena cinnabari* Balf.f. This is a monocotyledonous species considered to be a symbol of the island's wildlife, which is currently considered vulnerable to extinction [17]. Although a significant part of the island was covered extensively with dragon's blood trees, their original range was reduced as a result of overgrazing and overmaturity (lack of natural regeneration and a large proportion of old and dead trees) [18]. *Dracaena cinnabari* meets the requirements for being considered an umbrella species [19] due to its size, shape, and distribution throughout Socotra, as well as its rarity and sensitivity to human disturbance [2]. Reptiles could be the target beneficiary taxon, as this tree was referred to as being occasionally used by some reptile species and the exclusive habitat of the Critically Endangered *Hemidactylus dracaenacolus* Rösler & Wranik, 1999 [11]. Only one other tree was referred to as being used by a significant number of reptile species, *Phoenix dactylifera* L. [11]; however, this tree is extensively cultivated, and it does not constitute a natural habitat to be protected.

In this study, we describe and quantify the reptile community living on *D. cinnabari* with the aim of determining whether this tree should be classified as an umbrella species for reptiles. In particular, we will answer the following questions: Is this tree a common habitat for the reptile community? Does reptile richness on *D. cinnabari* habitats depend on tree density or maturity? How many *D. cinnabari* populations need to be protected to cover most of the reptile community? If this tree serves as habitat for at least one third of the native reptile species and it is important for near-threatened/threatened species, we consider it should be classified as an umbrella species. If species richness is higher in denser or more mature *D. cinnabari* populations, we should give higher conservation priority to those areas. If the reptile population is structured, the number of *D. cinnabari* populations to be protected should match the number of sub-communities to guarantee the protection of a higher number of reptile species. Population structure could also be explained by previously known allopatric distributions (disjunct geographic ranges) or unveiled competitive interactions (interactions that result in negative outcome for both parts involved).

2. Materials and Methods

2.1. Study Sites and Sampling

In February and March 2014, we conducted an extensive sampling of *D. cinnabari* populations in Socotra aimed at describing co-occurrence patterns and building the ecological network of the reptile community living in this particular habitat. We sampled 11 *D. cinnabari* populations (280 individual trees) covering the species' entire distribution on the island, including intact forest (two sites, in Diksam and Firmihin forests), sparse woodland (three sites, around Firmihin forest), mountainous areas (three sites, in the Haggeher Mountains), and major isolated *D. cinnabari* remnants (three sites, in the

Eastern side of the island) (Figure 1A). Currently, only 10% of the island is covered with *D. cinnabari* forest/woodland (Figure 1A). The largest populations of *D. cinnabari* are located in the Haggeher Mountains and the adjacent limestone plateau of Diksam, in the center of the island (Figure 1A), usually forming a sparse woodland. In the Natural Sanctuary of Firmhin's plateau, *D. cinnabari* trees form a continuous forest, possibly reflecting the aspect of the island before human occupation (Figure 1B).

