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# THE STUDY OF THE TROPHIC SPECTRUM OF *BOMBINA BOMBINA* (LINNAEUS 1761) POPULATIONS IN THE IER VALLEY AREA (COUNTY OF BIHOR, ROMANIA)

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**Abstract. The study of the trophic spectrum of *Bombina bombina* (Linnaeus 1761) populations in the Ier Valley (County of Bihor).** We analyzed the trophic spectrum of 331 samples of *Bombina bombina,* belonging to four populations. We found vegetal remains, mineral fragments and exuvia in the stomach contents. The 2708 animal preys were grouped in 30 categories, representing 22 taxon preys. *Gasteropods, Araneids, Colembolans, Coleopterans, Isopods, Heteropternas* and *Hymenopterans* were appear almost constantly in the stomach contents. Three of the investigated populations consumed mostly *Colembolans*, and one population ate *Coleopterans.* The most frequently consumed taxon preys are *Isopods* and *Hymenopterans*. The weight of aquatic and terrestrial taxon preys varies depending on the environmental conditions. Because of the drying of the puddles the aquatic taxon preys disappear, thus terrestrial taxon preys dominate the stomach contents.

## 1. Introduction

*Bombina bombina* is one of the most common species in Romania, being largely spread in the plain regions (Cogălniceanu et

al., 2000 a). Although, the studies about the trophic spectrum of red - bellied toad are rare in the Romanian specialty literature (Cogălniceanu et al., 2000 b, Sas et al., 2003 a). Studies in Ukraine, in the North – West of Rusia (Medvedev, 1974; Goncharenco et al., 1978; Tertyshnikov and Gorovaya, 1982) and in Hungary (Kovács & Török, 1992, 1997) obtained data regarding the feeding of the red - bellied toad. Our study targeted the completion of data regarding the trophic spectrum of *Bombina bombina* in Romania, focusing on several populations in the North of the County of Bihor.

## 2. Materials and Methods

The populations investigated are located in the North – West of the County of Bihor, close to the Săcuieni Bihor locality, in the hydrographic basin of the Ier Valley. The study took place during the year 2002. The samples were taken during of spring due to the drying of the habitats at the beginning of summer. Only for two populations we have samples taken during one or two summer months.

**Description of Habitats**

The investigated habitats are close to the localities of Cherechiu, Cheşereu and Târguşor (all belong to the Cherechiu commune) and in the Săcuieni Bihor commune. The habitats are situated in the hydrographic basin of the Ier Valley at approx 150 m altitude. These biotopes are some remains of a large humid area that occupied this region, now being mostly dry (Poliş, 1977).

The biotope at **Săcuieni Bihor** is a swamp situated along the railway, to the North of the locality. The swamp is edged to the east by the railway that ties the towns of Oradea and Satu-Mare and by agricultural fields. The swamp is continued with a 150 m long ditch, parallel to the railway. The characteristic vegetation of the swamp and of the ditch consists of the *Typha* sp., *Juncus* sp., *Phragmites* sp. The swamp shows denser vegetation, while along the ditch it is more rare.

The biotope at **Cherechiu** is a secondary canal to the Ier Valley, several kilometers long. The canal is made out of parts with shalow water and dense vegetation and with parts with deeper water and less dense vegetation. The vegetation of the canal is represented mainly by *Typha* sp., *Phragmites* sp. There are

agricultural fields and pastures around the canal. The parts that *Bombina bombina* populate dry at the beginning of summer.

The habitat at **Cheşereu** is a biotope that resembles the one at Cherechiu, being only 4 km away, on the other bank of the Ier Valley, close to the locality of Cheşereu being a secondary canal of the river as well. Only the Northern part of the ditch is edged by agric fields, the communal road that ties the localities of Cherechiu and Cheşereu is to the South, between the road and the ditch there is a small area uncultivated terrain. The vegetation of the ditch resembles the one at Cherechiu, with the same contiguous species of bulrush. The water level is low but does not dry during the summer.

