# Field observations on the natural history of the Malagasy hingeback tortoise, *Kinixys zombensis domerguei*

**David Mifsud[1], Maegan Stapleton[1] and Ryan Walker[2]**

[1] Herpetological Resource and Management, LLC, P.O. Box 110, Chelsea, MI 48118 USA
[2] School of Environment, Earth and Ecosystem Sciences, The Open University, Walton Hall, Milton Keynes MK7 6AA, UK

Corresponding author: DMifsud@HerpRMan.com

## Introduction

The hingeback tortoise (genus *Kinixys*) is a historically understudied and poorly monitored group of chelonians. As a result, there is a lack of published data regarding their population viability, habitat use, natural history and conservation needs. Until 2012, six *Kinixys* species were fully recognized. Following molecular phylogeny research, this has been elevated to eight species named *Kinixys homeana, K. erosa, K. nogueyi, K. spekii, K. belliana, K. lobatsiana, K. natalensis* and *K. zombensis* (Kindler *et al.* 2012). The latter includes two subspecies endemic to southeastern Africa named *K. zombensis zombensis* and *K. z. domerguei.* Over 75% of the genus was considered Not Evaluated (NE) or Data Deficient (DD) prior to a recent International Union for Conservation of Nature (IUCN) Red List assessment held in 2013 (Mallon *et al.* 2015). All species were ranked as Vulnerable, Endangered, or Critically Endangered. To date, no assessments of population health and status in the field have been conducted for most species of *Kinixys*.

*K. z. domerguei* is endemic to Madagascar with its range currently limited to Nosy Faly, a small island off the northwest coast of mainland Madagascar and the adjacent Ambato Peninsula, with the total area of occupancy being previously thought to be as little as a few km$^2$ (Kuchling 1986; Pedrono 2008). Known to have colonized Madagascar within the last 1,000 years, this group is presumed to be an introduced population though no evidence to support the claim is available and tortoises are known to survive long distances at sea, colonizing new locales (Pedrono 2008).

Almost nothing is known about the ecology, status and conservation threats to this endemic population. In general, specific data on the *K. zombensis* complex is lacking, largely due to its recent taxonomic elevation. Much of the existing information on these tortoises is from

research focussing on *K. belliana*. It is known that *K. zombensis* prefers to inhabit moist savannah woodlands, coastal grasslands and forest edges. In Madagascar, they have also been noted to utilize plantations, crop fields and villages (Kuchling 1986; Pedrono 2008). They are generally crepuscular and activity peaks for this species during the wet season. Similar to other *Kinixys*, they are known to have an omnivorous diet which includes a variety of live food as well as plant matter and fungi (Kuchling 1986). The breeding patterns of this species complex are poorly understood and the incubation period for this endemic population is unknown.

The driver of this work was recommendations provided within the Kinixys Conservation Blueprint (KCB) (Mifsud & Stapleton 2014). This comprehensive manual was created to provide an introduction to the genus, known or expected range and threats. The KCB also discusses broad/holistic approaches to implementing conservation measures aimed at reducing the impacts and pressures on this genus and developing achievable objectives to help maintain viable populations throughout Africa.

The aim of this research is to study the spatial distribution, reproductive behaviour, nesting, incubation and associated diapause, diet and habitat selection of the Malagasy subspecies, *Kinixys zombensis domerguei.* Major objectives were to fill in data gaps regarding *K. z. domerguei* ecology as well as establish a population size and density estimate across the population's area of occupancy. This work represents the first population level assessment of the endemic species designed to establish the limits of the range (area of occupancy).

## Methodology

The study was conducted from February 12th to 23rd 2016 by a team of four chelonian researchers including Ryan Walker, David Mifsud, Michael Cummings and Andrea Currylow as well as a team of assistants. Methodologies for this study reflected those used in previous work focussed on similar species (Kuchling 1986; Pedrono 2008; Segniagbeto *et al.* 2014). Protocols included primarily visual encounter surveys using line transects within the island of Nosy Faly and the northern portion of the adjacent Ambato Peninsula. Proposed transects were approximately one kilometre in length and evenly distributed within the study area. To reflect the crepuscular activity displayed by *Kinixys*, surveys were conducted during early morning and late afternoon. Morphometric and other biological data on observed specimens were collected on pre-formatted data sheets and each individual tortoise was given a unique identifying marginal scute notch (Fig. 1). Opportunistic data was gathered on habitat characteristics and condition, microhabitat use, food selection, reproductive condition and behaviour.

