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VARIABILITY OF ADVERTISEMENT CALLS AND RELEASE CALLS OF GREEN FROGS IN THE MOSCOW OBLAST', RUSSIA

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Keywords: green frog, release calls, advertisement calls.

INTRODUCTION

Research on anuran bioacoustics has been intensively carried out during last 25 years. In the course of this period, a considerable amount of data was accumulated on qualitive as well as quantitative call parameters of many frog species. Frog calls seem to be largely species-specific, allowing for their use in regional faunistical explorations. New species and subspecies of frogs have been described based on their bioacoustic differentiation (Schneider and Sofianidou, 1985).

Comparative studies of acoustic signals in the amphibia are made difficult by the fact that the calls of these poikilothermic animals depend on environmental parameters. Dependence of call variables on temperature is known and, in general, is well-studied for many groups (Radwan and Schneider, 1988; Schneider et al., 1988), but other variables, such as body size and sex of the animal, or weather, level of motivation, season and interspecific hybridization also can play important roles (Green, 1982; Malmos et al., 2001). For example, influence of body size on various parameters of advertisement calls was revealed for the genera *Rana*, *Bombina*, *Alytes*, and *Bufo* (Egiasarian and Schneider, 1990; Nevo and Schneider, 1983).

The aim of the present work was an attempt to contribute to the understanding of the influence of temperature, body size and sex on different call types for two frog species: *Rana ridibunda* Pall. and *R. lessonae* Cam.

MATERIAL AND METHODS

Material was collected in July 1988 from ponds around the Zvenigorod biological station [Faculty of Biology, Moscow State University (MSU), Odintsovo raion, Moscow Oblast', Russia]. Calls of adult sexual mature animals were recorded in chorus and individually. In addition we captured 21 individuals of *R. ridibunda* and 40 individuals of *R. lessonae* of different sexes and size categories for which we recorded release calls (at water temperatures ranging between 6 to 22°C). Recording of signals were made with a dictaphone Forward LF-182A HONGMAN or a tape recorder Panasonic RX-M50, at a tape speed of 9.25 cm/sec and at a distance of about 40 cm from animal. Comparison and analysis of sound signals of frogs were made at PC employing "Avisoft-SASLabPro" software.

The studied animals were divided into the size classes "small" and "large." Snout-vent lengths of these categories were as follows: *R. ridibunda*: 84.0 – 93.0 and 74.1 – 76.6 mm for "large" and "small" males, respectively, and 120.0 – 150.2 and 75.0 – 80.0 for "large" and "small" females, respectively; *R. lessonae*: 58.7 – 60.7 and 54.3 – 55.0 mm for "large" and "small" males, respectively, and 62.1 – 67.0 and 58.1 – 61.6 mm for "large" and "small" females, respectively.

RESULTS AND DISCUSSION

Advertisment calls. With increasing temperature, the main parameters of the advertisement calls of both species change as follows, based on our analysis of recordings from frog choruses: intercall interval and call duration decrease (due to a decrease in the duration of intervals between single pulses); single pulse duration decreases, the number of pulses per call increases (Tables 1 and 2, Figs. 1 and 2). Some increase in energy maxima of the dominant frequencies is observed in *Rana ridibunda* calls, except the third frequencies maximum. Oppositely, *Rana lessonae* demonstrates the decrease of frequencies maximum values with the increase of temperature.

Release calls. Data on release calls (analysis of individual recordings) were analyzed separately for eight groups in *R. ridibunda*, depending on sex, size and temperature (Table 4). Data for *R. lessonae* were divided only into four groups, depending on sex and body size and refer all to a temperature of ~16°C (Table 3).

