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A NEW SPECIES OF *TOMOPTERNA* (ANURA: RANIDAE) FROM THE KRUGER NATIONAL PARK, WITH NOTES ON RELATED SPECIES

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Abstract – A new species of *Tomopterna, T. krugerensis* sp. n., has been recorded from the Kruger National Park, Republic of South Africa. Morphologically it is very similar to *T. delalandei cryptotis* (Boulenger) but the mating call is markedly different from that of the other members of the genus and this is coupled with small but consistent morphological differences.

T. krugerensis sp. n. is known to occur only on a portion of the western fringe of the vast sandveld areas of Moçambique, but possibly has a much wider distribution. Mating call, calling behaviour, eggs, early development and defence mechanisms are described. The affinities of the new form are discussed and the mating calls of other members of the genus are reviewed. Mating call is again shown to be a sensitive non-morphological taxonomic tool.

Introduction

Three species of *Tomopterna* (*Pyxicephalus* (part) of Poynton 1964a) have been recorded from the Kruger National Park, (K. N. P.), Republic of South Africa. In the northern region of the Park (Fig. 1) a fourth species was recently discovered and is here described. The new form is morphologically very similar to *T. delalandei cryptotis* (Boulenger) and would possibly have remained undetected had its distinct and characteristic mating call not been heard.

Following the early summer rains of 1973, breeding aggregations of *T. delalandei cryptotis* (Boulenger), *T. marmorata* (Peters) and the new form were encountered in the Park and this facilitated the recognition of an otherwise cryptic species.

Poynton (1964a) divides the subfamily Raninae into five genera; *Pyxicephalus, Rana, Hylarana, Hildebrantia* and *Ptychadena.* The

genus *Pyxicephalus* here includes the subgenera *Tomopterna* and *Pyxicephalus* of Boulenger. Poynton (1964a) holds that there is little to justify the separation of *Tomopterna* and *Pyxicephalus* and consequently treats these forms as a single genus. Opinions of other workers on African Amphibia seem divided as to whether *Tomopterna* and *Pyxicephalus* should be treated as a single genus, or whether *Pyxicephalus* should be left monotypic and *Tomopterna* treated as a full genus.

The present authors feel that separation at the generic level is warranted and accordingly the new form is here described as *Tomopterna krugerensis* sp. n.

Tomopterna krugerensis sp. n.

Holotype

A sexually mature male, Transvaal Museum reg. no. TM44670. Locality: Machayipan, Kruger National Park, Republic of South Africa 2231Cb. Date: 23 October 1973. Collectors: N. I. Passmore and V. C. Carruthers.

Paratypes

24 mature males, Transvaal Museum reg. no. TM44671 to TM44694. 13 mature females, Transvaal Museum reg. no. TM44695 to TM44708. Locality: Machayipan, Kruger National Park, Republic of South Africa. Date: 23 October 1973. 10 males, Kruger National Park Museum no. NKW250 to NKW259, and 9 females NKW260 to NKW268. Locality: Wambiya sandveld, Kruger National Park, 2231Cb. Date: 15 to 17 March 1974. Collectors: N. I. Passmore and V. C. Carruthers.

Other Material

The following specimens in the Transvaal Museum collection are referred to this form: TM29600 to TM29609 from Magude district, Mocambique; TM29546 to TM29550 from Chigubo district, Mocambique; TM29625, TM29626 and TM29629 from Mapulanguene, Mocambique.

Materials

A total of 57 specimens of *Tomopterna krugerensis* sp. n. were collected by the authors during two collecting expeditions to the north-eastern region of the K.N.P. (Fig. 1). The first of these was in early summer when 38 specimens (TM44670 to TM44707), forming part of a large breeding aggregation, were collected by hand at the type locality (Machayipan). A second sample of 19 specimens (NKW250 to NKW268) was collected during late summer. This latter sample was not part of a breeding aggregation and the animals were collected by hand whilst foraging at night.

All animals were killed with urethane and preserved in 70 per cent alcohol.

Comparative studies were based on the following collections; *T. delalandei cryptotis* (Boulenger): 29 specimens collected by the authors at Punda Milia, K. N. P. and deposited in the Park Museum at Skukuza;

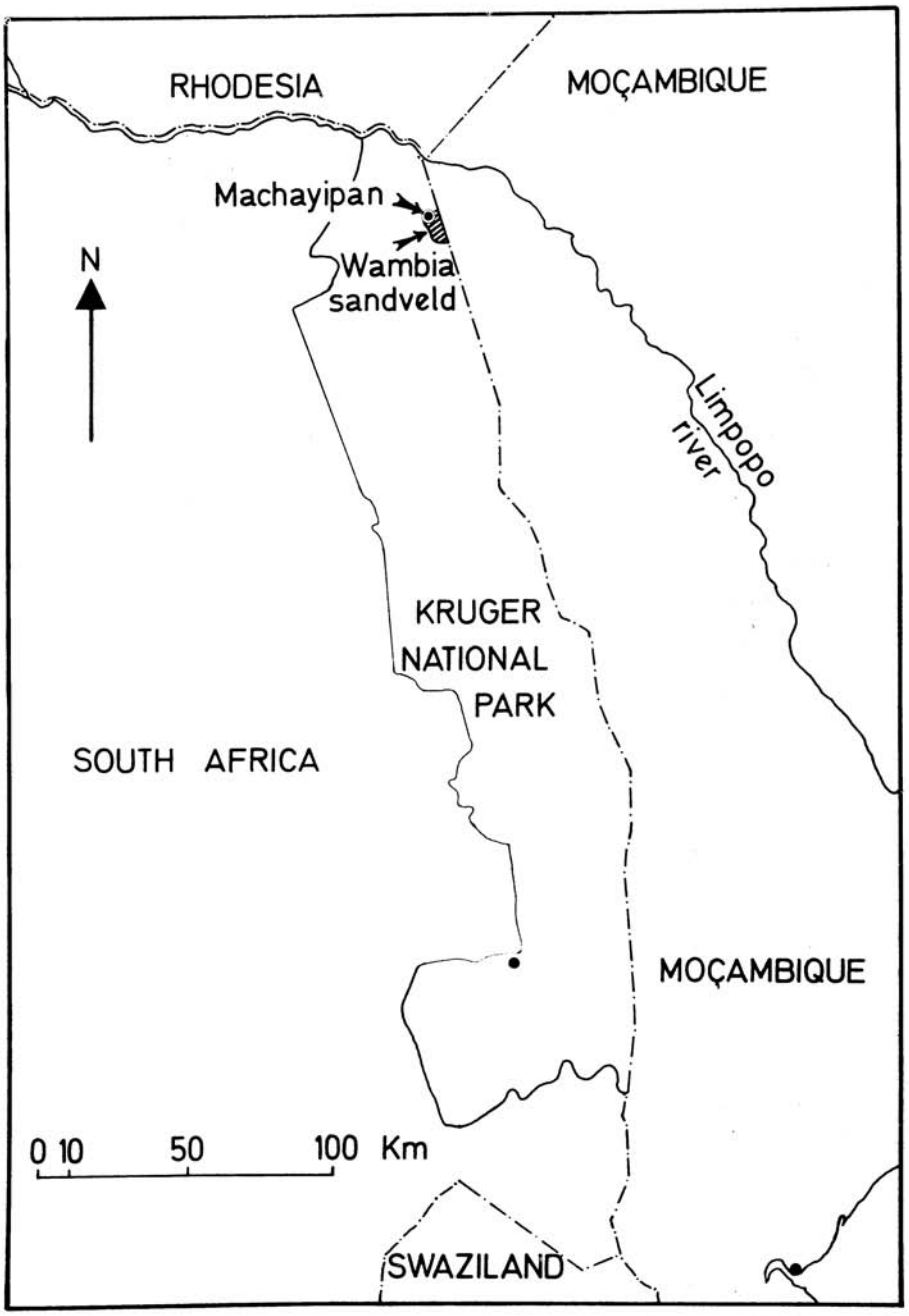

Fig. 1. Type locality (Machayipan) and distribution of *Tomopterna krugerensis* sp. n. in the Republic of South Africa.