The biotope at **Târguşor** is a 4 km long ditch, continued with a swamp in the Southern side and a puddle in the Northern side. The ditch is edge by uncultivated terrains and pastures up to a distance of about 50 m, perhaps due to floaded area during the raining periods. The most samples of *Bombina bombina* were found in the puddle, fewer frogs were retreated along the canal. As the puddle is used to water the herds of cattle, the water is polluted with excrements. The vegetation of the biotope is identical with the one at Cherechiu.

We analyzed a total of **331** *Bombina bombina* samples, taking **70** samples from the frogs at Săcuieni Bihor, **59** from Târguşor, **60** from Cherechiu and **142** stomach contents from Cheşereu. The *Bombina bombina* samples were captured from the aquatic environment using a net tied to a handle or by hand.

According to a Hungarian study using the "rarefiaction" analysis, the minimum number of samples to be taken for the study of the trophic spectrum of the *Bombina bombina* species and this number is 13 (Kovács & Török, 1997). Thus, we tried to capture a number of samples larger than this figure. The sampling of the stomach contents was done using the stomach flushing method (Opatrny, 1980; Legler and Sullivan, 1979), the advantage of the method consisting in the taking of stomach contents without harming the animal. We used a syringe with a perfusion tube at the end (Cogălniceanu, 1997). The stomach contents were sampled as soon as possible after the animals were captured, as the amphibians have a rapid digestion (Caldwell 1996). The sampled stomach contents were stored in airtight test tubes and preserved

in a 4 % concentration formaldehyde solution. Their analysis was made in laboratory conditions with the help of the binocular magnifying glass. We used the data in the speciality literature (Ionescu et al, 1971; Crişan & Mureşan, 1999; Radu & Radu 1967; Móczár, 1990) of the domain to assess the prey we identified.

## 3. Results and Discussions

From a total of **331** investigated samples, **316** stomachs had contents, representing 95.45 %. In these stomach contents we identified both vegetal and mineral remains and the shed skin of other individuals in the population and contents of animal nature as well. We will present these categories of contents in the following.

Analyzing the 331 stomach contents we noted that not all the *Bombina bombina* individuals ate. Thus, the empty stomachs in percentages were as follows: Târguşor, 3.38 %, Cherechiu, 5 %, Cheşereu 5.36 % and 2.85 % at Săcuieni. This kind of situation was identified at numerous species of amphibians, in *Rana temporaria* (Houston, 1973), in *Rana ridibunda* (Covaciu-Marcov et al., 2000) or in *Triturus cristatus* (Covaciu – Marcov et al., 2001).

The number and the amount of empty stomachs vary depending on the environmental conditions. Thus, for the populations at Cherechiu, Cheşereu and Târguşor, the animals with empty stomachs appear in March, this being the first month of activity of the red-bellied toad. In April, all the captured *Bombina bombina* individuals had stomach contents. For the population at Cheşereu, after the month of May we met again samples with empty stomachs. The amount of empty stomachs grows progressively from May to July (11.11 %), when already exceeds the value recorded in March (8.82 %). The apparition of empty stomachs is due to low or too high temperatures in the days when the samples were taken and they negatively influenced both the prey and the predators. The low temperatures in March do not allow the activity of some taxon prey, fact that greatly narrows the trophic offer accessible to the red - bellied toads. In these circumstances the preys were hardly accessible to the frogs, only cold resistant taxon prey being present. So, the amount of empty stomachs is conditioned by the ambiance, their apparition

signifying unfavorable environmental conditions. Contrary, the lack of empty stomachs indicate optimal conditions for hunting corresponding to more intense feeding periods.

Generally, the food of amphibians is uniform, consisting of different invertebrates. Although the adult amphibians are carnivorous, there are known exceptional situations when not only the larvae consume vegetation but also the adults like the *Rana hexadactyla* species (Das, 1996). The highest number of stomachs with vegetal remains we find in the case of the population at Cheşereu. The low value of the stomachs with vegetal remains at Târguşor is probably due to the fact that the biotope of origin of the captured animals is poorer in vegetation compared to the other investigated habitats. It is considered that the presence of vegetal remains in the stomach contents is accidental, being ingested simultaneously with the targeted prey (Whitaker et al, 1977). This fact is suggested by the observation that the amount of vegetal remains in the stomach contents grows once with the growth of the number of preys and strengthened by the observation that the amphibians consume mainly mobile prey (Zimka, 1966). Vegetal remains were frequently met in the stomach contents of other species of amphibians*: Rana ridibunda* (Covaciu – Marcov et al., 2000), *Rana arvalis* (Covaciu–Marcov et al., 2002 a) and *Phaeognatus hubricti* (Gunzburger, 1999).

