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Reintroduction of Giant Tortoises, *Geochelone gigantea*, to the Seychelles' Islands

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Introduction

Giant tortoises are the largest living terrestrial member of the Testudines family and in the past these reptiles populated numerous islands in the Indian Ocean and Galapagos Islands (Gaymer, 1968). Two hundred years ago the Indian Ocean had more than fifteen different species of these giant land tortoises but many of these populations were exterminated for their meat and oil.

The Aldabra giant tortoise, *Geochelone gigantea*, inhabits the Aldabra atoll (off the coast of Kenya and north of Madagascar) and is now the only remaining species on the islands of the Indian Ocean. The giant tortoise population on Aldabra has been estimated at 150,000 individuals (Bourn and Coe, 1978). This colony is at present the largest population of giant tortoises in the world and remains a living reminder to mankind of how vulnerable nature can be to over-exploitation.

This paper will focus on the dynamics of the existing population of giant tortoises on Aldabra, the difficulties in maintaining populations of giant tortoises in captivity, and the ecological implications of reintroducing tortoises to Curieuse Island in the Indian Ocean.

Giant Tortoise Populations on Aldabra

Aldabra atoll is composed of four islands, three of which have tortoise populations. Two of these islands, Malabar and Grande Terre, contain the majority of the total population. The Malabar population of 2,250 is restricted to the coastal strip, whereas the Grande Terre population of 147,000 is found throughout the length of the island (Bourn and Coe, 1978). Malabar is covered by dense vegetation, but the coastal area, inhabited by the tortoises, is more open and contains shrubs and grassland. Grande Terre has a much more open vegetative cover composed of woodlands, shrubs and grasslands (Swingland and Lessells, 1979). Tortoises are selective grazers, feeding on a wide range of foodstuffs of which the most important is "tortoise turf"(Merton et al, 1976). Tortoise turf is a complex of grasses, herbs, and sedges that have been dwarfed by the grazing pressure of the tortoises.

There are two seasons on Aldabra: the monsoon season, from November to April with high temperatures and the dry season, from May until October with cooler temperatures (Gaymer, 1968). Annual rainfall varies with an average of 1056 mm. The onset of the rainy season also varies considerably. The distribution of tortoises is correlated to the seasonal distribution of preferred vegetation that is determined by the precipitation cycles (Swingland and Lessells, 1979). Swingland and Lessells (1979) documented that some of the tortoises on Grand Terre migrated to the coast at the onset of the rainy season to reap the benefit of the emerging vegetation. This benefit was shown in a higher reproductive fitness for the migratory individuals. Their study also showed that mortality rates were higher on the coast due to a lack of shade trees and the subsequent dehydration and heat exposure of the tortoises. In contrast to Grand Terre,

none of the tortoises on Malabar migrated. The authors argue that both migrant and non-migrant populations will persist together as long as the received pay-offs are approximately equal.

In a further study done by Swingland et al. (1989) their findings indicate that not only do certain individuals migrate while others do not but those same tortoises have a longer narrower shell shape. In addition, there is higher mortality on the coastal habitat among tortoises having the rounder, flatter shell shape. Mortality is equal between the body shapes in the upland habitat. The authors state that the carapace or shell shape is derived from the influence of habitat and diet and not genetically determined in the Aldabran tortoise. Having this knowledge will influence the site selection process and food availability and abundance concerns of anyone conducting reintroduction projects for giant tortoises.

The interactions between plants and animals within any system or community will often determine the abundance and distribution of the species of concern (Merton et al., 1976). On Aldabra the distribution of various types of vegetation is largely determined by the topography of the islands and has been co-evolving with the grazing pressure of the tortoises. The giant tortoise is the only large herbivore on Aldabra and occurs at high density, 27 individuals per hectare (Gibson and Hamilton, 1983). In addition, their distribution is not even with higher concentrations occurring in preferred habitat areas. Tortoises, being poikilotherms, are active and feed during the cooler times of the day, morning and evening (Merton et al., 1976). In the heat of the day, especially in summer months, the tortoises must find shade and usually shelter under trees or shrubs. In the Merton et al. (1976) study there was evidence that tortoises could cause damage to both vegetation and soils if numbers and concentrations were high.

Giant tortoise diet includes many plant species, nearly all taken from the ground, but most are only taken at particular seasons or in small amounts. "Tortoise turf" is the most highly selected food in the diet, and is taxonomically diverse but all components are maintained as new growth from the intense grazing by the tortoises (Gibson and Hamilton, 1983). High nutrient value, low toughness, and small particle size are all important diet characteristics because the tortoise has very little physical breakdown and mixing of their food in the gut and rely on long periods of digestion to achieve energy assimilation. Other preferred items in their diet include flowers and fruit that share the same characteristics of high nutrition and low toughness. Diet selectivity declines after the peak of tortoise turf feeding and broadens as the dry season progresses (Gibson and Hamilton, 1983). Giant tortoises are tightly restricted by food supply and seasonal movements are determined by the changing patterns of plant productivity and distribution. Also, the tortoise’s movements are restricted by the island topography and their morphology making this a unique herbivore-plant system.

