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STUDIES ON THE TREATMENT OF INDUSTRIAL WASTE WATER USED BY CHEMICAL AND ELECTROCTROCHEMICAL METHODS

László BERKESY[1], Corina BERKESY[2]

Abstract: Waste waters is the main source of natural water pollution, when it is discharged in the receptors. The industrial waste water is characterized by a great diversity as the physical-chemical and microbiological composition shows mainly because of the technology used in the production process. Due to this fact the methods used for cleaning are different. [1,2,3,]

The purpose of this work presents studies performed to correct certain parameters of waste water resulting from different industries to bring their limits of pollution reduced by using chemical and electrochemical metods.

Treatment complex electrochemical treatment with coagulants and flocculants had expected the effect of 50% reduction in the amount of chlorine and reduction of total suspensions admitted to the levels in NTPA 002/2005, for discharge in the municipal sewerage systems and 001/2005 for NTPA discharge in emissary.

In the case of waste water containing heavy metals the treatment with coagulants and floculanţs also gave good results. Next should be a monitoring of the waste water parameters results from the technological process survey taken in highlighting the economic benefits of this process.

Key words: waste water, electrochemical treatment, chemical treatment, coagulants, floculants.

Introduction

The treatment of industrial waste water is generally the same as for municipal waste water, that is mainly mechanical and biological processes.

These industrial waste waters are filled, most often by physical and chemical processes of a great complexity: ionic exchange, electrodialysis etc. [2,3]. The using of chemical preparations in the treatment of industrial waste water from textile industry, food industry, metal coverings has increased, due to raise of water pollution and its concentration. Now these preparations are used as coagulants to adjust pH, to recarbonate as nutrients in the biological treatment, or for desinfection to reduce phosphorus and nitrogen as well as sludge conditioning [4]. The coagulating substances are used in cases where there are quantitative and qualitative variations, as is the case of water taken in the study. The samples were taken after the homogenization of waste water and then were performed four tests for each quality parameter of waste water taken in the study. The results were compared against a trial witness average.

For waste water treatment analysed in the paper we improved the chemical step of WWTP using polyelectrolytes alone or in combination with electrochemic process.

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Methods

The chemical treatment. In case of chemical treatment we used the methods with coagulants and flocculants, complex preparations based on polyelectrolytes as well as in combination with common coagulants. The clotting – flocculation process depends on water chemism, on the pH value indicator Cl^-, on present organic substances. In practical use, especially, metal salts trivalent Fe (III), Al (III)are used. If tests on industrial waters, Al (III). salts were used.

For the experiment we used test equipment called Jar. This equipment allows comparison of various doses of chemical reactives added in water and different doses to which we analyze the volume and size of the formed flakes, the clarity of the supernatant, the speed of sedimentary (Fig.nr.1). For that to be possible the comparison between the experimental variations were followed the same parameters of the plant such as :moving speed, period of time and time of moving decanter. Also reactives were added at once. After the distribution of 500 ml sample of each glass plant is to start the mixer to maximum speed of 150 rot./min. Add the coagulating substances simultaneously according to the treatment variations. Maintain the mixing 3-5 min. [5,6].

It made the correction of pH then it added the flocculation substances, and maintain a slow stiring of mixture for some minutes. The estimate the coagulate substances and stop stiring. The analysis of the parameters of treatment alternatives are carried out [1,4].

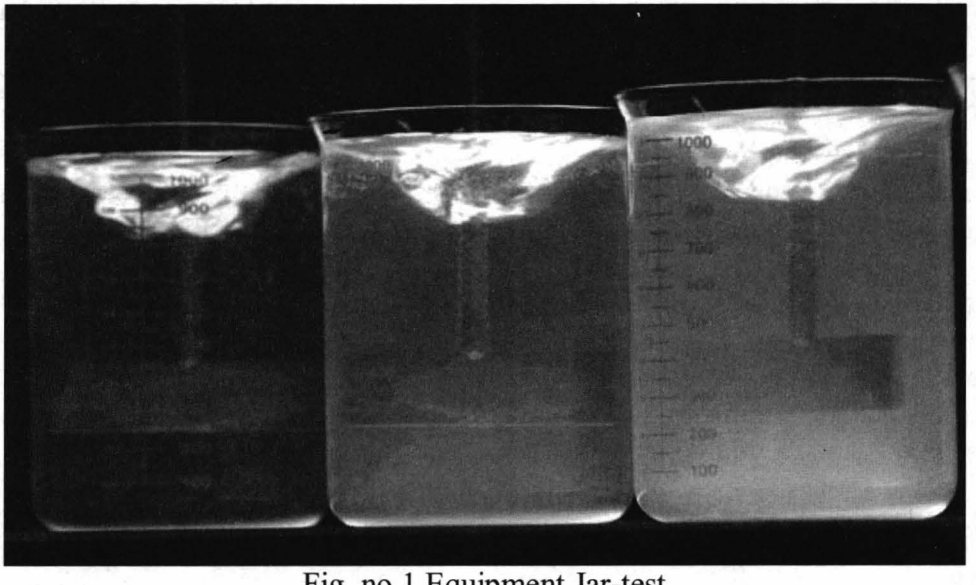

Fig. no.1 Equipment Jar-test

Electrochemic treatment. Tests conducted in the electrochemic treatment were made with an electrochemical cell with aluminium and iron electrodes, depending on the content of waste water. As a result, sodium chloride salts are converted into insoluble salts, in water, which with the help of products with coagulant and floculant substances are precipitated. The work method consists of placing air in the water the water folloving a processing work by means of an ejector system, then it arrives in a side room, in which aluminium and iron electrodes are installed with pulsating-voltage of pulsatorie medium frequency, by an electronically generator [6,7].

Versions of treatment

In the case of waste water from textile industry (two factories with different technologies of coloring and treatment), the waters are characterized by a neutral pH up to high and with a high chloride content and residue to 105 °C (Caz no.1) and residue 105 °C and CCO - Cr (Case no.2), an electrochemic treatment was used followed by a chemical treatment. For waste water from food industry (beer and milk) was used a chemical treatment to improve the chemical step and it was made a fall on the biodegradable organic substances of nitrogen and phosphorus, Case no.3 and no. 4 and for waste water from the section of metal covering was used a chemical treatment, reducing the quantity of zinc. In case no. 1 it was used a variant of treatment with 250 Q, 4 ml coagulant 71228 0.5%, 1 ml floculant anionic 71605 0.05% and a variant of treatment using Q 500, 10 ml aluminium sulphate 0.5%, 4 ml coagulant 71228 0.5%, 1 ml floculant anionic 71605 0.05%. (Table no.2).

In case no. 2 was used a variant of treatment with 250 Q, 4 ml coagulant 71228 0.5%, 1ml floculant anionic 71605 0.05% and a variant of treatment using Q 500, 10 ml aluminium sulphate 0.5%, 4 ml coagulant 71228 0.5%, 1ml floculant anionic 1605 0.05% (Table no. 2).

In case no.3, for waste water from the milk industry it was used a chemical treatment with coagulant 71221 0.5%, 15 ml and floculant anionic 7725 0.05% 2 ml (Table no. 3).

In case no. 4 for waste water from the brewing industry it was used a chemical treatment with coagulant 71225, 0.5%, 10 ml and floculant anionic 7725 0.05% 1 ml (Table no. 3).

In case no.5 for waste water from the department of metal coverings it was used a chemical treatment used to reduce the quantity of zinc, using a coagulant 8702, 15 ml 0.5% (Table no. 3).

Table no. 1. The limit values indicators of quality of industrial waste water stipulated in the norms in order to be discarged into the sewerage in th municipal sewerage systems or directly into the emissary

No.	Parameter of wasrewater	U/M	Limit values	
			NTPA 002/2005	NTPA 001/2005
1	pH		6,5-8,5	6,5-8,5
2	Solid material in suspension(MTS)	mg/l	350	35
3	Chemical oxygen consuption(BOD)	mg/l	300	20
4	Chemical oxygen consuption (COD)	mg/l	500	70
5	Total Nitrogen	mg/l	-	10
6	Phosphor total	mg/l	5,0	1,0
7	Rezidue to105 °C	mg/l	-	2000
8	Chlorides	mg/l	-	500
9	Zn	mg/l	1,0	0,5

Table no. 2. The treatment applied in physical-chemical step in the waste water from the textile industry (case 1 and 2)

No.	Para-meter of wasre-water	U/M	Treatment						Value obtained
			Electrochemic			Chemical			
			250Q	500Q	Alumi-nium sul-phate 0,5% 10 ml.	Coagu-lant 71225 0,5%,qant 3ml.	Coagu-lant 71228 0,5%, qant 4ml	Floculant (anionic) 71605 0,05%, 1 ml	
1	Chlorides Caz 1	mg/l		x	x	x		x	1540
			x				x	x	1410
	Rezidue to105 °C	mg/l		x	x	x		x	2388
			x				x	x	2599
2	Chlorides Caz 2	mg/l		x	x	x		x	769
			x				x	x	650
	COD	mg/l		x	x	x		x	480
			x				x	x	400
	Rezidue to105 °C	mg/l		x	x	x		x	2498
			x				x	x	1980

Table nr. 3. Variantele chemical treatment applied in the case studied of the industrial waste water

No	Treatament						case
	Coagulant			Floculant			
	cod	conc. %	qant. ml.	cod	conc. %	qant. ml	
1	71225	0,5	3	71605	0,05	1	Caz 1
2	71228	0,5	4	71605	0,05	1	Caz 2
3	71221	0,5	15	7725	0,05	2	Caz 3
4	71225	0,5	10	7725	0,05	1	Caz 4
5	8702	0,5	15	-	-	-	Caz 5

Results and discussion

In the first case the water resulting from the waste water treatment plant had to be according to the rules stipulated in NTPA 002/2005, which did not achieve the parameters and chlorine residue to 105 °C. After applying the electrochemic treatment with 250Q în combination with coagulating and floculanting substances (Table no. 2) had been made a fall of the parameter from chlorides, 3900 mg/l at the entrance in the waste water treatment plant at 1410 mg/l at the exit of chemical step and 1300 mg/l at the exit of purification station and a decrease of the parameter of the residue to 105 °C from 6200 mg/l the value at the entrance to the waste water treatment plant, at 2599 mg/l at the exit of chemical step and 1990mg/l at the exit of the waste water treatment station (Table no. 4,5,6).

The waste waters from the textile industry in the second case had, the parameters of water discharged from the the waste water treatment plant and the values had to comply with the norms NTPA 001/2005. After the electrochemical and chemical treatment the values of the residue to 105 °C parameter decreased from 3880 mg/l at the entrance in the waste water treatment plant 1980mg/l at the exit of chemical step and 1886 mg/l at the exit of the the waste water treatment plant. It also had been made a fall of the parameter of chlorides at 650 mg/l at the exit of chemical step and at 500 mg/l at the exit of the, the waste water treatment plant, values which comply with the regulations. For CCO-Cr the parameter value decreased from 856mg/l at the entrance in the waste water treatment plant to 400mg/l at the exit of the chemical step and at 40 mg/l at the exit from the the waste water treatment plant, values that are registered in norms NTPA 001/2005 (Table no. 4,5,6).

The waste water from the food industry (milk industry), in case no. 3, it was used to bring parameters to the limits estimated in NTPA 001/2005, a chemical

treatment, using the coagulants and floculants in quantities mentionated in the table no.3.

Table no. 4. The quality of the parameters of industrial waste water taken in the study, at the entrance in the waste water treatment plant

No.	Parameter of wasrewater	U/M	Waste water at the **entrance** in the cleaning plant					Va-lue ob-tained
			Textile industry		Food industry			
			Case 1	Case 2	Case 3	Case 4	Case 5	
1	pH		6,5-8,5	8,5-10,5	-	6,8-11,2	5,5-6,5	
2	Solid material in suspension (MTS)	mg/l	-	-	1378	500	-	Chemical
3	Chemical oxygen con-sumption (BOD)	mg/l	-	-	810	5012	-	"
4	Chemical oxygen consuption (COD)	mg/l	-	856	1483	12550	-	"
5	Total Nitrogen	mg/l	-	-	41	17	-	"
6	Total Phosphorus	mg/l	-	-	12	20,6	-	"
7	Rezidue to105 °C		6200	3880	-	-	-	Electroche mical chemical
8	Chlorides	mg/l	3900	2100	-	-	-	"
9	Zn	mg/l	-	-	-	-	2,53	chemical

After the chemical treatment applied the values of the parameters of the solid materials in suspension decreased from 1378mg/l at the entrance in the waste water treatment plant to 25 mg/l at the exit in the chemical step and 20 mg/l at the exit of the waste water treatment plant. At the parameter CCO-Cr from the value of 1483 mg/l registered at the entrance in the waste water treatment plant at purging 138mg/l at the exit of the chemical step led to 11mg/l at the exit of the waste water cleaning plant.

The total nitrogens and the total phosphorus also decreased to the values specified in the regulation, namely the total nitrogen 2mg/l and total phosphorus 1 mg/l. (Table no. 4,5,6).

Table no. 5. The quality parameters of industrial waste water taken in the study, step-by physical chemical treatment station

Parameter	U/M	**Waste water after physical-chemical step**					**Applied treatment**
		Textile industry		Food industry		Metal covering	
		Case 1	Case 2	Case 3	Case 4	Case 5	
pH		7,5	7,5	7,5	7,5	7,5	
Solid material in suspension (MTS)	mg/l	-	-	25	-	-	Chemical
Chemical oxygen consumption (BOD)	mg/l	-	-	73	-	-	"
Chemical oxygen consuption (COD)	mg/l	-	400	138	-	-	"
Total Nitrogen	mg/l	-	-	5	-	-	"
Total Phosphorus	mg/l	-	-	2,8		-	"
Rezidue to105 °C		2599	1980	-	-	-	Electrochemical chimical
Chlorides	mg/l	1410	650	-	-	-	"
Zn	mg/l	-	-	-	-	0,5	"

Table no. 6. The quality parameters of industrial waste water taken in the study, at the exit of the waste water treatment plant

No.	Parameter	U/M	Waste water at the exit of WWTP					Treatament aplied
			Textile industry		Food industry		Metal co-verin g	
			Case 1	Case 2	Case 3	Case 4	Case 5	
1	pH		7,5	7,5	7,5	7,0-8,	7,5	
2	Solid material in suspension (MTS)	mg/l	-	-	16	288	-	Chimical
3	Chemical oxygen con-sumption (BOD)	mg/l	-	-	20	285	-	"
4	Chemical oxygen consuption (COD)	mg/l	-	40	11	1220	-	"
5	Total Nitrogen	mg/l	-	-	2	33	-	"
6	Total Phosphorus	mg/l	-	-	1	15	-	"
7	Rezidue to105 °C		1990	1867	-	-	-	Electro-chemi cal chimical
8	Chlorides	mg/l	1300	500	-	-	-	"
9	Zn	mg/l	-	-	-	-	0,4	chimical

The waste water from the brewing industry (case no.4), had the value of the CCO-Cr and total phosphorus to be brought to the norm NTPA002/2005. This had been made by an additional chemical treatment, (Table no. 3) to correct these parameters. Thus at the exit of, the waste water treatment plant the value of the parameter CCO-Cr was 1220 mg/l and total phosphorus of 15 mg/l. After the application of an additional chemical treatment (Table no. 3, 7), the parameter CCO-Cr decreased to 200-238 mg/l and to total phosphorus 1.6 mg/l.

Table no. 7. Parameters of quality of industrial waste water after addition chemical treatment at the exit from the waste water treatment plant

No.	Parameter	U/M	Waste water after the **additional treatment to the exit** from the waste water treatment plant	**Treatament aplied**
			Food industry case 4	
1	pH		7,5	Chimecal
2	COD	mg/l	200-238	"
3	Total Phosphorus	mg/l	1,6	"

The waste water from the department of the metal covering the value of the parameter zinc stipulated in regulation NTPA 002/2005, for discharge in the sewerage. After the treatment with chemical coagulant 8702 0.5% the value of this parameter decreased from 2.53 mg/l to 0.4 mg/l, values which are accepted for zinc by the norms in force.

Conclusion

1. To treat industrial waste water which at certain parameters cannot be registered in the norms in force it should be taken a further step in the physical-chemical treatment.

2. To reduce the chlorine in the waste water from textile industry, difficult to treat, it can be used an electrochemical treatment followed by a chemical treatment.

3. For the waste water from food industry it should be done an improvement in the chemical step, using coagulants and flocculants: type electrolytes.

4. For waste water containing heavy metals it can be achieved a decrease, of them using specific coagulants.

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RESEARCH CONCERNING THE FAECAL POLLUTION OF THE MUREŞ RIVER IN THE OCNA MUREŞ ZONE

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Abstract. Seasonal analyses have been carried out on the waters from 8 sampling sites in the Ocna Mureş zone. The presence of total coliform germs, faecal coliforms and faecal enterococci was analyzed. The presence in water of the bacteria which belong to all the three analyzed groups was detected in each sampling site, in each season, with higher values in summer, and lower in winter. A positive correlation, statistically very significant ($p<0.001$), was established between the number of bacteria which belong to the three groups. The ratio faecal coliforms/faecal enterococci shows the mixed source, animal and human, of the faecal pollution, prevalently human. In order to differentiate the genera of the faecal coliforms, 7 biochemical tests have been carried out on the water sampled in the spring, at the emergence from the town waste water treatment plant, where the highest number of coliforms had been registered: indole production, methyl red test, Voges-Proskauer test, citrate utilization, malonate utilization, N28 production on the. TSI medium and the urea hydrolysis. On the base of the results obtained from the 7 biochemical tests, four bacterial genera have been identified: *Escherichia, Citrobacter, Klebsiella* and *Enterobacter.*

Key words: polluted water, conform germs, faecal coliforms, faecal enterococci

Introduction

The water pollution is a pressing matter of our times worldwide, still insufficiently studied in our country. There are even cases when upon studies conducted by official institutes or by independent researchers, the surface waters are classified correctly according to the classes of quality legally defined, but they have no impact on population nor on pollution agents, or anyway they can't persuade them to follow some rules and to fix the problem.

Dufour (1984) proposes couple of bacterial indicators for measuring quality of water used leisure activities. Grimes *et al.* (1984) study the microbiological effects caused by the dump of used water in the coastline waters of Puerto Rico, resulting in the increase in number of faecal indicator bacteria and in water pollution with pathogen microorganisms. Gerba and Speed (1997) show the effects of pollution indicator bacteria living in a small tropical river and their impact on the quality of water used for leisure activities. A surface water with faecal pollution is recorded by Venter *et al.* (1997) in South Africa.

Anderson and Carpenter (1998) observe the pollution of Umpqua river, Oregon, leading to the eutrophic phenomenon. While investigating the water of

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Japanese rivers, Yamai *et al.* (1998) come out with a method for detecting the microorganisms within water filtering stations and within the above rivers.

Noble *et al.* (2003a) compare the bacterial indicators (total coliforms, faecal and enterococci) of water quality for ocean water used in leisure activities. Same year, Noble *et al.* (2003b) make another comparison of measurement methods for bacterial indicators of water quality in oceanic water from seashore zone.

As regard the Mureş river, Millea *et al.* (1993) recorded a strong faecal contamination of its waters 100 m downstream from the town waste water treatment plant of the Aiud city. The biochemical confirmation tests identified *Escherichia* genus in all water samples analyzed during the 6 sessions of measurement. In one of the water samples taken from the filter of the town waste water treatment plant, the *Citrobacter* genus has been identified.

Sárkány-Kiss *et al.* (1997) warned about the level of degradation of Mureş system but didn't point to the nature of the pollution factors responsible for such a situation.

Papp and Foctorpataki (2002) studied the ecological status of the river Mureş by observing the heterotrophic bacteria and indicator organisms (coliform germs and enterococci). The authors noticed that the water of the Mureş river is polluted by used water resulting from human activities, with organic pollutants allowing the saprophytic microflora to grow. The high number of the total coliform germs, faecal coliforms and faecal enterococci found, indicate a very polluted water with faecal materials.

This study aimed to detect the presence in the Mureş river water of microorganisms used as faecal pollution indicators, in order to offer information regarding the use of indicator organisms in predicting the presence of pathogen organism and human health risks.

Materials and Methods

The analyses were carried out on water sampled from eight sites, as follows: P1 – 100 m upstream, P2 – 50 m downstream, P3 – 1.5 km downstream, and P4 – 3 km downstream from the place where three sewers empty into the Mureş river the waste water from the enterprise GHCL UPSOM Ocna Mureş; P5 (entrance), P6 (aerator), P7 (decanter) and P8 (emergence) from the town waste water treatment plant in Ocna Mureş. The determinations of total and faecal (thermotolerants) coliform bacteria, and of the faecal enterococci were carried out according to the STAS 3001-91.

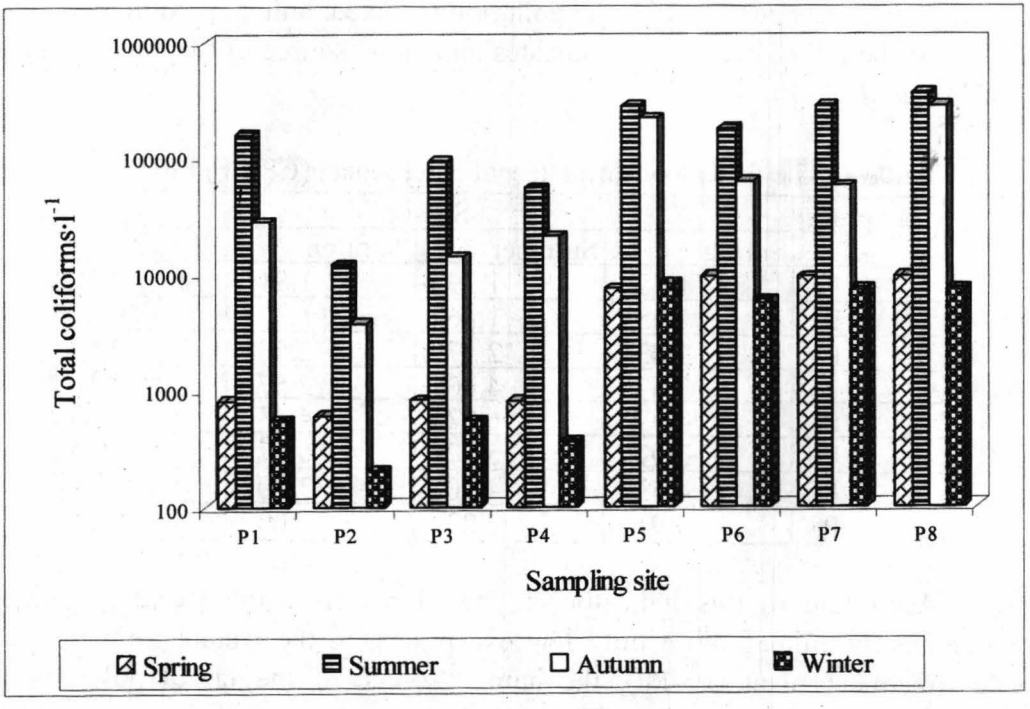
In order to differentiate the genera of the faecal coliforms, 7 biochemical

tests have been carried out on the water sampled in the spring, at the emergence from the town waste water treatment plant, where the highest number of coliforms had been registered: indole production, methyl red test, Voges-Proskauer test, citrate utilization, malonate utilization, H2S production on the TSI medium and urea hydrolysis on the Christensen medium (Atlas, 2004; Garrity *etal.,* 2005),

Results and discussion

Fig. 1 presents the seasonal variation of the number of total coliform germs in the 8 sampling sites.

Fig. 1. The number of total coliforms (logarithmic expression).



A similar situation can be noticed in the case of the faecal conforms (fig. 2). The number of faecal coliforms was lower by an order of magnitude as compared to the total coliforms. The higest value (13000 germs-1'[1]) was also registered in summer in the P8 sampling site.

The same order of magnitude as in case of faecal coliforms was registered

in case of number of the faecal enterococci (fig. 3), with the highest value (59000 germs • l'^{1}) in summer, in the P2 sampling site.

The presence of faecal enterococci in water indicates water pollution with faeces. *Enterococcus bovis, E. equinus* and £. *avium* are indicators of water pollution with mamalian and avian faeces. They don't resist much in the environment. *Enterococcus faecalis* and E. *faecium* are predominantly presents in human faeces, and they rest longer in the environment.

For estimating the nature of the faecal pollution of the surface waters, a numeric indicator is used, indicator which represents the ratio: number of faecal coliforms/number of faecal enterococci (FC/FE). A value of the FC/FE ratio higher than 4 shows a human source of the faecal pollution. When the FC/FE ratio has a value between 2 and 4, the pollution is mixed, human predominantly. When the FC/FE ratio is between 1 and 2, the pollution is mixed, animal predominantly, and a value of the ratio lower than 1 indicates an animal source of the faecal pollution (Barbato *et al.,* 1990).

Table 1. The faecal coliforms/faecal enterococci (CF/EF) ratio.

Sampling site	Season			
	Spring	Summer	Autumn	Winter
P1	1.42	1.29	1.81	0.50
P2	2.05	1.56	1.33	0.87
P3	3.83	2.57	2.58	2.05
P4	3.67	4.00	2.57	2.10
P5	4.27	6.92	4.43	6.55
P6	2.07	5.77	6.47	4.23
P7	4.43	4.50	3.00	3.75
P8	4.91	7.22	4.00	3.09

According to this indicator, in the Mureş river the faecal pollution is predominantly animal. With only few exceptions, in the waters from the waste water treatment plant (P5-P8), the human source of the faecal pollution was noticed, revealing the very low efficiency of the town waste water treatment plant (tab. 1).

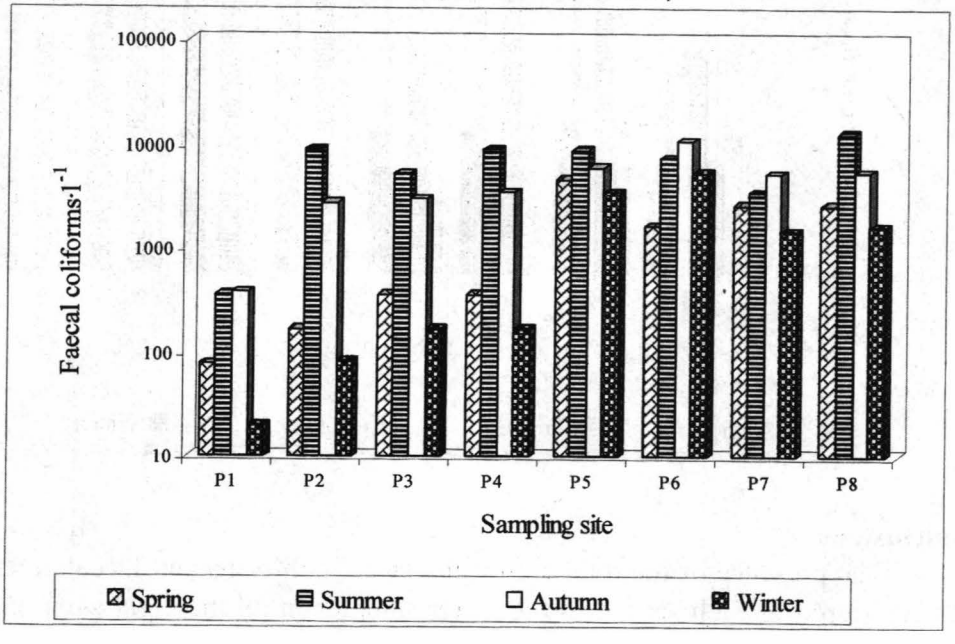
The results of the seven biochemical tests carried out in order to differentiate the genera of the faecal coliforms present in the water sampled in the spring at the emergence from the town waste water treatment plant are presented in tab. 2.

Table 2. Results of the biochemical tests for differentiation of the coliform species.

Test	Bacterial strain tested			
	S1	S2	S3	S4
Indole production	+	+	-	-
Methyl red test	+	+	+	-
Voges-Proskauer test	-	-	-	+
Citrate utilization	-	+	+	+
Malonate utilization	-	+	-	+
H2S production on TSI	-	+	-	-
Urea hydrolysis	-	+	+	+
Genus to whom belong the strains	*Esche-richia*	*Citro-bacter*	*Klebsiella*	*Entero-bacter*

High values of the number of total coliform germs (calculated bay McCrady matrix) have been noticed in most of the cases. The number of total coliform germs was lower in winter and sometimes in spring, and higher in summer and autumn, with the highest value (36000 germs. l^{+1}) in the P8, in winter.

