

# Anuran fauna of the Lesotho Highlands in the Khatse Dam catchment area and Jorodane River region

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Surveys were made of the anuran fauna of the Khatse Dam catchment area in the Lesotho Highlands, and of the region between the Central Mountains and the Thaba Putsoa Range which would be affected by Phase 1B of the Lesotho Highlands Water Scheme, if implemented. The Khatse Dam is at present filling. Seven species of anurans were encountered in the Khatse Dam catchment, and five of them also in the valley to the south-west. Four taxa occur all around central Lesotho, but one, the Gariiep toad, has its south-eastern limit on the Drakensberg Escarpment, and another, Gray's frog, shows indications in Lesotho, as elsewhere, of being distinct from the typical taxon. Two taxa are endemic to the mountains of the Lesotho region, the one being more rheophilic and more wide-spread. The remaining anuran, previously unknown in Lesotho, is now recorded from the highly characteristic, strongly rheophilic tadpoles, as *Heleophryne*. The various available habitats and the associated anurans are reviewed. Features of the reproductive cycles, are noted. Dispersal and isolation are outlined. Reference is made to the most probable additions to the anuran fauna which further collecting might reveal. The probable impact of the Khatse Dam is discussed.

Keywords: Anurans, Lesotho Highlands, Khatse Dam, Jorodane/Jordane River region, breeding, tadpoles, *Heleophryne*, impact.

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## Introduction

A recent study of anuran distribution in South Africa, Lesotho and Swaziland, based on published records and the collections of the South African and Port Elizabeth museums, includes maps of numbers of anuran species in quarter-degree squares (Drinkrow & Cherry 1995). In the eastern half of the map illustrating species richness (*op. cit.* Fig. 1), there are two notable regions with no records, the one in northern Natal, and the other, the larger, in Lesotho. The Lesotho region with no records includes a zone three-quarters of a degree west to east (28°00'E to 28°45'E) and a degree north to south (28°45'S to 29°45'S), with two further blocks to the west and two to the east abutting on the

middle of this zone (29°00'S to 29°30'S). The region of no records covers central Lesotho (Fig. 1) and is of especial interest because the Khatse Dam, at present filling up, is in this vicinity. Considerable information is now available for this region, largely derived from a faunal survey financed by the Lesotho Highlands Development Authority. A brief overview of the Anura of the survey was presented as a poster and accompanying abstract at a herpetological symposium in September 1995 (Van Dijk 1995). Since then, additional information has been obtained in a further survey, in another part of the region also without previous records. In preparation for the faunal survey of areas likely to be affected by proposed dams, documents were prepared concerning the general region which