13 specimens in the Kruger National Park Museum collection; 14 specimens collected at Gobabeb, South West Africa, in the private collection of A. Channing Esq., University of Natal; 2 specimens collected at Naboomspruit, Transvaal, in the collection of the Department of

Zoology, University of the Witwatersrand; 52 specimens in the Transvaal Museum collection; 21 specimens in the Natal Museum collection.
T. marmorata (Peters): 10 specimens in the Kruger National Park Museum collection; 1 specimen in the Transvaal Museum collection; 11 specimens in the Natal Museum collection.
T. delalandei delalandei (Tschudi): 52 specimens in the Transvaal Museum collection; 17 specimens in the Natal Museum collection.
T. natalensis (Smith): 3 specimens in the collection of the Department of Zoology, University of the Witwatersrand; 1 specimen in the Kruger National Park Museum collection.
T. tuberculosa (Boulenger): 1 specimen in the Transvaal Museum collection.

The type of paratypes of *Pyxicephalus obtusus* FitzSimons (FitzSimons 1930) were also examined.

The mating calls of *T. krugerensis* sp. n., *T. delalandei cryptotis* and *T. marmorata* were recorded with a Uher 4200 Report portable tape recorder at a tape speed of 19cm/second. The authors are grateful to Mr. H. H. Braack, National Parks Board, for recording calls of *T. marmorata* and collecting the calling individuals. Mating calls of *T. delalandei delalandei* and *T. natalensis* used here were recorded by Dr. J. C. Poynton, University of Natal, on a N•gra III portable recorder at a tape speed of 38cm/second. The recorded calls were analysed on a sound spectrograph (Kay model 7029A spectrum analyser) within the frequency range 160Hz – 16kHz, using a wide band filter (300Hz). Two types of sonagram portrayal are used, the normal portrayal of frequency *vs* time (Fig. 2A), and the section portrayal of frequency *vs* amplitude (Fig. 2B).

Diagnosis

Morphologically very similar to *Tomopterna delalandei cryptotis* (Boulenger). Mating call a characteristic slowly repetitive percussive "knock", almost metronome-like in nature and differing from the moderate to high-pitched rapid ringing calls of *T. delalandei cryptotis* (Boulenger) (Fig. 2), *T. marmorata* (Peters), *T. natalensis* (Smith) and *T. delalandei delalandei* (Tschudi) (Fig. 3). Large proximal subarticular tubercle on thumb commonly divided longitudinally in two (Fig. 4), but sometimes only partially divided. Double proximal subarticular tubercle sometimes present on second and rarely also third digit. Subarticular tubercles single in all the other species. Differing from the other species in the extent of webbing on the hind feet. Hind feet moderately webbed, this form being intermediate between *T. delalandei cryptotis* (Boulenger) and *T. marmorata* (Peters) in this character (Fig. 5) and differing markedly from *T. tuberculosa* (Boulenger) and *T. natalensis* (Smith) where webbing is much less extensive on all digits; length of unwebbed portion of first toe less than toe width (equal to, or greater than toe width in *delalandei cryptotis,* but similar to *marmorata,* although webbing never reaches to toe tip as is sometimes the case in *marmorata*) webbing approaching but not reaching middle subarticular tubercle on inner margin of fourth

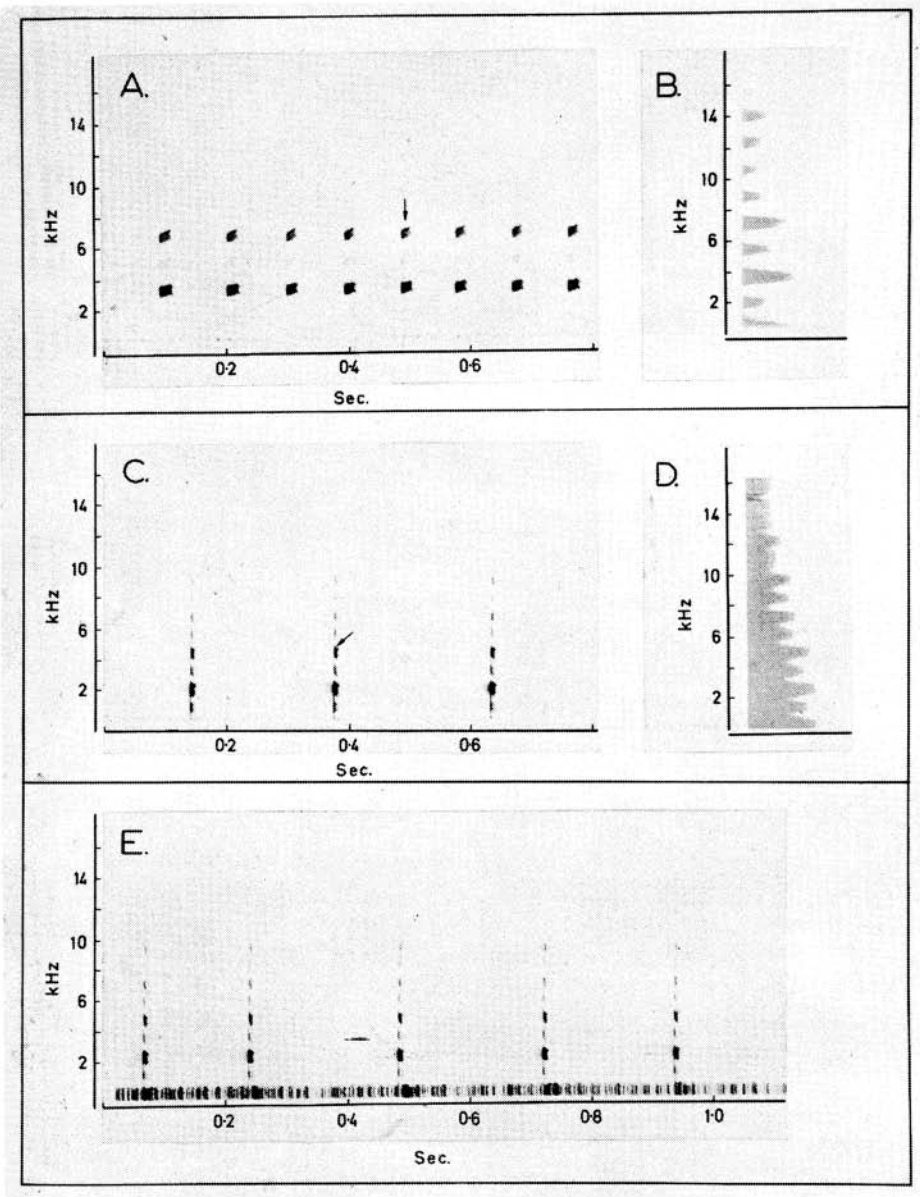

*Fig. 2. Sonograms of mating calls of *T. delalandei cryptotis* (A and B) and *T. krugerensis* sp. n. (C, D and E).

