STUDIES ON THE DYNAMICS OF THE MACROZOOBENTHIC INVERTEBRATE GROUPS IN THE THERMAL LAKE OCHIUL MARE NATURAL RESERVE (BIHOR COUNTY, ROMANIA)

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Abstract. In the thermal lake from Ochiul Mare the environmental conditions and especially the temperature of the water which do not drop under 20^{0}C in the substrate even in winter period determine a different dynamics of the macrozoobenthic populations than in other natural waters. Also the major groups in the communities differ from those of the non thermal waters. For these reasons we have studied the dynamics of the macroinvertebrate groups from the benthos to find out if they adapted their life cycles to the thermal environment. Also we wanted to find out which are the groups which have the greatest densities in the thermal environment and for which this environment is a limitating factor of the development.

INTRODUCTION

The macro invertebrate's fauna from the Ochiul Mare thermal lake has a different structure from that founded in non-thermal waters. This fact is due to the characteristics of this water especially the thermic regime. The higher temperature determines lower oxygen content in the water especially near the bottom. Here often it is an oxygen deficiency. In the lake the submerged vegetation is very well developed especially between April and October. The decays of the vegetation are decomposed by bacteria and this activity intensifies the oxygen deficiency and determines the liberation of some toxic gases as CH_4 and H_2S. So in the benthic habitat a series of environmental factors become restrictive and modify the species composition of the macrozoobenthic invertebrate community.

More than that the human activities create disturbances in the functioning of the community by the clearing the submerged vegetation manually in the march-may period of each year. This activity causes the extraction from the lake of a great quantity of phytophylous fauna and also determines the disturbance of the benthic substratum by the persons who enter in the water to collect the vegetation. These human actions desist at the end of May when there are a lot of water-lily leaves on the water. The presence of the leaves on the water make impossible the submerged plants extraction without damaging the water-lilies.

During our researches we wanted to compare the structure and dynamics of the macrozoobenthic invertebrates from three different sample sites in the lake. Also we wanted to compare our results with the anterior studies (Cupsa et al. 2002) made in a period when the submerged vegetation wasn't cleared away.

MATHERIALS AND METHODS

The samples were collected from three sample sites which differ from the point of view of the substratum and the thermic regime of the water.

P_1 is the first sample site situated in an area of the lake situated relatively close to the main spring. The substratum is made up from sand, molluscs shell remains and mud. The aquatic vegetation is very abundant; the deep of the water is 50-60 cm. The temperature of the water doesn't suffer great variations at the substratum level during the year because this place is close to the main spring and because the currents bring water from the spring in this area.

P_2 is situated in an area of the lake characterised by a substratum covered by a thick layer of mud. Here in the summer period take place intense anaerobic decomposing processes. As a result when the substratum is disturbed H_2S gas bubbles are disengaged. The submerged vegetation is the most abundant in this place and the water currents are almost inexistent.

The distance from the main spring is greater than at the precedent sample site and as a consequence the temperature varies with greater amplitude at this sample site during the year.

P_3 is situated in an area with a substratum made up from sand and molluscs shell remains close to the entrance in the lake of the tributary Valea Glighii which is a non thermal stream. In this place the vegetation is not as abundant as in the first two places and the water is colder even in the warm period of the year. The water at this sample site has a higher oxygen content because of the better oxygenated water brought by the Valea Glighii stream.

The samples were collected from the three sites monthly between January and July 2004.

The samples were quantitative, collected with the benthometer. The samples were preserved in the field in 4% formalin solution. In the lab the samples were sorted under a 400X magnifying stereomicroscope and transferred in 80% alcohol. The representatives of the different invertebrate groups were identified under the stereomicroscope or microscope depending on their dimensions.

RESULTS AND DISCUSSIONS

From the three sample sites we identified 19 groups of invertebrates (Table nr. 1).from these only 6 groups (Turbelariata, Nematoda, Oligochaeta, Ephemeroptera larvae, Odonata larvae and Chironomida larvae) are exclusively benthic. The others can swim in the water or they usually live on the submerged plants or even they are zooplanktonic. A single group do not occur never in the benthic samples the Aphidina group. The aphidina live on the water-lily leaves but in this year they were so abundant that is was impossible to not catch them in the benthic samples. We did count them but we ignore their presence in the interpretations.