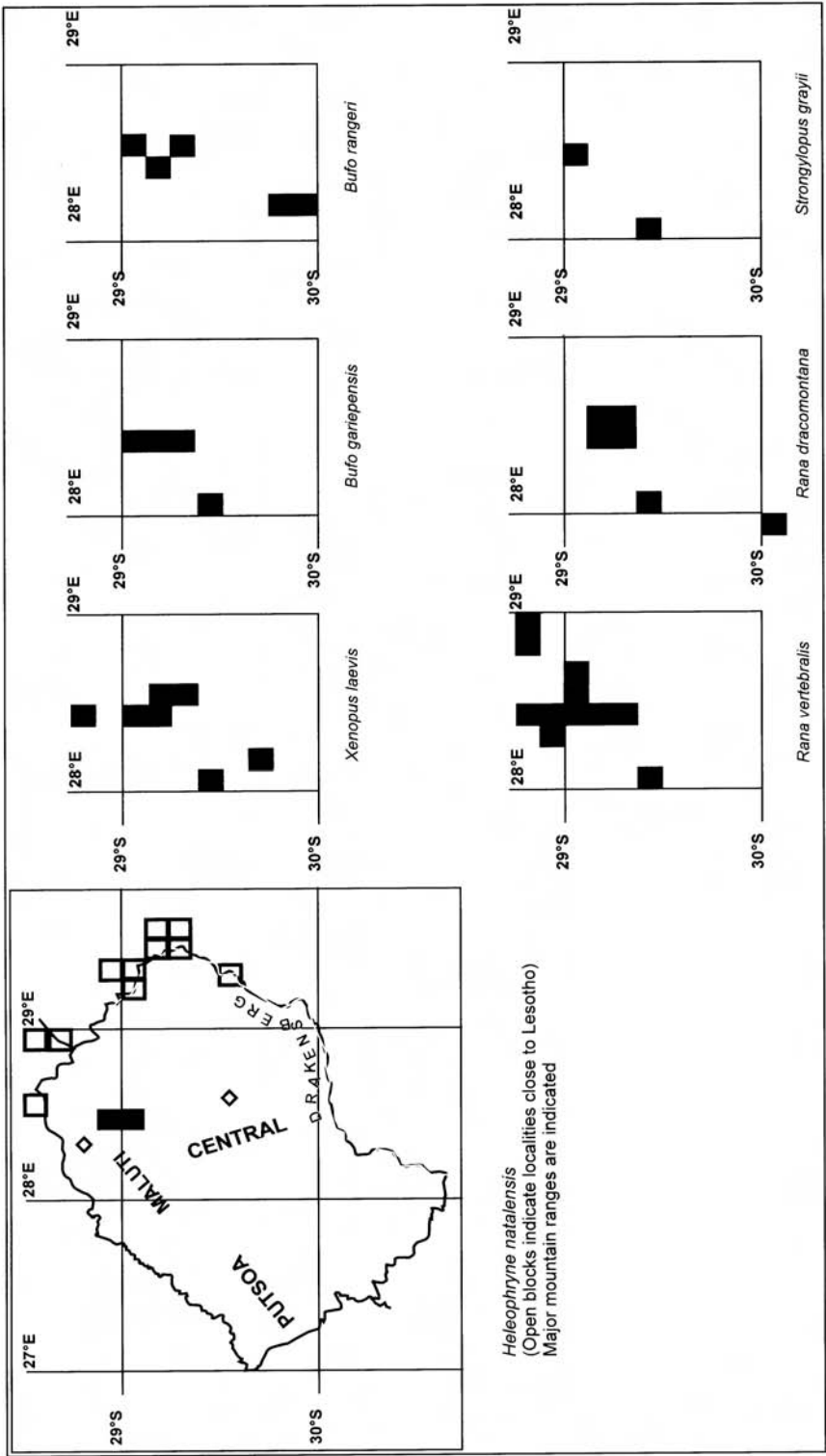


Fig. 1. Distribution of taxa in the study area, with the location of the study area shown with the first taxon, *Heleophryne natalensis*.

included information on anurans (Bourquin 1989; Skelton 1989), the latter being concerned with riverine aquatic systems, which included the biology of the umbraculate frog, *Rana vertebralis*, the Drakensberg frog, *Rana dracomontana*, and the platanna, *Xenopus laevis*. Neither of these documents referred to specific localities within the dam catchment region. Bourquin listed anurans in the Transvaal Museum from Khabos, to the north-west across the Maluti Mountains, and Thaba Tseka, in the south, east of the Central Range (indicated by diamonds on Fig. 1). Unpublished records from the National Museum in Bloemfontein were made available by L.H. du Preez and M.F. Bates. These included some records which fell within the dam study area and referred to *Xenopus laevis*, *Rana vertebralis* and the Gariep toad, *Bufo gariepensis*. All available records, published and unpublished, of anuran species occurring in or near Lesotho were mapped as eighth degree squares before the present survey of the Anura started, with updates as further information became available.

### Study area and observation sites

The faunal survey of which the Anura was part was made in 1991 and 1992. Results of this survey regarding the reptiles have been published (Mouton & Van Wyk 1993). For the Anura some of the collecting sites are approximately the same as for the reptiles (but not numbered similarly). The collecting sites are given in Table 1, and are indicated by their numbers on Fig. 2. All water bodies were investigated, while other members of the survey team collected adult toads or frogs encountered away from water. A few shady terrestrial sites were explored, with little success. Material collected by Drs P. le F.N. Mouton and H. Geertsema in December 1995 in the Jorodane River region, to the south-west, between the Central Range and the Thaba Putsoa, has been added (Fig. 2 and

Table 1), as well as records obtained by them during a river trip in March/April 1996 (Fig. 2).

### Material and Methods

The low number of anuran species represented by adults, and their distinctiveness, meant that adult specimens could usually be identified and released. Some were photographed. Only voucher specimens of adults, fixed in formalin (formaldehyde), were collected for retention in John Ellerman Museum, Department of Zoology, University of Stellenbosch. Where possible, tadpoles were collected, fixed in 10 % formaldehyde, and preserved in 4 % formaldehyde. Most tadpoles were visually located and then netted. At a few sites blind sweeps with a net in muddy or vegetated water yielded samples of tadpoles and occasional adults. Rocks were turned over in fast-flowing streams to search for cryptic rheophilic species. A small inexpensive tape recorder, National Model No. RQ-L305, was routinely carried and equipped with a lapel microphone, Electret Condenser Microphone Model EM-84. The only call heard was recorded, under very unfavourable conditions (high winds, rustling reeds). A second tape-recorder, the same model, was deposited at the base at Mamohau for other teams to use, and which could also be used to play a tape to identify pre-recorded calls of species most likely to be present. On completion of the collecting, the positions of the sites were determined using aerial photographs (Lesotho Highlands Water Project Environmental Study) and marked on photocopies of 1:50 000 topographical maps, from which the coordinates were calculated and the altitudes noted (see Table 1).

### Results

#### *Known and new general distributions*

The platanna *Xenopus laevis* occurs in all regions around the study area. It was expected to be present in the study area, although restricted by its breeding requirements to level ground. The known distribution of the Gariep toad *Bufo gariepensis* closely surrounds the study area, and is largely confined to mountainous terrain in the east. The