The increase of temperature induces the release call of *Rana lessonae* (we compared frogs equal in sex and of the same size) a decrease in call duration in all groups, except

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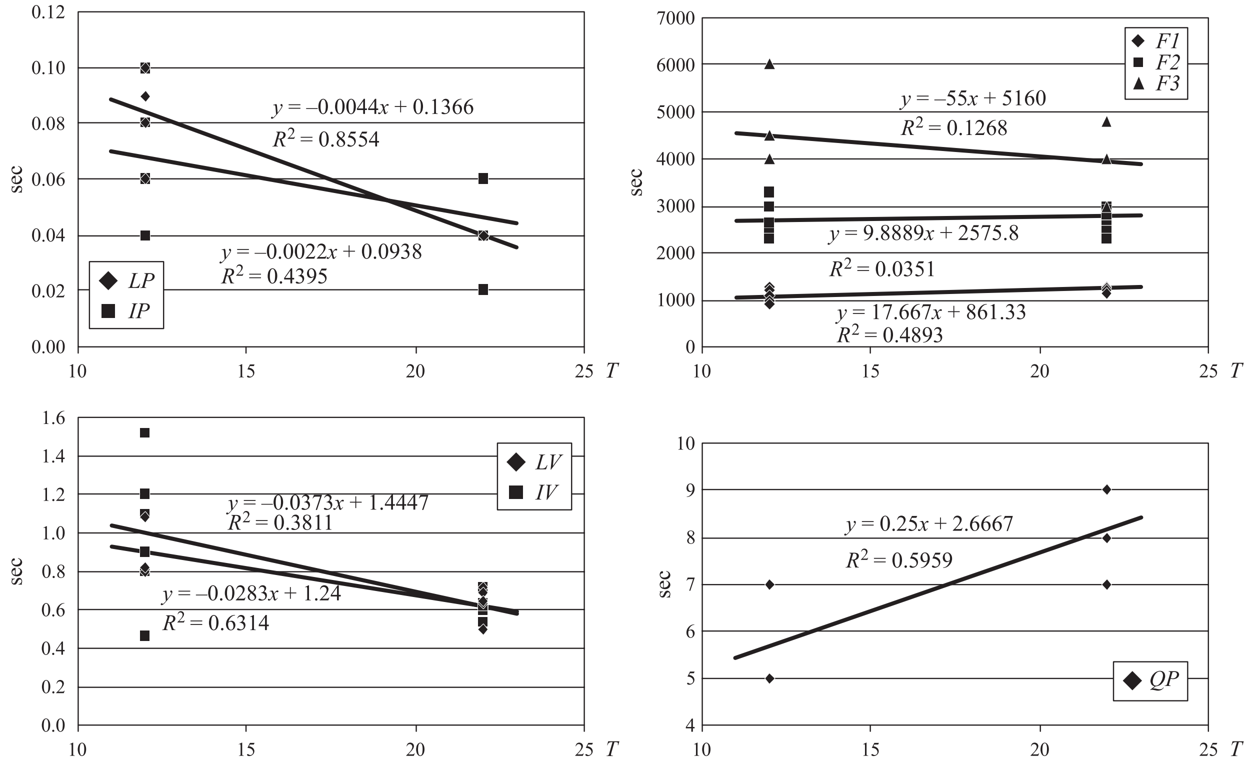

Fig. 1. Advertisement call of *R. ridibunda*. The influence of temperature on the components of call. *R*, coefficient of approximation. For other abbreviations, see Table 1.