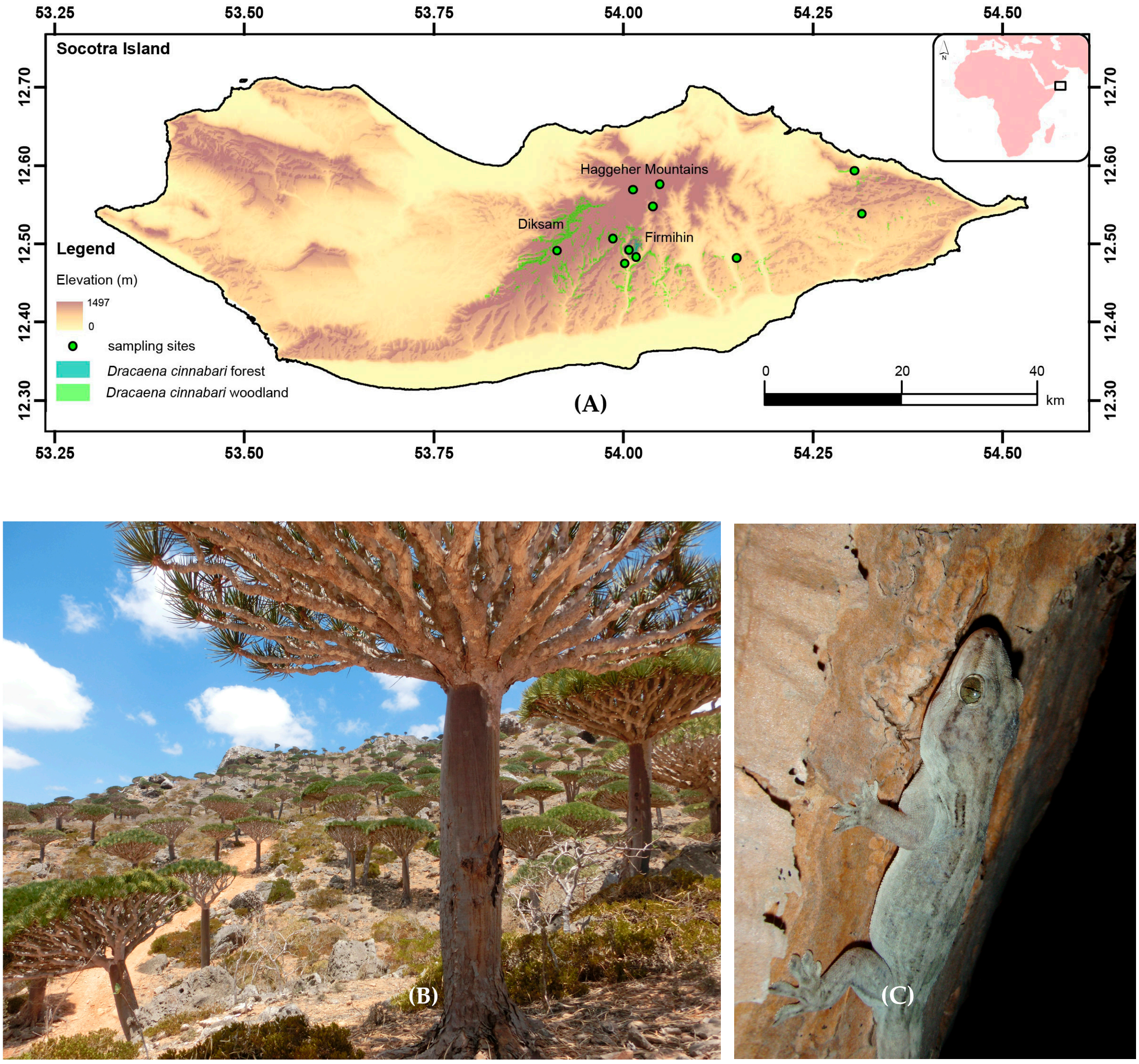

Figure 1. Map of Socotra Island (**A**) with the distribution of *Dracaena cinnabari* Balf.f. (green area) and the 11 study sites (green points), a general view of the *D. cinnabari* forest at Firmihin's plateau, (**B**) and the detail of a *Hemidactylus dracaenacolus* Rösler & Wranik, 1999 individual on a *D. cinnabari* trunk (**C**).

Sampling sites were selected when at least 20 *D. cinnabari* trees were less than 15 m apart from each other. Between two to four researchers examined *D. cinnabari* trees during 13 days and nights, totaling approximately 41 h of effective sampling effort. During the day, trees were selected and georeferenced, and distances among selected trees and the three closest neighbors were measured as estimators of tree density.

We measured the girth at 1 m height, stem height, and number of branching events as estimates of maturity of the selected trees. Trunks, visible canopy, and the nearest surrounding ground, including rocks and shrubs, were examined for the presence of diurnal and nocturnal (resting) reptiles. At night, the same trees were examined again with flashlights in order to record the presence of both (resting) diurnal and (active) nocturnal species. The Environmental Protection Authority (EPA) approved this study as it was in the scope of the agreement signed by an EPA representative and Salvador Carranza on March 22, 2010.

2.2. Data Analyses

A presence/absence and abundance matrix was compiled treating each *D. cinnabari* population as a sampling unit. From this matrix, we examined co-occurrence patterns and constructed an ecological network. Co-occurrence patterns were calculated by the C-score [20], which measures the average number of checkerboard units (pairs of sample sites where, when comparing the presence of two species, one is present and the other is not) between all possible pairs of species. In a competitively structured community, the C-score should be significantly larger than expected by chance, so we tested the null hypothesis if C-scores were identical to expectations. The C-score was measured with EcoSim software [21], with an alpha level = 0.05 and 5000 randomized simulations based on the matrix. As competition among species may result in allopatric distributions, this test is useful to guide conservation planning of the reptiles occurring in *D. cinnabari* populations.

Based on co-occurrence patterns of reptile species in *D. cinnabari* populations, we constructed an ecological network. We used the Louvain method [22] implemented by Pajek [23] for identifying reptile sub-communities within the network. This method attempts to optimize the modularity of the network, i.e., the network's strength of division into groups. Firstly, the method detects "small" communities, optimizing modularity locally; secondly, it aggregates nodes (species) belonging to the same sub-community and builds a new network. These steps were repeated iteratively until maximum modularity was attained and a hierarchy of communities was produced. Accordingly, species with similar co-occurrence patterns remained within the same sub-community. The resulting network was visualized with Gephi [24].

