Vocal signals in a tropical avian species, the redvented bulbul *Pycnonotus cafer*: their characteristics and importance

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Acoustic signals play an important role in the lives of birds. Almost all avian species produce vocal signals in a variety of contexts either in the form of calls or songs or both. In the present study different types of vocal signals of the tropical avian species *Pycnonotus cafer* were characterized on the basis of their physical characteristics and context of production. This species used six types of vocal signals: contact signals, roosting signals, alarm signals, twittering signals, distress signals and begging signals. Two types of alarm signals are produced based on predation pressure. These signals are dissimilar in all physical characteristics except for dominant frequency. Although alarm signal type I and roosting signals are phonetically similar, they have completely different sonogram characteristics.

1. Introduction

Birds use a variety of vocalizations with specific biological functions. These signals may be long and complex to short and simple and occur in particular contexts and can be characterized using just three measures: frequency, duration and amplitude (Catchpole and Slater 1995; Weary 1996). Sound spectrography is a well established method to study the physical structure of a sound and to compare the acoustical features of signals with each other (McGregor and Ranft 1994). Acoustic signals within a species vocal repertoire typically differ in structure, mode of presentation and situation of use (Smith 1977; Staicer 1996).

A variety of contact signals are presumed to maintain the cohesiveness of the pair/family/flock members (Caine and Stevens 1990). Interactions between parents and nestlings/juveniles have been characterized by a number of signals. Offspring signal to beg for food (Muller and Smith 1978; Miller and Conover 1983), warmth (Evans 1992), and protection from predators (Ritchison 1983), whereas parents signal to provide offspring with information regarding food (Whittemore and Fraser 1974; Nuechterlein 1988), predation pressure (Nuechterlein 1988) and location (Weary and Fraser 1995). Some passerines use a variety of signals while approaching and leaving their nests (Armstrong 1973; Bengtsson and Ryden 1981; Clemmons 1995a, b). Some of these signals are common in early nestling stages and enhance begging behaviour of nestlings (Bengtsson and Ryden 1981; Robertson *et al* 1992; Clemmons 1995b).

In the present study efforts have been made to characterize different types of vocal signals on the basis of their physical characteristics and significance in a tropical avian species, the redvented bulbul *Pycnonotus cafer*.

2. Materials and methods

2.1 *Materials*

The redvented bulbul is very widely distributed throughout the Indian sub-continent, and is divided into seven subspecies with intermediate forms. *Pycnonotus cafer* is a perky smoke-brown bird with partially crested black head, scale like markings on breast and back, a conspicuous crimson patch below root of tail, and a white rump,

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the last particularly noticeable in flight. It is a strictly resident species commonly available in gardens and light scrub jungle, both near and away from human habitations. It is arboreal, with quick flight, usually found in pairs, non-territorial, with sexes alike (Whistler 1949; Ali 1996; Kumar 1999).

2.2 *Recordings and analysis of signals*

Acoustic signals of *P. cafer* from a local population ($n = 24$ individuals) in Haridwar, UP (29°55′N, 78°8′E), were recorded across three seasons periodically from January 1997 to December 1999, using a JVC zoom MZ-500 unidirectional microphone and SONY CFS 1030S tape recorder. Most signals were recorded at 2 to 10 metre distances. After editing, cuts of high quality recordings (few seconds to a few minutes duration) were used for physical analysis (characteristics based on frequency and time duration). The analysis was carried out with the help of a Scientific 25 MHz Digital Storage Oscilloscope HM205-3 with Interface HO 79-4, IEEE Controller card HO 80 (this card enables a PC to receive and control the oscilloscope) and signal analyser software SP 91 in a Pentium DX2 100 MHz 16 MB RAM. The samples were analysed at the maximum sampling rate of 20 kHz/s. The horizontal resolution was 200 points/cm and vertical resolution was 28 points/cm. Spectrograms were generated using SIGNAL™, a software package for sound generation and analysis. Results were expressed as means ± SE. Differences between signals were tested by Student's *t*-test.

2.3 *Terminology and parameters*

Acoustic signals in birds can be classified into calls and songs. Vocalizations uttered in a single articulation for the purpose of an immediate requirement such as food, social contact, threat, alarm, and begging are known as calls, while songs in general are long and complex vocalizations produced by males in the breeding season; however, there are many exceptions. A vocal signal may be composed of a single element or note. In a spectrogram an element is simply a continuous sound, preceded and followed by a silent gap. If the signal has a single element, it is known as a simple signal (simple call) and if the signal has several elements, it is categorized as a complex signal (complex call or song). A complex signal is generally made up of a number of distinct sections called phrases. Each phrase consists of a series of similar or dissimilar structured elements (Catchpole and Slater 1995; Bhatt *et al* 2000).

