The populations of *Rana arvalis* Nills. 1842 from the Ier Valley (The Western Plain, Romania), Part II: sex ratio and body size distribution of some populations

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Abstract. In the present paper we want to bring the first data about the structure of some moor frog populations from the Ier Valley (The Western Plains, Romania), as a background for future monitoring studies. The study was made during the years 2002-2003, in March and April each year, which is a spawn laying period for the moor frogs. Regarding the sex ratio, this varies with the populations. Besides the population near Andrid, in all the other ones the number of males prevails in the population. On the whole, the ratio of the sexes varies between 0.66: 1 and 1.7: 1 (males: females). Generally, in the investigated populations it was a prevailing number of big specimens. The largest individuals of *Rana arvalis* had been found in the populations from Vărşad (75 mm ♂♂) and from Irina (74 mm ♀♀). In the other populations, the largest specimens were 65-69 mm long, among these only the specimen from Curtuişeni being a female. Apart from the population from Vărşad, the maximum length differences between females and males were not significant. The size structure of the populations from Curtuiseni and Vasad show that those weren't having a breeding success during the last 3-4 years. Continuous breeding success was found only for the moor frog populations from Resighea and from Andrid.

Key words: *Rana arvalis*, sex ratio, size structure, Ier Valley, Romania

Introduction

In Romania, the moor frog lives in the northern half of the country, being found in Romania at the southern margins of its distributional range (Cogălniceanu et al. 2000) and is considered critically endangered (Cogălniceanu & Venczel 1993, Cogălniceanu 1997, Iftime 2001). It is believed that this species is among the most rare to be found in Romania's herpetofauna (Fuhn, 1960, Poliş, 1977).

The presence of *Rana arvalis* in Transylvania was first observed in 1891 by Méhely. It is in 1960 when *Rana arvalis* is first found in the area of the Western Plain, more precise near Carei locality (Fuhn 1960). It was first known about the presence of the moor frog in Ier Valley in 1977, when Rozalia Poliş had found it there. As a result of the herpetological investigations made between 2000 and 2003, a continuous areal of the moor frog was mapped in the plain area from North-West Romania as a completion of previous mapping data (Covaciu-Marcov et al. 2003 and also see in: Sas et al. 2006).

Amphibian populations are declining worldwide, this becoming a global phenomenon in the last few decades (Blaustein et al.1994, and see in Alford & Richards 1999), primarily as a result of human activities. To evaluate the conservation status of amphibian populations it is critical to have monitoring data, preferably collected before. This monitoring data mainly regards to knowledge of the geographical distribution, preferred habitats and population sizes and structure.

The populations of *Rana arvalis* in Transylvania became a debated subject in some publications such as: Dély (1953, 1964), Fuhn (1956), Strugren and Popovici (1960), Stugren (1966) and Micluța (1969). But those studies mainly discuss only taxonomical or distributional features of the Romanian moor frog populations. Only in year 2006 have been published two works that bring data upon *Rana arvalis* population sizes and habitat use in Transylvania (Demeter & Mara 2006, Sas et al. 2006). But no published data exist about the structure of the Romanian moor frog populations. Data on the *Rana arvalis* populations' structure can be obtained only from foreign papers (see in: Ishchenko 1989, 1996, 2005).

In our previously paper (Sas et al. 2006) was debated the detailed geographical distribution, status, habitat use and population sizes of the *Rana arvalis* populations from the Ier Valley (The Western Plains). In

the present paper we want to complete the previously presented data (see in: Sas et al. 2006), with data about the structure of some moor frog populations from the Ier Valley, as a background for future monitoring studies.

Materials and methods

The period of the study and the researched area

The study was made during the years 2002-2003, in March and April each year, which is a spawn laying period for the moor frogs. The researched area was the hydrographic basin of the Ier (the Ier Valley) which is located in the Western Plain and is a strip of swampy meadow (fig. 1). Ier is the most northern river from the hydrographic basin of three Criş rivers, its whole length being found in the studied area. It springs from the Tăşnad Hills and it doesn't have a mountain flow. It has a reduced stream-flow and is almost entirely embanked, and in the past there were important moist areas around it. The Ier Valley is situated on an alignment of some 90 km in North-West Romania, continued for a few kilometers in Hungary. It is a considerable hydrographic basin of 1417 square kilometers and represents an important geographical element of the Bihor and Satu-Mare Counties.