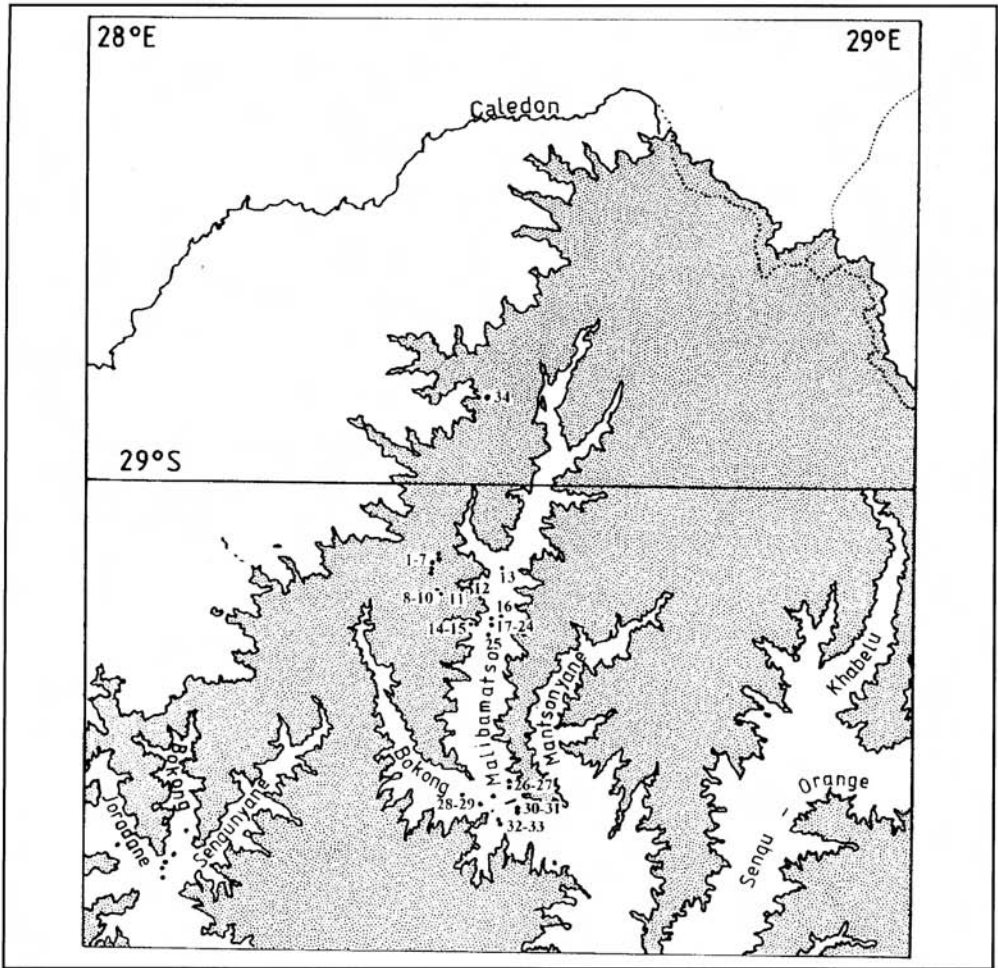


Fig. 2. Location of sites referred to in the text, with the main river valleys indicated and the Caledon River shown.

species was expected to be present, especially on high ground.

Ranger's toad *B. rangeri* occurs all around the study area, but not as close as *B. garipeensis*. Its rather wide distribution in the study area was surprising because of the limited number of suitable breeding sites. It usually breeds in gently flowing water, or in still water with marginal vegetation in which the egg-strings can be entangled.

The umbraculate frog *Rana vertebralis* is confined to the mountains of the Lesotho region and has been collected from most rivers in the region. It was almost certain to be present, and not surprisingly was found to be wide-spread. The Drakensberg frog, *Rana dracomontana*, was known only from the southern Drakensberg, where its habitat suggested that it was the most likely *Rana*, after *R. vertebralis*, to be found. It proved to be

wide-spread, although few breeding sites were identified.

The Natal torrent (ghost) frog *Heleophryne natalensis* has been known only from fast-flowing streams, *en route* to the Indian Ocean, in Natal and Eastern Transvaal. The discovery of *Heleophryne* tadpoles in Lesotho in November 1991 in the present study (Fig. 1, southern solid block; Fig. 2, Sites 8-11; Table 1) added the Orange River system to the distribution. Bates & Douglas (1991) found specimens in the Orange Free State on the western side of the Drakensberg near the Natal border (Fig. 1, north-eastern open block) in a tributary of the Wilge River, which flows north and then joins the Vaal River. In January 1992, in the present study, *Heleophryne* tadpoles were also observed in Lesotho in a tributary of the Caledon River (Fig. 1, northern solid block; Fig. 2, Site 34; Table 1), while L.H. du Preez, in the same month, collected the genus in the Golden Gate Highlands National Park (Bates 1992), where the flow is also into the Caledon River (Fig. 1, open block north of the study area).

Gray's frog *Strongylopus grayii* was known from all around Lesotho, especially along the Drakensberg. Apparently a highly adaptable species, perhaps composite, it was expected to occur in the study area, in or near restricted water bodies. A call like that of Gray's frog was heard and recorded. Tadpoles, similar to, but differing somewhat from typical *S. grayii*, were collected from two sites.

#### *Sites away from water*

Adults of *Bufo gariensis*, *B. rangeri*, and *Rana dracomontana* were quite common some distance away from water. This was surprising in the case of the *Rana*, one of which was encountered in grass on a steep slope just below the Mamohau camp, well above and distant from the nearest water, the Malibamatso River (Site 20). *R. dracomon-*

*tana* was also encountered away from water near Khatse (Site 26 and Site 29b). A *B. gariensis* was found under a rock near a breeding site (Site 17) while several toads were collected in the course of searches for reptiles or invertebrates either in the open or under rocks. Few shady places of the type in which frogs such as *S. grayii* are commonly seen, were found.

