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Description of a new subspecies of *Kinyongia uthmoelleri* (Müller, 1938) (Squamata: Chamaeleonidae) with notes on its captive propagation

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Abstract. A new population of *Kinyongia uthmoelleri* was found in the South Pare Mountains in Tanzania in 2000 by J. Mariaux of the Natural History Museum of Geneva (MHNG). The morphology of this population corresponds well with that of other previously known populations of *K. uthmoelleri* from Mt. Hanang and the Ngorongoro crater highlands. Specimens from South Pare and Ngorongoro are morphologically very similar and show some distinctive characters which are divergent from the holotype of *K. uthmoelleri* and other specimens from Mt. Hanang: smaller size, smooth squamation on head and body, smooth head crests, clearly bi-forked parietal crest (only in males), parietal crest composed of only a single row of scales, a relatively narrower and longer head and no sexual dimorphism in the tail length. *K. uthmoelleri* is known from only few museum specimens but these morphological differences and geographic isolation justify describing the Ngorongoro and South Pare populations as a new subspecific taxon: *Kinyongia uthmoelleri artytor* nov. ssp. The new subspecies has been successfully kept and bred in captivity by one author, and a short description is given of its captive maintenance.

Key words. *Kinyongia uthmoelleri*, new subspecies, South Pare Mountains, captive propagation.

INTRODUCTION

Despite several recently described *Kinyongia* taxa from East Africa (Menegon et al. 2009; Necas 2009; Necas et al. 2009) the diversity within this genus has not yet been completely uncovered. Several publications covering material from the Eastern Arc Range have contributed to knowledge on the systematics and taxonomy of these chameleons (Mariaux et al. 2008; Tilbury et al. 2006). The type material of the taxon described in the present paper was collected in 2000 and was at that time deposited under the name "*Bradypodion tavetanum*" in the Muséum d'histoire naturelle (MHNG) in Geneva.

Kinyongia uthmoelleri was described by Müller (1938) as *Chamaeleo uthmölleri* on the basis of a single specimen from Mt. Hanang. This specimen was collected at 2300 m asl in montane forest. In Loveridge's (1957) check list of East African reptiles and amphibians he designated *uthmoelleri* as a subspecies of *Ch. fischeri*, a two-horned species. Mertens (1966) followed this classification, despite the fact that he treated it as a full species in an earlier publication after discovering the second specimen known to science in the Staatliches Museum für Naturkunde Stuttgart (SMNS) (Mertens 1955). On the basis of lung and hemipenial morphology Klaver & Böhme (1986) recognized *uthmoelleri* as a full species and included it in the genus *Bradypodion*. Böhme & Klaver (1990) discovered a third specimen, the first recorded female of this species, in the Royal Museum for Central Africa in Tervuren (MRAC). The above mentioned second and the third specimens were collected from the locality of Oldeani in the Ngorongoro crater highlands, a massif several hundred kilometres north of the type locality on Mt. Hanang. Price (1996) also mentions statements from local people about locations between Babati and Singida (a road that passes close to Mt. Hanang) and 72 km northeast of Mt. Hanang but up til now the presence of *K. uth-*

Fig. 1. Head view of the holotype of *K. u. uthmoelleri* (photo: G. Vogel).

moelleri at these locations have not been confirmed. Recently the taxon *uthmoelleri* was placed with all other east African *Bradypodion* in a new genus, *Kinyongia* (Tilbury et al. 2006). In the last 15 years only two authors have published details on the captive husbandry and breeding of *K. uthmoelleri*, specimens collected from the Ngorongoro crater highlands (Price 1996; Necas & Nagy 2009). Around the year 2000, specimens of "*Bradypodion uthmoelleri*" appeared in the international pet trade. These animals were very small in overall size, more slender and with smoother scalation than *K. uthmoelleri* specimens from Mt. Hanang. Even after six years of keeping some of these specimens in captivity these distinct characters have not changed and so ontogenetic change in these characters can be ruled out. Unfortunately, the geographic origin of these specimens was not known until four similar specimens were discovered in the collection of the Muséum d'histoire naturelle in Geneva in 2004, which suggests they originate from the same locality, the South Pare Mountains, and belong to the new subspecies described in this paper.

