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Conservation Status of two Succulents Endemic to Soqotra Island, Yemen

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Summary: The conservation value of two Soqotran endemic succulent plant species, *Aloe perryi* Baker and *Duvaliandra dioscoridis* (Lavranos) M. Gilbert, was assessed as part of a study of some aspects of their ecology.

A. perryi is important locally as a source of medicinal extracts and is harvested at some locations for export as well as local use. At one of the study sites this harvesting may be having an adverse affect on the local *Aloe* population. Other populations of *A. perryi* are not harvested or may be harvested only infrequently, but demand for the sap is increasing. *A. perryi* is widespread on the island, occurring mostly in scattered discrete populations. *A. perryi* should continue to be assigned to the conservation status category 'Near Threatened'.

D. dioscoridis seems to be restricted to a single known population in one small area but appears to have a balanced population structure. Based on its restricted distribution *D. dioscoridis* should continue to be designated as 'Critically Endangered'.

Zusammenfassung: The conservation value of two Soqotran endemic succulent plant species, *Aloe perryi* Baker and *Duvaliandra dioscoridis* (Lavranos) M. Gilbert, was assessed as part of a study of some aspects of their ecology.

A. perryi is important locally as a source of medicinal extracts and is harvested at some locations for export as well as local use. At one of the study sites this harvesting may be having an adverse affect on the local *Aloe* population. Other populations of *A. perryi* are not harvested or may be harvested only infrequently, but demand for the sap is increasing. *A. perryi* is widespread on the island, occurring mostly in scattered discrete populations. *A. perryi* should continue to be

assigned to the conservation status category 'Near Threatened'.

D. dioscoridis seems to be restricted to a single known population in one small area but appears to have a balanced population structure. Based on its restricted distribution *D. dioscoridis* should continue to be designated as 'Critically Endangered'.

Introduction

The Yemeni island of Soqotra in the Indian Ocean is home to a unique assemblage of plants and animals and has been renowned among botanists since Balfour's visit in 1880 (Balfour, 1888). It is designated as one of the 'Global 200' priority natural habitats by WWF and is a candidate World Heritage Site and Man and Biosphere Reserve (CEC, 2000; Dumont, 1998; Miller & Morris, 2001; WWF, 2001). Of the 889 plant species recorded from the Soqotran archipelago, some 33% are endemic, making it one of the top ten island groups globally for unique plant species. Many of these species are designated as 'Threatened', 'Rare', 'Endangered' or 'Critically Endangered' due to their restricted distributions and vulnerability to human activities (Miller & Morris, 2001).

Soqotra is home to an estimated 44,000 human inhabitants (CEC, 2000). Although the island has been settled by people for over 2000 years, the remarkable degree to which the people have adapted to work with their unique environment has meant that there are surprisingly few environmental problems. This has been enforced by physical, political and climatic isolation, requiring self-sufficiency and promoting a sus-

tainable approach to the use of natural resources. However, the human population is now increasing and there are strong pressures for development to bring the benefits of modern health care, sanitation, education, improved nutrition, better housing and economic prosperity. The island has also become more accessible to visitors in recent years.

The people of Soqotra are dependent upon the sustainable management of the island's environmental resources. The concept of the sustainable use of biological resources is a critical aspect of the 1992 United Nations Convention on Biological Diversity. In order to establish whether existing or possible increasing levels of exploitation are sustainable it is therefore crucial that baseline information on the conservation status of the island's biota and biomes must be determined for biological resources that are, or may be, harvested from the wild.

Aloe perryi Baker is a species of great usefulness and historical significance to Soqotra. Its sap has been extracted for centuries for a variety of pharmaceutical and medicinal purposes and is currently exported in small but significant quantities, providing many local people with much needed cash income. Prior to the 19th century it was cultivated commercially (Simeone-Senelle, 1994) and the possibility of investigating commercial cultivation to provide a valuable source of income for local people has been suggested in the Socotra Master Plan (CEC, 2000). Although the species is widespread, locally abundant and 'under no immediate threat', Miller & Morris (2001) assigned it a conservation status of 'Near Threatened' (Rabinowitz, 1981; Mace & Stewart, 1994; IUCN/SSC, 1999) due to the potential danger to wild populations if the current small scale harvesting level were to be significantly increased. Due to the small size of Soqotra, many of its endemic species would technically fall into the 'Vulnerable' category using the Mace & Stewart (1994) criterion of 'occupying typically less than 100 sq km'. Miller & Morris (2001) feel this is overly severe and have reclassified many Soqotran endemics, including *A. perryi*, to the lower risk category of 'Near Threatened'. Miller & Morris (2001) also identified the 'white substance' (determined in the current study to be a scale insect infestation) as a potential threat that required further investigation.

