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# THE VOCALIZATIONS AND BREEDING BEHAVIOUR OF *KASSINA SENEGALENSIS* (ANURA, RHACOPHORIDAE) IN SUMMER BREEDING AGGREGATIONS

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*Abstract* – Two different call types are produced by male *Kassina senegalensis* (Dumeril and Bibron) in breeding aggregations. The most common of these is the mating call. A territorial call is also produced, and its production is dependent on the close proximity of other calling males. Mention is made of the ovipositional behaviour of this species.

*Introduction*

*Kassina senegalensis* is distributed throughout southern Africa, excluding the Western Cape, the Kalahari and, apparently, the coastal regions of South West Africa (Channing 1976).

Most anurans have a small vocabulary (Capranica 1965) consisting of several components, most of which function in a reproductive context (Salthe and Mecham 1974). The mating call is the most commonly heard vocalization in most anurans (Pengilley 1971). Other call types are decidedly less common and are probably often overlooked (N. I. Passmore *pers. comm.*). One objective of this study was to establish what vocalizations are employed by *Kassina senegalensis* males prior to amplexus, and the situations under which the calls are produced. In addition, the ovipositional behaviour of this species is here described.

Males of some species are known to call in aggregates in which individual callers are usually fairly evenly spaced and seldom very closely situated to one another (N. I. Passmore *pers. comm.*). Mating calls are often uttered by several males together, thereby forming a chorus. These phenomena of aggregation and chorusing are also examined in this study.

*Methods*

*Study Area*

The study was conducted on the farm 'Mosdene' in the Naboomspruit district, Republic of South Africa. Observations were limited to four ponds within the study area and several laboratory observations were made on captive animals.

The ponds were designated 'locality 1, 2, 3, 4' respectively (Table 1), and the majority of observations were conducted at localities 1 and 3. Table 1 describes localities in the study area.

Table 1

*Descriptions of localities in the study areas*

| | Description | Approx. Max. Depth | Approx. Min. Surface Area |
|---|---|---|---|
| Locality 1 | Semi-permanent pond. Grass ± 40 cm long and few rocks on periphery | 50 cm | 300 m$^2$ |
| Locality 2 | Semi-permanent pond surrounded by Acacia bush and ± 40 cm long grass | 20 cm | 250 m$^2$ |
| Locality 3 | Inundated grassland surrounded by grass ± 4 cm long and Acacia bushes | 15 cm | 200 m$^2$ |
| Locality 4 | Rain-filled roadside furrows surrounded by ± 40 cm long grass | 40 cm | 600 m$^2$ |

*Data Collection*

The observations were made between 1977.01.25 and 1977.02.05. All recordings and photographs were taken in the field. Calls were recorded with a Sanyo AR 50 tape recorder at a tape speed of 4,7 cm per second. The recorded calls were analysed on a sound spectrograph (Kay model 7029 A spectrum analyser) within the frequency range 80Hz-8 kHz using a wideband filter (300Hz).

Utmost care was taken to disturb the animals as little as possible during data collection. Observations of calling behaviour and some ovipositional behaviour were made in the field, while amplectant pairs were, on occasion, placed in aquaria in the laboratory for detailed observation. In order to minimize disturbance during observations, red light was used, although occasionally white light was also necessary.

## *Calling Behaviour*

Aggregates of calling males consisted of 3–10 (M=5) individuals whose callsites were located 1 m–2 m apart (n=5 observations). The aggregates themselves were about 12 m apart.

Choruses consist of the vocalizations of many males calling together over the whole locality. Two different chorus types were noted and are designated primary and secondary respectively.

Primary choruses were usually initiated at 18h30 (mean) (range 18h00–19h00) and were terminated between 21h00 and 00h30, while secondary choruses were observed to begin at about 04h30 and continue for a maximum of one hour. The intensity of the primary choruses was greatest immediately after rain, and decreased on subsequent nights. The majority of these choruses reached peak level at about 20h30. Intervals in the chorus were frequent both prior to and after the peak.

Following intervals, the first few calls uttered caused a chain reaction of calling from other males. Different males were responsible for chorus initiation (n = 8 observations). Many aggregates participated in these calling bouts. The calling rate of each individual increased to the peak and then decreased again towards the end of the chorus.

## *Callsites*

Males were seen emerging from holes beneath rocks, and were observed calling from the entrances to these holes, as well as from under fallen branches during the early part of the evening (between 17h30 and 18h00) (n=4 observations). These callsites in close proximity to the frogs' diurnal habitats, are referred to as primary callsites.

