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Kinixys homeana Bell 1827 – Home's Hinge-Back Tortoise

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Summary. – Home's Hinge-back tortoise, *Kinixys homeana* (Family Testudinidae), is a small to medium-sized forest tortoise (carapace length up to 220 mm), with a range extending over the coastal regions of the Gulf of Guinea, in the continuous Guinea-Congo West Africa rainforest region. The species belongs to a unique genus of tortoises that can close themselves entirely within their shells through a posterior carapacial hinge rather than a plastral one. Population structure, ecology, and abundance of *K. homeana* have been studied in the Niger Delta, southern Nigeria, and in western Cameroon, with ongoing research in Ghana and Togo. The species is omnivorous, with a diet based primarily on mushrooms. Population sizes may be strongly depressed in areas where the species is actively hunted by humans, and there is evidence that it is heavily declining throughout much of its range. The main threats include subsistence hunting by local people in desperately poor economic conditions, agricultural and industrial expansion with deforestation, and trade for the international pet industry. There are not yet any conservation actions known for this species and there is a strong need to conduct more field research (e.g., ecology, abundance) and to establish protected areas that include viable populations of the species across its natural range.

Distribution. – Benin, Cameroon, Central African Republic, Democratic Republic of Congo (Congo Kinshasa) (?), Equatorial Guinea, Gabon (?), Ghana, Ivory Coast, Liberia, Nigeria, Togo. Distributed mainly in the southern coastal region of West Africa from Liberia to Cameroon and into western Central African Republic, with a disjunct population reportedly occurring in eastern Congo Kinshasa (DRC).

Synonymy. – *Kinixys homeana* Bell 1827, *Cinixys homeana, Testudo (Kinyxis) homeana, Kinixys belliana homeana*.

Subspecies. – None recognized.

Status. – IUCN 2013 Red List Status: Vulnerable (VU A2cd, assessed 2006); TFTSG Draft Red List: Critically Endangered (CR, assessed 2013); CITES: Appendix II, as Testudinidae spp.

Taxonomy. — This species was described by Bell (1827) in honor of Sir Everard Home (1756–1832), who was a leading anatomist at that time. The taxonomy of this species is considered very stable, but the original type locality ("Africa occidentali") is unknown (Bour 2006). Iverson (1986) first incorrectly reported that the type locality had been restricted to "Cape Coast, Ashantee" [Ghana] by Boulenger (1889), but later (Iverson 1992) corrected it to the original designation.

All populations are considered to be homogenous and no subspecies are recognized (Bour 2006). However, the disjunct isolated populations reportedly inhabiting eastern Congo Kinshasa (DRC) need further verification and genetic study.

Phylogeny based on both mitochondrial (12S rRNA, 16S rRNA, and cytb) and nuclear (Cmos and Rag2) DNA data with a total of 3387 aligned characters suggests that *K. homeana*, as well as all examined *Kinixys* species, belong to a clade including also *Pyxis*, *Aldabrachelys*, *Homopus*, *Chersina*, *Psammobates*, and *Geochelone* (Le et al. 2006). Studies of three mitochondrial DNA fragments (2273 bp: 12S rRNA, ND4 + adjacent DNA coding for tRNAs, cytb) and three nuclear loci (2569 bp: C-mos, ODC, R35) using both Bayesian and Maximum Likelihood methods suggest that the savannah species of *Kinixys* are paraphyletic with respect to the rainforest species *K. homeana* and *K. erosa*, and that the rainforest species may be derived from a savannah-living ancestor (Kindler et al. 2012).

Description. — This is a terrestrial species of moderate size (Figs. 1 and 2), with a straight carapace length (CL) that does not exceed 220 mm. The body mass of a sample of 13 adult specimens from a population in Kpalimé, Togo averaged 756.2 g (median = 800 g; range = 398–1000 g; s.d. = 203.1), and that of a sample of 798 adult specimens from the Niger Delta, Nigeria, averaged 781.6 g (median = 813 g; range = 395-1104 g; s.d. = 238.1) (Akani, Eniang, and Luiselli, unpubl. data). Female Home's Hinge-back Tortoises were larger than males (in the Niger Delta of Nigeria; of 146

Figure 1. Adult female *Kinixys homeana* from Cameroon, central Africa. Photo by Tomas Diagne.

specimens weighing more than 1000 g, 108 were females (intersexual differences were statistically significant: X^2= 17.8, df = 1, $p < 0.0001$), and males possessed longer and thicker tails.