From the Table nr. 1 we can see that P_3 was the most abundant in species and P_1 the less abundant.

Table nr. 1. Macrozoobenthic invertebrate groups found at the three sample sites

	P_1	P_2	P_3
Turbelariata	+	-	-
Nematoda	-	-	+
Oligochaeta	+	+	+
Gastropoda	+	+	+
Acarina	-	-	+
Copepoda	+	+	+
Ostracoda	-	-	+
Gamarida	+	+	+
Colembola	+	+	+
Ephemeroptera (larvae)	+	+	+
Odonata (larvae)	+	+	+
Heteroptera (larvae)	-	+	+
Heteroptera (adults)	+	+	+
Aphidina	+	+	+
Coleoptera	-	+	+
Dytiscida (larvae)	+	+	+
Coleoptera*(larvae)	-	+	+
Diptera** (larvae)	+	+	+
Chironomida (larvae)	+	+	+
Total	**13**	**15**	**18**

* others than Dytiscida
** others than Chironomida

At $P_1$the most frequent groups were the Gasteropoda and Gamarida, which were present in every month, followed by the Copepoda, Chironomida larvae and Oligochaeta which frequencies were over 50%.(Table nr. 2, 3). The Copepoda which are usually found in the zooplankton can sometime descend to the subtstrate and they can be collected with the benthic samples accidentally from the zooplankton. The Gamarida also usually are found on the submerge vegetation. The Gastropoda are in the cold season months when the vegetation is scarce and the substratum is better oxygenated found in the benthos, consuming the periphyton from the rocks. From april when the submerge vegetation start to develop intensly, the Gastropoda start to migrate on the plants and in the substratum we will found less individuals. The Oligochaeta and Chironomida larvae can stand the oxygen deficiency and are found in the warm period of the year in the benthos.

The less frequent were the Turbelariata, Colembola, Ephemeroptera larvae, Diptera larvae and Ditiscidae larvae (Table nr. 3). The Colembola are notbenthonic species they occur in the samples during the collecting procedure. The Turbelariata and Ephemeroptera larvae are oxiphylous and rheophylous and that’s why their frequency is very low.

Table nr. 2. The density (N/m^2) of the zoobenthic macroinvertebrata groups from sample site P_1

	Turbe-lariata	Oligo-chaeta	Gast-ropoda	Cope-poda	Gama-rida	Colem-bola	Ephemeroptera larvae	Odona-ta larvae	Hetero-ptera	Aphidina	Dytiscida larvae	Diptera larvae*	Chiro-nomida larvae	**Total nr. of species**
Jan	0	0	1	0	216	0	0	0	0	0	0	0	0	2
Feb	0	0	15	2	95	0	0	0	0	0	0	0	0	3
March	0	0	25	8	400	0	0	0	1	0	0	0	1	5
Apr	1	3	18	72	612	0	0	0	1	0	0	0	33	7
May	0	4	4	113	96	3	0	0	0	3	8	0	2	8
June	0	12	1	18	36	0	0	2	0	76	0	0	3	7
July	0	4	23	35	19	0	9	1	1	18	0	2 (si-mulide)	9	10

* others than Chironomida

Table nr. 3. The percentages (%) of the zoobenthic macroinvertebrata groups from sample site P_1

	Turbe-lariata	Oligo-chaeta	Gast-ropoda	Cope-poda	Gama-rida	Colem-bola	Epheme-roptera larvae	Odona-ta larvae	Hetero-ptera	Aphidina	Larve de Ditiscide	Diptera larvae*	Chiro-nomida larvae
Jan	0	0	0,5	0	**99,5**	0	0	0	0	0	0	0	0
Feb	0	0	13,4	1,8	**84,8**	0	0	0	0	0	0	0	0
March	0	0	5,75	1,84	**91,95**	0	0	0	0,23	0	0	0	0,23
Apr	0,1	0,4	2,43	9,73	**82,70**	0	0	0	0,1	0	0	0	4,46
May	0	1,72	1,72	**48,5**	41,2	1,29	0	0	0	1,29	3,43	0	0.8
June	0	8,11	0.7	12,16	**24,32**	0	0	1,35	0	51,35	0	0	2,03
July	0	3,33	19,16	**29,16**	15,83	0	7,5	0,83	0,83	15	0	1,66 (simulide)	7,5
Freq.%	14,29	57,14	100	85,71	100	14,29	14,29	28,57	42,86	42,86	14,29	14,29	71,43