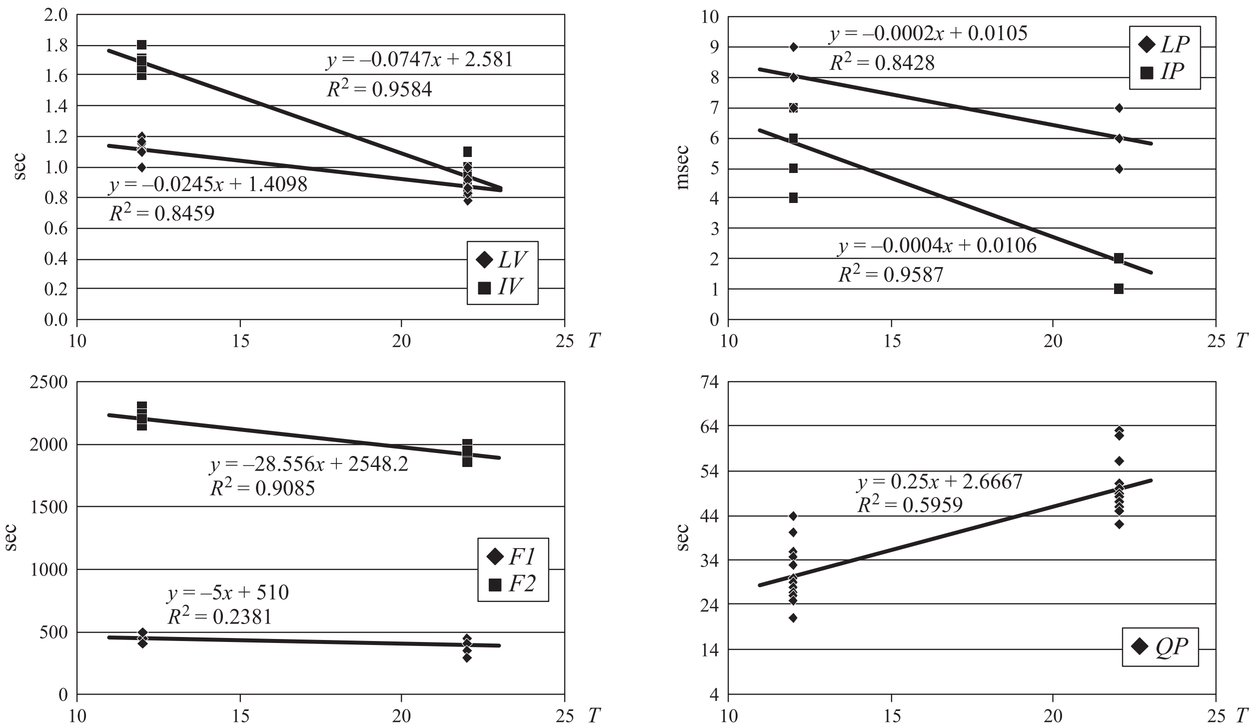

Fig. 2. Advertisement call of *R. lessonae*. The influence of temperature on the components of call. *R*, coefficient of approximation. For abbreviations, see Fig. 1 and Table 1.

TABLE 1. Main Parameters of Advertisement Call of *R. ridibunda*

T	*LV*		*IV*		*LP*		*IP*		*QP*		*F1*		*F2*		*F3*	
	20 – 24	12	20 – 24	12	20 – 24	12	20 – 24	12	20 – 24	12	20 – 24	12	20 – 24	12	20 – 24	12
M	0.617	0.900	0.623	0.997	0.040	0.084	0.046	0.068	8.167	5.667	1250	1073	2793	2619	3950	4500
S_x^2	0.009	0.024	0.003	0.132	0.000	0.000	0.000	0.000	0.967	0.952	2500.000	14952.381	46380.952	107777.778	543333.333	750000.000
S_x	0.095	0.156	0.059	0.364	0.000	0.013	0.011	0.014	0.983	0.976	50.000	122.280	215.362	328.295	737.111	866.025
S_d	0.039	0.090	0.024	0.149	0.000	0.003	0.002	0.003	0.401	0.252	12.910	31.573	55.606	109.432	368.556	387.298
$M \pm tS_x$, $P = 0.95$	0.002	0.006	0.001	0.009	0.000	0.000	0.000	0.000	0.025	0.016	0.810	1.980	3.487	6.862	23.111	24.286
F-test	2.715 ($P > 0.05$)		38.634 ($P < 0.01$)		3918.182 ($P < 0.01$)		1.559 ($P > 0.05$)		1.015 ($P > 0.05$)		5.981 ($P < 0.01$)		2.324 ($P > 0.05$)		1.380 ($P > 0.05$)	
t-test	1.731 ($P > 0.05$)		2.481 ($P < 0.05$)		16.117 ($P < 0.001$)		0.548 ($P > 0.05$)		1.235 ($P > 0.05$)		5.179 ($P < 0.001$)		0.281 ($P > 0.05$)		0.454 ($P > 0.05$)	

LV, length of call; *IV*, interval between calls; *LP*, length of pulse; *IP*, interval between pulses; *QP*, quantity of pulses per call; *F1*, *F2*, *F3*, first, second and, third frequency maximum, respectively; *T*, temperature; *M*, mean values; S_x^2, variance; S_x, standard deviation; $M \pm tS_x$, confidence interval; *P*, level of significance.