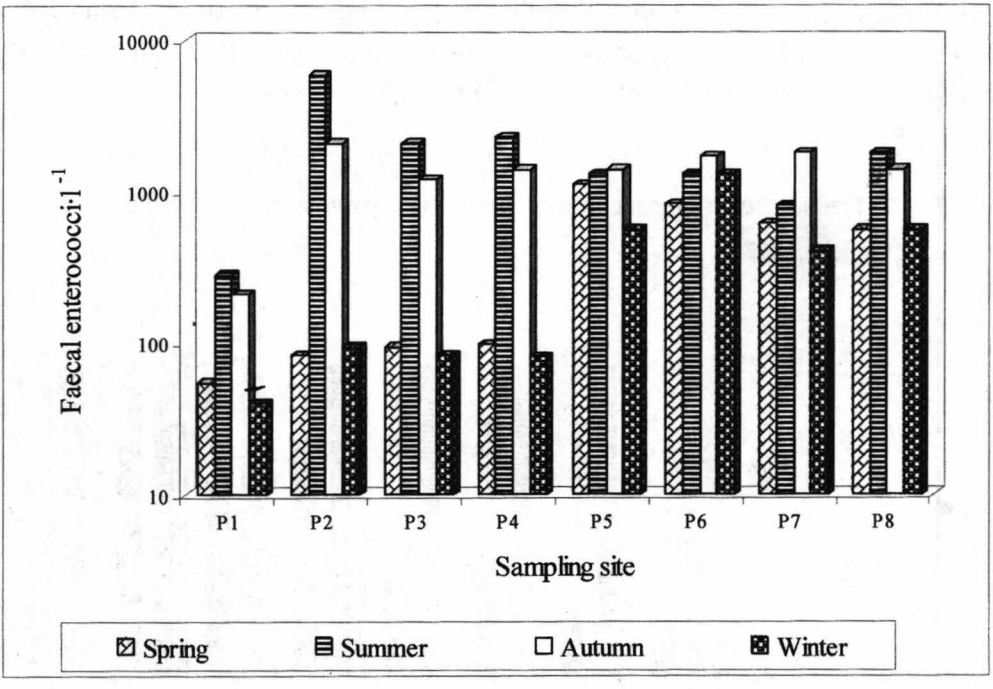
Fig. 2. The number of faecal coliforms (logarithmic expression).



We can notice that: strain 1 (S1) gave positive results only for indole production and methyl red test; strain 2 (S2) was positive for six tests and negative only for the Voges-Proskauer test; strain 3 (S3) was positive for methyl red test, citrate utilization and urea hydrolysis; and strain 4 (S4) was positive for citrate and malonate utilization, urea hydrolysis and Voges-Proskauer test. According to these results, we assume that the four analyzed strains belong to the following bacterial genera: *Escherichia* (S1), *Citrobacter* (S2), *Klebsiella* (S3) and *Enterobacter* (S4).

A positive correlation, statistically very significant ($p<0.001$) was registered between the number of total coliforms and faecal coliforms ($r = 0,993$), total coliforms and faecal enterococci ($r = 0.896$), as well as between the number of faecal coliforms and faecal enterococci ($r = 0.892$).

Fig. 3. The number of faecal enterococci (logarithmic expression).



Conclusions

The presence of the total coliforms, faecal coliforms and faecal enterococci was registered in each season in the water samples in all the eight sampling sites. Their number was lower in winter and sometimes in spring, and higher in summer and autumn. The number of total coliforms was higher by an order of magnitude as

compared to the faecal coliforms and faecal enterococci. Positive correlations, statistically very significant were registered between the three bacterial groups.

The ratio between the number of faecal coliforms and that of the faecal enterococci (FC/FE) indicate that in the Mureş river (samplig sites P1-P4), the faecal pollution is predominantly animal; with few exceptions, in the waters from the waste water treatment plant (sampling sites P5-P8), the faecal pollution is predominantly human, revealing the low efficiency of the waste water treatment plant.

Based of the results obtained from 7 biochemical tests (indole production, methyl red test, Voges-Proskauer test, citrate utilization, malonate utilization, H_2S production on the TSI medium and urea hydrolysis on the Christensen medium) four bacterial genera have been identified in the water sampled in the spring at the emergence from the town waste water treatment plant: *Escherichia, Citrobacter, Klebsiella* and *Enterobacter.*

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Rezumat. Au fost efectuate analize sezoniere asupra apelor prelevate din 8 puncte din zona Ocna Mureş. A fost determinata prezenţa în apă a germenilor coliformi totali, fecali şi a enterococilor fecali. Prezenţa bacteriilor din cele trei grupe a fost detectată în fiecare punct de prelevare, în fiecare anotimp, cu valori maxime vara şi minime iarna. Între numărul de bacterii care aparţin celor trei grupe s-a stabilit existenţa unei corelaţii pozitive, cu semnificaţie statistică foarte mare ($p<0,001$). Indicatorul care reprezintă raportul dintre bacteriile coliforme fecale şi enterococii fecali arată sursa mixtă, animalieră şi umană, a poluării fecatoide, cu preponderenţă umană, mai ales în apa de la staţia de epurare orăşenească. Pentru diferenţierea genurilor bacteriilor coliforme, au fost efectuate 7 teste biochimice asupra probei prelevate primăvara la ieşirea apei din staţia de epurare orăşenească, în care numărul germenilor coliformi a fost cel mai mare: evidenţierea producerii de indol, reacţia la roşu de metil, reacţia Voges-Proskauer, testul cultivării pe mediu cu citrat de sodiu, testul cultivării pe mediu cu malonat de sodiu, evidenţierea producerii de H_2S pe mediu TSI şi testul de hidroliză a ureei. Pe baza rezultatelor celor 7 teste biochimice de diferenţiere a enterobacteriaceelor au fost identificate 4 genuri bacteriene: *Escherichia, Citrobacter, Klebsiella* şi *Enterobacter.*

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STUDY OF ENDOCRINE-METABOLIC ACTION OF SOME *FILIPENDULA ULMARIA* PREPARED, UNDER SOME FREE RADICALS INFLUENCES

Ioana ROMAN[1], M.A. RUSU[1], C. PUICA[1], Maria BORŞA[1]

Abstract: we have administered in adult albino female Wistar rats that were previously intoxicated with CCLi, vegetal extracts of *Filipendula ulmaria* in two doses: a low one and a high one (lOx). It was removed blood for transaminasis (GOT and GPT) activity determination and adrenals for cholesterol concentration determination. Also were removed the liver and kidney for histological (hematoxylin-eosin staining) and histoenzymological and histoenyzmology (lactate dehydrogenase, LDH, succinate dehydrogenase, SDH, cytochrome c oxidase, CyOx and Mg2+ dependent adenosine triphosphatase, ATP-ase) studies. Administration *of Filipendula ulmaria* extracts in the CC14 intoxication case has some favorable effects at the liver level especially in a high dose.
Key words: *intoxicated liver,* CCLI, *Filipendula ulmaria* extract, rats

1. Introduction

Phytotherapy supposes utilization of some medicinal plants in curative or/and prophylactic goals. It uses plants under total or partial extracts shape in contrast with allopathic medicine which recommend some substances extracted from plants.

Many xenobiotics like: alcohol ethylic, some drugs and pesticides, CCl_4, nitrosamines, organic solvents, etc, with whom the body came in contact by destabilization, produce free radicals which interfere with the main metabolically processes (Rusu et al., 2005, 2007). The presence of noxious effects of some free radicals have impose finding of some remedies. Between these remedies also occur some extracts or biopreparates from plants (Weiss and Fintelmann, 2000). Were identified substances with antioxidant effects that can neutralize or limits the noxious effects of some free radicals. From this category also take part the polyphenols.

Polyphenols are most disseminated substances in vegetal regna and maybe only carbohydrates are more abundantly (Ciulei et al., 1993). Polyphenolic compounds are a large and complex group of active principles, which frequently exist in many medicinal plants. In this category are included caffeic acids derivates, flavonoides, tannins, etc. (Oniga et al., 1999). Flavonoides have more classes: flavanols, flavones, izoflavone, eatekine, antoeians, etc. (Bode, 1999, Ciulei et al., 1993, Oniga et al., 1999).

Flavonoides are derivates from polyphenols of vegetal origin which protect cells and tissues from noxious effects of oxygen reactive species, as well as other

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free radicals. Antioxidant effects of flavonoides are due also to cellular mitochondria protection (Lahouel et all, 2006). Plants from spontaneous and cultivate flora which contain many polyphenols, represent a category of plants required for their some possible utilization in phytotherapy. At present, attention of our researches is focused to *Filipendula ulmaria* species.

Filipendula ulmaria L. – is known as a medicinal plant, from which is utilized *Ulmarie flos* (inflorescence) and *Ulmarie herba* (aerial part of stalk, lives and inflorescences). *Filipendula* ***ulmaria*** is a perennial herbal plant from Rosaceous family, originary from Europe, populary named Creţuşcă.

Therapeutical indications: flowers contain salicylic and flavonoides compounds. This plant is considered like a natural "aspirin" because of their anti-inflammatory properties. So, it has anti-inflammatory antiseptic, diuretic (due to flavonoides), and astringent, tonic, stomachic, etc properties.

One of the most known xenobiotics that induce hepatic toxicities is CCl_4 that in the body generate the very reactive free radical $CCl_3^{\cdot}$. CCl_4 is a xenobiotic very well known for its toxic, hepatotrope effects produced by its free radicals. It was used in medical practice since 1847 like anesthesia, analgesic and even antihelmintic agent. Today, is utilized like degreasing and solvent in industry, partake of like organic reactive in synthesis reactions, including fluorocarbonate fabrication, in chemical cleaners as dry cleaner agent as well as in many experimental researches.

CCl_4 intoxicate hepatocytes both *in viva* and *in vitro* by a cascade of modifications that include, in a relatively chronological order (Brent and Rumaek, 1993): lipoperoxidation; inhibition of protein synthesis; inactivation or reduction of some (oxide-reduction and hydrolytic) enzymes activity; misbalances of Ca^{24} normal homeostasis, increases of cellular permeability by cell membrane affectation; cellular necrosis and cellular apoptosis.

Research aim: to test the *Filipendula ulmarie* biopreparates (extracts) effects upon some vital organs, in CCl_4 intoxicated rats.

2. Material and methods

Experimental model

Experiments were performed on albino male Wistar rats, weighing 150 ± 15 g. Animals were maintained in adequately conditions, feed with commercial food pellets and tap water *ad libitum.roman.*

Herbal extract: was administered during 10 days in two doses, lower and high. The high dose was 10 times higher than low dose. It was administered 1 ml/100 g bw from each doses. Since experimental day 4 we started liver intoxication with CCU in a dose of 0.1 ml/100 g bw, during 7 days. Both extract

and CCU were administered by intragastric gavages.

Experimental groups: animals were divided into the following experimental groups, consisting of 7/8 rats each, as follows:

1. the control group CO.

2. the treated group with herbal extract of *Filipendula ulmaria* in a high dose. 1 ml/100 g bw (E).

3. the CCl_4 treated group (CC_4), every rat received 0,1 ml CCl_4/100 g bw.

4. the CCl_4 intoxicated group and treated with herbal extract of *Filipendula ulmaria* in a low dose (CC_4E_1), of 0,1 ml CCl_4/100 g bw, and after 30 min. was administered 1 ml/100 g bw of herbal extract.

5. the CCl_4 intoxicated group and treated with herbal extract of *Filipendula ulmaria* in a high dose (CC_4E_2), each rat received 0,1 ml CCl_4/100 g bw, and after 30 min. was administered 1 ml/100 g bw of herbal extract in high dose.

The rats were killed and samples of blood were immediately taken for determination of GOT and GPT transminase activity and adrenals for cholesterol level determination. Also, were taken samples of liver and kidney for histology (hematoxylin-eosin staining) and histoenyzmology (lactate dehydrogenase, LDH, succinate dehydrogenase, SDH, cytochrome c oxidase, CyOx and Mg^{2+} dependent adenosine triphosphatase, ATP-ase) examination, by accepted methods (Mureşan et al., 1975).

Biochemical data were statistically processed by means of Student's t-test. Aberrant values were eliminated by means of Chauvenet's criterion. A probability value of $p < 0.05$ was considered to indicate a significant difference.

3. Results

Biochemical, histological histuenzymological and histochemical parameters:

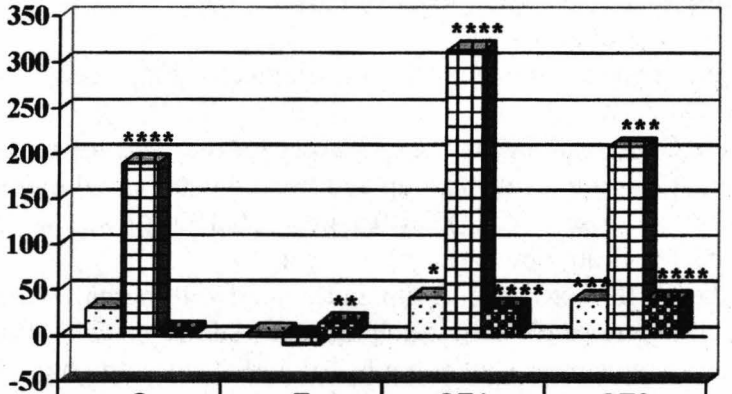
Biochemical results:

- **GPT level:** in C and E group is normal, but increase very much in CC_4 group (+189.69%), with 312,78% in CC_4E_1 group and with 208,17% in CC_4E_2 group.

- **GOT level:** both in C and E group is normal, but increase in CC_4 group (+30.10%), with 41.68% in CC_4E_1 group and with 39.65 in CC_4E_2 group.

- **Cholesterol content in adrenals increase** with 5.95% in CC_4 group, with 15,12% in E group, with 30,46% in CC_4E_1 group and with 33,56% in CC_4E_2 group. Biochemical results are shown in Fig. 1.

Fig. 1. Serum GPT and GOT level and adrenal cholesterol concentration in *Filipendula ulmaria* treated rats.



	C	E	CE1	CE2
GOT	30.1	3.81	41.68	39.65
GPT	189.69	-9.35	312.78	208.27
Colest.	5.95	15.12	30.46	39.65

GOT GPT Colest.

Histological results:

Hematoxylin-eosin staining

Liver – in C and E groups it can see cordons of hepatocytes with cytoplasm stained in red and nuclei in blue-black. CC4 group present multiple structural injuries such as: numerous "ballooning' cells, centrolobular necrotic cells and steatosis, infiltration with collagen fibers and round-cellular elements. These elements act like a "chemical bistouries" that realize a true chemical hepatectomy as we shown (Rusu et al., 2005). The modifications in CC4E1 group were closed to CC4 group. In contrast, in CC4E2 group lesions are more reduced comparative with CC_4 group, although they are composed from same elements. Thus, injured hepatic parenchyma areas are less extended, and gravity of lesions is more reduced (Fig. 2, 3, 4).

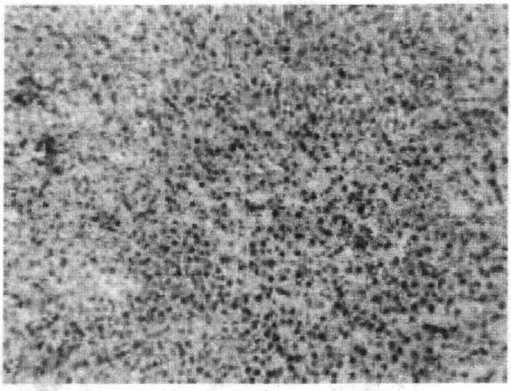


Fig. 2. Hematoxylin-eosine staining, C group, x60

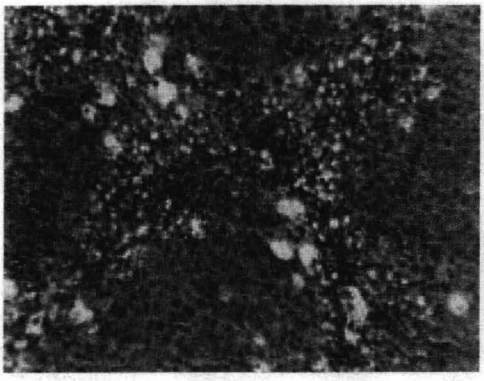


Fig. 3. Hematoxylin-eosine staining, CC4 group, x60.

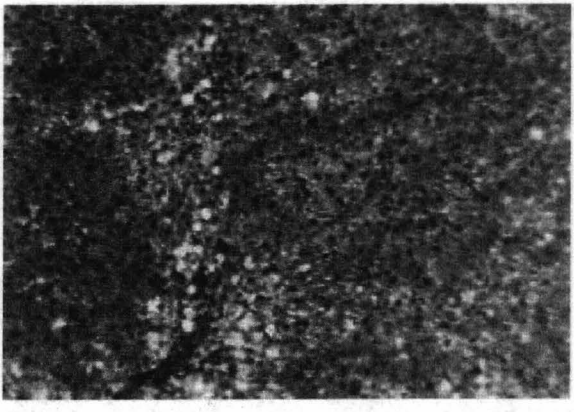


Fig. 4. Hematoxylin-eosine staining, CC4E2 group x60.

Kidney – in C and E groups it can be remarked the normal image of urinary tubes and of Malpighi glomerulus's. In CC4 group are present some lesions like: tubular dystrophy and tubular necroses as well as in Malpighi corpuscle. In CC_4E_1 and CC_4E_2 (especially) groups are the same type modifications but more reduced.

Histoenzymological-histochemical results:

Liver

Lactate dehydrogenase, ***LDH-*** a cytoplasmatic enzyme emphasized by a very intense blue staining, which have a zonal distribution, more intense periportal or in acinar I area. In C and E groups enzyme activity is similar. In CC_4 group,

enzyme reaction has a significant decrease. There are bigger or smaller areas with reduced enzyme activity. Also it can see zones with diphormazan having a reddish color. There also are destroyed areas, without enzyme activity or with very low activity. CC_4E_1 have a similar situation with C group. In contrast CC_4E_2 group evidently have a LDH activity more increased than CC_4 and CC_4E_1 group (Fig. 5, 6, 7)

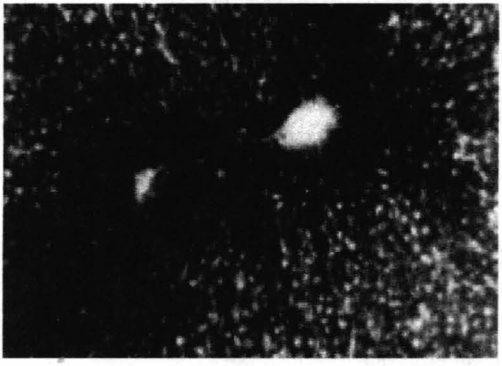


Fig. 5. Lactate-dehydrogenase, C group, x60.

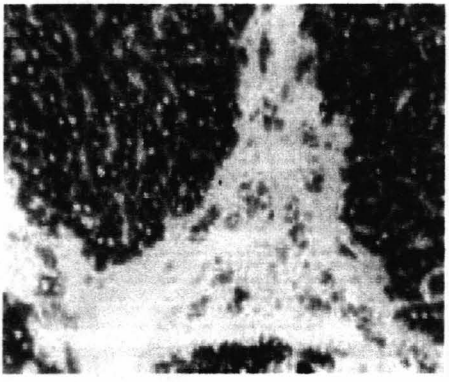


Fig. 6. Lactate-dehydrogenase, CC4 group, x60.

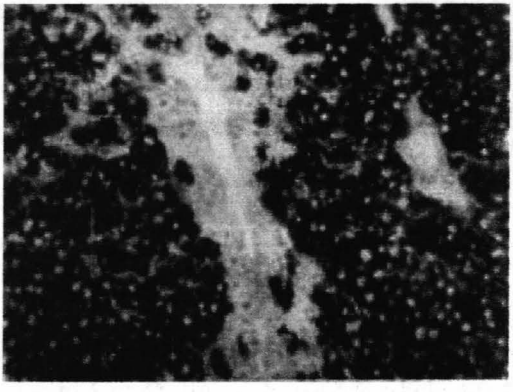


Fig. 7. Lactate-dehydrogenase, CC4E2 group, x60.

Succinate-dehydrogenase (SDH): is a mitochondrial enzyme, with an intense activity and normaly is divided into zonesc in C and E groups. Enzyme activity is decreased in CC_4 (more), CC_4E1 and CC_4E_2 (less)

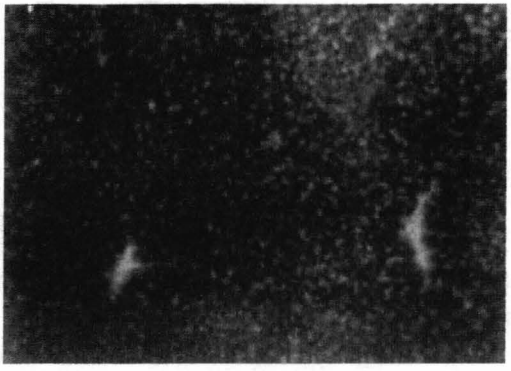


Fig. 8. SDH, C group, enzime heterogenity (×60)

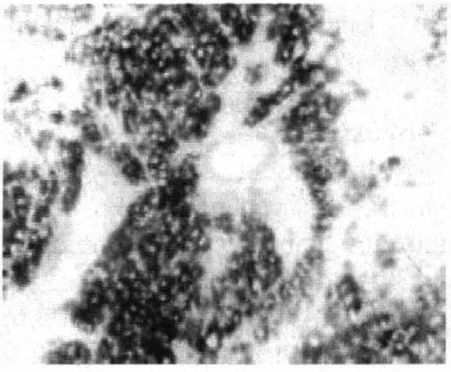


Fig. 9. SDH, CC4 group, the evident manifestation of chemical hepatectomy by the presence of enzime activity only in residual parenchima, bands of collagen hasn't SDH activity (×60)

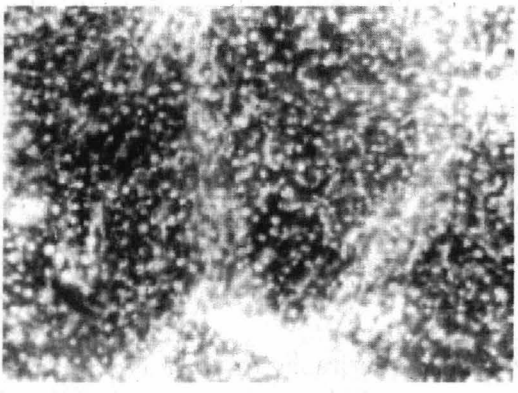


Fig. 10. SDH, CC4E2 group; the enzimae activity is more intense; the chemical hepatectomy is more reduced (×60)

Cytochrome c oxidase (CyOx): is also a mitochondrial enzyme emphasized through a blue-greenish stain which has an areal disposition. It has an intense activity in C and E groups, but deacrease very much espeacialy in CC_4 and CC_4E_1 groups. CC_4E_2 group has CyOx activity more intense than CC_4 and CC_4E_1 groups. *Mg^{2+} dependent adenosine triphosphatase, (ATP-ase),* is both a mitocondrial and membranal enzyme. It can be observed that enzyme activity decrease in CC_4, CC_4E_1 and CC_4E_2 (less) groups.

Kidney

Enzymes activity is reduced in CC_4 and CC_4E_1 groups; in CC_4E_2 group is less afected.

4. Discussions

In present our attention for researches was foccused on *Filipendula ulmaria,* Rosaceae family, which besides the salicilic compounds also contain important quantities of flavonoides like: kaempherol, quereetol, spireozida (specific for *Filipendula*), hiperozida, etc. The most emphasized contain of flavonoides is in blossom (rutozide) being almost 4,6% (Tamas et al., 1993).

From the analisis of results we can observe that GPT and GOT serum level increse in CC4 group, but also in CC_4E_1 and CC_4E_2 groups (the increase is reduced in CC_4E_2 than CC_4E_1 group). These results prove the presence of an intense hepatocytolise process (Qureshi, 2007; Jadon et al., 2007). In E group the transaminases level is the same with C group, so there is no cytolisis.

As concern the *Filipendula ulmaria* extract effects we mention that we used two doses of extract, a low one and a high one (lOx). Lesional, morfological, histoenzimological and histochemical modifications are more reduced especially in CC4E2 group. We consider that some positive effects of *Filipendula ulmaria* extract administration can be due to flavonoides content that are derived ofpoliphenols that protect the cells versus the noxious effects, especially in higher doses (Lahouel et al., 2006).

In the case of our experiment we consider that the high dose had some positive effects, more significantly than lower dose.

5. Conclusions

- It was realized an experiment of acut type, in which the *Filipendula ulmaria* extract was adminstered during 10 days, and intoxication during 7 days.
- Experiment had a preventive and curative caracter, being administered before of intoxication and together with it.
- The extract was administered in two doses, the high dose being of lOx higher than low dose.
- Were removed **liver, kidney, adrenals for** cholesterol determination **and blood for** transaminazes level determination
- We utilised a histoenzimological, histochemical, histological and biochemical methodology.
- The parameters of the group that received only *Filipendula ulmaria* don't vary versus the C group.

- CC14 intoxicated group present grave injuries especialy at the liver level, like: "ballooning' cells, hepatoeytolisis and steatosis, necrosis and infiltration with collagen fibers – chemical hepatectomy.

- A very good answer to the treatment has the group that received the high dose of *Fulmaria* extract.

- The hepatocitolisis is not influenced in both intoxicated and treated groups.

- The favorable effects that are obtained in the group that received lOx higher doses of extract is expressed by reduced histological damages, a reduced steatosis and enzymes activity is less affected.

- Administration of *Filipendula ulmaria* extract has some favorable effects, especialy at the liver level and the high dose of extract.

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Rezumat: Am administrat la şobolani Wistar femele adulte intoxicate cu CCl_4 extracte vegetale de *Filipendula ulmaria* in doua doze, mică şi mare (lOx). S-a recoltat sânge pentru determinarea activităţii transaminazelor GPT şi GOT şi glandele suprarenale pentru determinarea concentraţiei colesterolului. De asemenea, s-au recoltat ficat şi rinichi pentru studii histologice şi histoenzimologice (lactatdehidrogenaza – LDH, succinat dehidrogenaza – SDH, citocromoxidaza – CyOx, adenozintrifosfataza – ATP-aza). Administrarea extractelor de *Filipendula ulmaria,* în cazul toxicozei cu CCl_4, are unele efecte favorabile la nivelul ficatului, în special la doză mare de extract.

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BIODIVERSITY – DIRECTIONS OF PRESENT DAY RESEARCH AND METHODS OF STUDY

Adrian STOICA[1]

Abstract: Although biodiversity is considered in Romania a priority, most of the articles published on this subject are limited to lists of existing species from various areas. These kind of descriptive studies are very important for the field of biodiversity, as they lay at the base of any complex studies, but in our case they serve to prove that, in this moment, there is a lack of basic notions in statistical analysis and processing of field data, calculations that are absolutely needed for the correlation of the national biodiversity research to the international research. The most important cause for this „superficial" approach of biodiversity is the lack of materials presenting the methods and directions of biodiversity research at an international level. The article will try to clarify a few of the methods used in biodiversity research, and show some of its directions.
Key words: biodiversity, alpha beta gamma diversity, indexes and indicators of biodiversity, ordination methods, error-correction methods.

1. Introduction

The notion of biological diversity has appeared in the XIXth century as a result of the development of Ecology as a distinct field of science. In any scientific domain where it is approached, the notion of diversity is difficult to quantify. As such, in biology there are also many definitions of this term. In 1992, at the UN Summit from Rio de Janeiro, biodiversity has been defined as "the variability among living organisms from all sources, including, 'inter alia", terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems"[1].

The definitions of diversity manage to concentrate the essential on a large, conceptual scale. In reality, the high numbers of life forms on earth make it impossible to achieve an absolute inventory of biological diversity, which would allow a precise identification of interest areas, to be proposed for conservation. There is always missing data, translated in areas that are little or un-researched, undiscovered species, errors in data collection, changes in already collected data, etc. As there can be no absolute method to quantify and estimate biodiversity (in this moment we don't even know all the species on earth), scientists are obliged to use **indicators of biodiversity.**

These indicators can be: various species (threatened at local or global level, important or endemic species), quantity (number of species, number of individuals,

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biomass, abundance), aero-spatial data regarding the spread and fragmentation of habitats, data referring to areas with heavy impact from human activities, etc.

Brute data referring to species richness, together with the data given by biodiversity indicators can help scientists to choose the most important areas for conservation of biodiversity. Most of the biodiversity studies in Romania fall in this category.

But the process of quantification of biodiversity in this kind of areas should only begin with the conservation choice. The quantification process requires solid knowledge of mathematics and statistics, in order to obtain results universally comparable. Therefore, a series of indexes has been introduced, trying to describe as correctly as possible, in one number, the notion of biodiversity. But in order to understand these indexes we need to understand first the transformation of the notion of biodiversity. In 1972, Whittaker divides biological diversity, which he calls "species diversity", in to three main types: **alpha, beta** and **gamma** diversity.

In time, these three categories have been completed by four more, **delta, epsilon, point** and **pattern** diversity. The seven categories of biodiversity are ordered in two large groups: *descriptive diversity* and *differential diversity,* as can be seen in the table below (source: GAP bulletin, no. 5, June 1996[2]):

Table 1 – *Levels and types of species diversity*
(*Whittaker 1977, Stoms and Estes 1993* in GAP bulletin, no. 5, june 1996)

Descriptive diversity	***Differential diversity***
1. Point diversity – a small study area inside a alpha-diversity unit; in general from 10 to 100m^2;	
	2. Pattern diversity– diversity change between points inside the same community;
3. Alpha-diversity – the species diversity of a certain habitat; in general from 0,1 to 1.000 ha;	
	4. Beta-diversity – diversity change between the communities of a landscape. An index of intra-habitat diversity.
5. Gamma-diversity – the species diversity of a landscape composed from more then one type of natural communities; in general from 1.000 to 1.000.000 ha;	
	6. Delta-diversity – diversity change between landscapes along the major climate and physical-geographical gradients;
7. Epsilon-diversity – species diversity of a large region, with various landscapes; in general from 1.000.000 to 100.000.000 ha.	

The most used notions in today's literature are alpha and beta diversity, because the dimensions of the study areas in these cases are the most suited for field research. The other categories can be interpreted as a reiteration of these two notions at

a larger or smaller scale. Regarding their different meaning, usually areas with high *descriptive diversity* are considered more important for conservation compared to areas with low *descriptive diversity.* However, these areas with low *descriptive diversity* can be important for the overall diversity if they are very distinct in composition compared to the rest of the area, which would translate in a high *differential diversity* – as pointed out by Hernandez-Stefanoni J. L, Ponce-Hernandez, R. – 2004[3].