*Ignore base level interference (0,0 kHz–0,75 kHz) on sonograms B, D and E. This interference has been removed from sonograms A and C.

digit leaving $3^1/_4$ to $3^1/_2$ phalanges free of web, falling well short of middle subarticular tubercle on outer margin leaving $3^1/_2$ to $3^3/_4$ phalanges free (reaching middle subarticular tubercle in *marmorata* and *delalandei delalandei,* but webbing on this digit only very slightly more

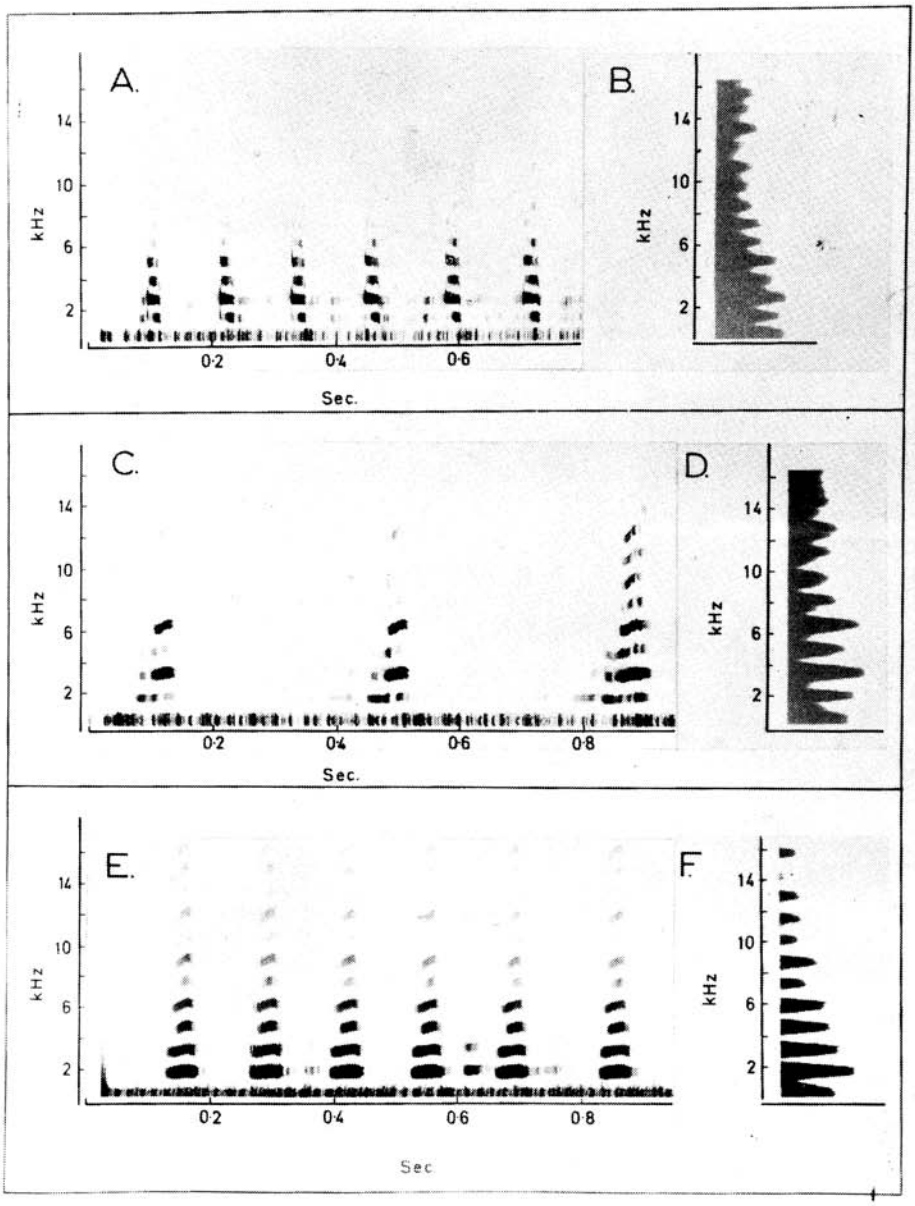

*Fig. 3. Sonograms of mating calls of *T. delalandei delandei* (A and B), *T. natalensis* (C and D) and *T. marmorata* (E and F).

* Ignore base level interference (0,0 kHz–1,0 kHz) on sonograms A to F.

extensive than that of *delalandei cryptotis*); webbing at least reaching proximal border of distal subarticular tubercle of fifth digit, but sometimes incised to just below level of tubercle (reaching beyond distal subarticular tubercle in *marmorata,* at least to distal border of this tubercle in *delalandei delalandei,* falling short of and incised to well below level of

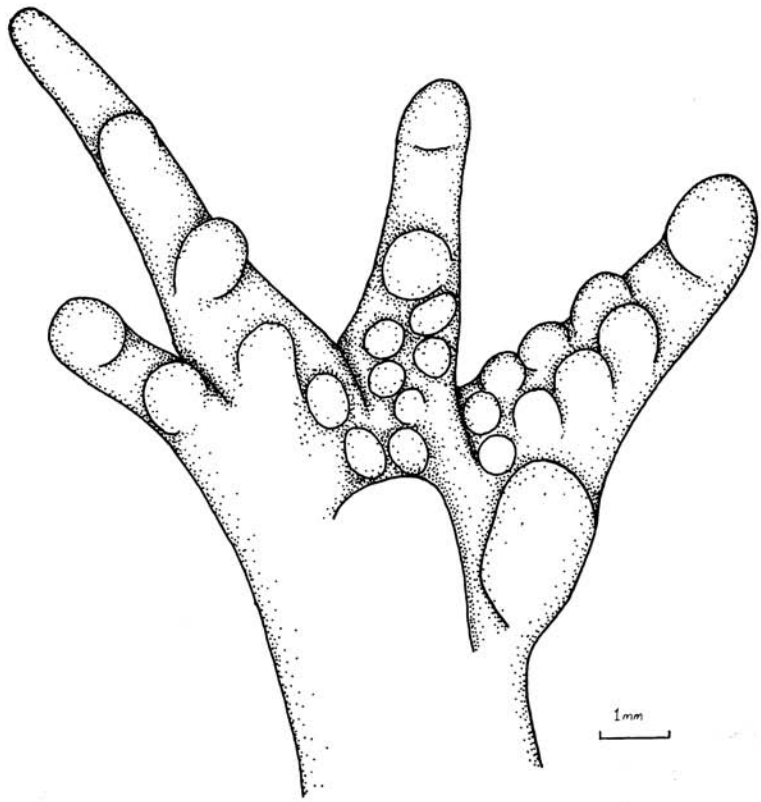

Fig. 4. Palmar surface of right fore foot of *T. krugerensis* sp. n.

this tubercle in *delalandei cryptotis*. Outer metatarsal tubercle either a feeble whitish bump or absent (differing from *tuberculosa* and *delalandei delalandei* where it is well developed and strongly projecting, but similar to *marmorata, delalandei cryptotis* and *natalensis)*. Conspicuous glandular ridge running from below eye to level of anterior face of fore arm, between tympanum and jaw angle (reduced to a short oblique ridge or series of small glandular patches in *marmorata* and not conspicuous anteriorly, also reduced to a series of glandular patches in *delalandei delalandei,* but a similar ridge present in *delalandei cryptotis* and *natalensis)*. Light vertebral and dorsolateral lines absent (both often present in *delalandei cryptotis* and *delalandei delalandei)*. Dorsum always with irregular dark markings and dark spots on a lighter ground colour (similar to dorsal markings of *delalandei cryptotis,* but differing from the scantily marked orange-brown to grey-brown dorsum of *marmorata)*. Dorsum comparatively smooth (lacking the distinctive and prominent tubercles of *tuberculosa)*.