Home's Hinge-back Tortoise belongs to a unique genus of tortoises (*Kinixys*) that can close themselves entirely within their shells. The genus possesses a hinge at the back of the carapace that can close off the vulnerable back legs and tail, providing excellent protection from potential predators. The nuchal scute is present and narrow and long in *K. homeana*, as opposed to *K. erosa* that lacks a nuchal.

The shell of *K. homeana* varies in color from dark brown to tan, and is distinguished by a pronounced vertical drop at the posterior end. The shape of the carapace also channels rainwater towards its head for drinking. The scutes are very flat, and the vertebrals are horizontal, giving the animal a decidedly angled appearance, especially toward the back.

Each forelimb bears five claws and the small head has a hooked upper jaw. Both the limbs and head are brown to yellow, and the plastron is yellow with blackish spots in the centers of the scutes.

Distribution. — *Kinixys homeana* is a forest tortoise, with a range extending throughout the coastal regions of the Gulf of Guinea, inside the continuous Guinea-Congo West Africa rainforest region. As a general rule, it can be considered as an obligate inhabitant of the continuous rainforest region. Several historical localities are provided by Iverson (1992), although comments are available also in later literature (e.g., Luiselli et al. 2000).

Kinixys homeana is found in Liberia, Ivory Coast, Ghana, Togo, Benin, Nigeria, Cameroon, Equatorial Guinea, Central African Republic (Chirio and Ineich 2006), and reportedly in Congo Kinshasa (Democratic Republic of Congo) (Trape et al. 2012). It may possibly occur in northern Gabon as well.

In Liberia, the species is found throughout the country, from the northwest provinces to the extreme southeast, around Harper (Iverson 1992). In the Ivory Coast, it has been

Figure 2. Adult specimens of *Kinixys homeana* from Benin, West Africa. Photos by Tomas Diagne.

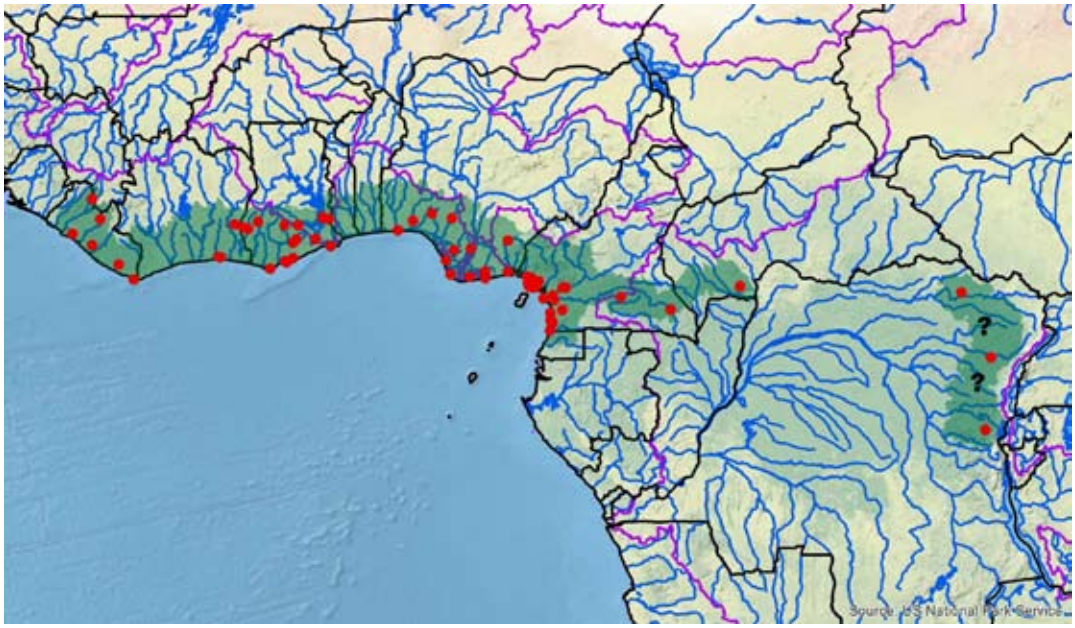

Figure 3. Distribution of *Kinixys homeana* in western and central Africa. Purple lines = boundaries delimiting major watersheds (level 3 hydrologic unit compartments – HUCs); red dots = museum and literature occurrence records of native populations based on Iverson (1992), plus more recent and authors' data; green shading = projected native distribution based on GIS-defined HUCs constructed around verified localities and then adding HUCs that connect known point localities in the same watershed or physiographic region, and similar habitats and elevations as verified HUCs (Buhlmann et al. 2009), and adjusted based on authors' subsequent data. The disjunct populations previously reported from eastern Congo Kinshasa (DRC) need verification.

recorded in all forest regions, including around Aboisso in the south (Iverson 1992).