TABLE 2. Main Parameters of Advertisement Call of *R. lessonae*

T	*LV*		*IV*		*LP*		*IP*		*QP*		*F1*		*F2*	
	20	12	20	12	20	12	20	12	20	12	20	12	20	12
M	0.870	1.116	0.961	1.697	0.006	0.008	0.002	0.006	50.000	30.400	400	450	1907	2200
S_x^2	0.002	0.003	0.006	0.003	0.000000	0.000000	0.00000	0.000000	35.571	37.543	2500.000	1785.714	2071.429	2152.778
S_x	0.050	0.059	0.077	0.052	0.000	0.001	0.000	0.001	5.964	6.127	50.000	42.258	45.513	46.398
S_d	0.014	0.016	0.021	0.015	0.000	0.000	0.000	0.000	1.540	1.582	12.910	10.911	11.751	15.466
$M \pm tS_x$, $P = 0.95$	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.097	0.099	0.810	0.684	0.737	0.970
F-test	1.410 ($P > 0.05$)		2.177 ($P > 0.05$)		3.4787.817 ($P < 0.01$)		7.817 ($P < 0.01$)		1.055 ($P > 0.05$)		1.400 ($P > 0.05$)		1.039 ($P > 0.05$)	
t-test	11.476 ($P < 0.001$)		19.189 ($P < 0.001$)		15.3597.817 ($P < 0.001$)		2.978 ($P < 0.01$)		8.878 ($P < 0.001$)		2.958 ($P < 0.05$)		2.627 ($P < 0.05$)	

For abbreviations, see Table 1.

TABLE 3. Main Parameters of Release Calls for *R. lessonae*

	LV				*IV*				*LP*				*IP*			
	lm	sm	lf	sf	lm	sm	lf	sf	lm	sm	lf	sf	lm	sm	lf	sf
M	0.595	0.329	0.496	0.480	–	0.301	0.356	0.475	0.008	0.018	0.009	0.008	0.039	0.036	0.020	0.033
S_x^2	0.004	0.005	0.037	0.015	–	0.025	0.003	0.014	0.000	0.001	0.000	0.000	0.001	0.001	0.000	0.001
S_x	0.000	0.062	0.188	0.109	–	0.159	0.057	0.098	0.003	0.029	0.009	0.002	0.022	0.023	0.019	0.038
S_d	0.013	0.014	0.038	0.024	–	0.031	0.029	0.060	0.000	0.002	0.001	0.000	0.002	0.002	0.001	0.004
$M \pm tS_x$, $P = 0.95$	0.000	0.001	0.002	0.001	–	0.002	0.002	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F-test, size	1.220 $P > 0.05$	2.431 $P < 0.05$			–	4.415 $P > 0.05$			89.389 $P < 0.01$	25.738 $P < 0.01$			1.086 $P > 0.05$	3.918 $P < 0.01$		
t-test, size	14.250 $P < 0.001$	0.370 $P > 0.05$			–	1.784 $P > 0.05$			4.687 $P < 0.001$	1.418 $P > 0.05$			0.015 $P > 0.05$	0.057 $P > 0.05$		
F-test, sex	9.110 $P < 0.01$	3.071 $P < 0.01$			–	0.574 $P > 0.05$			9.303 $P < 0.01$	247.302 $P < 0.01$			1.376 $P < 0.05$	0.381 $P > 0.05$		
t-test, sex	2.467 $P < 0.05$	5.411 $P < 0.001$			–	0.611 $P > 0.05$			0.175 $P > 0.05$	5.110 $P < 0.001$			0.115 $P > 0.05$	0.010 $P > 0.05$		

TABLE 3 (continued)