From the total of the frogs we investigated some samples showed mineral fragments in the stomach contents. Similar situations we met at the *Rana ridibunda* species (Vancea et al., 1961). The presence of minerals in the stomach contents of the frogs is accidental.

In the case of all the investigated populations a part of the individuals consumed shed skin fragments together with other categories of stomach contents. The stomachs with shed-skin content have quite large amounts. There are known cases of shed-skin eating in the specialty literature at the , *Bombina bombina* species (Sas et al., 2003 a), *Rana arvalis* species (Sas et al. 2003 b), *Rana dalmatina* species (Guidali et al, 1999) or at the *Phaeognatus hubricti* species when even the shed-skin of other individuals of the population appear in the stomach contents (Gunzburger, 1999). Some researchers considering this aspect of the trophic spectrum

as a cause of the recycling of epidermal proteins (Weldon et al., 1993).

Following our study we identified amphibian eggs in the stomach contents sampled from the *Bombina bombina* species. The consumption of eggs requires a minimum effort for capture. The consumption of eggs is not rare in the case of amphibians, as it is met at several amphibian species like *Triturus cristatus* when a part of the individuals of a population fed exclusively on eggs (Covaciu-Marcov et al., 2002 b).

The most important category of stomach contents are the preys of animal nature. The assessed preys were grouped in **30** categories, representing **22** identified taxon preys, separating the larvae and the adults of *Lepidopterans, Coleopterans, Odonatae* and *Dipterans.* We did the same with the *pupae* and the *larvae* and the terrestrial and aquatic *Isopods,* thinking that they represent distinct categories of prey as mobility and as environment from where they are captured. Redford and Dorea (1984) claimed that adult insects do not vary much as nutrition content but still it is considered that the larvae and pupae elements of homo – metabolic insects are rich in lipids and thus, more nutritive (Brooks et al., 1996).

Among the 22 taxon preys, 16 were identified at Cheşereu, grouped in 25 categories, 16 at Târguşor, grouped in 20 categories, 14 at Cherechiu, grouped in 18 categories and 17 at Săcuieni, grouped in 22 categories. The highest number of taxon preys was identified at Săcuieni, probably due to a larger diversity regarding the trophic offer from this biotope compared to the other two habitats.

Analyzing the number of captured preys from the investigated *Bombina bombina* populations, this is as follows: **971** preys for Cheşereu, **419** for the population at Târguşor, **871** for the population at Săcuieni and **447** for the *Bombina bombina* population at Cherechiu. Thus, in total, at all the four *Bombina bombina* populations we identified **2708** preys.

The average number of preys / individual varies in each of the investigated localities depending on the period. This fluctuation is noticed in the case of the maximum number of preys. The maximum number of preys/individual has the value of 29 in the case of the frogs in the population at Târguşor. In the case of the

*Bombina bombina* samples we captured in the habitat at Cherechiu this value is a lot higher, reaching 50 preys / individual. As for the two remaining populations, this value is 71 for the frogs at Săcuieni and 58 for the population at Cheşereu. These high values of the maximum number of preys / individual is due to the presence of *Coleombolans* and the *Nematoceran larvae* in the stomach contents, being small preys living in groups and can be captured by a large number of frogs. Regarding the average number of preys / individuals, this has values close to 7 for the populations in the Cherechiu commune, being 7.10 at Târguşor, 7.45 at Cherechiu and 6.83 at Cheşereu. For the *Bombina bombina* population at Săcuieni this figure is 12.44 preys / individual. In the case of some *Bombina bombina* populations in Hungary this value of the average number of preys / individual was of 47.4 (Kovács & Török, 1997), our values being closer to the ones obtained in the case of the related species *Bombina variegata* (Kuzmin, 1990). A decrease in the average and maximum numbers of preys / individual is noticed once with the coming of summer.