If the reptile population is random, it would not matter which *D. cinnabari* population should be protected in order to protect the reptile community. On the other hand, if it is structured, the number of *D. cinnabari* populations to be protected should match the number of sub-communities to guarantee the protection of a higher number of reptile species.

We performed statistical analyses to check if the total number of reptile species per site was correlated with any maturity variables or distance between trees calculating Pearson's r and the respective 95% confidence intervals (CI) with the Fisher transformation (F). If the F values were outside of CI, we rejected the null hypothesis of $\rho = 0$.

We considered *D. cinnabari* as an umbrella species for the reptile community if it served as habitat for at least one third of the native reptile species and some of those are near-threatened/threatened species, especially if they occurred in areas of higher density or maturity of the trees.

3. Results

In total, we found 91 specimens belonging to 12 reptile species (52.1% of the native reptile species of Socotra Island) including one chameleon, 10 geckos, and one colubrid snake (Table A1 and Figure A1). Following our previous definition, *D. cinnabari* should then be considered as an umbrella species for the reptile community of the island. *Hemidactylus homoeolepis* Blanford, 1881 (n = 29), *Haemodracon riebeckii* Peters, 1882 (n = 19), and *Hemidactylus inintellectus* Sindaco, Ziliani, Razzetti, Pupin, Grieco, 2009 (n = 13), were the species more frequently found on *D. cinnabari.* On the other hand, *Chamaeleo monachus* Gray, 1865, *Haemodracon trachyrhinus* Boulenger, 1899, and *Hemidactylus pumilio* Boulenger, 1903, were detected only once (see Figure A1).

The co-occurrence C-score measured for the reptile community living on *D. cinnabari* trees was 3.35, which was significantly higher (p = 0.02) than expected (expected C-score = 3.06, variance = 0.01) and confirmed the community's competitive structure. Network partition detected four sub-communities within the reptile community (Figure 2). The central sub-community was composed of widespread and generalist Socotran species that co-occurred at most of the sites sampled (the widest nodes and a dense set of connections among edges of the network in Figure 2) and were able to thrive in a wide variety of environmental conditions. Interestingly, two of the other three sub-communities likely corresponded to species that only occurred on a reduced portion of the island. One of these sub-communities was composed of two tree/shrub specialists that spatially segregated from the rest of the species, one of them being the Critically Endangered *H. dracaenacolus* (Figure 1C), a species that only lives on *D. cinnabari* trees, and *H. trachyrhinus*, which is mostly found active in *Cissus* bushes. Another sub-community included the rock-dwelling and cliff species *Pristurus insignis* Blanford, 1881, *Pristurus insignoides* Arnold, 1986, and *Hemidactylus granti* Boulenger, 1899, the sister species of *H. dracaenacolus*. Both *H. dracaenacolus* and *H. granti* have parapatric distributions possibly linked to a vicariant process that occurred on the island approximately 2.3 My ago [16]. Therefore, at least four *D. cinnabari* populations should be protected to cover most of the reptile community.