#### *Channel pools*

Pools were encountered in the channels left by reduced flow of rivers of various sizes (e.g. Sites 5; 21; 22). Some were muddy (Site 22), others had abundant hydrophytes, *Anacharis (Elodea)* and *Apogoneton* (Site 21). Only *Xenopus laevis*, adults and tadpoles, were found.

#### *Swamps*

Only one swamp was encountered (Site 1), which in wet periods would feed the Bokong River near a bend in one of its first tributaries. Besides *Xenopus laevis*, eggs (attached to submerged vegetation), larvae and adults, *Strongylopus* tadpoles close to *S. grayii* were found, and a call similar to that of *S. grayii* was recorded.

#### *Small pools*

Small pools were observed, notably close to, and at a slightly higher level than the Upper Bokong Swamp. No Anura were observed in several visits. On level ground above the Khohlontso River (Site 33) dried-out muddy hollows were observed in January 1992. These may be regarded as potentially suitable breeding sites for *Bufo gariensis*.

#### *Seepage on rocky bases*

Seepage on high ground provided breeding sites for *Bufo gariensis*, mostly in the form of very small shallow isolated pools.

Table 1

Site	Coordinates	Altitude	Taxon/Taxa	Stage/s
1 Upper Bokong Swamp	29°04'45"S 28°25'32"E	2850m (2850m-2950m)	<i>Strongylopus</i> ; <i>Xenopus</i>	tads; ova/embryos, tads,adults
2 Upper Bokong River	29 04 50 28 25 19	2850m	<i>Rana vertebralis</i> ; <i>Xenopus</i>	ova,tads,adults; adult
3 Upper Bokong East Slope	29 05 02 28 25 34	2900m	<i>Bufo gariepenis</i>	adult
4 Bokong River	29 05 37 28 25 08	2790m	<i>Rana vertebralis</i>	tads
5 Bokong River Channel Pool	29 05 37 28 25 09	2792m	<i>Xenopus laevis</i>	tads,adults
6 Tributary to Bokong River	29 06 00 28 25 13	2825m (2770m-2870m)	<i>Rana vertebralis</i>	tads,adults
7 High Ground above Bokong River	29 06 16 28 25 34	29 25m	Breeding Site for <i>Bufo gariepenis</i> ?	
8 W Stream above Mokhoulane River	29 06 58 28 26 15	2650m (2625m-2775m)	<i>Heleophryne</i> ; <i>Rana vertebralis</i>	tads,meta; tads
9 S Stream above Mokhoulane River	29 07 06 28 26 22	2625m (2625m-2800m)	<i>Heleophryne</i> ; <i>Rana vertebralis</i> ; <i>Xenopus</i>	tads; ova,tads,>meta,adults; early tads
10 Side Stream of S Stream	29 07 13 28 26 21	2675m	<i>Heleophryne</i>	early tads
11 E Stream above Mokhoulane River	29 06 54 28 27 17	2400m (2375m-2450m)	<i>Heleophryne</i> ; <i>Rana vertebralis</i>	tads; tads,adults
12 Range Management Stream and Dam	29 06 37 28 28 08	2275m	<i>Strongylopus</i> ; <i>Rana</i> ? <i>dracomontana</i>	meta tad; (tads, adults)
13 Beside Stream above River N of Ha Lejone	29 05 40 28 30 23	2020m	<i>Bufo rangeri</i>	small adult
14 Slope above Mamohau Camp	29 08 34 28 28 08	2500m	<i>Bufo rangeri</i>	adult
15 S of Crest above Mamohau Camp	29 08 41 28 28 08	2500m	<i>Bufo gariepenis</i>	tads(>meta)
16 S-facing Slope N of Mamohau Camp	29 08 34 28 30 00	2100m	<i>Rana dracomontana</i>	small adult
17 Mamohau Camp and Top of Cliff	29 08 44 28 29 47	2100m	<i>Bufo gariepenis</i> ; <i>Bufo rangeri</i>	late tads,meta,adults; small adult
18 Landing Strip N of Mamohau Camp	29 08 39 28 29 47	2100m	<i>Bufo rangeri</i>	small adult
19 Mamohau S of Stone House	29 08 47 28 29 39	2100m	<i>Bufo gariepenis</i>	meta tads
20 Slope below Mamohau Camp	29 08 44 28 29 53	2075m	<i>Rana dracomontana</i>	large adult
21 Pool by River below Mamohau Camp	29 08 54 28 29 53	2005m	<i>Xenopus laevis</i>	tads,juvs,adults

