**BABEŞ – BÓLYAI UNIVERSITY**
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**FACULTY OF BIOLOGY – GEOLOGY**

# BIOLOGICAL AND ECOLOGICAL RESEARCH ON AMPHIBIAN FAUNA (VERTEBRATA, AMPHIBIA) IN ALMAŞ-AGRIJ DEPRESSION

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**- Doctoral thesis abstract -**

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# CONTENT

**Key words:** amphibian distribution, trophic spectrum, morphological characteristics, anthropic impact, Almaş-Agrij Depression

# INTRODUCTION

The herpetofauna of Romania is little known, missing mainly the data referring to its geographical spread. The scarcity of the knowledge about the herpetofauna of Romania seems more serious when compared to the present situation in Europe.

The little knowledge on Romanian herpetofauna, and especially on that of the noth-western party of the country, made the starting point of this research.

The objectives of the research:

- The study of the species and their spread in the researched area, in the habitats populated by the amphibians. This was the main line of the research, and, in the same time, the first that was approached;
- The analysis of the feature variability of several populations of *Bombina variegata* in the Almaş–Agrij Depression in order to establish the proportion of *Bombina bombina* features;
- To establish the composition of food of some populations of amphibian species in Almaş–Agrij Depression. Six species of amphibians were investigated (*Mesotriton alpestris, Triturus cristatus, Lissotriton vulgaris, Bombina variegata, Rana dalmatina* şi *Rana temporaria*);
- To carry out conservation and protection activities of the amphibian fauna by involving students in order to provide ecological education and behaviour that are necessary to protect these species.

For his competent guidance, for his generous assistance in preparing and writing the thesis, I would like to express my most sincere feelings of respect and gratitude to **Professor Dr. NICOLAE TOMESCU,** scientific advisor.

Throughout the preparaion of the thesis I was fortunate to receive the help of exceptional specialists from the University of Oradea, the Biology Departament, whom I would like to thank.

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# III. THE AMPHIBIAN FAUNA IN ALMAŞ–AGRIJ DEPRESSION

## 3.1. Characterisation of the researched habitats

The research undertaken in the field were carried out on a period of 7 years, between 2004-2010. The steps to the target localities were taken at least two times each year.

I analysed the spread of the 11 amphibian species in the 68 localities in the Almaş-Agrij Depression. As a result of the research, from the total of 373 habitats I identified 308 aquatic habitats of the species I encountered in the 68 villages. There are 52 permanent aquatic habitats (17%), the remaining ones are temporary aquatic habitats (fig.1).

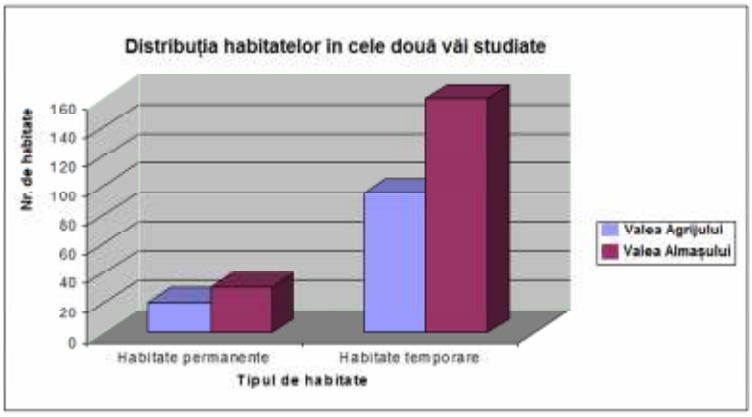


**Fig. 1**. The distribution of habitats in the two researched valleys

The most common species in the Almaş-Agrij Depression is *Bombina variegata,* identified in the most of the habitats, followed by *Rana dalmatina.*

The species that prefer permanent aquatic habitats for breeding are *Triturus cristatus, Bufo bufo* and *P. ridibundus* (Laurila, 1998; Cogălniceanu et al., 2000; Babik and Rafinski, 2001). Those that prefer temporary habitats for breeding are *Bombina variegata* (Barandun and Reyer, 1997 a;) and *Epidalea viridis* (Ghira et al., 2002).

*Salamandra salamandra* is spread in forest habitats situated along Agrij Valley. In higher altitude habitats of Agrij Valley *Mesotriton alpestris* was identified. *Triturus cristatus* and *Lissotriton vulgaris* are spread aproximately in the same proportion along the 2 valleys.

Permanent aquatic habitats are populated mainly by *Pelophylax ridibundus.* The forest area are populated mostly by *Rana dalmatina* and *Rana temporaria.*

The land habitats situated in the vicinity of aquatic habitats are represented by meadows separated by forest areas (beech, chestnut oak, oak and mixed) agricultural land and orchards.

Many of the permanent and artificial habitats were created by exploiting stream banks in gravel pits. I found such habitats on Băbeni Valley (in the vicinity of the villages of Almaş and Mesteacăn) and on Agrij Valley (next to Chechiş and Bălan). Other habitats were made for fish-breeding.

There are other types of artificial habitats such as the ditches along the roads or near forest limits, canals, tractor or forestry machinary traces, watering places.

There is a large quantity of eggs of frogs, numerous of them belonging to Ranidae, Bombinatoridae, Bufonidae.

### 3.2. Research methods

I anlysed the herpetofauna in 68 localities in the studied area, 38 of them having been researched for the first time. I used the transects method (Cogălniceanu, 1997a), in order to find the composition and geographical spreading of the herpetofauna, and I took several samples from each sampling site.
I used a net fastened on a telescoping metal pole, 2 m long so that I could capture the amphibians. The land species were caught by hand from the populated habitats especially those in forest areas.

In the researched area there are 11 amphibian species belonging to the following taxonomic integration:

- **Order Caudata**

- **Family Salamandridae**

- Genus *Salamandra* –1 species–*Salamandra salamandra* (Linnaeus, 1758)
- Genus *Mesotriton* – 1 species – *Mesotriton alpestris* (Laurentus, 1768)
- Genus *Triturus* – 1 species: *Triturus cristatus* (Laurentus, 1768)
- Genus *Lissotriton* – 1 species: *Lissotriton vulgaris* (Linnaeus, 1758)

- **Order Anura**

- **Family Bombinatoridae**

- Genus *Bombina* – 1 species: *Bombina variegata* (Linnaeus, 1761)

- **Family Bufonidae**

- Genus *Bufo* **–** 1 species - *Bufo bufo (*Linnaeus, 1758)
- Genus *Epidalea* – 1 species – *Epidalea viridis* (Laurentus, 1768)

- **Family Hylidae**

- Genus *Hyla* - 1 species: *Hyla arborea* (Linnaeus, 1758)

- **Family Ranida**e

- Genus: *Pelophylax* - 1 species: *Pelophylax ridibundus* (Pallas, 1771)
- Genus *Rana* - 2 species: *Rana dalmatina (Bonaparte, 1840), Rana temporaria*(Linnaeus, 1758)

# IV.THE DISTRIBUTION OF THE AMPHIBIANS IN THE RESEARCHED HABITATS

In Almaş–Agrij Depression I found 11 amphibian species: *Salamandra salamandra, Mesotriton alpestris, Triturus cristatus, Lissotriton vulgaris, Bombina variegata, Bufo bufo, Epidalea viridis, Hyla arborea, Pelophylax ridibundus, Rana dalmatina* and *Rana temporaria***.**

Most of the localities where the 11 species were found (164 habitats) are mentioned for the first time in the herpetofauna studies in Romania. However the number of habitats where a species had been recorded previously, being re-identified in the course of the present study, is also high; there are as many as 144 habitats (fig. 2).


**Fig. 2.** The distribution of the researched habitats (original)

## 4.1. The distribution of *Salamandra salamandra* (Linnaeus, 1758)

*Salamandra salamandra* is a species that can be found only in the forest area of the Almaş–Agrij Depression. The salmander was seen for the first time in 9 localities, but it was re-identified in 11 localities where it had been found before (Ghira et al, 2002) (fig. 3).

This species is very rare in the higher hill areas that separates the hydrologic basins of the two rivers.

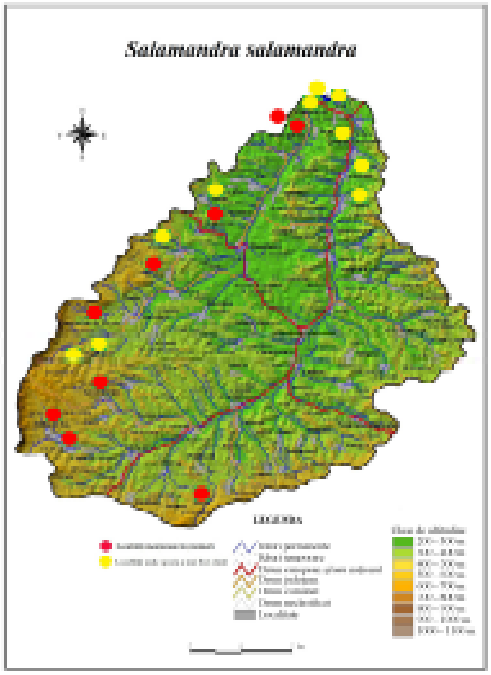


**Fig 3.** The distribution of *Salamandra salamandra* in the researched area (original)

The species was identified at 800 m in altitude in Măgura Priei area which is the top altitude of the studied area. Along the Someş River the salamander was also found at 200-220 m in altitude.

