

Anuran community structure in the Vernon Crookes Nature Reserve, South Africa

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ABSTRACT

The 27 anuran species and subspecies presently known to occur in the Vernon Crookes Nature Reserve in southern Kwazulu-Natal represent 94% of all anuran species and subspecies found in the Kwazulu-Natal coastal region. Four species, namely *Phrynobatrachus mababiensis*, *Semnodactylus wealii*, *Africalus spinifrons* and *Hyperolius tuberilinguis* are recorded from the reserve for the first time. Frog species were found to be active only during specific times of the year. Results of a case study, examining seasonal occurrence of tadpoles at a single water body, showed that although various species share the same water body, each species occupies a different microhabitat.

INTRODUCTION

Coastal forest destruction in Kwazulu-Natal has undoubtedly already caused irrevocable damage to habitats, including their fauna and flora. Cooper (1988) reported that 90% of the coastal lowland forest in Kwazulu-Natal has been totally destroyed to make way for sugar cane plantations. Kok & Seaman (1989) pointed out the uniqueness of coastal forest and the threat that destruction of water courses and wetlands poses to species like *Natalobatrachus bonebergi*. The Vernon Crookes Nature Reserve, surrounded by a sea of sugar cane plantations, is one of the few protected coastal forest reserves in Kwazulu-Natal.

Vertebrate surveys at the Vernon Crookes Nature Reserve by Bourquin & Sowler (1980), Bourquin & Van Rensburg (1984) and Maddock & Zaloumis (1987) have revealed a wide variety of anurans in this small geographical area. A detailed study of polystomatid flatworm infections of frogs conducted in the Vernon Crookes Nature Reserve (Du Preez 1994), posed an unique opportunity to study the community structure of anurans over successive years.

The objectives of the present study were to determine species diversity in different habitats, examine anuran community structure and determine seasonal tadpole community structure at a selected locality.

STUDY AREA

Location

The Vernon Crookes Nature Reserve, 2189 ha in size, is located in the southern part of Kwazulu-Natal province, South Africa. It is situated 20 km inland from the coast, between 30°15' and 30°19' S latitude and 30°33' and 30°38' E longitude.

The topography is undulating, very steep in places, with

ridges and hills dissected by deep drainage lines (Bourquin & Sowler 1980). Altitudes range from 200-538 m a.s.l. Sandwith & Brown (1981) identified nine vegetation types in the reserve, namely forest, riverine-forest, scrub-forest, bushclump, streambank scrub-forest, streambank forest scrub, wetland-swamp, wetland-sponge, and grassland.

Rainfall

Daily rainfall figures were obtained from the chief warden of the reserve. Surface water is usually freely available over most of the area throughout the year. Mean annual rainfall, calculated over a period of 26 years (1966-1992), is 980 mm. Highest figures were recorded for the months November (126 mm) and March (121 mm), and lowest figures for June (18 mm). During the study period the area experienced its most severe drought in decades, with only 391 mm (40% of the long-term average) of rain falling during 1992.

MATERIALS AND METHODS

Collecting of material

Between March 1983 and May 1993 the Vernon Crookes Nature Reserve was visited 16 times for three to seven days at a time. Collecting was undertaken during April of 1983, 1984, 1985, 1986, 1989 and 1990; January, August and November of 1991; January, March, May August, October and December of 1992; and April 1993.

Adult frogs were collected by hand, mainly at night (19h00-23h30) with the aid of a strong flashlight. All specimens were placed separately in 500 ml plastic containers with about 50 ml of water, and clearly marked for each locality. Tadpoles were netted during daytime, sorted and transferred to 5 l plastic containers. Tadpoles from different localities were kept separately and containers clearly marked. As many frogs and tadpoles of as many species as possible were collected.

Representative samples of each species were deposited in the amphibian wet collection of the National Museum, Bloemfontein. Additional frogs and tadpoles were released where collected.

Case study

One locality, an earth-walled dam on a plateau, hereafter referred to as locality A, was selected for an intensive study of anuran tadpole species composition, conducted between October 1991 and June 1992. To cover a variety of microhabitats with different vegetation, ten sampling points were identified at the periphery of the dam. All points were within 1 m of the shore with light penetrating to the bottom (littoral zone). Samples were taken during November 1991, January, March and May 1992. In May 1992, very little water remained in the dam because of the drought, and sampling was possible at only four of the ten points. During the next visit, August 1992, the dam at locality A had completely dried up.

In order to standardise procedures and quantify tadpole populations at each of the fixed points, samples were taken within the confines of a stainless steel box measuring 0,5 x 0,5 x 0,5 m and open at the top and bottom. The box was firmly and randomly pressed into the sediment (0,5 - 1,0 m from the shore) as quickly as possible to avoid disturbing the tadpoles. Trapped tadpoles were scooped out with small nets, fixed in 10% formalin and containers marked for later identification. Samples of the various plants at each of the ten sampling points were collected, dried and identified at the National Botanical Institute, Pretoria.

