

Advertisement calls of two anuran amphibians, *Rana tigrina* and *Tomopterna breviceps*

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Abstract. *Rana tigrina* and *Tomopterna breviceps* occur as sympatric species at Dharwad, India. Sexually mature males produce advertisement calls. The advertisement call of both the species consist of a number of calls produced in series forming a call group. Each call group of *Rana tigrina* comprises 10-40 calls, whereas that of *Tomopterna breviceps* consists 13-141 calls. Each call consists of a pulse group with variable number of pulses which lack pulse interval. Calls of both the species exhibit similarities in (i) call consisting of series of calls with a pulse group in each call, (ii) absence of pulse interval within the pulse group, (iii) the amplitude of the first pulse being always small, and (iv) the frequency spectrum beginning from 200 Hz. Based on the similarities in the spectral features of the calls, it is suggested that the two species may be closely related to each other.

Keywords. Sympatric species; acoustics; advertisement call; frogs.

1. Introduction

Acoustic signalling between animals involves a rather remarkable cooperative communication channel. It enables rapid transfer of information over a considerable distance in which the sender and receiver need not be in visible contact, such as through dense foliage or in total darkness (Capranica 1977). Studies on the bioacoustics of Indian anuran amphibians are limited to *Rana crassa*, *Ramanella variegata* and *Polypedates maculatus* (Kanamadi *et al* 1992, 1993a,b). Tropical southern India has a rich fauna of Ranids. The bull frog, *Rana tigrina*, and burrowing frog, *Tomopterna breviceps*, are sympatric species. Testicular activity and some aspects of breeding behaviour of both the species have been studied by several workers (Daniel 1963, 1975; Daniel and Sekar 1989; Saidapur 1989; Kanamadi and Jirankali 1991). Information on vocalization of *R. tigrina* is totally lacking, whereas only different types of calls have been described in *T. breviceps* by Kanamadi and Hiremath (1990). The present work was undertaken to analyse the advertisement calls in both the species.

2. Materials and methods

The vocalizations of *R. tigrina* and *T. breviceps* were studied under natural conditions in the vicinity of Dharwad (15° 17' N 75° 3' E) from 1987-1991. Calls were identified while frogs were calling and recorded on TDK cassette tape using a

AKAI AJ 490 FS tape recorder (4.8 cm/s speed) and AKG D 707C/190C microphones. Microphones were placed within a distance of 30–45 cm and 10–15 cm from *R. tigrina* and *T. breviceps*, respectively. Recordings were made at 22–25°C air temperature. Calls of ten frogs (N= 10) were analysed at the Zoologisches Institut der Universitat Bonn, Germany by using oscillograms (Tekronix oscilloscope 502 A; Toennies Recordine Camera; film speed 25 cm/s). Sonagram analysis was done on computer programme MOSIP (R) Spectro analyses V6.8, 41/89, MEDAV GmbH. The Statistical analysis was carried out with Statgraphics Programme STSC Inc., Knoxville, USA.