22	Pool by River downstream of Camp	29 08 58	28 29 49	2000m	<i>Xenopus laevis</i>	tads,adults
23	Bank above River Terrace below Camp	29 08 58	28 29 48	2010m	<i>Rana dracomontana</i>	adult
24	Stream entering River S of Camp	29 09 02	28 29 39	2010m	<i>Rana vertebralis</i>	small adult
25	Thabana-Il-Mele western Ridge	29 09 41	28 29 13	2125m	<i>Bufo rangeri</i>	adult
26	Slope N of dammed Stream	29 19 34	28 30 47	2150m	<i>Rana dracomontana</i>	adults
27	Dammed Stream W of Ha Ramanamane	29 19 42	28 30 47	2100m	<i>Rana dracomontana</i> ; <i>Xenopus</i>	tads; tads,adults
28	Tributary below Bokong Ha Kenman	29 20 08	28 27 30	2000m (1925m-2075m)	<i>Rana dracomontana</i>	ova,tads,juvs,adults
29	Ridge East of Tributary below Ha Kenman	29 20 07	28 29 32	2120m	<i>Bufo gariepensis</i>	adult
30	Ridge East of Tributary below Ha Kenman	29 20 49	28 28 15	2175m	<i>Rana dracomontana</i>	large adult
31	Junction of Khohlontso River	29 20 55	28 31 06	1890m	<i>Bufo rangeri</i> ; <i>Rana dracomontana</i>	early tads; small adult
32	South Terrace E of Junction of Khohlontso	29 21 02	28 31 13	1890m	<i>Bufo rangeri</i>	adult
33	Khohlontso River below Letlapeng Village	29 21 52	28 30 00	2050m	<i>Rana dracomontana</i> ; <i>Xenopus</i>	tads,adults; tads,adults
34	Level Ground above Khohlontso River	29 21 52	28 29 50	2150m	Breeding Site for <i>Bufo gariepensis</i> ?	
	Tributary to Hlotse above Hlotse Adit	28 53 55	28 26 15	2100m-2150m	<i>Heleophryne</i>	small tads
	Hlotse River above Hlotse Adit	28 53	28 26	2050m	<i>Rana vertebralis</i>	tads,adults
	Hlotse River 8km below Hlotse Adit	28 54	28 21	1750m	<i>Rana vertebralis</i>	tad
	Kao River	29 00 36	28 38 49	2525m	<i>Rana vertebralis</i>	adults
	Kao River	29 00 54	28 37 30	2375m	<i>Rana vertebralis</i>	adult
	Mothae (LH du Preez)	2828CDB		2950m	<i>Rana vertebralis</i>	
	Jorodane River	29 23 27	28 02 30	2080m	<i>Rana vertebralis</i> ; <i>Rana dracomontana</i>	meta, juv; juvs
	Ha Motoko	29 22 20	28 07 30	2060m	<i>Rana vertebralis</i>	meta
	N of Ha Montsi	29 24 00	28 06 32	2150m	<i>Bufo gariepensis</i> ; <i>Xenopus laevis</i>	larvae; tad,adult
	S of Ha Montsi	29 24 50	28 05 55	2100m	<i>Bufo gariepensis</i>	adults
	W of Maetsisa	29 25 15	28 05 47	2000m	<i>Rana vertebralis</i> ; <i>Rana dracomontana</i>	small adult; large adult
	SW of Maetsisa	29 25 35	28 05 47	2000m	<i>Strongylopus</i>	adult (male, nuptial state)

Tadpoles were obtained, in 1991 and 1992, in such pools (Sites 17 and 15), as well as in a more extensive muddy area at Mamohau (Site 19) which had deep and shallow pockets produced by trampling of horses and which formed the beginning of a small gully. A tributary to the Upper Bokong (Site 6) was supplied by several seepage zones (Site 7), but no anurans were found before a distinct river had formed.

#### *Sponges at the heads of streams*

Streams, followed up to their sources usually led to gently sloping regions with luxuriant swamp-like vegetation (e.g. above Sites 8 and 9), but no pools were found at the times visited, and no anurans.

#### *Trickles leading into streams near their sources*

Close to the point at which a stream channel could be recognised, the increased slope on the sides resulted in seepage trickles, some of which took the form of trickles a few metres long. Such a trickle (Site 10), well-shaded, proved to be highest point at which very small *Heleophryne* tadpoles were found, much higher in the system than *Rana vertebralis*. This suggests habitat separation between the young stages of the two, with *Rana vertebralis* breeding lower down in the system.

#### *Small streams (in soil, mainly covered by vegetation)*

A small pool ( $\pm 0.5$  m wide, 10 cm deep) in the lower part of a small stream (Site 12) contained a single *Strongylopus* tadpole, differing in mouthparts from typical *S. grayii* in having one less row of infra-angular (lower) keratodonts. A dam at this site had frogs and tadpoles which could not be reached with a long-handled net, but some of the frogs were

too large for *Strongylopus* and were probably *Rana dracomontana*.

#### *Streams*

Eggs, attributed to *Rana dracomontana*, were observed on an algal mat in a stream near its source, in slow-flowing water a few centimetres deep and less than a metre wide (Site 28). Only *R. dracomontana* adults and tadpoles were observed in this stream, from near the source to near the stream's entry into the Bokong River. *R. dracomontana* adults were observed on quite steep slopes in the stream, one about 2 m up a 70-80° slope. This is very unusual behaviour for *Rana*. A dam in a small stream harboured tadpoles of *R. dracomontana* (Site 27).