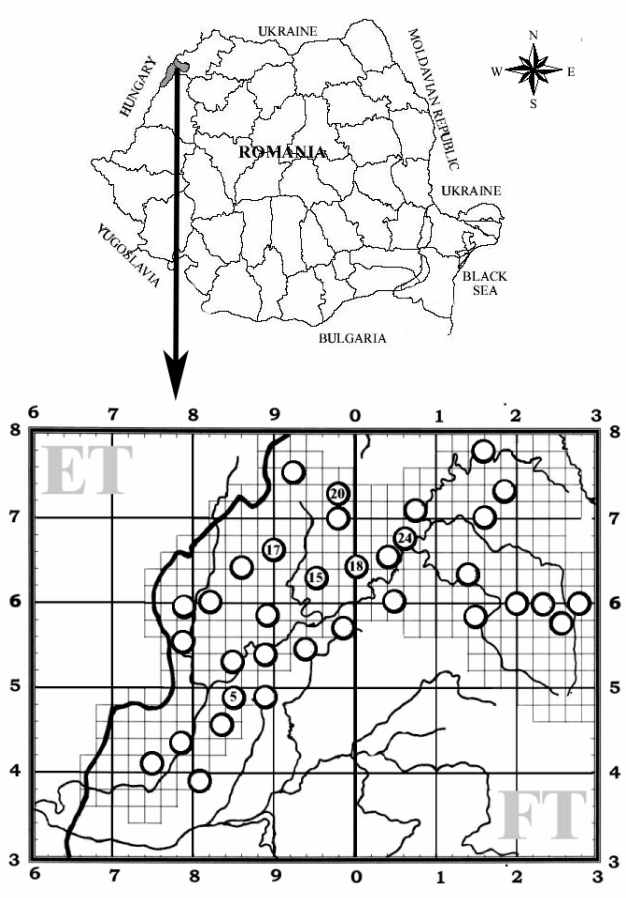

Figure 1 The study area and the nearest localities to the *Rana arvalis* populations in The Ier Valley (for rthe detailed map see in Sas et al. 2006). UTM scale 10x10 and 2x2 km. (5- Cherechiu, 15-Văşad, 17- Curtuişeni, 18- Andrid, 20- Resighea, 24- Irina)

Data analysis

Along our study, by investigating the populations of *Rana arvalis* from The Ier Valley, we were able to make population structure assessments for six populations located near the following localities: Văşad (47º31'00''N 22º16'00''E), Andrid (47º31'00''N 22º21'00''E), Resighea (47º36'00''N 22º19'00''E), Curtuiuşeni (47°33'0'' N, 22°12'0'' E), Cherechiu (47°23'0'' N, 22°8'0'' E) and Irina (47°33'0'' N, 22°24'0'' E). This low number of studied populations is a consequence of the small number of moor frogs found in some sites (less then 6 specimens /site), in the greater part of the investigated region, making the quantitative studies impossible for all of the visited sites (see in Sas et al. 2006).

On 553 captured specimen of *Rana arvalis* from the evaluated populations (see in the table 2), we made measurements of the snout-vent length (SVL) to the nearest mm using a dial caliper. All specimens of more than 50 mm SVL (and some smaller specimens of 37-40 SVL) could be reliably sexed and were considered as adults. The sex of the specimens was determined by the swollen / normal digitus primus. To avoid double measurements, adult specimens were marked by toe-clipping (wound treated with antiseptic) (Donelly et al. 1994). In order to reduce the impact of our study on the populations, we did not make individual markings but we marked them by clipping a different toe in different sample events. Direct observations on recaptured frogs indicated that all incisions healed, and there was no necrotic tissue present upon recapture. The marking data was also used to estimate the population sizes (see in: Sas et al. 2006).

RESULTS

Regarding the sex ratio (table 1), this varies with the populations. Besides the population near Andrid, in all the other ones the number of males prevails in the population. On the whole, the ratio of the sexes varies between 0.66: 1 and 1.7: 1 (males: females) (table 1).