MATERIAL AND METHODS

In total 20 specimens of *K. uthmoelleri* of both subspecies with a confirmed collection locality were located in museum collections and investigated: 8 from Mt. Hanang (5 males [ZSM 1/1948 (Holotype), ZFMK 74955, ZFMK 82188 and ZFMK 82189], 3 females [ZFMK74953, ZFMK 74954 and ZFMK 82191] and one subadult [ZFMK 82190]), 8 from the Ngorongoro crater highland area [1 male (SMNS 324), 2 females (ZFMK 58664 and ZFMK 58665), 1 subadult (MRAC R.G. 21852), 4 embryos (ZFMK 58666-69] and 4 from the South Pare Mountains [2 males (MHNG 2612.65 and MHNG 2612.66), 1 female (MHNG 2612.67), 1 juvenile (MHNG 2612.64)]. It seems probable that the embryos in the ZFMK collection are the unhatched specimens reported by Price (1996).

Head-body length (HBL), tail length (TL), total length (ToL), head length (HL) and head width (HW) were measured in all specimens except in the embryos. The data of MRAC R.G. 21852 were taken from Böhme & Klaver (1990). The ratio of HL to HW and the percentages of HL to HBL, TL to ToL and TL to HBL were calculated. In addition, we recorded head crest morphology following Necas (1994), and the morphology and pattern of body scalation.

RESULTS

All measurements and investigated morphological characters of the specimens are listed in Tables 1–3. The morphological traits which differentiate the male specimens of Mt. Hanang from those of the South Pare Mountains and Ngorongoro crater highlands are: higher measurements, a relatively broader and shorter head, rougher (more convex) scalation on the head and body, canthus parietalis (cp) not bi-forked anteriorly but fan-shaped anteriorly and the cp composed of two rows of scales (Fig.

Fig. 2. Type material of *K. u. artytor* ssp. n. (photo: G. Vogel).

Table 1. Morphological measurements of *K. uthmoelleri* in mm.

specimen	locality	sex	HBL	TL	ToL	HW	HL	remark
ZFMK 74955	Mt. Hanang	m	90.1	122.8	212.9	15.1	26.6	
ZFMK 82188	Mt. Hanang	m	85.2	119.6	204.6	15.8	26.0	
ZFMK 82189	Mt. Hanang	m	92.8	125.7	218.5	16.4	30.0	
ZFMK 82190	Mt. Hanang	m	69.9	93.1	163.0	12.0	22.7	subadult
ZSM 1/1948	Mt. Hanang	m	93.0	134.0	227.0	16.0	32.0	holotype of *K. u. uthmoelleri*
SMNS 324	Ngorongoro area	m	83.0	116.0	199.0	13.0	31.0	
MHNG 2612.64	South Pare Mountains	m	40.0	46.0	86.0	6.5	13.5	juvenile; paratype of *K. u. artytor* ssp. n.
MHNG 2612.65	South Pare Mountains	m	80.0	100.0	180.0	13.0	31.0	holotype of *K. u. artytor* ssp. n.
MHNG 2612.66	South Pare Mountains	m	67.0	86.0	153.0	10.0	24.0	paratype of *K. u. artytor* ssp. n.
ZFMK 74953	Mt. Hanang	f	86.1	95.3	181.4	13.2	20.2	
ZFMK 74954	Mt. Hanang	f	82.0	91.5	173.5	13.5	24.1	
ZFMK 82191	Mt. Hanang	f	78.5	82.9	161.4	12.9	21.3	
ZFMK 58664	Ngorongoro area	f	78.6	95.1	173.7	11.4	21.1	
ZFMK 58665	Ngorongoro area	f	76.1	92.2	168.3	12.2	21.0	
MRAC R.G.21852	Ngorongoro area	f	54.0	61.0	115.0	8.0	19.0	subadult
MHNG 2612.067	South Pare Mountains	f	70.0	81.0	151.0	10.0	21.0	paratype of *K. u. artytor* ssp. n.

1). The females show the same differences between both populations except that the females from the Mt. Hanang population show also a fan-shaped cp anteriorly, instead of no furcation at all in the females from the South Pare Mountains and Ngorongoro highlands. Additionally, the Mt. Hanang specimens are sexually dimorphic in tail length relative to body length (males having relatively longer tails than females), whereas relative tail length between the sexes of specimens from the South Pare Mountains and Ngorongoro highlands specimens is more or less the same. Based on these key characters that differentiate the two groups, we describe the populations from the South Pare Mountains and the Ngorongoro crater highlands as a new subspecific taxon.