* others than Chironomida

The most high density is realized by the Gammaridae which can reach hundred of individuals per m^2, due to the fact that they are distributed also on the submerged vegetation not only on the substratum (Table nr. 2). They are followed by the Copepoda in the april-may period when the adults hatch in great number and by the Chironomida larvae in april.

In P_2 the most frequent groups were also the Gasteropoda and the Gammarida due to the abundance of the vegetation in this sample site (Table 5). They were followed by the Dytiscida larvae and the Copepoda. The lowest frequency have the Coleoptera larvae and the Heteroptera larvae which occurred only in one month of the year.

The highest density has the Gammarida as in P_1 , followed by the Gasteropoda, Copepoda and Chironomida larvae (Table nr. 4).

At the sample site P_3 only the Gammarida realise frequency of 100% followed by thew Gasteropoda, Chironomida larvae and Copepoda (Table nr 7). The number of groups with low frequency (14,28%- which occur only in one month) is high (Nematoda, Ostracoda, Heteroptera larvae, Coleoptera larvae, Diptera larvae). This is due to the fact that in this sample site the environmental conditions are less favourable to the development of the benthic community than in the other sample sites. Some of this unvavourable environmental factors are the lowest temperature of the water and the smaller quantity of aquatic vegetation.

The densities realised by the different groups are also smaller than in the other sample sites. The highest density has the Gammarida followed by the Copepoda and Gatseropoda (Table nr. 6).

The monthly dynamics

At the P_1 sample site we can observe an increase of the number of species from January (2 species) to july (10 species). The community founder groups (Gasteropoda, Copepoda, Chironomida larvae) (Fig. nr. 1) have a different dynamic evolution. The Gasteropoda has two density peaks in march and in July, the Copepoda has one peak ofdensity in may when the most adult individuals hatch. Their density decrease progressively to July.the Gammarida has the maximum densities in January and April. The Chironomida larvae has the maximum density in april and after that they are found in the substratum but with a low density. This fact is due also to the fact that many individuals finish their aquatic life stage and emerge as terrestrial adults.

Between January and April the dominant group is the Gamarida. In June the most abundant are the Aphidina, but as I mentioned above we do not consider them because they never have a benthic behaviour, soin June the dominant group is also the Gammarida. In May and July the Copepoda are dominant.

At sample site P_2 we observed also an increase of the number of species from January to July. The number of species from the first two sample sites are comparable, greater in P_2 (Table nr. 2, 4). The dominant species are the Gasteropoda, Copepoda, Gamarida and Dytiscida larvae (Fig. nr. 2).

The Gasteropoda and Copepoda have a maximum density in april and the Gamarida has two maximum density periods in april and june. The Dytiscida larvae do not have high densities although their high frequency. This fact is due to their trophic position. They are predators and as a group situated almost on the top of the feeding pyramid their number is lower than that of the other groups.

The Chironomida larvae has the highest density in april as at the sample site P_1.

The dominant groups are the Gasteropoda in January, March, the Gammarida in February, April, June and July and the Chironomida larvae in May.

At the P_3 sample site we can observe an increase of the number of species in march after that there is a decrease and another peak in July. The number of species is comparable with the first two sample sites. The most frequent groups are the Gammarida, Gasteropoda, Copepoda and Chironomida larvae.

The Gasteropoda has two peaks in February and april, the Copepoda in June, the Gammarida in March and July and the Chironomida larvae in may.(Fig nr. 3). The Copepoda reach a maximum number of individuals in may, comparatively to the maximum in april at the first two saple sites. This is probably due to the fact that the temperature of the water is lower and the adults hatch later. Also the maximum number of the Chironomida larvae is reached in May because of the delay in the life cycle caused by the low temperature (Fig. nr. 3).