Generally, in the investigated populations it was a prevailing number of big specimens (table 2, fig. 2-3). We only found small specimens in the populations near the localities Andrid and Resighea (Fig. 4 and 6). As far as the males' average length (SVL) against the females' is concerned, in three populations of *Rana*

arvalis, the males were bigger (Văşad, Resighea, Cherechiu). In the case of the population from Irina the sizes of the females had slightly higher values (table 2).

Table 1 The sex ratio of four populations of moor frog within the Ier Valley area (the population size data was published in Sas et al. 2006)

Locality	Estimate no.			Sex ratio
	Total	Males	Females	
Văşad	190 ±23	118 ±18	72 ±24	1.63 : 1
Andrid	675 ±57	200 ±31	470 ±23	0.42 : 1
Resighea	354 ±25	168 ±25	152 ±26	1.15 : 1
Curtuişeni	170 ±41	107 ±26	63 ±14	1.7 : 1

Table 2 The SVL of the *Rana arvalis* samples from six populations within the Ier Valley area

Year	Locality		N	Mean	Max	SE
2002	Văşad	*Total*	99	59.62	75	-
		Females	39	57.19	66	1.32
		Males	60	61.2	75	1.05
2003	Andrid	*Total*	165	49.06	69	-
		Females	75	50.86	68	0.96
		Males	90	50.24	69	0.86
2002	Resighea	*Total*	152	47.87	67	-
		Females	84	47.77	66	0.90
		Males	68	54.85	67	0.99
2002	Curtuişeni	*Total*	111	59.64	65	-
		Females	40	60.46	65	1.31
		Males	71	58.4	64	0.97
2003	Irina	*Total*	15	65.8	74	-
		Females	9	63.61	74	-
		Males	6	69.08	71	-
2002	Cherechiu	*Total*	11	67.63	75	-
		Females	7	68.14	75	-
		Males	4	66.75	69	-

The largest specimens of *Rana arvalis* had been found in the populations from Văşad (75 mm ♂♂) and from Irina (74 mm ♀♀) (table 2 and fig. 2-3). In the other populations, the largest specimens were 65-69 mm long, among these only the specimen from Curtuişeni being a female. Apart from the population from Văşad, the maximum length differences between females and males were not significant (table 2).

DISCUSSIONS

As expected, with only one exception, the number of males was dominant (table 1). In Russia, there was a documentation about a population of *Rana arvalis* with a sex ratio of 2.5 : 1 in favor of the males (in lit., Ishchenko 1989). For the amphibians, generally the number of males in a population is larger than the number of females (Wells 1977). For *Pelophylax lessonae* it was shown that during the hibernation the females loose more weight than the males (Holenweg & Reyer 2000) and it is believed that there is a direct link

between loosing weight and mortality caused by laying spawn (using a lot of the accumulated reserve substances). On the other hand, the amphibians are poikilotherm animals, having a metabolic rate directly related to the temperature of the environment; in warmer winters thus they loose more weight than in cold winters (Holenweg & Reyer, 2000).