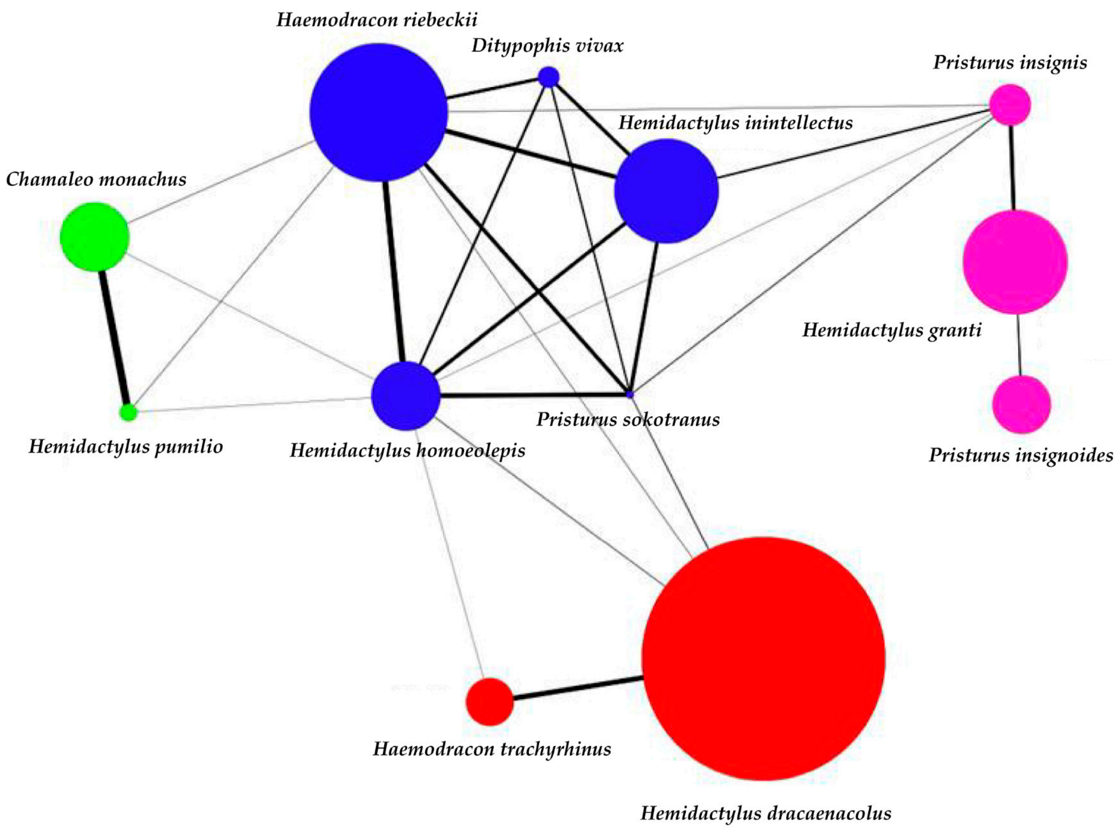

Figure 2. Ecological network of the Socotran reptiles found in *Dracaena cinnabari* Balf.f. trees. Nodes represent species; their size indicates the degree of specialization in the use of *D. cinnabari* trees with respect to other habitats, and colors indicate sub-communities according to the partition procedure (green: shrub/tree specialist community; blue: habitat generalists community; pink: rock-dwelling community; red: arboreal/shrub species). Edges join species that share at least one sampling point, and the higher thickness of the edges indicates those species with higher co-occurrence patterns within the 11 sampling points.

Concerning density, *D. cinnabari* sampled trees had an average minimum distance to the closest tree of 447 ± 505 cm (range = [65, 1500] cm) and an average distance to the three closest *D. cinnabari* trees of 1301 ± 128 cm (range = [1112, 1500] cm); see Table 1. The sites with the lowest referred average distances to *D. cinnabari* were Diksam and Haif, respectively (Table 1). Concerning maturity, the sampled *D. cinnabari* trees had an average girth at 1 m height of 178 ± 41 cm (range = [114, 246] cm), an average stem height of 287 ± 27 cm (range = [246, 336] cm), and average number of branching events of 5.4 ± 0.7 (range = [4.6, 7.2]); see Table 1. The site with the selected trees with the largest average girth was Qafshifo and with the highest average stem was Firmihin Protected Area (Table 1). The site with the selected *D. cinnabari* with the highest average number of branching events was Qafshifo

(Table 1). We counted up to 20% dead or partially damaged crown trees in some remnant woodlands. The average number of total reptile species found per site was 8 ± 5 (range = [2, 18]). The site with the highest richness of reptiles was Qafshifo, followed by Killisan (Table 1).

Table 1. Details of the sites and variables measured in *Dracanea cinnabari* Balf.f. trees with reptiles. The code of the sites (S) where *D. cinnabari* were sampled, its coordinates (latitude (Lat) and longitude (Long), in decimal degrees, WGS84), and location names are listed. The total number of reptiles species found on trees (N), the average minimum distance from the tree with reptiles to the closest tree (MD1), the average distance to the three closest trees (XD3), the average girth at 1 m height, the average stem height (SH), and the average number of branching events (BE) are detailed per site.

S	Lat	Long	Location	N	MD1	XD3	G	SH	BE
1	12.572	54.048	Adho Di Meleh, Haggeher	6	1500	1500	117	272	4.6
2	12.572	54.049	Ba'a, 2 km NE of Diksam	7	125	1360	158	281	4.8
3	12.467	54.002	Qafshifo, 3 km SE Firmihin	18	410	1186	246	288	7.2
4	12.476	54.017	Firmihin Protected area	12	1500	1500	226	336	5.4
5	12.485	54.008	Haif, Firmihin	4	345	1112	160	306	4.8
6	12.484	53.913	Shibehon plateau	4	262	1414	175	246	5.4
7	12.589	54.305	Homhil, Hallah	9	140	1342	225	290	5.6
8	12.475	54.149	Di Gisfo, Wadi Di-Fa'rhroh	8	192	1156	173	275	5.9
9	12.533	54.315	Killisan, 3km NW Qademinoh	17	150	1286	207	268	5.1
10	12.500	53.987	Diksam, Qafshifo	4	65	1269	160	333	5.6
11	12.565	54.013	Skand, Haggeher	2	233	1191	114	260	4.9

We found positive correlations of an estimator of tree maturity with the average number of reptile species present on *D. cinnabari* populations, but not with estimators of tree density. That is, we found positive correlations between the total number of reptile species found on a site and the average girth (r = 0.80; F = 1.10; IC = [0.41, 1.78]), but not with the average number of branching events (r = 0.57; F = 0.65; IC = [−0.03, 0.87]) nor with the average mean distance to one individual tree to its three closest neighbor trees (r = 0.03; F = 0.03; IC = [−0.58, 0.62]).