In Ghana, it is widespread in the southern territories (Iverson 1992), with the most important populations being in Kakum National Park and in the forested hills around Lipke Bakwa. It has also been recorded from Muni Lagoon, in coastal Ghana (Raxworthy and Attuquayefio 2000).

In Togo, although no localities are presented in Iverson (1992), *K. homeana* is certainly found in the hilly and montane forests bordering Ghana. More specifically, the species has up to now been recorded from six Togo localities: Badou, Kpalimé, Tomegbe, Akloa, Kpadapé, and Hanyigban (Segniagbeto et al., submitted a). In Togo, it appears to often be sympatric with *K. erosa*, and in Kpalimé it is also sympatric with *K. nogueyi*. In Benin, it is often found in bushmeat markets, but its real distribution is unknown.

Figure 4. Adult *Kinixys homeana* from Benin, West Africa. Photo by Tomas Diagne.

In Nigeria, it is found only in the southern regions, notably in the moist swamp forests of the River Niger Delta, and the hilly and montane forests of Cross River State. In Nigeria, it occurs often in sympatry with *K. erosa*, but it may be locally marginally sympatric also with *K. nogueyi*, for instance in the northernmost part of Rivers State, where patches of moist forest are interspersed within the forest-derived savannah habitat (Luiselli 2006a).

In Cameroon, it is found throughout the coastal regions and also in the Southern Province (Iverson 1992), but its presence has also been well documented in the Southwest Province (e.g., Lawson 1993, 2000, 2001; Chirio and LeBreton 2007) and in the Mount Cameroun area (Gonwouo et al. 2007). In Equatorial Guinea, it has been recorded both on Bioko Island and in Rio Muni (Iverson 1992).

There are also considerable problems in assessing the range of this species, given its overall morphological similarity with *K. erosa* and the potential for misidentification in the field. Indeed, uncertain presence records for *K. homeana* have been reported for three countries in Africa: Gabon, Republic of Congo (Brazzaville) and Democratic Republic of Congo (Kinshasa).

In Gabon, it has not been formally recorded by Iverson (1992) or others, but a few specimens were exported in recent years to international markets (Luiselli et al. 2006) and the species may occur there. However, recent long-term field

studies were unable to confirm its presence in that country (Laurent Chirio, unpubl. data).

In the Republic of Congo (Brazzaville), there are two recent records from an altered forest near Pointe-Noire (Jackson and Blackburn 2010). However, there are no voucher specimens and the species was identified by consultant survey personnel, not by the authors themselves. The habitat of capture for these tortoises was described as 'open' (degraded savanna habitat and cultivated fallow land near the Pointe-Noire urban center, see Jackson and Blackburn 2010), i.e., very different from the typical habitat features of this species (e.g., Lawson 2006). In addition, the two localities at which *K. homeana* was reportedly observed are very far south of the natural range of the species, with all of Gabon without any *K. homeana* occurring in between. Thus, until more decisive evidence emerges for the presence of this species in the Republic of Congo, we conservatively consider these records as representing misidentified *K. erosa*.

Kinixys homeana has also been historically reported from Congo Kinshasa (Democratic Republic of Congo), where it has been recorded only from isolated localities from the easternmost forests, close to the political borders with South Sudan and western Uganda (Iverson 1992). These supposedly disjunct populations from the Democratic Republic of Congo should be re-analyzed since there are no recent data and it is possible that the collected specimens might represent misidentified *K. erosa* or erroneously labeled individuals.

According to Luiselli et al. (2006), the entire range of *K. homeana* had a potential extent of occurrence of about 788,443 km^2 in 1992, with Nigeria being the country comprising the highest percentage of the range (23.4%), followed by Cameroon (20.3%). Overall, its range coincides widely with that of *K. erosa*, a frequently sympatric species (Branch 2007).

Figure 4. Several adult *Kinixys homeana* from a population in Kpalimé, Togo, West Africa. Photo by Luca Luiselli.

Habitat and Ecology. — *Kinixys homeana* is an elusive forest species that basks rarely in sunny spots on the forest floor and forages in the shade (Branch 2007). Most of the data available on the habitat preferences of *K. homeana* populations are based on anecdotal observations; the species' field ecology has been studied intensively only in southern Nigeria (e.g., Luiselli et al. 2003a, 2003b, 2005) and in western Cameroon (e.g., Lawson, 2000, 2001).