Although it is quite common in the most of the area investigated *Salamandra salamandra* does not make numerous populations. There were relatively few adults found. Even in rainy days and in the most favorable places I noticed as many as 10-15 individuals/habitat.

The anthropic impact on *Salamandra salamandra* is represented mainly by deforestation that affects the habitat of the species. Deforestation continues in the present in the investigated area.

### 4.2. The distribution of *Mesotriton alpestris* (Laurentus, 1768)

*Mesotriton alpestris* represents, probably the most important contribution of this study to a better knowledge of Almaş-Agrij Depression herpetofauna and of Romanian herpetofauna in general. This species was identified for the first time in 2 localities in the investigated area. The mountain newts were also re-identified in 3 of the localities where they have recently been found (Covaciu-Marcov et al, 2009b) (fig. 4).

It should be mentioned that before 2009 the mountain newt had been seen only in one locality in Sălaj county, namely in the surrounding area of Muntele Şes (Ghira et al, 2002), which is situated outside of the investigated area.

The mountain newts live between 400 m and 800 m in altitude. Considering this, it is important, both the identification of the species in more localities, where it had not been seen before and the rediscover of populations living at 400 m high and also identification of a population situated at 487 m high, taking into consideration that

according to the data in the Romanian scientific studies the species can be found from 500 m or 700 m high (Fuhn, 1960 a; Cogălniceanu et al, 2000).

Although it was noticed only in 5 localities the mountain newts reproduce in all localities in many habitats. Larger populations live in quasi-permanent habitats supplied by low flow streams. In Măgura Priei area there are 15 mating habitats. There can be found 50-60 individuals of *M. alpestris* in these habitats.

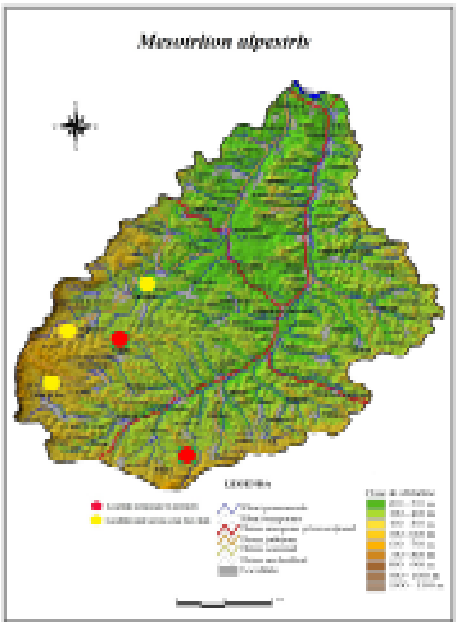


**Fig. 4.** The distribution of *Mesotriton alpestris* in the researched area (original)

*Mesotriton alpestris* is less exposed to human impact due to its habitat, which consists mostly of forests where human rarely interfere. Yet, deforestation can threaten in future the life of this species.

### 4.3. The distribution of *Triturus cristatus* (Laurentus, 1768)

*Triturus cristatus* is a species well represented in the Almaş-Agrij Depression. I identified it for the first time in Romanian herpetofauna research history in 12 localities in addition to the 10 localities in which I only acknowledged that it can be found. The crested newt is common in the investigated area both in the mountainous Meseş area or in the hillside region or even along river meadows. The species lives from 180-190 m in altitude, from he Someş River meadow, where the Almaş and the Agrij rivers flow into the Someş up to 600 m in the villages of Huta, Mesteacănu or Jebucu (fig. 5).

The populations of *Triturus cristatus* investigated in the investigated area are relatively large. In some large permanent habitats I captured as many as 100 individuals. The anthropic impact on this species is, mainly, overlapped on the one displayed on the populated wet areas along the Someş River meadows, the populations are endangered because of the efforts to turn swamps into fish breeding farms.

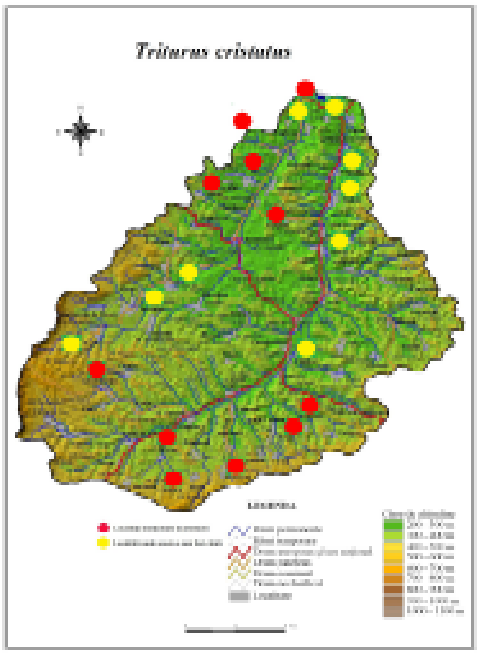


**Fig. 5.** The distribution of *Triturus cristatus* in the researched area (original)

**4.4. The distribution of *Lissotriton vulgaris* (Linnaeus, 1758)**

*Lissotriton vulgaris* is better represented than the crested newt in the Almaş-Agrij Depession (fig.6). The common newts were identified in 17 new localities for Romanian herpetofauna. In addition the species was also re-identified in 4 other localities in which it had been recorded before (Ghira et al, 2002).

*Lissotriton vulgaris* is the least unpretentious of the newt species in the investigated area as far as the used aquatic habitat is concerned, fact which had been mentioned before (Cogălniceanu et al, 2000). Thus, the common newts live in any water puddle that is not affected by humans.

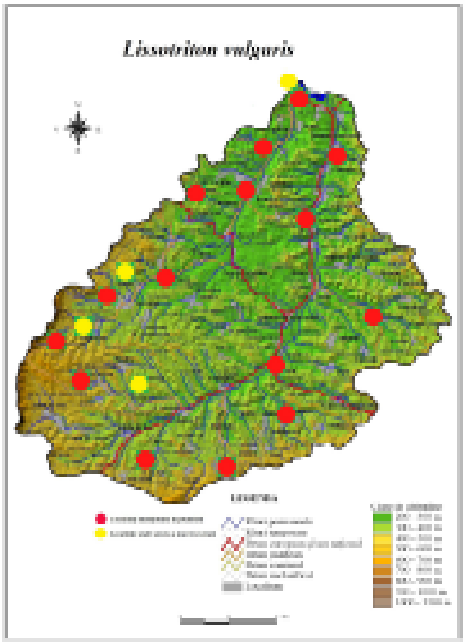


**Fig. 6.** The distribution of *Lissotriton vulgaris* in the researched area (original)

The threats are similar to those that put the other species in danger.

**4.5. The distribution of *Bombina variegata* (Linnaeus, 1758)**

*Bombina variegata* is the most common species of amphibians in Almaş-Agrij Depression, having been identified in 65 of the 68 villages analyzed (fig.7). The yellow-bellied toad is equally spread in the studied area. As for the altitude *B. variegata* lives from lower altitude of the region, 180 m in the Someş River meadow up to 800 m in the high parts of Măgura Priei, but it surely lives even higher. Despite these, taking into consideration that in Almaş-Agrij Depression the altitude drops to 180 m in the Someş River meadows I did not encountered *Bombina bombina.*

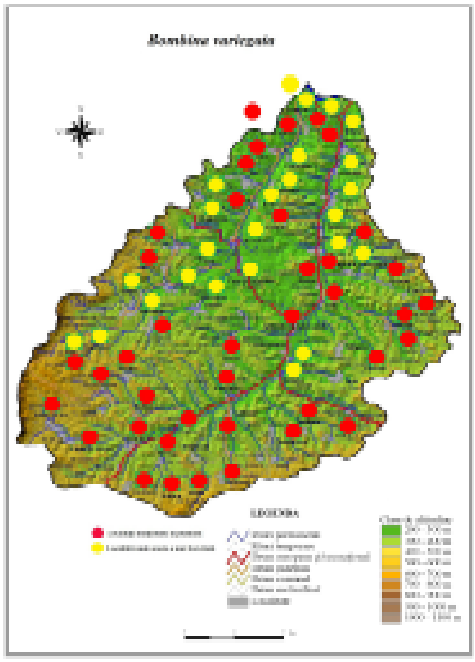


**Fig. 7.** The distribution of *Bombina variegata* in the researched area (original)

*Bombina variegata* is not only the most common species in Almaş-Agrij Depression, but also the least fastidious as far as the habitat is concerned. It is also the best represented species in the studied area and is not subject to serious anthropic impact. The species also has the advantage of great ecological adaptability.