Our study targeted the knowledge of the monthly evolution of the amount of preys belonging to each taxon. This way, starting from the number of preys that belong to diverse taxons, their amount in the trophic spectrum was assessed not just all along our study but also in every month, separately. And important variation of the amount of each taxon prey in the trophic spectrum of the *Bombina bombina* species was noticed depending on the period and on the habitat.

The *Coleombolans* are the taxon prey present with the highest amount at three of the investigated populations (Cheşereu - 44.79 %, Săcuieni - 50.17 %, Cherechiu - 53.91 %). Other researchers identified high amount of *Colembolans* in the stomach contents of the *Bombina bombina* species as well; thus, for a population in the Balaton area, this taxon prey is dominant in most of the samples (Kovács & Török, 1997).

For the *Bombina bombina* species at Târguşor, the *Coleopteran adults* are the dominant taxon prey (24.82 %). The *Coleopterans* occupy an important place among the identified taxon preys in the stomach contents of these frogs at the other three investigated *Bombina bombina* populations. The *Coleopterans* appear with a high amount in the case of several

*Bombina bombina* populations (Kovács & Török, 1997, Medvedev, 1974, Goncharenko et al., 1978), or *Bombina variegata* (Kuzmin, 1990). In the case of the populations at Cherechiu and Târgușor an important consumption of the *Coleopteran larvae* is noticed, with the values of the amount of 4.02 %, respective 2.62 %. The *Coleopterans* are also important preys for other species of *Amphibians* like *Rana arvalis* (Covaciu – Marcov et al., 2003), *Rana temporaria* (Houston, 1973). Other taxa occupy the second place as amount at the other populations. Thus, at Săcuieni the *Aphida – Homopterans* are represented with 10.44 %, while at Cheşereu this place is occupied by the *Hymenopterans* with 14.75 %.

*Hymenopterans* occupy an important place according to its amount not only in the case of the population at Cheşereu, but also at Târgușor, appearing still on second place with 17.18 % in the stomach contents sampled from the frogs there. On the third place, the adults of *Coleopterans* at Săcuieni and Cheşereu appear. In the case of the populations in the other two localities we meet other taxon preys on the same place. Thus, at the population at Cherechiu on this place we find the *Gastropods* (6.71 %) while for the population at Târgușor we find the *Gamarids* (15.03 %). The *Gastropods* only at Săcuieni it has a value that places it on the fourth place of the amount of the taxon preys with 5.16 %. The *Gastropods* appear frequently in the stomach contents of frogs, like a study conducted in the Kis–Balaton area shows (Holzinger et al., 1996).

The *Aquatic Isopods* appear in high amounts for the population at Târgușor (11.45 %), placing on the fourth place. Identically, on the fourth place as well we find the terrestrial *Isopods* at Cheşereu (3.81 %).

The presence of *Dipterans*, of both as larvae and adults, in the stomach contents of the puddle frogs is relevant. Thus, the *Dipterans* appear in large numbers in the case of the population at Târgușor and at Cherechiu. In the case of other *Bombina bombina* populations, the *Dipterans*, especially the adults appear in large amounts, being one of the main groups in the stomach contents (Medvedev, 1974, Goncharenko et al., 1978, Tertyshnikov and Gorovaya, 1982).

The other taxon preys record low amounts and relatively similar at the investigated populations, being auxiliary in the

trophic spectrum of the red – bellied toads. For example, *Trychopterans, Diplopod Miriapods, Kylopod Miriapods, Odonatae larvae, Lepidopteran larvae, Ephemeropterans, Cicadae – Homopterans, Acarians,* they all are trophic elements accidentally consumed by *Bombina bombina*.

The taxon preys with high possibilities of motion (flying species) record close amounts in the trophic spectrum of all the populations in the analyzed habitats. Different values are recorded by less mobile taxons (terrestrials) so somewhat dependant on the conditions of the biotopes.