	QP				*F1*				*F2*				*F2*			
	lm	sm	lf	Sf	lm	sm	lf	sf	lm	sm	lf	sf	lm	sm	lf	sf
M	13.583	8.000	19.600	13.000	858	1042	1100	840	2231	2406	2113	1069	–	4550	–	–
S_x^2	2.601	14.609	78.114	29.029	6602.564	38623.188	76818.182	99888.889	70828.804	164850.543	388958.333	69959.239	–	2857.143	–	–
S_x	1.613	3.822	8.838	5.388	81.256	196.528	277.161	316.052	266.137	406.018	623.665	264.498	–	53.452	–	–
S_d	0.329	0.780	2.282	1.347	22.536	40.116	80.009	99.944	54.325	82.878	311.833	53.990	–	18.898	–	–
$M \pm tS_x$, $P = 0.95$	0.021	0.049	0.143	0.084	1.413	2.516	5.017	6.267	3.407	5.197	19.554	3.386	–	1.185	–	–
F-test, size	5.616 $P < 0.01$	2.691 $P < 0.05$			5.850 $P < 0.01$	1.300 $P > 0.05$			2.327 $P < 0.05$	5.560 $P < 0.01$			–	–	–	–
t-test, size	6.593 $P < 0.001$	0.324 $P > 0.05$			0.381 $P > 0.05$	0.433 $P > 0.05$			1.766 $P > 0.05$	1.725 $P > 0.05$			–	–	–	–
F-test, sex	30.027 $P < 0.01$	1.987 $P > 0.05$			11.635 $P < 0.01$	2.586 $P < 0.05$			5.492 $P < 0.01$	2.356 $P < 0.05$			–	–	–	–
t-test, sex	0.355 $P > 0.05$	0.353 $P > 0.05$			0.484 $P > 0.05$	0.321 $P > 0.05$			0.196 $P > 0.05$	13.522 $P < 0.001$			–	–	–	–

F-test and *t*-test values are cited for the estimation of level of significance of size influence on the call parameters (size), the sex of animals is equal; and sex influence (sex), the size of animals is equal. bm, "big" males; sm, "small" males; bf, "big" females; sf, "small" females. For other abbreviations see Table 1. Temperature was constant (16°C).

TABLE 4. Main Parameters of Release Calls for *R. ridibunda*e

	LV								*LGP*							
T	8 – 10				15				8 – 10				15			
	lm	sm	lf	Sf	lm	Sm	lf	sf	lm	sm	lf	sf	lm	sm	lf	sf
M	0.480	0.580	0.515	0.220	0.270	0.410	0.310	0.250	0.061	0.106	0.170	0.080	0.065	0.048	0.059	0.073
S_x^2	0.002	0.000	0.002	0.001	0.001	0.006	0.003	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000
S_x	0.027	0.011	0.045	0.025	0.025	0.064	0.041	0.030	0.017	0.015	0.018	0.012	0.011	0.012	0.019	0.017
S_d	0.008	0.003	0.010	0.005	0.005	0.015	0.011	0.006	0.003	0.004	0.007	0.003	0.002	0.002	0.004	0.003
$M \pm tS_x$, $P = 0.95$	0.000	0.000	0.001	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F-test, T	2.516 $P < 0.05$	24.359 $P < 0.01$	1.218 $P > 0.05$	1.643 $P > 0.05$					2.134 $P < 0.05$	2.984 $P < 0.01$	4.315 $P < 0.01$	0.687 $P > 0.05$				
t-test, T	21.295 $P < 0.001$	10.973 $P < 0.001$	14.279 $P < 0.001$	4.020 $P < 0.001$					1.041 $P > 0.05$	12.657 $P < 0.001$	13.435 $P < 0.001$	1.835 $P > 0.05$				
F-test, size	7.469 $P < 0.01$		4.419 $P < 0.01$		8.206 $P < 0.01$		3.276 $P < 0.01$		1.542 $P > 0.05$		8.630 $P < 0.01$		1.102 $P > 0.05$		0.727 $P > 0.05$	
t-test, size	11.143 $P < 0.001$		27.625 $P < 0.001$		8.793 $P < 0.001$		4.932 $P < 0.001$		8.852 $P < 0.001$		11.458 $P < 0.001$		5.348 $P < 0.001$		2.890 $P < 0.01$	
F-test, sex	1.329 $P > 0.05$	2.247 $P < 0.05$			4.072 $P < 0.01$	6.601 $P < 0.01$			5.438 $P < 0.01$	2.447 $P < 0.05$			2.689 $P < 0.01$	0.564 $P > 0.05$		
t-test, sex	2.701 $P < 0.01$	65.240 $P < 0.001$			3.366 $P < 0.01$	9.912 $P < 0.001$			13.444 $P < 0.001$	5.582 $P < 0.001$			1.461 $P > 0.05$	6.390 $P < 0.001$		