Kinixys homeana inhabits only two geobotanic zones within the equatorial forest zone: dense moist evergreen rainforests and dense moist semi-deciduous forests (Maran and Serpol 2006). The species is also associated with streams and swampy areas (Branch 2007). In most of its distribution range *K. homeana* occurs sympatrically with *K. erosa* (Lawson 1993, 2000; Luiselli et al. 2000). It is not yet clear what the microhabitat preference differences are between these two species. Indeed, *K. homeana* has been reported to occur in forests of generally a drier type than the forests inhabited by *K. erosa* (Ernst and Barbour 1989), but in Cameroon it is linked to wetter areas than *K. erosa* (Chirio and LeBreton 2007), and the same is generally true for Nigeria (Luiselli et al., unpubl. data). More specifically, at least in Cross River State (Nigeria), *K. homeana* tends to be more common in lowland swamp forests, whereas *K.*

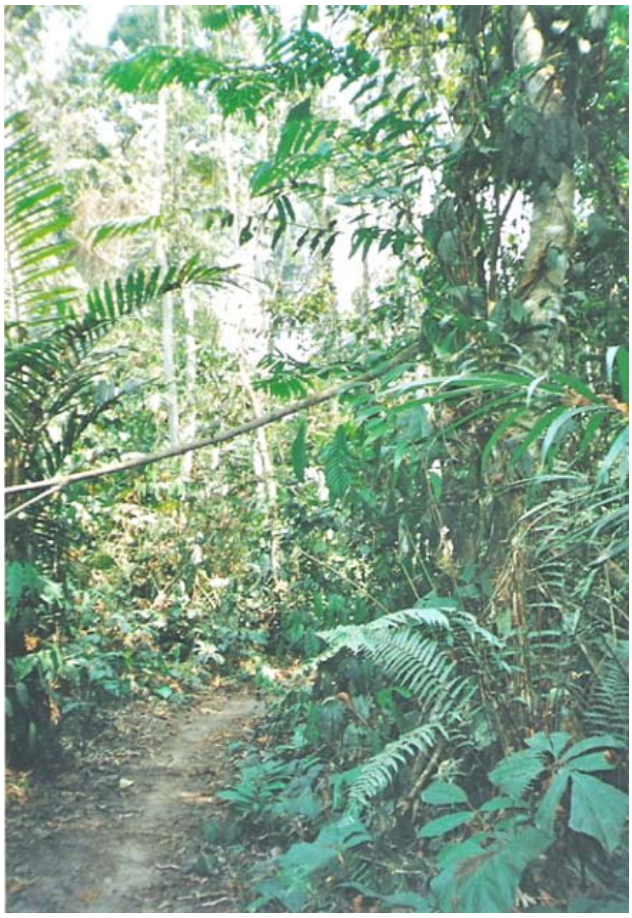

Figure 5. Typical habitat of *Kinixys homeana* in a mature secondary rainforest in southern Nigeria. Photo by Luca Luiselli.

erosa is clearly dominant in hilly and montane forests (> 500 m a.s.l., Eniang and Luiselli, unpubl. data).

Although *K. homeana* generally inhabits the lowland evergreen forest (Lawson 1993; Luiselli et al. 2000), where it is locally threatened by clearance of forest for cultivation (e.g., around Nfainchang, Cameroon; Lawson 1993), it has also been recorded in forest plantations such as for cocoa and coffee (for instance in the Ivory Coast [Maran 2004] and in Togo [Luiselli and Segniagbeto, unpubl. data]). In southern Nigeria, a statistical study (based on logistic regression of presence/absence data) conducted at the landscape scale revealed that this species is a habitat specialist, at least in the River Niger Delta region (Luiselli et al. 2000). Indeed, *K. homeana* was found to be linked to mature secondary dry forest around mangroves and to mature secondary swamp-forest (Luiselli et al. 2000). Considering that in the Delta states of Nigeria, these habitat types have declined dramatically during the last decades, falling from 2% of state area in 1976–78 to only 0.2% in 1993–95 (Geomatics 1996) due primarily to petrochemical expansion, it may be inferred that habitat loss represents a very serious reason for the decline of this tortoise species.

