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Vocalization of the tree frog *Polypedates maculatus* (Rhacophoridae)

R D KANAMADI, H SCHNEIDER*, C R HIREMATH and C S JIRANKALI
Department of Zoology, Karnatak University, Dharwad 580 003, India
*Zoologisches Institut, Universitat Bonn, D-5300 Bonn 1, Germany

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Abstract. The period of calling activity of *Polypedates maculatus* lies between April and October. Males possess an indistinct subgular vocal sac which turns yellow during the breeding season. Mating calls type I, type II and distress calls have been identified. Mating calls type I and type II consist of a single pulse group. Type I call comprises of 7-22 pulses, whereas type II call consists of 4-6 pulses. Pulses are short. The frequency spectrum is broad and continuous. Distress calls, with 6 hormonics, are given by the females with their mouth open.

Keywords. Tree frog; mating call; distress call.

1. Introduction

Acoustic communication constitutes an important and conspicuous part of the breeding biology of most anurans. It is involved in the establishment and maintenance of territories by the males, in facilitating the attraction of Conspecific females to the males, in courtship, and in the identification of sex and reproductive state (Littlejohn 1977). Reviews dealing with various aspects of vocalization in anuran amphibians have been published (Bogert 1960; Blair 1963, 1968; Paillette 1971; Straughan 1973; Capranica 1977; Schneider 1977, 1990; Duellman and Trueb 1985; Rand 1988; Ryan 1988). Bioacoustic studies in Indian anurans are limited to *Rana crassa* (Kanamadi *et al* 1992). Patterns of gonadal activity of the common tree frog *Polypedates maculatus* have been studied recently (Kanamadi and Jirankali 1991, 1992). But the information on its vocalization is lacking. Therefore, the present work was undertaken to study vocalization of *P. maculatus.*

2. Materials and methods

Field observations of the vocalization of P. *maculatus* (Gray 1834) were carried out in the vicinity of Dharwad (15° 17' N 75° 3' E). Frogs >4·5 snout-vent length give calls. Different types of calls were identified while the frogs were calling. Calls were recorded on TDK cassette tape using an AKAI A J 490 FS tape recorder (4·8 cm/s speed) and AKG D 707C/190C microphones. Microphones were placed within a distance of 10 cm from a calling frog. Recordings were done at 21–26° C air temperature and 85 to 98% relative humidity. The sound pressure level was measured by MEONIX sound level meter. Number of calls of five (N = 5) frogs were analysed at the Zoological Institute, University of Bonn, by examining oscillograms (Tektronix oscilloscope 502 A; Toennies Recording Camera; film speed 25 cm/s) and by sonagram analysis (with 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 *Calling behaviour*

The tree frog *P. maculatus* is found in moist deciduous forest and localities with extensive vegetation along with *Rana cyanophlyctis, R. limnocharis, Microhyla ornata* and *M. rubra.* These frogs are also seen in human localities such as bathrooms, overhead tanks and water pump houses from September to April. During the breeding season, from April to September, they are found in the areas around ponds.

Calling begins with the onset of the first heavy premonsoon rain in April. At Dharwad premonsoon rains occur during April-May and the monsoon rains begin from the 1st week of June. In case the premonsoon rains fail to occur, then the beginning of the calling coincides with the monsoon rains, from June onwards. Frogs call at night. But if placed in dark room during day time they give mating calls. Calling begins after sunset at 19·00–19·30h and continues till late night. While calling, the frogs sit on the leaves of shrubs or branches hanging over water and open dry ground. When calling males are 4–5 m apart the calling is irregular. Closely spaced males (0·5 m) call sequentially. However, this is not a chorus. During four years of study two types of mating calls and a distress call were identified. Mating calls are given during the breeding season by sexually mature males. They possess an indistinct subgular vocal sac which develops a yellow color during the breeding season. Distress calls are produced by females. Calling activity is intense during April to August and decreases noticeably during September to October.