In the present study, minimum frequency, maximum frequency, range of frequencies, duration, number of elements per phrase, and types of phrases were used to define the physical characteristics of the signals.

3. Results

The following types of vocal signals were observed during the course of the study. A summary of the signals is given in table 1.

Table 1. Physical characteristics of different types of signals in the redvented bulbul *P. cafer*.

Types of signals	Nature of signals	Number of individuals (*N*)	Number of elements	Types of elements	Min. freq. (kHz)	Max. freq. (kHz)	Range of freq. (kHz)	Duration (s)	Interval (s)	Rate (elements/min)
Social contact signals*	Complex	24	2·89 ± 0·22 ($n = 18$)	37 (Approx.)	1·58 ± 0·06 ($n = 18$)	3·33 ± 0·08 ($n = 18$)	1·76 ± 0·10 ($n = 18$)	0·410 ± 0·03 ($n = 18$)	0·87 ± 0·12 ($n = 18$)	34·92 ± 1·34 ($n = 18$)
Roosting signals	Simple	9	1	1	1·49 ± 0·02 ($n = 18$)	4·71 ± 0·03 ($n = 18$)	3·22 ± 0·02 ($n = 18$)	0·038 ± 0·002 ($n = 18$)	0·078 ± 0·001 ($n = 18$)	267·9 ± 6·30 ($n = 18$)
Alarm signals (type I)	Simple	8	1	1	0·93 ± 0·03 ($n = 16$)	5·03 ± 0·03 ($n = 16$)	3·98 ± 0·08 ($n = 16$)	0·160 ± 0·01 ($n = 24$)	0·360 ± 0·023 ($n = 24$)	77·3 ± 3·26 ($n = 24$)
Alarm signals (type II)	Simple	8	1	1	0·76 ± 0·02 ($n = 16$)	6·27 ± 0·02 ($n = 16$)	5·54 ± 0·03 ($n = 16$)	0·057 ± 0·002 ($n = 24$)	0·099 ± 0·002 ($n = 24$)	252·2 ± 7·02 ($n = 24$)
Twittering signals*	Complex	8	3·36 ± 0·32 ($n = 22$)	24 (Approx.)	1·62 ± 0·07 ($n = 11$)	3·09 ± 0·09 ($n = 11$)	1·47 ± 0·09 ($n = 11$)	0·460 ± 0·040 ($n = 11$)	0·790 ± 0·090 ($n = 11$)	38·92 ± 1·46 ($n = 22$)
Begging signals	Simple	7	1	1	0·16 ± 0·06 ($n = 14$)	7·96 ± 0·02 ($n = 14$)	7·87 ± 0·05 ($n = 14$)	0·190 ± 0·010 ($n = 14$)	0·740 ± 0·050 ($n = 14$)	46·3 ± 1·34 ($n = 14$)
Distress signals	Simple	7	1	1	0·47 ± 0·01 ($n = 14$)	6·79 ± 0·02 ($n = 14$)	3·44 ± 0·03 ($n = 14$)	0·270 ± 0·010 ($n = 14$)	0·710 ± 0·130 ($n = 14$)	67·0 ± 1·63 ($n = 14$)

N, Number of individuals; *n*, total number of signals analysed (2–3 signals per individual).
*Physical characteristics of this signal are based on the mean ± SE of types of phrases (*n*) (for example, the minimum frequency of social contact signal is the mean of minimum frequency of all 18 types of phrases observed in 24 individuals).

3.1 *Social contact signals*

These are complex vocalizations composed of different types of phrases. Eighteen types of phrases were observed in 24 individuals (a 2–8 min recording was analysed per individual) (table 2). These phrases were composed of 2–4 types of elements. The elements in a phrase were dissimilar in structure (except phrase No. XVI, in which all three elements were similar in structure). The minimum, maximum and range of frequencies of these signals were 1·58 ± 0·06, 3·33 ± 0·08 and 1·76 ± 0·10 kHz. respectively. The average duration of these phrases was 0·41 ± 0·03 s. The details of physical characteristics of phrases have been given in table 2 and figure 1 representing the structure of several types of phrases namely III, IV, VI, VII, VIII and X.

Individuals generally use the same types of phrases (for example, phrase type I was observed in 14 out of 24 individuals and the physical characteristics of this phrase were almost the same in all 14 individuals). Individuals were observed repeating a particular type of phrase in a vocal bout. However, in several cases ($n = 4$) individuals used several types of phrases in a bout (up to 5 different phrases in an 8 min recording). Social contact signals were widely used by this bird throughout the day possibly to maintain cohesiveness among members of the flock.