The primary callsites were generally concealed and situated between 15 m and 40 m from the water. Males occupying these sites were often only a few centimetres apart (n=3 observations involving more than 20 males). By 20h00 the majority of the males had moved to secondary callsites, which were considerably closer to the water, being between a few centimetres and 15 m from the pond. The distance between the secondary callsites and the water seems dependent on the availability of dense vegetation. In instances where the vegetation immediately surrounding the pond was sparse, males tended to call from denser areas up to 20 m from the water. Callers in secondary callsites were again grouped to form aggregates.

## *The Mating Call*

Table 2 summarises the mating call data obtained. The term 'mating call' is applied to the most common call. Females were observed to approach males uttering it (n=2 observations). No females were observed actually going into amplexus with calling males.

Table 2
Kassina senegalensis *mating call data*

| | N | RANGE | MEAN |
|---|---|---|---|
| Call Duration (secs.) | 23 | 0,083–0,163 | 0,114 |
| Frequency: (kHz) | | | |
| Lower limit | 23 | 0,25–0,9 | 0,438 |
| Upper limit | 23 | 1,8–2,45 | 2,12 |

The mating call is an untrilled sound of comparatively short duration: mean=0,114 secs; range=0,083–0,16 secs; N=23. It is similar to the sound of a bubble popping at the water's surface, or that made by a cork being extracted from a bottle. The energetic frequency band is wide, spanning a large proportion of the sonographic display between 0,25 and 2,45 kHz over the length of the call (Fig. 1. A, B, C).

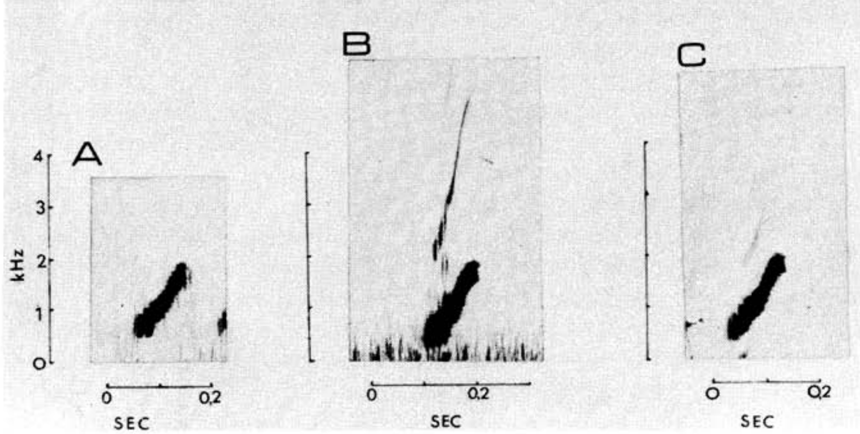


Fig. 1. *Kassina senegalensis* mating calls. A, B and C each represent a single call.

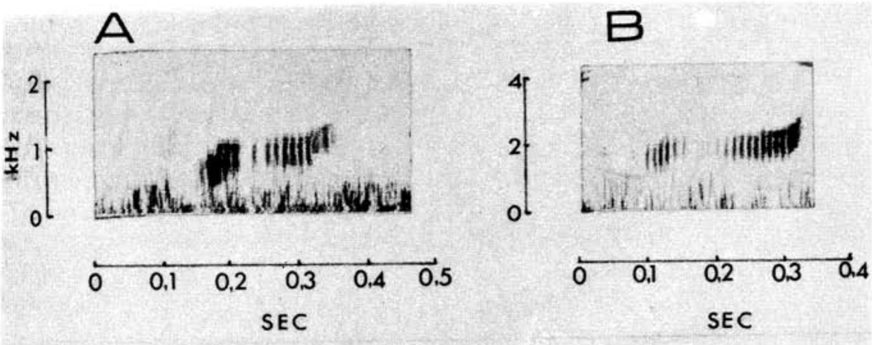


Fig. 2. *Kassina senegalensis* territorial calls. A and B each represent a single call.

*The Territorial Call*

Table 3 summarises the territorial call data obtained. Ambient air temperatures ranged between 21,5° C and 24,0° C (means=22,4° C) when recordings of both mating and territorial calls were made.