3.2 *Calls*

P. maculatus gives two types of mating calls *i.e.* type I and type II and a distress call.

3.2a *Mating call type I:* This call attracts the Conspecific female and is given most frequently. It is soft and audible from a distance of around 10–15 m in a quiet environment. The sound pressure level varies from 55 to 82 dB measured within 10 cm distance of calling frogs. The results of call analysis are given in table 1. Calls are not given regularly, hence, the call interval varies. Calls consist of a single pulse group comprising 7 to 22 pulses (figure 1). The pulses are short and repeated at distinct but variable intervals. Calls consist of two types of pulse groups *i. e.* type Ia and type Ib. The type Ia calls are with 15 pulses or less, the amplitude of the first pulse is always relatively small; it increases in the next 2 or 3 pulses and then gradually decreases to a certain extent. The type Ib calls are with 16 pulses or more, the amplitude remains almost the same from the beginning to the end. The pulse intervals are variable in type Ia, while they are regular in type Ib. The frequency spectrum is broad and continuous (figure 1). The sound energy is distributed between 100 and 3900 Hz.

Table 1. Acoustic features of mating call types I, II and distress call of *P. maculatus*.

Parameter	Sample size	Mean ± SE	Minimum	Maximum
Mating call type I				
Pulse number (*N*)	13	13·7 ± 1·4	7	22
Pulses/s (Hz)	13	13·3 ± 0·3	11·5	16
Pulse duration (ms)	156	8·7 ± 0·26	4	12
Pulse interval (ms)	156	72·3 ± 1·1	16	110
Pulse period (ms)	156	81·0 ± 1·0	26	114
Call duration (ms)	13	1024·0 ± 105·0	574	1702
Call interval (s)	35	7·2 ± 2·5	0·57	87
Call period (s)	20	15·7 ± 5·7	1·6	89
Mating call type II				
Pulse number (*N*)	21	5·7 ± 0·13	4	6
Pulses/s (Hz)	21	33·0 ± 1·5	21·5	46·3
Pulse duration (ms)	96	6·6 ± 0·15	4	12
Pulse interval (ms)	96	30·4 ± 2·4	14	94
Pulse period (ms)	96	37·0 ± 2·4	20	100
Call duration (ms)	21	181·1 ± 8·0	108	212
Call interval (ms)	19	447·0 ± 16·0	380	622
Call period (ms)	19	627·0 ± 9·0	584	732
Distress call				
Call duration (ms)	16	368·0 ± 69·0	240	1372
Call interval (ms)	16	248·0 ± 35·1	124	730
Call period (ms)	16	613·0 ± 79·0	394	1638

