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STRUCTURE AND VARIABILITY OF THE CALLS OF POLYPEDATES LEUCOMYSTAX (AMPHIBIA: RHACOPHORIDAE) FROM NEGROS, PHILIPPINES

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Polypedates l. leucomystax Boie on the island of Negros calls daily during the rainy season, beginning at twilight. Three calls can be distinguished. Typical mating calls have an average duration of 190 ms and are composed of 16 pulses. Short calls differ from these not only in being more brief but also in having fewer pulses and a lower frequency range. The third call is characterized by a considerably lower pulse repetition rate. These data are compared with published descriptions of the calls of P. leucomystax in two other habitats. The mating calls of the Philippine population resemble those of a population in northern Borneo despite significant differences in certain call parameters, but exhibit considerable discrepancies from those of a population in Thailand.

Polypedates leucomystax is one of the most widely distributed anuran species in Southeast Asia and parts of China. It is primarily an arboreal frog, but one with strong euryoecious tendencies, for it is also commonly found in low vegetation or on the ground. Some details of its reproductive behavior and ontogeny have been published by Alcala and Brown (1956).

In the Philippine region, Polypedates leucomystax inhabits nearly all the islands. Inger (1954), writing before the species was removed from the genus Rhacoporus by Liem (1970), distinguished two subspecies here: Rhacophorus leucomystax linki on Palawan and the Sulu Archipelago, and R. l. quadrilineatus on the islands further to the east, including Negros. In a later revision (1966) he raised the former to the rank of a separate species, R. macrotis, and renamed the eastern subspecies R. leucomystax leucomystax.

In this study, the calls of one population on the island of Negros are analyzed and the results are compared with published data from two other habitats.

MATERIALS AND METHODS

The calls were recorded in the field from 19 to 21 Septe 1983, 2000 to 2300 h. The habitat was a pond with an area about 20 m^2 on the experimental grounds of the College Agriculture, Silliman University, Dumaguete City. This po densely overgrown with bushes, was occupied during the record sessions by 10 - 15 calling P. leucomystax males. The anim sat 5 - 30 cm above the water surface, maintaining an indivi distance of at least 50 cm. The habitat was also occupied by few Rana erythraea during this time.

A condenser microphone (Sennheiser K3/ME80) and a U Report 4200 tape recorder were used to record the calls. The temperature at the time of recording was 28 - 30 °C. recordings were analyzed by means of a sonagraph (Kay Elect 7029A) and an oscilloscope and frequency analyzer (Nicolet UA A). The sonagrams presented here were obtained with wide-b filtering (effective filter width 150 Hz) to improve tempo resolution. A total of 488 calls, produced by 17 males, w evaluated. Nine of the animals were caught and measured af the recordings had been made, and two of these were preserved are kept in the Zoologisches Forschungsinstitut and Mus Alexander Koenig, Adenauerallee 150, 5300 Bonn, Federal Repub of Germany.

RESULTS

During the rainy season Polypedates leucomystax calls da usually beginning at the onset of twilight. Occasionally frogs also call during the daytime. Three calls are clea distinguishable, even to the unaided ear.

Mating call.

The frogs produce this call very persistently during activity period. The intervals between successive calls usually relatively long, with a distribution ranging from 1.6 70 s and peaking between 7.5 and 10 s (Fig. 1). Therefore, was very rare for the calls of different individuals in a gr of this size to overlap with one another. A mating call la 145 - 240 ms and consists of 10 - 22 similarly-shaped pul (Fig. 2). The mean pulse repetition rate, defined as the num of periods in the call divided by the time from the beginning the first pulse to the beginning of the last, is 49 - 95 pulse (Figs. 5 - 7). In about two-thirds of the calls the pulses oc at very uniform intervals. The timing of the pulses in the ot calls is irregular, with many intervals of the characteris duration but some that are considerably longer (Fig. 2). Stat

tests showed these calls to be significantly longer than with a regular pulse pattern, though they comprised fewer per call (Table 1). The temporal parameters of the calls

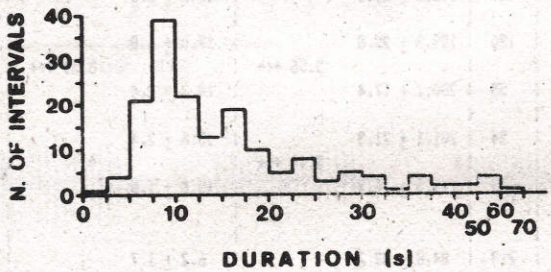


Fig. 1. Distribution of the intervals between the mating calls.

depend on body size; the calls of small frogs (≤43 mm snout-vent length) are significantly shorter than those of larger animals (≥48 mm). Because the two groups had the same average number of pulses per call, the small animals have a significantly higher pulse repetition rate (Table 1).