The same idea is underlined by Cristea and Denaeyer, in a hypothetical example with two coenosis, one richer in species compared to the second, but in the same time, poorer in interesting species (endemics, relict, protected, threatened, vulnerable species). Their conclusion is that the number of species can't serve as an absolute criterion in the determination of biodiversity (Cristea V., Denaeyer S. – 2004).

2. Biodiversity research methods:

A first method for the quantification of biodiversity is represented by the already-mentioned **alpha-diversity indexes.** There is more than one index of diversity because they try to quantify in one number two determining factors: species richness and equitability (abundance). As a result of this, depending on the different importance given to one of these two factors, there is a "plethora" of diversity indexes (table 2).

Table 2 – Alpha-Diversity Indexes (Magurran, 1988)

Table 2 – Alpha-Diversity Indexes (Magurran, 1988)

	Discriminant ability	*Sensitivity to sample size*	*Richness or evenness dominance*	*Calculation*	*Widely used?*
α (log series)	Good	Low	Richness	Simple	Yes
λ (log normal)	Good	Moderate	Richness	Complex	No
Q statistic	Good	Low	Richness	Complex	No
S (species richness)	Good	High	Richness	Simple	Yes
Margalef index	Good	High	Richness	Simple	No
Shannon index	Moderate	Moderate	Richness	Intermediate	Yes
Brillouin index	Moderate	Moderate	Richness	Complex	No
McIntosh *U* index	Good	Moderate	Richness	Intermediate	No
Simpson index	Moderate	Low	Dominance	Intermediate	Yes
Berger–Parker index	Poor	Low	Dominance	Simple	No
Shannon evenness	Poor	Moderate	Evenness	Simple*	No
Brillouin evenness	Poor	Moderate	Evenness	Complex	No
McIntosh *D* index	Poor	Moderate	Dominance	Simple*	No

The existence of so many diversity indexes made some authors (Hurlbert, 1971)[4] draw the conclusion that there is no sense in the concept of biodiversity. What we need to understand as we look to all these indexes is that they are not diversity, just a representation of diversity according to a purpose. The radius of a sphere is an index of its volume but not the volume itself. Using the radius instead of the volume in calculations will create false results. This is happening currently with the estimation of diversity using indexes, affirms Lou Jost (2006)[5].

The Shannon Index[6], the most common measurement of biodiversity, is, according to Jost, an index of the entropy in the system and not an index of diversity. In a simple example Jost demonstrates that by holding constant one of the two factors that determine biodiversity (abundance) and doubling the remaining factor (species number), the value of the index, which should double, in reality, doesn't. Even so, Jost continues to recommend the usage of the Shannon Index, as all communities that have the same value of the Shannon Index have equivalent diversities. Based on this discovery, we can create classes of diversity, each class being characterized by a defining community, that has equal species abundance. The separation of species communities in diversity classes allows us to create classes of diversity indexes as well – and Hill[7] did this in 1973. Hill demonstrates that diversity indexes measure different aspects of diversity, the results being comparable only between indexes that belong to the same order of diversity (e.g. Order 0 indexes: Species Richness, Order 1 indexes:

Shannon Index, Order 2 indexes: Simpson Index). Using Hill's results, Jost creates a formula that allows us to compare results from indexes of different orders of diversity. With the help of this formula, we can compare results which were previously very difficult to compare. For example it was difficult to compare a community with a species richness of 100 species to another one that has a Shannon Index of 3.91 and a third one that has a Simpson Index of 0,04. Which one is more diverse? Using Jost's formula, these indexes can be brought to a common unit, called "equivalent-species". The diversity of the first community is 100 "equivalent-species", that of the second community is 50 "equivalent-species" and that of the third 25 "equivalent-species". Another case where this transformation can prove to be very useful is where a diversity index has been used to prove the impact on a community. If the community had a 4,5 Shannon Index before impact and only a 4,1 Shannon Index after it, the most common action in an article would be to use the t test to see if the difference is statistically significant. Jost states that it is very useful to create a conversion to "equivalent-species" as it shows us more clearly the impact on the community. In this case, the diversity of

the community before impact is 90 "equivalent-species" and after impact only 60 "equivalent-species". As Jost puts it: "The question of the real magnitude of the drop is important and is separate from its statistical significance. It is essential to have informative, interpretable diversity and similarity measures, so we can go beyond mere statistical conclusions".

Another important note to the use of diversity indexes made by Jost based on Hill's research is that the order of diversity to which an index belongs to determines its sensibility to rare or common species. Diversity indexes from the order 0 are completely insensitive to species abundance, and are known as descriptors of species richness (alpha-diversity). Diversity indexes of negative order tend to give more importance to rare species in biodiversity, while diversity indexes of positive order give more importance to common species in biodiversity. The equilibrium point, where all species are taken into consideration in a relatively correct manner, is diversity of order 1. The best known index in this order is the Shannon Index. This is yet another argument for the wide-spread use of the Shannon index, which, for all its short-comings is considered by many authors as the most correct index of diversity.

Once we finish estimating the alpha-diversity of a community (diversity indexes are considered alpha-diversity indexes), we can go further to calculate the value of **beta-diversity,** (the *differential diversity).* Usually, beta-diversity measures the difference (or similarity) between various habitats or study areas, but it can also refer to the change of diversity along a gradient (turnover rate). Beta-diversity is the most widespread method of measuring *differential diversity.*

Magurran (1986), quoting Wilson and Shmida (1984) gives us six methods of measuring beta-diversity **the Whittaker method (ßw)** – 1960, **the Cody method (ßc)** – 1975 (the measurement of turnover), **the three methods of Routledge** and **the Wilson-Shmida method ($ß_T$)**[8].

Wilson and Shmida have designed an experiment to see which of the six indexes of beta-diversity is best to use in a field study[9]. The six indexes were tested for a response to four criteria: community change, additivity, independence from alpha-diversity[10] and independence from over-sampling. According to the results, Whittaker's index (3w gives the best answer to the four criteria, followed closely by the Wilson-Shmida index ßT.

Measures of beta-diversity are obtained also from a method of species ordination, namely DCA (Detrended Correspondence Analysis).

Vellend (2001) makes an important addnotation to the use of beta-diversity indexes, stating that such indexes from different parts of the globe need to be

normalized, before any comparisons can be made[11]. Qian and Ricklefs[12] propose a method that allows the comparison of beta-diversity from distant regions without normalization, method based on the comparison of the slope of a chart representing the similarity in species of different areas, as a function of the distance between those areas (Qian, Ricklefs et White, 2005).

In figure 1 we can see how the similarity of study areas decreases as they get farther away from each other (logically, as distance increases, there is a decrease in the common number of species).

The slope of this decrease is a good measure of beta diversity (the faster the similarity decreases, the higher the beta-diversity). Qian and Ricklefs compare the decrease of similarity on the North-South direction compared to the East-West direction, observing a more accentuated decrease from North to South; the similarity decreases differently on two different continents (the black dots are study areas from Eastern Asia, while the white ones are from the Eastern Coast of the United States), and he states that beta-diversity is bigger in Eastern Asia compared to Eastern North America (probably because of the more diverse relief and climate in Eastern Asia compared to Eastern North America).

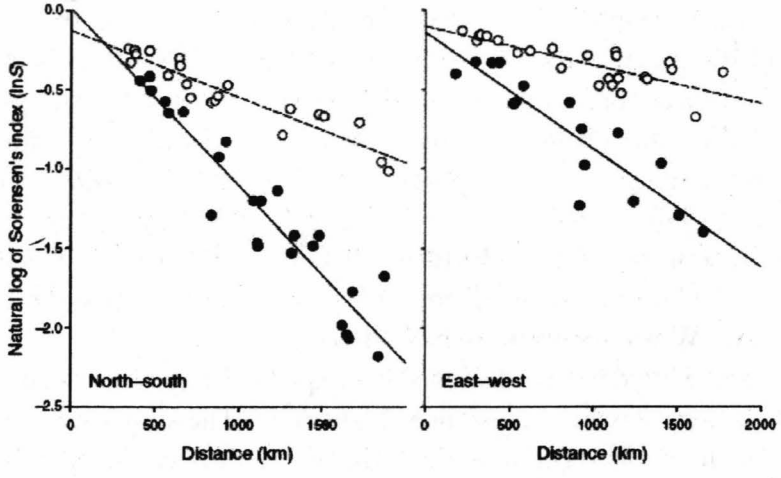

Fig. 1 – The relationship between the logarithm of Sorensen Index of Similarity (lnS) and the geographical distance between the study areas that it is calculated for (Qian, Ricklefs et White, 2005)

Mathematically speaking, beta-diversity is considered by Ricklefs and Qian to be the negative of the value of the slope "lnS-distance". In order to determine if the values obtained for the two continents and the two directions are significantly different, the two researchers applied a covariance analysis test (ANCOVA).

Methods of data ordination

Once described the alpha and beta-diversity of a study area, a series of questions appear regarding the causes for which it is high or low. Biodiversity varies as a function of a series of environmental gradients, and their quantification is attempted by data ordination methods. How much of the "fault" of high or low biodiversity can be placed on the pH, soil type, exposition, altitude, humidity, human impact?

Ordination represents the arrangement of species and/or study areas along multiple environmental gradients. In other words, ordination is a synonym for the term "multivariate gradient analysis". Arranging the species or study areas based on more then three gradients leads to graphics that have more then three dimensions, which can be very difficult to distinguish, let alone interpret. This is why a more correct definition of ordination is that of Gauch (1982): "0rdination is the representation of the relationship between species/study areas and the environment as correctly as possible in a low-dimensional space".

A lot of ordination methods have been proposed, and the most common are organizedin table 3[14]

Table 3 – Ordination methods (M. Palmer)

i. Informal techniques
1. Indirect Gradient Analysis
A) Methods based on ecological distance
a) Polar Ordination - PO (Bray-Curtis Ordination)
b) Principal Coordinates Analysis - PCoA (Metric Multidimensional Scaling)
c) Non-metric multidimensional scaling - NMDS
B) Methods based on Eigen-vector analysis
B1) Linear models
d) Principal Components Analysis - PCA
B2) Unimodal models
e) Correspondence Analysis - CA (reciprocal averaging)
f) Detrended Correspondence Analysis - DCA
2. Direct Gradient Analysis
A) Linear models
g) Redundancy Analysis - RDA
B) Unimodal models
h) Canonical Correspondence Analysis - CCA
i) Detrended Canonical Correspondence Analysis - DCCA

For example, you can see below a CCA diagram of a forest from North Carolina (Palmer, 1986)[15]. Environmental variables are represented by blue arrows, study areas by small opened circles, and species by bigger, blue, closed circles. The

species are represented using only the first four letters from the genus and species name.

The main advantage of ordination methods is represented by the possibility to interpret the causes of biodiversity in an objective way, independent of the researcher's knowledge of species ecology. Before these kind of statistical methods were used, it was considered a part of the ecologist's job to use his knowledge and his skills to collect and interpret data; in this case, the scientific objectivity of the study was opposite to the use of subjective abilities for distinguishing the most important environmental gradients. In that context, the ordination of the importance of gradients was as much an art as science, being based solely on the knowledge of the researcher.

Once the ordination techniques have been introduced, testing statistical hypothesis became routine. In case we decide to use these techniques, the data collection part of the experiment needs total objectivity, which would allow the repetition of the experiment obtaining the same results. Great importance in this type of studies needs to be given to the stage where the methods and techniques of data collection are established, because, for most of the studies involving statistical analysis, the study areas considered need to be chosen randomly and also need to be of equal size.

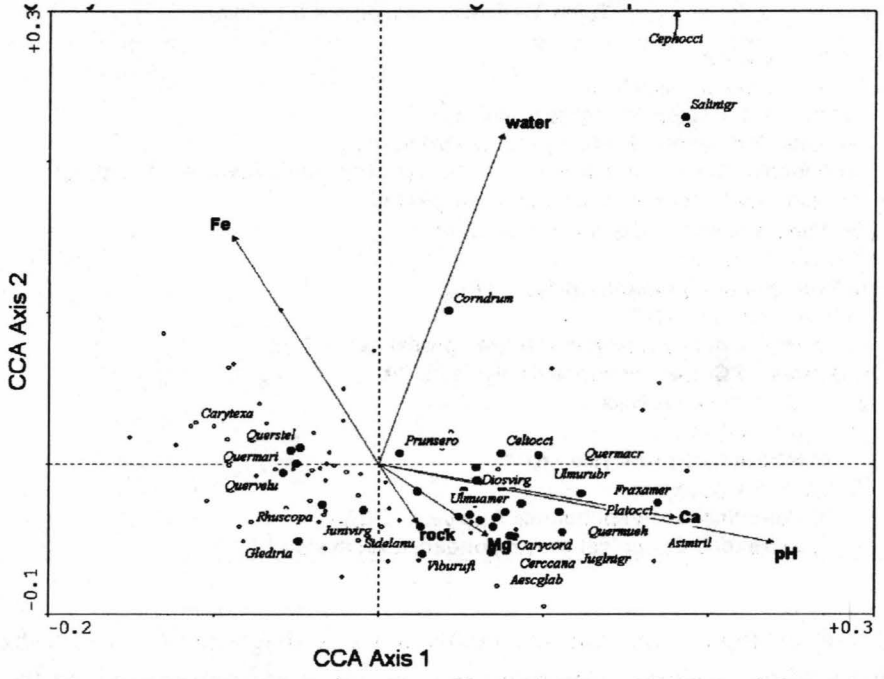

Fig. 2 – The relationship between the logarithm of Sorensen Index of Similarity (lnS) and the geographical distance between the study areas that it is calculated for (Palmer, 1986)

Error correction. In any statistical process it is impossible to avoid completely introducing errors. The possibility that our biodiversity data has errors can not be overlooked.

One of the basic conditions to obtain correct results it is the capacity to repeat the experiment and obtain the same results. In most cases, the studies do not allow the collection of 2-3 sets of data that would be needed for verification of repeatability. The most important impediments in the analysis of repeatability are: lack of funds, lack of time, the development of new study themes, the will/need to publish existing data, etc. The error-correction methods allow just that, the repeatability of the experiment, by excluding a part of the data and using the remaining data. In this way, we get not only a verification of repeatability but also a verification of the integrity of the existing data, because as parts of the data are excluded, we can notice which parts are very distant to the medium values, and suspect them as erroneous recordings.

In order to correct the errors in the data, a variety of techniques is applied. One of the most widespread methods of error-correction is the „Jack-knife" method. The Jack-knife method consists in repeated exclusions of certain parts of the gathered data, that allow us to recalculate the diversity index for each of the new situations. The Jack-knife method is not the only method used for error correction. In practice, we will often meet the..Bootstrap" method or the „Cross-validation" method. The above methods are similar to the Jack-knife method, all three being in the same category of calculations – „re-sampling techniques".

The bootstrap method uses a different algorithm of data exclusion. Compared to the Jack-knife method, it doesn't eliminate complete sub-sets of data, but only parts of these sub-sets in order to create new data. In this way, we can create in the laboratory new subsets of data (even hundreds of sub-sets!), based on our existing field research.

The..cross-validation" method implies the separation of data from the start, so not all the data collected in the field is used for statistical analysis. A part of the data is kept separately just for confirmation or infirmation of the initial analysis[17].

In conclusion, each of the three analysis improves our chances for an error-free analysis, by creating new data through the elimination of sub-sets from the existing data and comparing them to the original result. Each of the three analyses has its own advantages and disadvantages caused by their specific calculation method[18]:

• The „Jack-knife" analysis is used to detect the data very distant from the average – and by this, suspect to be erroneous (the so called „outliers");

• The „Bootstrap" analysis is used for improving the estimation of data sets that have abnormal distributions (especially those characterized by the existence of two or more clusters of data, situations where the median describes the dataset more correctly then the average; it can be applied for study areas that have few species – n<20);

• The „cross-validation" method is used to check the repeatability of a experiment.

3. Conclusions

Romanian biodiversity studies need to go beyond the descriptive state, of publishing lists of soecies oresent in a studv area. In order to get connected to the international research, it is recommendable for the biodiversity studies to cover as many of the methods presented in this article as possible:

1. Initial estimation of diversity using indicators – in order to determine areas of interest for a more detailed study;

2. Scientific data collection, where study areas are chosen randomly, and their dimensions are equal, in order to avoid the errors caused by the species-area relationship;

3. The calculation of alpha-diversity indexes: they can quantify in a single number the biodiversity of a certain area. Using Jost's formula, we can translate and compare afterwards areas described using different diversity indexes. Other ideas include diversity comparisons between different plant associations, followed by an explanation of the causes of the obtained results using ordination methods;

4. Calculating beta-diversity indexes in order to avoid losing areas that have low alpha-diversity but which are still important for the overall diversity, containing rare species.

5. The use of ordination methods to describe the causes of high or low biodiversity (CCA, DCA, NMDS, etc.). These methods are in common use in international studies.

6. Cleaning the field-data of errors, using various methods: Jack-knife, Bootstrap, Cross-validation, etc.

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CONTRIBUTIONS TO THE CHOROLOGY OF THERMOPHILE ELEMENTS *ARTEMISIA ALBA* TURRA AND *GYPSOPHILA* COLLINA STEVEN EX SER.

Monica BELDEAN[1], Gheorghe GROZA[1]

Abstract. This paper includes a completion of the existent information regarding the chorology of the two rare species from Romania's flora, *Artemisia alba* Turra and *Gypsophila collina* Steven ex Ser. and also a reviewing of the nomenclature of the species *Gypsophila collina.*
Key words: *Artemisia alba, Gypsophila collina,* Transilvania, Sălaj district, gypsum

Introduction

The both analized species are included in the category of rare species from our country's flora according to the red lists of lost, endangered, vulnerable and rare vasculary plants from Romania's flora (Boscaiu and co., 1994, Oltean M. and co., 1994).

The gender *Artemisia* is taxonomicaly included in the family **Asteraceae** and has an areal of vegetation extended over the entire Globe. The gender includes a number of approx. 550 species, spreaded mainly over the steppes of Eurasia, North and Central America. In our country's flora it is represented by a number of 14 spontaneous species and two cultivated species. *Artemisia alba* Turra *(A. lobelii* All.-*Artemisia camphorata* Vill.-*Artemisia saxatilis* W. et K.), named popularly rock wormwood, is a perennial, saxicole, thermophile, subfrutescent species. The inflorescence is, most frequently, a raceme with globulous calatides. The plant has a smell of camphor. In the conditions of our country's climate the anthesis includes the period august-September, and in the mediteranean and submediteranean areal the period june-october. It is an european species spreaded in S and SC Europe (Al Be Bu Ga Gr Hs Hu It Ju Rm Si), dissapeared from Austria and the former Czechoslovakia. In Romania, the presence of rock wormwood is signalled punctiformly on calcareous sides mostly with southern exposure.

The gender *Gypsophila* belongs to the family **Caryophyllaceae** and is widespread in Europe, Asia and the north of Africa. This gender includes approximately 150 species of which six are also found in Romania's flora. *Gypsophila collina* Steven ex Ser. (gypsum "baby's-breath") is a perennial, saxicole, thermophile species. The plant has an aspect of bush with glauc, rough leaves, reddish stems, very strong rhizomes. The inflorescence is a paniculiform dichasium, the petals are white, the sepals are reddish, and the pedicels are hairless. It grows on aflorate gypsums at the surface. G. *collina* is a rare, european species because of its pretensions for the

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substrate on which it vegetates. Its habitat includes only Romania and Crimea. In our country it is present punctiformly on gypsum rocks in Transilvania.

This article completes the information regarding the chorology of the species *Artemisia alba* Turra and *Gypsophila collina* Steven ex Ser. existent by now. Our contribution consists in finding a new station for the species *Artemisia alba* and new localities for both species.

Material and Methods

The utilised material consists of collected plants on the field, a herbarized material existent in USAMV Herbary Cluj-Napoca and the herbary of Botanical Garden *"Al. Borza"* in Cluj-Napoca and the existent bibliography. In order to collecting the material we went on the field in different periods of vegetation in all districts in Transilvania where are aflorate gypsums at the surface, and in Muntenia, Prahova district. For the identification of the areas with gypsum we used the geological maps of the Mining Institute.

The collected plants on the field and the existent ones in the herbaries of universities in Cluj were verified according to Romanian Flora, V. Ciocalan 2002 and European Flora. The utilised nomenclature is in correspondence with the European Flora.

In order to elucidating the species *Gypsophila collina* we compared the morphologic characteristics of the collected and identified plants by us and the two species existent in the USAMV herbary that are *Gypsophila fastigiata* L ssp. *arenaria* (W. et K) Richt-Gurke var. *leioclados* Borb. and *Gypsophila arenaria* W. et K. var. *arenaria.* We also compared the data referring to the nomenclature of the species in the specialized literature.

Results and Discussions

As a result of inventorying the existent material in the herbaries of universities in Cluj and of consulting the specialized literature we notify the species *Artemisia alba* Turra *(Artemisia tobelii M.)* in the following localities: The Bedeleu Massive (on Pietricele – 900 m alt.)***collected by Gergely (10.08.1952); Rimetea (Colţii Trascăului)*** St. Cürös – 1957; above the Vidolm village on Piatra Urdaşului (800-900 m alt.) A. Nyarady and C. Váczy (21.07.1959)**; A. Nyárády and D. Pázmány (1960)** on Piatra Urdasului above the Colţeşti village (alt. 650-800 m); Coasta de lângă Piatra Urdaşului**(800 m alt.), towards Cristeşti village A. Nyárády and C. Váczy; in 1961 at Piatra Cetăţii** above the Colţeşti village (alt. 740 m) Gergely. It was also signalled at Ocna Sibiului*** on marl hills by H. Schur; at Ciclova on calcareous rocks Heuff.*** and Wierzbicki* and by Gavril Negrean* (21.08.2002) at Cotu Văii (Constanţa district)* at the altitude of 70 m; Tilalma? Hill, Piatra Podmonului (exp. N), Colţeşti on Dl. Cetăţii, Piatra lui Nagypal and Dealul Mic***.

As a result of a study of the flora and vegetation on gypsums realized in the summer of 2007, we identified the species *Artemisia alba* on aflorate gypsums at the surface in three localities in Sălaj district namely Stana, Jebuc and Sfăraşu. The station has southern exposure and is situated in the superior third of mountain sides that have in their structure alabaster, gypsum and marl calcareous stone. The mountain sides are situated mostly between the precincts of the localities Sfăraşu and Jebuc (with access from the road that links the two villages) and above the Stana locality. In the past was exploited from here the deposit of alabaster, the signs of these exploits being the mine entries and some drills for geological prospectings left open in the superior third of the hill. The identified populations of *Artemisia alba are* cantoned on gypsum deposits around the drills (where vegetates with *Gypsophila collina),* and also on marl calcareous stones. Another station on gypsum is an old manual exploit situated above Jebuc village.

The coenotic composition of rock wormwood populations are represented mostly by saxicole, xeroterm, xerophile and basophile species. The species with the most constancy although few are the saxicoles. In this way are: *Gypsophila collina, Helianthemum canum, Festuca pattens, Thymus comosus, Teucrium montanum, Carex humilis, Inula ensifolia, Asperula cynanchica, Odontites verna, Potentilla arenaria, Thesium linophylton,* but also elements of the antropozoogenic impact as *Stipa capillata.* A rare element that enriches the floristical composition in some areas and gives colour to the landscape of these populations is *Daphne cneorum.*

The second analized species, *Gypsophila collina,* is better represented on gypsum hills, but unlike *Artemisia alba* it doesn't grow on calcareous stone, which confirms the entrance of rock wormwood in the habitat of the first species.

Analizing the herborized material with *Gypsophila collina* in the two universitary herbaries in Cluj, we found differences related to the nomenclature of the species..

In this way, in the sheets of the USAMV Herbary in Cluj-Napoca, *Gypsophila collina* Steven ex Ser. Is named *Gypsophila fastigiata* L. ssp- *arenaria* W. et K. var. *leioclados* Borb. The plants were collected by Á. Nyárády (5.10.1961 and 23.05.1961) and by T.A. Szabo (22.07.1975) and certifies the presence of the species on the gypsums in Cluj district in the localities Aghireş and Leghia (on Dealul Bart an toward the Nadăşului forest).

In the herbary of The Botanical Garden "Al. Borza" the species exists under the name *Gypsophila arenana* W. et K. var. *leioclados* Borb. The material was reviewed and corrected by V. Ciocârlan with the name *Gypsophila collina Steven ex Ser.* The plants were collected on 17.10.1933, and 04.08.1947, from the Cluj district, between localities Căpuşul Mic, Macău (600-700 m alt.) and Leghia (500 m alt.), by E. I. Nyárády, and from Sibiu district (Mediaş – 300 m alt.) by J. Barth on 01.08.1895.

The Flora R.P.R. signals the presence of the species on the gypsum hills between Căpuş and Macău, on Dealul Ţiganilor between Cojocna and Turda, on

gypsum rocks between Aghires and Leghia, from Gilău toward V. Dl. Ursului (Cluj district) as well as in Mediaş – Sibiu district (the typical place). We couldn't find material that would confirm the presence of the species at Gilău and on Dealul Ţiganilor in the herbaries of Cluj universities.

Because the name of the species *Gypsophila collina* isn't yet well elucidated we will show also the collected data from the specialized literature referring to its nomenclature (motivated by the fact that this species was long time considered as a variety of *Gypsophila fastigiata* L., that doesn't grow in Romania.)

Romanian Flora considers the species as being *Gypsophila fastigiata* L. var. *leioclados* Borb.; European Flora considers the species G. *fastigiata L.* synonymous with *Gypsophila arenana* W. et K. var. *arenana,* strange in Romania and the species *Gypsophilla collina* Steven ex Ser. synonymous with *Gypsophila arenana* W. et K. var. *leioclados* Borb., but doesn't recognize the taxon *Gypsophila fastigiata* L. var. *leioclados* Borb.; Ciocârlan based on the morphologic characteristics and on stations on which it vegetates differentiates the type of species G. *fastigiata* L. from G. *collina* Steven ex Ser. and relates G. *collina* Steven ex Ser. with G. *fastigiata* L. var. *leioclados.* Borb. (from Flora R.P.R.).

The morphologic characteristics of the material collected by us on the field correspond to the species *Gypsophila collina* Steven ex Ser. (Ciocârlan 2002) but only to the variety *leioclados* Borb. Of the species G. *fastigiata* L. from Flora R.P.R.; *Gypsophila collina* also varies from the species *Gypsophila arenana* W. et K. var. *arenana,* existent in the USAMV herbary (collected from the hungarian steppe), by the dimensions of flowers and the lack of hair on the flower's pedicels.

As the taxon *Gypsophila fastigiata L.* var. *leioclados* Borb. is not recognized by the European Flora we can't consider it synonymous with *Gypsophila collina* Steven ex Ser.. According to the same source the type of the species G. *fastigiata* L. is synonymous with *Gypsophila arenana* W. et K. var. arenana and doesn't grow in Romania, and *Gypsophila collina* Steven ex Ser. is synonymous with *Gypsophila arenana* W. et K. var. *leioclados* Borb., which is confirmed also by the morphologic characteristics of the species that were verified by us.

As a result of the studies on the field we found the species in the localities in Cluj district and in other four localities in Sălaj district, unknown until now in the literature, these being Gălăşeni, Sfăraşu, Jebuc and Stana. The station from Gălăşeni is situated on the gypsum breaks in the old quarry. It is doubtless that the exploitation of deposits favoured the installation and development of the species *Gypsophila collina* because the gypsums didn't aflorate at the surface before the exploitation. On the strips of gypsums remained uncovered by the soil blanket gypsum "baby's-breath" developed luxuriantly, without having other competing species. Beside *Cephalaria radiata* and *Erucastrum nasturtiifolium, Gypsophila collina* can be considered here as a pioneer species. The same status was obtained beside *Artemisia alba,* on the mountain side between Sfăraşu and Jebuc, being the only ones installed on the

extracted deposit beside drills of geological prospectings. We met a similar situation in the former quarry Lafarge on the territory of the Leghia locality (abandonned approximately 20 years ago), but in this case, besides the first species *(Gypsophila collina* and *Cephalana radiata),* other monocotyle and dicotyle species appeared, too, partialy recovering the existent coenotic ambience.

The stations with gypsum "baby's-breath" have a southern, south-western and south-eastern exposure, the substrate is always aflorate gypsum at the surface, and that's why the coenotic environment is composed mostly by xerophile, xerotherm and basic substrate loving species. The floristical composition is almost similar in every studied localities, the difference being the presence of the species *Artemisia alba* and *Daphne cneorum* on the gypsums from Sfarasu, Jebuc and Stana. From the most representative species we mention: *Festuca patens, Koeleria glauca, Potentilla arenaria, Carex humilis, Inula ensifolia, Euphorbia cyparissias, Seseli pallasii, Helianthemum canum, Scorzonera austriaca, Brachypodium pinnatum, Anthericum ramosum, Teuchum chamaedrys, Cephalaria radiata, Allium flavum, Helianthemum nummularium, Teucrium montanum, Thymus comosus, Asperula cynanchica, Unum flavum, Agrimonia eupatoria, Onosma arenaria, Artemisia campestris, Cleistogenes serotina, Seslenia heuffleriana, Astragalus austriacus, Odontites verna ssp. serotina, Unum tenuifolium, Thesium linophyllon, Thymus glabrescens, Bupleurum falcatum, Juhnea mollis, Allium albidum ssp. albidum, Aster amellus, Stipa capillata, Dichanthium ischaemum, Stipa pulcherrima, Stachys recta* etc.