The vegetation of Aldabra is heterogeneous at a wide range of pattern scales and tortoises respond to this pattern in both their daily movement and seasonal movement. In addition, the Aldabran giant tortoises have great flexibility in maximum size, size and age at maturity, and the rate of egg production and relative reproductive effort (Gibson and Hamilton, 1984). Gibson and Hamilton have documented that both growth and reproduction are a function of population density in the giant tortoise. In low density populations individuals grow at a fast rate, are large at sexual maturity, and continue to grow while producing eggs. Their overall reproductive effort is low. In contrast, individuals in high density populations grow slowly, are small at sexual

maturity, and stop growing once they become reproductively active. This allows them to put all their spare resources into reproduction. According to Gibson and Hamilton this life strategy is likely to be valuable for animals with indeterminate growth, in which phenotypic plasticity is possible (Gibson and Hamilton, 1984). This also makes Giant Tortoises an excellent species in which to study the relationship between resource distribution and intraspecific competition in a herbivore plant community.

Captive Giant Tortoises

The Aldabra giant tortoise was given a "rare" status by the International Union for the Conservation of Nature (IUCN) because of the species vulnerability to any interference with its limited natural habitat (Groombridge, 1982). A number of giant tortoises live in zoos but both husbandry and breeding have proven difficult.

One documented breeding of Aldabra tortoises occurred at the Sydney Zoo in 1976 (Peters and Finnie, 1978). The zoo imported several of the Aldabra tortoises in 1947. Over the years of 1967-1975, a few mating attempts were observed but no fertile eggs were laid. The caretakers concluded that the problem might have been caused by faulty husbandry practices. They changed both the enclosure and the diet of the tortoises in an attempt to remedy the situation. They seeded the enclosure with grass that the tortoises grazed on and they supplemented their diet with more fruits and vegetables. After five years one of the females made a nest and deposited 13 eggs. The eggs were collected and incubated in a plastic container with a damp paper towel and covered with a lid. The container was kept in the dark at 25-28 degrees Celsius. Nine out of the thirteen eggs were fertile and eight out of those nine survived. The next year the same female laid another clutch of 14 eggs one hatched, one was accidentally broken, and the rest were infertile. This was one of the first captive breeding successes and points to the importance of providing the appropriate diet and habitat for the tortoises.

In 1984, the Zoological Society of London conducted a survey of giant tortoises in which 28 individuals were found living in zoos (Samour et al., 1986). According to their study, the survival rate of giant tortoises kept in zoos was very poor and the mean longevity was five years. They attributed this poor survival to suboptimal housing and diet. The study was done over a two-year period and 21 individual giant tortoises had clinical observations and laboratory test done. Nine of the individuals were considered sick during the survey and were diagnosed with wasting syndrome (Samour et al., 1986). The symptoms of wasting syndrome were general weakness, lethargy, and inability to lift up their carapace. In chronic cases, there were individuals with secondary bacterial and respiratory infections. In all of these cases, the animals were housed indoors with no under-floor heating.

The findings of this study suggest that there is a lack of understanding of the proper housing and diet of the Aldabra giant tortoises. The Institute for Herpetological Research has had more success at housing and breeding giant tortoises (Stearns, 1988). In their breeding program much attention was paid to providing a large outdoor area with grass and alfalfa, temperatures were maintained, and a wide range of food types were provided. These studies point to the need for both further research on captive animals as well as on wild populations. In addition, the poor

survival and reproductive rate in captivity demonstrates the need for more effort at reintroductions of giant tortoises in the wild.

Curieuse Island Reintroduction

The Republic of Seychelles is composed of a group of islands in the western Indian Ocean (Stoddart et al., 1982). Historically, the economy of Seychelles was based on agricultural export, but in 1971, an international airport was built on the island of Mahe. In the following years the number of tourist rose from 1,000 in 1971 to 79,000 in 1979. Estimation for 1986 predicts 150,000 tourists are expected to visit the islands (Stoddart et al., 1982).

The Seychelles islands are attractive to tourist, for the beautiful beaches, for the natural history, and for the chance to see giant tortoises. The increase in the tourist industry represents the potential for economic gain and is a priority for the Seychelles' government.

In 1977, the Seychelles government and the Royal Society of London proposed the establishment of a daughter colony of giant tortoises on an island close to Mahe (Stoddart et al., 1982). This proposal was thought to have a double advantage; one, expanding the tourist industry and two, creating an opportunity to study the ecological and biological aspects of the giant tortoise. A set of criteria for site selection was made and included some of the following:

- The island should be reasonable small and not allow the tortoises to disperse off the island.
- It should have adequate food and shade for the tortoises.
- It should have suitable areas for tortoise nesting.
- It should have fresh water.
- If possible, it should be in Government ownership.
- There should be Government wardens present to monitor and protect the tortoises.