**4.6. The distribution of *Bufo bufo* (Linnaeus, 1758)**

*Bufo bufo* is more scarce than the previous species. It is less represented in the Almaş-Agrij Depression both in number of individuals and of localities where they can be identified. The species was seen in 18 localities, of which 8 localities are new habitats for Romanian herpetofauna. The common toad lives both in the lower area of the Someş river meadows and in the higher regions of Măgura Priei (fig. 8). The common toad lives in wet areas, mainly natural areas and seldom in artificial areas. In addition all the localities where it was identified are situated on or around Meseş Mountain. The scarcity of the species could be a consequence of the scarcity of suitable mating habitats which are rather rare in the area.

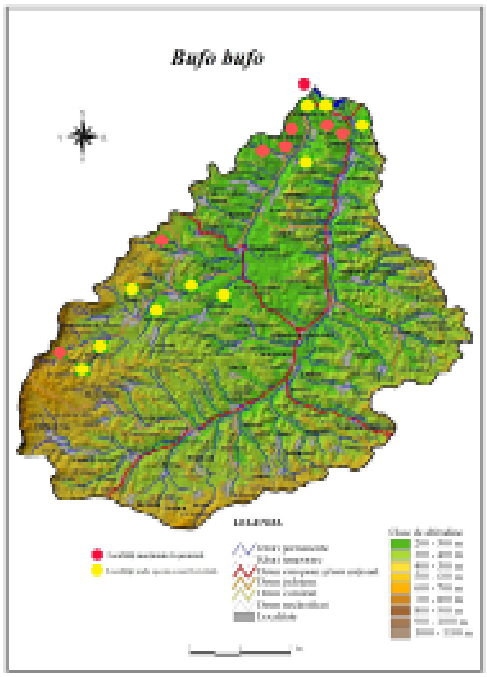


**Fig. 8**. The distribution of *Bufo bufo* in the researched area (original)

The human impact on the common toad is similar to that described as influencing the other species: deforestation and traffic that causes high mortality rates.

### 4.7. The distribution of *Epidalea viridis* (Laurentus, 1768)

*Epidalea viridis* is even scarcer than the common toad, being identified in few localities (9 localties of which 3 are new) situated mainly in the hydrographic basin of the Agrij valley. The green toad lives between 200-600 m in altitude (fig. 9).

*Epidalea viridis* is a species that inhabits areas intensively affected by human such as watering places or in temporary puddles polluted with domestic waste. The anthropic impact on the species is shown in mortality rate because of traffic.

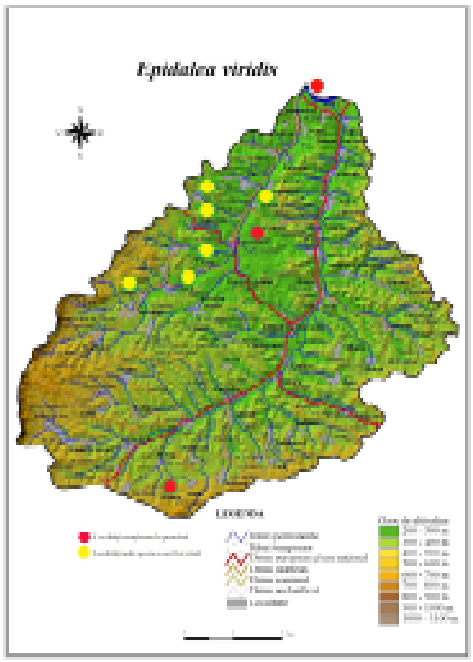


**Figura 9**. The distribution of *Epidalea viridis* in the researched area (original).

### 4.8. The distribution of *Hyla arborea* (Linnaeus, 1758)

*Hyla arborea* is a species better represented than the previous one, being identified in many localities (18), situated on a larger area of the Almaş-Agrij Depression (fig. 10). It has a relatively uniform spreading in the studied area, being identified both in the hydrographic basins of Almaş and Agrij valleys.

The main dangers are deforestation, draining mires, which are frequent dangers in Romania (Iftime 2005 a).

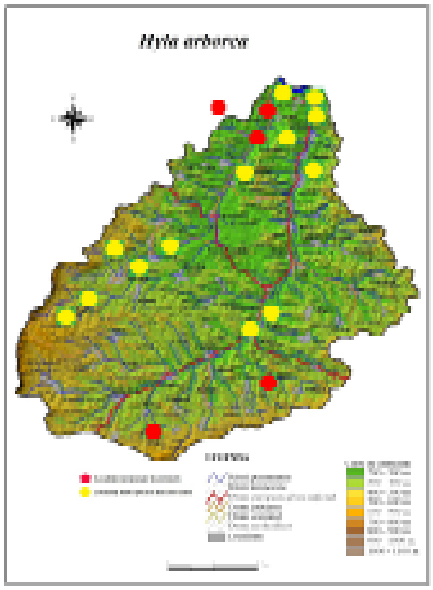


**Fig. 10.** The distribution of *Hyla arborea* in the researched area (original)

### 4.9. The distribution of *Pelophylax ridibundus* (Pallas, 1771)

*Pelophylax ridibundus* is a common species in Almaş-Agrij Depression, being identified in many localities (36).

The largest populations of *Pelophylax ridibundus* in Almaş-Agrij Depression are located in the Someş River meadow and down-stream Agrij and Almaş valleys (fig. 11). As they move upstream the number of individuals diminishes once the habitats provide unsuitable living conditions.

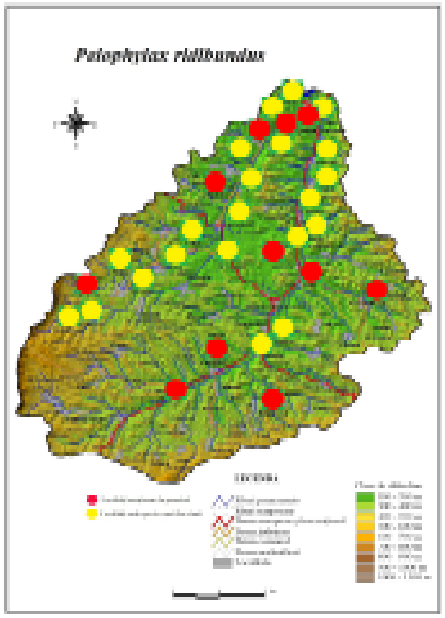


**Fig. 11.** The distribution of *Pelophylax ridibundus* in the researched area (original)

None of the studied individuals showed any characteristic features of the hybrid fom *Pelophylax esculentus,* which is a hybrid between *P. ridibundus* and *P. lessonae.* In the investigated area it was not identified any *P. lessonae.*

As it inhabits the lower areas of the Almaş-Agrij Depression *P. ridibundus* gets into contact more often with humans than other amphibians. Yet, the species is well represented in the area, the populations being large and widely spread. This fact is a consequence of the great ecological adaptability of the species that tolerates both in artificial or polluted habitats. The marsh frog is affected by changes of the quality of water because of pollution with domestic waste or with oil waste resulting of farming machinery.

### 4.10. The distribution of *Rana dalmatina* (Bonaparte, 1839)

*Rana dalmatina* is after *Bombina variegata* the second species as far as the localities where they were identified are concerned (64). This species is evenly spread in the area irrespective of altitude, from the valleys meadows up to the higher areas of Meseş Mountain at 800 m in altitude (fig. 12). The agile frog is one of the amphibian species which is used in alimentary purposes by locals.

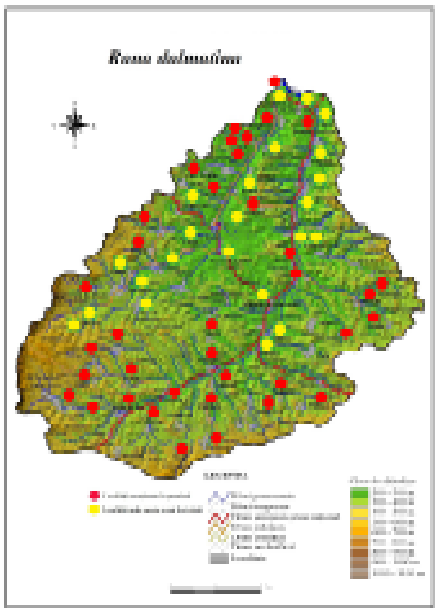

**Fig. 12.** The distribution of *Rana dalmatina* in the researched area (original)

### 4.11. The distribution of *Rana temporaria* (Linnaeus, 1758)

*Rana temporaria* is a common species in Almaş-Agrij Depression of Sălaj county, though it is not represented in as many localities as its congener species. It can be found from 200 m in altitude up to the higher areas of Meseş Mountain (fig. 13). It must be mentioned the fact that the species is widely spread at 200 m in altitude although this is considered the lower limit of its habitat (Cogălniceanu et al, 2000).

The threats of this species are the same as in the case of its congener species. It must be also pointed out that they are consumed by the local people and, thus, this area is notorious among other areas.