The individual pulses are usually simple in structure, with a sharp rise in amplitude and a logarithmic decay. Irregularly scattered through the pulse train are a few pulses with 2 - 4 amplitude maxima (Fig. 2a1); these are longer on average than the single-peaked pulses, 6 - 10 ms as compared with 4 - 7 ms. The frequency spectrum of the mating call is always broad, beginning at 1200 - 1800 Hz and reaching 2500 - 4000Hz. The spectrum of a given individual is quite constant but there are interindividual differences, such that larger animals call in a lower frequency range. Regression analysis showed that the peak of the frequency distribution shifts to lower frequencies as an approximately linear function of body size, by ca. 85 Hz per mm increase in snout-vent length (Fig. 8).

Short call.

Short calls last 20 - 180 ms and are composed of 2 - 12 pulses (Figs. 2, 5, 6). As in the mating call, the pulses may be either regularly or irregularly timed. Short calls with an irregular pattern on average comprise more pulses and last longer than

Table 1. The results of the statistical calculations.

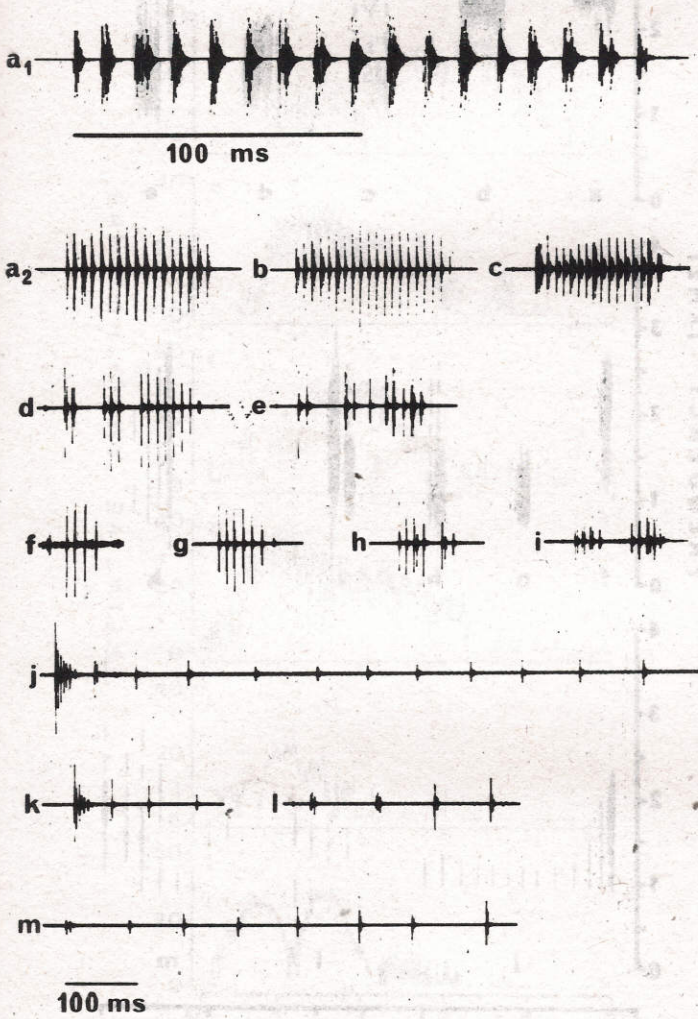
CALL TYPE		N	DURATION $\bar{x} \pm S$, (M)	t or z	NUMBER OF PULSES $\bar{x} \pm S$, (M)	t or z	PULSES PER SECOND $\bar{x} \pm S$	t
Mating call	all	185	192.7 ± 20.5		16.2 ± 2.3		81.4 ± 10.6	
	reg.	130	189.3 ± 28.8	3.56 +++	17.0 ± 1.8	8.50 +++	87.0 ± 3.9	18.8
	irr.	55	200.7 ± 17.4		14.3 ± 2.4		68.2 ± 9.7	
	big	54	201.1 ± 21.9	5.49 +++	15.6 ± 2.4	0.47	74.0 ± 13.5	4.9
	small	45	179.3 ± 16.2		15.8 ± 1.6		85.2 ± 7.9	
Short call	all	219	84.8 ± 33.2		6.2 ± 1.7		69.5 ± 15.2	
	reg.	94	57.5 ± 19.4	15.0 +++	5.4 ± 1.6	6.63 +++	84.1 ± 8.1	22.7
	irr.	125	105.3 ± 26.0		6.8 ± 1.5		58.5 ± 8.5	
Slow rattle call	all	84	(295)		(4 - 5)		13.6 ± 2.9	
	type 1	37	(200)	2.43 +	(4)	1.32	15.0 ± 2.7	4.5
	type 2	47	(340)		(6)		12.4 ± 2.7	

