

Mating Call Structures of the Chinese Frog, *Rana nigromaculata* (Amphibia, Anura, Ranidae)

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Abstract. -Mating calls of the Chinese Pond Frog, *Rana nigromaculata* at three localities were recorded and compared. The calls of *R. nigromaculata* are short in duration and consist of a few notes. Each note has several distinct pulses. The call structures of northern and central China are different from those of Sichuan, hence we tentatively regard them as different subspecies.

Key words: Amphibia, Anura, Ranidae, *Rana nigromaculata*, mating calls.

Introduction

Rana nigromaculata occurs widely in the lower Amur and Ussuri river valleys (USSR), Korea, Japan, and throughout northeastern and midwestern China. In China it occurs in all but Xinjiang, Tibet and Guangxi autonomous regions, and Yunnan, Taiwan, and Hainan provinces. As far as we know, no paper has been published in China analyzing the mating calls of Chinese anurans.

The mating call of frogs is a useful clue in revealing systematic and evolutionary relationships. Vocalizations are species-specific in anurans, and serve as isolating mechanisms. Therefore, some taxonomic revisions have been based primarily on call differences [see Kuramoto (1977) for review].

Methods

Calls of *Rana nigromaculata* were recorded in 1988 at three localities. Several calls of a single male were recorded on 19 March, in the suburbs of Hongya County, about 100 km southwest of Chengdu, Sichuan Province. The frog was calling from a stone near water. The water temperature was 19°C.

A number of calls from three males were recorded at East Lake Park, Wuchang, Wuhan, Hubei Province on 17 June. The frogs called while standing in shallow water shaded by grass. The water

temperature was 22°C.

The calls of 10 males were recorded at Wofoshi, Xiangshan Park, Beijing, on 28 May. Male frogs were found calling in surroundings similar to those of frogs in Hubei Province. The water temperature was 24°C.

Temperature records were always taken in the vicinity of calling males. Calls were recorded with a Sony TCS-370 cassette recorder and a Feidex TSM-91 microphone. Sonograms were prepared with Kay 7800 and Kay 7900 sonographs. For the analysis of mating calls, standard (2.56 sec) sonograms with a 150 Hz bandwidth filter were used.

When a call was composed of several groups of pulses, each group was termed a note. The main acoustic parameters measured were: duration of call, number of notes and pulses, pulse repetition rate (number of pulses per second), fundamental frequency, and dominant frequency.

Results and Discussion

The vocalizations of *Rana nigromaculata* consist of 4-10 notes, and each note has 3-7 distinct pulses. The higher frequency parts (above 2 kHz) are usually absent in the first few notes (1-3). Time intervals between pulses tend to become longer at the end of the call. In all localities, the frog's frequency band ranges from 0 to 8 kHz.

TABLE 1. Analysis of the calls of *Rana nigromaculata*. The dominant frequency and pulse repetition rate of *R. nigromaculata* from Hongya, Sichuan are about half of those recorded at the other localities. Note the divergence of the Sichuan call structure from northern (Beijing) and central (Wuhan) China.

Number of Notes	Call Duration	Pulse Repetition Rate	Number of Calls	Fundamental Frequency	Dominant Frequency
Beijing					
10	668.6	89.7	1	0.53±0.02	2.39±0.20
9	529.9±77.1	84.7±10.8	3		
8	450.5±26.4	80.6±27.4	12		
7	396.4±21.0	109.8±44.0	7		
6	344.7±33.1	104.7±22.1	6		
5	324.2±17.9	84.5±26.2	3		
4	255.0±35.8	43.2±11.2	5		
1	50.8±12.1	154.8±45.9	5		
Wuhan					
8	467.3	69.3	1	0.51±0.09	2.32±0.17
7	452.6	86.2	1		
6	426.6±53.6	77.7±8.7	3		
5	319.7	90.7	1		
1	50.8±17.5	120.8±34.1	10		
Hongya					
5	637.6±66.9	45.4±7.7	7	0.47±0.06	1.42±0.10
4	576.5±57.0	49.8±5.5	7		
1	79.9±13.1	125.4±2.1	2		