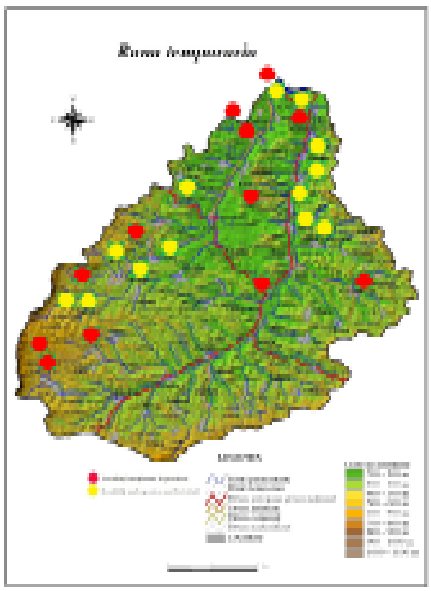

**Fig. 13.** The distribution of *Rana temporaria* in the researched area (original)

# V. THE FEEDING OF THE AMPHIBIANS

**5.1. Research materials and methods**

The stomach contents were obtained by using the stomach flushing method.
The analyzed parameters of the trophic spectrum were the following:

- The taxonomy affiliation of identified prey in the stomach contents of the amphibian species;
- The variation of the maximum and thye minimm number of prey/individual;
- The weight of a certain prey taxon on the whole of identified prey;
- The frequency on which the amphibians fed on a certain prey taxon. The affiliation of prey taxons to the aquatic or terrestrial habitat and the mass of prey from the two habitats;
- The Shannon-Wiener (H) diversity;
- Sorensen (S) (Chao et al, 2005) similarity.

The trophic spectrum was analysed in several amphibian populations belonging to several species. in the summary of the thesis I chose as an example of the research the trophical spectrum of two newt populations.

**5.2. The trophic spectrum in several populations of *Lissotriton vulgaris* and *Triturus cristatus***

In the present sub-chapter I studied, for the first time in Sălaj county, the trophical spectrum of two species of newts *Triturus cristatus* (90 individuals) and *Lissotriton vulgaris* (164 individuals).
The objectives of the research were as follow:

- To identify the contents of the food of the two species;
- To establish the differences between the two species and, if it was necessary, between the sexes of each species;
- To establish the native environment of the eaten prey;
- To identify the trophic strategies used by the 2 species;

The analysed newts originate from the four localities that live in the Almaș-Agrij Depression, both in the higher areas and in the lower sectors bordering the Someș riverside meadow.

***Results and debate***

Not all analysed newts had fed prior to capture. I identified individuals of both species of newts in 3 of the 4 studied habitats, with no stomach contents. In only one habitat, in Jibou, all newts had stomach contents. The fact that there were amphibians that had not fed within a certain period of time, usually proves the existence of unsuitable condition.
The presence of newts without food in Jebucu must be associated neither with some unfavourable thermic conditions, nor with them preparing to leave the water, but rather with the poverty of trophic offer which characterizes a temporary habitat.
The only habitat where there were no empty stomachs, the one in Jibou, was the largest of all researched areas. The newts that had no food in their stomachs were more frequent in the habitat of Gâlgăul Almaşului where 20,83% of the population had no fed prior to the research.

Within the comparative analyses of the no-food stomach frequences with the 2 species, it was determined that between the 2 species of newts there are significant differences as far as the number of empty stomachs is concerned (tab. 1).

**Table 1. The total number and the percentage of individuals with empty stomach in the researched habitats**

| **The habitat** | **All habitats** | | |
|---|---|---|---|
| **Species** | ***L. vulgaris*** | ***T. cristatus*** | **Total** |
| **Number of empty stomachs** | 13 | 2 | 15 |
| **Percentage of empty stomachs** | 7,92 | 2,22 | 5,9 |

As for the differences between sexes, in all cases the frequency of empty stomachs is higher with females (fig. 15). On this case it is possible that at the time of the sample collection, the mating season had ended, and, thus, the males had not been interested in this. In the same time, if the females were laying their eggs in that period, they stopped feeding.

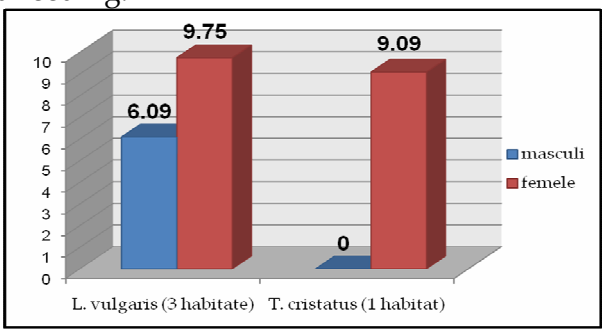


**Fig. 15. The percentage of individuals withy empty stomachs in both sexes**

**Table 2. The percentage of** individuals with empty stomachs in both sexes (M – males, F – females, T – total, T.c. - *Triturus cristatus*)

| **The habitat** | **Mesteacănu 22.04.2009** | | | | **Gâlgăul Almaşului 22.04.2009** | | |
|---|---|---|---|---|---|---|---|
| **Species** | ***L. vulgaris*** | | | ***T. c.*** | ***L. vulgaris*** | | |
| **Sex** | M | F | T | T | M | F | T |
| **Percentage of stomach with vegetals** | 24,1 | 71,4 | 47,4 | 55,6 | 41,7 | 50 | 45,8 |
| **Percentage of stomachs with shed skins** | 41,4 | 32,1 | 36,8 | - | 41,7 | 29,2 | 35,4 |
| **Percentage of stomachs with eggs** | 10,3 | - | 5,26 | 88,9 | - | - | - |
| **Percentage of stomachs with minerals** | - | - | - | - | 4,17 | 4,17 | 4,17 |

Continuing of table 2

| The habitat | Jibou 23.04.2009 | | | | Jebucu 27.06.2009 | | |
|---|---|---|---|---|---|---|---|
| **Species** | ***L. vulgaris*** | | | ***T. c.*** | ***T. cristatus*** | | |
| **Sex** | M | F | T | T | M | F | T |
| **Percentage of stomachs with vegetals** | 48,3 | 50 | 49,2 | 25 | 53,8 | 45,5 | 50 |
| **Percentage of stomachs with shed skins** | 3,45 | 23,3 | 13,6 | - | 23,1 | 9,09 | 16,7 |
| **Percentage of stomachs with eggs** | - | 3,33 | 1,69 | - | 7,69 | 72,7 | 37,5 |
| **Percentage of stomachs with minerals** | - | - | - | - | 7,69 | 9,09 | 8,33 |

The presence of vegetals with other types of prey confirms the assumption of accidental feeding on them.

Another category of trophic elements were the shed skins (tab. 2). These were represented in all cases by newt shed skins.

The highest frequency of feeding on shed skins is recorded in the habitats with poor trophic offer, within which the number of empty stomachs individuals was bigger too (Gâlgăul Almaşului and Mesteacănu). The eggs of amphibians were consumed in 3 of the 4 studied habitats (tab 2). This category of stomach contents was not found in the Gâlgăul Almaşului population of *Lissotriton vulgaris* (in that habitat not a single species of amphibians mated).

Another category of identified stomach contents were of inorganic provenence. This was explained as accidental, probably being swallowed together with the prey (Covaciu-Marcov et al, 2006f).

Altogether, the two species ate 1598 pieces of prey (tab. 3). *Lissotriton vulgaris*, a smaller species, ate more pieces, 904, and *Triturus cristatus,* in spite of being larger, ate only 694 pieces. The least of the total quantity of prey was eaten in the habitat of Gâlgăul Almaşului, and the most in the habitat of Jibou (tab.4). These data prove once more the scarcity of food of the Gâlgăul Almaşului population.

**Table 3.** Total number of prey and the maximum and average of preys/individuals

| The habitat | All the habitats | | |
|---|---|---|---|
| **Species** | ***L. vulgaris*** | ***T. cristatus*** | **Total** |
| **Total number of prey** | 904 | 694 | 1598 |
| **Maximum number of prey/individual** | 38 | 39 | 39 |
| **Average number of prey/individuals** | 5,51 | 7,71 | 6,29 |

As for the maximum number of prey/individual, the differences between *Triturus cristatus* and *Lissotriton vulgaris* are small. (tab. 3). The smallest maximum number of

prey/individual was found in the Gâlgăul Almaşului habitat, namely, as many as 3 preys/individuals (tab. 4).

**Table 4.** Total number of prey and maximum and average number of preys/individual in the studied habitats (M – males, F – females, T – total, T.c. - *Triturus cristatus*)

| **The habitat** | **Mesteacănu 22.04.2009** | | | | **Gâlgăul Almaşului 22.04.2009** | | |
|---|---|---|---|---|---|---|---|
| **Species** | ***L. vulgaris*** | | | ***T. c.*** | ***L. vulgaris*** | | |
| **Sex** | M | F | T | T | M | F | T |
| **Total number of preys** | 57 | 67 | 124 | 158 | 13 | 19 | 32 |
| **Maximum number of preys/individuals** | 8 | 6 | 8 | 17 | 2 | 3 | 3 |
| **Average number of preys/individuals** | 1,96 | 2,39 | 2,17 | 8,77 | 1,84 | 1,26 | 0,66 |
| **The habitat** | **Jibou 23.04.2009** | | | | **Jebucu 27.06.2009** | | |
| **Species** | ***L. vulgaris*** | | | ***T. c.*** | ***T. cristatus*** | | |
| **Sex** | M | F | T | T | M | F | T |
| **Total number of preys** | 392 | 356 | 748 | 298 | 110 | 128 | 238 |
| **Maximum number of preys/individuals** | 38 | 27 | 38 | 37 | 14 | 39 | 39 |
| **Average number of preys/individuals** | 13,51 | 11,86 | 12,7 | 12,41 | 4,23 | 5,81 | 4,96 |

All the populations of studied tritons fed mostly on aquatic prey (tab. 5). Nevertheless, in all habitats, both species and sexes, terrestrial prey was identified in the stomach contents. The quantity was usually small.