$\bar{x}$, arithmetic mean value; S, standard deviation; M, median; reg., calls with regular pulse pattern; irr., calls with irregular pulse pattern; big, calls of animals ≥48 mm; small, calls of animals ≤ 43 mm; comparison of means by t test: t value, comparison of medians by Wilcoxon-Mann-Whitney U test: z value; levels of significance: $P < 0.05$ +, $P < 0.01$ ++, $P < 0.001$ +++.

those with uniform intervals. The pulse repetition rates in two types of short call also differ statistically, in a relationship very similar to that between the corresponding types mating call (Fig. 7a, b,; Table 1).

The frequency spectrum is broad-band, like that of mating calls, but shifted downward, extending from 500 Hz lower to at most 3000 Hz (Figs. 3, 4). The position of the p in the frequency spectrum is related to the number of pulses the call; regression analysis revealed a positive, lin correlation between these two parameters. Again, the freque is also affected by the animal's size. Separate evaluation the calls of large (≥48 mm) and small (≤43 mm) frogs produ two, approximately parallel regression lines (Fig. 9).

that a call with a given number of pulses produced by a animal will have a frequency higher by about 300 Hz than it is produced by a large animal.



2. Oscillograms of mating calls with regular (a - c) and ular (d - e) pulse patterns, of short calls with regular (f, and irregular (h, i) pulse patterns and of slow rattle calls ype 1 (j, k) and Type 2 (1, m). In a_1 and a_2 the same call is shown on different time scales.