RESULTS

Anuran diversity at Vernon Crookes Nature Reserve

Twenty-three species of anurans, representing six families, were previously known to occur in the reserve. During the present study four additional species were recorded, namely *Semnodactylus wealii*, *Hyperolius tuberilinguis* (NMB A5574), *Afrixalus spinifrons* (NMB A5930) and *Phrynobatrachus mababiensis* (NMB A5719) tadpoles (Tables 1 & 2). Tadpoles of 14 taxa were also collected during the present study (Table 2).

For several species only one or two specimens were collected and seasonal patterns could thus not be identified for these taxa. Furthermore, no collecting was undertaken during the months February, June, July and September (Table 1). However, occurrence of adult frogs can be divided into six patterns, namely: all year; except mid-winter; autumn; winter & spring; spring; summer & autumn; early summer and spring & summer. Three species namely *Xenopus l. laevis*, *Rana angolensis* and *Phrynobatrachus natalensis* appear to be active throughout the year (Table 1). *Bufo gutturalis* and *Natalobatrachus bonebergi* were active throughout the year except during winter. *Strongylopus f. fasciatus* was active from autumn to spring. *Schismaderma carens*, *Ptychadena oxyrhynchus*, *Leptopelis natalensis*, *Hyperolius tuberilinguis*, *Hyperolius pusillus* and *Hyperolius m. marmoratus* were collected from spring to autumn (Table 1). *Cacosternum n. nanum* and *Afrixalus spinifrons* were collected only during early summer. *Kassina senegalensis* and *Afrixalus f. fornasinii* were collected during spring and mid-summer.

TABLE 1: Anuran taxa recorded at Vernon Crookes Nature Reserve, based on records of adults. Months during which individuals were collected are indicated for literature records (O) and frogs collected during the present study (X). Species for which sample sizes are not specified were not collected during the present study, but were recorded by Bourquin & Sowler (1980), Bourquin & Van Rensburg (1984) and Maddock & Zaloumis (1987).

Species/subspecies	n	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
<i>Xenopus l. laevis</i>	8	X	O	X	X	X		X		X			X
<i>Heleophryne natalensis</i>	3									O			X
<i>Bufo gutturalis</i>	25			X	XO	X				O	X	X	X
<i>Bufo rangeri</i>	2	O			X								
<i>Schismaderma carens</i>	1			X	O							O	
<i>Breviceps verrucosus tympanifer</i>	1				X							O	
<i>Ptychadena oxyrhynchus</i>	9				X	X				O	XO	X	
<i>Ptychadena porosissima</i>										O			
<i>Tomopterna natalensis</i>										O			O
<i>Cacosternum n. nanum</i>	5									O	X		X
<i>Rana angolensis</i>	114	X		X	X	X			X		X	O	XO
<i>Strongylopus f. fasciatus</i>	17				XO	X					XO	X	
<i>Strongylopus g. grayii</i>	12	X								O	X	X	
<i>Phrynobatrachus natalensis</i>	25	XO		X	XO	X			X	O	XO	XO	XO
<i>Natalobatrachus bonebergi</i>	65	X		XO	XO	X					XO	XO	XO
<i>Arthroleptis wahlbergii</i>	2			X	XO						O		
<i>Leptopelis natalensis</i>	10	XO			X					O		X	
<i>Semnodactylus wealii</i>	1				X								
<i>Kassina senegalensis</i>	46	X									X	O	
<i>Afrixalus spinifrons</i>	1											X	
<i>Afrixalus fornasinii</i>	2	XO								O		X	
<i>Hyperolius tuberilinguis</i>	15	X			X							X	
<i>Hyperolius semidiscus</i>											O	O	
<i>Hyperolius pusillus</i>	30	X		X	X						O	XO	
<i>Hyperolius m. marmoratus</i>	316	X		X	XO					XO	XO	XO	X

TABLE 2: Anuran taxa of Vernon Crookes Nature Reserve based on records of larval anurans. Months during which individuals were collected are indicated for literature records (O) and frogs collected during the present study (X). The species for which the sample size is not specified was not collected during the present study, but was recorded by Maddock & Zaloumis (1987).