#### *Torrential Streams*

Near the source of the Bokong (Site 2), the river and a group of smaller streams flowing into the Mokhoulane River (Sites 8; 9; 11) were of such a size range, not too large or too small, as to permit the formation of small pools suitable for eggs of frogs and young tadpoles. (The stream of Site 9 is associated with a vertical dyke in the basalt). *Rana vertebralis* tadpoles were found in all the torrential stream sites. Eggs were found in shallow slow-flowing water in both the Bokong (September 1991, approx. 10 °C, layer  $\pm 0.3$  m diameter) and Site 9 (November 1991, approx. 20 °C).

*Heleophryne* tadpoles were found in the upper reaches of all three smaller streams. In a large pool at Site 9 young tadpoles of *Xenopus laevis* were observed (November 1991). The Bokong and the Mokhoulane Rivers both flow into the Khatse Dam, and form part of the Orange River system. A torrential stream on the other side of the Maluti Mountains and flowing into the Hlotse River, which belongs to the Caledon River System, was studied in January 1992 (Site



34). Young *Heleophryne* tadpoles were observed in a broad shallow pool with fairly swiftly flowing water. The vegetation has been protected and the site is wooded, with *Leucosidea* dominant.

#### *Rivers (slow-flowing)*

Streams may become slow-flowing in their lower reaches (Site 28, mentioned above). The Khohlontso River is slow-flowing over most of its length, with substantial pools still enough and deep enough during low flow for *Xenopus laevis* to breed (Site 32, January 1992). Occasional adults and numerous tadpoles of *Rana dracomontana* were also observed at the edges of the river at this site. The Khohlontso River where it flows into the Malibamatso below the Khatse Dam is very shallow and broad, and *Bufo rangeri* tadpoles were observed and collected at the edges within 50-100 m of the junction (Site 30), while a small *R. dracomontana* was also collected close to the junction (Site 31).

#### *Rivers (fast-flowing, rocky bottoms)*

Tadpoles of *Rana vertebralis* were observed in shallow fringes of the Bokong River (Site 4), in the Hlotse River above the adit by Geertsema in February 1992 (near Site 34) and in this site and also 8 km below the Hlotse Adit (in block 2828CDC) by the Fish Survey Team. Adult *R. vertebralis* were observed at a number of sites in rivers by the Fish Survey Team, including in the Kao River in blocks 2928BAA and 2928BAB.

#### *Jorodane (Jordane, Jorotane)/ Bokong/ Senqunyane (Phase 1B)*

Anurans were sampled by Mouton and Geertsema in early December 1995 in the region of Phase 1B of the Lesotho Highlands Water Project, south-west of the Khatse Dam, across the Central Mountains in a different valley system, that of the Senqunyane

River. More specifically the collections were made in the neighbourhood of the tributaries of the Senqunyane River, the Jorodane (Jordane) and the Bokong (a different Bokong from that of the Malibamatso River system). A mountain slope, a swamp, and river sites were included. The collections differed from those from the Khatse system in the presence of a *Strongylopus* adult, and the absence of *Heleophryne* tadpoles and *Bufo rangeri* adults and tadpoles.

## **Discussion**

### *Reproduction*

Although breeding will depend on the presence of suitable water bodies, and hence particularly on the adequacy of precipitation in the spring, some idea of breeding seasons may be obtained by the records which cover parts of two breeding seasons.

The developmental stages of *Xenopus laevis* were as follows: eggs and embryos in September (Site 1); young tadpoles in November (Sites 1, 9 and 21); tadpoles and juveniles in January (Site 22); tadpoles in April (Site 5). From these data it would seem that the development begins at least as early as September, and metamorphosis may be completed as early as January or at least as late as April. In the Jorodane/Senqunyane area a tadpole was collected in early December with fully developed hindlimbs and undeveloped claws (*Xenopus* Normal Table Stage 56).

The eggs and early stages of *Heleophryne* were first obtained more than 70 years after the genus was described (Visser 1971). Despite intensive searches for young tadpoles for morphological research, no tadpoles as young as the youngest found in Lesotho had been reported prior to Visser's discovery. The presence of a skin flap at the base of the tail hides the developing hind-

legs while these are still small, making it difficult to detect the beginnings of metamorphosis. Nevertheless, the tadpoles were well-known, and of considerable size before metamorphosis was evident, and this, together with the occurrence in cold water, was a clear indication of over-wintering in the tadpole stage.

The findings in Lesotho are as follows: very young tadpoles, with functional mouths, which have not developed all the rows of keratodonts (horny "teeth") in January (Site 10, close to likely oviposition sites); small tadpoles in January (Site 34); tadpoles in November (Sites 9 and 11); tadpoles, mainly at late stages and metamorphosing in November and January (Site 8). The indications are thus of early development in the spring, with development and over-wintering as tadpoles through to the following November to January or later.

The developmental stages of *Bufo garipeensis* found were as follows: tadpoles in January (Site 14); late and metamorphosing tadpoles in January and April (Site 17); metamorphosing tadpoles in April (Site 19). External gill stage larvae which can be attributed to this species were collected in the Jorodane/Senquanyane region in early December 1995. Thus, there is evidence for development starting in November and being completed in April. Breeding would appear to start only when there is a continual seepage which produces the small, very shallow pools, in which the developmental stages were found. What were considered to be potential *Bufo garipeensis* breeding sites were identified, but they lacked sufficient water at the times visited, namely November and January (Site 7) and January (Site 33).