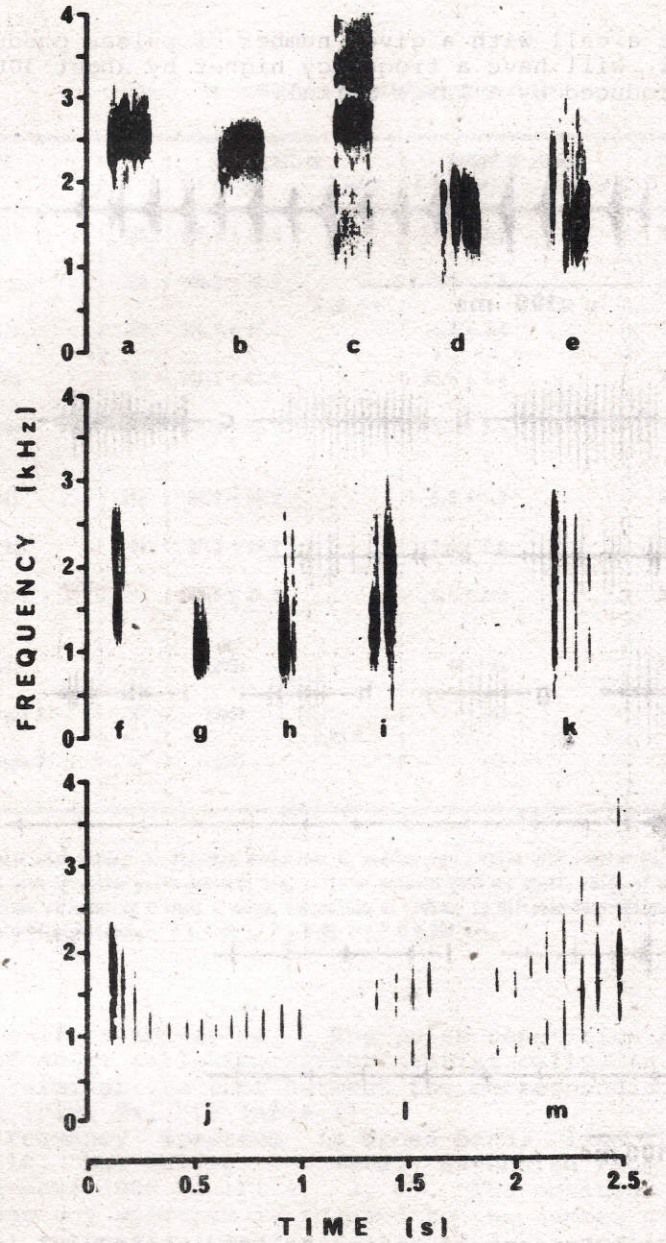


Fig. 3. Sonagrams of mating calls (a - e), short calls (f - and slow rattle calls (j - m); the calls analyzed here identical to those in Fig. 2.

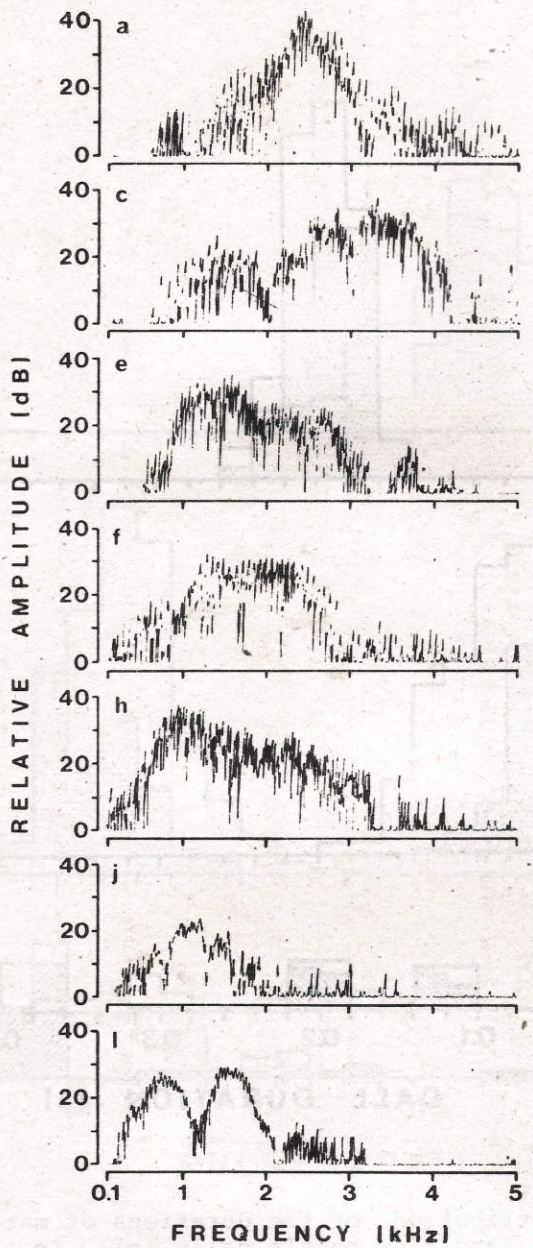


Fig. 4. Frequency spectograms of mating calls (a,c,e), short calls (f,h) and slow rattle calls (j,l); the calls analyzed here are identical to those in Figs. 2 and 3.