**Tortoise Data Sheet**

**Date:** _____ **Location:**_____ _____

**Species ID:** _____ **Marginal No. L**___ **R**___ **Sex (M, F, JUV, UNK):**_____

**Weight (g):** _____ **No. of Annuli:** _____

**Carapace Length (mm):** Straight:_____ Curved: _____

**Carapace Width (mm):** _____ **Plastron Length (mm):** _____

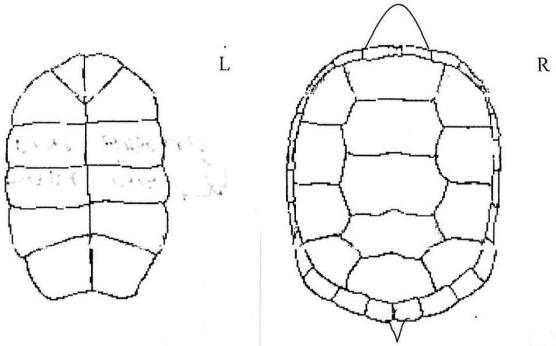
**Plastron Width (mm).** _____ **Shell Height (mm).** _____

**If female, gravid? Yes/No** _____

**Samples Collected? Y/N** _____ **Type (Tissue, Fecal, etc.):** _____

**Habitat:** _____

**Injuries:** _____




**Additional Notes:**

_____

_____

_____

Fig. 1. Pre-formatted data sheet used to collect morphometic and other notable data for *K. z. domerguei* observed in the study area.