Only one breeding site of *Bufo rangeri* was identified (Site 30), with young tadpoles in November, suggesting October to November as the beginning of the breeding season at this site. The site, in the shallows at the edge

of the Kholontso River at its junction with the Malibamatso River, is similar to the breeding sites elsewhere in the range of the species. *Bufo rangeri* usually breeds in streams when water levels are low, such as very early in spring in the summer rain-fall areas, or in still water with marginal vegetation in which the egg-strings can be entangled. Future investigators should be on the lookout for strings of dark eggs in gently flowing water or marginal vegetation of still-water bodies.

Eggs of *Rana vertebralis* were observed in September (Site 2) and late November (Site 9). In both cases the eggs were in shallow slow-flowing water, at approximately 10 °C at Site 2 and approximately 20 °C at Site 9. The eggs are similar to those of *R. angolensis* and *R. fuscigula* in forming a single layer on the substrate, but differ in being in a more coherent mass and are apparently sticky when laid. The mass at Site 2 was about 0.3 m in diameter. Measurement of gastrulae suggests approximately 1.8 mm as the size of the eggs. Clear evidence, of regular over-wintering, as tadpoles reach total lengths of at least 89 mm, exist. This is scarcely possible in one spring and one summer season when the food is obtained by browsing on the fairly clean rocky substrate. Tadpoles, observed in the Khatse catchment in late March, included some near metamorphosis. A large, robust metamorphosing individual, of 31 mm (snout to vent) body length, with the tail almost completely resorbed, was collected in the Jorodane area in early December. On the other hand, a tadpole with well-developed fore-limbs, of body length 24 mm and total length 56 mm, was found at Ha Motoko Bokong in the Jorodane area in early December, suggesting that development could sometimes be completed between Spring and Summer, yielding small juveniles. Completion of metamorphosis probably extends over a considerable period

of the spring and the summer, at least to April.

Eggs (1.4 mm) of *Rana dracomontana* were found in the tributary to the Bokong near Khatse (Site 28) at the side of a small stream on top of an algal mat in November/December. Tadpoles were also present nearby and further down the stream to its entry into the Bokong and at Site 27 in November/December, January and April, and in January at Site 32. Eggs are probably laid considerably earlier than the batch discovered. Tadpoles reach a total length of at least 93mm (developed but covered fore-limb stage: *Xenopus* Normal Stage 58); some probably continue their development through the winter, since stages with hind-limbs were found at the same time as the eggs. Juveniles with tail stubs were collected in the Jorodane area in early December.

Tadpoles of *Strongylopus* were collected at Site 1 (swamp) and Site 12 (small pool in small stream) in November. At the latter site the only tadpole found was 51 mm in total length (body 18.5 mm) and had fully developed hind-limbs and partially developed fore-limbs visible in the opercular chambers (*Xenopus* Normal Stage 58). A *Strongylopus* male with very well-developed nuptial asperites was collected in early December in the Jorodane area, in a wetland between the Jorodane and Senqunyane rivers south-west of Maetsisa. Frog choruses were heard at the time, suggesting that some frogs had yet to breed. *Strongylopus grayii* has been observed both in KwaZulu-Natal and the Western Cape to have an extended breeding season, which seems to be closely linked to rain. The eggs are typically laid out of water where water will reach them after further rain. The driest part of the year, late summer, is the only time of the year when tadpoles are not in evidence. The smaller size of the juveniles than is seen in *Rana*, and the often rich feeding environment of the tadpole, pro-

motes faster development which makes over-wintering unnecessary.

#### *Isolation of populations and dispersal*

Dependance of the filter-feeding larval *Xenopus laevis* on still water tends to isolate populations in places where such water is regularly available. Channel pools next to major rivers provide a series of sites via which *Xenopus* can disperse. It is probable that *Xenopus* adults move up small rivers during wet periods, in much the same way as cat-fish have been observed to do in Foxhill Spruit in Pietermaritzburg (own unpubl. obs.).

The tadpoles of *Heleophryne* in Lesotho are very similar to those of *Heleophryne natalensis* in KwaZulu-Natal, although the maximum size collected in Lesotho (total length 93 mm) is probably greater than that of most or all KwaZulu-Natal tadpoles. Dispersal along major rivers could occur, with invasion of more suitable torrential tributaries; but *Heleophryne* is not common in larger rivers, and it is doubtful whether such a river as the Caledon (Fig. 1) could serve as dispersal route, except in its upper reaches. The occurrence of *Heleophryne* west of the northern Drakensberg (Fig. 1), indicates dispersal over a divide. It would be of great interest to know how far up the Malibamatso River system *Heleophryne* occurs, and whether it is present in the tributaries which are close on the eastern side of the Maluti Mountains to the Hlotse River on the west, where *Heleophryne* is now known to occur.

Because it breeds in seepage pools in Lesotho, *Bufo gariiepensis* is able to disperse easily along mountains. Information on the breeding habits at various localities outside of mountain areas is needed to make it possible to evaluate the probable amount of isolation of mountain populations from others in the present, and in the wetter past.

More information about the breeding of *Bufo rangeri* in Lesotho is needed before isolation and dispersion can be discussed.