Fig. 3. Holotype of *K. u. artytor* ssp. n. (photo: N. Lutzmann).

***Kinyongia uthmoelleri artytor* ssp. n.**

We chose the syntopic specimens collected by J. Mariaux & C. Vaucher in the South Pare Mountains during their journey in 2000 as the type specimens (Fig. 2).

Diagnosis. A small chameleon, which differs from the nominate form on Mt. Hanang in the following characters: less convex scalation on body and head, smooth head crests, parietal crest distinctly bi-forked anteriorly, the ridge of the parietal crest contains only one scale row, a higher ratio of HL to HW and HL to HBL (relatively longer and narrower heads), smaller total length [153.0–199.0 mm in males (204.6–227.0 mm in *K. u. uthmoelleri*) and 151.0–173.7 mm in females (161.4–181.4 mm in *K. u. uthmoelleri*)] and no sexual dimorphism in the relative tail length.

Description of the Holotype (Figs 3–5). MNHG 2612.65, adult male, 1840 m asl, South Pare Mountains, North Tanzania, leg. J. Mariaux & C. Vaucher, 29. 09. 2000. HBL 80.0 mm, TL 100.0 mm, ToL 180.0 mm, HL 31.0 mm, HW 13.0 mm, the belly is cut and the intestine removed, both hemipenes are partly everted, length of lower jaw 21.0 mm, distance from front edge of eye to nostril 9.8 mm, distance from nostril to snout tip 5.4 mm, distance from lower jaw to the tip of casque 7.5 mm, head width between eyes 6.5 mm, canthus temporalis from eye to angle 7.7 mm, canthus parietalis (cp) is bi-forked anteriorly (Fig. 5), distance from bifurcation of cp to the top of

Table 2. Ratios of morphological measurements of *K. uthmoelleri*.

specimen	location	sex	HL/HW	HL as % HBL	TL as % ToL	TL as % HBL
ZFMK 74955	Mt. Hanang	m	1.76	29.52	57.68	136.29
ZFMK 82188	Mt. Hanang	m	1.65	30.52	58.46	140.38
ZFMK 82189	Mt. Hanang	m	1.83	32.33	57.53	135.45
ZFMK 82190	Mt. Hanang	m	1.90	32.47	57.12	133.19
ZSM 1/1948	Mt. Hanang	m	2.00	34.41	59.03	144.09
SMNS 324	Ngorongoro area	m	2.38	37.35	58.29	139.76
MHNG 2612.064	South Pare Mountains	m	2.08	33.75	53.49	115.00
MHNG 2612.065	South Pare Mountains	m	2.38	38.75	55.56	125.00
MHNG 2612.066	South Pare Mountains	m	2.40	35.82	56.21	128.36
ZFMK 74953	Mt. Hanang	f	1.53	23.46	52.54	110.69
ZFMK 74954	Mt. Hanang	f	1.79	29.39	52.74	111.59
ZFMK 82191	Mt. Hanang	f	1.65	27.13	51.36	105.61
ZFMK 58664	Ngorongoro area	f	1.85	26.84	54.75	120.99
ZFMK 58665	Ngorongoro area	f	1.72	27.60	54.78	121.16
MRAC R.G.21852	Ngorongoro area	f	2.38	35.19	53.04	112.96
MHNG 2612.067	South Pare Mountains	f	2.1	30.00	53.64	115.71

casque 13.1 mm, length of bifurcation of cp 4.4 mm, maximum width of bifurcation of cp 4.3 mm, one conical scale in the neck smaller than 2.0 mm, no ventral or tail crests, collection and field number (TZ-141) are tied around the left hind leg. The scales on the head, the head crests and the body are flat. Only the ridge of the cp is pronounced though not denticulate. Fig. 6 shows the colouration of the holotype in life.