Other important objective of our study, beside the amount of prey, was to assess the frequency of the preys were consumed. The frequency is important in assessing the value that a certain taxon prey has for the whole analyzed population as a consequence of the fact that a *Bombina bombina* individual can consume not only several taxon preys but also more individuals of a certain taxon prey. The frequency can be defined as the ratio of the stomachs that contain a certain taxon prey and the total of analyzed stomachs, the obtained value being expressed in percentages. The amount of a taxon prey does not always correspond with the frequency it was consumed by the investigated *Bombina bombina* populations. This fact appears more eloquently in the case of the taxons belonging to the groups of Coleopterans and *Collembolans.*

Thus, the group of *Coleopterans* at each of the four populations we investigated represents the most frequently consumed taxon prey. At these populations, at least half of the investigated individuals consumed *Coleopterans*. The *Coleopterans larvae* appear with the same significance in approx ¼ of the analyzed stomachs. The *Coleopterans* are a group of preys with a relatively large size, thus, although many of the *Bombina bombina* individuals captured beetle samples, as the value of the frequency shows, their number is smaller, as the value of their amount shows.

The *Colembolans* with large frequency appear only in the case of the population at Cherechiu (33.33 %). At all the other investigated populations, the *Collembolans* are only on the third place, although as amount they rank first. This fact can be explained through the fact that the preys that belong to this taxon have a small size and lead a gregarious life. A reduced number of

*Bombina bombina* sample consumed a lot of *Colembolans.* Thus, the *Colembolans* do not have a great significance for the whole *Bombina bombina* population, but only for some individuals of the population. Among the other taxon preys consumed frequently by *Bombina bombina* we must mention the *Hymenopterans, Dipterans, Araneids, Isopods* and *Gastropods.*

Another important parameter is the environment of origin of the taxon prey the *Bombina bombina* consumed, as this is a species tied to the aquatic environment (Fuhn, 1960), thus, being expectable a consumption of mainly aquatic preys.

In the investigated stomach contents, we identified both aquatic and terrestrial preys. Although the aquatic taxon preys appear in high percentages, the terrestrial taxons have a high amount, in the case of the population at Târguşor being even larger the amount of terrestrial preys.

The number and the amount of aquatic preys is very much dependant to the environmental conditions. During the months of spring the amount of the aquatic taxon preys is higher, dropping progressively towards the summer months, when the main preys are terrestrial. This is explained through the fact that once with the coming of summer and the raise of the temperature, the water in swamps and ditches evaporates, only some humid areas remaining for the frogs to live but to change their way of capturing the food, consuming terrestrial preys. In the case of the population at Cheşereu a rise of the amount of the aquatic taxon preys is noticed in July, due to the fact that during the sampling, although the temperature in the air was high, there was significant rainfall for a few days. Except for the *Bombina bombina* population at Cheşereu, the amount of taxon preys of aquatic origin is higher during the month of April than in March, probably caused by the rich trophic offer in this month.

## Conclusions

We noticed that a number of 15 of the investigated stomachs were empty, representing 4.53 % of the total samples.

In 57.70 % of the analyzed stomach contents we identified vegetal remains probably consumed accidentally, together with the

targeted prey. This fact is underlined by the fact that the amount the stomachs with vegetal remains increases with the number of consumed preys.

We identified mineral fragments, amphibian eggs and the shed-skin in the stomach contents sampled from the red-bellied toads. The presence of minerals in the stomach contents has a similar explanation with the presence of the vegetal remains, being accidentally ingested together with the targeted taxon preys.

The taxon preys that appear constantly along our study are: *Gasteropods, Isopods, Araneids, Coleopterans, Heteropterans Hymenopterans.*

Regarding the average and maximum number of preys / individual, a decrease of this parameters is noticed with the coming of summer. Our data underline the fact that *Bombina bombina* feeds less intensely during the days when certain physical factors do not correspond to their ecological demands.

The highest consumption rate have the representatives of the groups of *Colembolans* and *Coleopterans.* Thus, at three investigated populations the highest number shows the *Colembolans*, while at Târguşor this place is occupied by *Coleopterans*. In high amount percentages appear taxon preys like *Coleopterans, Aphidias – Homopterans, Hymenopterans.* With a high frequency of consumption we find the *Collembolans* and the *Coleopterans.*

The number and the amount of prey of aquatic origin is strongly dependant on the environmental conditions. During the months of spring the amount of the aquatic taxon preys is higher, dropping progressively towards the summer months, when the main preys are terrestrial. The growth of preys of terrestrial origin is due to the drying of the puddles, fact that leads to the disappearance of aquatic taxon preys.