Curieuse was selected for this experiment based on its size, accessibility, and apparent environmental suitability. Curieuse is a granitic island, 4.4 km long with a maximum width of 2 km and has a total area of 2.8 km square (Samour et al., 1987). The hill slopes are steep and consist of bare granite or eroded red soils. There are scattered areas of coastal plateaus and marshy lowlands. The island has mature woodland in the uplands and the plateau areas are vegetated with grasses and herbs. Curieuse has always been owned by the Seychelles government and was used as a leper colony in the 1800's (Stoddart et al., 1982). Interestingly in the 1890's, a colony of giant tortoises was deliberately maintained on the island. Unfortunately, there are no records of what happened to the colony. Curieuse was designated a National Park by the Seychelles government in 1979.

The reintroduction project started in 1978 with the collection of 101 giant tortoises from Aldabra (Stoddart et al., 1982). The tortoises were tagged, using the method developed by Gaymer (1973), measured and weighed. The animals were then held for 5 weeks and monitored. Ninety-five of the tortoises were finally released on Curieuse near the residence of the warden. Over the next two years the tortoise population was monitored periodically, animals were located, and in 1980, the first hatchlings were found. The evidence of breeding success lead to the decision to

relocate another group of tortoises from Aldabra. Seventy-eight more tortoises arrived in April of that year. Monitoring the following year resulted in 103 tortoises located, several hatchlings were found, and the animals had dispersed across the island. The future plans of the project call for the relocation of up to 500 tortoises at 100 per year followed by a monitoring effort to determine population status, breeding success, and effects on vegetation.

In 1986, the Zoological Society of London carried out a field study to assess the Curieuses experiment in terms of the impact of the tortoises on the ecosystem and what impact the local residents and tourists had on the tortoises (Samour et al., 1987). Their study included a population census, weighing and age classification, physical measurements, clinical observations, and ecological observations of the giant tortoises on Curieuse. The evidence they found was that the tortoises had adapted to the environment and had caused no damage to the native vegetation. There was, however, tourist impact on the tortoises (Samour et al., 1987). The main tourist activity that directly affected the tortoises was photography, with people sitting or standing on the tortoises for a picture.

In addition tourist were allowed to go anywhere on the island and a lack of supervision meant they could damage nest sight or hurt hatchlings. In addition, tourist-linked pollution such as bottles, cans, and discarded food posed a potential hazard for the tortoises.

The most dramatic results of the study were that the researchers were only able to find fewer than half the tortoises originally introduced. In addition, the number of hatchlings found was extremely small, numbering only 17. The authors concluded that the tortoise population was declining. Only 102 individuals were found and according to estimates of population growth there should have been 400 individuals between the ages of 0-5 years. They attribute the low population to poaching and theft done by the locals able to sell them on the illegal market for large profits.

A further study was done in 1990 and again a population census, weighing and age classification, physical measurements, clinical observations, and ecological observations were conducted (Hambler, 1993). The finding showed a total of 117 individuals were found: 73 adult males, 38 adult females, and 6 juveniles. Of the estimated 2,100 tortoises that have hatched on Curieuse, very few have survived. The author argues that hatchling losses could be due to predation. Both feral cats and rats are predators of tortoise hatchlings on Aldabra and they occupy Curieuse Island. In addition, the author presents evidence of tortoises having reproductive success on the Seychelles island of Fregate which is cat and rat free (Hambler, 1993). Poaching and predation could have severe consequences on the ability of the giant tortoises to propagate and prosper in the new location despite the fact that environmental conditions appear to be adequate.

Implications of Reintroduction

The future of the Curieuse experiment depends on the establishment of a self-sustaining population of giant tortoises on the island. Although the adult survivorship is not yet known, the hatchling and juvenile observed mortality would probably result in extinction of the tortoises on the island (Hambler, 1993). The reintroduction project was successful at choosing an appropriate environment for the tortoises in terms of their ecological requirements. There was insufficient

planning for other factors, such as poaching, interaction with tourist, and predation from feral cats and rats. If the goal remains to have a viable population of Aldabra giant tortoises on the island, mitigating steps may need to be taken to address these issues.

The tortoises are not being adequately protected even though they have a "rare" status and the island was designated a National Park. The growing demand from the international market to obtain giant tortoises and the easy money that this trade offers imposes a temptation on the locals and visitors. Stricter legislation may be necessary to combat the poaching and illegal market that is responsible for some of the tortoise losses. In addition, tighter control of tourists and tourist mobility will be increasingly necessary as more visitors come, to prevent damage to tortoises and their nesting sites. The loss of hatchlings from feral cats and rats must also be addressed. One option would be to implement a removal program but this may be expensive and difficult to accomplish.

Another option would be to create a properly managed tortoise nursery. This option could provide both a popular attraction for visitors and ensure the hatchlings and juveniles are able to survive. The Curieuse reintroduction has provided valuable knowledge to the field of restoration and demonstrates the need for further research in this area to assist in the recovery of rare, threatened, or endangered species and their environments.

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