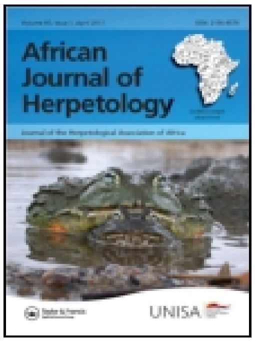

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Short Communication

Observations on the breeding behaviour of the Taita dwarf toad *Mertensophryne taitana* on Mt. Mbololo, Taita Hills, Kenya

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Abstract.—Very little life-history information is available regarding the 13 species of earless dwarf toads from the genus *Mertensophryne*. We report our observations on the breeding behaviour of *M. taitana* from Mount Mbololo in the Taita Hills, Kenya. Empirical data from pit-fall trapping suggest that they are not abundant in the area (< 1.5 % of captures), although we managed to batch mark 230 individuals from breeding assemblages in road puddles during 20 days in November 2007. Results reveal that most individuals depart from a breeding site within 24 hours, although some (around 10%) remain while others travel up to 100 m to nearby puddles. Despite their lack of columellae, these dwarf toads appear to react to conspecific distress calls. Eggs develop rapidly into tadpoles and toadlets within 15 days of being laid, but tadpoles were not observed to use their "crown" at the water surface as previously reported. Instead they were observed submerged in liquid mud at the periphery of puddles. Our brief observations on this species suggest that conservation assessments on threatened members of the genus may be problematic, and we highlight the paucity of natural-history information on dwarf toads in general.

Key words.—Dwarf toads, Bufonidae, breeding, vocalisation, development, behaviour, tadpoles.

The genus *Mertensophryne* consists of 14 species of dwarf toads which lack columellae and whose tadpoles possess a characteristic crown on the head (Frost 2008). The genus was previously monotypic, but was long since expected to encompass more taxa from other genera (including *Stephopaedes* and *Bufo*, e.g. Poynton 1991) due to the crown-like synapomorphy of the larvae and more recently for molecular similarities (Cunningham & Cherry 2004), so that they were formally united (Frost *et al*. 2006). Several studies have described the morphology of the tadpoles of this genus (Channing 1978; Grandison 1980; Müller *et al*. 2005; Wasonga & Channing 2007) including suggestions that the fleshy protuberances on the head are accessory respiratory structures for small water-bodies (e.g. phytotelma, Channing 1993), and they have been observed using them to cling to the surface tension in low oxygen conditions (Grandison 1980; Channing 1993; Müller *et al*. 2005; Wasonga & Channing 2007). Adults of the genus *Mertensophryne* have received less attention, perhaps due to their cryptic colouration, moving amongst the leaf litter of the forest floor (Grandison & Ashe 1983; Channing 1993), but also due to their small size (Clarke 1989).

Grandison & Ashe (1983) provided a detailed account of the natural history of *M. micranotis* in what had been the coastal forests of south-eastern Kenya. They noted short calls from the males consisting of chirps and ticks. Fertilisation was found to occur independently of laying by the folding and thrusting of the

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male cloaca and use of the males' feet either side of the female cloaca, over a prolonged period (5 to 10 hours). They also observed the behaviour of the tadpoles in tree holes; each time the sun hit the water's surface, they hung from the surface by the fleshy 'crown' (Grandison & Ashe 1983).

Other than the most general notes on natural history and distribution, very little is known of the adults of *Mertensophryne taitana* (see Stuart 1967; Channing & Howell 2005). Müller *et al*. (2005) found adults in amplexus and laying eggs during the short rains in November on Mt. Mbololo, in the Taita Hills. Two of us (PKM & GJM) had found that this reproduction was repeated annually at the same locality, despite *M. taitana* being very infrequently encountered for the rest of the year. We decided to investigate this with the aim of making a general description of the natural history of breeding in *M. taitana*, with particular attention to breeding sites, duration and time of breeding, egg clutch size, and time taken to complete metamorphosis.