**Table 5.** The percentage of terrestrial and aquatic prey diminished in the studied habitats according to the habitat (M – males, F – females, T – total, T.c. - *Triturus cristatus*)

| **The habitat** | **Mesteacănu 22.04.2009** | | | | **Gâlgăul Almaşului 22.04.2009** | | |
|---|---|---|---|---|---|---|---|
| **Species** | ***L. vulgaris*** | | | ***T. c.*** | ***L. vulgaris*** | | |
| **Sex** | M | F | T | T | M | F | T |
| **The percentage of terrestrial preys** | 5,27 | 1,5 | 2,42 | 3,8 | 61,54 | 12,5 | 25 |
| **The percentage of aquatic preys** | 94,73 | 98,5 | 97,58 | 96,2 | 38,46 | 87,5 | 75 |
| **The habitat** | **Jibou 23.04.2009** | | | | **Jebucu 27.06.2009** | | |
| **Species** | ***L. vulgaris*** | | | ***T. c.*** | ***T. cristatus*** | | |
| **Sex** | M | F | T | T | M | F | T |
| **The percentage of terrestrial preys** | 0,52 | 7,59 | 1,48 | 45,5 | 56,37 | 34,38 | 45,54 |
| **The percentage of aquatic preys** | 99,48 | 92,4 | 98,52 | 98,32 | 43,63 | 65,62 | 55,46 |

I encountered habitats in which the mass of terrestrial prey is big. For example the habitat of Jebucu, where the mass of terrestrial prey was 45,54% of the total quantity.

The explanation of this situation is that in Jebucu habitat there are temporary puddles and the trophic offer is diminished, therefore the newts are obliged to hunt terrestrial prey.

In this case the consumption of terrestrial food is due to the abundance of warms in the vicinity of the habitat.

The largest diversity of food is consumed by the crested newts (tab. 6).

**Table 6.** Diversity of food (Shannon-Weaver) of newts in the researched habitats (M – males, F – fem, T – total)

| **Mesteacănu 22.04.2009** | | | | **Gâlgăul Almaşului 22.04.2009** | | | **Jibou 23.04.2009** | | | | **Jebucu 27.06.2009** | | | **Total** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***L. vulgaris*** | | | ***T. cristatus*** | ***L. vulgaris*** | | | ***L. vulgaris*** | | | ***T. cristatus*** | ***T. cristatus*** | | | ***L. vulgaris*** | ***T. cristatus*** |
| M | F | T | | M | F | T | M | F | T | | M | F | T | | |
| 1,48 | 1,55 | 1,61 | 0,78 | 1,67 | 1,73 | 1,9 | 1 | 1,22 | 1,4 | 1,5 | 1,23 | 1,55 | 1,12 | 1,79 | 1,9 |

Totally, the 2 species of newts fed on prey belonging to 21 prey taxons (tab. 7).

| Prey taxons | |
|---|---|
| *Lissotriton vulgaris* | *Triturus cristatus* |
| Nematoda | Annelida – Oligochaeta |
| Annelida – Oligochaeta | Gastropoda - melci (terestri) |
| Gastropoda (acvatice) | Bivalvia |
| Bivalvia | Crustacea – Cladocera |
| Arachnida – Araneae | Crustacea – Ostracoda |
| Crustacea – Cladocera | Coleoptera – Dytiscidae (l.) |
| Crustacea – Ostracoda | Coleoptera – Dytiscidae |
| Crustacea – Copepoda | Coleoptera – Carabidae |
| Ephemeroptera (l) | Coleoptera (ter.) |
| Plecoptera (l) | Coleoptera (nedet.) |
| Homoptera – Aphidinea | Diptera - Nematocera (l.) |
| Coleoptera – Dytiscidae | Diptera – Brachycera |
| Coleoptera - Dytiscidae (l) | Lepidoptera (l.) |
| Coleoptera (terestre) | Trichoptera (l.) |
| Diptera - Nematocere (l) | Anura (l.) |
| Diptera - Nematocera – Culicidae | |
| Diptera – Brachycera | |
| Lepidoptera (l) | |
| Trichoptera (l) | |
| Anura (l) | |

**Table 7.** The taxons for *Lissotriton vulgaris* and *Triturus cristatus* in the researched habitats

Of the 21 prey taxons, *Lissotriton vulgaris* consumed 20, and *Triturus cristatus* fed on less, consuming only 15 (tab 7).

There are numerous larva in the stomach contents and they are an advantageous energetic trophic category as they are rich in fats (Brooks et al, 1996).

In the case of *Lissotriton vulgaris* the micro crustaceous had been mostly consumed, being mainly *Ostracoda* but also *Cladocera.* Unlike the common newts, *Triturus cristatus* consumed mostly amphibian larva, but *Diptera Nematocera* larva too. The prey taxon generally consumed is the *Diptera Nematocera* larva in all habitats. The mosquito larva is a fundamental trophic resource for many newt populations (Covaciu-Marcov et al, 2002c; Cicort-Lucaciu et al, 2005a; Dobre et al, 2007).

Average sided prey was mainly consumed by the larger species and the smaller species fed on smaller prey.

The differences in feeding can give evidence of using different trophic strategies by the two species of newts on research. In the case of *Lissotriton vulgaris*, the consumption of smaller prey proves the existance of "active foraging" trophic strategy. This implies active foraging, looking for the prey, and automatically it triggers higher energy consumption in the process (Anderson & Karasov, 1981). The crested newts seem to use "sit and wait" strategies, saving energy and attacking larger prey they encounter.

# VI. THE ANALYSES OF MORPHOLOGIC FEATURES OF *BOMBINA VARIEGATA* POPULATIONS IN THE ALMAȘ-AGRIJ DEPRESSION COMPARED TO THE FEATURES OF *BOMBINA BOMBINA*

The research was carried out in the sprinf of 2009. I analysed 249 individuals of *Bombina variegata* from 9 localities in the Almaş-Agrij Depression.

The method used to establish the affiliation of the populations involves the analyses of the main morphologic and chromatic features of the two species, that are divided in two grids that represent standard models of study in this field.

The first grid analyses the morphology, sizes and position of light ventral spots (tab. 8).

**Table 8.** Grid 1- the differentiation of the species of *Bombina*: the ventral model

| **The character (light spots on the:)** | | Bombina bombina | Bombina variegata |
|---|---|---|---|
| 1 | Chin – chin | Separated | United |
| 2 | Chin – chest | Separated | United |
| 3 | Chest – Chest | Separated | United |
| 4 | Chest – shoulder | Separated | United |
| 5 | Shoulder – arm | Separated | United |
| 6 | Chest – abdomen | Separated | United |
| 7 | Abdomen– abdomen | Separated | United |
| 8 | Abdomen – basin | Separated | United |
| 9 | Basin – basin | Separated | United |
| 10 | Basin – thigh | Separated | United |

The degree of confluence or separation of different ventral spots is scored for 10 chromatic groups. When the light spots are separated by a black pigment, a *B. bombina* feature is shown. If the spots are united the feature is similar to *B. variegata.*

The second grid analysis 10 features as well, and was used by Stugren (1980) and modified by Ghira & Mara (2000) (Table 9).

**Table 9.** Grid 2 – the differentiation of the species of *Bombina.*

| **Caracterul** | | ***Bombina bombina*** | ***Bombina variegata*** |
|---|---|---|---|
| 1 | Color of light ventral spots | Red, orange, yellowish | Yellow |
| 2 | Color of the top of fingers | Black | Yellow |
| 3 | Dorsal color | Black | Pale grey |
| 4 | Relation between tarsal and plantar light spots | Separated | United |
| 5 | Ventral color | Orange spots on black background | Black spots on yellow background |
| 6 | Relation between the head length and width | Length > width | Length < width |
| 7 | The drawing of the lateral and ventral parts | White spots around the verrucae | Without white spots around the verrucae |
| 8 | Aspect of the dorsal black tubercles | Regulated | Scattered or absent |
| 9 | The aspect of the dorsal verrucae | Lens-shaped, squatted | Sharp, rough |
| 10 | Ratio of tibia-tarsian joints when the legs segments are parallel | Not touching | Touching |

For both grids each feature receives a mark: 1 if it is expressed like *B. variegata* and 0 if it is expressed like *B. bombina.*

***Results and discussions***

All the populations studied in Almaş-Agrij Depression belong to *Bombina variegata* as they have most of the characteristics of the species. Nevertheless, none of the studied populations is *B. variegata* pure, as they have features of *B. bombina,* dispute the fact that this had not been identified in the area, and the closest red-bellied toad populations can be found tens of kilometers off.