3.2 *Roosting signals*

Pycnonotus cafer roosts in flocks in dense trees. Immediately after returning to roosting sites the birds give 'roosting signals' for about 15 min. These signals were delivered rapidly, about 267·92 ± 6·30 elements/min ($n = 18$). The minimum, maximum, range and dominant frequencies ($\bar{x}$ ± SE) were 1·49 ± 0·02, 4·71 ± 0·03, 3·22 ± 0·02 and 3·08 ± 0·03 kHz respectively. The duration of a single note was 0·038 ± 0·002 s and average interval among notes was 0·078 ± 0·001 s (table 1).

3.3 *Alarm signals*

Two types of alarm signals are found in *P. cafer* (table 1, figure 2).

Type I: When a predator such as a sparrow hawk, eagle or tree pie appeared in the vicinity of a nest the parents used a specific type of alarm signal accompanied by raising of the crest to alert the nestlings. The minimum, maximum, range and dominant frequencies of these signals were 0·93 ± 0·03, 5·03 ± 0·03, 3·98 ± 0·08 and 2·63 ± 0·08 kHz respectively. The duration of the notes was 0·16 ± 0·01 s and interval among notes was 0·36 ± 0·02 second. The rate of delivery was 77·3 ± 3·26 elements/min (table 1).

Type II: This type of signal was used by the birds when their nest or nestlings or fledglings were in great danger and approached by predators directly. All the physical characteristics of this signal with the exception of the dominant frequency are significantly differ from the 'type I' alarm signal (table 3). The minimum, maximum, range

Table 2. Physical characteristics of social contact phrases in redvented bulbul *P. cafer*.

Types of phrases	Number of individuals (*N*)	Number of elements/ phrase	Types of elements/ phrase	Min. freq. (kHz)	Max. freq. (kHz)	Range of freq. (kHz)	Duration (s)
I	14	4	4	1·92 ± 0·02	3·61 ± 0·03	1·67 ± 0·02	0·52 ± 0·01
II	12	3	3	1·82 ± 0·02	3·25 ± 0·02	1·43 ± 0·04	0·48 ± 0·02
III	6	4	4	1·81 ± 0·04	3·73 ± 0·03	1·92 ± 0·02	0·50 ± 0·02
IV	7	3	3	1·90 ± 0·03	3·50 ± 0·01	1·61 ± 0·01	0·45 ± 0·02
V	9	3	3	1·43 ± 0·03	3·23 ± 0·02	2·80 ± 0·02	0·53 ± 0·01
VI	11	3	3	1·29 ± 0·02	3·27 ± 0·01	1·98 ± 0·02	0·55 ± 0·01
VII	16	2	2	1·84 ± 0·02	3·51 ± 0·01	2·67 ± 0·01	0·39 ± 0·01
VIII	15	3	3	1·26 ± 0·02	3·24 ± 0·02	2·95 ± 0·03	0·56 ± 0·01
IX	12	4	4	1·50 ± 0·02	3·08 ± 0·02	2·57 ± 0·05	0·47 ± 0·02
X	12	4	4	1·38 ± 0·02	3·12 ± 0·02	2·74 ± 0·03	0·52 ± 0·01
XI	13	3	3	1·97 ± 0·03	3·08 ± 0·02	2·12 ± 0·02	0·58 ± 0·01
XII	13	4	4	1·84 ± 0·03	2·72 ± 0·03	0·88 ± 0·03	0·52 ± 0·02
XIII	9	4	4	1·60 ± 0·02	2·96 ± 0·02	1·30 ± 0·02	0·51 ± 0·03
XIV	7	3	3	1·82 ± 0·02	3·95 ± 0·03	1·13 ± 0·02	0·32 ± 0·01
XV	14	3	3	1·42 ± 0·02	3·12 ± 0·03	1·71 ± 0·02	0·47 ± 0·02
XVI	12	3	1	2·00 ± 0·04	3·72 ± 0·03	1·72 ± 0·01	0·75 ± 0·01
XVII	9	4	4	1·73 ± 0·02	3·28 ± 0·03	1·56 ± 0·02	0·92 ± 0·01
XVIII	8	3	3	1·22 ± 0·02	3·12 ± 0·02	1·91 ± 0·02	0·47 ± 0·01

Note: Physical characteristics of social contact signal are based on 18 types of phrases recorded in 24 individuals (*N*); a 2–8 min recording was analysed per individual and 6 samples of each phrase were analysed.