The coenotic environment of both populations is represented by frequent species characteristic for the class of vegetation *Festuco-Brometea.*

Conclusions

Until now it was considered that the species *Artemisia alba* Turra vegetates only on calcareous stones and marls, but our researches confirm its presence also on gypsum rocks in a cenotic environment particularised by the characteristic species for this substrate, *Gypsophila collina* Steven ex Ser.

As regard the spreading of the two species, we add the localities Sfăraşu, Jebuc and Stana (Sălaj district) for *Artemisia alba* and Gălăşeni, Sfăraşu, Jebuc and Stana (Sălaj district) for *Gypsophila collina.*

The reviewing of the nomenclature of the species *Gypsophila collina* Steven ex Ser. results in relating it with *Gypsophila arenaria* W. et K. var. *leioclados* Borb. according to the European Flora.

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Rezumat. Lucrarea de faţă cuprinde o inventariere şi analiză a informaţiilor existente cu privire la corologia a două specii rare din flora României, *Artemisia alba* Turra şi *Gypsophila collina* Steven ex Ser., precum şi o revizuire a nomenclaturii speciei *Gypsophila collina.* În literatura prezentă specia Artemisia albă (pelinul de stâncă) este semnalată numai în staţiuni cu expoziţie sudică, cu o singură excepţie, Piatra Podmonului cu expoziţie nordică. Contribuţia noastră constă în descoperirea staţiunii pe gipsuri şi a celor trei localităţi noi în aria ei de răspândire (Sfăraşu, Jebuc, Stana – jud. Sălaj), precum şi prezenţa într-o ambianţă cenotică diferită, particularizată de specia caracteristică staţiunii, *Gypsophila collina.* În ceea ce priveşte cea de a doua specie, adăugăm patru localităţi (Gălăşeni, Sfăraşu, Jebuc, Stana – jud. Sălaj) la corologia acesteia şi coplementar primei specii, o nouă ambianţă cenotică în care aceasta se dezvoltă. Adoptăm nomenclatura conform Florei Europaea, considerând *Gypsophila collina* Steven ex Ser. sinonim cu *Gypsophila arenana* W. et K. var. *teioclados Borb.* şi nu cu G. *fastigiata* L. var. *teioclados* Borb. care nu e recunoscută de Flora Europaea. Cercetările noastre în teren confirmă prezenţa speciei *Gypsophila collina* pe stâncăriile de gips din judeţele Cluj şi Sălaj. Cercetările noastre se soldează cu identificarea unei staţiuni noi pentru specia *Artemisia alba* situată pe teritoriul a trei localităţi din judeţul Sălaj, iar în ceea ce priveşte cea de a doua specie, *Gypsophila collina,* adaugăm informaţii privitoare atât la corologia, cât la nomenclatura acesteia.

Note

* material in the *Herbary of the Botanical Garden „Al. Borza".*

** material in the *USAMV Herbary.*

*** signalled in *Flora R.P.R.,*1964, vol. IX.

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RESEARCHES ON THE FLORA OF THE LOPADEA PLATEAU (ALBA COUNTY)

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Abstract. This article comprises the inventory, the systematic categorization and the ecological, phytogeographical and bioform analysis of the flora of the Lopadea Plateau (Alba county), the distribution of species included in national and European red lists, as well as the identification of habitats according to the list of Romanian habitats and Natura 2000 European habitats, with the aim of proposing a future Natura 2000 site.
Key words: Lopadea Plateau, Alba county, flora, Ciuguzel, Ocnişoara, forest, grasstencf

Introduction

The Lopadea Plateau is situated in the western extremity, of the Transylvanian Plateau and includes hills with a 280-500 m altitude. The slopes have a general wave-like appearance due to the very frequent landslides. The lithological substrate, predominantly formed by marls (clay, sandy and carbonatic) generated the light brown slope soils, under the conditions of a steppe climate, sun exposure and a slope of about 32%. Under the same pedogenetic conditions, but on steeper slopes, regosols and erodisols were formed. The chemical reaction of the soil is from weakly to moderately alkaline, and humus content varies between 2.6-5.6%. The various microrelief forms favoured an extremely wide range of ecological stations and habitats with a spectacular floristic diversity. The region is of a special importance due in particular to the ecological value of priority status habitats and to many floristic rarities of national and community interest.

Materials and methods

Between 2006-2007, we performed field work during different vegetation periods in order to study the flora and vegetation of the area between Ciuguzel and Ocnişoara (Alba county).

The inventory and the identification of floristic species were carried out in the field, being subsequently verified according to the Flora RPR. The species nomenclature was updated according to the Flora Europaea. The habitats were identified based on the Habitat Manual. The material collected in the field has been deposited to the Herbarium of the USAMV of Cluj-Napoca.

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Results and Discussion

I. List of grassland cormophyte species

Agrostis capillaris L., *Convolvulus arvensis* L., *Elymus repens* (L.) Gould, *Cirsium arvense* (L.) Scop., *Equisetum ramosissimum* Desf., *Lotus corniculatus* L., *Poa pratensis* L., *Poa pratensis* L. ssp. *angustifolia, Plantago lanceolata L., Plantago major* L., *Leucanthemum vulgare* Lam., *Trifolium pratense* L., *Achillea millefolium* L., *Taraxacum officinale* Weber, *Agrostis stolonifera* L., *Deschampsia caespitosa* (L.) Beauv., *Poa trivialis L, Triglochin palustris* L., *Ranunculus thychophyllus* Chaix *[Batrachium divaricatum* (Schrank) Winner], *Erigeron canadensis* L., *Poa annua L., Ranunculus acris* L. *(Ranunculus* acerauct. rom. non L.), *Thiaspi kovatsii* Heuffel, *Carex rostrata* Stokes, *Festuca pratensis* Huds., *Carex montana* L.. Carex *caryophyllea* Latourr., *Arenaria serpyllifolia* L., *Bellis perennis* L.. *Galium verum* L., *Briza media* L., *Carex hirta* L., *Cuscuta epithymum* L., *Bromus commutatus* Schrader, *Vicia sativa L., Alyssum alyssoides* L., *Nepeta nuda* L. ssp. *nuda (Nepeta pannonica), Reseda luteola* L., *Cerastium pumilum* Curt., *Carduus acanthoides L., Thesium dollineh, Lolium perenne* L, *Prunella vulgaris* L., *Chenopodium album* L, *Chenopodium album* L. ssp. *spicatum* (Koch) Nyar., *Carex tomentosa* L., *Hypencum perforatum* L., *Myosotis arvensis* (L.) Hill, *Odontites verna* (Bell.) Dumort. ssp. *serotina* (Dumort.) Corb., *Fllago germanica* L., *Kixia britannica* L., *Cerinthe minor* L., *Alopecurus pratensis* L., *Symphytum officinale* L., Carex *melanostachya* Bieb. ex Willd., *Orchis laxiffora* Lam., *Lycopus europaeus* L., *Verbena officinalis* L., *Cerastium glomeratum* Thuill., *Daucus carota* L., *Orchis ustulata* L., *Knautia arvensis* (L.) Coulter, *Lepidium campestre* (L.) R. Br, *Melilotus officinalis* (Lam.) Pallas, *Epilobium lamyi* F. W. Schultz, *Cynodon dactylon* (L.) Pers., *Euphorbia villosa* W. et K.ssp. *villosa, Typha latifolia* L., *Bromus tectorum* L., *Lactuca serriola* L., *Hypencum elegans* Stephan, *Carlina vulgaris* L., *Tragopogon dubius* Scop., *Cuscuta epilinum* Weihe, *Marubium peregrinum* L., *Salvia verticillata* L., *Euphorbia agraria* Bieb., *Thymus glabrescens* Willd., *Lycium barbarum* L., *Rhinanthus rumelicus* Velen, *Ononis arvensis* L., *Cuscuta approximata* Bab., *Robinia pseudacacia* L., *Carthamus lanatus* L., *Mefampyrum pratense L., Hieracium pilosella* L., *Valehana officinalis* L., *Cruciata glabra* (L.) Ehrend., *Calamagrostis arundinacea* (L.) Roth., *Genista tinctoria* L., *Centaurium erythraea* Rafn., *Lembotropis nigricans* (L.) Griseb, *Carduus hamulosus* Ehrh., *Senecio papposus* (Rchb.) Less., *Polygonum aviculare* L., *Pimpinella saxifraga* L., *Centaurea apiculata* Ledeb., *Galium mollugo* L., *Centaurea phrygia* L. ssp. *phrygia, Scutellaria supina* L., *Unaria vulgaris* Mill., *Prunus spinosa* L., *Dianthus armeria* L., Rosa canina L., Sesew *annuum* L.,

Trifolium ochroleucum Hudson, *Chamaespartium sagittate* (L.) P. Gibbs. (*Genista sagittalis* L.), *Gatium aparine* L., *Polygonatum multiflorum* (L.) All., *Vicia sepium* L., *Polygala vulgaris* L., *Lathyrus aphaca L, Euphorbia platyphyllos* L., *Euphorbia helenium* L., *Lysimachia nummularia* L., *Euphorbia stricta* L., *Xeranthemum cylindraceum* Sibth. et Sm., *Calamintha clinopodium* Bentham, *Cruciata laevipes* Opiz., *Cruciata salicina* L., *Senecio jacobaea* L., *Sclerochloa dura* (L.) Beauv., *Ranunculus polyanthemos* L., *Ranunculus repens, Vicia tetrasperma* (L.) Schr., *Centaurea nigrescens* Willd., *Juncus effusus* L., *Lathyrus nissolia* L.. *Crepis foetida* L., *Stachys annua* (L.), *Prunella laciniata* L., *Crataegus monogyna* Jacq., *Chamaecytisus albus* (Hacq.) Rothm., *Nonea pulia* (L.) DC, *Veronica prostrata L., Euphorbia virgata* W. et K., *Fragaria viridis, Stachys germanica* L., *Lathyrus hirsutus* L., *Adonis aestivalis* L., *Salvia nemorosa* L., *Sisymbrium toeselii* L., *Danthonia alpina* Vest *(Danthonia provincialis* DC), *Nuga chamaepitys* (L.) Schreber, *Euphorbia epithymoides* L., *Asparagus officinalis* L., *Dichanthium ischaemum* L., *Hieracium bauhinii* Besser, Stipa firsa Steven (S. *stenophylla* Czern), *Buglossoides arvensis* (L.) Johnston, *Puccinellia distans* (L.) Parl. ssp. *distans, Veratrum nigrum L, Anthyllis vulneraria* L., *Dactylis glomerata* L., *Eligeron annuus* ssp. *strigosus* var. *septentrionalis, Thgiochin maritima* L., *Phragmites australis* (Cav.) Trin. et Stendel, *Centaurea scabiosa L, Thymus pannonicus* All. ssp. *pannonicus, Trifolium montanum* L., *Linum catharticum* L., *Galium boreale* L., *Thalictrum aquilegiifolium* L., *Mercunalis ovata* Sternb. et Hoppe, *Tussilago farfara* L., *Woita curta* L., *Euphorbia cyparissias* L., *Echium vulgare* L., *Verbascum nigrum* L., *Eryngium planum* L., *Phleum phleoides* (L.) Karsten, *Polygonatum odoratum* (Miller) Druce, *Coronilla varia* L., *Pyrus pyràster Burgsd.*, *Geranium sanguineum* L., *Cirsium pannonicum* (L. fill.) Link., *Medicago lupulina* L., *Thfotium alpestre* L., *Linus monor.* Mill., *Tragopogon pratensis* L. ssp. *orientalis* (L.) Celak., *Gentiana cruciata* L., *Crepis biennis* L., *Ranunculus sardous* Crantz., *Scutellaria galericulata* L., *Carex vulpina* L., *Carex distans L., Festuca arundinacea* Schr., *Euphorbia lucida* W. et K., *Picnis hieracioides L.* ssp. *hieracioides, Artemisia vufgans* L., *Campanula glomerata* L., *Agrimonia eupatoria* L., *Tilia platyphyllos* Scop., *Clematis recta* L., *Juncus tenuis* Willd., *Lofus tenuis* W. et K., *Ranunculus sceleratus* L., *Mentha longifolia* (L.) Hudson, *Rugis caesius* L., *Linum perenne* L., *Tetragonolobus maximus* (L.) Roth., *Euphorbia seguiehana* Necker, *Sesleria pallasii* Besser (*Sesleria varium* Trev.), *Bupleurum falcatum* L., *Adonis vernalis* L., *Myosotis ramosissima* Rochel. *(M.collina* auct.), *Valerianella dentata* Pollich, *Ballota nigra* L., *Jurinea ledebourii* Bunge *(J.simonkaiana* Nyár.), *Peucedanum tauricum* Bieb., *Cephalaria transsilvanica* (L.) Roem. et Schultes,

Salvia austriaca Jacq., *Chamaecytisus austriacus* (L.) Link., *Iris variegata* L., *Polygonatum latifolium* (Jacq.) Desf., *Dipsacus laciniatus* L., *Scorzonera parviflora* Jacq., *Salvia transsilvanica* (Schur ex Griseb.) Schur, *Thymus pannonicus* All. ssp. *auctus, Astragalus onobrychis* L., *Onosma arenaria* W. et K, *Calamintha acinos* (L.) Clairv. *(Acinos arvensis* (Lam.) Dandy), *Inula ensifolia* L., *Inula germanica* L., *Linum hirsutum* L., *Phlomis tuberosa* L., *Muscari botryoides* (L.) Mill., *Veronica spicata* L., *Pulsatilla montana* (Hoppe) Reichenb., *Genista januensis* Viv., *Leontodon crispus* Vill. (*Leontodon asper* (W. et K.) Poiret non Forsk.), *Cephalaria radiata* Griseb. et Schenk, *Thalictrum minus* L., *Sideritis montana* L., *Festuca pseudovina* Hackl ex Wiesb., *Scabiosa ochroleuca* L., *Verbascum phoeniceum* L., *Cardaria draba* (L.) Desv., *Lathyrus tuberosus* L., *Falcaha vulgaris* Bernh., *Thesium linophyllon* L., *Teucrium chamaedrys* L., *Ornithogalum ortophyllum* Ten. ssp. *kochii* (Parl.) Zahar. (O. *gussonei*), *Rosa gallica* L., *Astragalus vesicarius* L., *Asperula glauca* f. *hirsuta, Galium glaucum L., Veronica austriaca L.* ssp. *dentata, Muscari tenuiflorum* Tausch., *Echium maculatum* L., *Iris pumila* L., *Linum flavum* L., *Pastinaca sativa* L., *Althaea officinalis* L., *Juncus inflexus* L., *Carex riparia Curtis, Vincetoxicum hirundinaria* Medicus, *Festuca rupicola* Heuff., Stipa *pennata* ssp. *pennata* (S. *joannis* Celak), *Brassica elongata* Ehrh., *Linum nervosum* W.et K., *Astragalus monspessulanus L, Allium flavum* L., *Campanula sibirica* L., *Brachypodium pinnatum* (L.) Beauv., *Kickxia spuria* (L.) Dumort., *Ornithogalum pyramidale* L., *Potentilla reptans* L., *Limonium gmelini* (Wilid) 0. Kuntze, *Juhnea moilis* (L.) Reichenb., *Elymus hispidus* (Opiz) Melderis *(Agropyron intermedium), Elymus hispidus* (Opiz) Melderis ssp. *barbulatus* (Schur) Mendelis, *Phleum montanum* Koch, *Plantago argentea* Chaix, *Festuca valesiaca* Schleicher, *Stipa capillata* L., *Eryngium campestre* L., *Plantago laxmanni* (L.) Bentham, *Dorycnium pentaphyllum* Scop.; ssp. *herbaceum* (Vill.) Rouy, *Vinca herbacea* W. et K., *Onobrychis viciifotia* Scop., *Epipactis atrorubens* (Hoffm.) Besser, *Galeopsis angustifolia* Ehrh.. *Orhis coriophora* L., *Plantago media* L., *Viola* joói Jka., Carex *humilis* Leysser. *Polygala major* Jacq., *Prunella grandiflora* (L.) Schöller, *Filipendula vulgaris* Moench, *Cirsium canum* (L.) All., *Melampyrum arvense* L., *Centaurea rhenana* Boreau, *Potentilla arenaria* Borkh., *Asperula cynanchica* L., *Serratufa radiata* (W. et K.) Bieb., *Cichon'um inthybus* L., *Althaea hirsuta, Prunus tenella* Batsch, *Koeleria glauca* (Schr.) DC., *Allium rotundum* L., *Scorzonera cana* (C. A. Meyer) Gris., *Crambe tataria* Sebeok, *Silene otites* (L.) Wibel, *Veronica teucrium* L, *Trinia glauca* (L.) Dumort.ssp. *glauca, Allium albidum* Fisch. ex Bieb. ssp. *albidum* {*Allium flavescens* Besser), *Cephalaria uralensis* (Murray) Roemer et Schultes,

Artemisia pontica L., *Buglossoides purpureocaerulea* (L.) Johnston, *Veronica teucnum* L., *Haplophyltum suaveolens* (DC.) G. Don fil., *Stipa lessingiana* Trin. et Rupr., *Dictamnus albus* L., *Puccinellia distans* ssp. limosa, *Primula vehs* L., *Heracleum sphondylium* L., *Achillea setacea* W. et K., *Plantago cornuti* Gouan, Salvia *pratensis* L., *Juncus gerardi* Loisel, *Bolboschoenus maritimus* (L.) Palla, *Thalictrum lucidum L.* var. *angustifolium, Globulalia punctata* Lapeyr., *Althaea cannabina* L., *Aristolochia clematitis* L., *Teucrium montanum* L., *Koeleria macrantha* (Ledeb.) Schultes et Schultes fill., *Caucalis platycarpos* L., *Linum tenuifolium* L., *Aristolochia pallida,* Med – R, *Stipa pufcherrima* Koch., *Salvia nutans* L., *Dianthus carthusianorum* L., *Stachys recta* L., *Euphorbia nicaeensis* All. ssp. *nicaeensis* (E *pannonica* Host.), *Euphorbia nicaeensis* All. ssp. *glareosa* (Pallas) A. R. Sm., *Cuscuta epithymum* ssp. *trifolli* (Bab. et Gibson) Berger, *Pinus nigra* Arnold, *Prunella intermedia* Link (P. *lacimata* x *P. vulgaris).*

II. List of forest species

Acer campestre L., *Acer tataricum* L., *Ajuga reptans* L., *Arctium lappa L., Aristolochia clematitis* L., *Asarum europaeum* L.. *Asperula odorata L., Astragalus glycyphyllos L, Athyrium filix-femina* (L.) Roth, *Ballota nigra* L., *Brachypodium sylvaticum* (Huds.) Beauv., *Bromus ramosus* Huds., *Calamagrostis arundinacea* (L.) Roth, *Campanula patula* L., *Campanula persicifolia* L., *Campanula ranunculus* L., *Campanula trachelium* L., *Cardamine impatiens* L., *Carpinus betulus* L., *Cephalanthera damasonium* (Mill.) Druce, *Circaea lutetiana* L., *Clematis vitalba* L., *Convallaria maj'alis* L., *Cornus sanguinea* L., *Corylus avellana* L., *Crataegus monogyna* Jacq., *Cruciata glabra* (L.) Ehrend., *Dactylis glomerata* L., *Daphne mezereum* L, *Dentaria bulbifera* L., *Digitalis grandi flora* Mill., *Dryopteris filix-mas* (L.) Schott, *Euphorbia amygdaloides* L., *Evonymus verrucosus* Scop., *Fallopia convolvulus* (L.) A. Love, *Festuca altissima* All., *Festuca heterophylla* Lam., *Fragaria vesca* L., *Fraxinus excelsior* L., *Galeopsis speciosa* Mill., *Galium mollugo* L., *Galium schultesii* Vest, *Galium verum* L., *Geum urbanum* L., *Glechoma hirsute* W. et K., *Helleborus purpurascens* W. et K., *Hieracium bifidum* Kit., *Hypericum hirsutum* L., *Hypericum montanum* L., *Iris grammes* L., *Iris ruthenica* Ker.-Gav., *Lamium galeobdolon* (L.) Nath.. *Lapsana communis* L., *Laser trilobum* (L.) Borkh., *Lathraea squamaria* L., *Lathyrus niger* (L.) Bernh., *Lathyrus vernus* (L.) Berih., *Ligustrum vulgare* L., *Lilum martagon* L., *Luzula luzuloides* (Lam.) Dandy et Willm., *Lychnis viscaria* L., *Maianthemum bifolium* (L.) F. V. Schmidt, *Melampyrum bihariense* Kern., *Melica nutans* L., *Melittis melissophyllum L., Mercurialis perennis* L., *Milium effusum* L., *Mycelis muralis(* L.) Dumort, *Neottia nidus-avis* (L.) L. C. M. Richard, *Ptatanthera bifolia*

(L.) L. C. M. Richard, Poa *nemoralis L., Polygonatum multiflorum* (L.) All., *Polygonatum odoratum* (Mill.) Druce, *Populus tremula* L., *Prunus avium* L., *Pulmonaria mollis* Wulfen ex Hornem., *Pulmonaria officinalis* L., *Pyrus pyraster* Burgsd., *Quercus petraea* (Matt.) Liebl., *Quercus robur L., Robinia pseudacacia* L., *Rosa canina* L., *Sambucus nigra* L., *Scabiosa columbaria* L., *Scrophularia nodosa* L., *Scutellaria altissima* L., *Sedum maximum* (L.) Hoffm, *Silaum silaus* (L.) Schinz et Thell., *Silene heuffelii* Soo, *Sorbus aucuparia* L., *Stachys officinalis (L.)* Trevisan, *Stachys sylvatica* L., *Staphylea pinnata L., Stellaria holostea* L., *Symphytum tuberosum L., Tanacetum corymbosum* (L.) Sch. Bip., *Trifolium arvensis* (Huds.) Link, *Trifolium medium* L., *Ulmus montana* With., *Veratrum nigrum* L., *Veronica chamaedrys* L., *Veronica officinalis* L., *Viburnum lantana* L., *Viola pisiformis* L., *Viola reichenbachiana* Jordan ex Boreau.

Seventeen of these species are included in Romanian red lists: *Allium albidum ssp. albidum (A. flavescens)-R, Aristolochia pallida-R, Cephalaria uralensis-A,* R, *Crambe tataria-V/R, Dictamnus albus-V/R, Genista januensis-R, Gentiana cruciata-b, R, Globularia punctata-R, Onosma arenaria-b,* E, *Peucedanum tauricum-R, Prunus tenella-V, Salvia trassilvanica-A, R, Scutellaria supina-R, Serratula radiata-R, Veratrum nigrum-R, Neottia nidus-avis-R, Veratrum nigrum-R,* most species being rare species in the Romanian flora. Two of them *(Echium russicum* and *Crambe tataria)* are species of community interest (Annex 3 of Law 57/2007). *Crambe tataria,* being extremely sensitive to grazing, is found in a single population, in a grassland located between cultivated fields, where animals had no access. We believe that if the impact due to grazing decreases, the species will increase its population.

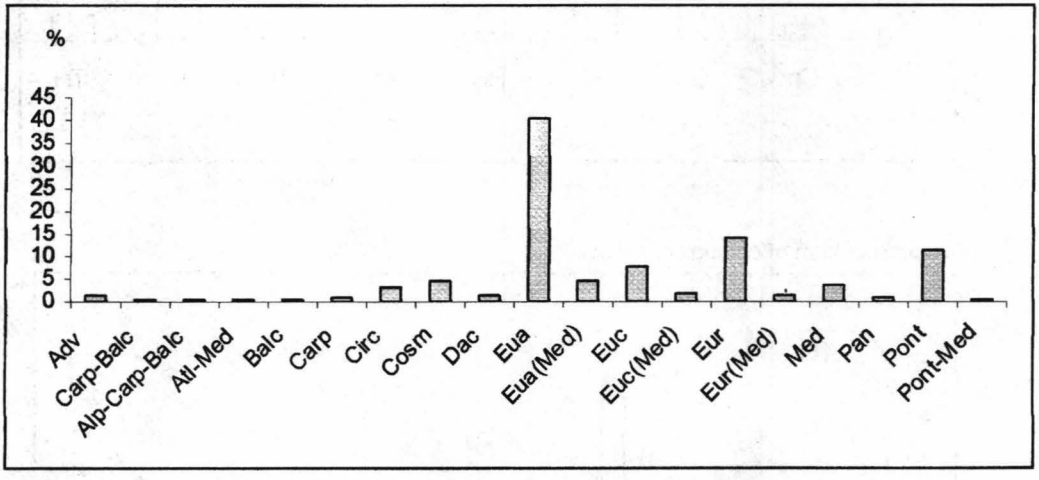
The inventory of the flora in the area includes 449 taxa assigned to 62 botanical families. In grasslands, we identified 342 taxa. of which 12 subspecies and 1 hybrid, belonging to 48 families. From a systematic point of view, the Poaceae are quantitatively dominant in most of the grasslands, through the populations of the 38 species. However, the Asteraceae (48 species), Poaceae (38 species), Fabaceae and Lamiaceae (31 species each) are qualitatively dominant, followed by the Apiaceae, Scrophulariaceae, and Liliaceae (more than 10 species each) etc.

Although they occupy small surfaces, the forests have a relatively high biodiversity, a number of 107 species being inventoried in these. Even if the number of arborescent ligneous species is low, shrubs are well represented. As these are bright forests, the grass cover is often abundant.

The quantitative analysis of the flora shows in particular a high diversity of

the phytogeographic index (Fig. 1) due to the specific microclimate and landscape conditions, and implicitly to the multitude of stations favored by these. The spectrum of geoelements includes floristic elements of all climatic regions that exert influences on the climate of our country. Thus, although the Eurasian geoelement is dominant, Atlantic, Mediterranean, Pontic, Pannonian species are also found along with endemic species.

Fig. 1. Spectrum of geoelements.



The spectrum of bioforms (Fig. 2) evidences the dominance of Hemicryptophytes (about 50%), followed by Therophytes and Geophytes, the rest of biological elements being distributed in the categories of Helohydatophytes, Phanerophytes and Camephytes. Annual and biennial Therophytes represent a 10% proportion and are part of the floristic composition of grasslands, but with the decrease in the anthropozoogenic impact, we estimate that they will be mostly replaced by Hemicryptophytes.

The analysis of the flora according to the main ecological indices – humidity, temperature and soil chemical reaction (Fig. 3) indicates the dominance of the element specific for the temperate zone from the point of view of the temperature factor (micro-mesothermal elements, more than 55%), but moderately thermophilic species are also present in a high proportion (more than 20%). However, the humidity factor expresses the dominance of the xero-mesophilic species, characteristic of dry and sunny slopes, followed by mesophytes and xerophytes. The analysis of species according to the soil chemical reaction evidences the weak acid-neutrophilic to acid-neutrophilic character.

Fig. 2. Spectrum of bioelements.

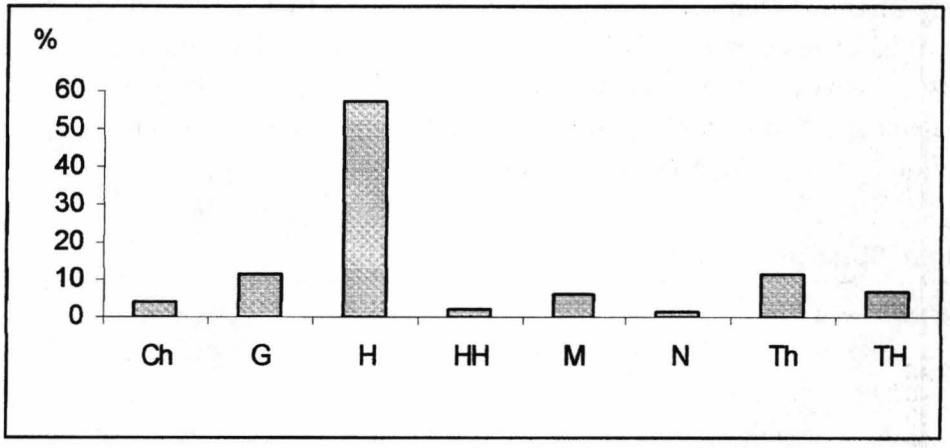
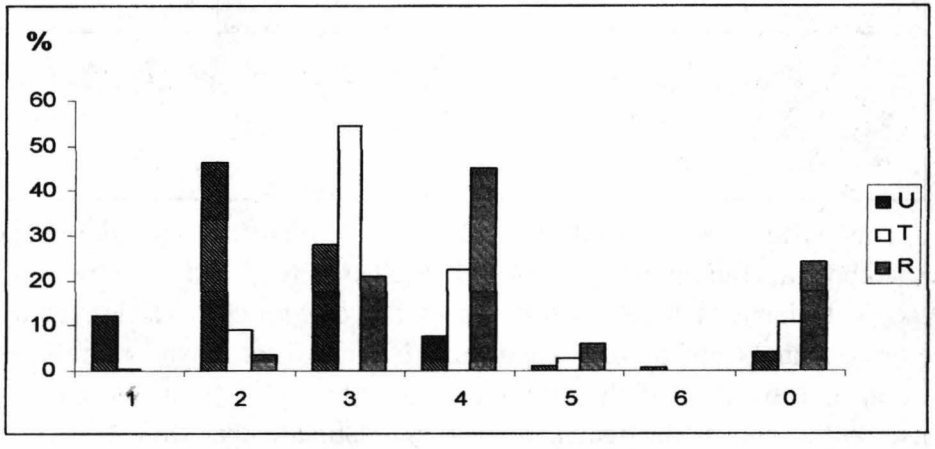


Fig. 3. Spectrum of ecological indices.