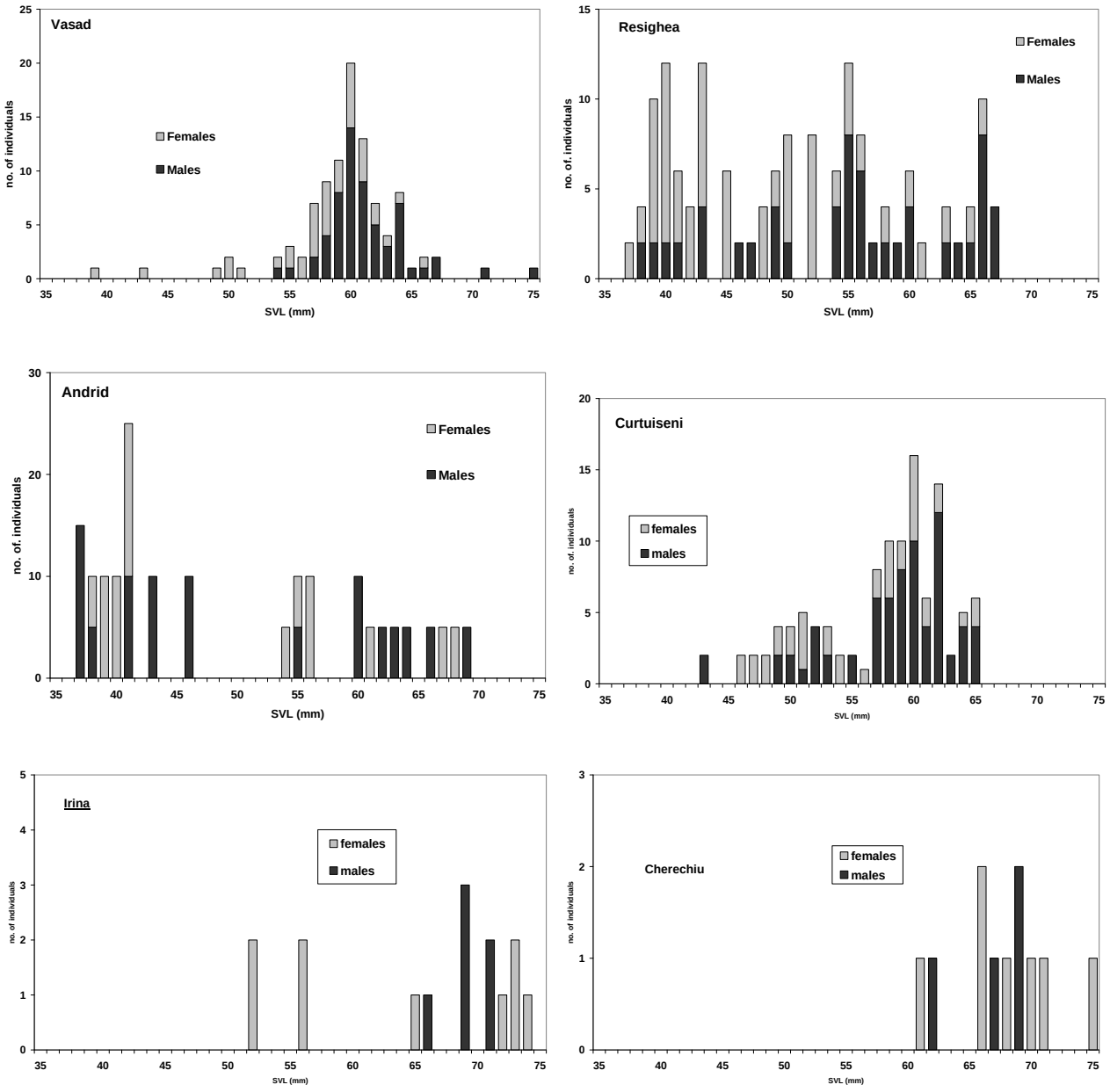

Figure no.2 Size distribution (SVL) of the *Rana arvalis* individuals in the six studied populations from the Ier Valley

As it was mentioned above, there is one exception among the studied populations, more particular the population from Andrid. For this population the sex ratio is 0.42 : 1, therefore predominant females. This sex ratio indicates an even smaller number of males than in some exceptional sex ratios known in the specialty literature (0.79:1 or 1:1 in lit. Ishchenko 1989). The species *Rana arvalis*, similar to *Pelophylax lessonae*, normally hibernates in terrestrial environment, having suitable body shape (small body, relative short limbs and big internal callus). Thus, considering Holenweg & Reyer's studies (2000), shown above, the explanation

for the sex ratio for the studied populations can be the mortality of the females during the winter. The pedological properties of the studied area (Stoenescu et al. 1966) show that the predominant type of soil from Andrid area is different to the other regions where we had estimated the sizes of populations of *Rana arvalis* (see in: Sas et al. 2006). On the other hand, the aquatic habitat from Andrid is a reservoir with a terrestrial habitat at its end (where the frogs probably hibernate) whilst for the other populations the aquatic habitat is temporary with its lasting time directly linked to the amount of winter rainfall. It is also known that in the terrestrial environment the temperatures vary more than in the aquatic one; and having said that, it could explain the larger number of females from Andrid by the fact that the reservoir (which is a permanent water) has its part in maintaining a constant temperature of the soil around it (in this case terrestrial habitat for the frogs) during the winter. In addition to this situation is the soil type from Andrid which is clayey / clayey-sandy (Stoenescu et al. 1966) and hence it heats up easier during the warmer days in winter.

