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Amphibians from Sabah II.
Acoustic Characteristics of Three Common Anuran Species[1)]

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Abstract

Call characteristics of *Bufo juxtasper*, *Rana erythraea* and *Polypedates leucomystax* recorded at Ranau, Sabah, Northern Borneo, were analyzed with a sound spectrograph. Each of the three species possessed unique call characteristics and suggested the presence of valid preisolating mechanisms. For *Bufo juxtasper*, characteristics of mating calls were compared with those of release calls. The mating calls of *Polypedates leucomystax* were suggested to differ from those of the same species from Thailand and Nepal reported by the previous authors.

In my previous paper, taxonomic and natural history notes on the anurans from Sabah have been made (Matsui 1979). This paper reports the results of analyses on the acoustic characteristics of the three common species from Sabah. Few paper dealt with the call characteristics of tropcial Asian anurans, and, to my knowledge, no reports on the frogs and toads from Sabah have been made.

Materials and Methods

Recordings of calls were made in mid March of 1979 at the riverside, on the grass land and along ditches of the suburbs of Ranau (for detail, see Matsui 1979). Of the three species whose calls were recorded, oviposition was ascertained only for *Polypedates leucomystax*, and the calls for this species were regarded to the mating ones. For *Rana erythraea*, the calling aggregations of the males could be considered to the breeding colonies, and females with ripe eggs were collected. Therefore, the recorded calls were considered as mating. For *Bufo juxtasper*, three different kinds of calls were recorded. Among them, the two were distinct from the apparent release calls emitted when males were handled, and were considered as the mating calls. Recordings were made by a cassette tape recorder (Sony TC-D5) with an external microphone (Sony ECM-23F). The air temperatures during

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recordings ranged from 26 to 27 C. The recorded calls were analyzed by a sound spectrograph (Kay 7029A).

Results and Discussion

Bufo juxtasper

Forty-eight calls from four males were analysed. For the mating call, two types were recognized, and the shorter type calls were more commonly uttered than the longer type, which sometimes follows the shorter.

The shorter call (Fig. 1) does not form a trill. It lasts .07 to .16 seconds ($\bar{X}$=.12±.02), and is repeated 2.0−2.8 ($\bar{X}$=2.2± .2 (SE)) times per second. Each call consists of two to four ($\bar{X}$=3.1± .5) notes, each of which lasts .02 to .03 seconds ($\bar{X}$=.028±.002) and includes three to five ($\bar{X}$=4.2±.4) rather clear pulses.

The dominant frequency ranges between 540−730 hz ($\bar{X}$=622±46). Harmonics are not evident, and the second dominant frequency is traced between 1800−2300 hz ($\bar{X}$=2022±91).

The longer call (Fig. 2) is a typical trill, which is widely found in many

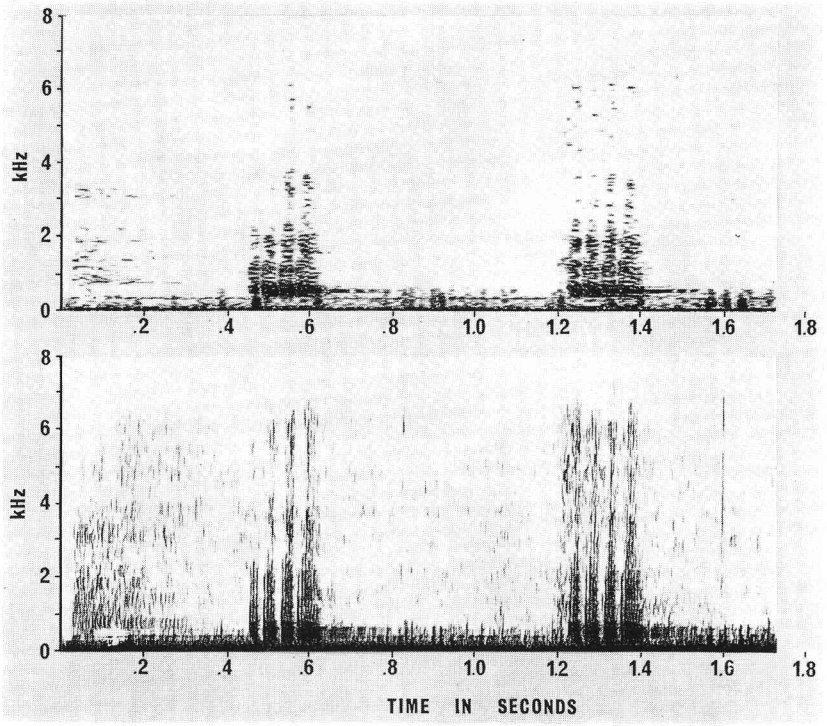


Fig. 1. Two successive mating calls of *Bufo juxtasper* (short type calls), analyzed with narrow (top) and wide (bottom) band filters.