Conclusions

The area studied by us presents a special ecological importance materialized in a high cormofloristic diversity and of a great number of species included in European and national red lists.

The correlated analysis of the three qualitative indices (geoelements, bioforms and ecological factor) shows the presence of a steppe climate which favors the populations of thermophilic floristic species. The analysis of the three indices also suggests the presence of highly diversified stations such as wet stations, forests, salt marshes, sunny slopes or shaded and wet valleys.

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*** Monitorul Oficial al Romaniei, Anul 175 (XIX)-Nr. 142, 29 iunie 2007, Partea I, Ordonanţa de urgenţă privind regimul ariilor naturale protejate, conservarea habitatelor naturale, a florei şi faunei sălbatice, anexa 3 (Specii de plante şi animale a căror conservare necesită desemnarea ariilor speciale de conservare şi a ariilor de protecţie specială avifaunistică) şi anexa 4B (Specii de interes national, Specii de animale şi plante care necesită o protecţie strictă).

*** 1952 -1973, *Flora R.P. R. – R. S. R.,* vol. I-XIII, Ed. Academiei Republicii Populare Romane, Bucureşti.

Rezumat. În anii 2006-2007 am întreprins studii floristice şi de vegetaţie în regiunea cuprinsă între Ciuguzel şi Ocnişoara (Jud. Alba), în vederea propunerii unor suprafeţe pentru un viitor sit Natura 2000. Studiile au vizat în special suprafeţele naturale sau seminaturale al căror impact antropo-zoogen este mai redus. Acestea sunt pajiştile (păşuni şi fâneţe), tufărişurile, sărăturile şi pădurile. Articolul prezintă inventarierea florei din regiune, încadrarea sistematică, analiza acesteia din punct de vedere ecologic, fitogeografic şi al bioformelor. Am urmărit răspândirea populaţiilor speciilor cuprinse pe listele roşii naţionale, precum şi identificarea habitatelor conform listei habitatelor din România şi a habitatelor europene Natura 2000. Cercetările de botanică efectuate în regiune evidenţiază o mare diversitate cormofloristică, datorată condiţiilor pedo-climatice, precum şi modificărilor survenite în urma modalităţilor de folosire în trecut a terenului. Relieful şi microrelieful unor staţiuni au facilitat instalarea unor specii caracteristice unor bioregiuni mai mult sau mai puţin îndepărtate.

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SOIL REACTION SPECIFICITY OF THE VASCULAR PLANT SPECIES IN *ARNICA MONTANA* HABITATS FROM GÂRDA DE SUS COMMUNITY (APUSENI MOUNTAINS– ROMANIA)

A. STOIE, I. ROTAR[1]

Abstract: The superior basin of Arieş River, Gârda de Sus community comprises important areas with the endangered medicinal plant *Arnica montana.* In these habitats, 161 species of vascular plants have been identified, of which clear dominates the number of the ones with acid-neutrophilic and moderate acid-neutrophilic character, but the acidophilic species are also good represented. High acidophilic and neutro-basophilic species are lesser represented but also identified in the *Arnica montana* habitats.
Key words: mountain grassland, *Arnica montana* habitats, soil reaction.

Introduction

The superior drainage basin of the Arieş River in the Apuseni Mountains includes notable areas with *Arnica montana,* an endangered medicinal plant species. At present, Romania is one of Central Europe's foremost sources of *Arnica montana* anthodia (Kate et al., 2004 in Michler et al. 2005). The natural habitats of *Arnica montana* distinguish themselves by a remarkable flower diversity, including species with varying degrees of preference for the local environmental conditions. These grasslands generally show a more or less acidic nature, according to *Arnica montana's* ecological preferences. The acidity is determined, on one hand, by the local conditions and by the traditional management methods that still prevail in the region, on the other.

Material and Method

The survey of the ecological preferences manifested by vascular plants from *Arnica montana* natural habitats was carried out by means of vegetation sampling throughout their vegetation period in 2005. 49 *Arnica montana* lots were randomly selected in the vicinity of the Gârda de Sus community. The random selection was carried out by the „golden numbers" method, i.e., by assigning numbers to the mapped areas that were entirely digitized by means of the GIS softwares (Michler 2005). The lots have been exactly identified by means of satellite images and topographic maps and confirmed by GPS. Using already existing data from the specialist literature (Popescu & Sanda 1998), appropriate soil reaction indices were assigned to the identified species. The applied index includes 5 steps, from strongly acidophilic species to neutro-basophilic ones:

1-1,5 - strongly acidophilic

2-2,5 – acidophilic

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3-3,5 – acid-neutrophilic
4-4,5 – weakly acid-neutrophilic
5 – neutro-basophilic

The 0 value – amphitolerant – was used in case of species that do not show clearly-defined characteristics in terms of soil reaction.

Results and discussions

Of the 161 identified vascular plant species, 5 species are rated as strongly acidophilic, 20 as acidophilic, 34 as acid-neutrophilic, 42 as weakly acid-neutrophilic and 4 as neutro-basophilic (Table no. 1). The number of species that do not generate relevant data concerning soil reaction (amphitolerant) amounts to 56.

Table no. 1: **Index cathegory regarding soil reaction for the identified species**

1- strongly acidophilic
Deschampsia flexuosa
Lycopodium clavatum
Vaccinium myrtillus
Vaccinium vitis-idaea

1,5 – strongly acidophilic
Nardus stricta

2- acidophilic
Betula pendula
Cardaminopsis halleri
Carex nigrum
Crocus vernus
Danthonia decumbens
Galeopsis tetrahit
Hieracium pilosella
Hypericum maculatum agg.
Luzula luzulina
Luzula luzuloides
Populus tremula
Pseudorchis albida
Rumex acetosella
Sorbus aucuparia
Veronica officinalis
Viola canina
Viola declinata

2,5 – acidophilic
Homogyne alpina
Polygonatum verticilatum
Thesium alpinum

3- acid-neutrophilic
Acer pseudoplatanus
Antennaria dioica
Arnica montana
Campanula patula agg.
Carex ovalis
Carex pallescens
Carum carvi
Centaurea mollis
Centaurea pseudophrygia
Corylus avellana
Cynosurus cristatus
Doronicum austriacum
Euphrasia officinalis
Galium album
Genistella sagittalis
Gnaphalium sylvaticum
Gymnadenia conopsea
Hieracium murorum
Laserpitium krapfi
Listera ovata
Luzula campestris agg.
Myosotis sylvestris
Phlatantera chlorantha
Polygala vulgaris
Polygonum bistorta
Ranunculus auricomus
Ranunculus bulbosus
Rosa bendulina
Solidago virgaurea
Stellaria graminea
Thymus pulegioides
Vicia cracca

3,5 – acid-neutrophilic
Aposeris foetida
Hieracium bauhini

4- weakly acid-neutrophilic
Achillea distans
Aconitum vulparia
Ajuga genevensis
Anthyllis vulneraria
Arabis hirsuta
Colchicum autumnale
Crepis biennis
Dactylis glomerata
Dactylorhiza fistulosa
Dianthus barbatus
Euphorbia amygdaloides

Euphorbia carniolica
Gentiana asclepiadea
Gentianella austriaca
Helianthemum numularium
Hieracium aurantiacum
Juncus inflexus
Juncus tenuis
Lathyrus pratensis
Linum catharticum
Medicago lupulina
Polygala comosa
Populus nigra
Salix caprea
Scorzonera rosea
Silene nutans
Silene vulgaris
Tragopogon pratensis
Trifolium alpestre
Trollius europaeus
Tussilago farfara
Urtica dioica
Veratrum album
Verbascum nigrum
Juniperus sibirica

4,5 – weakly acid-neutrophilic *Astrantia major*
Cirsium erisithales
Geum rivale
Plantago media
Polygala amarela
Scabiosa columbaria
Traunsteineria globossa

5 – neutro-basophilic
Melitis melissophyllum
Mercurialis perenis
Parnassia palustris
Primula veris

0 – amphitolerant
Abies alba
Achillea millefolium
Agrostis capillaris
Alchemilla vulgaris agg.
Anemone nemorosa
Anthoxanthum odoratum
Arenaria serpyllifolia
Athirium filix - femina
Botrichum lunaria
Briza media
Campanula persicifolia
Campanula serrata
Carlina acaulis
Cerastium holosteoides
Chaerophyllum hirsutum
Cirsium arvense
Deschampsia cespitosa
Equisetum sylvaticum
Erigeron acris
Fagus sylvatica
Festuca pratensis
Festuca rubra agg.
Filipendula ulmaria
Fragaria vesca
Juniperus comunis
Knautia dipsacifolia
Leontodon hispidus
Leucanthemum vulgare
Lotus corniculatus
Lysimachia vulgaris
Melampyrum sylvaticum
Ophioglossum vulgatum
Phleum alpinum
Picea abies
Pimpinella major
Plantago lanceolata
Plantago major
Poa pratensis
Poa trivialis
Potentilla erecta
Prunella vulgaris
Ranunculus acris
Rhinanthus glaber
Rhinanthus minor
Rumex acetosa
Rumex alpinus
Soldanella hungarica
Taraxacum officinalis
Trifolium campestre
Trifolium dubium
Trifolium pratense
Trifolium repens
Trisetum flavescens
Veromica serpyllifolia
Veronica chamaedrys
Viola tricolor

The great number of more or less acidophilic species (strongly acidophilic, acidophilic and acid-neutrophilic) clearly shows the preference of *Arnica montana* for relatively acidic habitats. However, the small number of markedly acidophilic species indicates the lack of the said species' preference for exceedingly high values of soil acidity. The small number of strongly acidophilic species is also influenced by the relatively low degree of plant diversity in these extreme habitats. (Table no. 1) (Diagram no. 1)

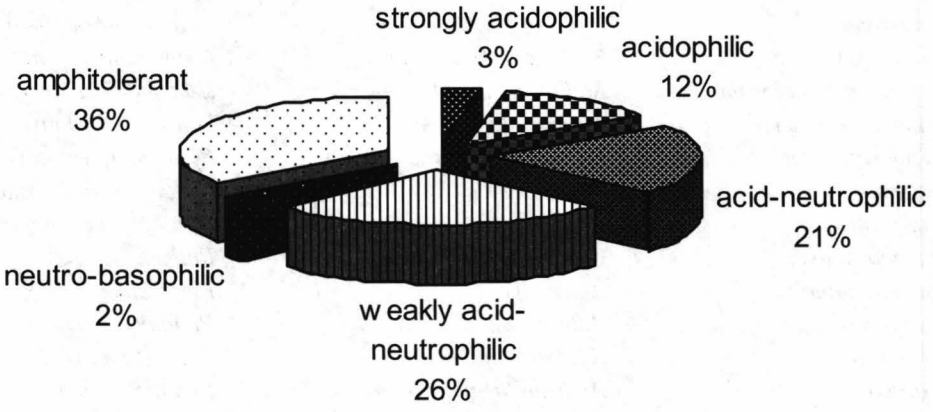

Fig. 1 Soil reaction – based distribution of species on *Arnica montana* grassland habitats in the area of the Gârda de Sus community

The great number of acid-neutrophilic and weakly acid-neutrophilic species also confirms the tendency of *Arnica montana* populations to associate with neutrophilic species, rather than with strongly acidophilic ones. (Diagram no. 1)

Arnica montana populations avoid alkaline soils. The extremely small number of neutro-basophilic species clearly indicates the avoidance of alkaline soils, although many of this *Arnica montana* habitats are frequently located on limestone substrata (alkaline rocks).

The acidic nature of these grasslands is also preserved by the absence of any soil improvement procedures that would alter the pH.

Conclusions

In the natural habitats of *Arnica montana* have been identified 161 species of vascular plants. Among those, acidophilic species prevail, namely: acid-neutrophilic (34 species), acidophilic (20 species) and strongly acidophilic (5 species). Weakly acid-neutrophilic species are also well-represented, with 42 species. There are extremely few basophile vascular plants species: 4 species neutro-basophilic (Table no. 1). Amphitolerant plants are represented by 56 species.

The preservation of *Arnica montana* populations requires the preservation of the more or less acidic nature of the grasslands in this region. On the other hand, extreme acidification of these pastures could have inhibiting effects on this endangered plant species. However, soil improvement with alkalic components would also lead to the decline of the *Arnica montana* populations.

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* www. Floraweb.de

Specificitatea plantelor vasculare privind reacţia solului în habitatele cu *Arnica montana* din comuna Gârda de Sus (Munţii Apuseni – România)

Rezumat: Bazinul superior al Arieşului, comuna Gârda de Sus prezintă suprafeţe importante cu specia medicinală periclitată *Arnica montana*. În aceste habitate au fost identificate 161 de specii de plante vasculare, dintre care domină numărul celor acid-neutrofile şi slab acid-neutrofile, însă sunt bine reprezentate şi speciile acidofile. Speciile puternic acidofile şi cele neutrobazifile sunt mai putin reprezentate dar au fost şi ele identificate în habitatele cu *Arnica montana*.

Studii şi cercetări, Biology 13, Bistriţa, p. 67-74

THE SOIL REACTION CHARACTERISTICS OF *ARNICA MONTANA* HABITATS FROM THE TWO GEOMORPHOLOGICAL UNITS OF GÂRDA DE SUS COMMUNITY

A. STOIE, I. ROTAR[1]

Abstract: Gârda de Sus community is situated also on limestone geological substratum as well as on siliceous substratum. Habitats with endangered medicinal species *Arnica montana* are spread on both. The vascular plants from these habitats have been studied under qualitative and quantitative aspects. The dominance of the acid-neutrophilic species number is more pronounced on limestone substratum than on siliceous substratum. The coverage of this species shows a clear dominance of the acid-neutrophilic vascular plants only on limestone substratum. On siliceous substratum a clear coverage dominance of the high acidophilic vascular plants was found.

Introduction

Due to the spread of these pastures on both siliceous and limestone geological substrata, a great diversity in terms of ecological soil reaction preferences of the vascular plants species identified in the *Arnica montana* habitats is found. The siliceous substratum imparts a relatively acidic character to the soil, but on limestone substratum a great microstational variability of soil acidity – alkalinity can be found.

Material and Method

In 2005, a balanced number of *Arnica montana* lots were randomly selected on both types of geological substratum found in the surveyed area. 26 test lots were selected on limestone substratum, in the northern area of Gârda de Sus. In the southern area, which is entirely siliceous, 23 test lots were selected (Michler 2005). On each of these randomly selected lots, vegetation samples were carried out, using the metric frame method, combined with a modified Braun – Blanquet method. By means of the metric frame, all species of vascular plants on a 1 sqm – vegetation sample were identified and their degree of coverage was determined with a 0,25 % accuracy, especially in the case of species with a lower degree of coverage. In order to apply the modified Braun – Blanquet method, a 5 x 5 m square vegetation sample was delineated, having the metric frame as centerpiece. On these 25 sqm vegetation samples, all species of vascular plants were quantified according to the improved Braun – Blanquet scale. It was therefore possible to collect very accurate data by means of the metric frame method and more relevant information concerning plant diversity by the Braun – Blanquet method on 25 sqm vegetation samples. The approximate coverage percentages on the 25 sqm vegetation samples were computed by converting the values obtained by the Braun – Blanquet to percentages.

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The values of the indices used are: 1-1,5 – strongly acidophilic, 2-2,5 – acidophilic, 3-3,5 – acid-neutrophilic, 4-4,5 – weakly acid-neutrophilic and 5 – neutro-basophilic. The 0 value –amphitolerant - was assigned to the species that do not show obvious soil reaction characteristics. (Popescu & Sanda 1998).

The tables thus obtained were subsequently processed by means of statistical softwares, such as Excel and SPSS. The graphics were designed by means of the Box plots method. In case of the graphs, the inner surface of the rectangles represents 50% of the test items ascendingly sorted. The inner line represents the median value. The side lines separate the other 50% of the test items out, while the isolated dots stand for the extreme values identified.

For each of the two regions, separate diagrams were designed, both for the metric frame, as well as for the Braun – Blanquet method. There have been designed separate diagrams for the number of species (presence or lack of species), as well as for the coverage of each individual species, according to soil reaction indices.

Results and discussions

First of all, the species distribution diagrams per vegetation sample related to the soil reaction categories taken into account clearly reveal a much greater number of species in the northern limestone region, compared to the small number of species in the southern silicious region. The number of acid-neutrophilic species that prevail both in the northern limestone, as well as in the southern silicious region shows a similar distribution in the two regions. However, in the northern limestone region, there is an obviously greater number of acid-neutrophilic species per vegetation sample then in the southern region. There are notable differences between the above-mentioned regions in what concerns the strongly acidophilic species that are well-represented in southern silicious region and poorly represented in the northern limestone region. Conversely, the neutrophilic (weakly acid-neutrophilic) species are well represented in the northern limestone region and poorly represented in the southern siliceous region. Finally, one can notice the poor presence of basophilic (neutro-basophilic) species in the northern region and the absolute lack thereof in the southern siliceous region. These differences are rather moderate (but more realistic) on larger vegetation samples (25 sqm) and more blatant on smaller ones (1 sqm). (Diagrams no.: 1, 2, 3 and 4).

The diagrams that also take into account the coverage of each species per vegetation sample highlight a generally different distribution as compared to the species count per vegetation sample. As far as the northern limestone region is concerned, the balanced distribution of species per vegetation sample that we have noted in our previous analysis is maintained. In this case, the dominance of acid-neutrophilic species remains obvious. The other two related categories, namely acidophilic and weakly acid-neutrophilic – are represented by less than half as many species, compared to the above-mentioned category. Strongly acidophilic species generally have a very poor coverage. Neutro-basophilic species also show a poor coverage, with sporadic occurrences in *Arnica montana* habitats from the northern limestone region. (Diagrams no. 5 and 6)

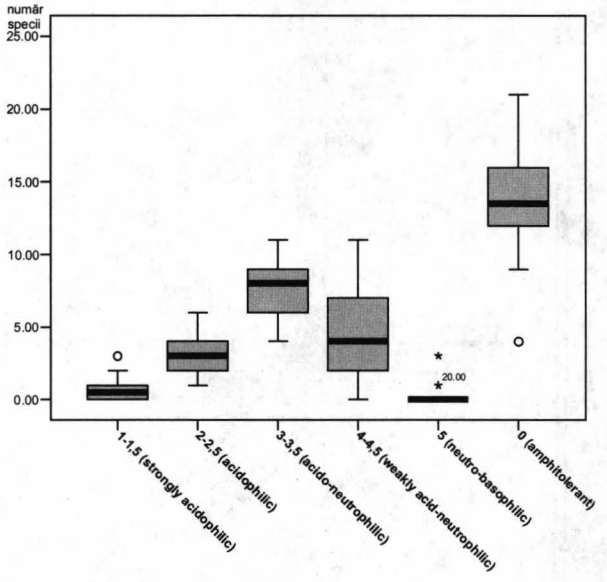

Fig. 1 Number of species per vegetation sample for *Arnica montana* grasslands in the northern (limestone) region of Gârda de sus - 1 m² vegetation sample.

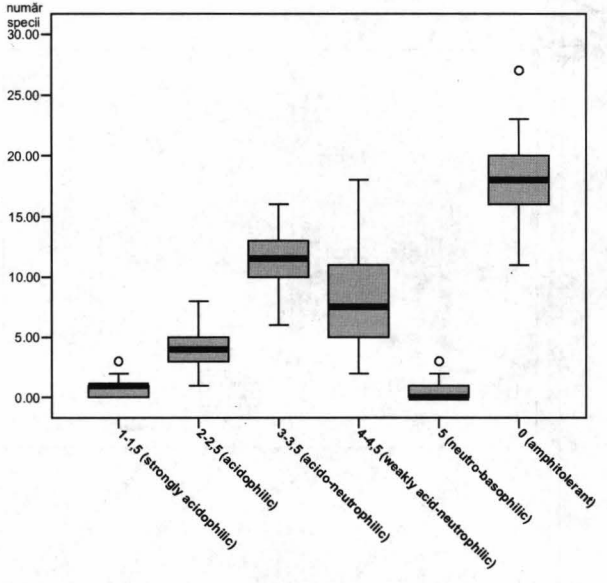

Fig. 2 Number of species per vegetation sample for *Arnica montana* grasslands in the northern (limestone) region of Gârda de sus - 25 m² vegetation sample.

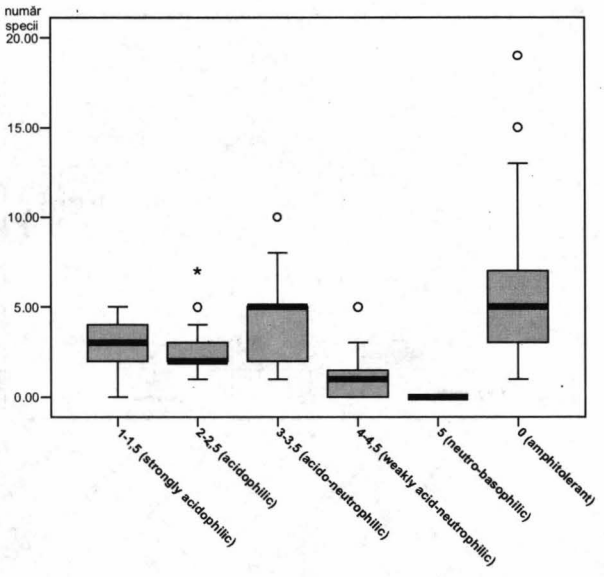

Fig. 3 Number of species per vegetation sample for *Arnica montana* grasslands in the sourthern (siliceous) region of Gârda de sus - 1 m² vegetation sample.

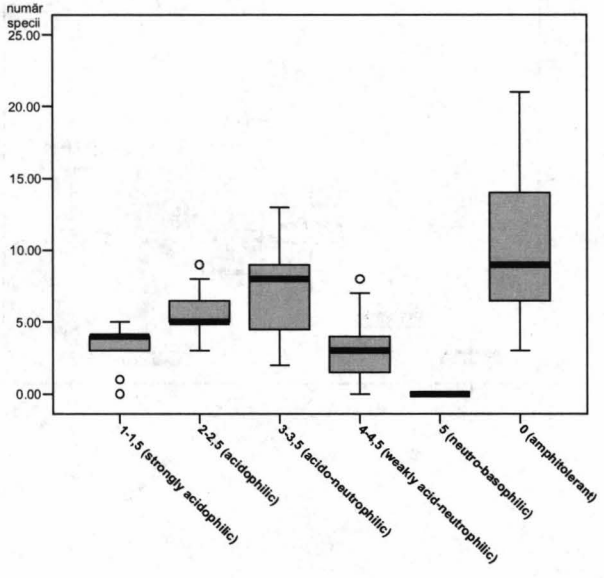

Fig. 4 Number of species per vegetation sample for *Arnica montana* grasslands in the sourthern (siliceous) region of Gârda de sus - 25 m² vegetation sample.

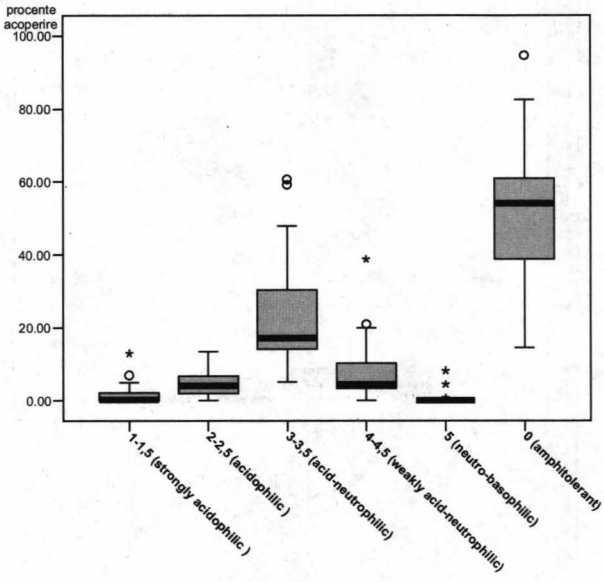

Fig. 5 Coverage of various categories of species per vegetation sample for *Arnica montana* grasslands in the northern (limestone) region of Gârda de Sus - 1 m² vegetation sample.

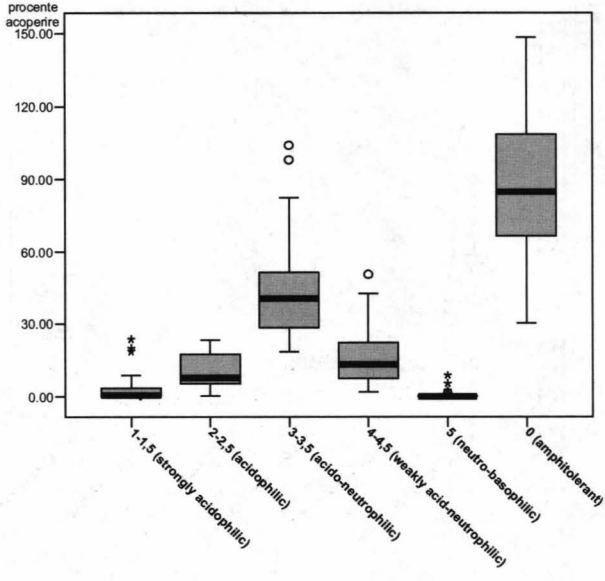

Fig. 6 Coverage of various categories of species per vegetation sample for *Arnica montana* grasslands in the northern (limestone) region of Gârda de Sus - 25 m² vegetation sample.

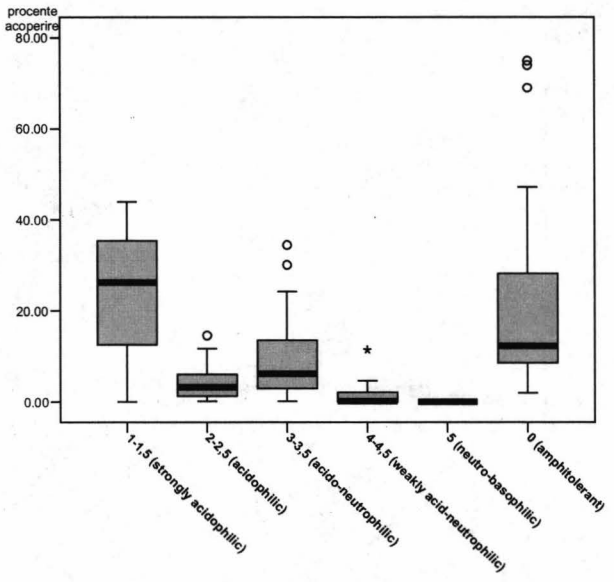

Fig. 7 Coverage of various categories of species per vegetation sample for *Arnica montana* grasslands in the southern (siliceous) region of Gârda de Sus - 1 m² vegetation sample.

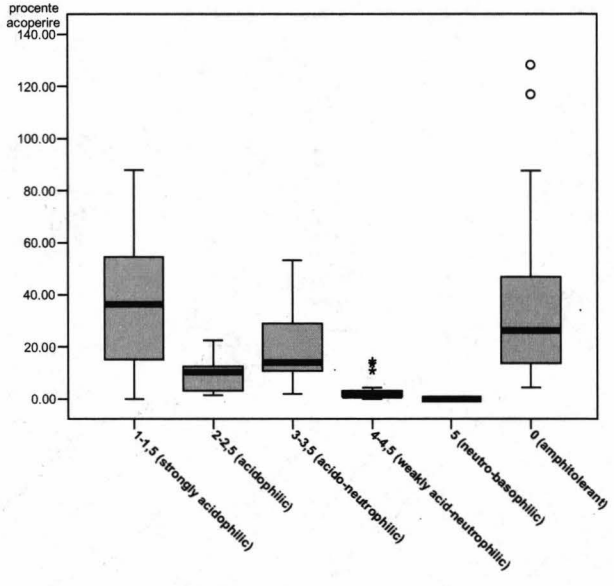

Fig. 8 Coverage of various categories of species per vegetation sample for *Arnica montana* grasslands in the southern (siliceous) region of Gârda de Sus - 25 m² vegetation sample.

In the southern siliceous region, one can discover a very clear and unequivocal image of each species' coverage per vegetation sample. These habitats are unquestionably dominated by a few strongly acidophilic species. All the other species are poorly represented, only the acid-neutrophilic species are sporadically better represented. Neutro-basophilic species are completely absent. This type of distribution highlights the extreme character of *Arnica montana* habitats from the southern siliceous region, which also accounts for the low plant diversity, both in terms of number of species, as well as in terms of relative coverage. (Diagrams no. 7 and 8)

The differences related to the size of the vegetation samples are relatively small. On smaller vegetation samples (1 m^2), the values are notably smaller, but these accurately quantified values are realistic. The higher coverage values observed in case of larger vegetation samples (25 m^2) derive from the inherent inaccuracy that occurs in the process of converting the Braun – Blanquet scale values to percentages. (Diagram 5, 6, 7 and 8)

We may conclude that habitats of *Arnica montana* from both regions depend on the preservation of certain soil acidity values. In case of the northern limestone region, it is important to preserve the marked microstational diversity (with mosaique-patterned distribution) related to the currently determined soil reaction. In the southern regions, the preservation of the strongly acidic grasslands is required, as they are the only suitable habitats for *Arnica montana* in this area. Therefore, the future management of these grasslands will have take into consideration these facts concerning soil reaction, too, in order to preserve the extant *Arnica montana* populations.