TABLE 4 (continued)

	QGP								*IGP*							
T	8 – 10				15				8 – 10				15			
	lm	sm	lf	sf	lm	Sm	lf	sf	lm	sm	lf	sf	lm	sm	lf	sf
M	3.500	3.000	2.500	2.000	1.500	5.000	3.500	2.654	0.046	0.010	0.037	0.060	0.628	0.036	0.037	0.036
S_x^2	1.700	2.800	0.260	0.240	0.340	0.400	1.300	0.555	0.000	0.000	0.000	0.000	0.018	0.000	0.000	0.000
S_x	1.340	1.679	0.511	0.522	0.593	0.638	0.947	0.775	0.015	0.005	0.020	0.015	0.073	0.013	0.016	0.009
S_d	0.256	0.328	0.100	0.096	0.114	0.124	0.224	0.146	0.003	0.001	0.004	0.003	0.026	0.003	0.003	0.002
$M \pm tS_x$, $P = 0.95$	0.016	0.021	0.006	0.006	0.007	0.008	0.012	0.010	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
F-test, T	5.000 $P < 0.01$	7.000 $P < 0.01$	5.000 $P < 0.01$	2.314 $P < 0.05$					76.166 $P < 0.01$	0.148 $P > 0.05$	1.817 $P > 0.05$	3.180 $P < 0.01$				
t-test, T	7.140 $P < 0.001$	5.701 $P < 0.001$	4.082 $P < 0.001$	3.738 $P < 0.001$					21.886 $P < 0.001$	8.762 $P < 0.001$	0.039 $P > 0.05$	7.213 $P < 0.001$				
F-test, size	1.647 $P > 0.05$		1.083 $P > 0.05$		1.176 $P > 0.05$		2.341 $P < 0.05$		0.117 $P > 0.05$		0.492 $P > 0.05$		96.104 $P < 0.01$		0.281 $P > 0.05$	
t-test, size	1.202 $P > 0.05$		3.606 $P < 0.01$		20.746 $P < 0.001$		3.168 $P < 0.01$		11.154 $P < 0.001$		4.654 $P < 0.001$		22.307 $P < 0.001$		0.080 $P > 0.05$	
F-test, sex	6.538 $P < 0.01$	11.667 $P < 0.01$			3.824 $P < 0.01$	1.388 $P > 0.05$			1.740 $P > 0.05$	7.313 $P < 0.01$			79.560 $P < 0.01$	0.340 $P > 0.05$		
t-test, sex	3.642 $P < 0.01$	2.924 $P < 0.01$			7.963 $P < 0.001$	12.239 $P < 0.001$			1.805 $P > 0.05$	16.522 $P < 0.001$			22.240 $P < 0.001$	0.284 $P > 0.05$		