In January there are found two groups – Gammarida and Chironomida larvae - with the same abundance 50%. In the other February and March the Gamarida are dominant, in April and July the Gasteropoda, in May and June the Copepoda.

The monthly biologic diversity on each sample site increases from January to July and is the lowest in P_1 and the highest in P_3.(Table nr. 8).

Comparatively to the results of the study from 1999 we can observe that in the former study were found only 12 groups, they are lacking the Nematoda, Ostracoda, Aphidina (Table nr. 9).

In april, may and October the oligochaeta are dominant, in June the Gammarida, in July the Copepoda. So we can say that the anthropic activity of clearying away the submerged vegetation affected the benthic community and determined their reorganisation.

Table nr. 4 . The density (N/m^2) of the zoobenthic macroinvertebrata groups from sample site P_2

	Oligo-chaeta	Gast-ropoda	Cope-poda	Gama-rida	Colem-bola	Epheme-roptera larvae	Odona-ta larvae	Hetero-ptera larvae	Hetero-ptera	Aphidina	Coleo-ptera	Dytisci-da larvae	Coleo-ptera larvae *	Dipte-ra larvae **	Chiro-nomida larvae	**Toral nr of species**
Jan	0	11	0	9	0	0	0	0	0	0	0	1	0	0	0	3
Feb	0	4	0	26	0	0	0	0	0	0	0	0	0	1	0	3
March	2	5	0	1	0	0	0	0	0	0	0	0	0	0	1	4
Apr	0	166	119	332	4	0	0	0	2	0	2	20	0	0	103	8
May	2	10	44	37	0	0	7	0	1	0	0	10	1	0	46	9
June	0	29	1	180	0	3	1	1	4	35	5	2	0	0	1	11
July	4	45	14	99	1	12	0	0	2	26	7	3	0	2	8	12

* others than Dytiscida
** others than Chironomida

Table nr. 5. The percentages (%) of the zoobenthic macroinvertebrata groups from sample site P_2

	Oligo-chaeta	Gast-ropoda	Cope-poda	Gama-rida	Colem-bola	Efphme-roptera larvae	Odona-ta larvae	Hetero-ptera larvae	Hetero-ptera	Aphidina	Coleo-ptera	Dytiscida larvae	Coleo-ptera larvae *	Diptera larvae **	Chiro-nomida larvae
Jan	0	**52,38**	0	42,86	0	0	0	0	0	0	0	4,76	0	0	0
Feb	0	12,9	0	**83,87**	0	0	0	0	0	0	0	0	0	3,23	0
March	22,22	**55,55**	0	11,11	0	0	0	0	0	0	0	0	0	0	11,11
Apr	0	22,19	15,9	**44,39**	0,53	0	0	0	0,27	0	0,27	2,67	0	0	13,77
May	1,26	6,33	27,85	23,42	0	0	4,43	0	0,63	0	0	6,33	0,63	0	**29,11**
June	0	11,07	0,38	**68,7**	0	1,15	0,38	0,38	1,53	13,36	1,9	0,76	0	0	0,38
July	1,79	20,18	6,28	**44,39**	0,45	5,38	0	0	0,9	11,66	3,14	1,35	0	0,9	3,59
Freq. %	42,86	100	57,14	100	28,57	28,57	28,57	14,29	42,86	28,57	42,86	71,43	14,29	28,57	71,43

* others than Dytiscida
** others than Chironomida

Table nr. 6. The density (N/m^2) of the zoobenthic macroinvertebrata groups from sample site P_3