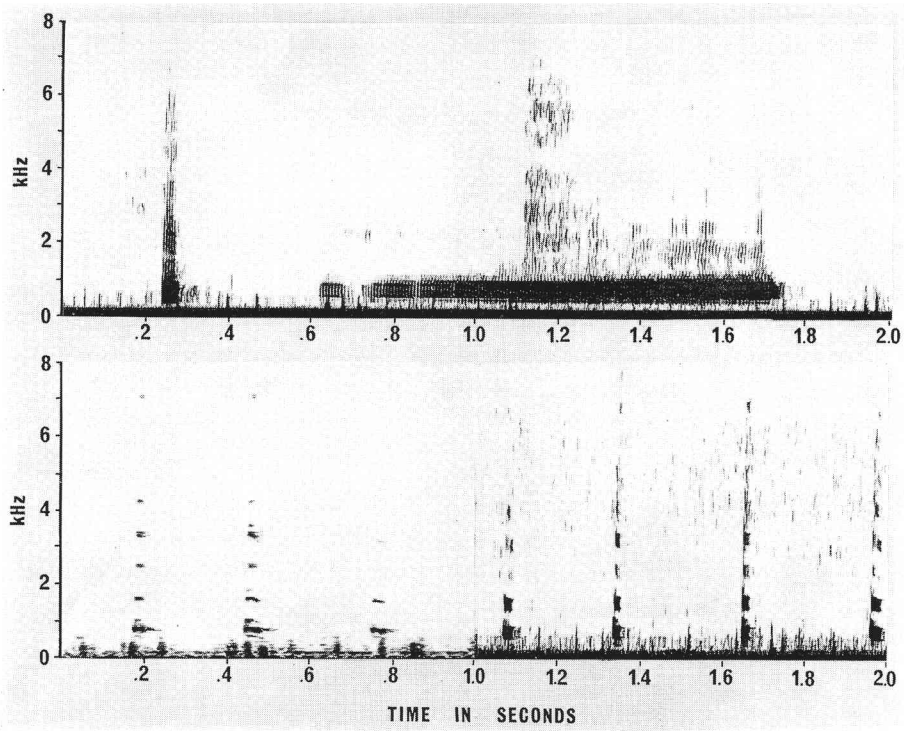


Fig. 2. A long mating call (top, wide band filter analysis) and release calls (bottom) of *Bufo juxtasper*. A successive release calls were analyzed with narrow (left) and wide (right) band filters.

species of *Bufo*. In this call, a shorter note lasting .05 seconds is followed by a longer one lasting more than one second. The shorter consists of six pulses, whereas the longer consists of 130 fine pulses.

Harmonic frequencies are rather indistinct in the shorter note, and the longer lacks frequencies above 2000hz. The dominant frequencies of these notes are in a slightly higher region than in the shorter mating call ($\bar{X}=814$ hz, compared with 622 hz of the shorter call).

The release call (Fig. 2) consists of a single note with one pulse. The call lasts .03 seconds and is repeatedly emitted at a rate of 3.9 times per second.

There are clear harmonics, and the dominant frequency ($\bar{X}=789\pm12$ hz) is somewhat higher than in the shorter mating call, and is almost similar to that of the longer mating call.