4. Discussion

This study demonstrated that *D. cinnabari* was a suitable habitat for half of the native reptile community of Socotra Island, but we could not disregard the occurrence of other unexplored endemic fauna living in the bark and canopy of the tree species. Although few trees have been proposed as umbrella species (however, see [19,25]), we supported the consideration of *D. cinnabari* as an umbrella species for vertebrates as well. This was due to its ecological, environmental, and evolutionary functions for the Socotra endemic reptiles, in addition to its historical economic and social role for local people that harvest *D. cinnabari* resin, which is an activity that could be sustainable if carefully regulated.

Network and co-occurrence analyses, together with previously known distribution data and ecological modelling [26,27], showed that reptiles living on *Dracaena* trees belonged to different structured communities reflecting both allopatric distributions and competitive interactions. Some habitat generalists (e.g., *Haemodracon riebeckii* and *Hemidactylus inintellectus*) [11] likely avoided the presence of the *Dracaena*-specialist *H. dracaenacolus*, and even in sympatry in the study sites, the former only occupied *D. cinnabari* trees when the latter were absent, so they were not syntopic. The high intra-island speciation displayed by some reptiles [16] suggested that adaptation to new niche opportunities such as the use of *D. cinnabari* trees might be one of the evolutionary drivers in Socotra. In this study, we showed higher co-occurrence patterns among some reptile species than others; however, we did not specifically check for species interactions, and co-occurrences and interactions did not necessarily match [28,29]. For these reasons, it would be interesting to check for interactions among reptiles as well in future works using different methodologies.

As our study was performed during a short period of time and reptiles' detectability could vary along the year, it is possible that we have underestimated the importance of *D. cinnabari* trees for some reptile species. However, the number of species detected was enough to demonstrate that the tree is indeed important for the reptile community, even for species that were not previously described to use *D. cinnabari* trees (e.g., *Ditypophis vivax* Günther, 1881) and for the Near Threatened *Chamaeleo monachus*. Thus, we recommend that local authorities repeat this survey after the rains to check for undetected reptile species such as the worm snakes and to perform further research to unveil the link between dragon's blood trees and chameleons. It is important to mention that endemic gecko species were recorded with pollen of *D. cinnabari* on their snouts, suggesting that they may pollinate this highly valued tree [28]. If this is to be proven for chameleons, it may help conservation actions as they are typically persecuted and feared on Socotra [28] (it is said that a person hearing its hiss will lose the ability to speak).

Currently, *D. cinnabari* woodlands and forests occupy only 10% of its current potential habitat [24], and forests continue to be threatened by a number of local and general processes. The abundance of goats across the island exerts a grazing pressure on seeds and young shoots that precludes *D. cinnabari* turnover, causing a general reduction of its distribution and density in many areas. Adolt and Pavlis [30] concluded that the lack of regeneration could lead to an irreversible loss of the structure of *D. cinnabari* forests within 30–77 years. It seems, from our results, that the most mature *D. cinnabari* populations hold a larger number of reptile species, so those populations should have higher conservation priority, regardless of tree density. This scenario is even more impacting as it especially affects the reduced area where *H. dracaenacolus* occurs. Moreover, by 2080, a predicted increase in aridity is expected to reduce the potential *D. cinnabari* distribution by up to 45% [31]. Indeed, fragmentation and degradation of *D. cinnabari* populations could trigger the extinction of endemic reptile specialists, as well as remove one of the (biotic) drivers that might be participating in the speciation processes of the reptile community on Socotra Island. It is also important to highlight that, in this work, we did not take into account the genetic diversity of the reptiles, most of it hidden cryptic diversity [26], and previous studies have shown its importance for persistent conservation measures [27]. Thus, fragmentation or degradation of some *D. cinnabari* populations could promote the erosion of particular genetic pools of some reptile species. Measures should be taken to avoid that by protecting the richest and most unique genetically diverse areas where both *D. cinnabari* and reptiles co-occur.

Conservation of *D. cinnabari* forests is urgent. Two nurseries funded by international institutions were producing *D. cinnabari* seedlings in the past, although now, funding is on hold due to the country's political situation. The slow growth of this tree [30] calls for the immediate protection of remnant populations, drastically reducing the grazing pressure by means of necessary agreements with shepherds.