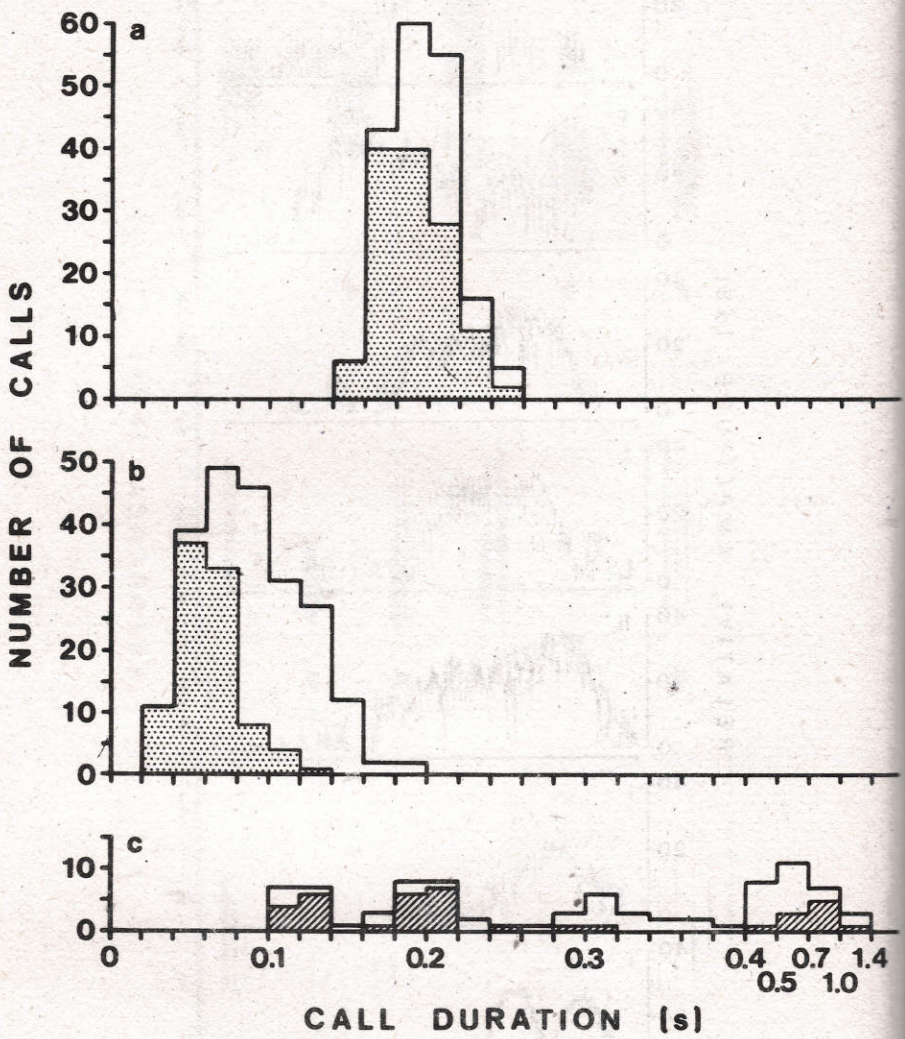


Fig. 5. Distribution of the durations of mating calls short calls (b) and slow rattle calls (c). In a and b stippled area represents calls with regular pulse patterns the remaining area, calls with irregular patterns; in c hatched area represents slow rattle calls of Type 1 and remainder, calls of Type 2.