Conclusions

In *Arnica montana* habitats, it is easy to notice a much larger number of species in the northern limestone region in comparison with the small number of species in the southern siliceous region. (Diagram 1, 2, 3 and 4)

Acid-neutrophilic species prevail in both regions, however, in the northern limestone region a significantly higher number of acid-neutrophilic species per vegetation sample can be found, in comparison with the southern siliceous region. (Diagram 1, 2, 3 and 4)

The acidophilic species are relatively well-represented in the southern siliceous region, at the expense of weakly acid-neutrophilic species. In the northern limestone region, the weakly acid-neutrophilic species are well-represented, at the expense of strongly acidophilic species, but other categories are also well-represented. (Diagram 1, 2, 3 and 4)

The coverage analysis for each species per vegetation sample highlights a generally balanced soil reaction – related distribution in the northern limestone region. In the southern siliceous region, the habitats of *Arnica montana* are firmly dominated by several strongly acidophilic species. All the other categories are rather poorly and sporadically represented. (Diagram 5, 6, 7 and 8)

Habitats of *Arnica montana* from both regions depend on the preservation of certain soil acidity values. The future management of these grasslands will have take into consideration these facts concerning soil reaction, too, in order to preserve the extant *Arnica montana* populations.

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Studii privind reacția solului în habitatele cu *Arnica montana* din cele două unități geomorfologice ale comunei Gârda de Sus

Rezumat: Comuna Gârda de Sus cuprinde suprafețe situate atât pe substrat calcaros cât şi pe substrat silicios. Habitatele cu *Arnica montana* sunt răspândite pe ambele tipuri de teren. Plantele vasculare din aceste habitate au fost studiate sub aspect calitativ şi cantitativ. Pe substrat calcaros dominanța numerică a speciilor acid-neutrofile este mai pronunțată decât pe suprafețele cu substrat silicios. Gradul de acoperire al acestor specii arată o dominanță clară a speciilor acid-neutrofile numai pe substrat calcaros. Pe substrat silicios s-a constatat o dominanță evidentă a speciilor acidofile.

Studii şi cercetări, Biology 13, Bistriţa, p. 75-82

OLD PHARMACEUTICAL VESSELS IN THE HISTORY OF PHARMACY COLLECTION IN CLUJ-NAPOCA

Radu CRIŞAN[1]

Abstact. The History of Pharmacy Collection in Cluj-Napoca is placed in the oldest chemist's shop in Cluj (1573). The paper deals with historiographical data concerning this shop, names of the chemists who have worked there for almost four centuries, also offering information about the present History of Pharmacy Collection. Various details concerning both the outer and inner part of this chemist's shop-museum are given too. The devices here turn the building into one of the most valuable collecions of old pharmaceutical vessels in Romania from the XVIIth to the XIXth century. These vessels are described according to the pharmaceutical substance of animal or vegetal origin they contained, and whose name is mentioned on the vessel.
Key words: pharmaceutical vessel, roob, extraclum

Introduction

The History of Pharmacy collection is to be found in the oldest chemist's shop in Cluj. Its name is "Sfantul Gheorghe" (St.George), and its first documentary attestation is dated as early as 1573. From the beginning of the 18th. century till 1949 the uninterrupted succession of its heirs could be reconstructed: Alexander Schwartz (1727-1749), Tobias Maucksch (1752-1802), Tobias Samuel Maucksch (1802-1805), Johann Martin Maucksch (1805-1817), followed by his widow (1817-1822), Daniel Szlaby and his heirs (1822-1863), and then by the family of chemists Hintz (1863-1949).

At the origin of this museum is the collection of Transylvanian pharmaceutical devices belonging to Professor luliu Orient (1869-1940), exposed for the first time in 1904 in one of the rooms of the Erdely Museum. Later on this collection was given to the museum, valuable donations which illustrate the pharmaceutic activity in Transylvania between 16th and 19th centuries being added to it.

History of Pharmacy Collection – Description

In the entrance hall a map can be seen; it shows where the shops are which had been attested in Transylvania from the end of the 15th century til! the end of the 18th century. Close to the map, there is professor V.L. Bologa's bust (1892-1971). He was the manager of the History of Medicine and Pharmacy Department that belonged to the Faculty of Medicine and Pharmacy in Cluj. In 1954, professor

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Bologa founded the Pharmacy Museum, situated in the old chemist's shop. It was later on that the Pharmacy Museum was renamed as the History of Pharmacy Collection, being dependent on the National Museum of Transylvania History.

The structure of the museum is similar to that of the old shop, respectively to that of European chemist's shops in the 16th century: *Oficina, Room for Pharmaceutical Devices,* and *Laboratory.*

Oficina is the room where medicine is sold. On the reception desk, in baroque style, a couple of drugs are exposed. These are drugs used by former chemists: *mummy powder and powder of precious stones,* both being used as universal medicine; *hyraceum* of animal origin with multiple medical uses; *the asphalt from Syria* used in the treatment of rheumatism; *coralline powder* as well as *crowfish eyes,* both being natural sources of caldum; *thehaca veneta* – a Venetian antidote etc. Here also are weights and balances which were used in chemist's shops up to the 19th century.

The shop windows, in Empire style, both in the *Ofidna* and in the other rooms show pharmaceutical vessels made of polychrome enameled ceramics, faience, porcelain, transparent glass and opaque glass. These are decorated by means of painting techniques and are given the abbreviated Latin names of various drugs they contained. In most instances drugs were obtained from medicinal herbs. The pharmaceutical vessels were made in manufactories in Transylvania, Hungary, Czecho-Slovakia, Austria and Germany, in the 18th and 19th centuries.

Fig. 1. Shop windows with pharmaceutical vessels.

In the *Oficina* one may also see a pharmaceutical chest of drawers, with ten drawers, from the 17th. century. Each drawer has an inscription painted on a white background with black characters and red initial letters: Borax; *Crem.tartari; Lap. Pumicis; Pad.* Jalapae; *Vitriol. Hung.* si *Vstr. Alb et Cyp., Sem. Staphisag; Cret. Colon; Lap. Haematid.; Rad. Ireos Flor.*

The *Oficina* is decorated with mural painting in baroque style (Fig. 2), ordered by the chemist Tobias Maucksch and finished in 1766. Four medallions are painted on the vault. Two are egg-shaped and two are heart-shaped. In the northern egg-shaped medallion there is the Tree of Life, surrounded by two snakes, Aesculapius' symbol; in the other egg-shaped one, placed in the southern part, there is a crane – the protector of life, with a stone in its daws, standing on branches covered with leaves. In the heart -shaped medallions, which are in the eastern and western part of the vault, there are the horns of plenty. The decoration of the *Oficina,* because of its age and symbolism, is unique in Romania.

The Room for *Pharmaceutical Aids* actually was the storage room of the shop. In its seven shop windows there are more than 200 pharmaceutical wooden vessels, specific for the 17^{th} and 19^{th} centuries. In these vessels the chemists kept powders prepared from medicinal herbs, minerals and some stuff of animal origin (Fig. 1).

In the same room there were two cupboards, in Transylvanian baroque style, for depositing expensive pharmaceutical products. On the panels of one of the cupboards one may see man's ages: childhood, youth, maturity, and death.

In the same room there were two cupboards, in Transylvanian baroque style, for depositing expensive pharmaceutical products. On the panels of one of the cupboards one may see man's ages: childhood, youth, maturity, and death.

In the basement, there is the *laboratory* of the old shop with many alchemical elements. It was placed in the most isolated room where only the chemist and his assistants were allowed to enter. The laboratory distinguishes itself through the authenticity of the exposed objects, dated as early as the 16th. century till the beginning of the 19th. Century, and reflects the standard reached in producing various drugs during this period (Crisan, R., 2005a, 2007).

Old vessels for keeping pharmaceutical products of vegetal origin

We selected several types of pharmaceutical vessels meant to keep some pharmaceutical products of vegetal origin.

Fig. 2. *Oficina,* mural painting with pharmaceutical symbols.

Photo 1a: cylindrical pharmaceutical vessel made of glass; 1-1=12,0 cm; D.B.=7,0 cm; D.M.= 3,4 cm; NHMT=Nb.lnv. IF. 1787 18th century, painted label with egg-shaped margin, two handles on the sides, superior part a crown, all yellow. On the white background of the label the inscription TINCT:SANGVIN:DRAC;(Tinctura sanguinis draconis) written with black capital letters, red initial letters. Tinctura sanguinis draconis, prepared from *Calamus rotand* L. sin. *Calamus draco* Willd., used as astringent and haemostatic in haemoptysis (Ph.univ. 1832,p.540).

Photo 1a ***Photo 1b*** ***Photo 1c*** ***Photo 1d***

Photo 1b: parallelipipedic pharmaceutical vessel made of glass, the 18th century: H=12,0 cm; DB=7,0 cm; DM=2,7 cm; NMT=Nb.inv. IF.991, label painted with two leaves of laurels, superior part: a red ribbon with the inscription *TINCT.CHAMOM.VULG. (*Tinctura Chamomillae vulgaris), written with black capital letters on a white background. (Crisan, E. P.227) Wild camomile tincture used as antispasmodic (Ph.univ. 1838, p.532).

Photo 1c: parallelipipedic pharmaceutical vessel made of glass, the 18th century; H=11,5 cm; L=8,0 cm; DM=2,7 cm; NMT=Nb.inv=IF. 1263, painted label, red frame with little laurels branches and leaves; superior part red and brown crown. On the label's background with black capital letters the incription SPiR.MENTI (Spiritum Menthae), alcoholic extract of *Mentha piperita* L, peppermint, used as antispasmodic, carminative, odorant, strengthening (Reuss, p. 127; Ph. univ. 1832, p.122).

Photo 1d: pharmaceutical glass vessel, 19th century; H=11,8 cm; L=5,5 cm; W=5,7 cm; DM=2,8 cm NHMT, Nb.lnv.lF.1795, painted label as a red frame, leaves of laurels at the superior part, on its white background the inscription *Tinctura Ratnanhiae* cursively written in black. *Tinctura Ratnanhiae* is an alcoholic preparation made out of roots of *Crameha thandra* Ruiz et Pav., used as astringent (Ph.univ.1832, p.540).

Photo 2a: cylindrical pharmaceutical vessel made of wood, 18th century; 1-1=18,2 cm; DB=7,2 cm; DM=7,1crn; NHMT,Nb.lnv. IF. 688 painted in brown, vignette with vegetal motifs and crown both painted in the chromatic scale of red, green and brown. On white background the inscription CARIO PHIL. Written with black capital letters, red initial letters, at the superior part the alchemic sign pulvis, in red. (Crişan, E., p.242); Maior, Sk. XIX). Pulvis CARIO PHIL. (dove powder) *Caryophyllus aromaticus* L aromatic doves, substance used in pharmaceutical preparations used as antiseptic, and for the stimulation of gastric secretion (Ph. Austriaca, 1774; Reuss, 1786; Ph. univ., 1838, p. 488).

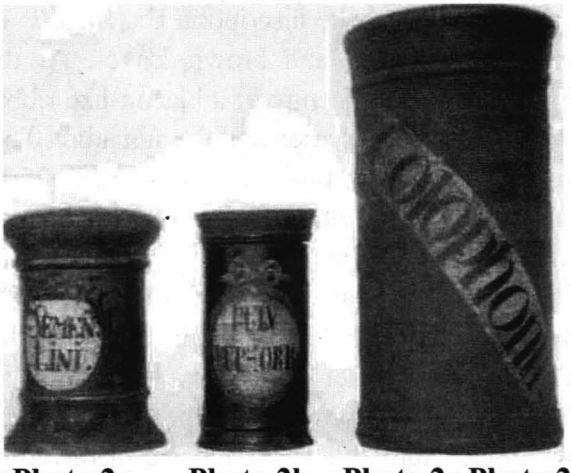

Photo 2a Photo 2b Photo 2c Photo 2d

Photo 2b: cylindrical pharmaceutical vessel made of wood, 18th century; H=11,3 cm; DM=5,8 cm; DB= 8,5 cm; NHMT,Nb.lnv. IF. 1105, painted green; the inscription SEM. LINI. written with black capital letters, initial red letters on the white background of the vignette, framed with red vegetal ornaments, at the superior part a crown painted in a brown scale (Crisan, E., p.243). In this vessel *Linum usitatissimum* L.,flax seeds were kept, used in emollient preparations (Ph. univ. 1832,p.76; Hartmann, vol.2, p.248; Reuss, p.1097).

Photo 2c: PULV. EUPHORB. Cylindrical pharmaceutical vessel made of wood, 18th century, H=13,5 cm; DM=5,9 cm; DB=7,2 cm; NHMT.Nb.lnv. IF. 1176 painted brown, painted label, egg-shaped with a ribbon at the superior part painted in brown and yellow hues; on the white background of the label the inscription PULV: EUPHORB, with black capital letters, red initial letters. Gum resin belonging to various species of *Euphorbia* is for external usage in sciatica and rheumatism (Reuss, p. 364; Ph. univ., 1838, p. 725).

Photo 2d: cylindrical pharmaceutical vessel made of wood, 17th century; H=20,8 cm; DM=9,O cm; DB=10,O cm; NHMT.Nb.lnv. IF. 1105, painted in bright red; the inscription Colophonii is written with black capital letters on the white background of the oblique label unfolded on the surface of the vessel. (Roth, F. J., Sk. XVIII; Crisan, E., p.241), meant for Colophoniu, a secondary substance got by means of distilling turpentine, used for antirheumatic patches (Reuss,1785, p.130; Hartmann, p.72; Ph. univ. 1838,p. 6).

Photo 3a: pharmaceutical vessel of enameled ceramics, 18th century; H=10,0 cm; DB=7,4 cm; DM=5,1 cm;NI-IMT,Nb.lnv. IF 862. The yellow-grey vassel, is cylindrical with a flaring basis. The inscription Ex. *Angelic* is surrounded by stylized decorations in relief with green and brown leaves. At the inferior part a much protruded yellow flower. It is the centre of a blazon-like ribbon oriented right-left that doses the basis of the decorative elements of the signature. The decorative elements are enameled in ocre -yellow, green and blue.(Crisan, R. 2005 b. p.62, fig 2) Extractum Angelicae an alcoholic preparation with roots of Angelica archangelica L, Gardenangelica, used as bitter tonic (Reuss.1791, p.1271;Ph. univ, 1838, p.228).

Photo 3b: pharmaceutical vessel of ceramics, 18th century; H=23,0 cm; DM=12,0 cm; NHMT, Nb.lnv. IF 2401, cylindrical, without lid, enameled white-grey. The label painted under the enamel represents a blue, white and green drapery, whose fringes are painted yellow and brown. On the background, the inscription ROOB: EBUU written with black capital letters. This is a medicine having the consistency of honey that is obtained from the fruit juice of *Sambucus ebulus* L., and used as diuretic (Reuss,1791, p.970; Ph. univ. 1832, p.536).

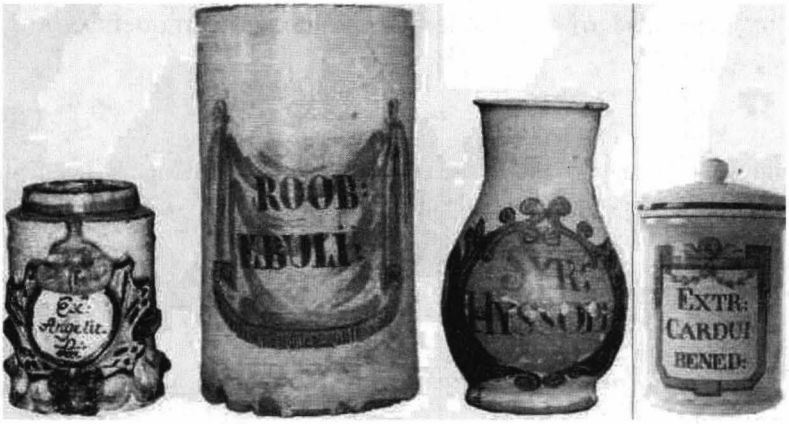

Photo 3 a **Photo 3 *b*** ***Photo 3 c*** ***Photo 3 d***

Photo 3c: faience pharmaceutical vessel, manufactured in Limbach, Germany, H=16,5 cm; DB=6,8 cm; DM=7,O cm., NHMT, Nb.lnv. IF 873, enameled white-grey, in the shape of a truncated cone, flaring lip. The label painted on the glaze – the frame in baroque style is brick-red coloured, surrounds the background painted in hues of blue, with the inscription SYR.;HYSSOPI., written with black capital letters, the initial letters being red (Crisan, E. p. 213, 8k. V; Orient, l., Sk. V) Syrupus Hyssopi prepared from *Hyssopus officinalis* L, Hyssop, used in pulmonary affections (Reuss, 1791, p.1216; Ph. univ. 1838, p.877).

Photo 3d: faience pharmaceutical vessel, manufactured in Batiz, Hunedoara district in the 19th century; H=10,9 cm; DM=6,5 cm; DB=6,6 cm; cylindrical, enameled white-yellowish, the lid with spherical button. Ornamented with classicist vignette, margins in hues of blue; at the superior part a rosette painted yellow and blue, and two green garlands of leaves. Within the vignette there is the inscription EXTR.CARDUI BENED. written with black capital letters (Crisan, E., p.209) Extractum Cardiu benedicti is a bitter tonic prepared from leaves of *Cnicus benedictus* L. Gartn, Blessed thistle (Ph. univ.,1838, p.481).

Conclusions

The History of Pharmacy collection in Cluj-Napoca is one of the most valuable museums of this kind in Romania, not only because of the oldness of its devices, but also of the authenticity of its exposing place, that is to say the oldest chemist's shop in Cluj.

Most of the objects here (pharmaceutical vessels, furniture, old books – Pharmacopei, etc.), because of their scientific value and uniqueness are part of Romania's treasure.

Abbreviations:

H = Height; DB = Diamter of the Basis; DM = Diameter of the Mouth; L = Length; W = Width; NHMT = National History Museum of Transylvania; Nb.Inv. IF = Number of Inventory IF; Sk. = Sketch; Ph.univ. = Pharmacopoea universalis.

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Rezumat. Colecţia de Istorie a Farmaciei din Cluj-Napoca este situată în cea mai veche farmacie a Clujului (1573). Lucrarea prezintă date istoriografice privind această farmacie, numele farmaciştilor care au funcţionat aici de-a lungul celor aproape patru secole, precum şi informaţii despre constituirea actualei Colecţii de Istorie a Farmaciei. Sunt prezentate de asemenea aspecte de ansamblu şi detalii din interiorul farmaciei-muzeu. Artefactele de aici se constitute în una dintre cele mai valoroase colecţii de vechi vase farmaceutice din România, încadrate cronologic între secolele al XVII-lea şi al XIX-lea. Acestea sunt descrise şi prezentate în funcţie de produsul farmaceutic de origine vegetală pe care îl conţineau şi al cărui nume este inscripţionat pe vas.

Studii şi cercetări, Biology 13, Bistriţa, p. 83-93

PRELIMINARY RESULTS ABOUT ORTHOPTERA FAUNA FROM RODNA MOUNTAINS NATIONAL PARK (BIOSPHERE RESERVE)

Claudiu IUŞAN*

Abstract. The present paper is a part of an ample study regarding taxonomical, faunistical and ecological fauna of Orthoptera group in Rodna Mountains National Park from Eastern Carpathians, drawing the preliminary conclusions of our investigations. In the period 2004-2008 were identified 52 Orthoptera species and majority of them are: chortobiont life forms (44,23%), eurosiberian elements (36,53%), spread under 1 800 m altitude and prefer mezophilous meadows (48,07%). A high number of endemic species for Carpathians is present: *Isophya brevipennis, Isophya pienensis, Miramella ebneri carpathica, Odontopodisma carpathica* and *Pholidoptera transsylvanica.*
Key words: Orthoptera, Rodna Mountains National Park, period 2004-2008

Introduction

The Orthoptera insects are known under the common names as grasshoppers, crickets, locusts and they play a very important role in natural ecosystems, and which, except for some species which can bring about damage, includes many species considered as scientific treasures which are protection dignified. In Romania, in the present are 183 Orthoptera species and subspecies, 9 species are protected by 462/2001 Law, one species by L 13/1993 Bern and 7 species by Habitats Directive 92/43/CEE.

Rodna Mountains National Park (Biosphere Reserve) is placed in Eastern Carpathians, was established as a national park in 1990 and declared as a Biosphere Reserve in 1979, covering a surface of 46 399 ha and shelter the highest peak from northern Romania – Pietrosu Mare (2 303 m).

Our research were carried out in the period 2004-2008 in Rodna Mountains National Park and in near vicinity areas, covering a surface of 50 000 ha, between latitude 47°25'54" and 47°37'28" north and longitude 24°31'30" - 25°01'30" east. (APNMR, 2007, www.parcrodna.ro, Plan de management, fig. 1).

Materials and methods

There were collected 959 quantitative samples of Orthoptera species from all types of habitats from Rodna Mountains (fig. 2), between 500- 2303 m altitudes. The main types of habitats are: xerophilous, mezophilous, hygrophilous meadows, pastures and hayfields, edge of coniferous, deciduous and mixture forests, forest clearings, swamps, screes, bushes, riparian habitats, orchards, ant hillocks.

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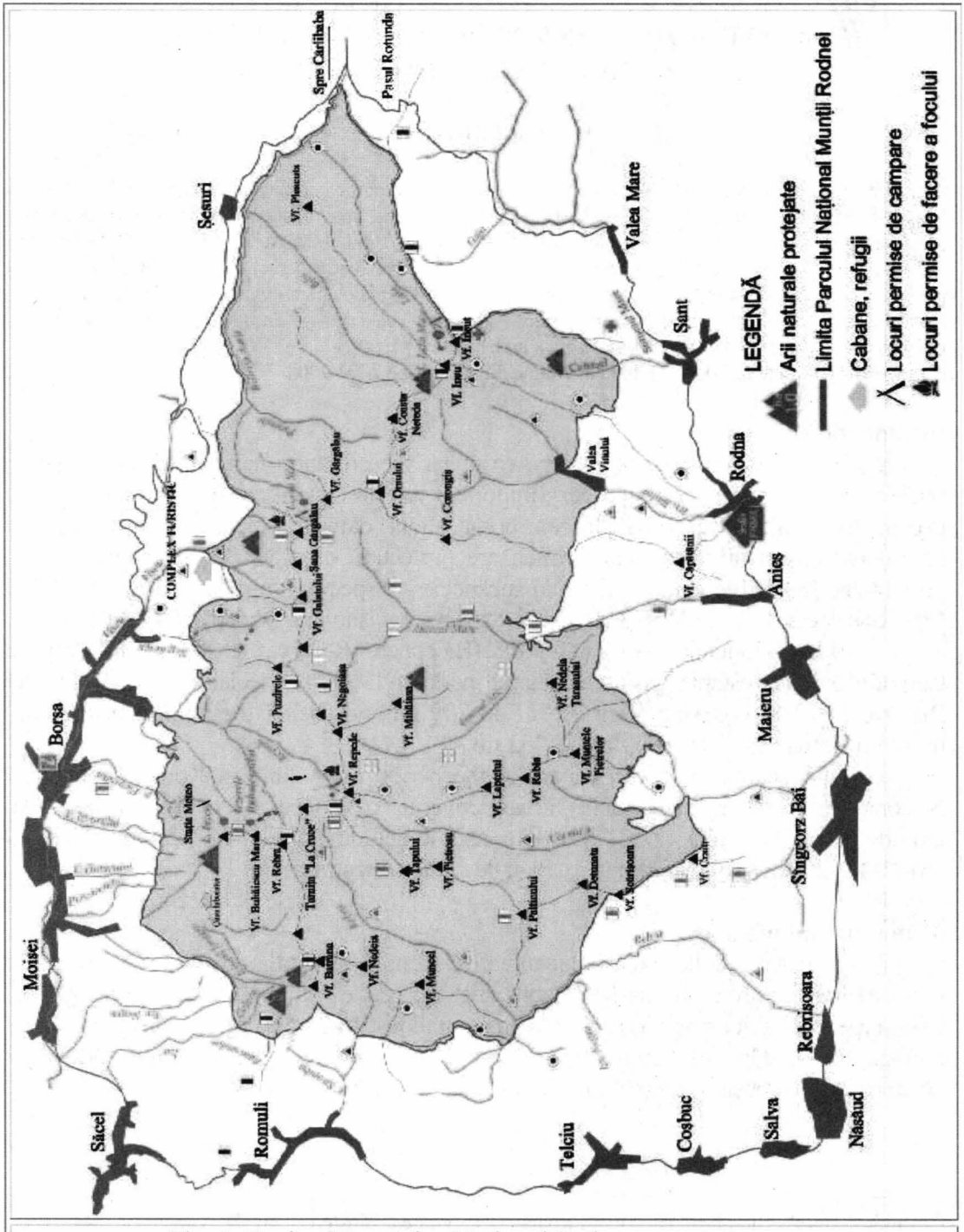

Fig. 1. Rodna Mountains National Park map – study area

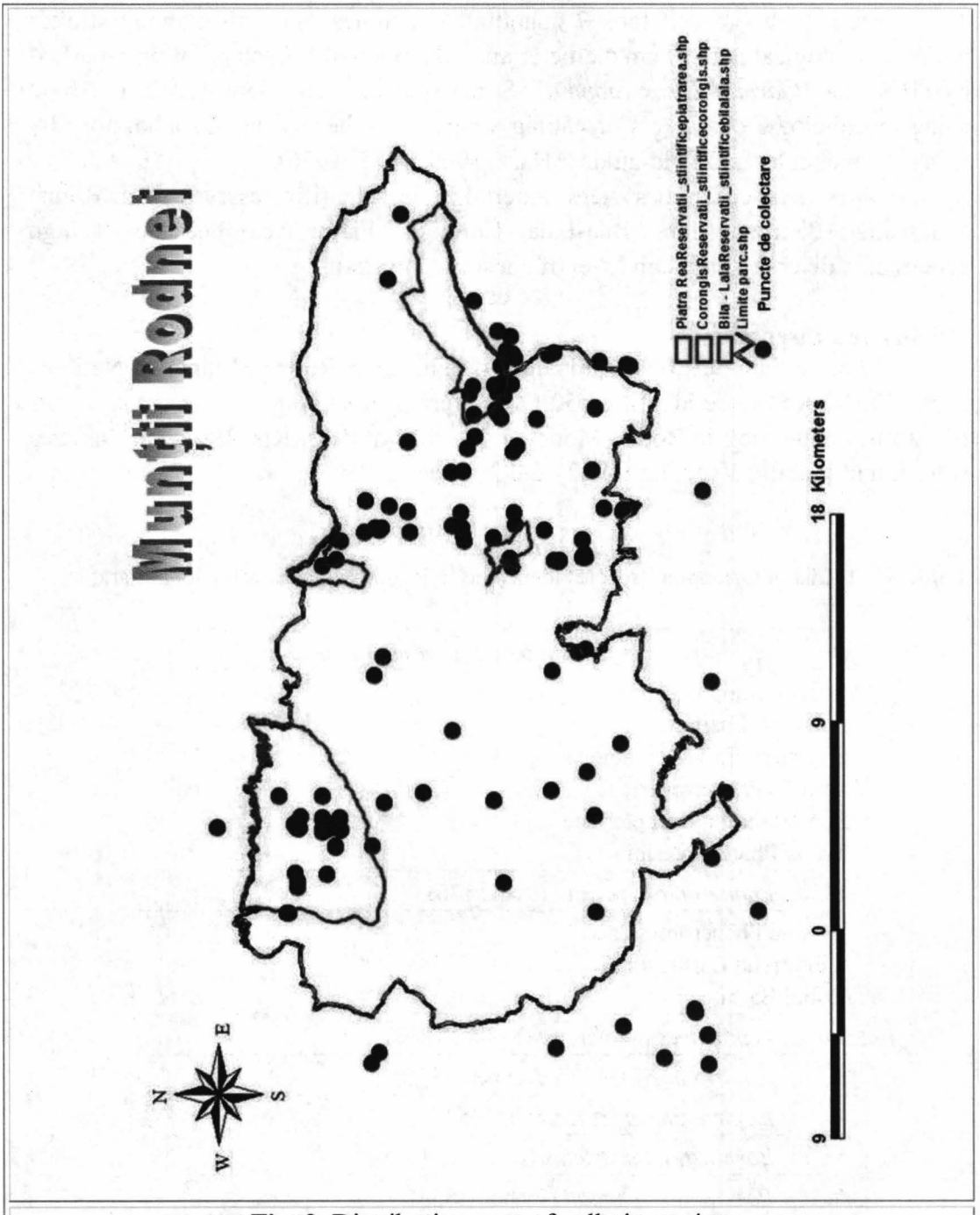

Fig. 2. Distribution map of colleting points

From each site was took 7 quantitative samples using 50 mowing strokes with entomological net (30 cm diameter and 70 cm length). Each point was marked by GPS unit (*Garmin Etrex Summit*). Some species were identified in the field using morphologic characters or calling songs and other species in laboratory by using the binocular and field guides (Harz, 1969, 1975, 1976).

More detailed studies were undertaken in scientific reserves from Rodna Mountains (Pietrosu Mare, Bila-Lala, Corongis, Piatra Rea) because of high ecosystems diversity and high level of conservation status.

Results and discussions

In more than 100 field campaigns organized in Rodna Mountains National Park (2004-2008) were identified 52 Orthoptera species (fig. 3). According to the old studies undertook in Rodna Mountains (Szilady, 1922, Kis, 1967), in this area were found initially 5 species (1922) and 39 species (1954).

Table no. 1. List of Orthoptera species identified in Rodna Mountains National Park.