	Nematoda	Oligochaeta	Gastropoda	Acarina	Copepoda	Ostracoda	Gamarida	Colembola	Ephemeroptera larvae	Odonata larvae	Heteroptera larvae	Heteroptera	Aphidina	Coleoptera	Dytiscida larvae	Coleoptera larvae *	Diptera larvae **	Chironomida larvae	**Total nr. of. species**
Jan	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	2
Feb	0	0	32	0	0	0	33	0	0	0	0	0	0	0	0	0	0	0	2
March	1	0	34	1	139	6	335	3	0	1	3	3	0	3	2	0	0	15	13
Apr	0	2	6	0	3	0	5	0	0	0	0	0	0	0	0	0	0	1	5
May	0	3	15	1	37	0	5	1	0	0	0	0	3	0	2	0	0	6	9
June	0	3	11	0	89	0	27	0	3	0	0	0	18	2	0	1	0	3	9
July	0	6	8	1	24	0	77	0	3	5	0	3	112	13	0	0	7	9	12

* others than Dytiscida
** others than Chironomida

Table nr. 7. The percentages (%) of the zoobenthic macroinvertebrata groups from sample site P_3

	Nematoda	Oligochaeta	Gastropoda	Acarina	Copepoda	Ostracoda	Gamarida	Colembola	Ephemeroptera larvae	Odonata larvae	Heteroptera larvae	Heteroptera	Aphidina	Coleoptera	Dytiscida larvae	Coleoptera larvae *	Diptera larvae **	Chironomida larvae
Jan	0	0	0	0	0	0	**50**	0	0	**50**	0	0	0	0	0	0	0	0
Feb	0	0	49,23	0	0	0	**50,77**	0	0	0	0	0	0	0	0	0	0	0
March	0,18	0	6,23	0,18	25,46	1,09	**61,35**	0,55	0	0,18	0,55	0,55	0	0,55	0,37	0	0	2,75
Apr	0	11,76	**35,29**	0	17,65	0	29,41	0	0	0	0	0	0	0	0	0	0	5,88
May	0	4,11	20,55	1.37	**50,68**	0	6,85	1,37	0	0	0	0	4,11	0	2,74	0	0	8,22
June	0	1,91	7,01	0	**56,69**	0	17,19	0	1,91	0	0	0	11,46	1,27	0	0,64	0	1,91
July	0	2,24	2,98	0,37	8,96	0	**28,73**	0	1,12	1,87	0	1,12	41,79	4,85	0	0	2,61	3,36
Freq%	14,28	57,14	85,71	42,86	71,43	14,28	100	28,57	28,57	42,86	14,28	28,57	42,86	42,86	28,57	14,28	14,28	71,43

* others than Dytiscida
** others than Chironomida

Table nr. 8 The monthly biological diversity (Shannon index) for each sample sites

	P_1	P_2	P_3
Jan.	0,03	0,85	0,69
Feb.	0,48	0,52	0,69
March	0,34	1,15	1,13
April	0,65	1,42	1,46
May	1,12	1,66	1,53
June	1,08	1,08	1,39
July	1,89	1,73	1,68

Table nr. 9 Comparative aspects of the perecntages of the macrozoobenthic invertebrate groups from the thermal lake in the two studied periods

	1999					2004						
	April	May	June	July	October	Jan	Feb	March	April	May	June	July
Turbelariata	2,35	-	0,51	-	-	-	-	-	0,1	-	-	-
Oligochaeta	51,05	32,09	4,59	7,89	50,45	-	-	-	0,40	1,72	8,11	3,33
Gastropoda	0,42	0,31	0,51	0,65	0,90	0,5	13,4	5,75	2,43	1,72	0,7	19,16
Acarina	-	0,31	0,51	-	-	-	-	-	-	-	-	-
Copepoda	1,68	12,34	23,46	59,53	6,30	-	1,8	1,84	9,73	48,50	12,16	29,16
Gamarida	24,08	14,04	65,81	6,90	23,42	99,5	84,8	91,95	82,70	41,20	24,32	15,83
Colembola	-	0,31	-	-	0,90	-	-	-	-	1,29	-	-
Ephemeroptera larvae	-	-	1,02	-	-	-	-	-	-	-	-	7,50
Odonata larvae	0,42	-	0,51	2,96	10,81	-	-	-	-	-	1,35	0,83
Heteroptera	0,84	18,15	1,02	-	-	-	-	0,23	0,1	-	-	0,83
Aphidina	-	-	-	-	-	-	-	-	-	1,29	51,35	15,00
Coleoptera	-	-	-	-	-	-	-	-	-	-	-	-
Dytiscida larvae	-	-	-	-	-	-	-	-	-	3,43	-	-
Diptera larvae*	0,42	0,31	-	-	-	-	-	-	-	-	-	1,66
Chironomida larvae	18,56	22,15	2,06	22,07	7,22	-	-	0,23	4,46	0,80	2,03	7,50