The sap of *A. perryi* is known as bitter aloes or in the Soqotri language as *tayf* (meaning 'bitter' and also used to refer to the plant itself) and has a variety of uses (Miller & Morris, 2001; Simeone-Senelle, 1994). It has been used traditionally throughout the region (especially in Dhofar on the Arabian mainland closest to the island) as a purgative, decongestant, disinfectant

and cicatrizing agent, to relieve stomach pains, aid digestion and to treat boils, haemorrhoids and sores in the mouth, nose and eyes, as a vermifuge and even to treat poor eyesight (Miller & Morris, 1988). In high doses it can lead to abortion. Bitter aloes were regarded by Abu Zayd Hasan at the beginning of the 10th century AD as 'the most important drug, without which a medicine is not complete' (Simeone-Senelle, 1994). On Soqotra the traditional uses were more restricted, the main applications being to bind fractures (root and stem 'bark'), to wean young (of both people and animals by being painted around the nipple/teat), to drip into infected eyes (especially of livestock), to 'clean out the stomach' in almost any illness (taken orally, diluted in water) and to smear on containers of cereals to deter rodents (M. Morris, pers. comm.). Currently the sap is used as an antiseptic for wounds, drunk diluted in water for stomach upsets and as a cure and preventative for malaria. Babies have a drop of the juice put on their tongues within a few days of birth to promote malaria resistance and for overall vitality. Additional medicinal uses are spreading inland from the more populated coastal areas where visitors from abroad are promoting its use. Demand for the sap is clearly increasing, and it is currently possible to sell as much *Aloe* juice as the people harvest (M. Morris, pers. comm.).

Duvaliandra dioscoridis (Lavranos) M. Gilbert is a small, clump-forming stem succulent belonging to the Apocynaceae (tribe Stapelieae). It was first discovered in 1967 by J. J. Lavranos and described by him as *Caralluma dioscoridis* (Lavranos, 1970). Later Gilbert (1980) established the monotypic genus *Duvaliandra* for this species based on distinctive floral characteristics. This species has only been found at one restricted site on Soqotra and has only been observed on a few occasions since its original discovery. Miller & Morris (2001) reported only three specimens in 1992, but were confident more could be found in the surrounding area. Orlando (2000) reported that the population consisted of mature plants exhibiting two flower colour forms, as well as some seedlings.

On the basis of its limited distribution, specialised habitat and appeal to succulent enthusiasts Miller & Morris (2001) had no hesitation in including *D. dioscoridis* in the IUCN category Critically Endangered along with three other Soqotran endemics (*Taverniera sericopylla*, *Pelargonium* sp. nov. and *Cadaba* sp. nov.).

Methods

This study was part of a research trip undertaken by the authors in December 2001 and January 2002 that set out to investigate the distribution,



Figure 1. A dense population of *Aloe perryi* near the Jabal Falanj study site. Photo: Susan Christie.



Figure 2. The habitat of *Duvaliandra dioscoridis* in the granitic Haggeher mountains. Photo: Susan Christie.



Figure 3. Large clump of *Aloe perryi* at the Meyhah study site, demonstrating the build-up of sand around the clump over the years. Compare the leaf shape and colour with the plants in Figures 1 & 4. Photo: Susan Christie.



Figure 4. A previously harvested *Aloe perryi* at the Qatariyah study site. Photo: Neil Oakman.



Figure 5. Two rosettes of *Aloe perryi* (probably the same individual) at Meyhah, one showing severe scale, the other showing no appreciable infestation. Photo: Susan Christie.



Figure 6. A *Duvaliandra dioscoridis* clump. Photo: Neil Oakman.

harvesting and reproductive status of *A. perryi* and the possible effects of these factors on its current conservation status. In the case of *Duvaliandra* the population was studied to gauge its reproductive success and the surrounding areas were checked for further populations. Both species were examined for evidence of pests, diseases and predation that might threaten their long-term survival.

Aloe perryi

Four sites with large populations of *A. perryi* were surveyed intensively, and additional populations were visited and notes made on the plants. At each of the four main study sites a grid of sampling points was established with 42 (in one case 44) quadrats sampled, each two metres square. Quadrats were sited every 20 m in a north-south by east-west rectangular grid. Both qualitative and quantitative data were collected in each plot concerning the physical features and health (categorised from 1 (dead) to 5 (excellent)) of all *Aloe* plants found within the quadrat. The physical environment as well as the plant and animal species occurring with the *Aloe* were noted in detail. Information on the human uses of the *Aloe* was gathered through discussions with local people who are actively involved in its harvesting and use.