The percentage of *B. variegata* features is different in the 9 populations, varying between 69,33% and 78,9% (fig. 16).

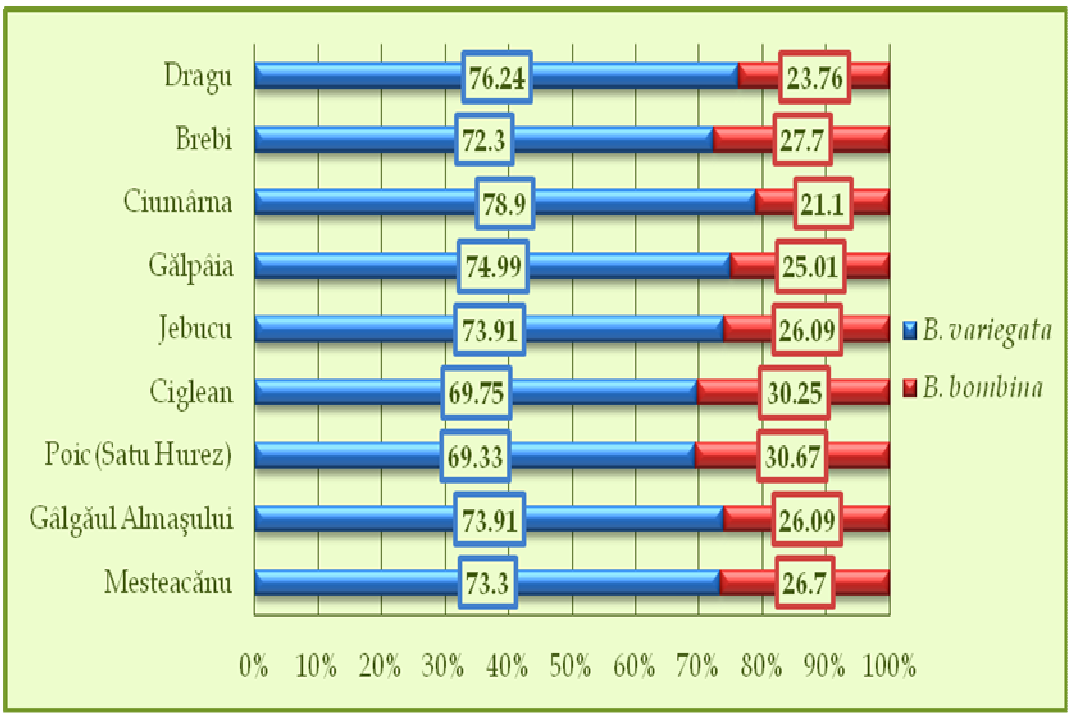


**Fig. 16.** The percentage of *Bombina bombina* features in the *Bombina variegata* populations

# VII. THE ANTHROPIC IMPACT ON SOME AMPHIBIAN POPULATIONS IN ALMAŞ-AGRIJ DEPRESSION

The amphibians are threatened because of different activities such as: collecting for preparing dishes from them, deforestation, puddles that go dry, intensive farming, pollution, diseases, etc (Alford & Richards, 2000; Biek et al., 2001; McCallum, M.L., 2007).

In the report presented by Romania within the Convention of Berne that took place in Malmö (Sweden) between 26-27th September 2003, it is pointed out the alarming situation of the 2 species of amphibians: *Rana dalmatina* and *Rana temporaria.*

In Romania frog legs are considered culinary delicacy. Collecting and slaughtering frogs take place in spring before mating season, when adults get together in puddle for mating; the massacre happens before females lay their eggs. Approximately 200 adult frogs are slaughtered in order to obtain a kilogram of hind legs.

## 7.1. Collecting breeding frogs for alimentary purposes

The localities where amphibians are eaten are those situated along Agrij Valley: Agrij, Bodia, Buciumi, Bogdana, Huta, Measteacăn, Bozna, Sângeorgiu de Meseş. As a result of the many discussions with the villagers, we concluded that frog legs are very appreciated, they eating them because it is a spring tradition and, thus, entire populations are slaughtered (fig. 17).

**Fig. 17.** Slaughtered frogs in different habitats on Agrij Valley

## 7.2. The anthropic impact on amphibian populated habitats

The degradation of many amphibian species habitats was noticed because of farming, gravel pit exploitation (fig. 18), deforestation (fig. 19), household pollution, road building, etc.

Gravel pits have a dramatic consequence on the environment. These destroy the natural habitats of the amphibians. They change the valleys course and pollute the environment with different substances.

**Fig. 18.** Destruction of habitats bcause of gravel pit exploitation on the Rât Valley in Almaş area

a. b.

**Fig. 19.** Causes of the amphibians' extinction: traffic (a), deforestation near Fildu de Sus (b)

In the researched area there are evident traces of polluted habitats and household pollution (fig. 20).

**Fig. 20.** Household waste on the banks of Agrij Valley, near Bogdana village

**7.3. Students involvement in herpetofauna protection**

We initiated a project on amphibian protection as a result of the situation we noticed of whilst we researched the ares. Our parteners were "The Romanian Herpetology Society", "Babeş-Bolyai" University in Cluj-Napoca, "The Foundation for Partnership" in Miercurea Ciuc, Sălaj County School Inspectorate, The Agency of

Environment of Sălaj County and The Sălaj County Environment Guard. Many students from different schools in Sălaj county were involved in the project.

The aim of the project was to get knowledge of, to survey and to protect the frog fauna in the surrounding area of the town of Zalău, as well as to stop slaughtering of brown frog populations during the mating season, by making the locals to be aware of their importance and changing the people's attitude towards these species and last, but not least to convince people to give up their habit of eating them. Two species were targeted in the course of the project: *Rana dalmatina* and *Rana temporaria.*

**The objectives of the projects:**

1. To survey the puddles during the mating season;
2. To evaluate the spreading of frog eating phenomenon, to sensitize the locals and make them cooperate in implementing the project and finally to change their attitude by giving up this habit;
3. To disseminate the project in the media;
4. To obtain legal prohibition of collecting the 2 amphibians during the mating season. This objective has been accomplished in collaboration with the Romanian Herpetology Society.

***Survey of habitats***

The survey of the puddles during the amphibians' mating season was the first stage of the project. There were many organized trips during which the students surveyed the populations of amphibians and recorded the data on monitoring sheets (fig. 21).

**Fig. 21.** Collecting and observing the amphibian species

In order to study the effect of frog legs eating on the amphibian populations and to get knowledge of the dimension of the phenomenon in Agrij Valley, the students made a survey with 50 people of different ages, educations, who live in the villages where amphibian "massacre" was recorded: Bucium, Bogdana and Huta. The results were shown in the grids and diagrams (fig. 22).

The students wanted to find out how many people eat frog legs and what are their reasons.

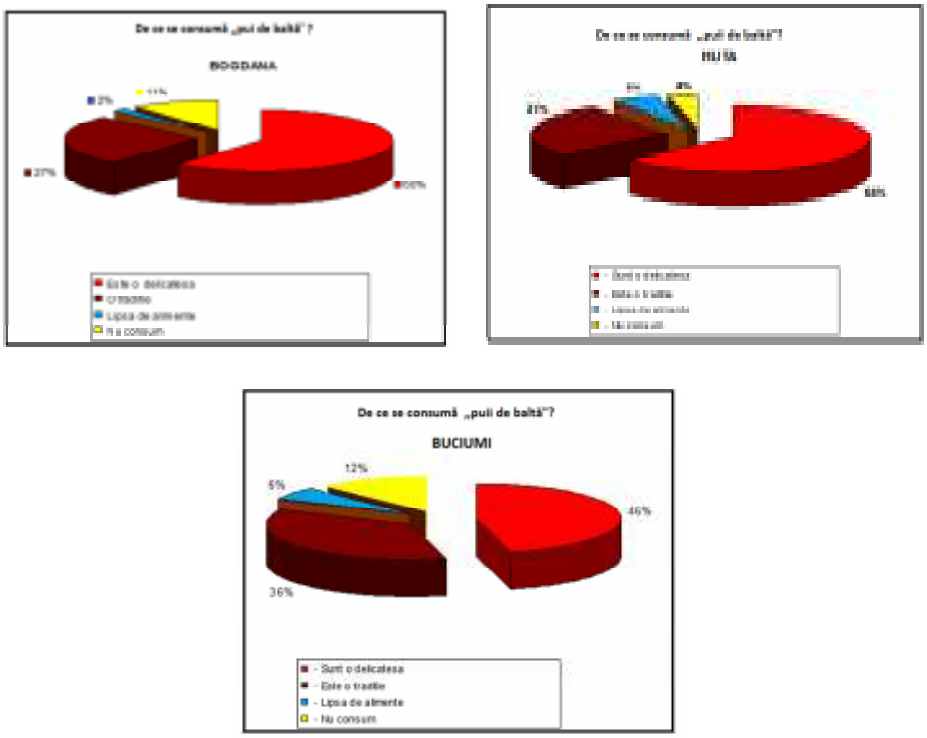


**Fig. 22**. The Bogdana, Huta şi Buciumi villagers' motivation regarding the consumption of frog legs

Most of the interviewed people consider frog legs exquisite food.