Variation on the paratypes (MNHG 2612.64, 2612.66-67). All measurements of the paratypes and the other specimens of *K. u. artytor* ssp. n. are shown in Tables 1–2. MNHG 2612.64 is a juvenile male, the belly is cut and the intestines are removed, the colouration after preservation is very dark, collection and field number (TZ-138) is tied around the right hind leg. MNHG 2612.66 is an adult male and fits quite well with the description of the holotype: belly is cut but the intestines are still present, 2 conical scales in the neck, collection and field number (TZ-143) are tied around the right hind leg. The original colouration is better preserved: head is greyish, red radiations on the eyes, which continue darker on the head sides, the interstitial skin is red around throat and neck, the lateral stripe is greyish on dark background, the tail is greyish. MNHG 2612.67 (Fig. 7) is an adult female with a flat casque, cut belly without intestines and one conical scale in the neck. Collection and field number (TZ-144) are tied around the left hind leg, the colouration after preservation is very dark with only some greyish flat scales on the head and body.

Fig. 4. Portrait of the holotype of *K. u. artytor* ssp. n. (photo: N. Lutzmann).

Distribution. *K. u. artytor* ssp. n. is know only from the South Pare Mountains and the Ngorongoro crater highlands (Fig. 8).

Etymology. The subspecies name "*artytor*" is the latinised substantive of the Greek verb "αρτυειν" (artyein), which can be translated as "to prepare / to make ready requiring skills". We name this new subspecies in honour and tribute to Prof. Dr. Wolfgang Böhme and his skills to prepare dozens of students on their way to scientific careers, which was also the case for four of the authors of this publication.

Captive maintenance. All specimens were kept individually in full gauze terrariums indoor and outdoor in the same cages in order to minimize the stress of relocation. The size of the terrariums were for females 50x50x80 cm and for males 45x50x70 cm (length x width x height). All specimens were kept outdoor from spring to autumn, if the temperatures did not fall consistently below 10 °C at night time. The highest recorded temperature was 35 °C at noon, the lowest 5 °C at night time. The cages were exposed to the sun in the morning and fell into shade around

Table 3. Morphological characters of *K. uthmoelleri*.

specimen	location	sex	head scalation	body scalation	bi-forked cp	No. scale rows on the ridge of cp
ZFMK 74955	Mt. Hanang	m	rough	rough	no	2
ZFMK 82188	Mt. Hanang	m	rough	rough	no	2
ZFMK 82189	Mt. Hanang	m	rough	rough	no	2
ZFMK 82190	Mt. Hanang	m	rough	rough	no	1–2
ZSM 1/1948	Mt. Hanang	m	rough	rough	no	2
SMNS 324	Ngorongoro area	m	flat	flat	yes	1
MHNG 2612.065	South Pare Mountains	m	flat	flat	yes	1
MHNG 2612.066	South Pare Mountains	m	flat	flat	yes	1
ZFMK 74953	Mt. Hanang	f	rough	rough	no	2
ZFMK 74954	Mt. Hanang	f	rough	rough	no	2
ZFMK 82191	Mt. Hanang	f	rough	rough	no	2
ZFMK 58664	Ngorongoro area	f	flat	flat	–	1
ZFMK 58665	Ngorongoro area	f	flat	flat	–	1
MRAC R.G.21852	Ngorongoro area	f	flat	flat	?	?
MHNG 2612.067	South Pare Mountains	f	flat	flat	–	1

noon. In spring and autumn the cages were sprinkled with water four times per day (in midsummer 6 times) for up to four minutes in the hottest time of the day. During the winter the terrariums were illuminated with common terrarium-tubes (T5 with 35 W) 13 hours per day. A halogen spot was activated for 45 minutes three times per day for basking, so that the ambient temperature stayed between 22 and 24 °C at day time and between 6 and 16 °C at night time. The terrariums were completely sprinkled with water in the morning and evening. The diet consisted of small arthropods, mainly self-bred crickets, grasshoppers, flies, cockroaches etc. Every second feeding the food was enriched with vitamins and minerals. Only pregnant females were additionally given small pieces of cuttlebone. To trigger mating behaviour, the males were transferred into the cages of the females. Immediately, the males started head bobbing and displayed bright colours.

Fig. 5. Head view of the holotype of *K. u. artytor* ssp. n. (photo: N. Lutzmann).