Species/subspecies	n	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
<i>Xenopus l. laevis</i>	13	X			X						X		
<i>Heleophryne natalensis</i>	7				X						X		
<i>Bufo gutturalis</i>	10								X			X	X
<i>Cacosternum n. nanum</i>	60					X			X				
<i>Rana angolensis</i>	373			X	X	X			X		X	X	X
<i>Rana fuscigula</i>							O						
<i>Strongylopus f. fasciatus</i>	45				X				X				
<i>Phrynobatrachus natalensis</i>	6				X								
<i>Phrynobatrachus mababiensis</i>	21				X								X
<i>Natalobatrachus bonebergi</i>	215	X		X	X	X			X		X	X	X
<i>Leptopelis natalensis</i>	9										X	X	X
<i>Kassina senegalensis</i>	69	X			X							X	
<i>Afrixalus spinifrons</i>	5	X										X	
<i>Hyperolius tuberilinguis</i>	4	X							X				
<i>Hyperolius pusillus</i>	67	X		X									
<i>Hyperolius m. marmoratus</i>	911	X		X	X	X						X	X

TABLE 3: Plant species from sampling points at locality A.

Species	Sampling point									
	1	2	3	4	5	6	7	8	9	10
Cyperaceae										
<i>Cyperus sensilis</i>	X	X	X	X	X	X	X	X	X	X
<i>Cyperus sphaerospermus</i>		X		X	X					
<i>Eleocharis limosa</i>				X	X					
<i>Isolepis fluitans</i>		X	X	X	X					
<i>Rhynchospora holoschoenoides</i>		X	X	X		X	X			
<i>Mariscus solidus</i>	X					X				
Gramineae										
<i>Leersia hexandra</i>		X		X	X					
Polygonaceae										
<i>Persicaria attenuata</i>									X	X
Thelypteridaceae										
<i>Thelypteris interrupta</i>										X
Nymphaeaceae										
<i>Nymphaea nouchali</i>		X				X				
Gentianaceae										
<i>Nymphoides thunbergiana</i>	X	X	X		X					

Seasonal occurrence of anuran larvae at a single water body, a case study

Eleven plant species, representative of six families, were collected at locality A (Table 3). *Cyperus sensilis* occurred at all sampling points (Table 3) and covered about 50% of the dam-surface. Mixed vegetation occurred at sampling points 2-6, with as many as seven species at point 2, while the vegetation diversity was limited at sampling points 1, 7, 8, 9 and 10 (Table 3). Sampling points 1 - 3 were against the dam wall and because the water deepened rapidly here, vegetation was restricted to a narrow strip. Sampling points 4 to 10 had a moderate slope and a broad strip of vegetation. Due to the prolonged drought, large herds of game utilized this dam as a water hole. As a result, sampling points 4 and 5 were trampled and although six different plant species were recorded at both points, vegetation was sparse with areas of open water. Sampling points 6-10 were characterized by thick stands of vegetation. The bottom was covered by

a thick layer of decomposing sedges. At point 6, decomposing sedges formed a thick mat which reached the surface and no open water existed.

Tadpoles were present in all samples taken. Although numerous other anuran taxa have been observed breeding at this locality, only tadpoles of *Kassina senegalensis*, *Hyperolius m. marmoratus*, *H. pusillus* and *H. tuberilinguis* were recorded during the present study. Samples were dominated by *K. senegalensis* and *H. m. marmoratus*.

During November 1991 only *K. senegalensis* and *H. m. marmoratus* tadpoles were collected, with *K. senegalensis* constituting 70% of the sample (Fig. 1). Tadpoles of both species were collected at nine of the ten sampling points and occurred together at eight points.

In January 1992, *K. senegalensis* tadpoles represented only 18% of the total sample and were collected only at

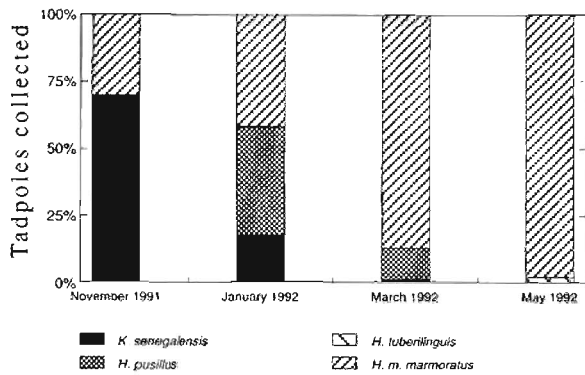


FIGURE 1: Total numbers of tadpoles collected at the ten fixed sampling points during the months November 1991, January 1992, March 1992 and May 1992.

sampling points 2, 5 and 9 (Fig. 1). *H. m. marmoratus* tadpoles represented 42% of the total sample. The remaining 40% was made up of *H. pusillus* tadpoles (Fig. 1).

In March 1992 a large sample size of 198 *H. m. marmoratus* was collected comprising 91% of the sample (Fig. 1). *K. senegalensis* represented only 1% of the sample and *H. pusillus* 8%.