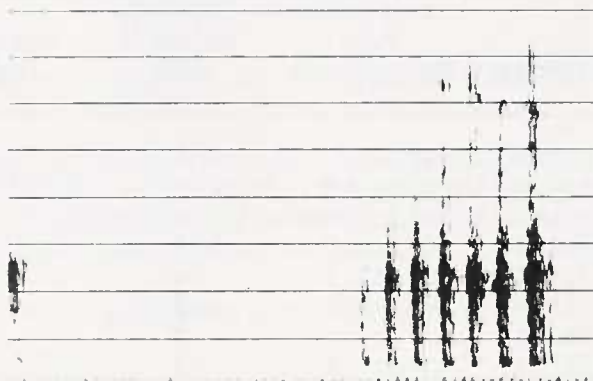
Their fundamental frequencies are approximately identical (0.5 kHz). Since fundamental frequencies are dependent on the oscillations resulting from air passing over the vocal cord, causing it to vibrate at a frequency which is a function of the mass and tension of the cord (Duellman and Trueb 1986), it is likely that the frogs have a common vocal structure.

As well as multi-note calls, *Rana nigromaculata* has a single-note call. Frogs in northern and central China (Beijing and Wuhan) emit this sound repeatedly and usually in groups. Each group is composed of 5-10 single-note calls. In Hongya, the single-note call could rarely be heard. Because *R. nigromaculata* in Sichuan is peripheral in distribution, we believe that the call structure in northern and central China represent the basic structure, and that the Sichuan structure was derived from it.

the divergence of call structure between northern and central China, and Sichuan. In comparing the three main acoustic parameters, call duration, pulse repetition rate, and mean dominant frequency, a general pattern is evident (Zweifel 1959). Pulse repetition rate and dominant frequency correlate positively with temperature, but duration of call correlates negatively with temperature. However, we feel that this is not sufficient to explain the differences between the populations. At a temperature only 3 and 5°C lower than in Wuhan and Beijing, respectively, the dominant frequency and pulse repetition rate of Sichuan *Rana nigromaculata* are about half of those found in the former localities. The length of calls of Sichuan frogs is approximately equal to the maximum call length of frogs from the Wuhan and Beijing localities, and their vocal sacs are of the same size. In addition, they have very similar fundamental frequencies. We conclude that they have nearly identical sound-producing

Table 1 and Figure 1 clearly demonstrate

TYPE B/65 SONAGRAM • KAY

a

TYPE B/65 SONAGRAM • KAY ELEMETRICS CO PINE BROOK, N.J.

b

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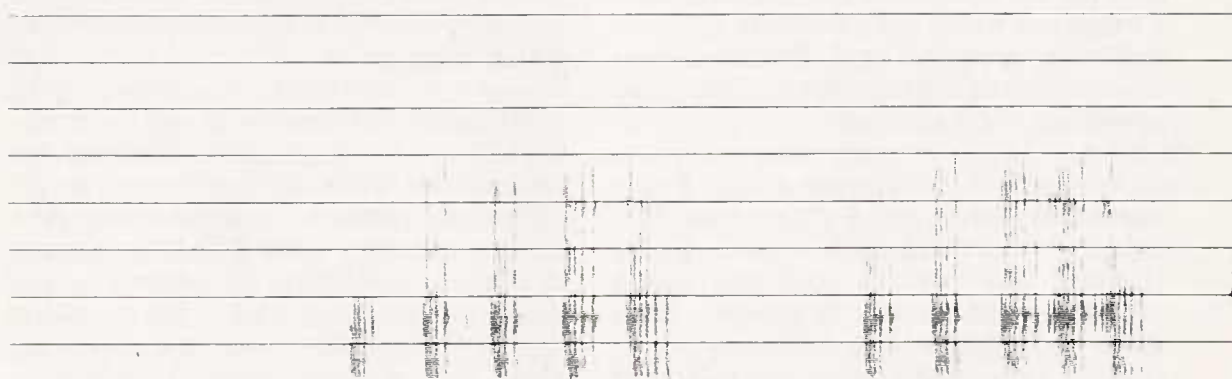
c

FIG. 1. Sonagrams of the calls of *Rana nigromaculata* in China. a. Seven note call from Beijing on May 27, 1988. The water temperature was 24°C. b. One 6 note call and two 1 note calls from Wuchang, Hubei Province, June 17, 1988. The water temperature was 22°C. c. Two 5 note calls from Hongya, Sichuan Province, March 19, 1988. The water temperature was 19°C.

structures, but different controlling mechanisms.

In acknowledging that our analysis of frog calls may not be exhaustive, we can only tentatively suggest that the Sichuan population of *Rana nigromaculata* is a separate subspecies from the Wuhan and Beijing populations.

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