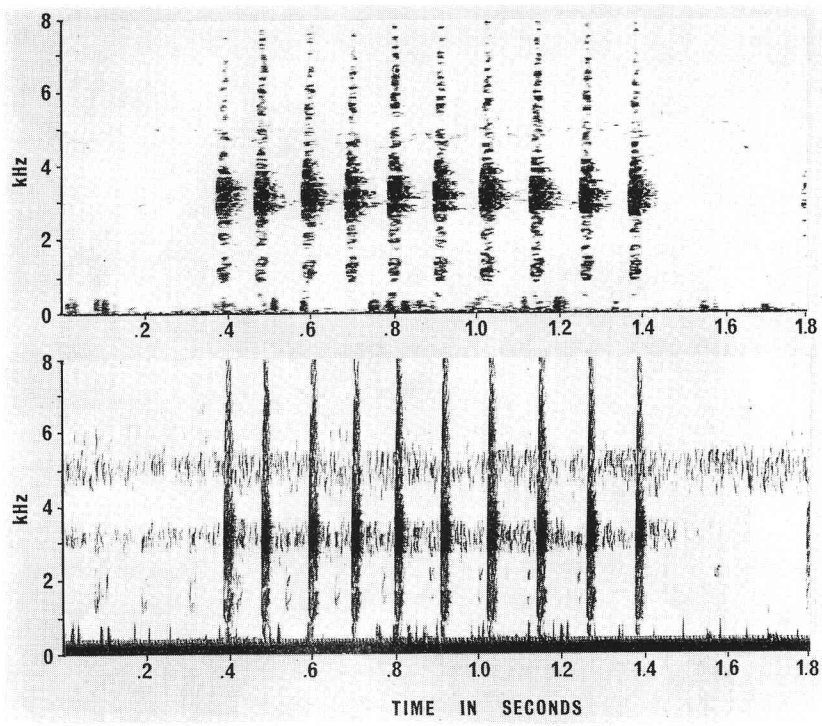
The shorter duration in the release call than in the mating call in *Bufo juxtasper* is in agreement with the results obtained for the North American *Bufo woodhousei*, *B. americanus*, *B. hemiophrys* and *B. terrestris* by Brown and Littlejohn (1972). Further, *B. juxtasper* resembles *B. woodhousei* in that the

dominant frequency in the release call is higher than in the shorter mating call. The dominant frequency of the longer mating call, however, is almost similar to that of the release call, and in this respect, *B. juxtasper* resembles North American species of *Bufo* other than *B. woodhousei*.

No evident pulses are found in the release call of *B. juxtasper*, and the pulse rate, 3.9 per second, equals to the note or call rate. The shorter mating call is not a trill, and hence, to calculate a pulse rate leaves some problems, but by multiplying call rate with notes per call, average pulse rate, 29.3 per second, is obtained. The longer mating call has the pulse rate 115.6, and in both types of the mating call, the pulse rates are higher than in the release call. This result well agrees with that obtained for *B. woodhousei* by Brown and Littlejohn (op. cit.).

Rana erythraea

Six calls from six males were analyzed. The call lasts .66−1.15 ($\bar{X}$ = .95± .01) seconds. A call consists of regularly repeated six to 11 notes ($\bar{X}$ = 9.2±.8), each of which lasts .02−.03 ($\bar{X}$ = .027±.002) seconds and consists of a number of fine pulses (Fig. 3).



Fig, 3, A mating call of *Rana erythraea*, analyzed with narrow (top) and wide (bottom) band filters.

Harmonics are not clear and the dominant frequency is spread over the wide ranges from 2500−3700 (Midpoint =3050±47) hz. The second dominant equals the fundamental frequency and ranges from 900−1800 (Midpoint =1339±22) hz.

Polypedates leucomystax

Seventeen calls from nine individuals were analyzed. The main call lasts .11− .16 ($\bar{X}$= .13± .055) seconds and consists of a single note. The note includes 11−16 ($\bar{X}$=12.8± .5) clear pulses.

Harmonics are recognized and each of them tends to rise towards the end of the note (Fig. 4). The dominant frequency equals the fundamental, and ranges from 1400−3200 (Midpoint at the end of the note =2488±67) hz. The second and the third dominant frequency bands are recognized at the frequency ranges from 4600−5800 (Midpoint =5323±97) hz and from 7000 to over 8000 hz, respectively.

Of the nine main calls analyzed, six were followed by after calls. The after call of the two main calls consisted of short and long notes, and the

