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Conservation of *Lygodactylus williamsi* (Reptilia: Squamata) in the Kimboza Reserve, Tanzania, and its breeding in Liberec Zoo, Czech Republic

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Abstract. One of the main roles of modern zoos is the conservation of endangered animal species, primarily by keeping populations of them in captivity (*ex situ* conservation) and also by protecting these animals in their natural environment (*in situ* conservation). Liberec Zoo meets both of the aforementioned roles for several of the species kept, especially birds of prey. However, the zoo has never focused on the *in situ* and *ex situ* conservation of an endangered reptile species. The limiting factor in the past has often been the size of the exhibits and a lack of new spaces. The turquoise dwarf gecko (*Lygodactylus williamsi* Loveridge, 1952) was an ideal candidate for this due to its small size. The aim is to become part of a coordinated captive breeding programme, while also getting involved in turquoise dwarf gecko conservation in the wild. This Tanzanian *in situ* project is underway in the tropical lowland forest of the Kimboza Reserve. Here, the turquoise dwarf gecko is intricately tied to the screw pine (*Pandanus rabaiensis*), which is being displaced by the non-native and fast-growing Spanish cedar (*Cedrela odorata*). Other no less significant threats to the local gecko population include fires caused by slash-and-burn farming, illegal logging and mineral extraction, and the illicit capture of specimens for the pet trade. The project is focused on protecting the turquoise dwarf gecko's habitat with the support of local communities. By means of various educational and fundraising activities, project members are trying to secure the financial means necessary to implement sub-activities such as creating firebreaks to prevent the spread of fires in the forest, funding forest rangers and their equipment, as well as clearing the forest of invasive trees. There is also an emphasis on environmental education, training and awareness raising, not only for students in schools in Tanzania but also in Europe by means of the zoological institutions involved.

Key words. Ex situ conservation, in situ breeding, reserve, *Pandanus*, gecko.

INTRODUCTION

The turquoise dwarf gecko (*Lygodactylus williamsi* Loveridge, 1952) is a small lizard species that currently occurs in just two locations, both fragments of the tropical forest in eastern Tanzania. These are the Ruvu and Kimboza Forest Reserves, with a total area of approximately 20 km^2. The Kimboza Reserve lies at the foothills of the Uluguru Mountains (eastern part) and, due to deforestation, a fragment of just 4.05 km^2 forest now remains (Kilawe et al. 2022). The Ruvu River flows through Kimboza and is an important source of water not only for the local inhabitants but also for the flora and fauna. Despite its small size, it has a high biodiversity of animal and, in particular, plant species (Rodgers et al. 1983, Kacholi 2013). Kimboza is a lowland forest with the highest number of recorded bird species in East Africa, a total of 82 species have been described (Doggart et al. 2001). Scientists have classified 22 amphibian species and 34 reptile species in both reserves, some of which have been discovered for the first time (Flecks 2022).

The turquoise dwarf gecko is an endemic reptile species that inhabits a relatively small, fragmented area where it lives exclusively on the screw pine (*Pandanus rabaiensis*) which must have

sufficiently long leaves (Flecks et al. 2012). It prefers large trees and lives at a height of 2–5 m (Figs. 1–2). This tree species occupies 17.6% of the area in the reserve and only grows on limestone bedrock (Weinsheimer & Flecks 2010). The characteristics described above mean the turquoise dwarf gecko is highly vulnerable to extinction. Due to long-term, large-scale disturbances to its natural habitat, the turquoise dwarf gecko has been on the International Union for Conservation of Nature's (IUCN) Red List of Threatened Species in the category "Critically Endangered" since 2012. In the Convention on International Trade in Endangered Species (CITES), it falls under Appendix I, which includes animal species threatened with extinction. International trade in wild-caught specimens is prohibited. A project to protect the turquoise dwarf gecko from the negative impacts that are primarily caused by human activities has been underway in the Kimboza Reserve since 2020. The main threats include deforestation caused by fires from slash-and-burn farming and illegal logging for timber, gold and gems. A similarly serious problem is the spread of the non-native Spanish cedar (*Cedrela odorata*) in the forest, this being at the expense of the native screw pine (*Pandanus rabaiensis*). The geckos are also illegally caught for the pet trade, mainly due to demand from private breeders in Europe and the USA. Conservation activities in the Kimboza Reserve involve local communities under the leadership of Dr. C. J. Kilawe of the Sokoine University of Agriculture. Dr. Heike Maisch from Erfurt Zoopark in Germany coordinates the project in Europe. Apart from the afore-mentioned zoopark, the project is financially supported by the Zoological Society for the Conservation of Species and Populations (Zoologische

Fig. 1. The turquoise dwarf gecko is bound to the pandan tree (*Pandanus rabaiensis*) in the Kimboza reserve. It prefers taller trees with leaves up to 1 m long (photo by C. J. Kilawe).

Fig. 2. The adult male of turquoise dwarf gecko is blue in color with black stripes on the throat. Males are territorial and guard their territory, the pandan tree (photo by C. J. Kilawe).

Gesellschaft für Arten- und Populationsschutz, ZGAP) and ViVe (Vivaristische Vereinigung e.V.) the German exotic animal breeders' association.