The study was carried out on Mt. Mbololo in the Taita Hills (E 38º 20', S 03º 25'; Fig. 1) in south-eastern Kenya. The Taita Hills form the northernmost mountain block of the crescent-shaped Eastern Arc Mountains that stretch south from Udzungwa Mountains in Tanzania (Lovett & Wasser 1993). Mt. Mbololo (1779 m asl) is one of four main mountain blocks (others being Dawida, Sagalla and Kasigau) that make up the Taita Hills. A general description of the area and its climate is published elsewhere (Malonza & Measey 2005; Measey *et al*. 2008). Within Mt. Mbololo, our study was concentrated on farmland areas in Wongonyi, Rong'e as well as adjacent Mwambirwa plantation and Mbololo forest (c. 220 ha along the hill crest). The farmland areas are dotted with pine and eucalyptus tree stands. Topographically the area comprises stream valley and slopes prone to erosion. Fires have often been reported in this area.

Sampling.—Drift fence and pit-fall traps were used in a 'Y'-shaped drift fence array (Corn *et al*. 2003, each arm of four meters plastic sheeting 30 cm high, with four buckets of 10 litres) were placed in three areas on Mount Mbololo: indigenous forest, plantation, and small scale agriculture (Fig. 1). One to four trap arrays were set in each site for five days (trapping sessions) after which they were closed and reopened after five days. Traps in the plantation and forest were set from November 2005 to January 2007, and in the farm from May 2006 to January 2007. Checking of the traps was done once every morning not later than 07h30. Quantitatively, the data can be expressed as the number of individuals per trap day (Rödel & Ernst 2004).

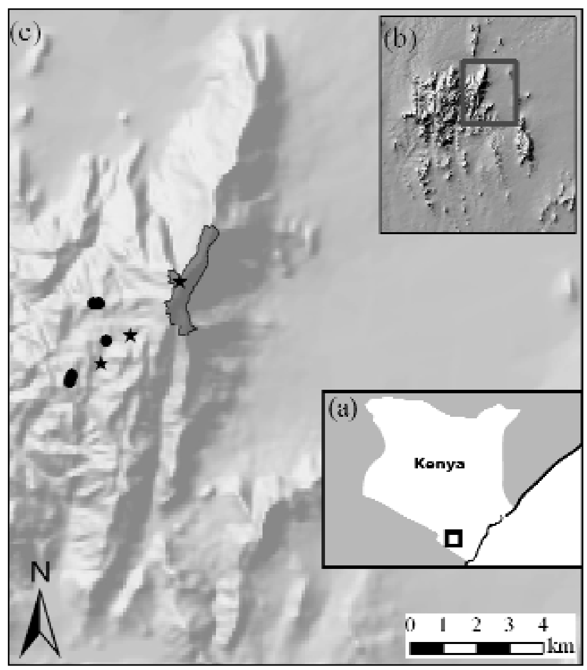

Figure 1. (a) The locality of the Taita Hills, in south-eastern Kenya. (b) Position of Mount Mbololo within the Taita Hills. (c) Localities of study sites in puddles (•; note that several sites overlie each other) and the location of pit-fall traps in three different vegetation types (★), in the North in indigenous forest (position of Mbololo forest marked with a black outline), in the middle in plantation, and in the South in agricultural land.

Breeding sites.—In November 2007, we identified puddles as potential breeding sites based on observations from Müller *et al*. (2005) and subsequent visits by GJM and PKM. We searched for adjacent sites on and off roads, but were not able to find any breeding sites not located on roads. Puddles were developed from vehicle tracks forming potholes or troughs on the roads which were later filled with rainwater. Examinations were made on these water puddles as well as adjacent sites during the short rains, between 13th November and 2nd December 2007. The roads passed through both agricultural land and plantations, but not indigenous forest, therefore all areas had a high level of human disturbance. We recorded puddle size, depth, water temperatures and prevailing weather conditions.

Exhaustive census.—In each puddle, we enumerated all adult toads by removing them from the pool and placing them into a container. Snout vent length (SVL) and body mass were measured from a sub-sample of dwarf toads. The left outer toe was clipped as a batch mark (e.g. Donnelly *et al*. 1994). We isolated one pair in amplexus and counted all eggs that were laid. Simultaneous watch was kept over eggs laid in containers from two amplectant pairs and others in the breeding pools.