In general, *K. homeana* needs closed forest canopy and shady microhabitats to avoid overheating, and shows behavioral thermoregulation in its avoidance of overheating (Luiselli 2005), i.e., allowing only short periods of exposure to the sun during movements between sunlit and shaded areas (Hailey and Coulson 1998; Luiselli 2005). Even on the rare occasions when basking, these tortoises avoid full sunlight (Luiselli 2005). Both male and female *K. homeana* maintain similar body temperatures during most of the day (at about 28.5 to 29°C, with ranges of 26–31°C). Overall, their body temperatures are directly correlated to air temperatures throughout most of the daytime, and this thermoconformity may save energy by reducing shuttling, although any movement out of cover may increase the costs of shade seeking (Luiselli 2005).

At a local scale, the type of attitude displayed by human communities towards tortoises may have serious consequences on their habitat preferences, as shown by Luiselli (2003a). That research compared tortoise population ecology at six sites with similar habitat characteristics in the eastern Niger Delta; in three areas the tortoises had been worshipped by local communities for a long time as holy animals, whereas in three other areas they were actively hunted for subsistence. In the veneration areas the tortoises were frequently found in disparate habitats (i.e., dense dry bush, sparse dry bush, riparian vegetation, swamps, and plantations). In the hunting areas, the tortoises were found almost exclusively inside dense bush, and always avoided plantations. Thus, the different habitat usages may reflect extirpation from easier hunting areas (Luiselli 2003a). Obviously, this study may have consequences for this species' global conservation status because it demonstrates that wherever it is hunted for subsistence (which is a common occurrence in West and Central Africa, e.g., see Lawson 2000), the habitat in which it is still found is just a fraction of the potential habitat. The species is limited to forest patches with very dense vegetation where access for human hunters is difficult. Clearance of forest for cultivation is also considered a cause of decline for *K. homeana* in Cameroon (e.g., around Nfainchang; Lawson 1993).

The feeding ecology of *K. homeana* has been studied in the wild only in the forests of the River Niger Delta, in southern Nigeria. In this area, *K. homeana* exhibits an omnivorous diet both in mature and in altered moist forest patches, with plant matter, seeds, fungi, Oligochaeta, Gastropoda, and a wide range of arthropods being frequently eaten (Luiselli 2006b), with some quantitative variations in diet composition by habitat type. It may also forage on frogs and scavenge corpses (Branch 2007), and compared to most other tortoise species, it has a more carnivorous diet (Luiselli 2006c). Overall, the diet composition of this species was relatively similar to that of sympatric *K. erosa*, but with a relative prevalence of plant matter, Gastropoda, Isopoda, and insects in *K. homeana* versus the prevalence of Oligochaeta in *K. erosa,* although *K. homeana* also eats Oligochaeta and both species feed frequently on mushrooms (Luiselli 2006b). The food niche overlap values between *K. homeana* and *K. erosa* were much higher within heavily altered forest habitats than within mature forest habitats, thus revealing that the potential for interspecific competition for food is much higher in degraded forests (Luiselli 2006b). The implications of this study are that, in altered habitats, the reduced niche differentiation might result in the over-exploitation of certain prey types if both the tortoise predators now include these items in their diets. If the above scenario is correct, one would predict that in one, or both, of the species population numbers would be reduced with forest habitat loss (Luiselli 2006b). When searching for food, these tortoises follow olfactory paths through straight and darting movements (Eglis 1962).

As mentioned above, *K. homeana* is potentially in interspecific competition with *K. erosa*, which shares a similar diet composition, habitat requirements, and geographic range. Overall, interspecific competition at the local scale between these two species produces dominance of one species over the other, albeit without extirpation of the locally disfavored species (Luiselli 2006c; Luiselli et al. 2008). The spatial niche is likely the niche dimension most clearly partitioned by these tortoises (Luiselli 2006c), but further research is needed to understand exactly how spatial niche partitioning occurs in these two forest species.

Data on homing patterns of *K. homeana* are available by means of radiotracking studies conducted in both Cameroon (Lawson 2000) and Nigeria (Luiselli et al. 2006).

In western Cameroon, male home range may exceed 0.5 km^2 (Lawson 2000). In the Niger Delta (southern Nigeria), radiotracking of 33 adults (20 males and 13 females) for 40 continuous days revealed a measured mean home range size (quantified via minimum convex polygon) of 0.37 km^2 for males and 0.24 km^2 for females, with some specimens (especially males) exhibiting home ranges as large as 0.46 km^2. Moreover, both in Nigeria (Luiselli et al., unpubl. data) and in Cameroon (Lawson 2000), male tortoises are highly territorial and usually drive other males away from their core home ranges. Thus, the density of these tortoises is low in most places, even in highly suitable environments.