In all cases the females displayed a colouration of greenish-white with small black dots, whereon the males stopped courtship. Matings have not be observed until now, but after several days the females started gaining weight and became visibly rounder. The males were subsequently removed, because it seemed that the females only lay their eggs if there were no males in their vicinity. Older females laid their clutches without test excavations, younger females with test excavations at a depth of 5 to 7 cm into the terrarium substrate. The clutches consisted of 7 to 12 eggs. The dimensions of the eggs were approximately 8.0x4.0 mm. The eggs were incubated in completely closed, small plastic boxes in wet vermiculite. After approximately 115 days at 19–21 °C during the day and 15–18 °C at night, the temperatures were increased to 22 °C during the day and 20 °C at night. At this time the humidity of the vermiculite was also increased to simulate the beginning of a rainy season. Hatching started after 147 to 161 days. After the hatchlings opened the egg shells, they occasionally paused for up to 3 days to resorb the yolk. The young chameleons were kept individually in smaller cages 25x25x40 cm under the same conditions as the adults. It should be taken into account that the temperature changes should not be as pronounced for the juveniles as for the adults, because it seems that they are unable to thermoregulate effectively. The maximum recorded lifespan in captivity for this species is six years (Fig. 9).

DISCUSSION

The genus *Kinyongia* contains currently 17 species, all of which are restricted to moist montane forests in the East and Central African highlands. Recently several new

Fig. 6. Holotype of *K. u. artytor* ssp. n. in life (photo: J. Mariaux).

species have been described from montane forests in Kenya and Tanzania (Menegon et al. 2009, Necas 2009, Necas et al. 2009) and several subspecies have also been raised to species status based on genetic divergence and detailed morphological studies (Mariaux et al. 2008). No doubt more species remain to be discovered in the still poorly surveyed mountain ranges across East Africa. The discovery of *K. uthmoelleri* in the South Pare Mountains also shows that species' distribution ranges are not well documented and it is quite likely that *K. uthmoelleri* also occurs on other massifs in-between these now known populations, such as Mt. Kilimanjaro and Mt. Meru (Fig. 8). *K. uthmoelleri* has a similar distribution to the *Trioceros sternfeldi* species complex, including the recently described *T. hanangensis* (Krause & Böhme 2010). Although the phylogeography of all *T. sternfeldi* populations has not been investigated, the Mt. Hanang population has been identified as a divergent sister clade to the Mt. Meru/ Kilimanjaro populations. A similar pattern is found in *K. uthmoelleri*, the Mt. Hanang populations morphologically divergent from the Ngorongoro/ Pare populations, suggesting that despite its geographically intermediate position, Mt. Hanang populations have been isolated for a longer period of time. Volcanic activity in the North of Tanzania, which created these massifs, persisted from Oligocene (37 myr ago) to the Quaternary. Subsequent colonisation and population fragmentation of chameleon populations on these massifs has resulted in their diversification into a number of morphologically similar but clear divergent (sub-) species.

Fig. 7. Female paratype of *K. u. artytor* ssp. n. in life (photo: J. Mariaux).

The rarity of some species of the genus *Kinyongia* in museum collections is explainable because they inhabit the rainforest canopy and their cryptic morphology and behaviour (Necas & Nagy 2009). Unfortunately *Kinyongia uthmoelleri* is one of the rarest chameleons of East Africa in museum collections, although Price (1996) mentioned, that this species is common in the Ngorongoro crater highlands. But during eight days of fieldwork he also found only five specimens. In total, there are only 20 specimens in museum collections in Europe from three different localities and more intensive fieldwork is required to bring to light if this reflects the real situation of population densities, distribution and ecology of this species in the wild. Further collections will also confirm if the morphological variation recorded here, from the relatively few specimens available, is consistent within and between the three populations.

Nevertheless, there are pronounced morphological differences between the Ngorongoro and South Pare specimens and the specimens from the type locality on Mt. Hanang (Müller 1938). These are sufficiently distinct to justify their description as a new taxon. This is similar to the situation where *K. boehmei* was originally described as a subspecies of *K. tavetana* (Lutzmann & Necas 2002) and later elevated in to full species rank based on genetic divergence from all other two-horned chameleons (Mariaux