Table 3

Kassina senegalensis *territorial call data*

| | N | RANGE | MEAN |
|---|---|---|---|
| Call duration (secs.) | 4 | 0,191–0,229 | 0,209 |
| Frequency: (kHz) | | | |
| Lower limit | 4 | 0,37–0,229 | 0,495 |
| Upper limit | | 1,25–1,63 | 1,27 |
| No. Pulses per call | 4 | 14–20 | 17 |
| Pulse rate (pulses/sec.) | 4 | 0,011–0,014 | 0,011 |

This call was heard mainly during the early part of the evening (17h30–19h30) while calling males were located at primary callsites (n = 5 observations). The territorial call was heard on three occasions after 20h00 when the calling males were < 1 m apart and the moon was full. This call is very different from the mating call both in that it is obviously trilled and in its longer duration (Mean=0,209 secs; range=0,191–0,229 secs; N=4). The energetic frequency lies between 0,37kHz and 1,63kHz, and covers a mean frequency range of 0,75kHz. It was produced by closely located males together with mating calls.

On one occasion a male was heard to give this call repeatedly while located at its primary callsite. When discovered, he was about 3 cm from a second male. The two males went into a pseudo-amplexus facing in opposite directions, but the uppermost male soon rotated through 180°. After approximately one second they separated and one male departed, leaving the original caller at the callsite. No calls were produced while the pair was in contact, indicating that this call does not function as a male release call.

The function of the territorial call appears to be in the maintenance of spacing between males.

*Ovipositional Behaviour*

Amplexus is initiated at the secondary callsite (n=5 observations). Pairs in the field were observed between 19h45 and 03h00. Once in amplexus the pairs moved from the secondary callsite to the water, where eggs were laid and fertilised. The time at which pairs reached the water was dependent on the distance between the secondary callsite and the pond. Where this callsite was 10 m to 15 m from the pond, pairs were observed in the water at 22h00. However, where this callsite was at the pond's edge, the first pairs were in the water as early as 19h45.

The females actively seek out calling males, probably by searching for the source of a mating call, as the males were observed to remain stationary for long periods of time.

*Clasping Position*

Amplexus is axillary with the male lying very far back on the female with his arms extended forward, parallel to the female's sides. The tip of the male's snout extends about halfway up the female's back.

*Oviposition*

Egg laying appears to be initiated by the female. Her feet are moved together medially beneath her body, and the posterior part of her body is lifted. In response to this the male bends the posterior part of his body ventrally.

In this position their cloacae are about 2 mm apart, with that of the male being slightly ventral to that of the female. The pair maintain this position for approximately one second, during which time a single egg is laid and fertilised. After fertilisation the male relaxes and straightens out his body before responding to the next stimulus. The female's feet move away from each other, coming to lie laterally once more, while the posterior part of her body relaxes.

*Egg Dispersal*

Oviposition was observed in one amplectant pair in the field. This began at 23h15 and was terminated at 02h15. During this period the pair moved a total distance of three metres. The average distance moved between successive egg laying sequences was approximately 30 cm (range 17 cm–61 cm). The number of eggs deposited at each position varied between one and fifteen. The average depth at which eggs were laid was 4 cm (range 1 cm–6 cm). Some eggs were laid while the pair was completely submerged, but most while their heads were above the surface.

In the field amplectant pairs were often seen to fall over backwards. This occurred most frequently in water deeper than four centimetres. It seems to occur due to the weight of the male being so far back on the female.

*Termination of Amplexus*

No visible release mechanism was observed. The female adopted no particular posture immediately prior to separation. No release call was heard (n=8 observations).

*Eggs*

Each egg was about 3 mm in diameter, including the thin jelly membrane. Immediately after being laid, the eggs are adhesive and stick to submerged vegetation. Their specific gravity is greater than that of water and the eggs sank rapidly. Five females were dissected immediately after having laid. Their ovaries were found to contain many eggs in various stages of development, some of which were in late stages, suggesting that the females would probably be able to mate again during the season. Eggs hatch six days after being laid.

*Secondary Sex Characteristics*

Males are slightly smaller than females and have paired subgular sacs with a median strap-like protective flap. During calling this median section is extended to almost twice its resting size. On either side of this a thin chocolate coloured vocal sac distends as the call is sounded and as quickly collapses. In the female the throat region is unpigmented and unfolded. A lightly pigmented, hardened area is present on the inner surface of the forearm of the male during the breeding season.

*Discussion*

The mating call is the most common component of the anuran vocabulary. It has been found to be species specific, each species differing distinctly from every other species in at least one, and often more of the attributes of the call (Blair 1958). The mating call of *Kassina senegalensis* is similarly highly characteristic and varies within fairly narrow limits with respect to the parameters considered (Table 1).