5. Conclusions

The unique flora and fauna of islands and the evolutionary processes that they hold are fragile treasures that should be integrally protected. On the island of Socotra, the protection of *D. cinnabari* forests may not only save this relict of the Mio-Pliocene Laurasian subtropical forests, but also a number of endemic species, including reptiles, as well as biotic interactions and ongoing evolutionary processes, such as those involving reptile species as shown by this study. For this reason, we recommend protecting at least four of those *Dracaena* populations, namely in Haif, Killisan, Skand, and Shibehon, to maximize protection of all the reptile sub-communities detected, specially populations with older and thicker trees, as those seem to hold higher numbers of reptile species.

Author Contributions: Conceptualization, R.V., E.P.-B., and G.A.L.; methodology, R.V., E.P.-B., and G.A.L.; validation, R.V. and G.A.L.; formal analysis, R.V. and E.P.-B.; investigation, R.V., E.P.-B., and G.L.; resources, A.S.; data curation, R.V.; writing, R.V., E.P.-B., G.L., and S.C.; visualization, R.V. and E.P.-B.; supervision, R.V., G.A.L., and S.C.; project administration, R.V., A.S., and S.C.; funding acquisition, R.V. and S.C. All authors read and agreed to the published version of the manuscript.

Funding: This article is an output of Project 13055714, financed by the Mohamed bin Zayed Species Conservation Fund, and Grant CGL2012–36970 from the Ministerio de Economía y Competitividad, Spain (co-funded by FEDER). R.V. was supported by a postdoctoral grant (SFRH/BPD/79913/2011) from the Fundação para a Ciência e Tecnologia (FCT) and national funds under the scope of "Norma transitória" through FCT (DL57/2016/CP1440/CT0002). S.C. was supported by grant PGC2018-098290-B-I00 (MCIU/AEI/FEDER, UE) and grant 2017-SGR-00991 from the Secretaria d'Universitats i Recerca del Departament d'Economia i Coneixement de la Generalitat de Catalunya.

Acknowledgments: We wish to thank Xavier Santos for help with fieldwork, data preparation, and writing, and Mohamed Uthman, Abubakar Salim, and Yahya Salah for field assistance. Fieldwork was conducted under permits of the Environmental Protection Authority (Socotra, Yemen Government).

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; nor in the decision to publish the results.

Appendix A

Table A1. List of reptile species found in *Dracaena cinnabari* Balf.f. trees on Socotra Island. For each species, IUCN status (according to the IUCN Red List of Threatened Species, Version 2014.2: Near Threatened (NT), Least Concern (LC), and Critically Endangered (CR)) and distribution are also included. Sites refer to the number of *D. cinnabari* populations where each reptile species was found.

Species	Codes	Family	IUCN	Distribution	Sites
Chamaeleo monachus	CHmo	Chamaeleonidae	NT	Socotra Island	1
Haemodracon riebeckii	HAri	Phyllodactylidae	LC	Socotra, Samha	8
Haemodracon trachyrhinus	HAtr	Phyllodactylidae	LC	Socotra Island	1
Hemidactylus dracaenacolus	HEdr	Gekkonidae	CR	Socotra Island	2
Hemidactylus granti	HEgr	Gekkonidae	NT	Socotra Island	2
Hemidactylus homoeolepis	HEho	Gekkonidae	LC	Socotra, Samha & Darsa	9
Hemidactylus inintellectus	HEin	Gekkonidae	LC	Socotra Island	5
Hemidactylus pumilio	HEpu	Gekkonidae	LC	Socotra Island	1
Pristurus insignoides	PRig	Sphaerodactylidae	LC	Socotra Island	2
Pristurus insignis	PRin	Sphaerodactylidae	LC	Socotra Island	1
Pristurus sokotranus	PRso	Sphaerodactylidae	LC	Socotra Island	7
Ditypophis vivax	DIvi	Pseudoxyrhophiidae	LC	Socotra Island	2