During the 336 pit-fall days only a single *Mertensophryne taitana* was found in the plantation site during April 2006, representing less than 1.5% of total anuran captures (Table 1). Clarke (1989) stated that for dwarf amphibians: "there is a tacit general assumption that they are either rare (known from only one or a few specimens from a single locality), or have a restricted distribution (a small population, or set of small populations, at most locally abundant and occupying a narrow ecological niche)." Our observations of *M. taitana* both in this study and in a larger study of the biodiversity of amphibians in the Taita Hills (Malonza *et al*., unpublished) concur with this statement. Despite extensive trapping and survey work throughout a range of altitudes and habitat types, *M. taitana* is only known from two localities in the Taita Hills. Both are above 1300 m asl, and breeding sites are only known for one of these localities; the other locality is represented by two individuals caught within 1 km of each other 10 years apart (February 1998, Macha forest and November 2007, Mwachora forest). However, it appears that these dwarf toads are locally abundant, but to see these large congregations of breeding adults requires precise timing (toads were only observed at the breeding sites during 11 days of the year).

A total of 230 adult *M. taitana* were captured and toe-clipped during November 2007 at 10 different puddles. A well marked sexual dimorphism in size (SVL and body mass) was found in which adult females (mean 2.2 g; 30.4 mm; n = 14) were larger and heavier than males (mean 1.2 g; 27.2 mm; n = 28). Toads were found to congregate once puddles were formed after rains. We found toads present at most of the puddles on the road, but eggs were deposited in only six of the ten puddles where dwarf toads were found. The highest number of individuals was at puddle six where 78 dwarf toads were recorded, and the least in puddle ten where only one toad was observed (Table 2).

Table 1. Summary of numbers of anurans caught in Y-shaped pit-fall arrays from November 2005 to January 2007

Site	S	E	Altitude (m)	No. arrays	No. trapping nights	Total Anurans	*M. taitana*
Mwasange farm	437290	9630988	1309	1	79	8	0
Mwambirwa plantation	436415	9630144	1300	3	134	52	1
Mbololo forest	438781	9632602	1600	3	123	12	0
Total					**336**	**72**	**1**

Table 2: Summary of the number of Mertensophryne taitana observed and characteristics of road puddles during November 2007.

Puddle	1	2	3	4	5	6	7	8	9	10	Total
Puddle area (m2)	0.9	12.5	3	24	1.8	5	2.5	13.5	6	0.5	
Mean daily water temperature °C	20.4	21.96	21.81	20.9	26	26.2	24	24	24.75	23	
Number of newly marked toads	52	19	43	6	4	78	12	15	1	0	**230**
Number of males	27	6	16	4	4	24	4	8	1	0	
Number of females	14	1	3	2	0	9	3	3	1	1	
Number of recaptured toads	11	0	21	0	0	14	0	1	2	1	**50**

Interestingly, the dwarf toads were found to be most abundant at the breeding sites in the morning (06h00 to 11h00), and least abundant in the evening (19h00 to 23h30). Out of the 20 days of observations, adult *M. taitana* were recorded in puddles during only 11 days, notably, when it was raining and up to two days after heavy rains. In addition to *M. taitana*, we found three *Ptychadena anchietae* adults and numerous floating rafts of their eggs in the road puddles.

During courtship, male-male interactions were abundant with obvious attempts to displace males already in amplexus. One case was noted whereby three males were observed grasping a single gravid female at the same time. Toads removed from the pools and put into a container were heard to produce a low croaking click (phonetically: krr krr krr krr). This appeared to immediately attract other toads in the vicinity towards the call source.

Some *M. taitana* appear to disperse between breeding sites while others visit and vacate within a single day. For example, one marked individual was recaptured 50 m away in a previously unvisited puddle. Another was recaptured 100 m away from the nearest puddle where adults had been marked, and yet another 45 m away. Our methodology had not anticipated this movement which would be better monitored with site specific batch marks. Of the three toads recaptured at previously unvisited sites, two were females. In puddle 6 we batch marked all 23 toads present on the 18th of November, but on subsequent visits on 19th and 20th November, we captured 20 and 19 toads of which only one and three toads respectively were recaptures. It is noteworthy that one of these sites is the same puddle in which dwarf toads were found breeding by Müller *et al*. (2005). Visits by two of us (GJM & PKM) in each of the intervening years have also found toads breeding in this same puddle.