During the wet season, these tortoises can use the floods produced by heavy rainfall for dispersal. In these cases, the tortoises do not actively swim but simply float. This type of dispersal is fairly common in swampy areas, e.g., in the seasonally flooded forests of the River Niger Delta (southern Nigeria). Apparently, this is the main reason why these animals can occasionally be observed also in unsuitable non-forest habitats (Luiselli et al., unpubl. data).

Kinixys homeana is mainly diurnal, but also active very early in the morning and at twilight or in the early nocturnal hours; its activity peaks during the wet months (April to October in Nigeria), whereas it may be nearly inactive also for prolonged periods during the dry months (November to March in Nigeria) (Luiselli 2003c). Nonetheless, there is no true estivation during the dry months (Luiselli 2003c), and reproductive females may still be active in this period of the year for ovipositing. Similar seasonal activity patterns were also observed in Cameroon (Lawson 2006).

Mating events were observed in the wild from mid-March to the end of May in southern Nigeria (Luiselli and Akani, unpubl. data). Mounting vocalizations by males occur both in the wild and in captive pairs (Galeotti et al. 2005; Luiselli et al., unpubl. data); these may convey information to conspecifics, hence influencing the outcome of sexual interactions (Galeotti et al. 2005).

Female *K. homeana* oviposit one or two times per year, generally between December and January, i.e., in the dry season (Blackwell 1968; Brown and George 1994). Eggs, which are oval to nearly spherical and have brittle shells (Branch 2007), measure approximately 46 by 35 mm, are generally deposited on the forest litter and sometimes into excavated burrows (Blackwell 1968). Each female produces 2–4 eggs, that hatch, in captivity, 89–102 days after oviposition at an incubation temperature of 28–30°C (Koehler 1997). Incubation time in the wild is unknown, but possibly not shorter than five months (Blackwell 1968). Hatchlings measure about 42–47 mm CL (Branch 2007) to 50 mm CL (Farkas and Satorhelyi 2006). The number of eggs produced by females is positively correlated to the female body size (Akani et al. 2004).

Population Status. — There are no exhaustive data on the global population size and density of *K. homeana* at the continental scale, but under these aspects this species is probably better known than most of the other continental tortoise species. In general, there is widespread evidence that this species is declining strongly throughout its range (Luiselli et al. 2006; Branch 2007; Chirio and LeBreton 2007). Apparent declines were also reported by interviewed hunters selling these animals in bushmeat markets (Luiselli et al. 2013).

Luiselli et al. (2008) estimated population size of *K. homeana* and *K. erosa* along 59 transects in selected wet forest habitats along the coast of West Africa, from Ghana to Nigeria, by means of a DISTANCE modeling procedure. Model results indicated that the density of the two species was inversely related at the local scale, and complementary across the region; such that the density of *K. erosa* increased from west to east while *K. homeana* declined from west to east (Luiselli et al. 2008). The density of *K. homeana* was also invariably higher than that of *K. erosa* in the Niger Delta (Luiselli 2003a), whereas exactly the opposite abundance trend was observed in western Cameroon (Lawson 2000). Overall, the comparison of these density estimates between the two tortoise species is consistent with the hypothesis suggesting interspecific competition and consequent resource partitioning (Luiselli et al. 2008). However, other causes may contribute to explain the observed patterns, including the low productivity of rainforest habitats and long-term human perturbation (Luiselli et al. 2008).

In good forest habitats, the average density of *K. homeana* varied between 0.403 individuals per ha and 1.480 individuals per ha when estimated by DISTANCE methodology (Luiselli et al. 2008), and about 1.4 individuals per ha by mark-recapture protocols (Luiselli 2003a). However, the density ranged from 0.15 to 0.9 tortoises per ha in harvested areas, and from 1.65 to 2.85 tortoises per ha in areas where these animals are traditionally venerated and hence not hunted (Luiselli 2003a). Population sizes of *K. homeana* are strongly depressed in areas where these tortoises are actively hunted by human populations.

High predation rates are likely crucial for regulating the population dynamics of *K. homeana*, exactly as for *K. spekii* (Coulson and Hailey 2001). However, very little is known about the natural predators of these tortoises. Snakes may eat juvenile tortoises (Akani et al. 2003), and the adults may be eaten by genets, mongooses, leopards, and birds of prey. *Kinixys homeana* has been identified as a Tsetse Fly host in southern Cameroon (Farikou et al. 2010).