Nr.	***Specia şi încadrarea taxonomică***
	Ordin Orthoptera Subordin Ensifera Superfamilia Tettigonoidea Familia Phaneropteridae Subfamilia Phaneropterinae Tribul Phaneropterini
1	*Phaneroptera falcata* (Poda, 1761)
	Familia Phaneropteridae Subfamilia Barbitistinae Tribul Barbitistini
2	*Leptophyes albovittata* (Kollar, 1833)
3	*Isophya brevipennis* (Brunner, 1878)
4	*Isophya pienensis* (Maran, 1954)
5	*Barbitistes constrictus* (Brunner, 1878)
6	*Poecilimon schmidti* (Fieber, 1853)
7	*Polysarcus denticaudus* (Charpentier, 1825)

Nr.	***Specia şi încadrarea taxonomică***
Familia Chonocephalidae Subfamilia Conocephalinae Tribul Conocephalini	
8	*Conocephalus dorsalis* (Latreille, 1804)
9	*Conocephalus fuscus* (Fabricius, 1793)
Familia Meconemidae Tribul Meconematini	
10	*Meconema thalassina* (De Geer, 1771)
Familia Tettigoniidae Subfamilia Tetigoniinae Tribul Tettigoniini	
11	*Tettigonia cantans* (Fuessly, 1775)
12	*Tettigonia viridissima* (Linne, 1758)
Subfamilia Decticinae Tribul Decticini	
13	*Decticus verrucivorus* (Linne, 1758)
Tribul Platycleidini	
14	*Platycleis grisea* (Fabricius, 1781)
15	*Metrioptera brachyptera* (Linne, 1761)
16	*Metrioptera bicolor* (Phiippi, 1830)
17	*Metrioptera roeseli* (Hagenbach, 1822)
18	*Pholidoptera griseoaptera* (De Geer, 1773)
19	*Pholidoptera fallax* (Fischer, 1853)
20	*Pholidoptera transsylvanica* (Fischer, 1853)
21	*Pholidoptera aptera* (Fabricius, 1793)
22	*Pachytrachis gracilis* (Brunner, 1861)
Superfamilia Grylloidea Familia Gryllidae Subfamilia Gryllinae Tribul Gryllini	
23	*Gryllus campestris* (Linne, 1758)

Nr.	Specia şi încadrarea taxonomică
	Familia Gryllotalpidae Subfamilia Gryllotalpinae Tribul Gryllotalpini
24	*Gryllotalpa gryllotalpa* (Linne, 1758)
	Subordin Caelifera Suprafamilia Tetrigoidea Familia Tetrigidae Subfamilia Tetriginae Tribul Tetrigini
25	*Tetrix subulata* (Linne, 1761)
26	*Tetrix nutans* (Hagenbach, 1822)
27	*Tetrix bipunctata* (Linne, 1758)
	Superfamilia Acridoidea Familia Catantopidae Subfamilia Podisminae Tribul Podismini
28	*Miramella ebneri carpathica* (Galvagni, 1953)
29	*Pseudopodisma fieberi* (Scuder, 1897)
30	*Odontopodisma carpathica* (Kis, 1961)
	Subfamilia Calliptaminae Tribul Calliptamini
31	*Calliptamus italicus* (Linne, 1758)
	Familia Acrididae Subfamilia Acridinae Tribul Parapleurini
32	*Mecostethus grossus* (Linne, 1758)
	Tribul Chrysochraontini
33	*Chrysochraon dispar* (Germar, 1834)
34	*Euthystira brachyptera* (Ocskay, 1826)
	Subfamilia Oedipodinae Tribul Locustini
35	*Psophus stridulus* (Linne, 1758)

Nr.	***Specia şi încadrarea taxonomică***
Tribul Oedipodini	
36	*Oedipoda coerulescens* (Linne, 1758)
Subfamilia Gomphocerinae Tribul Arcypterini	
37	*Arcyptera fusca* (Pallas, 1773)
Tribul Stenobothrini	
38	*Stenobothrus stigmaticus* (Rambur, 1839)
39	*Stenobothrus lineatus* (Panzer, 1796)
40	*Omocestus viridulus* (Linne, 1758)
41	*Omocestus ventralis* (Zetterstedt, 1821)
42	*Omocestus haemorrhoidalis* (Charpentier, 1825)
Tribul Gomphocerini	
43	*Myrmeleotettix maculatus* (Thunberg, 1815)
44	*Gomphocerus rufus* (Linne, 1758)
45	*Chorthippus stauroderus scalaris* (Fischer, 1846)
46	*Chorthippus biguttulus* (Linne, 1758)
47	*Chorthippus brunneus* (Thunberg, 1815)
48	*Chorthippus pullus* (Philippi, 1830)
49	*Chorthippus albomarginatus* (De Geer, 1773)
50	*Chorthippus dorsatus* (Zetterstedt, 1821)
51	*Chorthippus montanus* (Charpentier, 1825)
52	*Chorthippus parallelus* (Zetterstedt, 1821)

According to these data, Rodna Mountains is a rich area in Orthoptera species (52), being on the first place in eastern Carpathians, after Vrancei Mountains (39, Iuşan & Oltean, 2002), Călimani Mountains (36, Mihuț I., 1997), Tibles Mountains (29, Iuşan, 2008).

From ecological point of view, Orthoptera fauna from Rodna Mountains is compound from 44,23% chortobiont life forms (fig. 3) which are developing on meadows and 17,30% thamnobiont life forms which are developing on wooden vegetation (shrubs, bushes, edge of forests, forest cuttings). A high number of chortobiont and thamnobiont species can be explain through the species

preferences for meadows and forest habitats, prevalent ecosystems from Rodna Mountains.

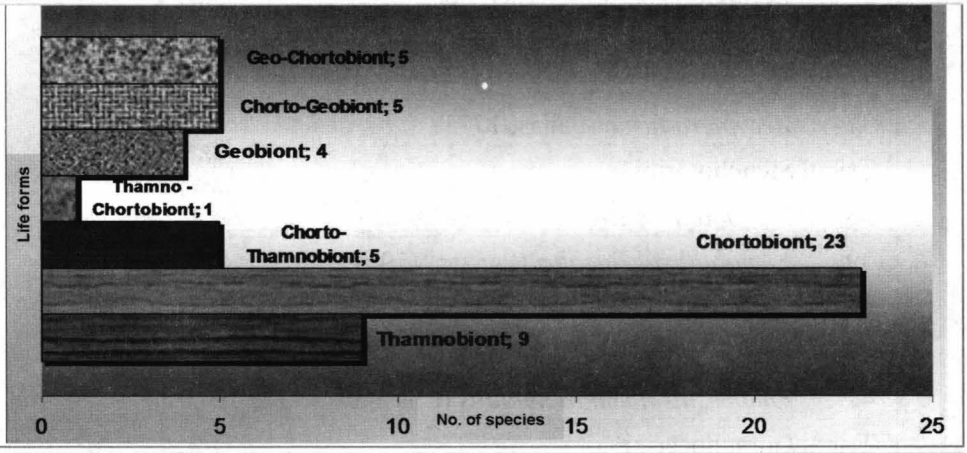

Fig. 3. Life forms spectrum of Orthoptera species

The majority of species prefer mezophilous meadows (48,07%, fig. 4), after that are species characteristic for bushes, edge of forests (19,38%), hygrophilous meadows (11,53%), mezzo-hygrophilous species (9,61%), mezzo-xerophilous species (9,62%), xerophilous species (3,84%) and rocky species (1,92%).

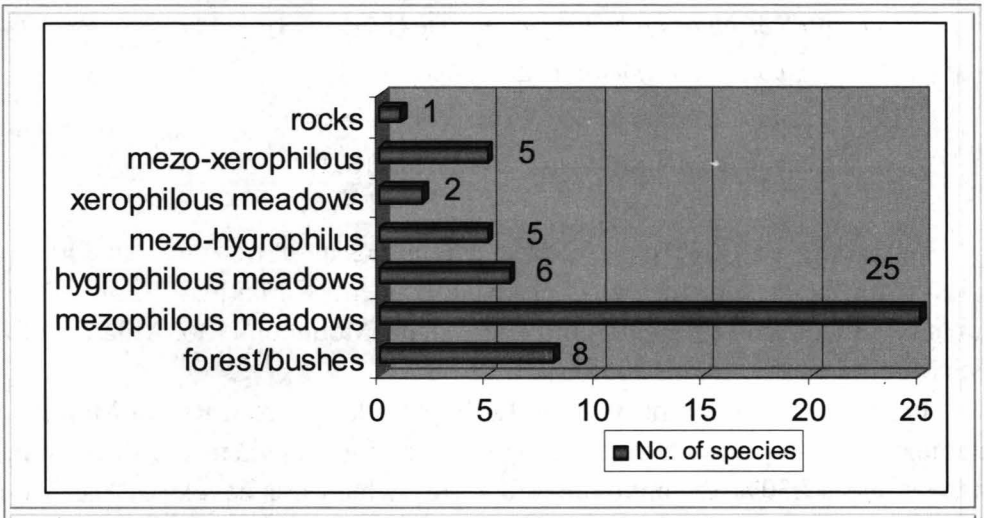

Fig. 4. Orthoptera species distribution by habitats

The altitude is very important factor for Orthoptera species distribution, also demonstrated in Rodna Mountains, thus, majority of species are spreaded under 1 800 m altitude. Above 1 800 m but under 2 000 there are 4 species: *Myrmeleotettix maculatus, Psophus stridulus, Tettigonia cantans* şi *Barbitistes constrictus*. Above 2 000 m can be found 8 species: *Omocestus viridulus, Polysarcus denticaudus, Chorthippus parallelus, Stenobothrus lineatus, Miramella ebneri carpathica, Pholidoptera transsylvanica, Metrioptera brachyptera* and *Isophya brevipennis*, which are very common in the massif (fig. 5).

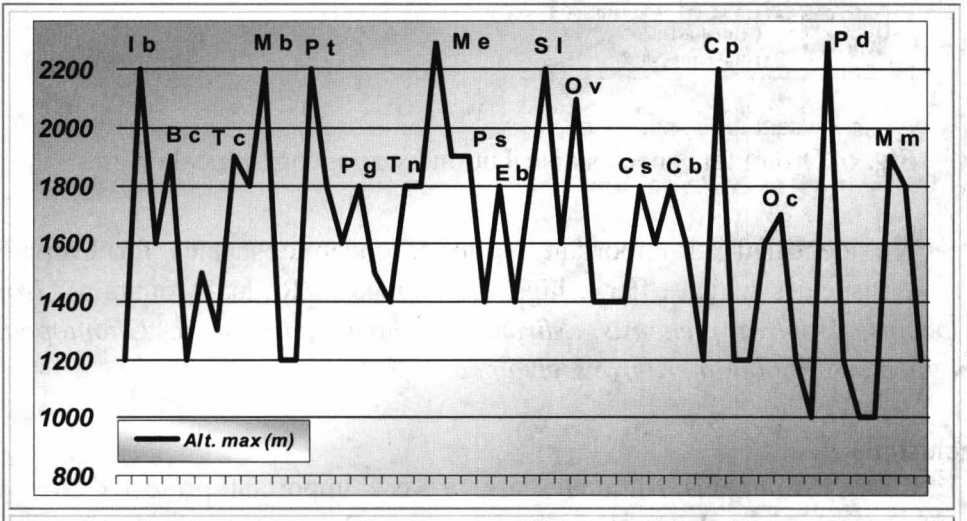

Fig. 5. Orthoptera species distribution by altitude

From zoogeographical point of view (fig. 6), the Orthoptera fauna of Rodna Mountains comprise the following elements: eurosiberian species (36,53%), very common and wide spreading: *Conocephalus dorsalis, Tettigonia cantans, Decticus verrucivorus, Metrioptera brachyptera, Psophus stridulus, Chryschraon dispar* etc.; holopalearctic species (23,07%) such as: *Conocephalus fuscus, Tettigonia viridissima, Tetrix nutans, Oedipoda coerulescens, Omocestus ventralis, Chorthippus brunneus* etc.

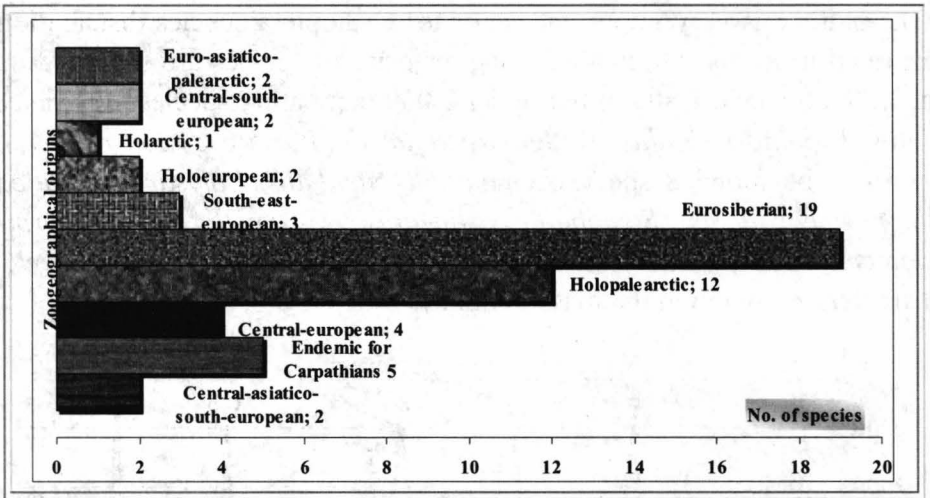

Fig. 6. Orthoptera species distribution by zoogeographical origins

We identified an important group of endemic species for Carpathians (9,61%), 5 species which offer a high importance of Rodna Mountains: *Isophya brevipennis, Isophya pienensis, Miramella ebneri carpathica, Odontopodisma carpathica* and *Pholidoptera transsylvanica*.

Conclusions

Rodna Mountains National Park, a very important protected area from Eastern Carpathians and a biodiversity hotspot in Romania, shelter a high number of Orthoptera species (52), beside of more than 3 500 species of flora and fauna known at local level.

A huge percent from them (44,23%) are chortobiont life forms which are developing on meadows and 17,30% thamnobiont life forms which are developing on wooden vegetation (shrubs, bushes, edge of forests, forest cuttings).

Most of the species prefer mezophilous meadows (48,07%), are spreaded below 1 800 m and are eurosiberian elements (36,53%).

A group of endemic species for Carpathians (9,61%) confer a real prove for site protection. A communitarian species was found – *Pholidoptera transsylvanica* in many plots from Rodna Mountains and will be a clue species for future monitoring strategy of biodiversity.

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Studii şi cercetări, Biology 13, Bistriţa, p. 95-113

WINTER ROOSTS AND DAILY DYNAMICS OF ROOK (*CORVUS FRUGILEGUS* L.) IN CLUJ-NAPOCA MUNICIPALITY, IN THE PERIOD 2001-2007

Claudia PINTICAN-MUNTEANU

Abstract. The behaviour of rooks in the non-breeding period has been monitored between the years 2001-2007, several types of roosts being identified. They are located both in the inhabited area of Cluj-Napoca municipality, and outside it (the roost from Someşeni military base). The following parameters have been monitored: roost departure and entry, influence of some environmental factors on the daily activities of rooks, their flight between the roosts and the feeding areas. The observations were performed both in the proximity of the roosts, and along the flight path. Numerical evaluations on the bird flocks have been as performed for various months along the year. It was noticed that in general, the rooks follow specific behavioural patterns. Thus, the daily flights take place along specific routes, many of these being identical each year. As a rule, the roosts were located in the same places year by year. However, deviations from behavioural patterns have been also noticed, with seasonal or even daily periodicity, sometimes without obvious causality.
Key words: Cluj-Napoca municipality, winter roost, morning dispersal, preroosting aggregation, evening arrival

1.Introduction

A typical aspect of the behaviour of rooks during non-breeding period is represented by the aggregation of these birds during night time on restricted areas, the so-called "roosting sites", which are used for roosting until the beginning of the reproduction cycle of the subsequent year.

Based on his own studies and on reference data, Z. Hubálek (1980) has proposed a classification of the roosts that we have also used for this study. One criterion for his classification is represented by the phase of the biological cycle; accordingly, the following roost types have been defined: winter, migration, prebreeding and breeding.

The winter roosts are subdivided into two subtypes: regular and occasional. The first subtype can be further subdivided into: *basic* (Germ.: Hauptschlafplatz, according to Zdobnitzky, 1907) and *satellite* (Germ.: Nebenschlafplatz, according to Zdobnitzky, 1907).

The basic roost – is used during several successive winters, and for the whole duration of the season; the number of birds in such roosts is larger than in the other cases. The basic roost is promptly occupied in the autumn.

The satellite roost – is used regularly (for several successive nights), being occupied in the late autumn for short intervals; it coexists with the basic roost. The number of birds in such roosts is relatively smaller than in the basic roost.

The occasional roost – is not used on a regular basis, *i.e.* the birds do not use it during consecutive nights.

According to the criterion of *stability*, the basic roosts (as well as the satellite ones) can be grouped into *stable* (perennial) – those that are continuously used during several successive winters (sometimes even for a decade), and *unstable,* which are used during a winter season (annual) or during two winter seasons (biennial).

As it was stated earlier (Hubàlek, 1980), the basic roost is used *along a whole winter season.* Coombs 1960, 1978 (in Cramp, 1994) noticed that in England, the formation of large flocks and the establishment of the roosts take place gradually starting with July; however, their location and duration may differ from one region to another. For example, along the Ythan Valley, in July the birds have established a roost located at about 1 km distance from the colonies, in September they moved to a new location at about 8 km from the colonies, while in October the rooks have again changed the roost location (the location was differing from year to year). Our observations led to the conclusion that also in the case of the rooks from Cluj-Napoca changes of the basic roost location took place along the years of study (respectively during the winters) from one season to the other or even during the same season.

The volume co-ordinated by S. Cramp (1994) includes a unique example at European scale: the isolated rook population from Leon (Spain) is roosting during winter in the same place where during the summer it locates its breeding colony (Ena Alvarez, 1979, according to Cramp, 1994). In Cluj municipality, this situation represents a *constant* feature that is annually iterated: the arboretum where the basic roost is located during the winter (Clinicilor – Haşdeu streets) is also used as location for the largest breeding colony within the city limits. Also, the breeding colony within the area of the Someşeni military base turns into post-breeding roost at the end of the reproduction period. In the same time, some assemblages along the flight route of the rooks are located within the perimeter of some breeding roosts.

2. Means, research methodology

We have carried out observations on roosts and daily flights in the period October 2001–February 2007, most of them located in the area of Cluj-Napoca municipality.

By monitoring the flight of the rooks in several observation sites, in the morning and in the evening, we could identify and mark on maps the locations where rooks aggregate during the night (winter roosts); we have observed the aggregation behaviour of the birds, their flights, indices for constant elements but also deviations from patterns. Thus we could evidence the general traits of the studied elements (roosts, intermediary assemblages, routes, effectives) in the monitored area, as well as the peculiar situation resulted from specific interactions (some of them of anthropogenic nature, for example expelling of the birds from a roost by using firecrackers, immediately followed by the change of the location and establishment of a new roost).

We have also monitored the dispersal from the roosts, the duration of the dispersal within the roost and in the first assemblage; also we have observed the pattern of the roost entry.

3. Results and discussions

We have identified the following roost types in Cluj-Napoca: *winter roosts* (including the basic roost and the successive roosts) and *summer (post-breeding) roosts*. Among the *winter roosts*, the one called „Zoology" (located in the area of the streets Clinicilor and Haşdeu, in the vicinity of the zoology laboratories of the Faculty of Biology and Geology) represents a basic roost that was used along the whole study period; it is located in the area of the breeding colony 1 (Zoology/TB hospital) (fig.1). Another roost was built outside town, in the area of the military base Someşeni; this is a post-breeding roost that was used during the summer.

In the area of Cluj-Napoca municipality, the roosts where the breeding rooks within the city limits or in its close neighbourhood (Someşeni, Jucu, Gilău) aggregate are established during the summer (July - August). From this point on, the rooks will fly daily between the roost (located in the town) and the feeding areas (located outside the town).

In the winter of 2001/2002, several successive re-locations took place. Thus, since the summer (August) until December, the birds have used the „Zoology" roost, but starting with Januáry 2002 they moved to „Haţieganu" Sports Park, within the trees located in its eastern side (towards the meadow of Someşul Mic River). In February 2002, following several banishing actions undertaken by the guardians of the park (by using firecrackers), the rooks moved in the "Simion Bărnuţiu" Municipal Park, where they have concentrated during the night in the chestnut trees in the middle area of the main alley of the park. We have called these types "successive (temporary) roosts" (fig. 1).

Starting with the autumn of 2004 we could notice a constant trend concerning the roosts location and re-location from one roost to another, according to the model of Cramp (1994).

The general rule of such roosts' changes was represented by the abandon of the „Zoology" roost in November or December and the relocation of the birds in the Central Cemetery. Thus, during the winter season 2004/2005 (Table 1), following an interval when the base, Zoology roost was used, the rooks have moved the roost to the Central Cemetery, in its lower part (there is no information on the exact date of this move, but on January 10, 2005 the re-location was already done). During the winter seasons 2005/2006 and 2006/2007, the move of the rooks from the Zoology roost to the Central Cemetery took place during November, the birds using this new one constantly until the last decade of March (fig. 2).

It is worthy to mention that the locations that were used as successive roosts („Hațieganu" Park, Municipal Park, Central Cemetery) have subsequently represented assemblages along the daily routes from and to the basic roost in the next years. An explanation for selecting assemblages proper as successive (temporary) roosts could be related to the fact that the rooks already "knew" the sites, the trees and the neighbourhoods.

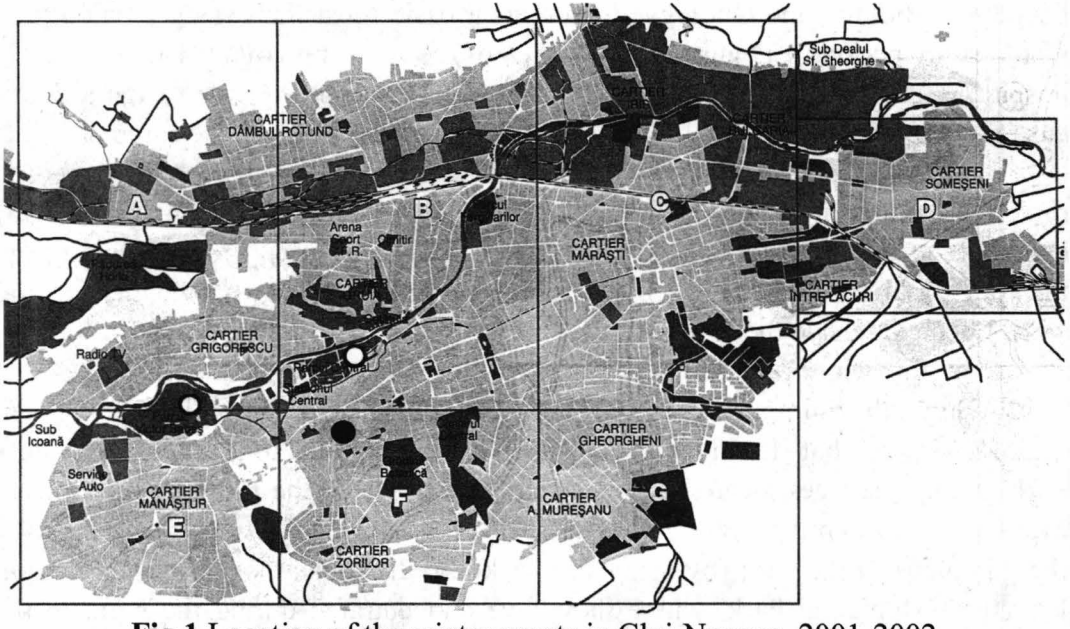

Fig.1 Location of the winter roosts in Cluj-Napoca, 2001-2002
(black circle – basic roost; empty circle - successive/temporary roosts)

A phenomenon that was noticed in the area of Cluj-Napoca in the last years, and which was not indicated in the publications available consists in the birds' relocation, at certain time intervals, from one place to another within the perimeter/wide arboretum of the basic roost.

In the case of the roost located in the green area located in the neighbourhood of the faculties of Biology-Geology and Geography (Clinicilor street, the former Botanical Gardens), the relocations took place as follow:

- in the period October-December 2002 the birds spent the overnight in the trees of the park around the faculties of Biology and Geography, as well as in the trees around the TB Hospital, while in the period January-February 2003 they could be found only in the trees around the TB Hospital (Haşdeu street area);

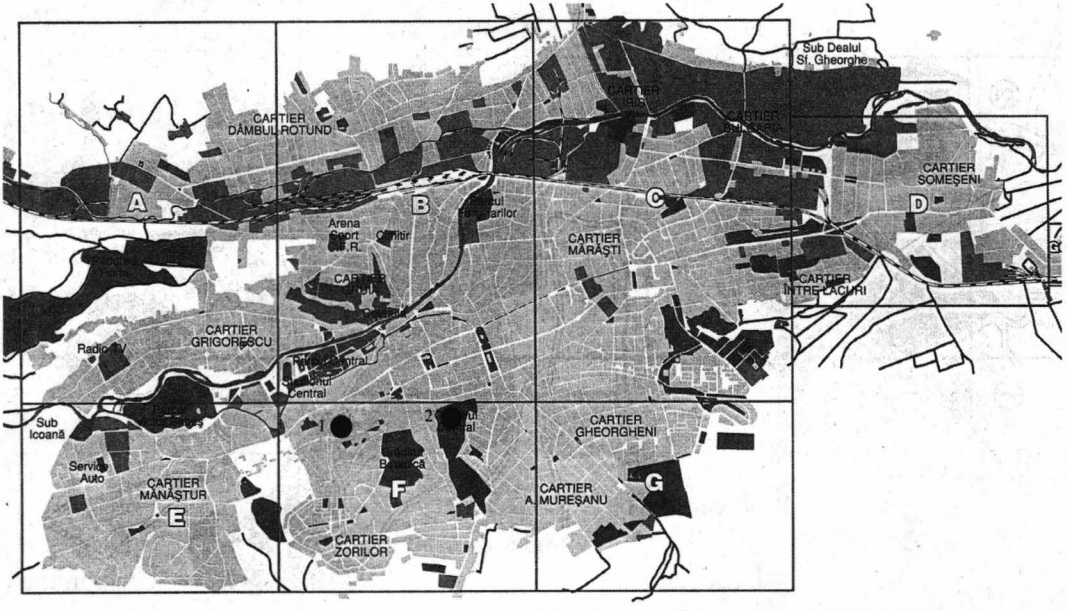

Fig. 2 Location of the winter roosts in Cluj-Napoca, 2005-2007
(1 – Zoology; 2 –Central Cemetery)

- this relocation of the roosts in the area delimited by the Clinicilor and Haşdeu streets had iterated also in the following winter season, 2003/2004; it is worthy to underline that during these periods of the cold season the rooks did not occupy the trees that usually were used as the core of the breeding colony in the

same area (*i.e.* the green area behind the building of the Zoology Museum, towards the Haşdeu Street).

Table 1

Changes of location of rooks' roosts in the area of Cluj-Napoca municipality in the interval October 2001 – February 2007

Winter season	Month	Rooster location	Observations
2001/2002	October November December January February	Faculty of Biology and Fac.of Geography (Clinicilor Str.) „Haţieganu" Park Central Park	Birds banished from the Sports Park „Haţieganu" by using firecrackers
2004/2005	October November December January February	Faculty of Biology – Geology and Fac.of Geography TB Hospital Central Cemetery	Assemblage in the period Oct.-Dec. 2004
2005/2006	October November December January February	Faculty of Biology TB Hospital (a reduced number of individuals) Central Cemetery	Assemblage in the period Oct.- Nov. 2005 and 2006
2006/2007	October November December January February	Faculty of Biology TB Hospital (a reduced number of individuals) Central Cemetery	This change was preserved also in the following season

- concerning the Zoology roost, in the subsequent years (2005-2006), several relocations were recorded from one side to the other within the same perimeter: in August, only the area towards Haşdeu Street (A zone) was occupied, in September also the trees located along the main alley have been used, however the area around the TB Hospital was not; subsequently, die to the increase of the number of rooks, also the TB

Hospital area has been occupied (in 2006, the trees in zones F and D added to the occupied area) (figs. 3 and 4).

A phenomenon that was noticed in the area of Cluj-Napoca in the last years, and which was not indicated in the publications available consists in the birds' relocation, at certain time intervals, from one place to another within the perimeter/wide arboretum of the basic roost.