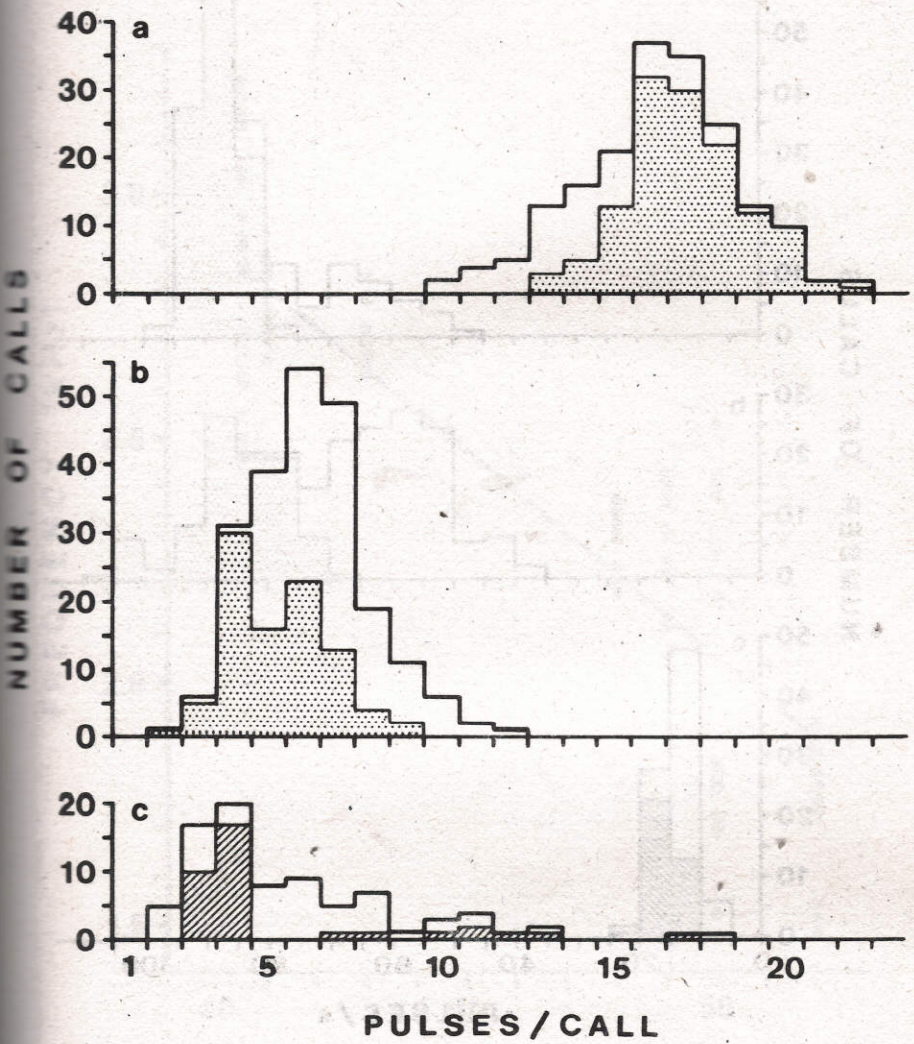


Fig. 6. Distribution of the number of pulses per call in calls (a), short calls (b) and slow rattle calls (c); shading as in Fig. 5.