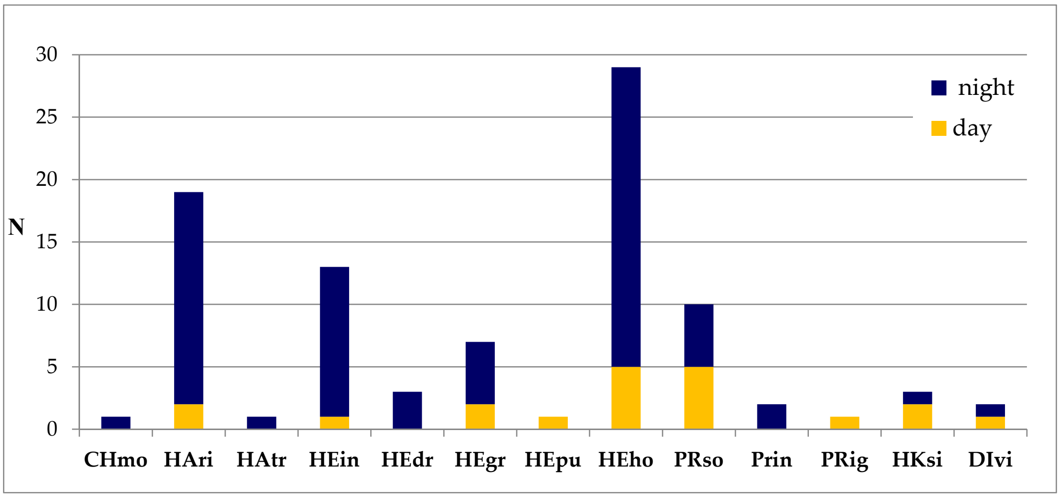

Figure A1. Number of Socotran reptiles found on *D. cinnabari* trees. Colors indicate when animals were found (blue: at night; yellow: at daytime). The codes of species are shown in Table A1.

References

1. Lambeck, R.J. Focal species: A multi-species umbrella for nature conservation. *Conserv. Biol.* **1997**, *11*, 849–856. [CrossRef]
2. Fleishman, E.; Murphy, D.D.; Brussard, P.F. A new method for selection of umbrella species for conservation planning. *Ecol. Appl.* **2000**, *10*, 569–579. [CrossRef]
3. Roberge, J.; Angelstam, P. Usefulness of the umbrella species concept as a conservation tool. *Conserv. Biol.* **2004**, *18*, 76–85. [CrossRef]
4. Mittermeier, R.A.; Turner, W.R.; Larsen, F.W.; Brooks, T.M.; Gascon, C. Global biodiversity conservation?: The critical role of hotspots. In *Biodiversity Hotspots Distribution and Protection of Conservation Priority Areas*; Zachos, F.E., Habel, J.C., Eds.; Springer-Verlag: Basel, Switzerland, 2012; pp. 3–22.
5. Courchamp, F.; Hoffmann, B.D.; Russell, J.C.; Leclerc, C.; Bellard, C. Climate change, sea-level rise, and conservation: Keeping island biodiversity afloat. *Trends Ecol. Evol.* **2014**, *29*, 127–130. [CrossRef]
6. MacArthur, R.H.; Wilson, E.O. *The Theory of Island Biogeography*; Princeton Univ. Press: Princeton, NJ, USA, 1967.
7. Losos, J.B.; Ricklefs, R.E. *The Theory of Island Biogeography Revisited*; Princeton Univ. Press: Princeton, NJ, USA, 2009.
8. Autin, J.; Bellahsen, N.; Leroy, S.; Husson, L.; Beslier, M.-O.; d'Acremont, E. The role of structural inheritance in oblique rifting: Insights from analogue models and application to the Gulf of Aden. *Tectonophysics* **2013**, *607*, 51–64. [CrossRef]
9. Miller, A.G.; Morris, M. *Ethnoflora of the Soqotra Archipelago*; The Royal Botanic Garden: Edinburgh, Scotland, 2004.
10. Van Damme, K. Socotra Archipelago. In *Encyclopedia of Islands*; Gillespie, R., Clague, D., Eds.; Univ. California: Berkeley, CA, USA; Los Angeles, CA, USA, 2009; pp. 846–851.
11. Razzetti, E.; Sindaco, R.; Griego, C.; Pella, F.; Ziliani, U.; Pupin, F.; Riservato, E.; Pelliteri-Rosa, D.; Butikofer, L.; Saeed Suleiman, A.; et al. Annotated checklist and distribution of the Socotran Archipelago Herpetofauna (Reptilia). *Zootaxa* **2011**, *2826*, 1–44. [CrossRef]
12. Sindaco, R.; Metallinou, M.; Pupin, F.; Fasola, M.; Carranza, S. Forgotten in the ocean: Systematics, biogeography and evolution of the *Trachylepis* skinks of the Socotra Archipelago. *Zool. Scr.* **2012**, *41*, 346–362. [CrossRef]
13. Vasconcelos, R.; Carranza, S. Systematics and biogeography of *Hemidactylus homoeolepis* Blanford, 1881, with the description of a new species from Arabia. *Zootaxa* **2014**, *3835*, 501–527. [CrossRef]
14. Schätti, B.; Utiger, U. *Hemerophis*, a new genus for *Zamenis socotrae* Günther, and a contribution to the phylogeny of Old World racers, whip snakes, and related genera (Reptilia: Squamata: Colubrinae). *Rev. Suisse Zool.* **2001**, *108*, 919–948. [CrossRef]
15. Nagy, Z.T.; Joger, H.; Wink, M.; Glaw, F.; Vences, M. Multiple colonization of Madagascar and Socotra by colubrid snakes: Evidence from nuclear and mitochondrial gene phylogenies. *Proc. R. Soc. B* **2003**, *270*, 2613–2621. [CrossRef]
16. Gómez-Díaz, E.; Sindaco, R.; Pupin, F.; Fasola, M.; Carranza, S. Origin and in situ diversification in *Hemidactylus* geckos of the Socotra Archipelago. *Mol. Ecol.* **2012**, *21*, 4074–4092. [CrossRef] [PubMed]
17. Miller, A. *Dracaena Cinnabari*. The IUCN Red List of Threatened Species 2004: E.T30428A9548491. 2004. Available online: https://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T30428A9548491.en (accessed on 17 January 2020).
18. Adolt, R.; Habrova, H.; Madera, P. Crown age estimation of a monocotyledonous tree species *Dracaena cinnabari* using logistic regression. *Trees* **2012**, *26*, 1287–1298. [CrossRef]
19. Maděra, P.; Volařík, D.; Patočka, Z.; Kalivodová, H.; Divín, J.; Rejžek, M.; Vybíral, J.; Lvončík, S.; Jeník, D.; Hanáček, P.; et al. Sustainable Land Use Management Needed to Conserve the Dragon's Blood Tree of Socotra Island, a Vulnerable Endemic Umbrella Species. *Sustainability* **2019**, *11*, 3557. [CrossRef]
20. Stone, L.; Roberts, A. The checkerboard score and species distributions. *Oecologia* **1990**, *85*, 74–79. [CrossRef] [PubMed]
21. Gotelli, N.J.; Entsminger, G.L. *EcoSim: Null models Software for Ecology*; Version 7.0; Acquired Intelligence Inc.; Kesey-Bear, 2001; Available online: http://homepages.together.net/~{}gentsmin/ecosim.htm (accessed on 17 January 2018).