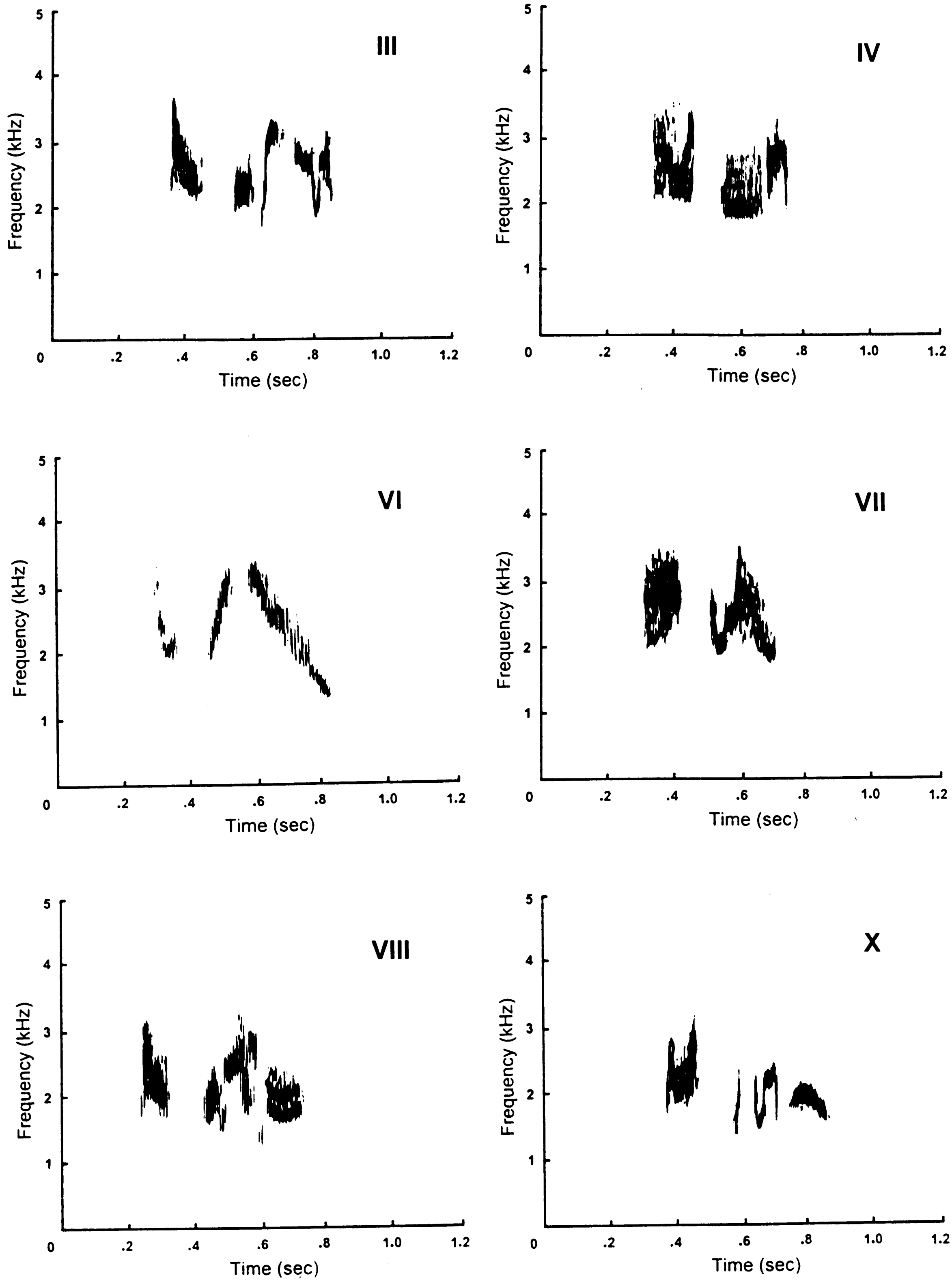

Figure 1. Spectrograms showing structure of several social contact phrases (No. III, IV, VI, VII, VIII, X) in red-vented bulbul.