The vocabulary of most anurans consists of no more than four components (Salthe and Mecham 1974). The term 'mating call' can easily be assigned to the most common call component. The fact that females move towards males producing this call indicates that it functions in the attraction of females.

The formation of separate calling aggregates clearly demonstrates the importance of the mating call in establishing the distribution of males over the available breeding territory. These aggregates or regional concentrations of males most probably facilitate the directed approach of females towards the aggregate, with subsequent location of a mate.

A female, directed to an aggregate of males by their calls, would certainly locate one of the closely spaced males soon after her arrival. A random distribution over the available breeding area might be less advantageous in this respect (Passmore 1976).

The application of the term 'territorial call' to that call produced by males which are inordinarily close together is justified in that the observable retreat of one of the individuals occurs as a result (Passmore 1976). Calls that function in the maintenance of spacing between individuals have been described in a number of species and are presently lumped together as territorial calls (Salthe and Mecham 1974). The separation of this call into two catagories, i.e. true territorial calls which function at a distance, and so called aggression calls involved in close range interaction is considered feasible by these two authors. The territorial call here described for *Kassina senegalensis* is produced as close range interaction call.

Release calls appear to be present in most anuran families and, although often present in both sexes, they are frequently better developed in males (Salthe and Mecham 1974). No release calls were observed in either sex during this study.

It seems unlikely that secondary choruses result in amplexus, as no amplectant pairs were discovered at this time. This lack of mating could probably be due to the low intensity of the chorus and the presence of light soon after its termination.

During the day the frogs live in holes, under logs and fallen branches (Power 1925). Eloff (1952) recorded finding *Kassina senegalensis* in the burrows of the mole-rate *Cryptomys hottentotus*. In the study area the animals were observed emerging from holes beneath rocks as well as from the holes of the termite *Odontotermes* species. According to Stewart (1967) they feed heavily on termites. Both males and females were observed emerging from each of these holes while mating and territorial calls were uttered from the entrances to, and from within, the holes. The fact that no amplectant pairs were seen emerging from these holes probably indicates that the stimuli for amplexus include darkness, the availability of open water and the production of mating calls by the males.

During the breeding season *Kassina senegalensis* aggregates at large bodies of water, including ponds, dams and inundated grasslands within the study area. The breeding season starts during September (latest record: 15th) on the highveld (Balinsky 1969) Spawning is not continuous during the breeding season, but appears to follow periods of wet weather.

In the study area wet periods were followed by dry periods lasting up to three weeks. This allowed sufficient time for many of the smaller ponds to disappear completely. Air temperatures of up to 40° C were characteristic of these dry periods. Little or no calling was heard and no amplectant pairs were seen during these periods.

The presence of eggs at different stages of development in the ovary could probably increase the reproductive potential of each female. If the eggs mature at intervals during the breeding season, and are fertilised during and subsequent to periods of wet weather, it is likely that a larger number of offspring will survive than if the female's whole egg complement was fertilised during one period of oviposition. If a female was able to mate successfully more than once during the breeding season the probability of at least one set of offspring surviving would increase.

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## REFERENCES

BALINSKY, B. I. 1969. The reproductive ecology of the amphibians of the Transvaal Highveld. *Zool. afr.* 4(1):37–93.

BLAIR, W. F. 1958. Mating call and speciation of anuran Amphibians. *Amer. Natur.* 92:27–51.

CAPRANICA, R. R. 1965. The evoked vocal response of the bullfrog. *Res. Monogr.* 33. Cambridge, Mass.: MIT Press.

CHANNING, A. 1976. Premating isolation in the genus *Kassina* (Amphibia, Anura, Rhacophoridae) in southern Africa. *J. Herpetol.* 10(1):19–23.

ELOFF, G. 1952. Sielkundige aangepastheid van die mol aan onderaardse leefwyse. *Tydskr. Wet. en Kuns.* 12:210–325.

PASSMORE, N. I. 1976. Vocalizations and breeding behaviour of *Ptychadena taenioscelus* (Anura: Ranidae). *Zool. afr.* 11(2):339–347.

PENGILLEY, R. K. 1971. Calling and associated behaviour in some species of *Pseudophryne* (Anura: Leptodactylidae). *J. Zool. Lond.* 163: 73–92.

POWER, J. H. 1925. Notes on the habits and life histories of certain little known Anura. *Trans Royal Soc. S.A.* XIII:107–110.

SALTHE, S. M. and J. S. MECHAM. 1974. Reproductive and courtship patterns. *In:* LOFTS, B. (Ed.). *Physiology of the Amphibia.* New York: Academic Press.

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