*Rana vertebralis* is found in fairly big rivers, which could serve as dispersal routes provided they had shallow fringes suitable for breeding.

The occurrence of *Rana dracomontana* far from water suggests that access to small streams, for breeding, limits dispersal. Suitable breeding sites are not as clearly defined as those of *Rana vertebralis*.

Although *Strongylopus grayii* is usually found in pools or swamps and very slowly flowing water in small streams, the taxon is very adaptable, and will breed successfully in conditions which do not appear to be ideal. It is possible that channel pools beside large rivers would serve as dispersal routes.

#### *Other anurans most likely to be present in the study area*

Because they do not require water bodies for breeding, the presence of *Breviceps* species is not easy to establish except by incidental discovery when overturning stones or rooting through the, very sparse, leaf litter; or hearing a call. *B. maculatus*, possibly synonymous with *B. verrucosus* (Frost 1985), is the most likely species to be present. It is recorded both to the west and east of the study area (across the Maluti Mountains near Maseru, and across the Drakensberg at Drakensberg Gardens, respectively).

Seepage areas are possible habitats for *Arthroleptella*, in which genus development occurs in the egg capsules kept moist by the seepage, the tadpoles not entering water and not feeding. *Arthroleptella hewitti* occurs along the Drakensberg.

Burrowing frogs of the genus *Tomopterna*, if present (most likely species *T. natalensis*)

are also encountered when turning over stones within their range, while the breeding sites favoured by *Rana dracomontana* and *Strongylopus* are the most likely to yield tadpoles if the genus is present in the study area.

Shallow pools in short vegetation (similar to the surrounds of Site 1) or among reeds (Site 1) are suitable breeding, and residence, sites of *Cacosternum* species and *Phrynobatrachus*, of which the most likely species to be present is *P. natalensis*. *Strongylopus fasciatus* is another possibility, provided the water is not too shallow (as at Site 1). Sponges could support the same species.

Rocky rain and seepage pools (e.g. *Bufo gariiepensis* breeding sites) may harbour *Phrynobatrachus* tadpoles, and were accordingly investigated, but without success.

Sites with shade and high humidity, as occurs in ravines, were not encountered in the study area although such sites are common in the Natal Drakensberg. One of the torrential streams (Site 9) followed a vertical dyke. On a larger scale such a stream cut in a line of weakness, a fault or dyke, could provide a refugium for shade and humidity-loving species, such as appears to be the case with *Ptychadena porosissima* in Rustenburg Kloof. An attempt should be made to locate shady humid ravines of any size and explore such for such taxa as *P. porosissima* and, in seepage zones, *Arthroleptella* species.

Fast-flowing streams appear to be the preferred habitats of *Strongylopus hymenopus*, which should accordingly be considered as possible inhabitants of such streams in Lesotho, including the study area.

Pools suitable for *Xenopus*, such as swamps (Site 1) and channel pools with vegetation, appeared to be suitable for kassinines, of which *Semnodactylus wealii* is the mostly likely to have reached the study area.

Since little is known of distribution of *Leptopelis xenodactylus*, and since it has burrowing spurs (and burrows into moss in a terrarium), it would not be very surprising if the species, known from the Drakensberg foothills, also occurs in Lesotho and in the study area. Nothing is known of its reproduction.

#### *Impact of the Khatse Dam and additional Dams, if built*

As may be gathered from the fore-going descriptions of breeding sites, anurans have preferred breeding sites which tend to be highly specific. Large permanent water bodies, from small dams to very large ones, are avoided by most anurans, one of the chief advantages of such avoidance probably being the initial absence of predator populations. Fish, such as introduced trout, are likely to make dams totally unusable as successful breeding sites for most anurans. Shallow water is required for the eggs of the *Rana* species and *Bufo garipeensis*, which sink to the bottom, while *Strongylopus grayii* deposits clumps of eggs out of water in sites where rise of water level permits the escape of the young larvae. Oviposition in deep water can occur in *Xenopus*, where the amplexed couples swim while the female attaches eggs individually to submerged objects. It is also possibly in *Bufo rangeri*, where the amplexed couples normally stand in shallow water but can float during oviposition, entangling the egg-strings just below the water surface in vegetation.

The Khatse dam will not reach and flood the Upper Bokong Swamp (Site 1), but there may be other swamps which were not observed which will be flooded. The loss of channel pools, such as Sites 5, 21 and 22, and similar ones, may seriously affect the viability of species which use them for breeding.

At present only *Xenopus laevis* is known from the three channel pools investigated. The area south of Maetsisa in the Jorodane/Senqunyane region is identified on large-scale maps as a wetland of significant extent. This is the only place where an adult *Strongylopus* was collected. If the Mohale Dam is built, this wetland habitat of this frog, and rich cultivated surrounds, will be lost.

A major effect of the Khatse dam will be the isolation of populations of anurans which inhabit small streams and torrents. The surprisingly long distances from water at which *Rana dracomontana* was found suggests that isolation of populations of this species, like those of the toads, will be slight. The isolated populations of *Heleophryne* and *Strongylopus* may be affected by the dam, but more needs to be known about the distribution, and degree of differentiation which has taken place in the populations, before some idea can be formed of whether the present distributions are relicts of a pluvial period, or products of dispersion in more recent times.

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