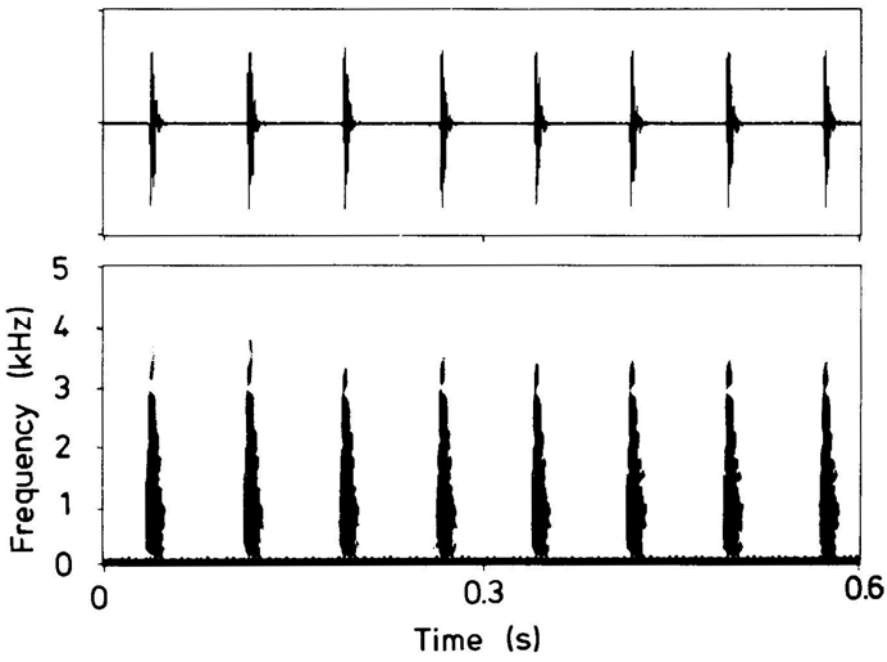

Figure 1. The oscillogram and sonagram of the part of mating call type I.

3.2b *Mating call type II:* This call, which often precedes or succeeds the type I mating call, is also given independently. It is softer than the type I call and audible from a distance of 3 to 4 meters. The details of call analysis are given in table 1. Calls are highly irregular and the call duration is short. Each call consists of a single pulse group (figure 2). Each pulse group comprises 4 to 6 pulses with variable intervals. The pulses are short. Often this call may be followed by a type I. call or *vice versa.* The first pulse is always slightly smaller than the rest; the amplitude increases in the subsequent two/three pulses and decreases in the last two pulses. The sound energy is distributed between 200 and 2900 Hz with a sudden decrease in the middle (figure 2).

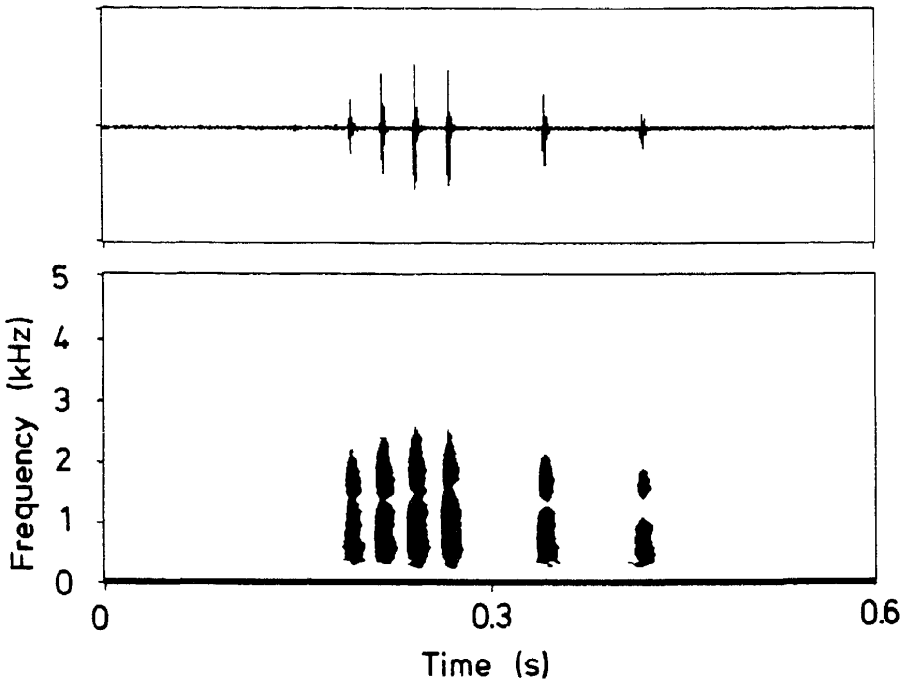

Figure 2. The oscillogram and sonagram of mating call type II.

3.2c *Distress call:* Distress call is given by the females with an open mouth. It is audible even from a distance of around 40 to 50 m. The analysis of the distress call is given in table 1. Each call consists of a large number of pulses without intervals (figure 3). The amplitude of the call is smaller at the beginning and rises quickly. There is a slight decrease in the middle of the call, followed by a slight increase and a final decline to a smaller amplitude. The call consists of 6 harmonics and the sound energy is distributed between 600 and 5300 Hz.