During May 1992 the dam was rapidly drying up and samples could be taken only at sampling points 2, 4, 5 and 9. A single *H. tuberilinguis* tadpole was collected at sampling point 2. The remainder of the sample consisted of *H. m. marmoratus* ($n=51$) tadpoles. No *K. senegalensis* or *H. pusillus* tadpoles were found (Fig. 1).

Comparison of the total samples of *Kassina senegalensis* and *Hyperolius m. marmoratus* tadpoles, collected in November 1991, January and March 1992, show that tadpoles are not homogeneously distributed at locality A (Fig. 2). Samples collected during May 1992 were excluded because sampling was not possible at all points. *K. senegalensis* tadpoles were found at all sampling points with a combination of vegetation and open water. A very small sample of *K. senegalensis* tadpoles was found at point 4 where vegetation was so sparse that it provided no shelter. No *K. senegalensis* tadpoles was found at point 6 where no open water existed. Although *H. m. marmoratus* tadpoles were collected at all sampling points, large variation in sample sizes were noted. *H. m. marmoratus* tadpoles were mainly found in very shallow water and mud mixture at the periphery of the dam where they were observed feeding on decomposed vegetation. Very small samples were collected at points 1, 3, 4 and 5 where areas of open water existed but decomposing plant material was limited. Large samples were found at points 6 and 10 where a very thick layer of decomposing sedges were present.

DISCUSSION

Bourquin & Sowler (1980) pointed out that even after two years of intensive surveys at the Vernon Crookes Nature Reserve species lists for all vertebrate groups were still incomplete. Bourquin & Sowler (1980) recorded 17 species and estimated that a further eight anuran species could be found in the reserve. Bourquin & Van Rensburg

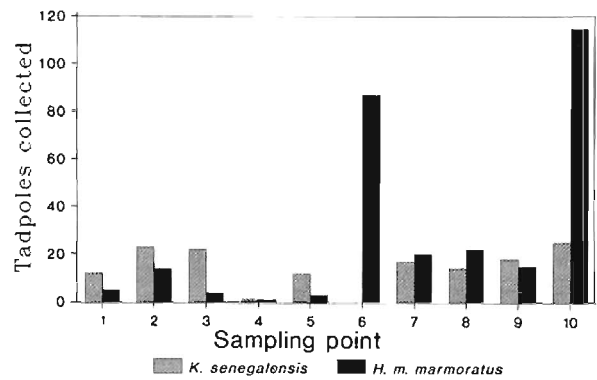


FIGURE 2: Total numbers of *Kassina senegalensis* and *Hyperolius m. marmoratus* tadpoles collected at ten fixed sampling points during the months November 1991, January 1992 and March 1992.

(1984) added four more species, namely *Heleophryne natalensis*, *Breviceps verrucosus tympanifer*, *Cacosternum nanum nanum* and *Kassina senegalensis*. Maddock & Zaloumis (1987) added *Xenopus laevis laevis* and *Rana fuscigula* to the list. With the further four species found during the present study, the expectations of Bourquin & Sowler (1980) were surpassed, as 27 species and subspecies are currently known to occur in the reserve. This represents 94% of all anuran species and subspecies found in the southern Kwazulu-Natal coastal region (Lambiris 1989). The high anuran diversity in the area can probably be explained by the warm, wet and humid climate of coastal Kwazulu-Natal and the diverse habitats and microhabitats available. Furthermore, the area is high-lying and as most of the streams have their origin in the reserve, water bodies are unpolluted. However, the rich anuran diversity would not have been discovered were it not for intense collecting over successive years, as well as collecting during different seasons.

Although most anurans collected were active during the warmer, wet summer months, some were only active during the cooler months of autumn and winter. While some species were active for several months or even throughout the year, others were recorded only during very short periods. This supports Van Dijk (1961) and Balinsky (1969) who noted that different anuran species often breed in a definite sequence.

Larvae of *Kassina senegalensis* and *Hyperolius m. marmoratus* were not uniformly distributed throughout locality A. *K. senegalensis* tadpoles were found in mid-water and close to the water surface in areas where vegetation provided shelter. *H. m. marmoratus* tadpoles were found only in shallow water at the periphery of the water body and were bottom-dwelling. *H. m. marmoratus* larvae were often found among partly-decomposed plant material with hardly any open water. Although larvae of *K. senegalensis* and *H. m. marmoratus* were collected at the same sampling points, they utilised different microhabitats and were thus not in direct competition. These observations support Van Dijk's (1972) finding that there is a discernable association between microhabitats and aspects of tadpole behaviour.

Poynton (1994) noted that the present state of distribution studies in herpetology is in a state of immaturity due to a

shortage of data and a lack of careful and insightful work. The results presented here are a first attempt at a numerical base-line from which further long-term studies in the Vernon Crookes Nature Reserve can follow.

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