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ASPECTS REGARDING THE SOUND EMISSION AT *RANA RIDIBUNDA* PALL.

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INTRODUCTION

Sound emission in animal world is a means to perceive the surrounding environment, the space orientation, and the transmission of biological information.

The analysis of the sound emissions at the anuras has a very important role (beside the morphological criteria) to the taxonomic identification. That is the reason for the characteristics of the amphibians'song are intensely studied lately. The investigations of the sound emissions were done at *Bufonidae* (9) and *Hylidae* (5, 6). Thus, the green frogs were carefully observed, because it is considered that their sound emissions allow a more precise identification of the species, especially of those from *Rana esculenta* complex (1 – 4, 7, 8, 10 – 14).

Many scientific papers published recently refer to bioacoustic analysis (besides the traditional methods that investigate intra- and interspecific variability). This facts led us to initiate our study of sound emissions of *Rana ridibunda* Pall., free or in captivity, and to the determine their individual variability.

MATERIAL AND METHODS

In order to characterize the sound emissions, we used the method proposed by LODÉ and PAGANO (2000). It is based on sound emissions recorded in the field, using a tape recorder with a high-resolution microphone (a microphone with electrets, having a 20 – 22000 Hz resolution, a sensibility of 3 – 27 dB and distortions < 0.3%). After the registration of the sounds in nature, they are transformed into a digital format with a 16 bit resolution and then sonograms (spectrograms) are made, using different softs.

In this case, we recorded the sounds with a Sony tape recorder, and after the sounds are introduced in a computer, we used the Steinberg – WaveLab 5 soft, which may analyze the sonograms. The interpretation of the sonograms was done using the parameters proposed by LODÉ and PAGANO (2000): the duration of the acoustic emission (in ms), the dominant frequency at the beginning of the song (in Hz), the dominant frequency at the end of the song (in Hz), and the maximum dominant frequency (in Hz). The minimum dominant frequency (in Hz) and the duration of the pause between the sound emissions (in ms) were also investigated. In view of obtaining a better accuracy during the analysis of the sound signals of the green frogs, the sound emissions were sequenced, using the system proposed by CARRIERE (1999). According to this system, the sound emissions can be divided into three sequences: *the theme or the acoustic phrase of the song*, which represents the acoustic sequence in its wholeness (it lasts for a few seconds) which the green frogs repeats in an identical manner for a variable number of times, *the note of the song*, which is a division of the phrase, understood as an elementary sound unit, lasting some tens of seconds and *the impulse*, which is a subdivision of the note, which can not be perceived by the human ear, lasting a few hundreds of seconds.

A bioacoustics analysis was made with the recordings from 8 individuals of *Rana ridibunda* Pall. Among these, 2 were recorded out, in the field, with distinct sounds, without the superposing of other sound emissions, and 6 individuals were recorded in temporary captivity, in an aquarium. All males that were used in the study come from a pond from the area of Dorohoi (Botoşani).

We determined the average values of each bioacoustic parameter, for each song and each individual.

The results are presented in the Tables 1 and 2.

RESULTS AND DISCUSSIONS

The sound emissions recorded at the individuals in their natural environment are characteri-zed by a completely different acoustic structure, compared to those recorded at the individuals in captivity. A regular pattern of the sound themes was registered at the individuals from the pond. These themes succeed accurately, which enables even the recognition of sound structure. The precision and the accuracy of the motifs and of the notes from the individuals which were in their natural environment can be noticed in the analysis of the sonograms presented in figures 1 and 2.

During our research of captive amphibians' activity, we acknowledge that the acoustic signals are a response to stress, alarm signals or even "sounds of liberation", regarding the fact that, in their attempt to free themselves, the males had to adopt, in a wrong way, the *amplexus* position, (11).

The observations made in the field lead us to the idea that those may be territorial sounds, which explains the different sound construction.

Comparing the acoustic parameters investigated at *Rana ridibunda* Pall., in natural conditi-ons and in captivity, we encountered some major differences (rendered in Tables 1, 2).

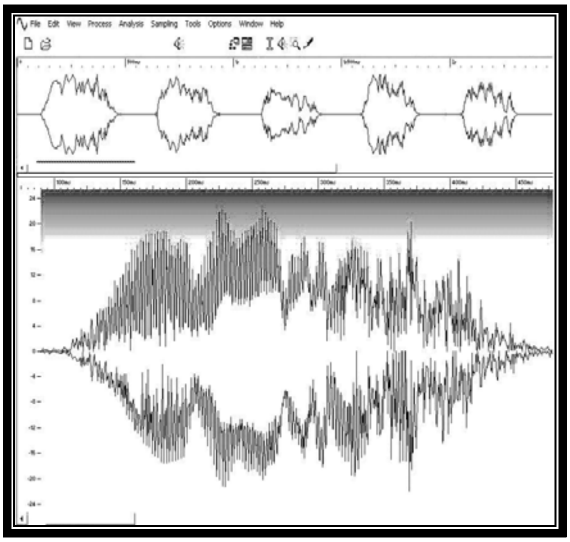

Fig. 1 - Sonogram characteristic to the sound emission of *Rana ridibunda* Pall. in captivity:

Up – the whole sound emission with 5 motifs;
Down – a single sound motif (the first);
(picture made with the Steinberg – WaveLab 5)