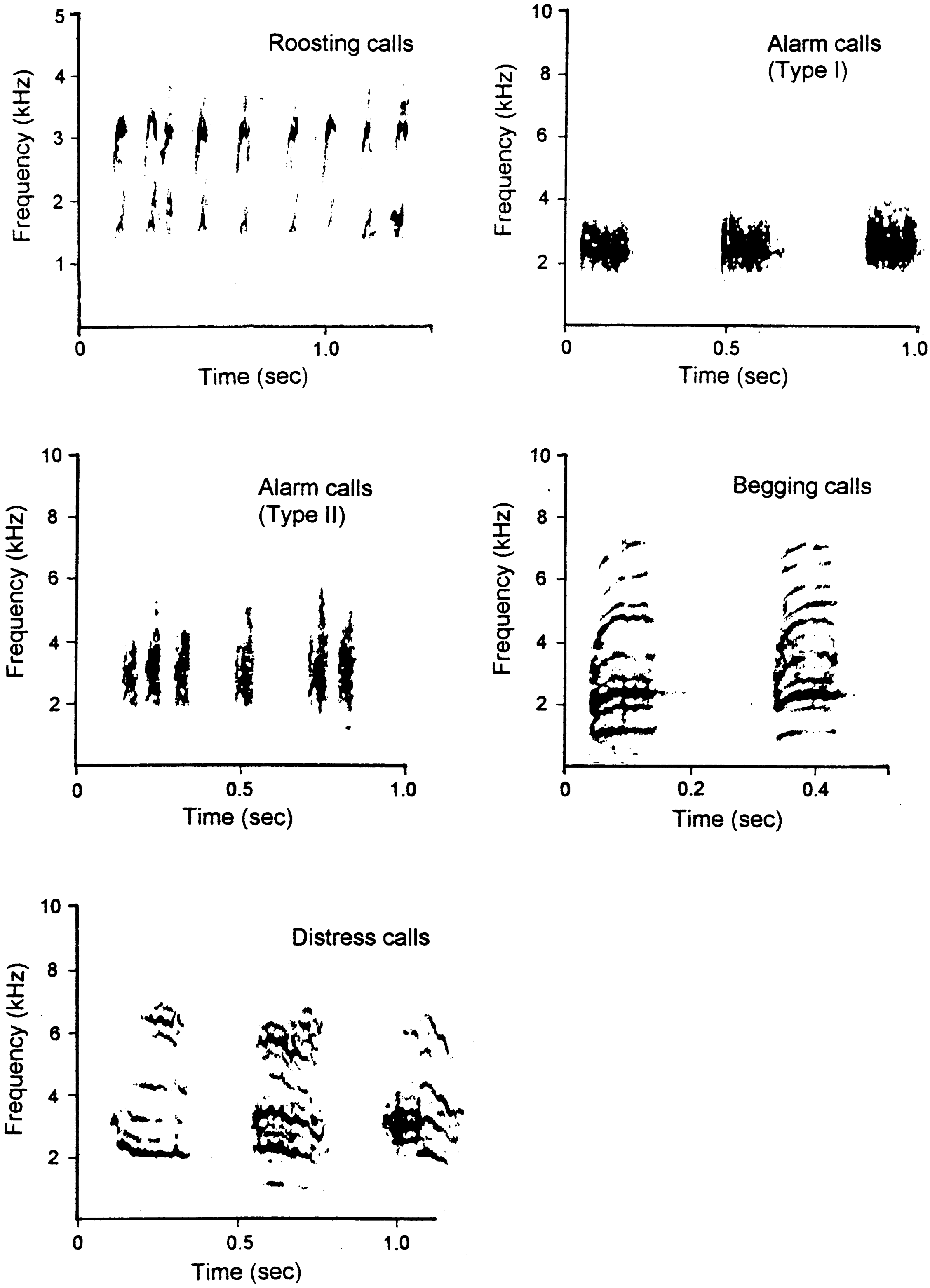

Figure 2. Spectrograms of different types of signals in redvented bulbul, namely roosting signals, alarm signals (type I and II), begging signals and distress signals.

and dominant frequencies of these vocalizations were 0·76 ± 0·02, 6·27 ± 0·02, 5·54 ± 0·03 and 2·743 ± 0·02 respectively. The duration of notes was 0·057 ± 0·002 s, while the interval among notes was 0·099 ± 0·002 s. The rate of signal production was 252·2 ± 7·02 notes/min.

3.4 *Twittering signals*

This is a song-like vocalization produced by the bulbul especially during the resting period. Both male and female were observed using this type of vocalization. This is a complex signal composed of several types of phrases. Eleven types of phrases were observed in 8 individuals (a 2–8 min recording was analysed per individual). These phrases were composed of 2–6 types of elements. All the elements in a phrase were dissimilar in structure (figure 3). The minimum, maximum and range of frequencies of these signals were found to be 1·62 ± 0·07, 3·09 ± 0·09 and 1·47 ± 0·09 kHz respectively. Duration of phrases was 0·46 ± 0·04 s and the interval between any two phrases was 0·79 ± 0·09 s. The details of phrases have been given in table 4.

3.5 *Begging signals*

In *P. cafer*, begging vocalizations are produced by nestlings when the parents arrive at the nest. These signals are simple, made up of a series of wide band, monosyllabic notes with overtones. The minimum, maximum, range and dominant frequencies were 0·16 ± 0·06, 7·96 ± 0·02, 7·87 ± 0·05 and 6·44 ± 0·03 kHz respectively (table 1). The duration of notes was found to be 0·19 ± 0·01 and the interval between notes was 0·74 ± 0·05 s. The rate of delivery was 46·3 ± 1·34 notes per min in normal situations while in delayed visits the rate of delivery was found to be higher (80·71 ± 0·86 notes/min).