The four sites surveyed for *A. perryi* represented a variety of physical, geological, climatic and harvesting conditions. The first was in the west of the island, near the steep coastal escarpment with cliffs dropping over 350 m directly to the sea, in the vicinity of Jabal Falanj (Figure 1). This site consisted of sloping limestone pavement rising out of a sandy plain. The second site, Di-Hashus, was in the granitic Haggeher Mountains near the north central part of the island. The third site, Qatariyah, was again on limestone pavement, close to the edge of the southwestern coastal escarpment, where the limestone cliffs plummet 500 m to the wide coastal Noked Plain. The final site, Meyhah, was nearer the centre of the island in the west at an altitude of about 100 m. This site exhibited primarily sandy soils, with some emergent limestone pavement.

Duvaliandra dioscoridis

Following the site description given by Lavranos (1970) the type locality was found in the Haggeher Mountains at 900m elevation (Figure 2). A small but healthy population occurred within a confined area of some few hundred square metres. All plants located were surveyed for a variety of physical and biological characteristics. An extensive survey of the surrounding area was conducted to determine if additional populations could be found.

Results

Aloe perryi

The four study sites were selected to represent a range of attributes. Sites varied with regard to altitude (130 to 500 m), location (coastal to inland), substrate (limestone pavement, sandy soil, granitic outcrops), timing and amount of moisture (northeastern or southwestern monsoon or mists) and harvesting (only Qatariyah and Meyhah are currently harvested). Predation by domestic animals was found to be low or non-existent. Although goats were abundant at all sites and there was evidence of their grazing and browsing many other plant species, there was no evidence of goats eating adult or seedling *Aloe*. However, local people informed us that goats would consume *Aloe* in times of severe drought and food shortage.

All study sites were selected for their dense populations of *A. perryi*, which is widely but patchily distributed on the island. At all sites *Aloe* tended to occur on rocky outcrops, or amongst boulders or stones. The Meyhah site was primarily a sandy plain (Figure 3), but even here the majority of *Aloe* plants were closely associated with rock outcrops or scattered surface rocks. Physical shelter appears necessary for successful seedling establishment at all of the sites studied.

Plants were healthy overall, with most plants at all sites exhibiting 'Good' or 'Excellent' health; only at Di-Hashus were there more than 20% of plants exhibiting 'Fair' health. The percentage of rosettes exhibiting disease was below 10% at all sites. There were striking differences between the age distributions at the four sites, with healthy populations of adults, sub-adults, juveniles and seedlings being evident at both Jabal Falanj and Qatariyah, but with almost no seedling recruitment at Di-Hashus. No seedlings were observed at Meyhah despite the presence of many dehisced seed-pods. Vegetative offsets of mature plants were the only form of reproduction observed at Meyhah, and a small number of locations were found where offsets had apparently been transplanted by local people.

Plants are currently harvested at Qatariyah and Meyhah only (Figure 4), although the density of plants appeared sufficient to provide a harvest at Jabal Falanj. This area has been harvested in the past and the sap is likely to be of acceptable quality. Informants stated that the plants at Di-Hashus are used locally, but they also informed us that they did not consider the sap produced by these plants suitable for export. Only sap of plants growing in the driest areas is regarded as valuable commercially and medicinally, with the sap of the large, green, fleshy aloes of wetter areas (as at Di-Hashus) having

little or no value (M. Morris, pers. comm.). Although the population at Qatariyah is heavily harvested, this activity does not seem to be having an adverse effect on reproduction or plant health. Unfortunately, this healthy situation does not pertain at Meyhah. This site was extensively harvested twice each year, with most adult plants evidencing signs of repeated and heavy harvesting.

Two invertebrate infestations were found. *Aloe* mite was present in very low numbers at all sites and generally affected only inflorescences. A pale scale insect was also found at all sites, generally at low levels. At most sites there were occasional plants with severe scale infestations (Figure 5) and at Meyhah the infection rate of plants near the study area was often severe, with significant numbers of dying plants that showed evidence of heavy infestation, with death possibly due to subsequent bacterial infection.