The project's main objectives are to preserve the gecko's natural habitat and to prevent it from being illegally caught. The following sub-activities are intended to contribute to the achieving these objectives. The first is to create and regularly maintain firebreaks in the forest. The next is to clear the forest of the invasive Spanish cedar and provide funding for forest rangers to prevent poaching in the reserve (Figs. 3–4). So far, Spanish cedar has been cleared from 50 ha of forest in the reserve. It was also possible to clear 15 km of firebreaks to prevent the spread of fires and another 5 km of firebreaks have been recently created under the leadership of Dr. Kilawe. Eight men chosen from local communities are now being trained under the guidance of rangers from the Tanzania Forest Service Agency (TFS) and together they have conducted 36 patrols which have reduced illegal logging in the reserve. In the future, conservation activities should also focus on planting indigenous trees in the reserve and providing additional income opportunities for local communities from ecotourism and the sale of honey from apiaries.

One very important aspect of the project is likewise educating the public, e.g., students in schools, and not just in the gecko's homeland but also abroad. This is where the participating zoos play an important role by educating their visitors, for example during guided tours, holding public events, information panels or via websites and social networks. Liberec Zoo is the only Czech zoo to be involved in the project so far, having become involved at the end of 2020. Promotional activities for the project involve not only the small exhibition of turquoise dwarf geckos and information boards in the tropics pavilion, but also, for example, handing out worksheets for young visitors to the zoo.

Fig. 3. One of the rangers creating a gap against the spread of a forest fire in the Kimboza Reserve (photo by C. J. Kilawe).

Fig. 4. A very important activity of the conservation project in the Kimboza reserve is the clearing of the forest from the invasive cedrela tree, which is rapidly spreading through the forest and displacing the original and vital pandanus for the geckos. Cedrela is a popular fuel and construction wood. Students from the local Sokoine University are also involved in clearing the forest of non-native cedrela (photo by C. J. Kilawe).

Part of the effort to save the turquoise dwarf gecko on our planet is to breed it in captivity in conservation institutions, which serve as a backup if the worst-case scenario, the extinction of the species in the wild, were to occur. The European Association of Zoos and Aquaria (EAZA) has established a European Studbook (ESB) for the species. The aim is to coordinate international cooperation to ensure that a viable and healthy population of turquoise dwarf geckos can be set up in captivity. Erfurt Zoo has been successfully breeding captive turquoise dwarf geckos for a long time. Thanks to the cooperation with Erfurt's curator, Heike Maisch, it was possible to obtain an adult female and male gecko from Leipzig Zoo and accommodate them in the Liberec Zoo (Figs. 5 and 6).

Fig. 5. Exhibition terrarium for the turquoise dwarf geckos in the tropics pavilion of the Liberec Zoo (photo by P. Hnidová).

MATERIALS AND METHODS

A custom-made terrarium was built for the turquoise dwarf geckos. Instead of screw pines it had commonly available *Sansevieria* plants as well as bamboo and a cork branch (Fig. 5). The back wall of this small display consists of a background imitating a rock. A substrate for tropical terrariums with a mixture of sand is used as litter. A drainage layer is placed under the substrate. The lighting, installed above the stainless-steel mesh ceiling, consists of a 35 W halogen bulb (12 h/day) and a 5.0 15 W UVB lamp (4 h/day). The geckos' background area then has a 35 W UVB lamp. The terrarium is usually kept around 24–28 °C during the day, 34–36 °C under the heat lamp. At night, the temperature drops a few degrees lower to 18–20 °C. The humidity in the terrarium is usually between 50–70% during the day and up to 90% at night.

RESULTS

For the first fortnight after arrival, both adults were timid and spent most of the day hidden among the plants. However, they quickly got used to the presence of visitors and keepers. Nevertheless, the keepers' great excitement at the arrival of the new, critically endangered reptile was soon replaced by a modicum of stress. The geckos' acclimatization was also accompanied by a desire to explore the entire pavilion environment, and they tried to escape from their quarters at every opportunity. The fact that the turquoise dwarf geckos are thriving in Liberec is testified to by the fact that less than four months after their arrival at the zoo, the first mating took place and the female laid her first clutch of two eggs.

After 20 days she laid two more. All the eggs were glued to the terrarium wall in a place where the temperature is 24–26 °C during the day and 18–20 °C at night. Given the fact that the

Fig. 6. An adult male of the turquoise dwarf gecko kept in a terrarium in the tropics pavilion of the Liberec Zoo (photo by T. Hnida).

eggshells are very fragile, it was not possible to transfer them to the incubator and there was no interference with the breeding.

In the case of incubation in an incubator, the sex of the turquoise dwarf geckos' young can be influenced by regulating the temperature. According to Heike Maisch, females hatch at 24 °C and males hatch if the temperature is set 2 degrees higher. Thus, the clutches were a surprise, which was only revealed a few months later. The first clutch hatched two young after 55 days, unfortunately the next clutch was not successful.

The offspring were left in the parents' terrarium for the next four months to observe their behaviour within the family. From the very beginning, the parents did not show any predatory or agonistic behaviour towards their offspring. The young often kept close to their mother. At 120 days after hatching, it was decided to separate the juveniles from the adults as they had already started to change into the adult colours. One offspring, the male, acquired the blue colour typical for a male and the other juvenile retained the bronze female coloration.

After a break of almost a year, it is expected that there will be another clutch, as the adult pair was observed mating less than 20 days ago. It is sincerely hoped that the breeding will once again be successful and, as in the case of the first offspring, it will be possible to enrich the population of turquoise dwarf geckos bred in captivity in other zoos involved in the coordinated breeding of this species.

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