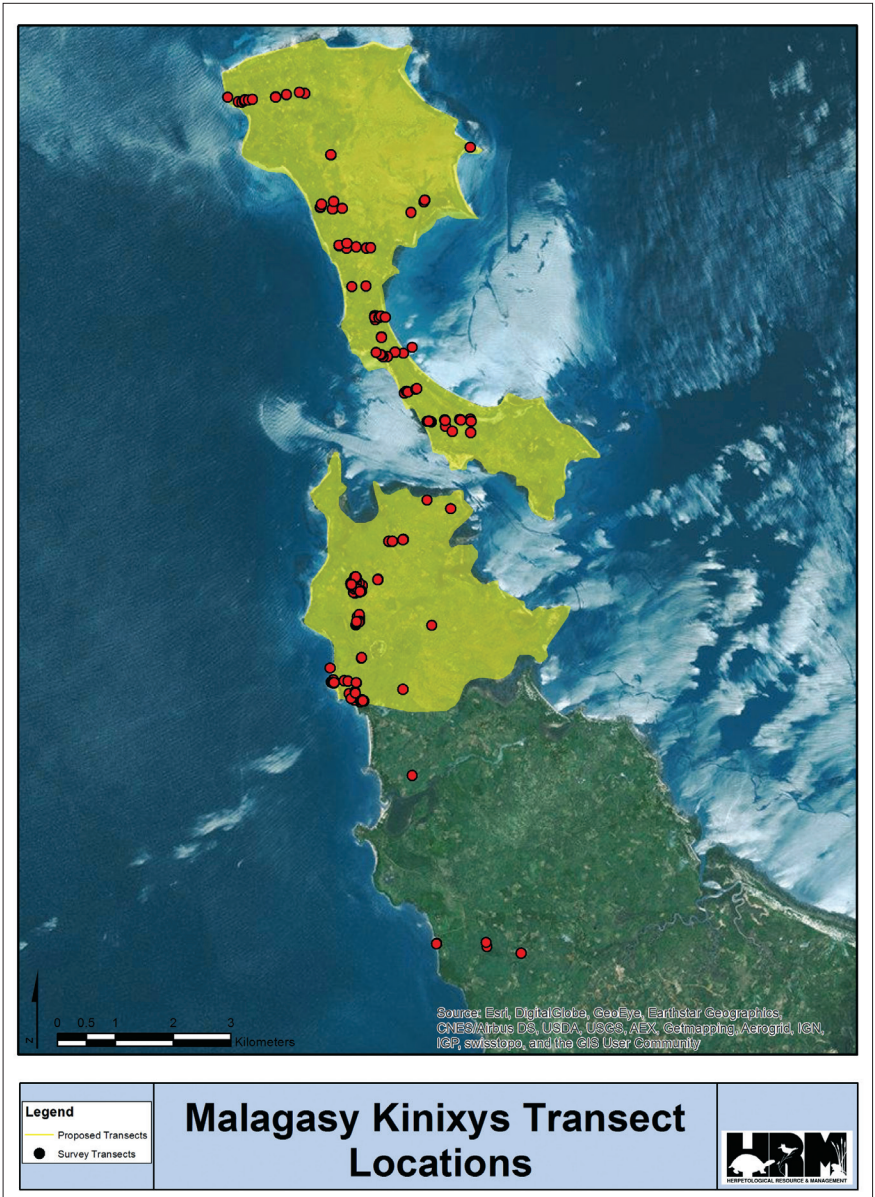



Fig. 2. Map showing locations of the observations of *K. z. domerguei* made by the research team within Nosy Faly and the northern portion of the adjacent peninsula. The light green areas represent the suspected range of the population (Pedrono 2008). However, individuals were encountered further south representing a range extension.

## Results

In total, 113 *K. z. domerguei* individuals were documented including 62 males and 51 females (Table 1). The research team observed tortoises throughout Nosy Faly and portions of the adjacent peninsula. Encounters were slightly limited on the north and south eastern portions of Nosy Faly. Several observations were also made further south than previously noted on the peninsula (Fig. 2).

Morphological data collected for male specimens supported the ranges of weight and length presented in previous work (Kuchling 1986; Pedrono 2008); however, data on captured females resulted in a higher average and maximum for both weight and straight carapace length (Table 2).

Table 1. Morphometric results gathered by the research team.

| | **Males (N=62)** | | | **Females (N=51)** | | |
|---|---|---|---|---|---|---|
| | **Average** | **Range** | **Maximum** | **Average** | **Range** | **Maximum** |
| Weight (g) | 1089.24 | 510-1800 | 1800 | 1481.3 | 700-2250 | 2250 |
| Carapace length (straight, mm) | 191.45 | 154-227 | 227 | 198.17 | 154-246 | 246 |
| Carapace length (curved, mm) | 236.97 | 179-293 | 293 | 256.86 | 209-310 | 310 |
| Carapace width (mm) | 126.09 | 104-260 | 260 | 139.91 | 115-160 | 160 |
| Plastron length (mm) | 157.34 | 116-187 | 187 | 172.29 | 128-260 | 260 |
| **Plastron width (mm)** | **114.24** | **95-161** | **161** | **129.21** | **103-178** | **178** |
| **Shell height (mm)** | **86.02** | **67-124** | **124** | **91.81** | **74-106** | **106** |

Table 2. Weight and growth measurements taken by the research team compared to values known from previous literature.

| | | **Walker, Mifsud *et al.* 2016** | **Pedrono 2008** | **Kuchling 1986** |
|---|---|---|---|---|
| Females | Average weight (g) | 1481.3 | 1400 | 1175.79 |
| | Max weight (g) | 2250 | 2200 | 2175 |
| | Av. carapace length (mm) | 198.17 | 196 | 180.63 |
| | Max carapace length (mm) | 246 | 230 | 230 |

Several varying types of habitats including grasslands, plantations, and village gardens and rubbish piles were observed to be actively in use by *K. z. domerguei* during our assessments (Figs 3 & 4). Many of these habitats were occupied and utilized based on time of day. Tortoises were commonly seen hiding under cover, particularly during the hottest periods of the day (Fig. 5). A noticeable preference for cashew trees (*Anacardium occidentale*) was observed. Similarly to the North American box turtle of the genus *Terrepene*, *Kinixys* utilize constructed depressions within leaf litter, also known as a form. In general the species had higher densities in close proximity to villages and seemed to avoid aquatic habitats.

Tortoises were actively observed foraging on numerous occasions (Figs 6 - 8). Some of the more commonly observed foods included soursop (*Annona muricata*), mango (*Mangifera indica*), mushrooms, slugs/snails and carrion (chicken gizzards from locally slaughtered chickens). Opportunistic observations of scat included invertebrate pieces as well as several different seed types. Mating was frequently encountered during field assessments. Pairing of males and females (sometimes with multiple males) was a common sight.