	LP								*IP*							
T	8 – 10				15				8 – 10				15			
	lm	sm	lf	sf	lm	sm	lf	sf	lm	sm	lf	sf	lm	sm	lf	sf
M	1.008	0.009	0.009	0.007	0.010	0.007	0.995	0.006	0.007	0.018	0.013	0.004	0.008	0.001	0.006	0.003
S_x^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
S_x	0.003	0.008	0.001	0.001	0.003	0.001	0.002	0.001	0.014	0.025	0.008	0.004	0.008	0.002	0.009	0.001
S_d	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.002	0.004	0.001	0.001	0.002	0.000	0.001	0.000
$M \pm tS_x$, $P = 0.95$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F-test, T	0.836 $P > 0.05$	0.030 $P > 0.05$	1.640 $P < 0.05$	1.173 $P > 0.05$					2.950 $P < 0.05$	168.634 $P < 0.01$	0.669 $P > 0.05$	8.072 $P < 0.01$				
t-test, T	89.837 $P < 0.001$	0.056 $P > 0.05$	125.111 $P < 0.001$	0.108 $P > 0.05$					0.010 $P > 0.05$	0.197 $P > 0.05$	0.175 $P > 0.05$	0.265 $P > 0.05$				
F-test, size	0.129 $P > 0.05$		0.893 $P > 0.05$		0.195 $P > 0.05$		1.247 $P > 0.05$		3.345 $P < 0.01$		4.660 $P < 0.01$		0.059 $P > 0.05$		0.018 $P > 0.05$	
t-test, size	25.706 $P < 0.001$		0.440 $P > 0.05$		0.400 $P > 0.05$		97.129 $P < 0.001$		0.108 $P > 0.05$		0.390 $P > 0.05$		0.515 $P > 0.05$		0.099 $P > 0.05$	
F-test, sex	0.215 $P > 0.05$	0.031 $P > 0.05$			0.295 $P > 0.05$	0.826 $P > 0.05$			0.308 $P > 0.05$	50.620 $P < 0.01$			1.359 $P > 0.05$	2.423 $P < 0.01$		
t-test, sex	82.778 $P < 0.001$	0.086 $P > 0.05$			125.151 $P < 0.001$	0.128 $P > 0.05$			0.093 $P > 0.05$	0.189 $P > 0.05$			0.062 $P > 0.05$	0.228 $P > 0.05$		

TABLE 4 (continued)

T	QP								F1							
	8 – 10				15				8 – 10				15			
	lm	sm	lf	sf	lm	sm	lf	sf	lm	sm	lf	sf	lm	sm	lf	sf
M	6.429	8.556	7.600	8.000	4.003	5.556	6.714	20.643	575	667	600	1050	505	900	575	1067
S_x^2	15.341	26.278	20.800	4.800	0.000	7.278	6.527	14.401	2500.000	83333.333	0.071	5000.000	50.000	20000.000	2500.000	3333.333
S_x	3.917	5.126	4.561	2.191	0.006	2.698	2.555	3.795	50.000	288.675	0.267	70.711	7.071	141.421	50.000	57.735
S_d	1.086	1.709	2.040	0.894	0.003	0.899	0.683	1.014	25.000	166.667	0.071	50.000	5.000	100.000	25.000	33.333
$M \pm tS_x$, $P = 0.95$	0.068	0.107	0.128	0.056	0.000	0.056	0.043	0.064	1.568	10.451	0.004	3.135	0.314	6.271	1.568	2.090
F-test, *T*	460219.780 $P < 0.01$	3.611 $P < 0.05$	3.187 $P > 0.05$	3.000 $P > 0.05$					50.000 $P > 0.05$	4.167 $P > 0.05$	35000.000 $P < 0.01$	1.500 $P > 0.05$				
t-test, *T*	0.470 $P > 0.05$	0.345 $P > 0.05$	0.147 $P > 0.05$	1.801 $P < 0.01$					1.395 $P > 0.05$	0.854 $P > 0.05$	0.656 $P > 0.05$	0.244 $P > 0.05$				
F-test, size	1.713 $P > 0.05$		4.333 $P > 0.05$		218333.333 $P < 0.01$		2.206 $P > 0.05$		33.333 $P < 0.01$		70000.000 $P < 0.01$		400.000 $P < 0.05$		1.333 $P > 0.05$	
t-test, size	0.216 $P > 0.05$		0.070 $P > 0.05$		0.429 $P > 0.05$		11.392 $P < 0.01$		0.375 $P > 0.05$		17.995 $P < 0.01$		3.945 $P > 0.05$		8.924 $P < 0.01$	
F-test, sex	1.356 $P > 0.05$	5.475 $P > 0.05$			195824.176 $P < 0.01$	1.979 $P > 0.05$			35000.000 $P < 0.01$	16.667 $P > 0.05$			50.000 $P > 0.05$	6.000 $P > 0.05$		
t-test, sex	0.160 $P > 0.05$	0.069 $P > 0.05$			0.725 $P > 0.05$	1.886 $P > 0.05$			0.656 $P > 0.05$	1.463 $P > 0.05$			1.395 $P > 0.05$	1.614 $P > 0.05$		