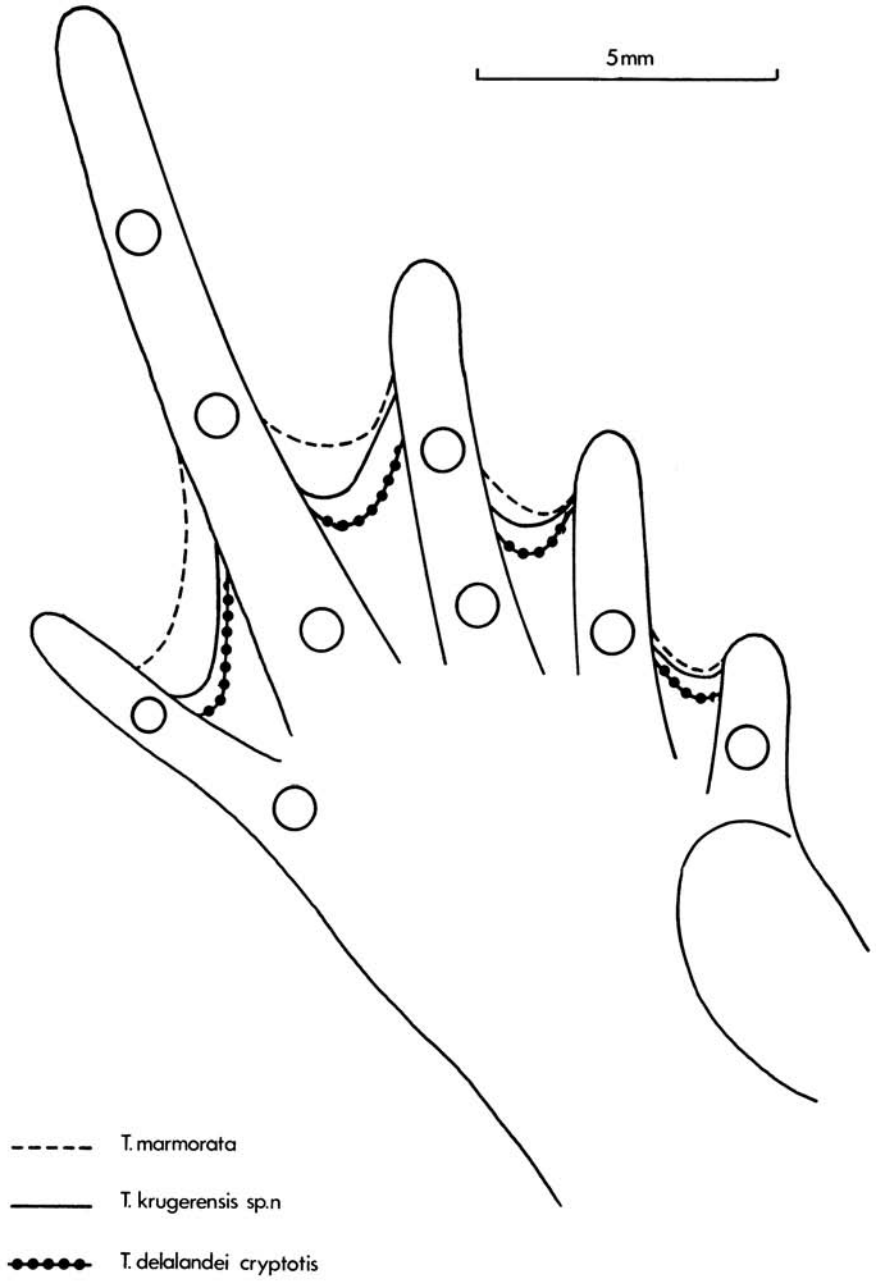

Fig. 5. Sole of right hind foot showing the extent of webbing in *T. marmorata*, *T. krugerensis* sp. n. and *T. delalandei cryptotis*.

Table 1

Measurements of Tomopterna krugerensis *sp.n. (holotype and paratypes), expressed in mm and as a percentage of total body length (TL)*

	HOLOTYPE		PARATYPES					
			MALE			FEMALE		
			MEAN		RANGE	MEAN		RANGE
	mm	% TL	mm	% TL	% TL	mm	% TL	% TL
Body length (snout to urostyle tip)	42,0	—	41,3	—	37,9–44,8	44,0	—	41,1–46,4
Head length (snout tip to occiput)	10,2	24,3	11,1	26,9	24,1–29,6	10,9	24,8	22,1–27,3
Jaw width (between jaw angles)	17,1	40,7	16,6	40,3	36,[illegible]-43,4	17,7	40,2	37,4–44,0
Interorbital (between anterior corners of eyes)	8,2	19,5	7,8	18,8	16,6–20,0	8,2	18,6	17,8–19,9
Eye diameter (from anterior to posterior)	6,7	16,0	6,9	16,6	15,8–17,9	7,1	16,2	15,1–18,1
Internarial (between medial edges of nostrils)	3,9	9,3	3,8	9,2	8,5–10,0	4,1	9,3	8,7–10,2
From anterior corner of eye to nostril	2,9	6,9	2,6	6,4	5,6–8,0	2,7	6,2	5,1–7,1
Hind limb (vent to tip of fourth digit)	55,4	131,9	55,7	134,8	123,5–147,6	60,2	136,9	129,3–145,2
Thigh (vent to outer face of flexed knee)	19,2	45,7	18,8	45,4	41,3–50,0	19,4	44,0	38,1–50,1
Shank (knee to ankle with leg flexed)	17,3	41,2	17,1	41,5	38,5–45,0	18,3	41,6	39,2–44,0
Foot (including inner metatarsal tubercle)	18,4	43,8	18,3	44,3	42,0–47,7	19,4	44,0	41,6–48,2
Inner metatarsal tubercle length	4,2	10,0	4,0	9,6	8,6–10,7	4,3	9,7	8,8–10,4
Fore limb (axilla to tip of third digit)	22,0	52,4	22,3	54,1	50,1–58,5	24,3	52,2	51,0–61,0
Upper arm (axilla to elbow with limb flexed)	7,0	17,9	7,5	18,2	15,6–20,6	8,4	19,1	16,3–21,7
Fore arm (elbow to wrist with limb flexed)	8,4	19,5	8,2	19,9	17,9–22,4	9,2	20,9	19,4–21,7
Hand (wrist to tip of third digit)	10,5	25,0	10,5	25,4	22,4–28,5	10,9	24,8	22,9–26,7

Description of Holotype

Habit stout. Head short, much broader than long. Eyes large and bulging, horizontal diameter just less than distance between their anterior corners; a group of conspicuous small tubercles on posterior third of upper eyelid. Snout obtuse, projecting slightly beyond upper and lower labial margins anteriorly, almost squared between nostrils. Nostrils set wide apart, internarial distance greater than distance from anterior corner of eye to nostril; nostrils placed anterolaterally on snout, much nearer to tip of snout than to eye. Canthus rostralis straight. Tympanum indistinct and vertically elongated. Uninterrupted conspicuous glandular ridge running between eye and jaw angle from below posterior third of eye to level of anterior face of fore arm; ridge wider posteriorly.

Fore limbs short and stout. Fingers short, first slightly longer and more stout than second, both larger than fourth; third finger longest, more than twice length of fourth, but less than twice length of first and second. Two subarticular tubercles prominent on each finger; proximal subarticular tubercle on first digit double (divided longitudinally in two), but on other digits single; distal subarticular tubercles single; small double tubercles located at bases of first, second and third digits. Two well developed flattened palmar tubercles (Fig. 4). Hand longer than fore arm, which is longer than upper arm (Table 1).