Threats to Survival. — The main threats to *K. homeana* include: 1) subsistence hunting by local people; 2) habitat loss through agricultural and industrial expansion with massive deforestation; and 3) trade for the international pet industry.

Concerning the threat of subsistence hunting, Lawson (2000) studied the harvest rates of *K. homeana* in three protected areas of Cameroon (Korup National Park, Banyang-Mbo Sanctuary, and Nta-Ali Reserve), and estimated an overall mean annual harvest rate of 0.3 animals/km^2 in these areas with good habitat conditions and relatively low human density. Then, if 100% of the species' range was protected and under relatively low human density, and extrapolating harvest data by Lawson (2000), the expected annual harvest rate would have been 236,532 tortoises, i.e., an estimated 5.6% of the total estimated surviving tortoise population (Luiselli et al. 2006). However, the percent of protected territory is less than 3% of the species' range, and the human population density is much higher in several regions of the species' range than in the three protected areas of Cameroon studied by Lawson (2000), and hence we may conclude that the annual harvest rate is certainly much higher than the calculated estimate (Luiselli et al. 2006).

Tortoises are often collected by people searching for snails (*Achatina* sp.), because they co-occur in the same microhabitats (Akani et al., unpubl. data). Generally, only adult tortoises are removed for subsistence reasons, with no difference between males and females (Luiselli et al. 2003). People prefer large-sized tortoises for food (Luiselli et al. 2003), and these are most likely to be reproductive females, given the sexual size dimorphism observed in this species. Therefore, in any harvested site, it is likely that most of the larger females, which generally produce more eggs (Akani et al. 2004), are eaten before producing their highest theoretical lifespan clutch sizes.

There is considerable seasonal variability in the frequency of occurrence of these tortoises in the bushmeat markets: most of the animals are traded in April, May, and June (Luiselli et al. 2003). In addition, in the Nigerian bushmeat markets, this species is now much less frequently found than 10+ years ago, and interviews with hunters and traders suggest that this is due to the extirpation of many wild populations and a general increased rarity, and not to variation in market demand (Luiselli et al. 2013). Even more worryingly, during surveys conducted in 2013, these tortoises were never observed in two forest bushmeat markets of the Niger Delta where they were frequently traded in earlier years, with hunters reporting their total extirpation since a few years ago (Akani, Luiselli, and Petrozzi, unpubl. data). There is also confirmed evidence that this species is subjected to clandestine and unauthorized bushmeat trade inside protected areas in southeastern Nigeria (Eniang and Ijeomah 2011).

Kinixys homeana is also used in local African traditional medicine and therefore traded in regional fetish markets. For instance, during surveys of the traditional fetish market in Lomé, Togo, conducted in 2012 and 2013, specimens of *K. homeana*, *K. erosa*, and *K. nogueyi* were regularly observed (Segniagbeto et al. 2013). However, the animals traded in these fetish markets are kept for sale for a long time (even years; Segniagbeto et al. 2013), and so it is unlikely that the use for African traditional medicine actually threatens the survival of wild populations of this species. However, the species has also been recorded in Chinese traditional medicine markets in China and Hong Kong (Cheung and Dudgeon 2006), and the potential threat of that international trade could well become significant.

The threat of habitat loss is particularly strong in southern Nigeria, where heavy deforestation occurs due to oil and natural gas industry development, this region being the most important oil-producing zone in all of Africa (Akani et al. 1998). There is clear evidence of massive population declines for *K. homeana* in this region (e.g., Lea et al. 2003; Luiselli et al. 2013), and there is no reason to think that this negative trend may reverse in due time. Also, the few remnant forest sites where this species is found in Togo are under heavy deforestation pressure (Segniagbeto et al., submitted b).

Figure 6. Tortoises of the genus *Kinixys*, including *K. erosa* and *K. homeana*, are often traded as traditional medicinal products in the fetish markets. Here, the Marché au Fétiches, Lomé, Togo. Photos by Luca Luiselli (left) and Anders G.J. Rhodin (right).

The threat of international pet trade is potentially relevant in Ghana, Togo, and Benin (Ineich 2011), the main export countries for this species (CITES database analysis, www.cites.org/eng/resources/species). In Togo, where exploitation for the pet trade occurs in conjunction with local forest habitat loss, the population status of this species is seriously at risk (Segniagbeto et al., submitted a, b).