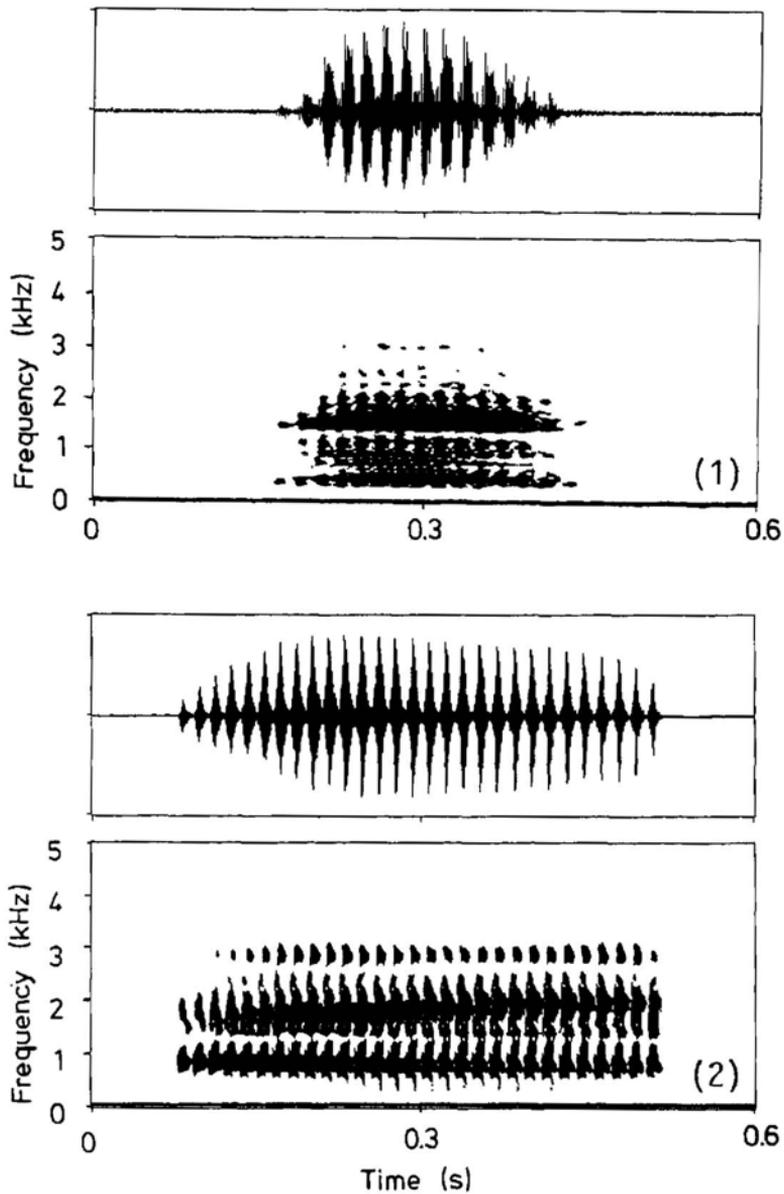
3. Results

3.1 *R. tigrina*

This species is found in shallow temporary ponds, tanks and paddy fields. After the first premonsoon (April-May)/monsoon (June) heavy showers the males with yellow colour emerge from the aestivation sites and congregate in large number and the breeding activity is completed within a few days. The males possess a pair of lateral vocal sacs. Intense calling and mating activity can be observed around 06.00 h. Females respond to calls from the second half of May. Occasionally few amplexed pairs are found during the second half of May. *R. tigrina* has one reproductive period in a year.

Calling period begins from April and continues up to the first week of August. If heavy rains fail to occur during the premonsoon (April-May) period, the beginning of calling is delayed till the onset of the monsoon (June onwards) showers. At the beginning of the breeding season after the heavy showers the frogs call early in the morning. However, at other times the calling begins at 20.00-20.30 h and continues even after midnight. The males give calls sitting in water at the edges of the ponds with less than half of their body submerged in water. Calls are audible from a distance of 100–150 m. Advertisement call and release calls have been identified. Both types of calls are produced by sexually mature males, whereas sexually mature females do not produce any type of call. Calling is in chorus. However, rarely the calls may be individual also. The calls of nearest calling males are antiphonal. Only the advertisement call has been studied.

The advertisement call of *R. tigrina* consists of number of calls (figure 1) produced in series at variable intervals forming a call group (terminology: Wagner 1989). Each call group comprises 10–40 calls (table 1). Each call consists of single pulse group. The number of pulses per call varies from 10–14 and lack pulse intervals. The call duration, call interval and call period vary from 164–260 ms, 330-3356 ms and 560-3520 ms (table 1) respectively. Call amplitude of first pulse is always very small. The amplitude of following pulses increase slowly and reaches maximum in the middle (figure 1). This is followed by the pulses in which amplitude gradually decreases till the end. The frequency spectrum comprises two dominant bands of 200–1200 Hz and 1500–2200 Hz. Fundamental frequency lies at 900 Hz, whereas the dominant frequency peak lies at 1800 Hz. The sound energy is concentrated between 200 Hz and 3100 Hz.



Figures 1 and 2. Osillogram and sonogram of the advertisement call of (1) *R. tigrina* and (2) *T. breviceps*.

3.2 *T. breviceps*

This species is found in very small temporary ponds and also in slightly bigger ponds. The breeding activity coincides with first heavy premonsoon (April-May)/ monsoon (June onwards) rains. Amplected frogs are seen from April to the end of August. This species reproduces once in a year. Calls are audible from a distance

Table 1. Acoustic features of advertisement calls of *R. tigrina* (R) and *T. breviceps* (T).