3.6 *Distress signals*

These are signals produced by nestlings/juveniles when they are captured by a predator. These are wide band signals with overtones. These signals are delivered to seek help from conspecifics or heterospecifics. The minimum, maximum, range and dominant frequencies were 0·47 ± 0·01, 6·79 ± 0·02, 3·44 ± 0·03 and 6·44 ± 0·03 kHz respectively. The duration of notes was 0·27 ± 0·01 s, while the interval between notes was 0·71 ± 0·13 s. The rate of delivery was 67·0 ± 1·63 notes per min (table 1, figure 2).

4. Discussion

4.1 *Social contact signals*

Our analysis indicates that the redvented bulbul uses about eighteen types of social contact phrases (table 2). In the present study the 'social contact signals' were used in more than one kind of situation. For example, the same phrases of the signal can be used during emergence (when birds leave roosting sites in the morning) and foraging. In another study, the magpie robin *Copsychus saularis* was also reported to use the same signal type during roosting and emergence (Kumar 1999). In the peregrine falcon *Falco peregrinus*, the 'wailing call' is used as an antago-

Table 3. Comparison of alarm signals (type-I and type-II) of *P. cafer*.

Characteristic	Type-I	Type-II	*t*-test	*P*	d.f.
Min. freq. (kHz)	0·93 ± 0·03 (*N* = 8, *n* = 16)	0·76 ± 0·02 (*N* = 8, *n* = 16)	4·30	< 0·001	30
Max. freq. (kHz)	5·03 ± 0·03 (*N* = 8, *n* = 16)	6·27 ± 0·02 (*N* = 8, *n* = 16)	30·62	< 0·001	30
Range of freq. (kHz)	3·98 ± 0·08 (*N* = 8, *n* = 16)	5·54 ± 0·03 (*N* = 8, *n* = 16)	18·37	< 0·001	30
Dom. freq. (kHz)	2·63 ± 0·08 (*N* = 8, *n* = 16)	2·74 ± 0·02 (*N* = 8, *n* = 16)	1·19	n.s.	30
Duration (s)	0·16 ± 0·01 (*N* = 8, *n* = 24)	0·057 ± 0·002 (*N* = 8, *n* = 24)	33·71	< 0·001	46
Interval (s)	0·36 ± 0·03 (*N* = 8, *n* = 24)	0·099 ± 0·002 (*N* = 8, *n* = 24)	8·35	< 0·001	46
Rate (elements per min)	77·3 ± 3·26 (*N* = 8, *n* = 24)	252·1 ± 7·02 (*N* = 8, *n* = 24)	22·58	< 0·001	46

N, Number of individuals; *n*, number of signals analysed (2–3 signals per individual); n.s., not significant; d.f., degree of freedom..

nistic signal, a parental food-signal and a heterosexual signal (Cramp and Simmons 1980; Carlier 1995).

4.2 *Roosting signals*

In the redvented bulbul roosting signals appear to be phonetically similar to alarm signals. But sonogram characteristics reveal that these signals are dissimilar (table 5). The flock of bulbuls roosts communally and before sleeping all flock members deliver roosting signals together. The roosting chorus has been reported in a number of other avian species also (Wynne-Edwards 1962; Braestrup 1963; Siegfried 1971; Ward and Zahavi 1973; Khera and Kalsi 1986; Mahabal 1997).

4.3 *Alarm signals*

For a number of species, the acoustical structure and the ecological and social context of these alarm signals have been well described (Marler and Hamilton 1966; Klump and Shalter 1984; Ficken *et al* 1994; Ficken and Popp 1996). Many species of birds use more then one type of signal in the presence of a predator (Bright 1984; Ficken and Popp 1996). In a classical study, Marler (1955) demonstrated the antithetical acoustic structure of two types of vocalizations elicited by predators. Signals given when a hawk is flying overhead are often high pitched, cover a narrow frequency range, and lack abrupt onsets or termination, while those given during mobbing cover a wide frequency range and have slow, abrupt onsets. Signals in