**Discussion**

Several individuals found further south within the peninsula than noted in past literature indicate that the range of *K. z. domerguei* is likely to be larger than previously described. Morphometric values collected also point to growth rates larger than the known maximums for females of this species. Data on natural diet including observations of direct feeding and scat material support the notion that hingeback tortoises probably play a large role in their environments as local seed dispersers. Based on observations and correspondence with locals, it was concluded that assessments were conducted during the peak of the mating season. This was further supported by the fact that no evidence of nesting or late stage follicular development was documented in captured females based on palpation of the females.

*In situ* research focussed on the endemic *K. z. domerguei* since its recognition as a separate subspecies in 2012 is extremely limited. This study was initiated to fill in data gaps regarding the species' natural history and limits of range. The research team was successful in gathering valuable data that will lead to a better understanding of this genus as a whole.

It is well known that hingeback tortoises, similarly to several other African species, face numerous stressors that continue to reduce their range, population size and overall species viability (Mifsud & Stapleton 2014). The subspecies *K. z. domerguei* is especially at risk due to the extremely small range it inhabits. The severity and effects of major threats to this endemic population have not been examined prior to this work. Results

Fig. 3. Survey team conducting a visual encounter survey for *K. z. domerguei.* Photo by David A. Mifsud.

from this study will enable a better understanding of the ecology and conservation status of the threatened subspecies, allowing for applied *in situ* conservation management strategies to be developed.

**Acknowledgements**

Funds for undertaking this field work were provided by the British Chelonia Group, The Leicester Tortoise Society and the Andrew Sabin Family Foundation. The authors and lead research team would also like to acknowledge Riana Rakotondrainy and Soary Randrianjafizanaka for their logistical support and help with field work.

Fig. 4. *K. z. domerguei* observed using habitat within a local village.
Photo by Scott Trageser.

Fig. 5. *K. z. domerguei* observed during a visual encounter survey using vegetation as cover.
Photo by David A. Mifsud.

Fig. 6. A young *K. z. domerguei* observed eating a fallen mango fruit. Photo by Scott Trageser.

Fig. 7. *K. z. domerguei* observed foraging on mushrooms. Photo by David A. Mifsud.

Fig. 8. *K. z. domerguei* observed feeding on carrion. Photo by David A. Mifsud.

## References


Kindler, C., Branch, W.R., Hofmeyr, M.D., Pavel, J.M., Vences, S.M., Harvey, J., Hauswaldt, J.S., Schleicher, A., Stuckas, H. & Fritz, U. (2012). Molecular phylogeny of African hinge-back tortoises (*Kinixys):* implications for phylogeography and taxonomy (Testudines: Testudinidae). *Journal of Zoological Systematics and Evolutionary Research* 50(3): 192-201.

Kuchling, G. (1986). Biology of *Kinixys belliana* at Nosy Faly, Madagascar. Studies in Herpetology, Proceedings of the European Herpetological Meeting (3rd Ordinary General Meeting of the Societas Europaea Herpetologica, Prague, August 19-23). pp 435-440.

Mallon, D.P., Hoffman, M., McCowan, P.J.K., Grainger, M.J., Hilbert, F. & van Vliet, N. (2015). An IUCN situation analysis of terrestrial and freshwater fauna in West and central Africa. Occasional Paper of the IUCN Species Survival Commission Vol. 54. 2015. IUCN, Gland, Switzerland, p. 40.

Mifsud, D. & Stapleton, M. (2014). *Kinixys Conservation Blueprint: A Comprehensive Assessment to Ensure the Future of a Genus*. Herpetological Resource and Management, Chelsea, Michigan, USA, pp 1-5.

Pedrono, M. (2008). *The tortoises and turtles of Madagascar*. Natural History Publications (Borneo), Kota Kinabalu, Malaysia, pp 55-61.

Segniagbeto, G.H., Eniang, E.A., Petrozzi, F., Vignoli, L., Dendi, D., Akani, G.C. & Luiselli, L. (2014). Aspects of the ecology of the tortoise *Kinixys nogueyi* (Lataste, 1886) in Togo and Nigeria (West Africa). *Tropical Zoology*. DOI: 10.1080/03946975.2014.992616.