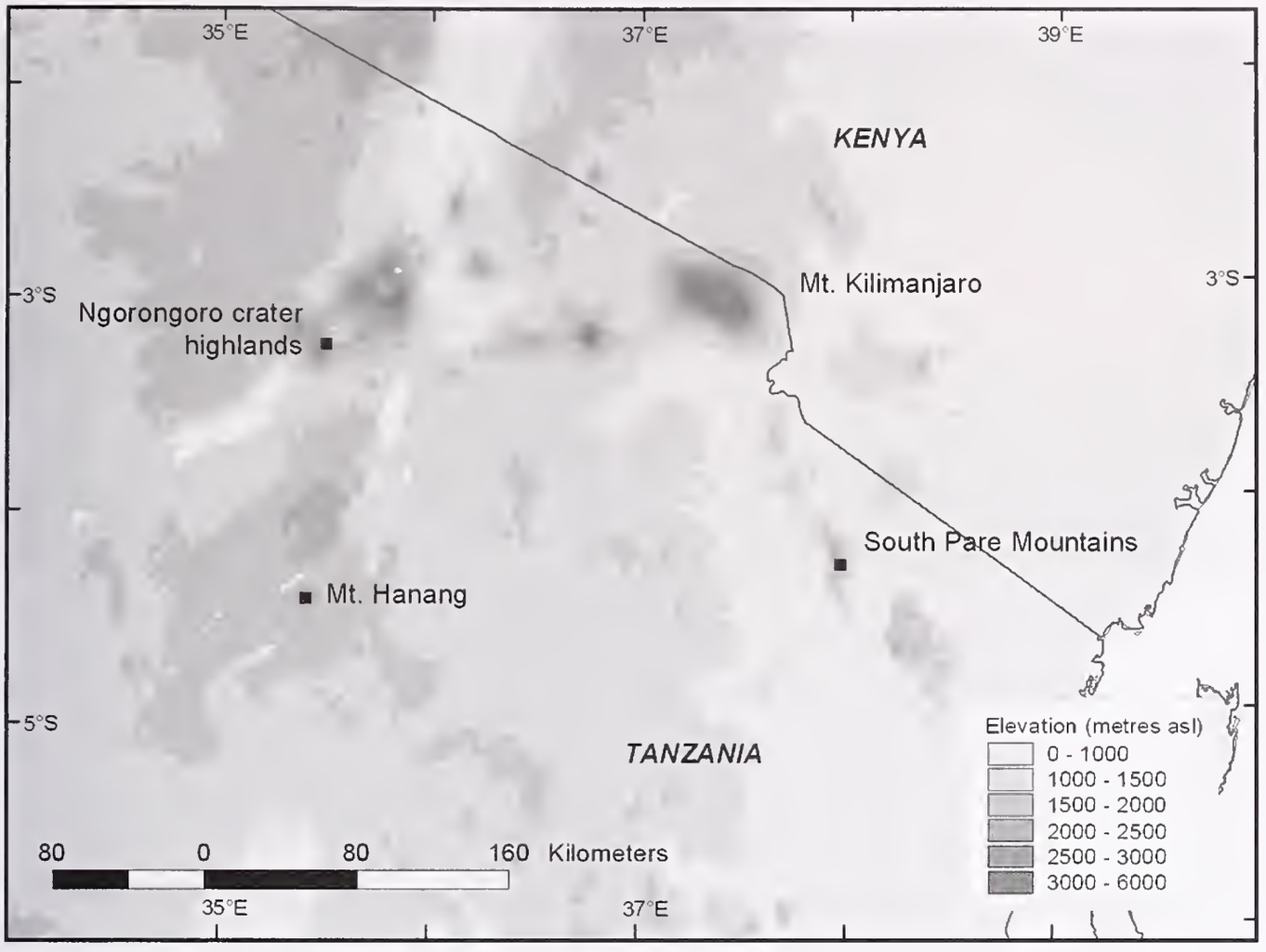

Fig. 8. Collecting localities of *K. uthmoelleri* [*K. u. uthmoelleri* (Mt. Hanang); *K. u. artytor* ssp. nov. (South Pare Mountains and Ngorongoro crater highlands)].

et al. 2008). Molecular studies have revealed numerous cryptic species among East African chameleons (Matthee et al. 2004; Tilbury & Mariaux 2006; Mariaux et al. 2008, Krause & Böhme 2010) and follow-up studies using molecular data should provide a better insight into the evolutionary relationships and genetic divergence that exists between the three isolated populations of *K. uthmoelleri*, some of which may justify species status.

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Fig. 9. A six year old *K. u. artytor* ssp. n. in captivity (photo: R. Lademann).

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