22. Blondel, V.D.; Guillaume, J.-L.; Lambiotte, R.; Lefebvre, E. Fast unfolding of communities in large networks. *J. Stat. Mech. Theory Exp.* **2008**, *10*, P10008. [CrossRef]
23. Batagelj, V.; Mrvar, A. Pajek 2.05. Program for Analysis and Visualization of Large Networks. 2001. Available online: http://mrvar.fdv.uni-lj.si/pajek/be2.htm (accessed on 17 January 2018).
24. Bastian, M.; Heymann, S.; Jacomy, M. Gephi: An Open Source Software for Exploring and Manipulating Networks. 2009. Available online: https://gephi.org/publications/gephi-bastian-feb09.pdf (accessed on 17 January 2018).
25. De la Cruz-Francisco, V. *Rhizophora mangle* Linnaeus, 1753 as umbrella species and biological reason for the protection and restoration of Tampamachoco lagoon, Veracruz, Mexico. *BIOCYT* **2012**, *5*, 341–352.
26. Vasconcelos, R.; Montero-Mendieta, S.; Simó-Riudalbas, M.; Sindaco, R.; Santos, X.; Fasola, M.; Llorente, G.; Razzetti, E.; Carranza, S. Unexpectedly high levels of cryptic diversity uncovered by a complete DNA barcoding of reptiles of the Socotra Archipelago. *PLoS ONE* **2016**, *11*, e0149985. [CrossRef]
27. Vasconcelos, R.; Razgour, O.; Tarroso, P.; Fasola, M.; Carranza, S.; Alves, P.C. Combining molecular and landscape tools for targeting evolutionary processes in reserve design: An approach for islands. *PLoS ONE* **2018**, *13*, e0200830. [CrossRef]
28. García, C.; Vasconcelos, R. The beauty and the beast: Endemic mutualistic interactions promote community-based conservation on Socotra Island (Yemen). *J. Nat. Conserv.* **2017**, *35*, 20–23. [CrossRef]
29. Dormann, C.F.; Bobrowski, M.; Dehling, D.M.; Harris, D.J.; Hartig, F.; Lischke, H.; Moretti, M.D.; Pagel, J.; Pinkert, S.; Schleuning, M.; et al. Biotic interactions in species distribution modelling: 10 questions to guide interpretation and avoid false conclusions. *Glob. Ecol. Biogeogr.* **2018**, *27*, 1004–1016. [CrossRef]
30. Adolt, R.; Pavlis, J. Age structure and growth of *Dracaena cinnabari* populations on Socotra. *Trees* **2004**, *18*, 43–53. [CrossRef]
31. Attorre, F.; Francesconi, F.; Taleb, N.; Scholte, P.; Saeed, A.; Alfo, M.; Bruno, F. Will dragonblood survive the next period of climate change? Current and future potential distribution of *Dracaena cinnabari* (Socotra, Yemen). *Biol. Conserv.* **2007**, *138*, 430–439. [CrossRef]