Parameter	Sample size		Mean \pm SE		Minimum		Maximum	
	(R)	(T)	(R)	(T)	(R)	(T)	(R)	(T)
Pulse number (N)	24	42	12.6 \pm 0.2	28.1 \pm 0.4	10	25	14	34
Pulses/s (Hz)	24	42	58.1 \pm 0.6	68.5 \pm 0.6	51	43	62	62
Pulse duration (ms)	24	42	17.2 \pm 0.2	14.7 \pm 0.1	15	14	20	17
Calls/call group (N)	7	25	20.1 \pm 4.7	45.0 \pm 6.7	10	13	40	141
Call duration (ms)	24	42	218.2 \pm 5.6	411.0 \pm 7.0	164	360	260	512
Call interval (ms)	24	39	1075.8 \pm 170.8	717.0 \pm 54.0	330	235	3356	1522
Call period (ms)	24	39	1292.3 \pm 170.8	1130.0 \pm 57.0	560	592	3520	1924
Call group duration (s)	7	23	31.0 \pm 7.3	51.0 \pm 7.5	10	11	57	124
Call group interval (s)	5	9	5.8 \pm 0.9	8.4 \pm 2.4	4	1	8	20
Call group period (s)	5	9	42.8 \pm 6.7	65.5 \pm 11.3	18	20	56	126

of 500-600 m. Sexually mature males possess a pair of gular vocal sacs and only the males produce advertisement call and release call. Balling period begins from April and continues up to first week of September. Balling begins at around 20:00 h and continues till late night. Balls are given by sitting at the edges of small puddles, ponds or within one or two meters away from water. On the days when there are heavy showers, intense calling can be heard. Balls are given individually, and also in duets antiphonally. Only the advertisement calls has been studied.

Advertisement calls last up to 2 min and each call consists of number of calls (figure 2) produced in series at variable intervals forming a calls group. Each call group comprises 13-141 calls and each call consists of a single pulse group. The call duration, call interval and call period vary from 360-592 ms, 235-1522 ms and 592-1924 ms (table 1), respectively. Each call consists of 25-34 pulses without interval. The amplitude of the first pulse is always small and it increases gradually in subsequent 7-8 pulses (figure 2). After reaching the peak the amplitude decreases negligibly and at the end in the last two pulses it decreases slightly faster. The frequency spectrum comprises four bands of 400-1050 Hz, 1100-2500 Hz, 2700-3050 Hz, and 3500-4900 Hz. The dominant frequency lies between 1100-2500 Hz. The fundamental frequency lies at 875 Hz, whereas dominant frequency peak lies at 1950 Hz.

4. Discussion

Several recent studies have demonstrated that acoustic communication in Anura has reached a remarkably high level of development and differentiation, even though there are surprisingly few different types of calls among various species (Schneider 1990). Various types of calls such as mating call (advertisement call), territorial call, distress call and transitional calls are made by *Rana esculenta* (Wahl 1969), *Rana ridibunda* (Kuhn and Schneider 1984), *Rana graeca* (Asimakopulos *et al* 1990) and *Rana perezi* (Schneider and Steinwarz 1990). The present study has shown that *R. tigrina* and *T. breviceps* produce advertisement calls.

The problem of acoustic interference in large choruses has been solved in similar

ways by frogs and many insects. In both the groups, males tend to space their signals so that those of one individual do not overlap those of its near neighbour. In some species, call alternation is very precise and may lead to the formation of duets, trios, or other call groups within a large chorus. Call alternation has been reported in most of the major anuran families (Wells 1977). In both *R. tigrina* and *T. breviceps* the nearest calling males call in alternation spacing the calls very precisely.

Sympatric species have distinct calls if they are closely related to each other. Selection will favour acoustic divergence where two species with similar calls are sympatric (Bogert 1960). As the mating calls of a species are always highly characteristic, they are useful criteria for the determination of interspecific and intraspecific relationships (Schneider *et al* 1986). *R. tigrina* and *T. breviceps* are sympatric species and their advertisement calls exhibit similarities in (i) call consisting of a series of calls with a pulse group in each call, (ii) absence of pulse interval within the pulse group, (iii) the amplitude of first pulse being always small, and (iv) frequency spectrum beginning from 200 Hz. In the other sympatric frog *R. crassa* (Kanamadi *et al* 1992) mating call consists of 2–4 pulse groups, and the pulse groups have well defined harmonic and the frequency spectrum begins from 500 Hz, in contrast to that seen in *R. tigrina* and *T. breviceps*. The upper maxima of the frequency spectrum (figures 1 and 2) is higher in *T. breviceps* as compared with *R. tigrina*. This may be related to the small body dimensions of *T. breviceps*. This is consistent with the findings of Schneider and Steinwarz (1990) in *R. perezii* and *R. ridibunda*. The maximum number of pulse groups and the number of pulses within the pulse group are much higher in *T. breviceps* as compared with *R. tigrina*. The differences indicate acoustic divergence. However, based on the similarities in some spectral features of the advertisement calls of these two sympatric species, it may be suggested that they are closely related to each other.

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