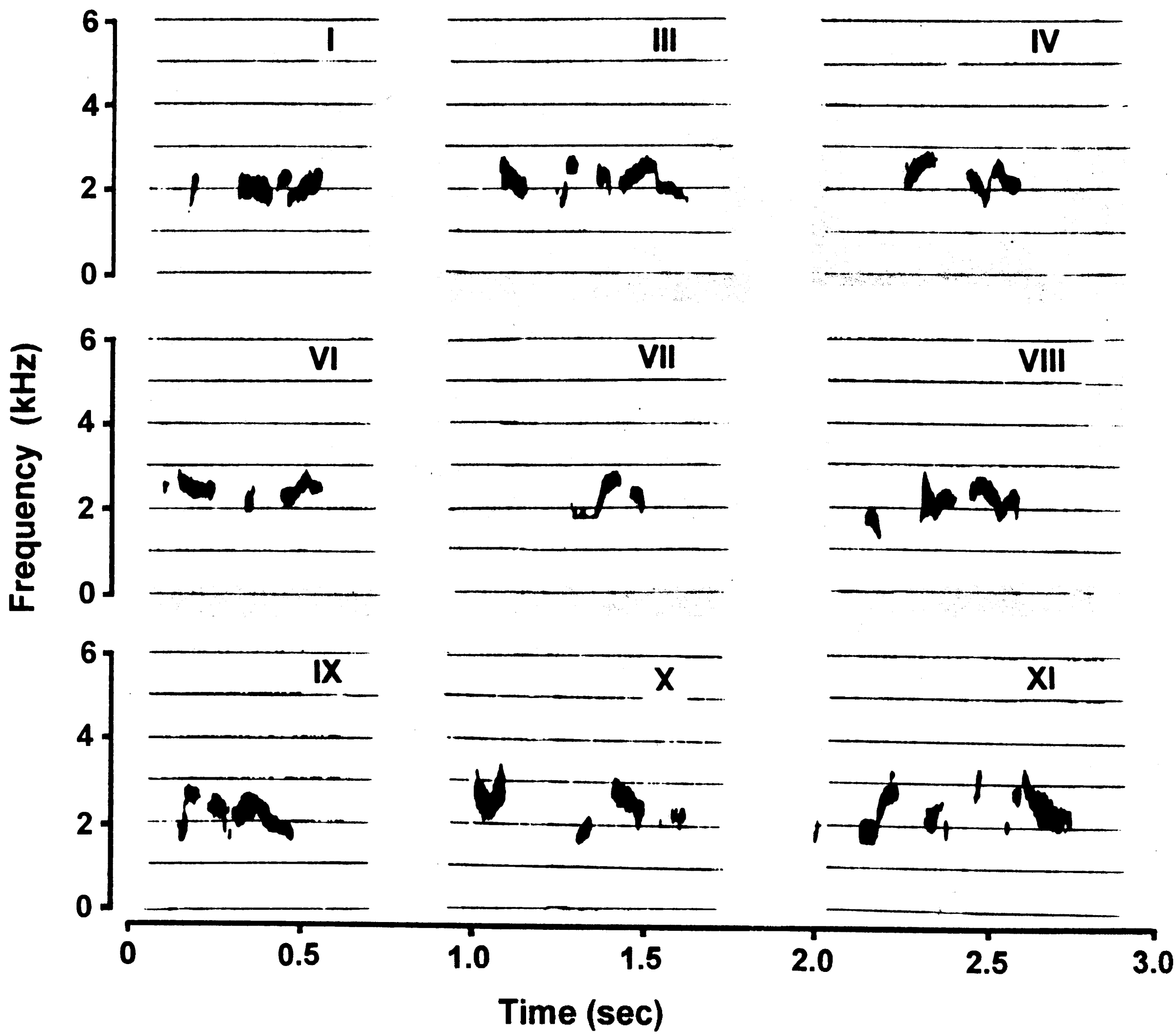

Figure 3. Spectrograms of the twittering signals showing several representative phrases.

the first category may have features making them difficult to localize, while mobbing signals have features enhancing locatability (Marler 1955, 1959; Marler and Hamilton 1966). The redvented bulbul also appears to follow almost the same pattern in producing two types of alarm signals. The type I signal (produced under low predation pressure) has a narrower frequency range, longer duration, longer intervals (between signals) as compared to the type II signal which is generated under high risk of predation (table 1).

4.4 *Twittering signals*

Since the bird uses this vocalization while resting, the communication value of this sound is uncertain. In song birds such low amplitude, soft, short signals have been classified as sub-song which is uttered by first year juveniles in the process of song learning (Kroodsma and Miller 1996). But the same does not appear to be true in the case of the redvented bulbul because in this species all individuals, irrespective of age and sex have been found to produce twittering signals.

4.5 *Begging signals*

In any 'parent-juvenile' interaction the signals produced by parents are known as 'provisioning signals', while the vocalizations uttered by nestlings/juveniles to beg food from parents are known as 'begging signals' (Lessells

Table 4. Physical characteristics of twittering signals in redvented bulbul *P. cafer*.