Another survey aimed to find out if people are aware of the legislation regarding the protection of eadible frogs.

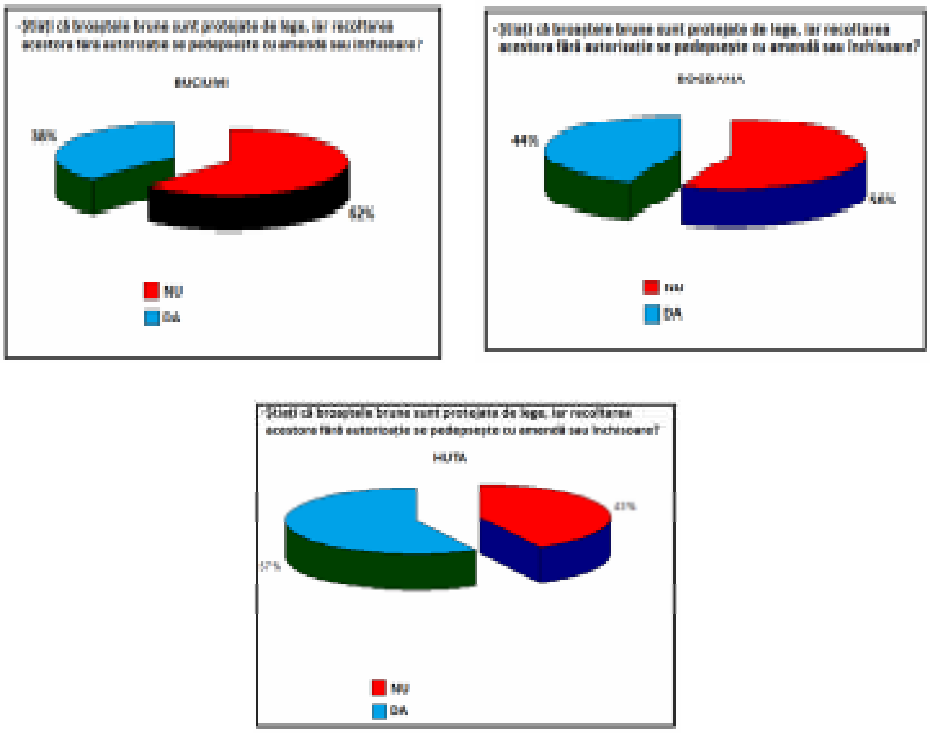


**Fig. 23.** The percentage of the people who know the legislation regarding the protection of eadible frogs

Analysing the grids, it becomes obvious that most of the interviewed people from the 3 villages do not know that the slaughtered species are protected and they can be fined if they collect frogs without a license (fig 23). Therefore, a campain was initiated so that the people could receive information related to this problem.

***Sensitizing the villagers***

A leaflet and a poster were issued and their purpose was to sensitize the locals so that they would stop slaughtering the frogs during the mating season (fig. 24). These materials were made in collaboration with the "Romanian Herpetology Society" and with the financial support of "The Foundation for Partnership" in Miercurea Ciuc.

In February 2005, there were many activities meant to make the locals aware that it is important to protect the species during the mating season. Leaflets and posters were given away in the schools in the villages of Buciumi, Huta and Bogdana. The posters were displayed at the Mayor's Office and all public places. Many leaflets were given to villagers (fig. 25).

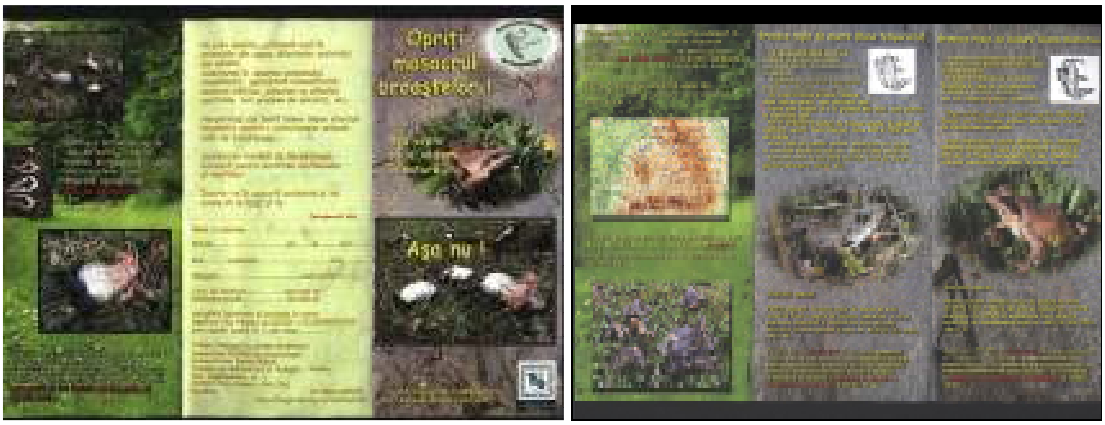


**Fig. 24.** The leaflet published with the collaboration of the Romanian Herpetology Society and The Miercurea Ciuc Foundation for Partnership

**Fig. 25.** Giving away leaflets to villagers

Articles were written in the local and national newspapers and news were broadcasted on all important TV channels (fig. 26). The news were broadcast on prime time and had a great impact on the population. Its aim was to make the phenomenon known, to make people aware of the importance of these species in nature and, consequentely, of the necessity to protect them.


**Fig. 26.** Articles in the local newspapers

*The evaluation of the project*

Between 2004 and 2005, the project "S.O.S. Endangered Frogs!" won all the environment protection competitions it entered: The National Evironment Protection Competition, Iaşi 2004, The Environment Ford Galla, 2004, The National Students's Council Projects Competition, The Excellence Award for Research at the National Ecology and Dendrology Conference, **The Golden Medal at the "International Environment Olympiad", Istanbul 2005, The bronze Medal at the "Mostratec" International Science Fair, Brazil, 2005** (fig. 27-31).


**Fig. 27.** The Romanian stand at the International Environment Olympiad "S.O.S. Endangered frogs!" (**Golden Medal**)


**Fig. 28.** First prize and the Golden Medal Certficate at the International Environment Olympiad, Istanbul, 2005


**Fig. 29**. Prize winning ceremony at the "Mostratec International Science Fair" Brazil (**Bronze Medal**)


**Fig. 30.** 3rd prize and Bronze Medal Certificate at "Mostratec International Science Fair" Brazil (**Bronze Medal)**

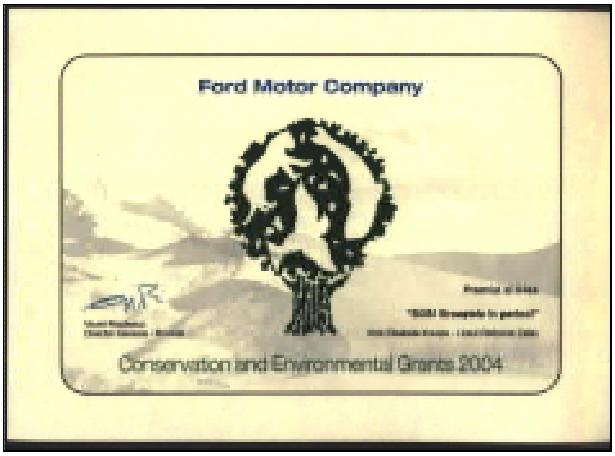


**Fig. 31.** Certificate obtained at the Ford Prizes for Environment Galla, 2004

The succes of the project "S.O.S. Endangered Frogs!"was vastly presented in the media and, thus, it drew people's attention to the importance of the amphibian protection (fig. 32).