Unfortunately, there are no specific data on the decline in the actual population size for this species, even at a very local level. Robust global calculations are therefore impossible, although there is multiple evidence that populations are strongly declining in several areas of the Gulf of Guinea's countries. In addition, there is no reason to predict that this trend will be reversed or slowed (Luiselli et al. 2006). Although *K. homeana* is still found in many forest zones, hunting is still rampant in all these protected areas (Lawson 2000; Eniang and Luiselli 2002; Luiselli 2003b). In general, its status is considered to be threatened in Ghana, Togo, and Benin, where it occurs only in isolated forest fragments and forest galleries (Maran and Serpol 2006).

Conservation Measures Taken. — No real conservation measures have been taken up to now, apart from generic site preservation in protected areas and/or traditional protection given to these tortoises at the local level of some villages (Luiselli 2003a). This species is legally protected in Togo under Article 62, Section 2, Chapter II of the law N° 2008-005, regulating the environment protection and wildlife conservation; exports are also not allowed from Nigeria. In any case, illegal hunting for tortoises, even in protected areas, is still widespread in West Africa (Lawson 2000).

Kinixys homeana is currently listed on the IUCN Red List as Vulnerable, having been assessed in 2006 (Luiselli et al. 2006). The IUCN/SSC Tortoise and Freshwater Turtle Specialist Group has recently provisionally updated its assessment of the species to Critically Endangered as a result of an IUCN African Tortoise and Freshwater Turtle Red Listing workshop held in Lomé, Togo, in August 2013. The species is also included on CITES Appendix II.

The species occurs in the following protected areas: Parc National d'Assagny and Parc National Tai in Ivory Coast; Kakum National Park in Ghana; Okomu National Park, Upper Orashi Forest Reserve, Taylor Creek Forest Reserve, Stubbs Creek Forest Reserve, and Cross River National Park in Nigeria; and Korup National Park, Banyang-Mbo Sanctuary, and Nta-Ali Reserve in Cameroon.

Conservation Measures Proposed. — A crucial point to be addressed by future studies is the impact that illegal hunting activities may have on populations of *K. homeana* inside formally established protected areas. Indeed it is clear that, at present, protected area populations are not free from exploitation (Lawson 2000; Luiselli et al. 2006). We suggest that it should be important to plan the management of this species by collecting as much information as possible on the cultural interactions between local human communities and tortoises, because it may be possible to create a mosaic of protected areas linking all the forested zones in which people traditionally worship tortoises. Demographic and ecology studies inside protected areas should also be of priority relevance.

International trade of specimens should be also monitored, especially in Togo and Ghana (Ineich 2011). Indeed, *K. homeana* is listed on CITES Appendix II, thus banning the import of wild individuals into Europe (EC regulation number 338/97). It is suspected that several of the officially defined 'ranched' individuals that are exported outside Africa from countries like Togo are in actuality wild animals (Ineich 2011). At the national and subnational level, it is necessary to include this species among the protected fauna in all the countries of occurrence. At present, there is virtually no country that can reliably preserve this species. There is a strong need to establish additional protected areas that include populations of these tortoises, and perhaps a very promising initiative would be to create protected corridors by linking areas where local people traditionally protect tortoises.

Captive Husbandry. —In captivity, this species feeds on mushrooms, tomatoes, fruits (banana, mango, strawberry, etc.), and earthworms, mollusks, fish, dead mice, etc. (Maran and Serpol 2006). This species is not easy to keep and breed in captivity, also because many wild individuals arrive in suboptimal health conditions (i.e., heavily parasitized) in the western countries. Many individuals do not even accept food when captive because of their poor health and bad conditions or inappropriate caging. The cage should always be kept moist, with an ample water basin, and with air temperature constantly kept at 27–32°C.

Current Research. — Currently, the ecology of this species is being studied only in southern Nigeria through mark-recapture protocols, under the supervision of Luiselli and in collaboration with scientists at the Rivers State University of Science and Technology (mainly Godfrey C. Akani) and at the University of Uyo (mainly Edem A. Eniang). The Nigerian studies, which have been continuing without interruptions for over 15 years, also involve monitoring of bushmeat markets in order to verify whether the trade trends vary over the years. Luiselli, Fabio Petrozzi, and Gabriel H. Segniagbeto are starting ecological studies on *Kinixys* in Togo, and the ethnozoology of these tortoises is also being studied in Nigeria and Togo. In Kakum National Park of Ghana, a population ecology study with capture-mark-recapture protocols has been undertaken by Phil Allman and colleagues. We are not aware of other similar field projects in other regions of Africa. *Ex-situ* conservation programs on the various species of the genus *Kinixys* have also been initiated recently in the USA, led by David Mifsud.

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