In the case of the roost located in the green area located in the neighbourhood of the faculties of Biology-Geology and Geography (Clinicilor street, the former Botanical Gardens), the relocations took place as follow:

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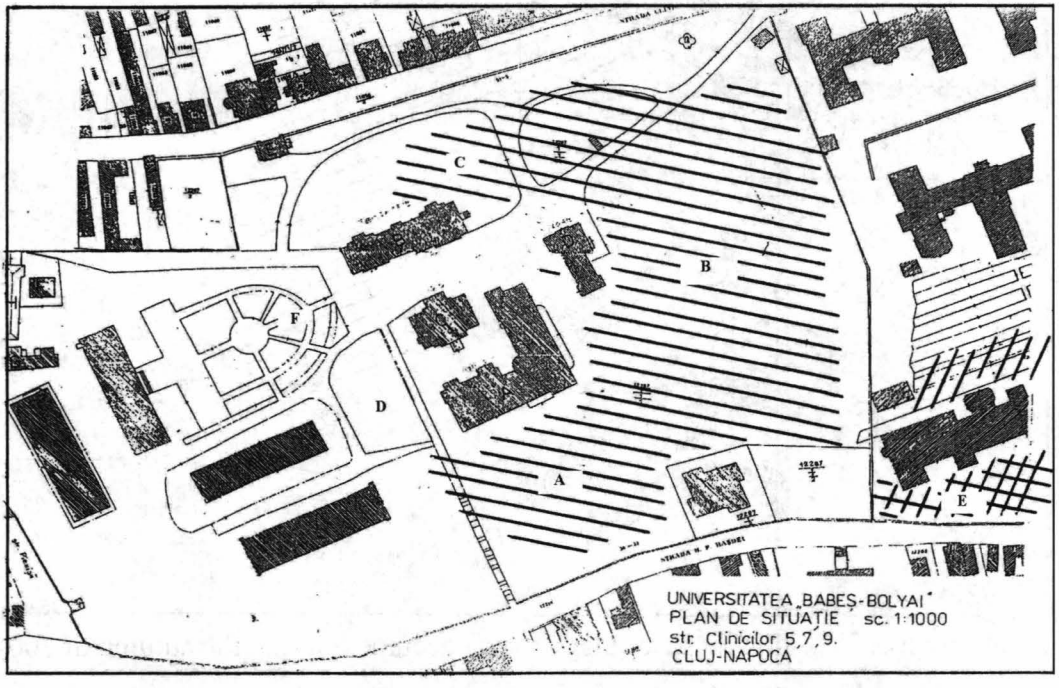

Fig.3. Perimeters within the „Zoology" roost occupied during the winter seasons 2002-2003 and 2003-2004

A phenomenon that was noticed in the area of Cluj-Napoca in the last years, and which was not indicated in the publications available consists in the *birds' relocation*, at certain time intervals, from one place to another within the perimeter/wide arboretum of the basic roost.

In the case of the roost located in the green area located in the neighbourhood of the faculties of Biology-Geology and Geography (Clinicilor street, the former Botanical Gardens), the relocations took place as follow:

- in the period October-December 2002 the birds spent the overnight in the trees of the park around the faculties of Biology and Geography, as well as in the trees around the TB Hospital, while in the period January-February 2003 they could be found only *in the trees around the TB Hospital* (Haşdeu street area);

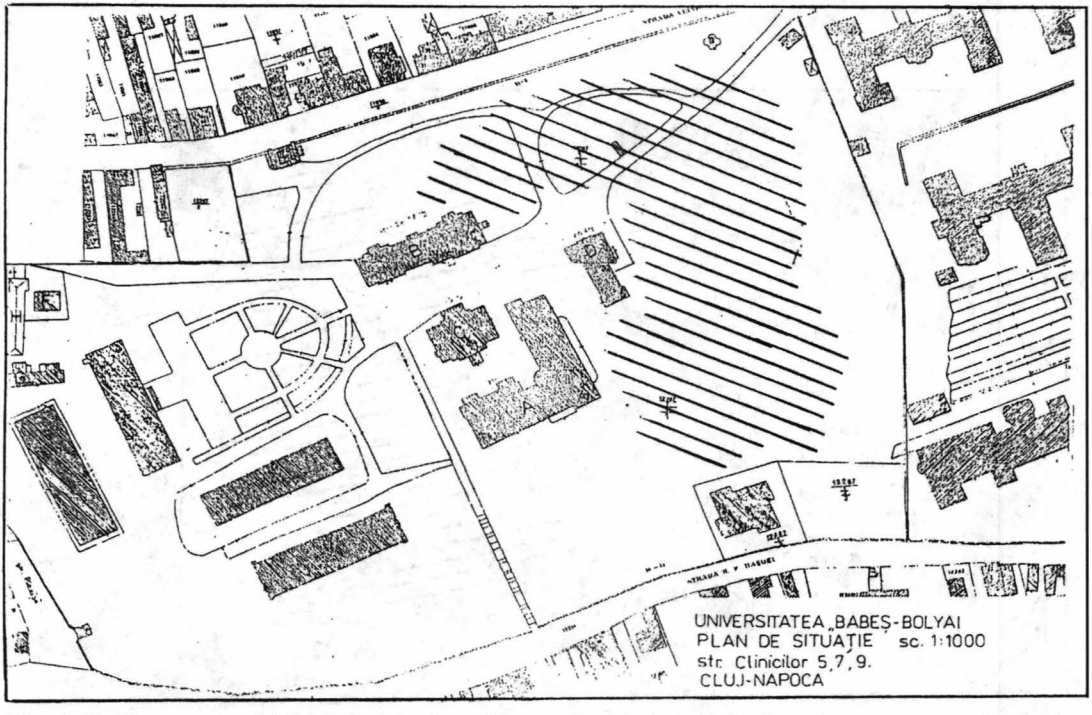

Fig.4. Perimeters within the „Zoology" roosts occupied during the autumn of 2004

Relationships between the breeding colony and roosts

Another typical feature of the rooks' behaviour is that some assemblages along the daily flight routs overlap some locations of breeding colonies. Thus, among the birds with morning departure from the Zoology roost (in August) some

of them assembled in the trees of breeding colony no. 4 (Hotel „Sport"/Stadium colony); along the western route, the birds concentrated in the area of the „Hațieganu" Sports Park, area that hosts, during the spring, the breeding colony no. 6; along their eastwards route, birds assemble in the trees of colony no. 7 („A. Iancu" Lyceum) and in the trees of colony no. 9 (Sports Base „Clujana"). The Central Cemetery has hosted a breeding colony in 1995. In December 2002 this was the location of an assemblage during the evening arrival of the birds, while in 2004 it turned into a roost during the second half of the winter season.

Departure from the roosts

Our observations concerning this element referred to: time interval when the roost departure took place, time of the roost departure related to the sunrise, the path followed by the birds during their departure, and the assemblages (location/constancy of their assemblages), and dispersal directions.

Along the flight routes, there are several assemblages. The closest site to the roost was called *preroosting site* (in the same time, it represents the *first* assemblage for the birds taking part to the morning departure from the roost).

The roost departure is illustrated in fig. 5

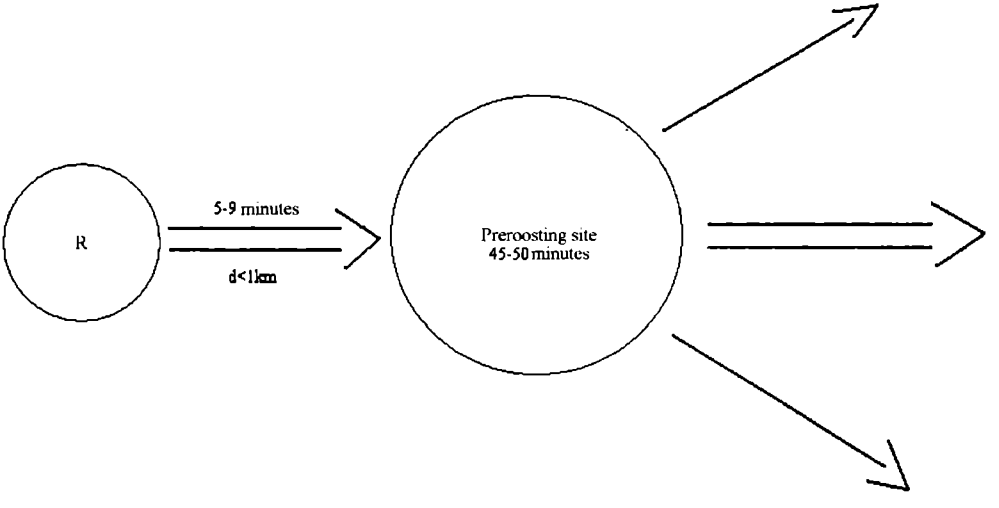

Fig.5. Scheme of the morning departure from the roost.

Below, several examples of the rooks' morning departure scheme are presented, in correlation with various meteorological conditions. The symbols used are: T1 – time interval for departing the roost; T2 – time interval between the departure from the roost and the sunrise:

Location	Date	Meteorological conditions	Time of departure from the roost	T1 (minutes)	T2 (minutes)
Central Cemetery	21.01.2005	-2°C, clouds	7:20	2	46
Central Cemetery	14.02.2005	-5°C, fog	6:56	3	40
Zoology	11.10.2006	5°C, fog	7:02	7	35
Zoology	13.10.2006	3°C, clear sky	7:05	3	35
Zoology	15.10. 2006	3°C, clear sky	7:08	2	35
Zoology	18.10.2006	-2°C, clear sky	7:06	10	41
Central Cemetery	02.12.2006	5°C, clouds	7:10	20	37
Central Cemetery	03.12.2006	-6°C, fog	7:10	**40**	37
Central Cemetery	12.12.2006	-1°C, fog	7:13	14	47
Central Cemetery	17.12.2006	-4°C, fog	7:25	23	40
Central Cemetery	13.01.2007	1°C, fog	7:24	10	41
Central Cemetery	20.01.2007	4°C, clear sky	7:19	8	44
Central Cemetery	24.01.2007	7°C, clouds	7:30	7	29
Central Cemetery	29.01.2007	1°C, clear sky	7:14	3	40
Central Cemetery	04.02.2007	-2°C, clouds	7:05	5	41
Central Cemetery	10.02.2007	0°C, clear sky	6:57	6	41
Central Cemetery	16.02.2007	2°C, clouds	6:51	5	40
Central Cemetery	07.03.2007	2°C, fog	6:10	5	48

In 12 of the 18 presented cases, the departure from the roost took place in less than 10 minutes; in two cases, the departure lasted 10 minutes; in four mornings, the departure lasted between 14 - 40 minutes.

The distance between the roost and the first assemblage varies, but it is less than 1 km: 250 m from the Hațieganu Park, between 550 and 600 m from the Zoology roost and between 500 m or even 300 m and 900 m from the Central Cemetery roost. In the latter case, a re-grouping of the rooks within the roost was recorded because, as it was mentioned previously, the birds fly from this site in several successive groups. The delayed birds do not stop in the first assemblage; instead they join the rooks that had already left the assemblage (figs. 5, 6). The location of the first assemblage differs according to the location of the roost within the city limits. However, in some cases we have noticed changes concerning the

location of the first assemblage that are not related to potential relocations of the basic roost. Thus, preroosting sites related to the „Zoology" roost have been noticed in three sites inside the town: L. Blaga Square – P. Maior Street (on the roofs of the buildings in the area), „Sport" Hotel – in the surrounding trees and on the top of the building, in the area of colony no. 4 („Sport" Hotel/Stadium), and Unirii Square (on the top of the buildings).

Influence of meteorological factors. The main environmental factor that often influences the timing of the rooks' morning departure is nebulosity *i.e.* its direct effect – luminosity. We did not have the means for a quantitative measurement of this factor, thus we give only some direct observation.

Two completely opposite situations could be noticed: during consecutive days, one with clear sky, the other one cloudy (and sometimes rainy), the departure times could be very close to each other (sometimes with only a few minutes difference); in other cases, departures were separated even by one hour. A few examples are presented below:

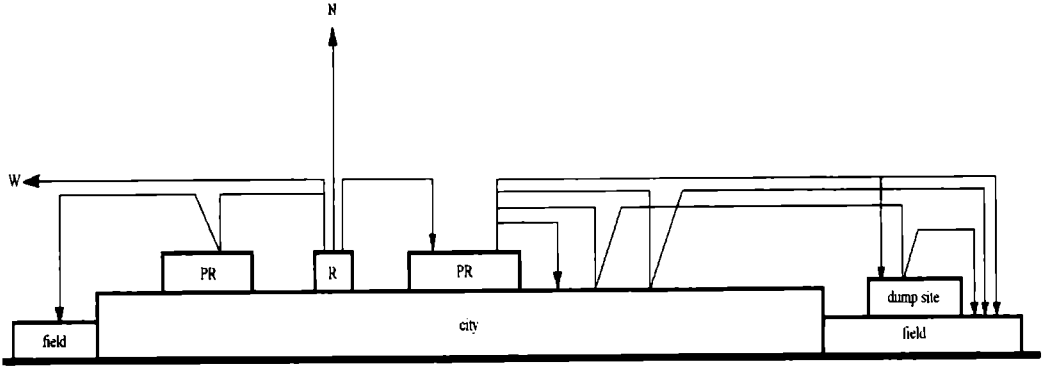

Fig.6. The chart of the morning dispersal

a/ Minor differences under conditions of various luminosity:
13.01.2007, fog – departure 7:24
20.01.2007, clear sky – departure 7:19
24.01.2007, cloudy – departure 7:30
04.02.2007, cloudy – departure 7:05
10.02.2007, clear sky – departure 6:57
16.02.2007, cloudy – departure 6:51

According to the registered data, we could remark that during warmer mornings, rooks left their roosts at relative later times.

b/ Significant differences under conditions of various luminosity:

06.11.2007, clear sky – departure about 6:35

12.11.2007, cloudy, rain – departure 7:45

11.02.2008, clear sky – rooks already departed before 7:11

18.02.2008, cloudy – departure 6.45 (still dark)

21.02.2008, fog – departure 7:42

The studies of Hubálek (1978) proved that cloudiness and fog (thus reduced luminosity) delayed the departure (in average with 13 minutes) of the rooks' morning passage in an observation site located about 21 km from the roost. In our opinion, such a relatively constant delay may be caused not only by the delay of the departure from the roost, but also by delays (*i.e.* stops) along the route. The duration of the stop in the first assemblage and the successive departures of the birds from this site may cause the subsequent "delays".

We argue that rooks show aleatory modifications of their behaviour, which contradict with the apparently fixed behavioural patterns. These modifications are not necessarily related to specific environmental factors.

The duration of the stops (Tst) in the first assemblage (fig. 5) is in average 49 minutes, with a minimum of 40 minutes and a maximum of 65 minutes.

Morning dispersal

The morning dispersal was observed during several successive winters, by using the following parameters: influence of meteorological factors on the timing of the passage through the observation site; duration of the morning passage; the succession of the birds' fronts; numerical estimation for 5 minutes intervals.

Duration of passage. Between October 2002 and February 2003, the passage observed in the eastern side of Cluj lasted in average 58 minutes, with a minimum of 40 min. on 25.12.2002, at t°= - 20° C and a maximum of 75 min. on 20.02.2003 under snow, at t°= - 3° C. In spite of these observations, we cannot state that temperature represents a determining factor, because close valued were recorded at different temperatures:

- 45 min. on 3.12.2002, at t°=5° C and on 7.12.2002 at t°=0° C;
- 47 min on 10.12.2002 at t°= - 13° C and on 21.12.2002 at t°= -11° C.

By observing the morning passage between 5.11.–7.12.2002, we could notice that, in average, rooks pass by the observation site 24 minutes after the civil twilight and 11 minutes before the sunrise. On 5.11.2002, under sleet, the passage took place 2 minutes after the sunrise (*i.e.* with a delay) and 34 minutes after the

civil twilight; these observations confirm that some environmental factors (precipitations, cloudiness) can influence the activity of rooks.

During October 2004 – January 2005 we have performed a numerical evaluation of birds during the morning passage, along 5-minute intervals, for 15 mornings (figs. 7, 8).

The order of passage of the birds' fronts was a constant parameter in each morning. The first front noticed in the observation site was the group crossing the industrial area of the town, followed by the group crossing over the "Între Lacuri" area; the last front consists of the birds following the southern side of the wide passage route (fig. 9). The limits between these fronts are not fixed, daily left or right variations from the flight route, or solitary birds or small groups between the main fronts being observed.

A single front (the closest to the observation site) was also numerically/quantitatively estimated. We could notice that the massive passage (the largest number of individuals) took place in general in the first 25 minutes, with no correlation with the total duration of the dispersal; this was followed by more scattered groups, less and less abundant as number of birds was concerned.

We have also monitored **the changes of the flight routes** and their factors:

i) in principal, determined by changes of the location of the roosts, while the breeding sites were constant;

ii) due to aleatory changes of the birds' behaviour proving the capacity of rooks to disobey fixed patterns.

The diurnal passages of rooks over the town register maximum values during the cold season, being constant from October (or even mid-September) until March. In this interval, rooks flight over the eastern side of the town in large (hundreds or thousands of individuals), more compact or dispersed flocks, which are interrupted by smaller groups. As a rule, rook flocks include jackdaws *Corvus monedula*; we have visually evaluated their ratio as 20-30 %. The morning passage takes place from the town area towards its neighbouring areas, and it continues outside the city limits.

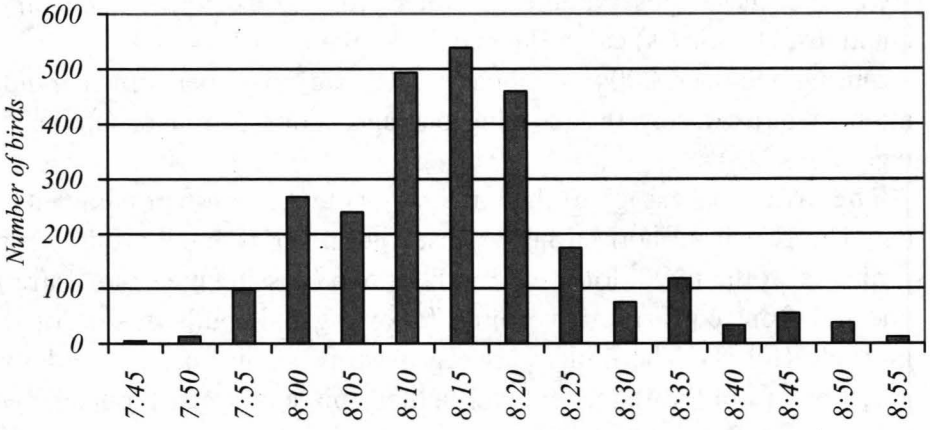

Fig.7 The variation of birds' number during morning dispersal, 22.10.2004

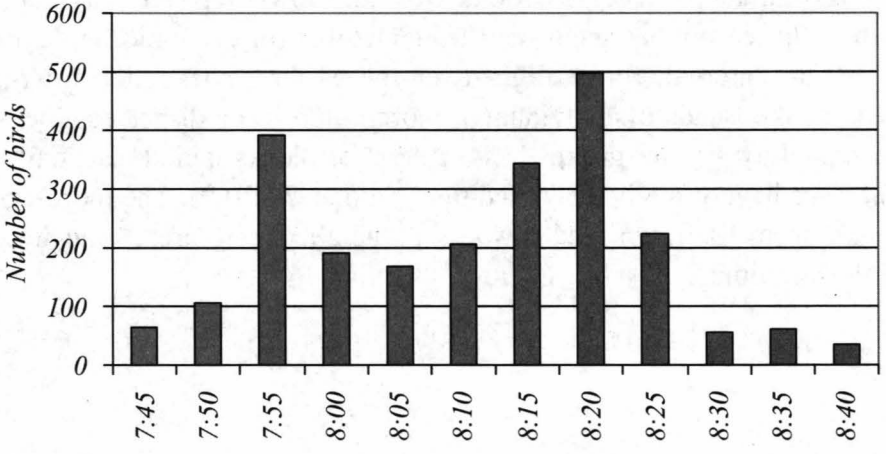

Fig.8 The variation of birds' number during morning dispersal, 25.11.2004

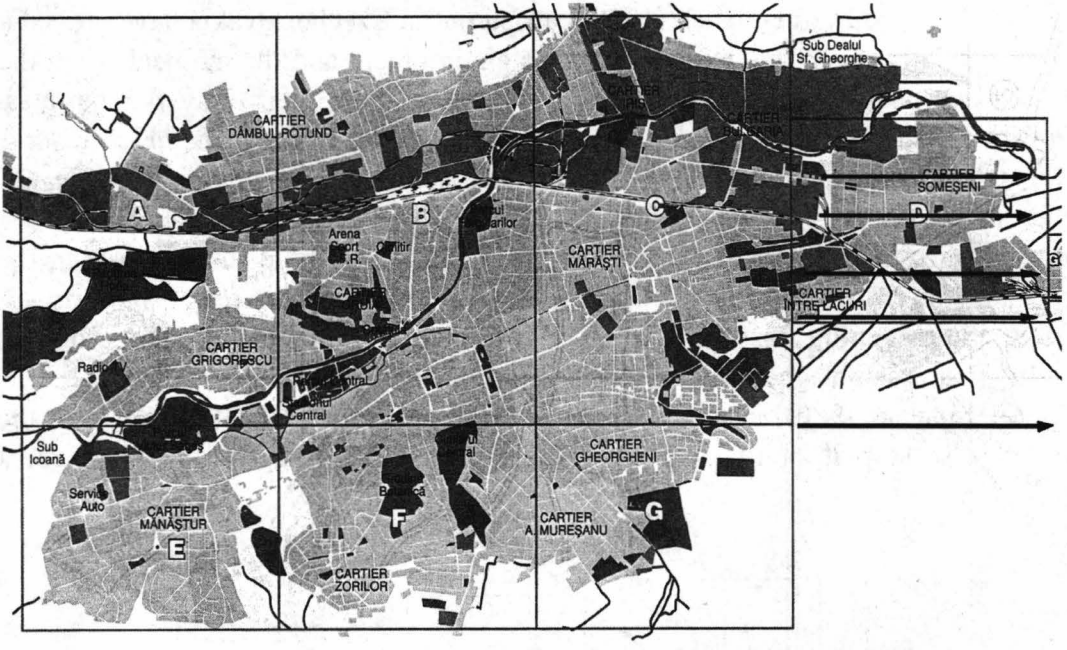

Fig.9. Morning dispersal of the rooks on the eastern edge of Cluj-Napoca

During October 2002 – March 2003 we performed some observations on the morning passage in the eastern part of the city by registering the **light intensity** in each case. The results of the 35 data sets are presented in Table 2

Table 2

Light intensity during the morning passage (measured while rooks were crossing the eastern edge of Cluj-Napoca)

Light intensity (relative values /photographic exponometer)	No. of records	Relative frequency (%)
<1	4	11.43
1	9	25.71
2	18	51.43
3	.4	11.43

The studies of Hubálek (1978) carried out in Czechoslovakia have proven a relationship between the luminosity of the environment and the moment when the birds have passed by the observation site located along their daily flight routes. However, our observations have shown that *their departure from the urban area is not strictly correlated with this factor (even if some influence cannot be denied)*, the only possible explanation being the fact that the durations of the stops in the assemblages along the route, including the flight along the distance between the roost and the outskirts of the town *follow aleatory daily, or even longer patterns.*

The evening passage (fig. 10) involves several moments: rooks' grouping in the first assemblage/initial assemblage (according to the terminology of Gerber, 1956; Hubálek, 1980), in our case the waste dump from "Pata Rât"; flight to the basic roost; stop at intermediary assemblages; preroosting aggregation (PR); roost (R) entry.

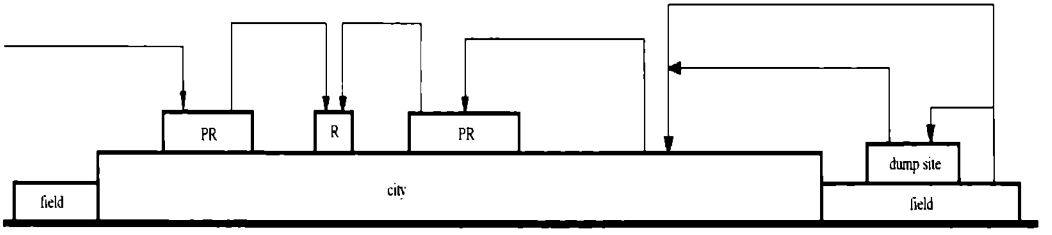

Fig. 10. General scheme of the evening flight along W-E axis.

During the evening passage, the birds take several successive stops within the city limits, in the so-called *intermediary assemblage/stop sites*, some of them being located in the same sites as during the morning passage.

The distance to the roost of the final assemblage is: 600 m (Avram Iancu Square- Central Cemetery roost); 600 m (L. Blaga Square – Zoology roost); 700 m (Botanical Garden –Zoology); 550 m (Municipal Park - Zoology).

Between 2001 – 2005, *the recorded duration of the stop* in the preroost (before the roost entry) was 40 minutes, with a maxim of 68 minutes and a minim of 30 minutes.

The *departure from the preroost* (monitored in the case of the Central Cemetery preroost) was following a linear pattern. The first to leave are the birds located in the distal area (related to the location of the roost), successively followed by the others; the last ones to leave are the birds located in the proximal area of the

preroost. The ascent of the rooks from the preroost is a relatively short process – of about 2-3 minutes, the flight towards the roost taking place in compact flocks, of thousands of birds.

The roost entry is a mass procedure consisting of small altitude circular flights over the trees; it takes not more than 10-12 minutes.

The duration of the evening flight. In the period October 2002 – February 2003, 37 observations have been achieved on the evening passage consisting of the duration of the passage over a fixed point located in the eastern side of the town, the light intensity during the passing of the first birds, the aggregation of the rooks during the flight. The results show that the average duration of the evening passage was 52 minutes (maximum - 90 min., minimum - 35 min.). Our data did not show any direct correlation between temperature and the duration of the evening passage (for example: passages of 45 minutes took place at various temperatures, both above and below 0 ° C). Smaller durations for the evening passage (25–35 minutes) were registered at the end of February - beginning of March, when the number of rooks crossing the town was smaller, some of them being already dispersed towards the breeding colonies.

Light intensity has been recorded (by using a photographic exponometer) during the passage of the first birds by the observation site in the eastern edge of the town. We could notice that flights under favourable luminosity conditions (value 7 on the photographic exponometer) were dominant (48.65 % of the total recordings) (Table 3).

Table 3

Light intensity during the evening passage
(Someşeni area, 37 records)

Light intensity (relative values /photographic exponometer)	No. of records	Relative frequency (%)
8	5	13.51
7	18	48.65
6	6	16.21
5	6	16.21
4	1	2.70
2	1	2.70

The entry within the city limits, the stops at assemblages, the duration of the stops are related to a continuous decrease of light intensity, while the roost entry takes place at dusk, under poor visibility conditions, after sunset.

Below we present a few data on this stage of the diurnal cycle of rooks.

15.09.2003 - „Zoology" roost – entry time: 20:03 / 35 minutes after the sunset / 6 minutes before the civil twilight;

18.09.2003 - „Zoology" roost – entry time: 20:10 / 38 minutes after the sunset / 7 minutes after the civil twilight;

16.01.2005 - Central Cemetery roost – entry time: 17:45 / 40 minutes after the sunset / 6 minutes after the civil twilight.

Conclusions

- Summer (post breeding) and winter roosts have been identified on the territory of Cluj-Napoca municipality.

- Post-breeding roosts were established on the area of breeding colony no. 1 (Zoology/TB Hospital) and in the area of Someşeni (military base) colony;

- During the winter season, the „Zoology" site is used as regular (basic) roost, being inhabited each year in the period of our study (2001-2007); the roosts from the Sports Park („Haţieganu") and from the Municipal Park have been considered by us as successive/temporary roosts, being used only for shorter time intervals (for a month, in 2002);

- The winter roost is established gradually, starting with August when the rooks depart from the Someşeni roost;

- Along the flight routes there are several assemblages, some being stable (regularly used for successive years), others unstable (their location being changed from one year to the other, or even during the same season);

- Some assemblages are located in the areas where breeding colonies are established during the spring (for example „Sport" Hotel, „Clujana" pool, „Avram Iancu" Lyceum);

- The roost departure is a short process (2-10 minutes) that is followed by a stop in the first assemblage; the stop lasts about 50 minutes; then most of the rooks that used the roosts inside the town scatter along various routes and flight towards the town periphery (respectively outside the city limits).

- The roost departure takes place, in average, 35 minutes before the sunrise, while the roost entry happens in general 35-40 minutes after the sunset.

- The duration of the morning dispersal and of the evening passage (recorded in the eastern part of the town) is largely variable, having values between 45-115 minutes.

- The duration of the also has wide variation ranges; in the eastern part of the town it lasts between 35- 90 minutes, with an average value of 52 minutes.

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Rezumat. A fost urmărit comportamentul ciorii de semănătură (*Corvus frugilegus* L.) în timpul iernii. În sezonul rece ciorile se adună în număr foarte mare, de ordinul miilor, înnoptând, în aşa-numitele "dormitoare". Astfel, în municipiul Cluj-Napoca au fost identificate mai multe tipuri de dormitoare: de vară şi de iarnă, acestea din urmă reprezentând obiectul studiului. S-a constatat că dormitoarele de iarnă, la rândul lor pot fi de mai multe tipuri, respectiv: dormitor de bază, dormitor succesiv (temporar). În Cluj-Napoca dormitorul de bază se formează pe locul celei mai mari colonii de cuibărit (din perimetrul construit al oraşului), colonia 1 (Zoologie/TBC). Unele locuri de popas de pe traseul zborurilor zilnice efectuate de ciori au aceeaşi localizare ca şi colonii de cuibărit. Ciorile efectuează zboruri zilnice între dormitor şi teritoriile de hrănire, aflate în afara oraşului. În general, păsările urmează anumite rute de zbor, fiind observate însă şi modificări de la aceste tipare zilnice, unele dintre ele neavând o cauzalitate evidentă. Alte modificări sunt determinate de schimbarea locaţiei dormitorului de bază. Momentul plecării din dormitor este determinat de luminozitate şi de condiţiile meteorologice. După părăsirea dormitorului ciorile fac un prim popas în apropiere (pe clădiri înalte sau copaci), după care se dispersează peste oraş şi în continuare în afara lui. Pasajul de seară se desfăşoară pe rute asemănătoare cu cele ale dispersiei de dimineaţă.

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