Hind limb approximately one third longer than body (Table 1). First digit short, second and fifth subequal and about half length of fourth, third approximately two thirds length of fourth. Subarticular tubercles distinct but smaller than those on hand; one subarticular tubercle present on first and second digits, two on third and fifth, three on fourth (Fig. 5). Inner metatarsal tubercle prominent, rounded in outline, sharp-edged and strongly projecting; length approximately equal to internarial distance; outer metatarsal tubercle absent. Foot length one third of total leg length, just greater than length of shank, but just less than length of thigh (Table 1).

Length of unwebbed portion of first digit not exceeding width of digit; webbing on inner margin of second digit reaching subarticular tubercle, on outer margin leaving less than one phalanx free, although incised to level of terminal phalanx; $2^1/_2$ phalanges free of web on inner margin of third digit, webbing reaching distal subarticular tubercle on outer margin; $3^1/_2$ phalanges free of web on inner margin of fourth digit, $3^3/_4$ phalanges free on outer margin; webbing reaching proximal border of distal subarticular tubercle of fifth digit, but incised to just below level of tubercle.

Dorsum smooth in alcohol. Venter smooth but granular around vent.

Dorsal pattern: Ground colour in alcohol pale grey between extensive mid-grey markings, each of which with a dark grey to black outline; anterior two thirds of dorsum with scattered light spots, each possessing a thick black rim; on posterior third of dorsum light spots with

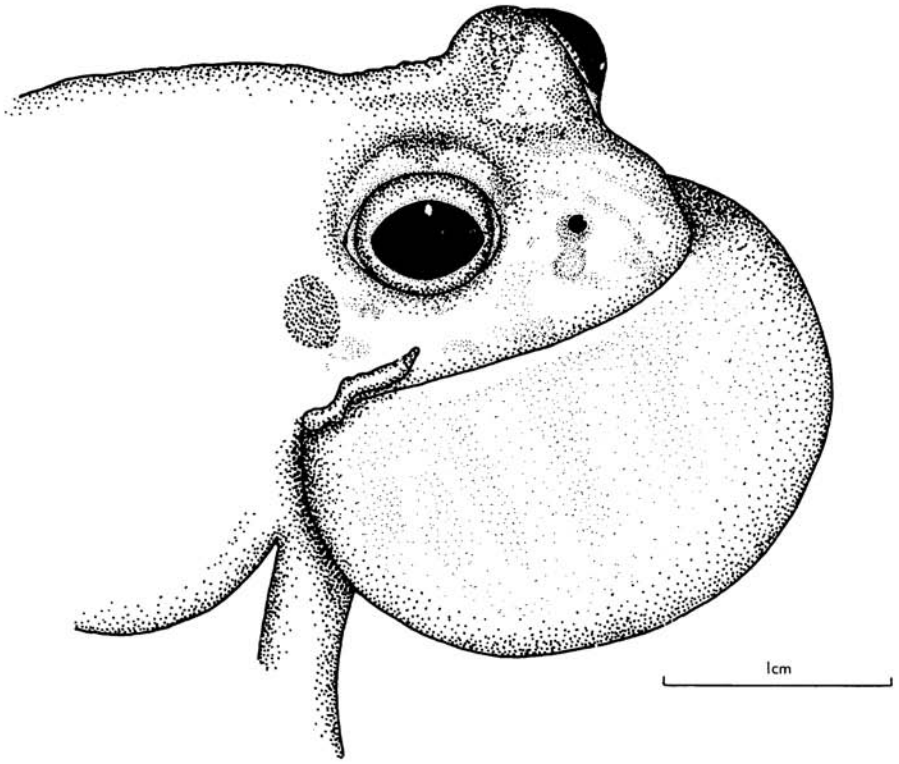

Fig. 6. Male T. krugerensis sp. n. with fully distended vocal sac.

narrower and less dense dark rim (Fig. 6) Ventral surface, excluding throat, immaculate white. Throat darkly pigmented; labial margin white; heavily pigmented black crescentic area covering anterior half of throat, shading posteriorly into a less heavily pigmented crescentic region which reaches anterior face of fore arm laterally; posterior edge of pigmented area irregularly sculptured (Fig. 7A).

Variation in Paratypes

Females larger than males (Table 1). Throat of females in breeding condition with irregular grey-brown blotches or fine shading concentrated laterally, commonly leaving a sparsely pigmented area along the midline of the throat; pigmentation darker towards jaw angle (Fig. 7B and Fig. 7C). The throat of males collected out of the breeding season (NKW250 to NKW259) not as heavily pigmented as when in breeding condition; sexing by this character is consequently more difficult out of the breeding season.

Tympanum sometimes very indistinct, but always visible. Glandular ridge below eye commonly wider posteriorly and often interrupted on one or on both sides anteriorly (Fig. 7D).

Proximal subarticular tubercle on first digit of hand double (84 per cent) or at least partially divided (16 per cent); on second digit either

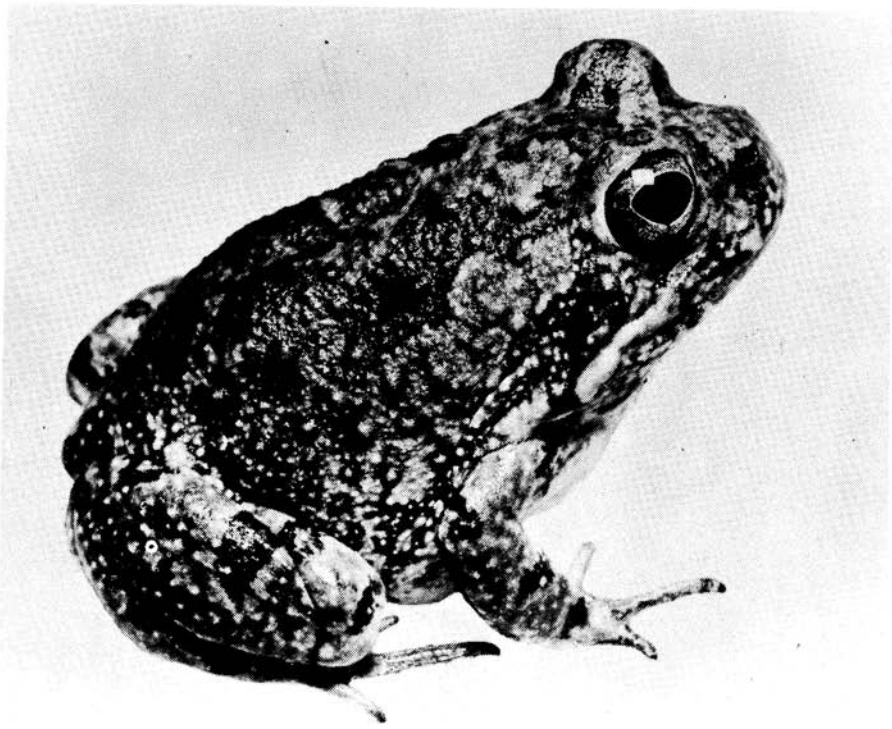

Fig. 7D. *Tomopterna krugerensis* sp. n. (Female).