4. Discussion

Recent studies have shown that the anuran mating calls have specific biological significance. They serve to attract females ready to mate (Gerhardt 1978; Schneider 1982), to mark the territory of the calling male (Brzoska 1982), or both (Schneider

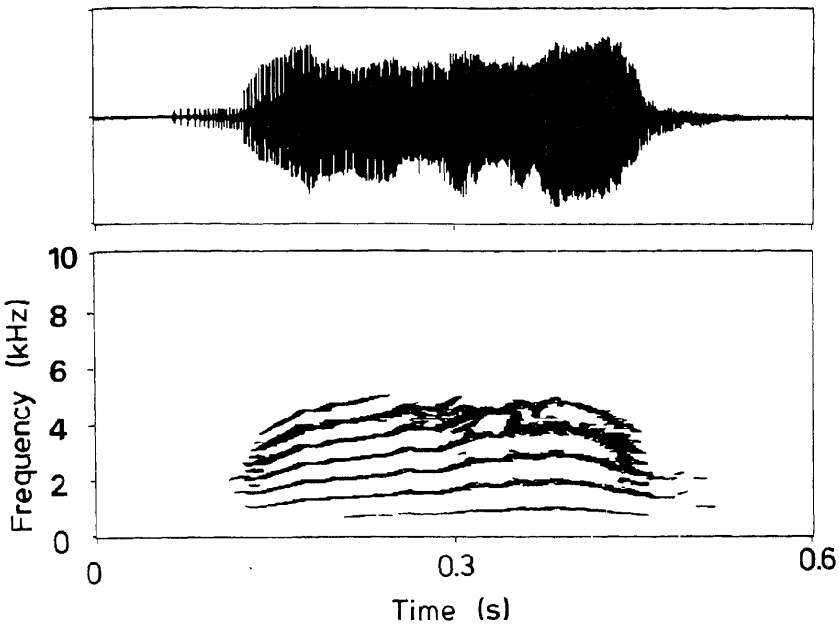

Figure 3. The oscillogram and sonagram of distress call.

et al 1984). Because mating calls of a species are always highly characteristic, they are useful to evaluate inter and Intraspecific relationships. Indeed they are often better than morphological characteristics for this purpose (Schneider *et al* 1986). Species specific mating calls are used as an important criterion in identifying and locating the anuran species of Dharwad (Kanamadi and Hiremath 1989). Mating calls of *P. maculatus* serve attract the Conspecific females.

Schiotz (1967) described the reproductive calls of large number of species of Rhacophoridae belonging to West Africa. A majority of tree frogs give mating calls during nights or when the light intensity is reduced in the evening. *P. maculatus* always calls by night. The fact that darkness stimulates calling during the day time suggests the necessity of darkness for calling activity, as has been found in *Hyla arborea* (Schneider 1967, 1971). The calls of *Rhacophorus taipeianus, Rhacophorus moltrechti, Polypedates leucomystax, Buergeria robusta, B. japonica* and *Chirixalus eiffingeri,* all native to Taiwan, consist of short pulses (Kuramoto 1986). This feature has also been reported in Japanese rhacophorids (Kuramoto 1975). In *P. maculates* too, the pulses are short. Both types I and II calls of *P. maculatus* are multi-pulsed and the frequency spectrum is of a continuous type, unlike that of many frogs of Taiwan and Japan.

A distress call is relatively uncommon in European tree frogs. Normally it is a piercing cry that varies in duration, intensity and pitch. These calls are given when the frogs are caught (Schneider 1977). Distress calls are emitted with the mouth open, but their production with the mouth closed has been reported in *Rana catesbeiana* and *Bufo calamita* (Duellman and Trueb 1985). Female *P. maculatus* gives the distress call with an open mouth.

In the Indian subcontinent a large number of species of Rhacophoridae are known to occur. Future studies on other species are expected to reveal variations in call structure and species specific characteristics.

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