Types of phrases	Number of individuals (*N*)	Number of elements/ phrase	Types of elements/ phrase	Min. freq. (kHz)	Max. freq. (kHz)	Range of freq. (kHz)	Duration (s)
I	3	4	4	1·43 ± 0·03	3·05 ± 0·06	1·61 ± 0·04	0·45 ± 0·01
II	5	3	3	1·89 ± 0·03	3·01 ± 0·05	1·04 ± 0·04	0·51 ± 0·02
III	4	4	4	1·48 ± 0·04	2·74 ± 0·04	1·26 ± 0·02	0·57 ± 0·03
IV	4	2	2	1·54 ± 0·03	2·83 ± 0·02	1·24 ± 0·02	0·34 ± 0·03
V	3	3	3	2·06 ± 0·05	3·48 ± 0·03	1·30 ± 0·01	0·26 ± 0·02
VI	6	3	3	1·84 ± 0·02	3·05 ± 0·04	1·15 ± 0·01	0·46 ± 0·02
VII	5	2	2	1·52 ± 0·02	2·79 ± 0·02	1·28 ± 0·02	0·38 ± 0·01
VIII	5	3	3	1·30 ± 0·04	2·76 ± 0·02	1·42 ± 0·03	0·44 ± 0·02
IX	6	3	3	1·50 ± 0·03	3·16 ± 0·05	1·70 ± 0·04	0·35 ± 0·01
X	3	4	4	1·73 ± 0·02	3·51 ± 0·04	1·81 ± 0·02	0·60 ± 0·03
XI	4	6	6	1·53 ± 0·01	3·74 ± 0·02	2·21 ± 0·02	0·74 ± 0·02

Note: Physical characteristics of twittering signal are based on 11 types of phrases recorded in 8 individuals (*N*); a 2–8 min recording was analysed per individual and 6 samples of each phrase were analysed.

Table 5. Comparison of alarm signals (type-I) and roosting signals of redvented bulbul, *P. cafer*.

Characteristic	Alarm signal (Type-I)	Roosting signal	*t*-test	*P*	d.f.
Min. freq. (kHz)	0·93 ± 0·03 (*N* = 8, *n* = 16)	1·49 ± 0·02 (*N* = 9, *n* = 18)	15·30	< 0·001	32
Max. freq. (kHz)	5·03 ± 0·03 (*N* = 8, *n* = 16)	4·71 ± 0·03 (*N* = 9, *n* = 18)	7·69	< 0·001	32
Range of freq. (kHz)	3·98 ± 0·08 (*N* = 8, *n* = 16)	3·22 ± 0·02 (*N* = 9, *n* = 18)	9·16	< 0·001	32
Dom. freq. (kHz)	2·63 ± 0·08 (*N* = 8, *n* = 16)	3·08 ± 0·03 (*N* = 9, *n* = 18)	4·76	< 0·001	32
Duration (s)	0·16 ± 0·01 (*N* = 8, *n* = 24)	0·038 ± 0·002 (*N* = 9, *n* = 18)	42·72	< 0·001	40
Interval (s)	0·36 ± 0·02 (*N* = 8, *n* = 24)	0·078 ± 0·001 (*N* = 9, *n* = 18)	11·75	< 0·001	40
Rate (elements per min)	77·3 ± 3·26 (*N* = 8, *n* = 24)	267·92 ± 16·3 (*N* = 9, *n* = 18)	26·88	< 0·001	40

N, Number of individuals; *n*, number of signals analysed (2–3 signals per individual); d.f.. degree of freedom.

et al 1995). Like many other avian species, in the redvented bulbul, begging signals are a normal feature of the vocalizations of nestlings. However, 'provisioning signals' are not observed in this species. There is evidence from a number of studies that parental response varies in relation to signalling by the nestling. For example, young American white pelicans, *Pelecanus erythrorhynchos*, produce a characteristic 'squawk' when they are exposed to low ambient temperatures, and the likelihood of parents responding by brooding their chicks depends on the number of 'squawks' produced in a signalling bout (Evans 1992, 1994). Similarly when nestlings of *Pica pica* were kept without food for a longer period, they enhanced the frequency of signals, as a result of which parents visited nestlings more frequently to feed them as compared to the normal condition (Redondo and Castro 1992). In the present study also it has been observed that delayed visits of parents to their nestlings increased the rate of production of begging signals.

4.6 *Distress signals*

Distress signals are also used by adults and juveniles if captured by any predator. Most avian species use such signals of wide frequency range and high amplitude when in distress.

Sometimes redvented bulbul uses a preflight signal. This vocalization is soft, simple, slow, and produced once or twice. Observations suggest that this signal is used to signal to the mate to fly away together.

5. Conclusions

The present study indicates that the redvented bulbul is a good model to study the different aspects of acoustic communication in birds, such as individual variations, microstructure, taxonomic and social significance of vocal signals. These aspects are the focus of our research.

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