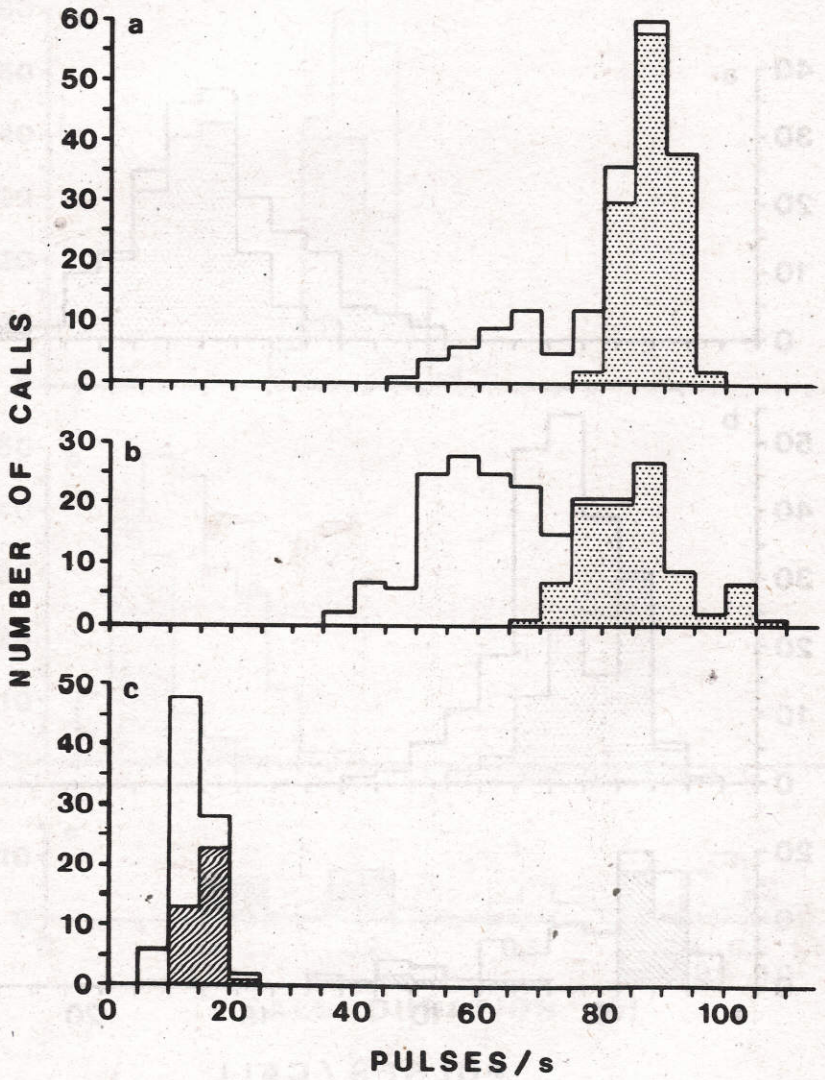


Fig. 7. Distribution of pulse repetition rates in mating calls (a), short calls (b) and slow rattle calls (c); shading as in Fig. 5.

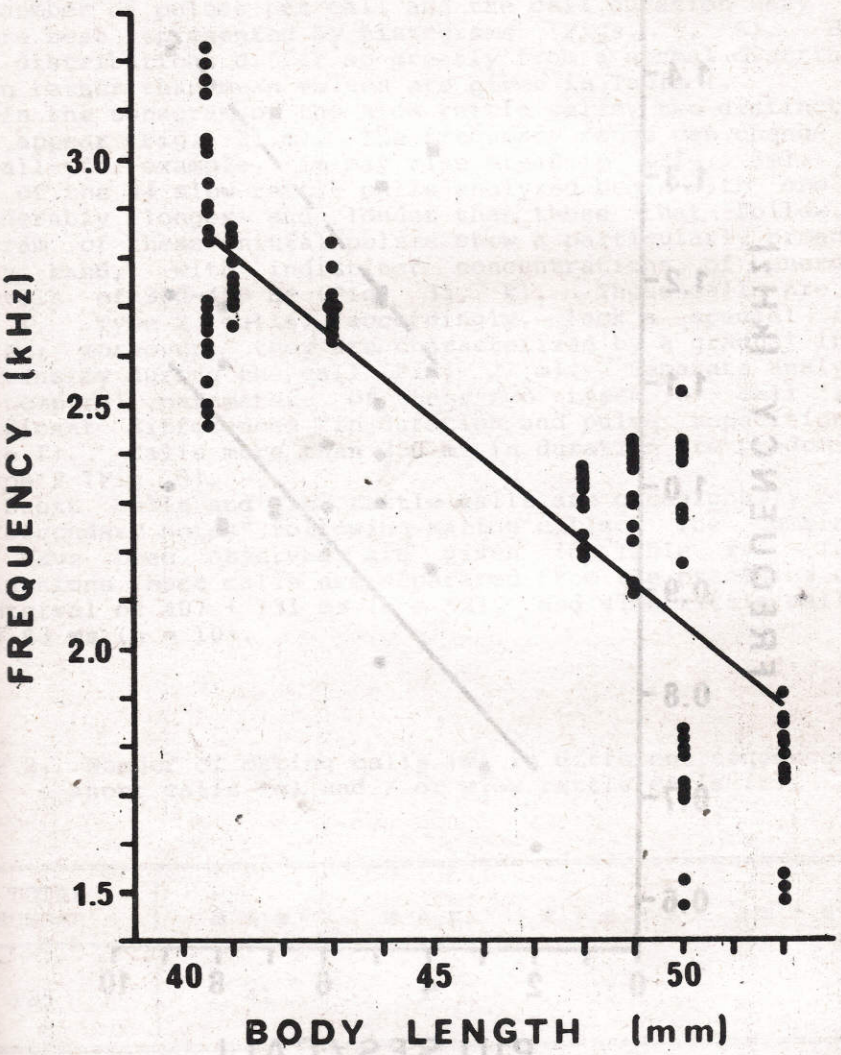


Fig. 8. Dominant frequency of the mating calls as a function of body size; 10 - 12 calls of each of 9 animals are represented. The equation for the regression lines is y = 6294-84.9x; r=0.86.