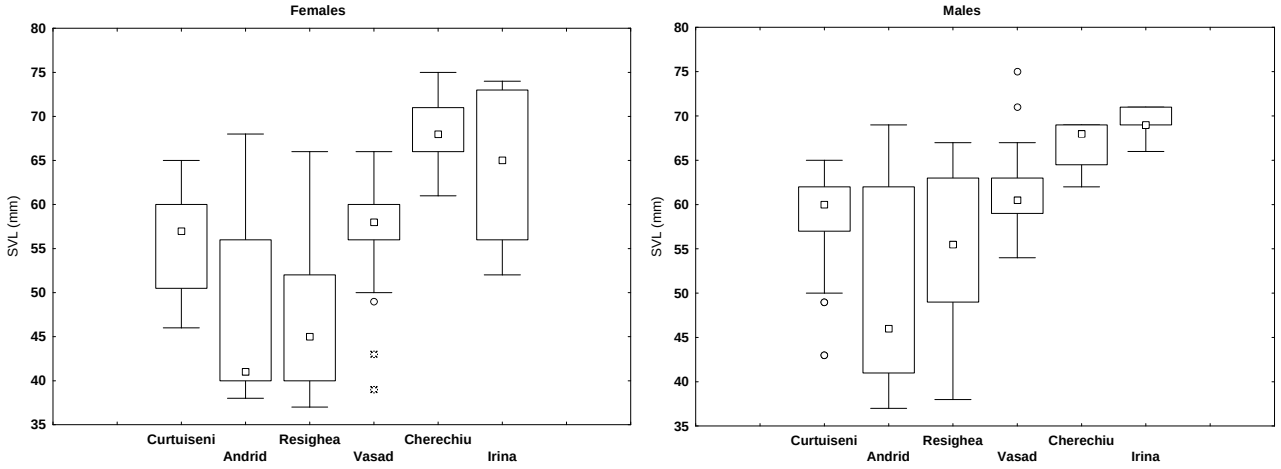

Figure no.3 Comparative size distribution (SVL) of the *Rana arvalis* females and males in the six studied populations from the Ier Valley. The minimum, maximum, median, outlines, extrem and 25–75 % values are presented with 95% Cf.

The high number of large sized specimens of *Rana arvalis*, up to 75 mm (e.g. Irina), is not an unseen situation worldwide; for instance, there had been found specimens of moor frog as big as 72 mm (Nikol'skij 1918 - in lit.) or even 82 mm (Scerbak & Scerban 1980). In average, the specimens with their size bigger than 55 mm are older than 5-6 winterings (according to Ishchenko 1989, 1996, 2005).

If we consider Ishchenko's results (1989, 1996 and 2005) on the structure of some populations of *Rana arvalis* from Russia by age and size, we can deduce indirectly the age of the specimens we had found in our studied area. Most of the moor frog populations we identified contained only or mostly large sized specimens, situation that indicates a reduced breeding success in the last few years (probably last 3-4 years). Looking at the figures 2 and 3, we can see a breeding success only for two populations, as a matter of fact for the two biggest populations (see in: Sas et al. 2006): the one from Resighea and the one from Andrid. In these two populations were found a large number of specimens of sizes between 37 and 43 mm, which should be approximately 2 years old. Only within these two populations we have been encountering froglets in springtime, with sizes under 35 mm (probably one year old) and freshly metamorphosed froglets in summertime. Aside from these two populations, we had only found three other that had youngsters among their individuals (Piscolţi, Sărăuad, Sânmiclăuş –see in Sas et al. 2006), but due to the small number of specimens identified, we hadn't been able to estimate their population size and to make another quantitative analyzes (see in: Sas et al. 2006).

When analyzing figure 2, the size structure of the population from Curtuişeni tells us that it is very likely that it wasn't having a breeding success during the last 3-4 years (before the year 2001), due to the large number of big specimens in the population. A similar situation is that of the population from Vaşad, where the number of specimens 55-65 mm big was startlingly significant compared to the smaller sized specimens found in it (probably between 2-4 years old). As we previously mentioned, many aquatic habitats

dry out before the eggs are hatching or before tadpoles completely metamorphose, hence most probably the unsuccessful breeding from the last few years.