Duvaliandra dioscoridis

A total of 58 discrete clumps (Figure 6) or individual plants were located at the type locality, ranging from clumps 1.3 m across to recently germinated seedlings. The plants were relatively easy to locate, growing in the open on a granite outcrop. The habitat is an exposed south to south-east facing portion of a ridge with a slope of around 45°. Very little other vegetation occurred with the *Duvaliandra* plants, with only 16 low-growing species found growing in close association. Little or no shading from plants or rocks occurs. A search was made of similar outcrops in the area but no further populations were located. This search included investigation of the ridge that supports the population and exhibits similar outcrops and slope exposure features along its length. Our local informant (a camel driver from a nearby village who uses the pass frequently) reported that *Duvaliandra* is edible but is not eaten regularly. Some evidence was found of rocks having been prised away from the outcrop for use as building stone for local boundary or house walls. Apart from the reported occasional consumption by the local human population, *Duvaliandra* does not seem to suffer predation from grazing animals. A few minor aphid infestations were found, mostly affecting unopened flower buds and young seed-horns.

Discussion

The Socotra Master Plan (CEC, 2000) makes a number of recommendations which are designed to protect the unique biology of the island while providing for an enhanced quality of life for the people through improved standards of nutrition, education, health and economic opportunities. Implementation of these recommendations is

dependent on extensive funding being accessed. Development of the island's infrastructure (roads, airport, towns) and increased tourism, and changing traditional land management practices, will continue to put pressure on the populations of all wild species. The local people have a clear understanding of the balance between their natural environment and their way of life, but desire for development, demographic influences and changing lifestyles all affect this relationship. The two species studied here are but two of many for which conservation strategies are required. More research is required to develop further the conservation strategies for these and other species.

The Soqotran people and the Yemeni Government are aware of the need to protect the environment of the Island and Yemen is a signatory to the Convention on Biological Diversity. As part of this commitment there is a complete ban on the removal of living material from the island, and this is enforced by baggage searches at the airport and a system of permits for scientists working on the island. Despite these measures biological piracy by private plant collectors or commercial interests remains a threat to many of Soqotra's endemic succulents, including *D. dioscoridis*.

Aloe perryi

Whereas two of the populations studied appeared relatively healthy with a balanced age structure, there are some concerns about the Haggeher population due to very low levels of seedling recruitment. However, it is the study site at Meyhah that causes the most concern. There is no evidence of seedling recruitment and many of the plants are dying following heavy scale insect infestation. Drought stress and the high levels of local harvesting are also likely to be contributing to the stress on these plants, increasing their vulnerability to pests. Unlike at the other study sites, a village lies only a few hundred metres from the harvested plants. It is also at this site that the people rely heavily on the *Aloe* harvesting to supplement their income, and therefore the apparent decline of this population has social as well as ecological ramifications. Urgent action is required if harvesting is to continue at this site at current levels without causing damage to the population in view of the levels of scale infestation and lack of seedling recruitment. Several other species at Meyhah that showed evidence of population decline were noted and the possibility exists that a gradual drying of the area is the primary factor contributing to the lack of *A. perryi* regeneration. Further research on the effects of climate and climate monitoring are required to determine if this is a relevant factor. Based on

the current information *A. perryi* should still be considered 'Near Threatened'. Increased harvesting, land use changes, climate change and a variety of other factors could push the species into the 'Vulnerable' or 'Endangered' category.

Duvaliandra dioscoridis

The only known population of this species seems to be healthy and reproducing well, but not spreading to other similar habitats locally. Orlando (2000) reports that the seed coma is very short and easily detached in this species, which is presumably an adaptation to the strong winds prevalent in the area. It is unclear what possible factors, including the restricted dispersal ability or the lack of suitable nearby habitats, are limiting the distribution of this species. Although many more plants were located during this study than found by Miller in 1992, since the extent of the population appears to be limited to a few hundred square metres, this species must still be considered 'Critically Endangered'. The report that local people eat the plants raises the concern that an intense harvest could devastate the entire population of the species. Local people collect building stone in the area and this could also pose a threat through direct damage to plants and habitat destruction.

The Hageher Mountains, which are home to a majority of Socotra's rarest endemic plants, have been designated as one of 15 Sites of Special Scientific Interest (CEC, 2000) and this should afford some protection to the plants there. Protection from human predation and collection of building material will require the co-operation of local people. Miller & Morris (2001) suggest that long-term climate change may be affecting the regeneration of other endemic plants. With the extremely restricted distribution of the apparently sole population of *D. dioscoridis*, climate change could have a catastrophic effect on the survival of this species in the wild.

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