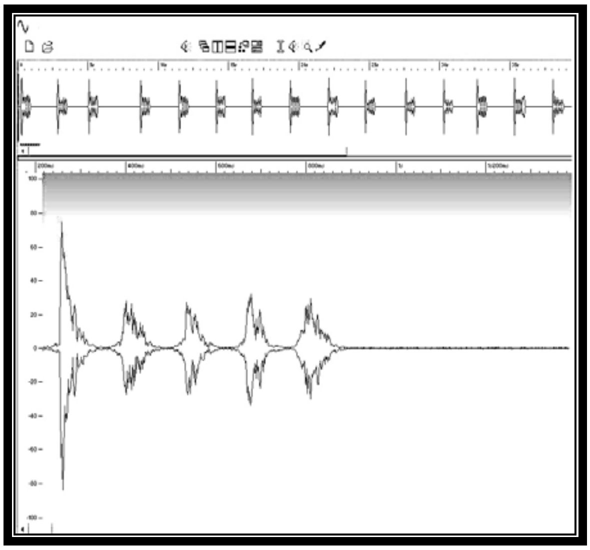

Fig. 2 - Sonogram characteristic to the sound emission in the pond at Rana ridibunda (Pall.):

Up – the whole sound emission with 15 motifs;
Down – a single sound motifs (the first) with 5 notes;
(picture made with the Steinberg – WaveLab 5)

Table 1. The values of some bioacoustics parameters at *Rana ridibunda* Pall

Rana ridibunda		In captivity	In the field
The duration of the motif (ms)	Minimum	259.8	598.3
	Average	280	641
	Maximum	319.2	685.5
Maximum frequency (Hz)	Minimum	1696	2700
	Average	1849	2703.3
	Maximum	2071	2706.6
Minimum frequency (Hz)	Minimum	341.8	117.3
	Average	439.7	150.6
	Maximum	624	184
Initial dominant frequency (Hz)	Minimum	743	1366.6
	Average	924	1606
	Maximum	1300	1846
Final dominant frequency (Hz)	Minimum	1038.8	1660
	Average	1199.9	1830
	Maximum	1354	2000
The duration of the pause between the motifs (ms)	Minimum	217.7	2050
	Average	520	2100
	Maximum	980	2172

To begin with, the total duration of a sound emission recorded in the field is much longer than in captivity, with average values between 22.540 seconds in the field, and 7.380 seconds in captivity. A complete sound emission comprises an average of 8 sound motifs in captivity, and of 9 sound motifs in their natural environment. The sound motif has 5 similar sound sequences which are easily distinguished at free individuals, that can not be observed in the sound emission from the individuals in captivity. Also, the pause between motifs is much bigger when they are free, with an average of 2.100 seconds, compared to 0.520 seconds in captivity. These facts are a consequence of the stress produced by captivity, resulting a song made of short and quick signals.

Analyzing the values of the recorded frequencies, we observed that males from *Rana ridibunda* Pall. utter sounds, when in captivity, in a *crescendo* harmony in every sound motif.

Table 2. Structural characteristics of the sound motif (in the field) at *Rana ridibunda* Pall.

The motif's duration (ms)	The motif's structure									The duration of the pause
	Sequence 1 (Hz)					Sequence 2 (Hz)	Sequence 3 (Hz)	Sequence 4 (Hz)	Sequence 5 (Hz)	
93	86-210	405-635	670-1300	1300-2600	2600-3750	1300-2600	1300-2600	1300-2600	1300-2600	39

Thus, the initial dominant frequency is between 743 Hz and 1300 Hz, with an average of 924 Hz, and the final dominant frequency is between 1038,8 Hz and 1354 Hz, with an average of 1199.9 Hz. When they are in their native environment, although the song is longer, the general harmony of a sound motif is similar, in a *crescendo,* though the values of the initial and final frequencies are in a higher register than in captivity. The average values of these frequencies recorded in the field are close to those registered by LODÉ and PAGANO (2000), of 1712 Hz for the initial dominant frequency, and of 1906 Hz for the final dominant frequency.

Regarding the minimum and the maximum frequencies registered during the sound motifs, the values from the sonograms indicate higher frequencies for both the acoustic parameters at the free individuals. In addition, in the case of the sound emission in the field, the value of the maximum frequency is close to the average (2509 Hz) determined by LODÉ and PAGANO (2000).

The compositional structure of sound motifs makes the major difference between the two types of sounds emissions at *Rana ridibunda* Pall. While sound motifs in captivity are more complex, (with no possibility to distinguish the acoustic elements of their structure), the ones recorded in field display a very reduced variability, with an acoustic pattern made of 4 sound sequences (easily distinguished by their own frequency values). In addition, the first sequence (note) of the motif (theme) can be decomposed into 5 frequencies (for *Rana ridibunda* in the field), whose values have very small variation limits and a *crescendo* harmony, between 86 Hz and 3750 Hz. The other 4 sequences of a sound motif recorded in the field are characterized by a perfect similarity, each one of them with values between 1300 Hz and 2600 Hz. The precise construction of the sound motif recorded in the field may be also observed during the analysis of each structural sequence's duration, and also rendered by the duration of the pauses between sequences. Thus, during a single whole song, produced by one of the individuals, we noticed a duration of a sound sequence among 90 and 95 ms, with an average of 92 ms, and the pauses between the sequences had an average duration of 38 ms. These values (hardly perceived by the human ear), render a precise construction of the sound motifs from the songs uttered by the free individuals of *Rana ridibunda*.

ABSTRACT

The individuals of *Rana ridibunda* Pall. have different sound emissions when in captivity, compared to those from their natural environment. The sound emission produced in natural habitats is characterized by a precise construction, with specific compositional elements.The song uttered in captivity (though it displays the same *crescendo* harmony) presents lower values of its acoustic parameters.

CONCLUSIONS

The individuals of *Rana ridibunda* Pall. have different sound emissions when in captivity, compared to those from their natural environment.

The sound emission produced in natural habitats is characterized by a precise construction, with specific compositional elements.

The song uttered in captivity (though it displays the same *crescendo* harmony) presents lower values of its acoustic parameters.

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