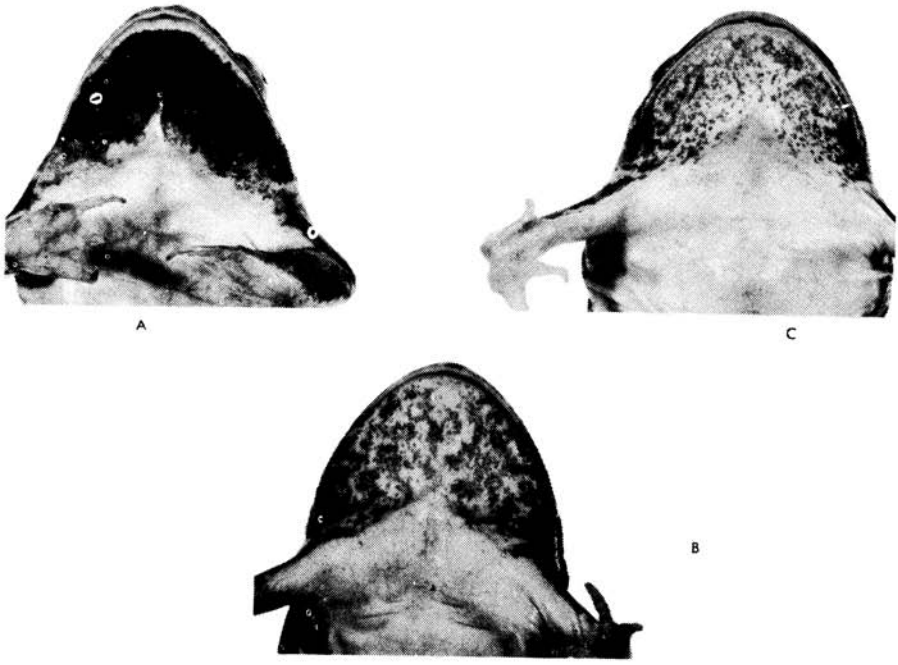

Fig. 7. A. *Tomopterna krugerensis* sp. n. Throat of male in breeding condition. B and C. *Tomopterna krugerensis* sp. n. Throat of female in breeding condition.

single (75 per cent) or double (25 per cent); on third digit either single (96 per cent) or double (4 per cent); on fourth digit single (100 per cent). Small double tubercles located at bases of digits one, two and three in most cases.

Foot length approximately equal to one third leg length, not always less than thigh, but always greater than shank (Table 1).

Webbing (Fig. 5): Occasionally approaching but not reaching tip of first digit; commonly reaching distal edge of subarticular tubercle on inner margin of second digit, on outer margin incised to, or to just below level of terminal phalanx, but reaching from one to two thirds of the way along it; 2 to $2^1/_2$ phalanges of third digit free of web on inner margin, 1 to 2 phalanges free on outer margin; webbing approaching but not reaching middle subarticular tubercle on inner margin of fourth digit, leaving $3^1/_4$ to $3^1/_2$ phalanges free of web, falling well short of middle subarticular tubercle on outer margin leaving $3^1/_2$ to $3^3/_4$ phalanges free; webbing reaching at least to proximal border of distal subarticular tubercle of fifth digit, commonly reaching to mid-tubercle level, but incised to just below level of tubercle.

Dorsum covered in life with conspicuous protruberances, which disappear following preservation in alcohol, leaving the dorsum more smooth than it is in life.

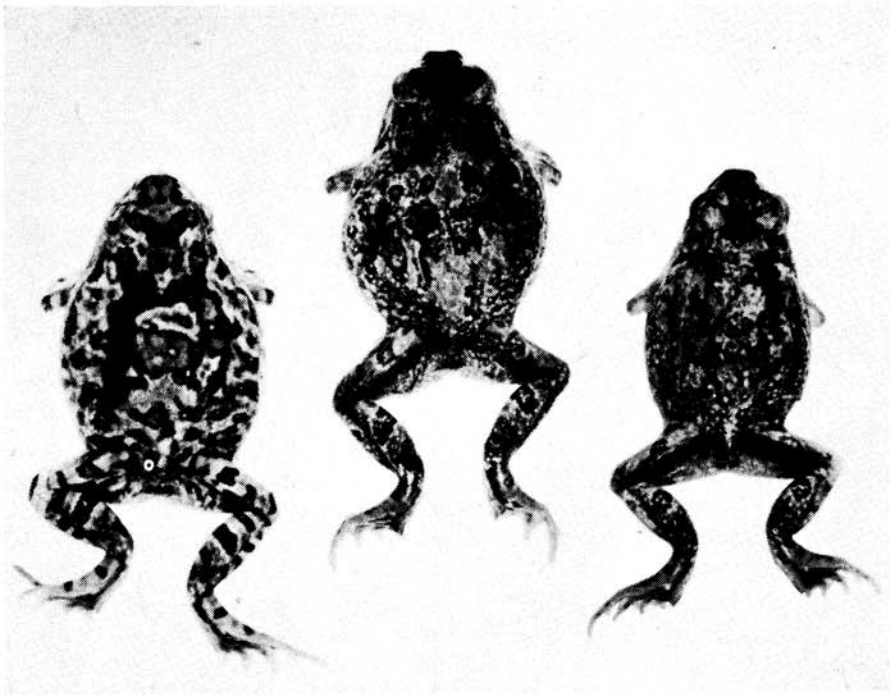

Fig. 8. *T. krugerensis* sp. n. (males) showing the variation in dorsal markings.

Colour and pattern in life: Dorsal ground colour commonly cream-beige, but ranging from very pale grey-brown to a mid-brown; large part of dorsum covered by irregular khaki-brown markings with moderate to thin dark-brown to black outline (Fig. 8). Bright orange tubercles scattered over entire dorsum, each surrounded by a black rim, tending to be larger and with a thicker black rim in the vertebral region. In the occipital region an irregular row of orange tubercles surrounds an occipital patch of ground colour; on sides of the tubercles facing this patch, the dark rim is absent, but it remains on the opposite sides of the tubercles, forming in aggregate an irregular dark outline to the lateral and posterior aspects of the patch; tubercles within the patch inconspicuous with little or no black edging; on posterior half to one third of dorsum tubercles smaller and with little or no dark outline. Bright orange tubercles present on posterior third to half of upper eyelid, much smaller tubercles present occasionally on anterior third of upper eyelid. Irregular dark markings present on lateral aspect of body, slightly darker than similar markings on the dorsum; tubercles in this region similar to those on posterior of dorsum, but frequently with darker edging (Fig. 7D). Posterior face of thigh dark fleshy-brown, with white granulations surrounding cloaca; unpigmented fleshy band on ventral surface of thigh, running through groin from foot to foot and contrasting strongly with immaculate white surrounding areas; two dark green-brown transverse bars prominent on dorsum of thigh. Shank with two dark green-brown transverse bars running across dorsum from medial to lateral aspect. Sole of foot uniformly pigmented, colour same as that of dorsal markings; dorsum of foot scantily pigmented; digits white. Anterior face of fore arm with uniform mid-brown pigmentation and two narrow faint transverse bars running across anterior and lateral aspects. Dorsum of foot white, sole unpigmented. Venter immaculate white. Glandular ridge below eye ranging from dirty-white to light orange. Dorsum without trace of light vertebral or lateral stripes (Fig. 8).