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Localities, period and number of the taken samples

*Table No.1*

| | III | IV | V | VI | VII | Total |
|---|---|---|---|---|---|---|
| **Cherechiu** | 30 | 30 | - | - | - | 60 |
| **Cheşereu** | 34 | 30 | 30 | 30 | 18 | 142 |
| **Săcuieni** | 6 | 30 | 30 | 4 | - | 70 |
| **Târguşor** | 29 | 30 | - | - | - | 59 |
| | | | | | | **331** |

The weight of: empty stomachs, the stomachs with vegetal remains, with shed-skin, with minerals, with amphibian eggs

*Table no.2*

| | Cherechiu | Cheşereu | Săcuieni | Târguşor |
|---|---|---|---|---|
| % of empty stomachs | 5 | 5.63 | 2.85 | 3.38 |
| % of stomachs with vegetal remains | 58.57 | 65.49 | 58.33 | 37.28 |
| % of stomachs with shed-skin | 10 | 9.15 | 10 | 13.55 |
| % of stomachs with minerals | 1.66 | - | 2.85 | - |
| % of stomachs with amphibian eggs | - | - | 1.42 | - |

Diagram no.1 the maximum and the average of the number of preys / individual

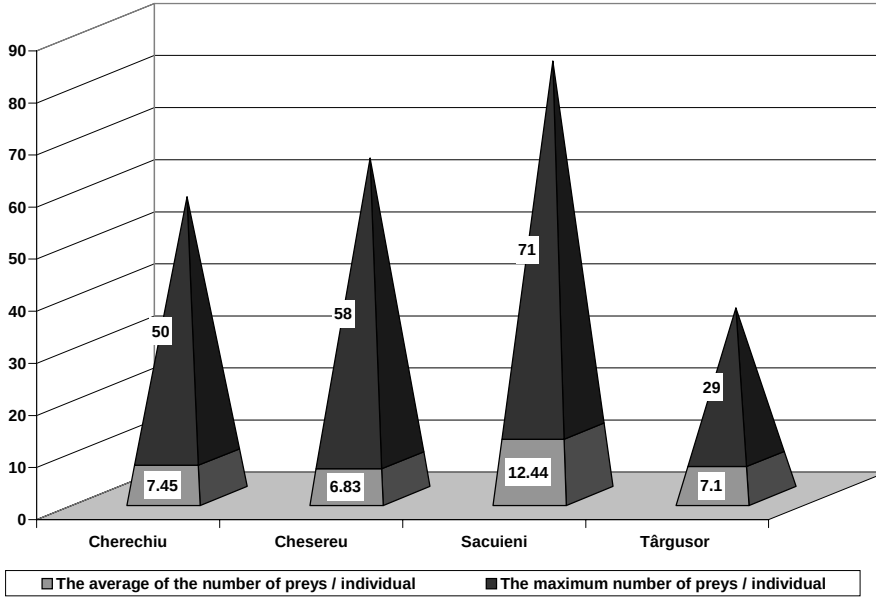
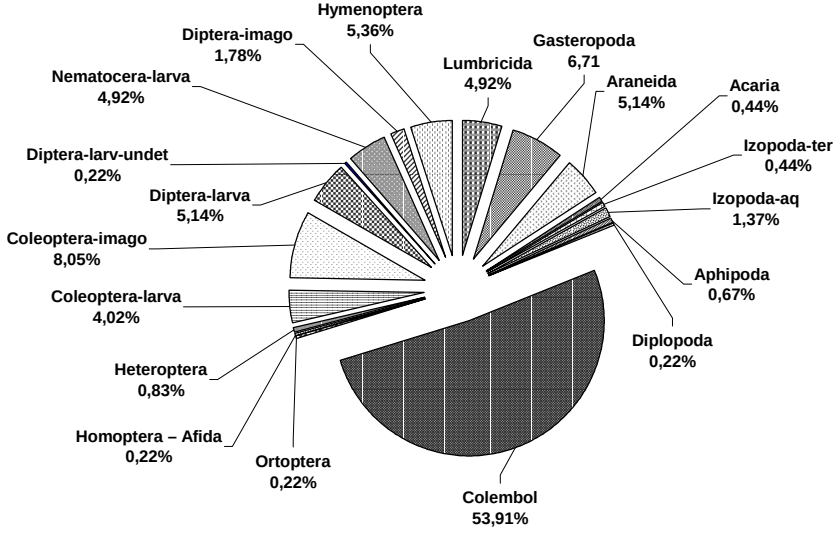
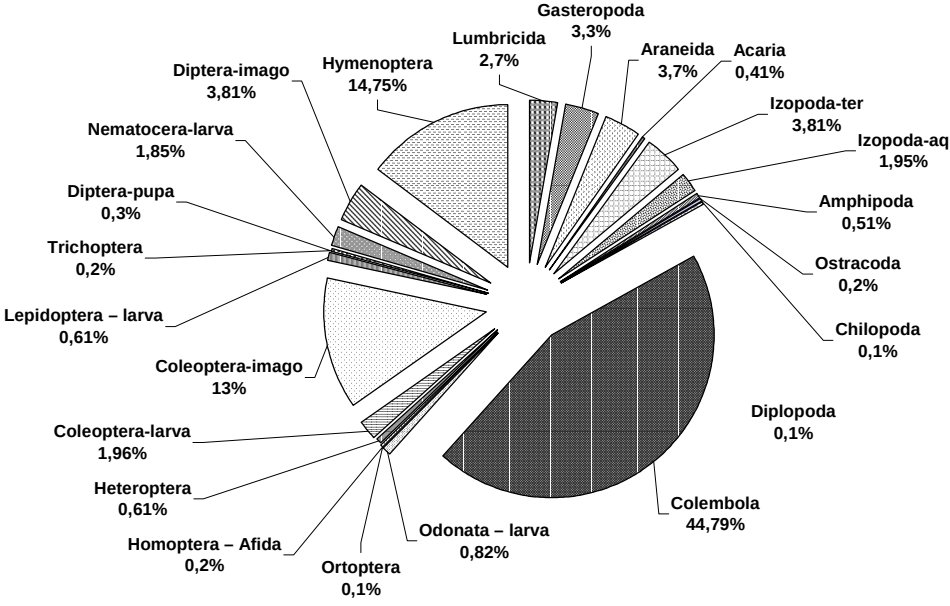