It is interesting that at Andrid besides a large number of adult specimens found (37-39 mm) we had found a large number of froglets as well (in the summer of 2003, over 100 froglets from the current year). However, the frogs of 46-53 mm cannot be found at all in this population, frogs that would have been 4-5 years old (Ishchenko 1989, 1996, 2005). In other words, it means this population's individuals were born in the years 1999 and 2000. These previous years correspond to a period when the water level in the lake dropped significantly, drying out the breeding site of this population. Thus, the breeding success in this period was close to zero percent, despite the fact that there was still plenty of water in the reservoir, but only in the fish populated areas. In their reproduction period, amphibians share their aquatic habitat with fish. But only in waters with lush submerged vegetation, shallow parts and complex bank vegetation can amphibians survive in their presence (in lit. Stumpel 2004), which is the case for the moor frog's breeding habitat from Andrid.

Population structure was directly affected by years with zero reproductive success (differential recruitment rate), differential age at maturity between the sexes, and differential adult mortality among years (Ricther & Siegel 2002). The survival of the *Rana arvalis* populations from the Ier Valley area is helped by the long life-span of the moor frog among the amphibians (Ishchenko 1996, Lyapkov 1999), in some populations being identified 8-9 years old individuals (Ishchenko 1989, 2005). In northern Russia, some populations of moor frogs which are characterized by long life-span and higher occurrence of older age groups were identified (Ishchenko 1996). Having in mind the long life span of the *Rana arvalis* species and the fact that these frogs reach the sexual maturity after two hibernations, we presume that these animals can have 5 to 7 and sometimes more breeding periods (Ishchenko 1989 and 1996). Therefore, some climate effects result in early dry outs of the ponds or some human activities with temporary effect (e.g. the level drop from the Andrid lake) are affecting the amphibians breeding success in some years with results in missing generations, but this can be remedied in the following years.

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References

Alford, R.A., Richards, S.J. (1999): Global amphibian declines: A problem in Applied ecology. Annual Review of Ecology and Systemathics 30: 133-165.

Blaustein, A.R., Wake, D.B., Sousa, W.P. (1994): Amphibian declines: Judging Stability, Persistence, and Susceptibility of Populations to Local and Global Extinctions. Conservation Biology 8 (1): 60-71.

Cogălniceanu, D. (1997): Practicum de ecologie a Amfibienilor - metode şi tehnici în studiul ecologiei Amfibienilor. Ed. Universităţii din Bucureşti.

Cogălniceanu, D., Venczel, M. (1993): Consideraţii privind ocrotirea şi conservarea populaţiilor de amfibieni şi reptile. Ocrotirea Naturii şi a Mediului Înconjurător 37 (2): 109-114.

Cogălniceanu, D., Aioanei, F., Bogdan, M. (2000): Amfibienii din România. Determinator. Ed. Ars Docendi, Bucureşti.

Covaciu–Marcov, S.D., Sas, I., Cupşa, D., Kovács, É.H., Groza, M. (2003): Contributions to the knowledge of the distribution of *Rana arvalis* – Nills. 1842 in the North – West region of Romania. Analele Universităţii din Oradea, Fasc Biologie 10: 39-48.

Demeter, L., Mara, Gy. (2006): A mocsári béka (*Rana arvalis*) elterjedése ée populációmérete a Csíki-medencében. A Csíki Székely Múzeum Évkönyve 2005: 439-450.

Dély, O.Gy. (1953): Examen systématique et ostéo – biométrique de la *Rana arvalis* Nills, et de la var. wolterstorffi Fejérváry. Ann. Mus. Nat. Hung. 3: 231-243.

Dély, O.Gy. (1964): Contribution a l'etude systematique, zoogeographique et genetique de *Rana arvalis arvalis* Nilss et *Rana arvalis wolterstorffi* Fejérváry. Acta Zool. Acad. Scient. Hungaricae 10 (3-4): 309-361.