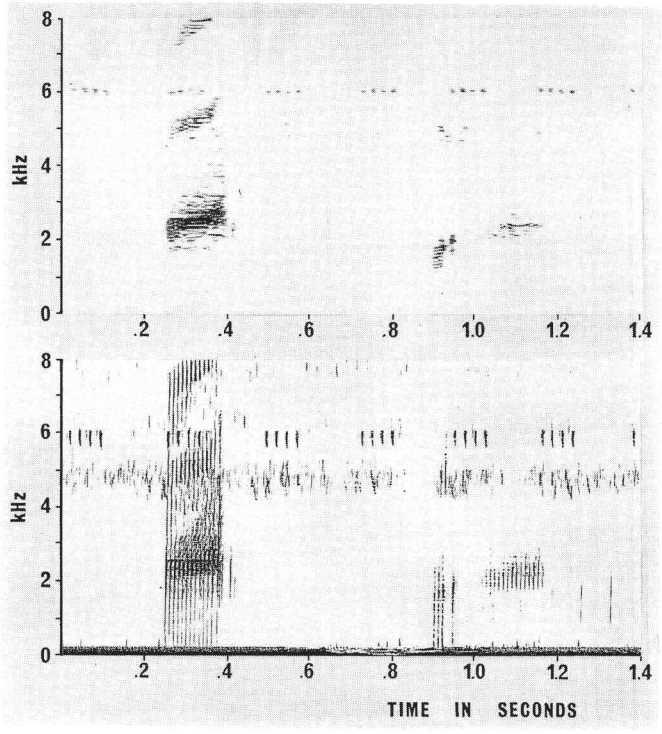


Fig. 4. A mating call group of *Polypedates leucomystax*, analyzed with narrow (top) and wide (bottom) band filters, showing the succession of a main call and two after calls. The background noises at about 5000 and 6000 hz are cricket calls.

other four main calls had either of these two notes. When the after call included two notes, the shorter proceeded the longer one.

The shorter after note lasts .02—.06 ($\bar{X}$=.04±.01) seconds and consists of three to four ($\bar{X}$=3.8+.3) pulses. Harmonics are absent and the dominant frequency is lower (900—2200, $\bar{X}$=1736±142 hz) than in the main call.

The longer note lasts .11— .15 ($\bar{X}$= .14± .01) seconds and consists of 9—15 ($\bar{X}$=13.0±1.4) pulses. As in the shorter note, no harmonics are recognized. The dominant frequency, however, is in slightly higher range (1000—2500, $\bar{X}$=2046±105 hz) than in the shorter. In both types, the dominant frequency is low at the beginning and rises at the end of the note, the same tendency found in the main call.

The above results on the population from Sabah fairly differ from those reported by Heyer (1971) on the Thailand population of the same species. According to that author, the Thailand *leucomystax* has a call group including two different call types.

The type A call in Heyer seems to correspond to the main call of the Sabah population, but radically differs from the latter in about twice longer call duration (.23— .38 seconds) and in about one-third smaller number of pulses (4—5 pulses). The dominant frequency in the type A call is slightly lower than in the main call presented here. The lack of harmonics in the type A call is also conspicuous.

The type B call in the Thailand population seems to correspond to the after calls of the Sabah population. The call duration is similar to the long after note, whereas the pulse number (2—4) is near short after note (3.8). The absence of harmonics in the type B call is the same condition with the Bornean after calls. Unfortunately, Heyer (op. cit.) failed to record the temperatures, and therefore, the precise comparisons are not possible.

Dubois (1976) diagrammatically presented the call characteristics of the Nepalese *leucomystax*. The calls differ from one individual to another in the Nepalese sample, but the duration (.11— .24 seconds calculated from the figure) and the dominant frequency (600—1700 or 1600—2500 hz) are within the range that described by Heyer (1971) for the Thailand population. Some of the Nepalese samples, however, possess harmonics. Since Dubois (op. cit.) did not give data for pulse number or temperature, direct comparisons with the present results are impossible.

Polypedates leucomystax is wide spread from China through Southeast Asia to Nepal, and includes a number of taxonomic problems (Liu and Hu 1961, Taylor 1962, Inger 1966). The analyses of call characteristics will throw light in classifying this morphologically variable species. The present comparisons of North Bornean population with the Thailand and Nepalese populations are not sufficient, but seem to suggest the presence of some genetic differentiation among the populations in the call characteristics.

Table 1. Comparison of characterstics of calls of three anuran species from Sabah.

	N. of calls	Call Duration (sec)	Notes/ call	Note Duration (sec)	Pulses/ note)	Dom. freq. (hz)	2nd dom. freq. (hz)
Bufo juxtasper							
mating call (short)	39	.12	3.1	.03	4.2	622	2022
(long)	1	1.51	2	.04, 1.13	6, 130	814	(1473)
release call	8	.03	1	.03	1	789	1640
Rana erythraea							
mating call	6	.95	9.2	.03	?	3050	1339
Polypedats leucomystax							
main call	9	.13	1	.13	12.8	2488	4600
after call (short)	4	.05	1	.05	3.8	1736	—
(long)	4	.14	1	.14	13.0	2046	—

The calls of the three species described above were heard in the same season within a narrow range, but the call characteristics were quite different from each other (Table 1), and suggested the presence of valid premating isolating mechanisms among the species.

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