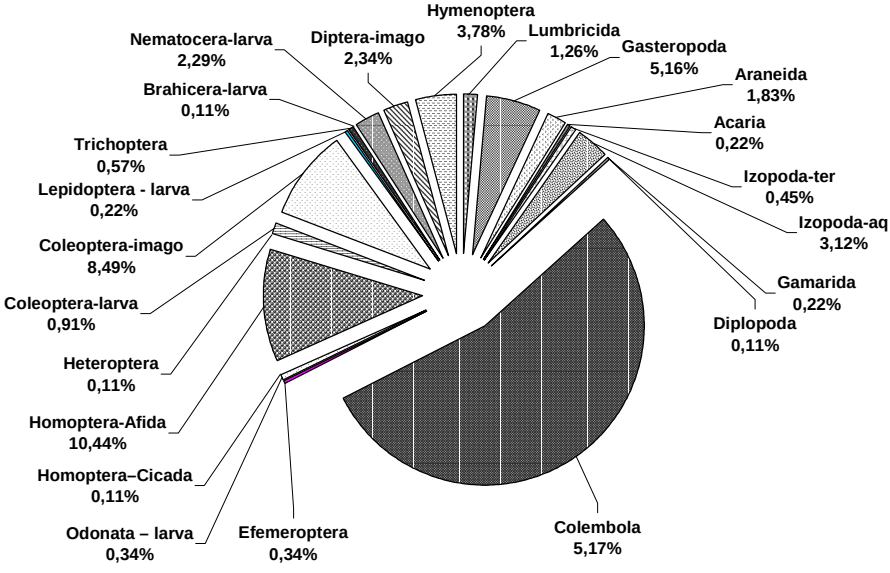

Diagram no.2 The weight of preys at Cherechiu



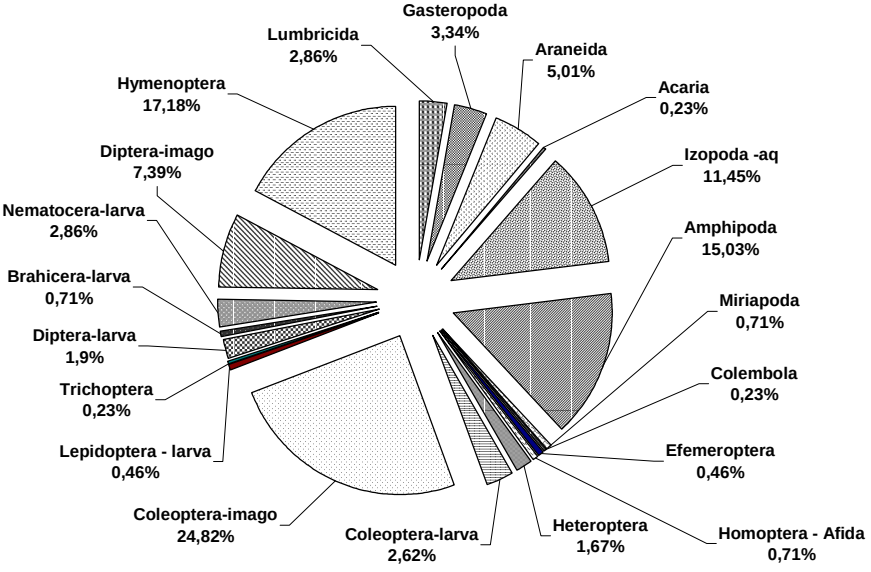
## Diagram no.3 The weight of preys at Cheşereu




## Diagram No.4 The weight of preys at Săcuieni



## Diagram no.5 The weight of preys at Târgușor




## Diagram no.6 The frequency of prey items

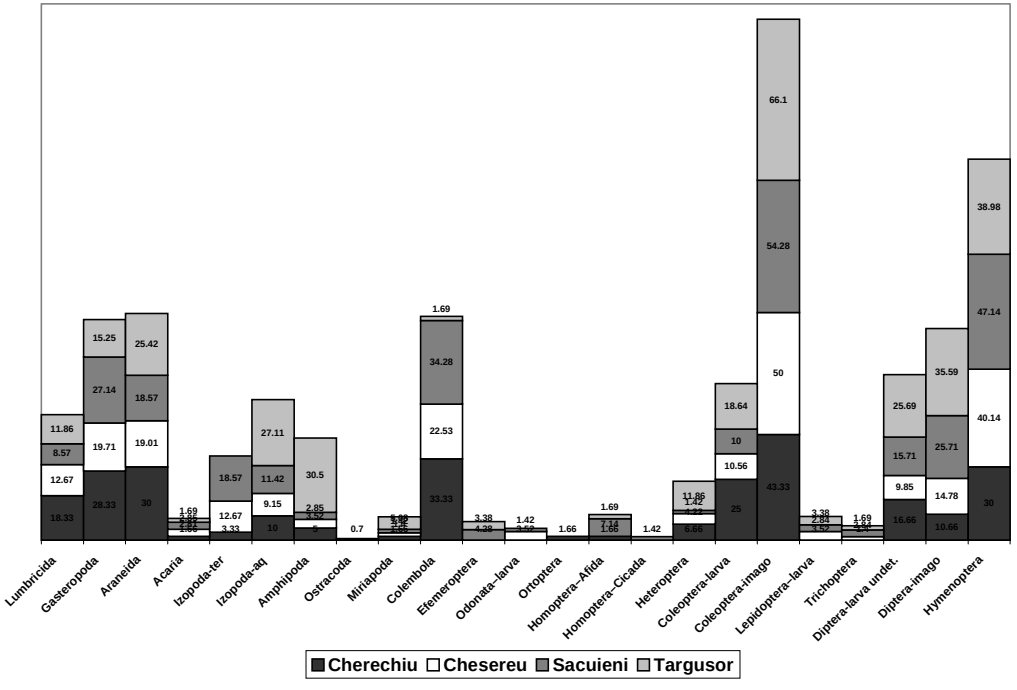


Diagram no.7 The weight of aquatic and terrestrial preys