*others than Chironomida

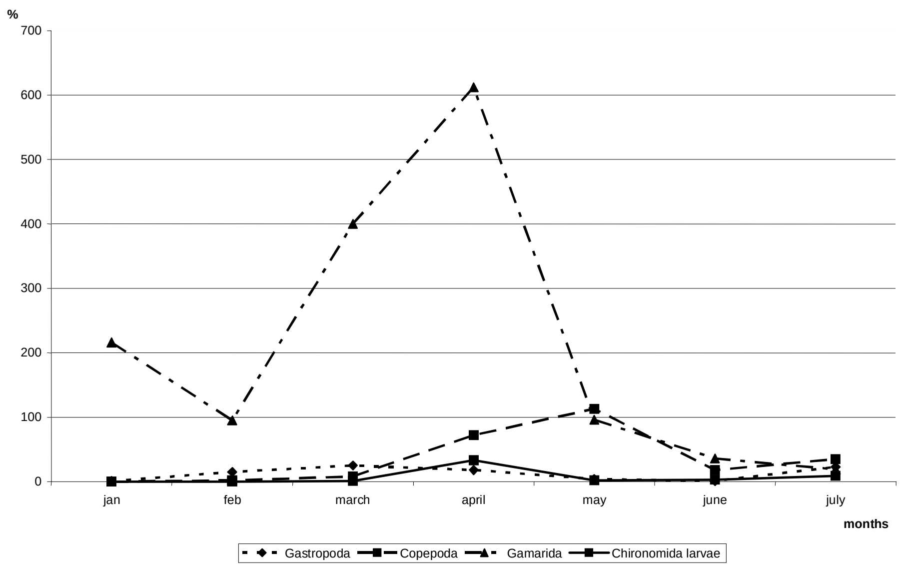

Fig. nr. 1. Monthly dynamics of the major macrozoobenthic invertebrate groups from P_1

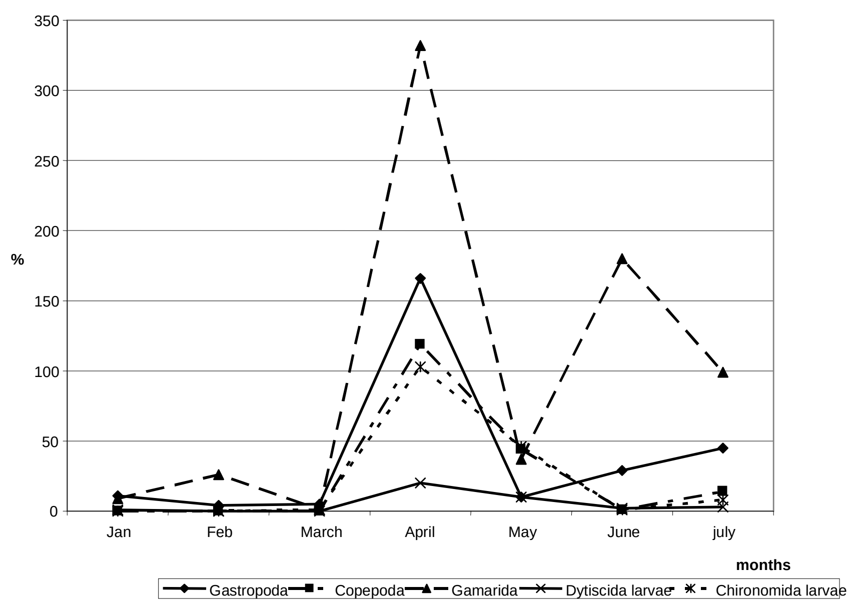

Fig. nr. 2. Monthly dynamics of the major macrozoobenthic invertebrate groups from P_2

Higher frequecy in the former study had the following groups Turbelariata, Oligochaeta, Copepoda, Colembola, Odonata, Diptera larvae, Chironomida larvae, Heteroptera larvae. The Gasteropoda and Gamarida have the same frequency in the two study periods.