Donnelly, M.A., Guyer, C., Juterbock, E., Alford, R.A. (1994): Appendix 2: techniques for marking amphibians. pp. 277-284, In: Heyer, W.R., Donnelly, M.A., McDiarmid, R.W., Hayek, L.A.C., Foster, M.S. (eds.), Measuring and monitoring biological diversity: standard methods for amphibians. Smithsonian Inst. Press, Washington, DC.

Fuhn, I.E. (1956): Date noi cu privire la prezenţa broaştei de mlaştină, *Rana arvalis arvalis* Nilsson în R.P.R. Com. Acad. R.P.R. 6 (2): 297-304.

Fuhn, I.E. (1960): Fauna R.P. Române, Vol. XIV, Fascicula 1, - Amphibia. Ed. Acad. R.P.R., Bucureşti.

Holenweg, A.K., Reyer, H.U. (2000): Hibernating behavior of *Rana lessonae* and *R. esculenta* in their natural habitat. Oecologia 123: 41-47.

Iftime, Al. (2001): Lista Roşie comentată a amfibienlor şi reptilelor din România. – Ocrotirea naturii si a mediului inconjurator. 44-45: 39-49.

Ishchenko, V.G. (1989): Population Biology of Amphibians. Sov. Sci. Rev. F. Physiol. Gen. Riol. 3: 119-155.

Ishchenko, V. G. (1996): Problems of demography and declining populations of some Euroasiatic brown frogs. Russian Journal of Herpetology 3 (2):143–151.

Ishchenko, V. G. (2005): Growth of brown frogs of fauna of Russia: some problems of study of growth in amphibians. Herpetologia Petropolitana, Ananjeva N. and Tsinenko O. (eds.): 153-157

Lyapkov, S M (1999): Geographical and local variation of age structure and reproductive characteristics in *Rana arvalis*. In: C., Miaud & G. Guyetant (eds.): Current studies of herpetology (Le Bourget du Lac: Societas Europaea Herpetologica). 295–304.

Méhely, L. (1891): A Magyar fauna Bombinatorjai és új Triton (Molge) faj hazánkból. Math es Termész. Közl. 24: 553-574.

Micluţa, H. (1969): Contribuţii la cunoaşterea broaştei de mlaştină, *Rana arvalis* Nilsson. Bul. Şt. Ser.B: Biol. Fiz-Chim, Mat. Institutul Pedagogic, Baia Mare 1 (1): 107-111.

Poliş, R. (1977): Răspândirea broaştei de mlaştină (*Rana arvalis*) în valea Erului (Judeţul Satu-Mare şi Bihor) Nymphaea, Folia Naturae Bihariae 5: 417-425.

Ricther S.C. & A.S. Siegel (2002): Annual Variation in the Population Ecology of the Endangered Gopher Frog, *Rana sevosa* Goin and Netting. Copeia 4: 962–972.

Sas, I., Covaciu-Marcov, S. D., Kovács, É. H., Radu, N. R., Tóth, A., Popa, A. (2006): The populations of *Rana arvalis* Nills. 1842 from the Ier Valley (The Western Plain, Romania): present and future. North-Western Journal of Zoology 2 (1): 1-16.

Ščerbak, N.N., Ščerban, N.I. (1980): Amphibians and Reptiles of Ukrainian Charpatians, Kiev, Ed. Nankova Dunka.(in Russian)

Stoenescu, Ş.M., Şchiop, A., Dica, I., Popescu, E., Patrichi, E., Ţepeş, E. (1966): Atlasul climatologic al R. S. R., Bucureşti.

Stugren, B. (1966): Geographic variation and distribution of the Moor Frog, *Rana arvalis* Nills. Annales Zoologici Fennici 3: 29-39.

Stugren, B., Popovici, M. (1960): Etude de la variation de quelques especes d'amphiblens de la Transyilvanie. Vertebrata Hungarica, Musei historico-naturalis Hungarici 2 (2).

Stumpel, A.H.P. (2004): Reptiles and amphibians as targets for nature management. Alterra Scientific Contrubitions 13, Alterra Green World Research, Wageningen.

Wells, K.D. (1977): The courtship of frogs. In: Taylor, D.H. & S.I. Guttman (eds.): The reproductive biology of amphibians. pp. 233-262. Plenum Press, New-York