Müller *et al*. (2005) gave a detailed description of tadpole development from ex-situ bred *M. taitana* and here we provide additional information from measurements made in-situ. Black rounded eggs with a white spot were laid on a long jelly-like strand. The egg diameter was 2 mm (ten eggs measured from four clutches) while the inter-egg distance within the string was also 2 mm. From the count of eggs laid by seven females, clutch size ranged between 190 and 350 eggs (mean 276 eggs). The amplectant pairs placed into containers produced 192 and 307 eggs, laid in continuous strings. Eggs took 48-52 hours to hatch into tadpoles of mean size 5 mm (five larvae measured). Mean daily water temperature differed among sites from 20 to 26° C (Table 2).

Our observations on development are only slightly longer than those of Müller *et al*. (2005), and this difference may be due to the cooler water temperature in 'natural' conditions. This extremely fast developmental time is likely explained in part by the very temporary nature of these breeding sites (see Denver 1997). Six days after hatching, tadpoles were not found moving about the clear surface waters. Instead, the tadpoles were found swimming into the bottom liquid mud towards the edges of each puddle, with only the movement of tails being visible. Within nine days, tadpoles had well developed limbs. Toadlets started leaving puddles 13 days after eggs were laid, but still retained a 2 mm tail. On the 15th day, the tail had been completely reabsorbed, and toadlets had a SVL of 6 mm. Several of the puddles were prone to drying and most of them to disturbance from vehicles. One puddle was observed to dry, but when evening rains replenished it on the same day, it was found to still contain live tadpoles.

Müller *et al*. (2005) recorded breeding in road puddles, and elsewhere members of this genus are reported to breed in tree holes and other small accumulations of water (Grandison & Ashe 1983; Channing 1993). Despite reports elsewhere (Müller *et al*. 2005), we never observed the tadpoles of *M. taitana* to use their crowns at the water surface in the puddles. Instead, the presence of tadpoles was observed at the edges of the puddles by their wriggling tails, apparently eating the mud there, their head and torso completely buried and out of sight. This environment is certainly very anoxic, and the tadpole crowns are likely to have aided in respiration, but not in the way that has been previously described for this and other species (Grandison 1980; Channing 1993; Müller *et al*. 2005; Wasonga & Channing 2007). It is possible that elsewhere tadpoles of this same species can be found in phytotelma, and that they use their crown as an accessory respiratory surface.

Our study reveals some remarkable similarities with other members of this genus. Despite the lack of tympanum (Tandy & Keith 1972), this genus of "earless" dwarf toads (Frost *et al*. 2006) appear to be very active in response to conspecific calls. Grandison & Ashe (1983) provided an account of courtship in *M. micronotis* which records that "the soft chirp of a male in amplexus prompted three other males that had been chasing each other around in the water container to call and mount each other indiscriminately and their calls appeared to induce two females to move in the direction of their calls but stop and wander off when the calling ceased". This observation was remarkably similar to our own, suggesting that despite the lack of auditory apparatus, these dwarf toads are capable of detecting the sounds and react immediately to them. If these vocalisations are not advertisement calls (cf Channing & Howell 2005), their role remains obscure, but appears to be very effective when animals are close together. These observations prompt follow up work into the system of mate attraction in *Mertensophryne*, and other earless dwarf toads (e.g. *Capensibufo* spp.).

Dwarf toads have remained enigmatic, both because of taxonomic uncertainties and as they are rarely encountered members of the amphibian fauna (e.g. Clarke 1989; Poynton *et al*. 2005). Based on our observations, conservation and monitoring of this and other species of dwarf toads might prove to be difficult. Breeding sites are hard to find and toads breed over a very short period with a high turnover. It is possible that *M. taitana* also uses tree holes as breeding sites, although none were detected in this study (within a transformed habitat). Otherwise, they are extremely difficult to detect using conventional survey methods (pit fall trapping) in the surrounding environment. If other species of dwarf toads also make use of road puddles, they may become vulnerable to changes in traffic levels and improvements to road surfaces. During this study we witnessed a high level of mortality of tadpoles due to road traffic. We strongly encourage more investigations into the life-history of this and other species of dwarf toads.

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