Mating call

The mating call is best described as a fairly slowly repetitive percussive "knock" or "cluck" reminiscent of the beat of a metronome and easily distinguishable in the field. The call is not trilled according to the definition of Blair and Pettus (1954) and subsequent workers, as individual pulses (bursts of sound) are not separated by intervals discernable on the normal sonagram portrayal (Fig. 2C and Fig. 2E). The call duration is short (0,008 to 0,011 sec.) (Fig. 2C and Fig. 2E). Each call covers a wide frequency range, in most cases almost the full range of the sonagram (Fig. 2D). The dominant or most emphasized harmonic occupies the frequency range 1,9 kHz to 3,1 kHz. Other emphasized harmonics occur further up the frequency range (4,3 kHz to 5,6 kHz; 6,8 kHz to 7,7 kHz; 9,0 kHz to 10,2 kHz) and each of these alternates with a progressively less emphasized harmonic. The frequency structure of the

call is such that it covers the entire frequency range without interval (Fig. 2D).

To the ear the call lacks the ringing quality of the calls of some of the other members of the genus.

Range and Habitat

The distribution of this form in South Africa appears to be restricted (Fig. 1), being confined to the Wambiya sandveld, a very narrow strip of Kalahari-like sands in the extreme northeastern Transvaal where the type series was collected. However, this area forms part of the western fringe of the vast sandveld areas of Mocambique which have been very poorly collected to date (Poynton 1964a). The distribution of this form is likely to be more extensive in Mocambique, but the authors have not been able to verify this. Some *Tomopterna* from the Mocambique region presently in the Transvaal Museum collection are provisionally referred to this form on the basis of morphological features e.g. webbing and hand tubercles.

Over its known range in the K.N.P., *T. krugerensis* sp. n. is not sympatric with any other *Tomopterna* species (Pienaar 1963 and personal observation).

T. krugerensis sp. n. occurs in an area of deep sandy soils, where the weather is hot and dry for the greater part of the year. The only available bodies of water suitable for breeding are temporary rain pools (pans), and breeding aggregations were found at two of these in early summer (Machayipan and Mathlakuzapan). Despite the apparent harshness of the environment, individuals were collected up to 2 km from the nearest semi-permanent body of water in late summer. The substrate of comparatively loose sand is ideal for burrowing frogs.

Field observations

The type locality was first visited in early summer, shortly after a period of substantial and widespread rains. The weather was warm and windless, and breeding activity of a number of anuran species was at peak level. Males of 11 species were calling on the night of 23 October 1973 and the chorus was clearly audible from a long way off. The characteristic and distinctive call of *T. krugerensis* sp. n. was immediately noticed in a large mixed chorus of the following species: *Kassina maculata, Kassina senegalensis, Phrynomerus bifasciatus bifasciatus, Ptychadena mossambica, Ptychadena superciliaris, Bufo garmani, Afrixalus brachynemis brachynemis, Hyperolius viridiflavus, Hyperolius pusillus* and *Chiromantis xerampelina*. The fact that the presence of the new form was evident in this large mixed chorus is indicative of the distinct nature of the call.

Calling site: The total number of *T. krugerensis* sp. n. males actively involved in calling at Machayipan was estimated at between 150 and 200. These were not evenly distributed around the circumference of the pan, but were present in isolated aggregates of 8 to 15 individuals, each

aggregate occupying a 3 m to 4 m strip of shore. The calling site ranges from completely exposed to partially concealed, the latter being more common and partial cover being provided by sparse vegetation. Occasional males were encountered up to 3 m from the edge of the water, but the majority of calling individuals were within 1 m of the edge. In this latter region, no marked calling site preference was evident. Some individuals were sitting in shallow water with both fore and hind feet submerged, while in others only the fore feet were submerged or the animal was calling from damp sand adjacent to the water.

The vocal sac is large (Fig. 6) and is only partially deflated between calls, its diameter decreasing by approximately 4 mm from its fully distended condition. Only following disturbance of the animal is the vocal sac deflated completely.

Chorus development: Following the discovery of the new form, some observations on chorus structure and development and movement of animals to the breeding site were made. The evening chorus at Machayipan began at 18h00 and the mixed chorus of 10 species was well established at last light (19h05). *T. krugerensis* sp. n. began calling at last light and its chorus reached peak level some 20 minutes later. During this time two males and three females were observed moving towards the water from the surrounding vegetation. The relatively sudden appearance of males at the water and the absence of large scale observable movement from the surrounds suggests that the calling males burrow near to the water during the day. For the following $2^1/_2$ hours, until observations were terminated, the chorus from the pan as a whole remained uninterrupted, although individual aggregates of calling males periodically lapsed into silence for one to two minutes.

Amplexus and eggs: Three pairs were collected in amplexus. One of these was in shallow water at the edge of the pan, presumably about to commence laying, and the other two pairs were found on the damp adjacent sand. Amplexus is thoracic. On the approach of the investigator, two of the pairs attempted to burrow without moving away or separating. Prior to the commencement of egg laying, each pair was placed in a separate plastic box containing about 1,5 cm of tap water. Nine hours later, one pair was found to have produced 5,000 (±5 per cent) eggs, the majority of which had already developed as far as the mid-gastrula stage. The eggs are demersal and laid singly, each enclosed in a jelly envelope 3 mm in diameter. Egg diameter is 1,2 millimeter. The animal hemisphere is uniform grey and lighter in colour than the corresponding region in *Xenopus laevis laevis* (Daudin). The vegetal region is uniform creamy-yellow and shades gradually into the pigmented area across the marginal zone. The jelly capsule is spherical and fairly flaccid. Small foreign particles were observed adhering to the jelly capsule, but the jelly is otherwise completely translucent. Attempts to rear the embryos in the field were unfortunately unsuccessful.

Defence mechanisms and burrowing: As is the case with other mem-

bers of the genus, considerable inflation of the body with air is resorted to on being handled or otherwise disturbed. Complete immobility or "playing possum", lying upside down, was also observed on occasions following capture by hand. This immobility lasted for 15 to 20 seconds. Burrowing is accomplished rapidly by a shuffling movement of the hind limbs and the animal is capable of disappearing from view in less than 20 seconds in loose sand.

Laboratory observations: A small number of individuals were maintained in the laboratory for a period of one week following capture. On being placed in a container with a soft sandy bottom, burrowing was immediate in all cases. All individuals remained in the burrow throughout the day either completely concealed or with at most the tip of the snout and the eyes exposed. Tempting partially concealed animals with food items would not extricate the animals from their burrows. Activity, including feeding activity, increased at night. No calling could be elicited from males in captivity by prompting with pre-recorded choruses.

Discussion

T. krugerensis sp. n. is very similar to *T. delalandei cryptotis* (Boulenger) and shows few really striking morphological differences. The observed difference in the amount of webbing (Fig. 5) is one of degree and series of each species are required to distinguish them. The other species of *Tomopterna* show fairly substantial differences in the amount of webbing, ranging from a trace in *T. tuberculosa* (Boulenger) and *T. natalensis* (Smith) to the extensive webbing of *T. marmorata* (Peters) and *T.delalandei delalandei* (Tschudi) (Poynton 1964a,b; Stewart 1967). *T. delalandei cryptotis* (Boulenger) is intermediate in respect of the amount of webbing between *T. natalensis* (Smith) and *T. tuberculosa* (Boulenger) on the one hand and *T. delalandei delalandei* (Tschudi) and *T. marmorata* (Peters) on the other (Poynton 1964a). *T. krugerensis* sp. n. provides a further addition to this series, being slightly more webbed than *T. delalandei cryptotis* (Boulenger), but not quite as extensively webbed as *T. marmorata* (Peters) (Fig. 5).

The double or partially divided proximal subarticular tubercle on the first digit of the hand is a further consistent morphological difference separating the new form from the other species of *Tomopterna*.

The absence of light longitudinal stripes in the new form is conspicuous, but cannot be given any real diagnostic significance since although the *T. delalandei cryptotis* (Boulenger) examined were commonly striped, individuals displaying partial or complete breakdown of stripes were also encountered.