**Fig. 32.** Article in the local press referring to the international success of the amphibian protection project

# CONCLUSIONS

- There are 11 amphibian species in the habitats of Almaş–Agrij Depression in Sălaj county: *Salamandra salamandra, Mesotriton alpestris, Triturus cristatus, Lissotriton vulgaris, Bombina variegata, Bufo bufo, Epidalea viridis, Hyla arborea, Pelophylax ridibundus, Rana dalmatina* şi *Rana temporaria*.
- I analysed the distribution of amphibians in 68 localities , 373 habitas of which 168 habitats had not been researched before and thus, these results are a scientific premiere in domain.
- The results we obtained referring to the distribution of amphibian species were predictable as compared to the situation in Romania. With one exception, there are no surprisez as far as the distribution of the species, the limiting factors of spreading (altitude and habitat limiting factors). It were recorded no particularities of the biology or ecology of the species compared to other regions of Romania or to their habitat in the broad sense of the word.
- There are some diferences between the amphibian fauna in the Almaş and Agrij hidrographic basins. Thus, the situation in Agrij basin is similar to that on the western part of Romania, which is proved by the presence of the mountain newt and lizard at lower altitude. Almaş basin misses these characteristics housing a more uniform amphibian fauna which is tipically Transylvanian. The differences between the two basins are a result of the relief as Almaş area is unvarying with lower altitude. Unlike this, Agrij valley is situated in the vicinity of Meseş Mountain which makes possible the presence of the mountain newt.
- *Salamandra salamandra* is a species that was identified only in the forest area af Almaş-Agrij Depression. The salamander was seen for the first time in 9 localities and it was re-identified in 11 localities where it had been noticed before.
- An important result of our research was identifying and reidentifying some population of *Mesotriton alpestris* at about 400 m in altitude.
- *Triturus cristatus* is a well represented species in Almaş-Agrij Depression. I identified it for the first time in Romanian herpetofauna history, in 12 localities in addition to the 10 localities where we only confirmed it existed.
- *Lissotriton vulgaris* is better represented than the crested newt in Almaş-Agrij Depression. The common newts were identified in 17 new localities, the species was found again in 4 localities where it had been signaled before.
- *Bombina variegata* is the most common amphibian species in Almaş-Agrij Depression, being identified in 65 of the 68 researched localities.
- *Bufo bufo* is a more scarce species being less represented in Almaş-Agrij Depression both in number of localities and in number of individuals. The species was found in 18 localities, 8 of them being new for the Romanian herpetofauna.
- *Epidalea viridis* is even more scarce than the common toad as it was noticed in 9 localities (3 of them are new) situated mainly in the hydrographic basin of the Agrij valley.
- *Hyla arborea* is a better represented species than the previous one, having been identified in a large number of localities (18) situated in a wide area of Almaş-Agrij Depression.

- *Pelophylax ridibundus* is a common species in Almaş-Agrij Depression and it was noticed in many localities (36).
- *Rana dalmatina* is, after *Bombina variegata,* the second species by the number of localities where it was seen. The agile frog can be found in many localities (64) and is unvaryingly spread in the researched area.
- *Rana temporaria* is like its congener, a common species as it was noticed in 30 localities.
- The feeding of the 6 amphibian species whose trophic spectrum was studied was widely influenced by the characteristics of the habitats in which these live. The composition of the food of other species that hunt in the same territory is extremely similar. The trophic spectrum of populations of the same species that live in different habitats is very different too, evan if we compare samples collected in the same day, in the same weather conditions. There is no food competition among the amphibian species that hunt in the same habitats, or the competition is insignificant. Both the particularities of the habitats and the sampling time influence the composition of the amphibian trophic spectrum. Broadly all 6 species consumed different animal prey from tens of prey taxons. In addition to these, the stomach contained vegetal remains, skin shed remains, minerals, and, in the case of the aquatic species, amphibian eggs. Vegetal remains seem to be swallowed accidentally together with the prey. Terrestrial species feed on terrestrial prey, aquatic species feed on aquatic prey but, if there are habitats with a diminished trophic offer, terrestrial prey replaces aquatic ones.
- Although that in Almaş-Agrij Depression the only species of *Bombina* is *B. variegata,* all the populations of this studied species have *B. bombina* features. Their number vary at analysed populations. There are characteristics which at the most of *B. variegata* individuals are similar to those of *B. bombina.* Despite the fact that between the researched populations there is on at 400 m in altitude, the number of features seem not to be influenced by altitude.
- Almaş-Agrij Depression and Sălaj county are widely anthropically influenced areas and greately altered. The anthropic impact is represented by deforestation and intensive farming. Deforestation is a continuous process, affecting forest species such as *Salamandra salamandra, Mesotriton alpestris* or *Rana temporaria*. Intensive grazing is another negative aspect that influences negatively the species in mires and deforested areas. Domestic waste can be found in the villages surrounding areas and they can have an impact on the habitats during the mating seasons. Last, but not least a general and global cause of the amphibian decline is traffic that results in high mortality rates.
- Within the researched area serious protection measures are necessary. In addition, legal procedures should be imposed in order to stop people slaughter amphibians during the mating season. Sensitising actions of the villagers must be continued so that they become aware of the importance of these species in the ecosystems they live.

## PUBLISHED ARTICLES FOR THE THESIS

1. **Kovacs, I., Covaciu-Marcov, S.D., 2010,** STUDIES REGARDING SOME POPULATIONS OF *BOMBINA VARIEGATA (*AMPHIBIA*)* FROM ALMAŞ-AGRIJ DEPRESSION, SĂLAJ COUNTY, ROMANIA, Anales of the University of Craiova, vol. XIV, p. 493-499.
2. **Kovacs, I. David, A. Ferenți, S. & Dimancea, N., 2010,** THE FOOD COMPOSITION OF TWO BROWN FROG POPULATIONS *(RANA DALMATINA* AND *RANA TEMPORARIA*) FROM SĂLAJ COUNTY, ROMANIA, Biharean Biol., Vol.4., No.1, p. 7-14.
3. **Kovacs, I., 2010,** CHANGING THE STUDENTS' ATTITUDE TOWARDS THE HERPETOFAUNA, Parteneriat în Educația pentru Mediul Înconjurător, Editura DECESFERA, vol. VI, p 140.
4. **Covaciu-Marcov, S.D., Kovacs, I, Cicort-Lucaciu, A.Ş., Sas, I. Secare, P., 2009,** DATA UPON THE COMPOSITION AND THE GEOGRAPHIC DISTRIBUTION OF THE HERPETOFAUNA OF THE ALMAŞ-AGRIJ DEPRESSION (SĂLAJ COUNTY, ROMANIA), Studii şi comunicări. Ştiințele naturii, Tom. XXV/2009.

# SELECTIVE BIBLIOGRAPHY


1. **Călinescu, R., 1935.** CONTRIBUȚIUNI SISTEMATICE ŞI ZOOGEOGRAFICE LA STUDIUL AMPHIBIILOR ŞI A REPTILELOR DIN ROMÂNIA. Academia Română: Memoriile secțiunii ştiințifice (seria 3), 7 (7): 119-291.
2. **Cicort-Lucaciu, A.Ş., Ardeleanu, A., Cupşa, D., Naghi, N., Dalea, A. 2005a.** THE TROPHIC SPECTRUM OF A *TRITURUS CRISTATUS* (LAURENTUS 1768) POPULATION FROM PLOPIŞ MOUNTAINS AREA (BIHOR COUNTY, ROMANIA). N. West. J. Zool., 1: 31-40.
3. **Cogălniceanu, D., 1997a.** PRACTICUM DE ECOLOGIE A AMFIBIENILOR – METODE ŞI TEHNICI ÎN STUDIUL ECOLOGIEI AMFIBIENILOR. Ed. Univ. din Bucureşti, 122p.
4. **Cogălniceanu, D., Aioanei, F., Bogdan, M., 2000.** AMFIBIENII DIN ROMÂNIA. DETERMINATOR. Ed. Ars Docendi, Bucureşti, 99p.
5. **Covaciu-Marcov, S.D., Ghira, I., Venczel, M., 2000b.** CONTRIBUȚII LA STUDIUL HERPETOFAUNEI DIN ZONA ORADEA. Nymphaea, Folia Naturae Bihariae, 28: 143-158.
6. **Covaciu-Marcov, S.D., Telcean, I., Cupşa, D., Schircanici, A., Sas, I., 2002g.** CERCETĂRI ASUPRA POPULAȚIILOR DE *BOMBINA BOMBINA* (AMPHIBIA, ANURA) DIN NORDUL JUDEȚULUI BIHOR (ROMÂNIA). Analele Univ. din Oradea, Fasc. Biol., 9: 59-69.
7. **Covaciu-Marcov, S.D., Kovacs, I., Cicort-Lucaciu, A.Ş., Sas, I., Secare, P., 2009c.** DATA UPON THE COMPOSITION AND GEOGRAPHIC DISTRIBUTION OF THE HERPETOFAUNA OF THE ALMAŞ-AGRIJ DEPRESSION (SĂLAJ COUNTY, ROMANIA). Oltenia, Studii şi Comunicări, Ştiințele Naturii, 25: 173-179.
8. **Fuhn, I.E., 1960a.** FAUNA R.P.R., AMPHIBIA (vol. 14, fasc. 1). Editura Academiei R.P.R., 288p.
9. **Fuhn, I.E., 1964**. SITUAȚIA ACTUALĂ A FAUNEI NOASTRE DE AMFIBII ŞI REPTILE ŞI OCROTIREA EI. Ocrot. Nat., 2: 231-248.
10. **Fuhn, I.E., 1969.** BROAŞTE, ŞERPI, ŞOPÂRLE. Ed. Ştiințifică, 246p.
11. **Ghira, I., Ghile, P., 1997.** CONTRIBUȚII LA STUDIUL HERPETOFAUNEI JUDEȚULUI SĂLAJ. Natura Silvaniae, 1: 169-176.
12. **Ghira, I., Venczel, M., Covaciu-Marcov, S.D., Mara, G., Ghile, P., Hartel, T., Török, Z., Farkas, L., Rácz, T., Farkas, Z., Brad, T., 2002.** MAPPING OF TRANSYLVANIAN HERPETOFAUNA. Nymphaea, Folia Naturae Bihariae, 29: 145-203.