T	F2								F3							
	8 – 10				15				8 – 10				15			
	lm	sm	lf	sf	lm	sm	lf	sf	lm	sm	lf	sf	lm	sm	lf	sf
M	1267	1433	1057	2825	1150	2025	571	1625	1750	2700	1667	–	1525	–	2325	–
S_x^2	163333.333	13333.333	22637.363	1250.000	405000.000	1250.000	23736.264	1250.000	125000.000	20000.000	83333.333	–	1250.000	–	1250.000	–
S_x	404.145	115.470	150.457	35.355	636.396	35.355	154.066	35.355	353.553	141.421	288.675	–	35.355	–	35.355	–
S_d	233.333	66.667	40.211	25.000	450.000	25.000	41.176	25.000	250.000	100.000	166.667	–	25.000	–	25.000	–
$M \pm tS_x$, $P = 0.95$	14.632	4.180	2.522	1.568	28.218	1.568	2.582	1.568	15.677	6.271	10.451	–	1.568	–	1.568	–
F-test, *T*	2.480 $P > 0.05$	10.667 $P > 0.05$	1.049 $P > 0.05$	1.000 $P > 0.05$					100.000 $P > 0.05$	–	66.667 $P > 0.05$	–				
t-test, *T*	0.216 $P > 0.05$	5.599 $P < 0.05$	1.206 $P > 0.05$	33.941 $P > 0.05$					0.896 $P < 0.05$	–	2.540 $P < 0.05$	–				
F-test, size	12.250 $P > 0.05$		18.110 $P > 0.05$		324.000 $P < 0.05$		18.989 $P > 0.05$		6.250 $P > 0.05$		–		–		–	
t-test, size	0.687 $P > 0.05$		33.163 $P < 0.01$		1.941 $P > 0.05$		5.354 $P < 0.01$		3.528 $P > 0.05$		–		–		–	
F-test, sex	7.215 $P > 0.05$	10.667 $P > 0.05$			0.059 $P > 0.05$	1.000 $P > 0.05$			1.500 $P > 0.05$	–			1.000 $P > 0.05$	–		
t-test, sex	0.655 $P > 0.05$	13.170 $P < 0.01$			1.937 $P > 0.05$	11.314 $P > 0.05$			0.244 $P > 0.05$	–			22.627 $P < 0.05$	–		

F-test and *t*-test values are cited for the estimation of level of significance of temperature influence on the call parameters (*T*), the sex and size of animals is equal; size influence (size), the sex and temperature of animals is equal; and sex influence (sex) — size and temperature of animals is equal. For other abbreviations see Tables 1 – 3.

small males, a decrease of pulse group duration, pulse duration, interval between pulses; and the number of pulse groups per call increases.

However, the large animals do not demonstrate such regularity. Perhaps, it can be explained by the fact, that in laboratory conditions frogs did not have time to cool off completely to 8°C in allocated time.

Frequencies maxima change chaotically, the third frequencies maxima can disappear with the increase of temperature. The small females do not demonstrate *F3*.

The small frogs (we compared frogs of similar sex, at the same temperature) have higher number of pulses per group, but the pulses are shorter, than pulses of the large ones. Values of the frequencies maxima of small frogs are higher, that of large ones, *F3* can disappear.

There are some differences in voice parameters of small and large frogs, depending on their sexual appertaining.

Large females have longer call duration than large males, and intervals between the pulse groups are shorter, and there is a contrary situation with small frogs.

The first frequencies maximum of females is higher than the males' one, independently of the size.

Large males of *Rana lessonae* have longer call duration, than large females, and vice versa, with small frogs. In other words, situation with *Rana lessonae* is reverse to the one with *Rana ridibunda*.

Females demonstrate the longer interval between pulse groups and the greater number of pulses per pulse group, males demonstrate longer interval between pulses, than females.

First and second frequencies maxima are observed in all groups, and *F3*, only in a group of small males.

The small frogs of *Rana ridibunda* utter the shorter call with less number of pulses per call.

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