The mating call has been found to be a sensitive means of separating closely related species (Porter 1964) and detecting intergrading between species (Passmore 1972). It is a particularly useful taxonomic aid when dealing with closely related members of species groups where distinction of component forms is difficult on morphological grounds

alone. Mating call analyses have been conducted on a large number of Anura. With very few exceptions, each species has been found to differ distinctly from every other species in at least one, and often more of the attributes of the call (Blair 1958). The mating call of *T. krugerensis* sp.n. is indeed very different from the mating calls of the other species of *Tomopterna* considered here (Fig. 2 and Fig. 3).

The extreme brevity of the call and the moderate call repetition rate clearly distinguish the species. The call of the new form is distinctly shorter than that of any of the previously known species (Fig. 2 and Fig. 3). The harmonic and tonal qualities of the call, both in analysed form and in the field, are equally characteristic. The calls of *T. marmorata* (Peters), *T. natalensis* (Smith), *T. delalandei cryptotis* (Boulenger) and *T. delalandei delalandei* (Tschudi) possess what is best described as a rather melodious high-pitched "ringing quality". *T. krugerensis* sp. n. lacks this completely and a "metronome-like clucking noise" conveys the auditory impression gained almost exactly. It can be confidently stated therefore that the degree of difference between the mating calls of the new form and the other members of the genus is greater than the difference that exists between the calls of these previously known *Tomopterna* species.

There appears to be confusion in the literature regarding the call of *T. marmorata* (Peters). Poynton (1964b) states that the calls of *T. delalandei cryptotis* (Boulenger) and *T. marmorata* (Peters) are unmistakably different, a view with which the present authors concur. Poynton (1964b) states "*cryptotis* having a rapid high pitched ringing call, while the call of *marmorata* is not so highly pitched, has a fuller timbre, and there is more of a pause between each individual call." After discussion with Poynton and reference to his original recordings, it is evident that his description of the call of *marmorata* (Poynton 1964b) was in fact based on the call of *T. krugerensis* sp. n., recorded at Mkuze, Natal. The statement quoted above therefore distinguishes the calls of *T. delalandei cryptotis* (Boulenger) and *T. krugerensis* sp. n., rather than those of *cryptotis* and *marmorata* as originally stated.

The mating call of *T.marmorata* (Peters) (Fig. 3E and fig. 3F) is a rapidly repetitive high-pitched ringing call and this description would apply equally well to the call of *T. delalandei cryptotis* (Boulenger) (Fig. 2A and Fig. 2B). The principal difference between the calls of these two species lies in the call duration (*marmorata* having a call approximately two to three times longer than that of *cryptotis*), and in the harmonic structure (the dominant harmonic in *marmorata* lying in the range 1 kHz - 2,2 kHz, while in *cryptotis* lying in the range 3 kHz–4,2 kHz). The call repetition rate is slightly slower in *marmorata* than in *cryptotis* (Fig. 2A, and fig. 3E), but not markedly so and certainly not recognizably so to the unaided ear.

In the field, the call of *marmorata* resembles closely the call of *T. natalensis* (Smith), both in length and roughly in harmonic structure. However, these two species are easily separated on the basis of the call

repetition rate, *natalensis* having a much more slowly repetitive call (Fig. 3C) than *marmorata* (Fig. 3E).

The known distribution of *T. krugerensis* sp.n. in South Africa is rather limited, but it is likely that the form occurs in the sandveld areas of Mocambique where it has been overlooked or perhaps mistaken for another species. The only *Tomopterna* known from northern Mocambique is *T. marmorata* (Peters) (Poynton 1966). In southeastern Malawi only *T. delalandei cryptotis* (Boulenger) has been recorded (Stevens 1974). It appears from the mating call collection of Dr. J. C. Poynton, University of Natal, that the new form also occurs in the Mkuze district, Natal.

Key to the genus Tomopterna *in southern Africa*

1. Hind feet scantily webbed, webbing only present between bases of digits, leaving more than $3^1/_2$ phalanges of fourth digit free of web 5

   Hind feet moderately to extensively webbed, leaving fewer than $3^1/_2$ phalanges of fourth digit free of web 2

2. Outer metatarsal tubercle well developed and projecting ..... *d. delalandei*

   Outer metatarsal tubercle a feeble bump or absent 3

3. Hind feet extensively webbed, webbing on first digit reaching almost to tip; on fourth reaching level of middle subarticular tubercle on at least one side; on fifth reaching beyond distal subarticular tubercle, although often incised to level of tubercle. Colour in life orange-brown to brown. Dorsal pattern uniform or nearly so, lacking numerous conspicuous dark markings ..... *marmorata*

   Hind feet less extensively webbed; on first digit falling short of tip; on fourth not reaching middle subarticular tubercle; on fifth not reaching distal subarticular tubercle and incised at least to level of proximal border of tubercle. Ground colour grey, with numerous conspicuous dark markings 4

4. Proximal subarticular tubercle on thumb double, or at least partially divided. Length of unwebbed portion of first toe less than toe width; webbing at least reaching proximal border of distal subarticular tubercle of fifth toe and incised to, or to just below level of tubercle. Light vertebral and dorso-lateral stripes absent. Mating call a repetitive, percussive, metronome-like "knock" ..... *krugerensis*

   Proximal subarticular tubercle on thumb single. Length of unwebbed portion of first toe equal to or greater than toe width; falling short of and incised to well below level of distal subarticular tubercle of fifth toe. Light dorsal and/or dorso-lateral stripes most often present. Mating call rapidly repetitive with a distinct ringing quality ..... *d. cryptotis*

5. Outer metatarsal tubercle conspicuous and projecting. Tarsal tubercle present just below tibio-tarsal articulation. Light vertebral line present ..... *tuberculosa*

   Outer metatarsal tubercle a feeble bump to absent. No clear tarsal tubercle. Light vertebral line absent ..... *natalensis*

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REFERENCES

BLAIR, W. F. 1958. Mating call and speciation of Anuran amphibians. *Am. Nat.* 92:27–51.

BLAIR, W. F. and D. PETTUS. 1954. The mating call and its significance in the Colorado river toad, *Bufo alvarius* (Girard). *Tex. Jnl. Sci.* 6:72–77.

FITZSIMONS, V. 1930. Descriptions of new South African reptiles and Batrachia, with distribution records of allied species in the Transvaal Museum collection. *Ann. Transv. Mus.* 14:20–48.

PASSMORE, N. I. 1972. Intergrading between members of the "regularis group" of toads in South Africa. *J. Zool., Lond.* 167:143–151.

PIENAAR, U. DE V. 1963. The zoogeography and systematic list of the Amphibia in the Kruger National Park. *Koedoe* 6:76–82.

PORTER, K. R. 1964. Morphological and mating call comparisons in the *Bufo valliceps* complex. *Am. Midl. Nat.* 71:232–245.

POYNTON, J. C. 1964a. The Amphibia of Southern Africa. *Ann. Natal Mus.* 17:1–334.

POYNTON, J. C. 1964b. The Amphibia of the Nyasa-Luangwa region of Africa. *Senckenb. Biol.* 45:193–225.

POYNTON, J. C. 1966. Amphibia of northern Moçambique. *Mems. Inst. Invest. cient. Moçamb.* 8 Ser. A:13–34.

STEVENS, R. A. 1974. An annotated check list of the amphibians and reptiles known to occur in south-eastern Malawi. *Arnoldia* 6(30) 1–22.

STEWART, M. M. 1967. *Amphibians of Malawi.* Albany: State Univ. of New York Press.