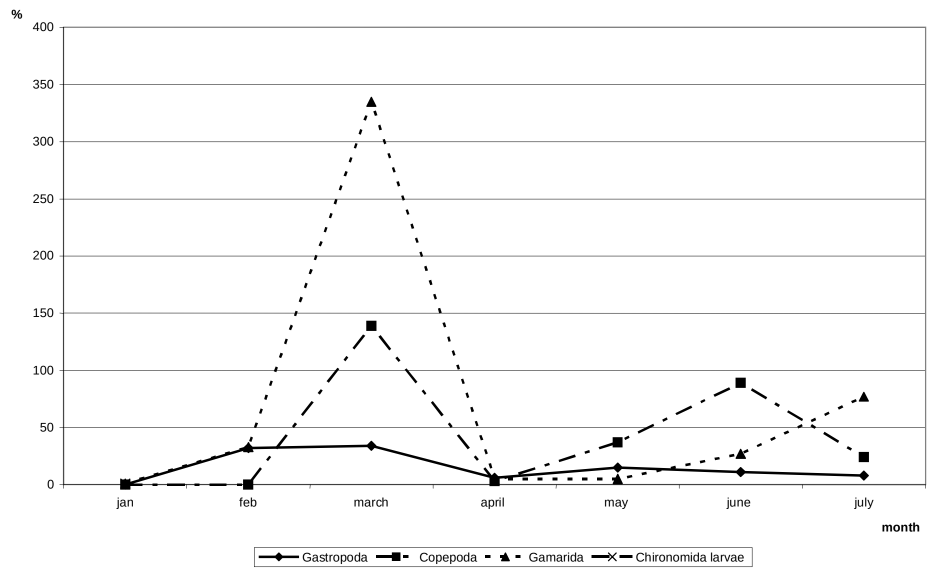

Fig. nr. 3. Monthly dynamics of the major macrozoobenthic invertebrate groups from P_3

CONCLUSIONS

In the three sample sites we found 19 groups of benthic invertebrates, the greatest number of groups (18) were in P_3 and the smallest number of groups (13) in P_1.

From these 12 groups (Oligochaeta, Gastropoda, Copepoda, Gamarida, Colembola, Ephemeroptera larvae, Odonata larvae, Heteroptera, Dytiscida larvae, Diptera larvae, Chironomida larvae) were found in all three sample sites. This fact shows a great uniformity of the fauna in the lake due also to the small surface and the resemblance of the habitats.

The greater number of groups in one month was 13 and the smaller 2.

In all sample sites the most frequent groups were the Gastropoda, Copepoda (except P_2), Gamarida, Chironomida larvae. The most abundant groups were the Copepoda (P_1, P_3), Gastropoda, Gamarida (P_2, P_3), Chironomida larvae (P_2).

So the community founding groups are the Gastropoda, Copepoda, Gamarida, and Chironomida larvae.

The more exacting species vis a vis the environmental factors are the Turbelariata, found only in P_1.Here the water currents bring oxygen in the substratum and the substratum is tough and favourize the Turbelariata development. The Nematoda, Acarina and Ostracoda are found only in P_3 here the water is colder and has a higher oxygen content and favourise these groups development.

The low density of the exclusively benthic groups (Turbelariata, Nematoda, Oligochaeta, Ephemeroptera larvae, Odonata larvae and Chironomida larvae) shows that in the lake the environmental conditions are not optimal for the development of the benthos. The major limiting factor is the low oxygen content near the substratum.

In compensation are more developed the groups which can migrate in the depth of the water and on the submerge vegetation to reach the water depths where the oxygen content is optimal for their living.

The biological diversity is high especially in the summer months in each sample site and it is the greatest in P_3.

The human activities from the lake affected the benthic community as it shows the comparison with the results from the research did in 1999, when the benthic groups were better represented.

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