

THE CHARACTERISTICS OF THE BIOCENOSES IN THE THREE LAKES FROM THE NEPTUNE – JUPITER RESORTS (CONSTANTZA COUNTY)

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INTRODUCTION

In the chain of natural lakes on the Romanian seashore of the Black Sea three new man-made lakes appeared in 1970, situated in the area between the Neptune – Jupiter resorts and the sand belt of the litoral. They were created by dredging the old swamp near the Comorova forest. The swamp covered an area of 44 acres and it used to stretch on a length of 1700 m and a width of approx. 380 m. After it was dredged, three lakes were created, two in the Neptune resort (called Neptune and Jupiter or Neptune 1 and Neptune 2) and one the Jupiter resort (called Tismana or Neptune 3) (Breier A., 1976, Gastescu, 1971) (Fig.1).

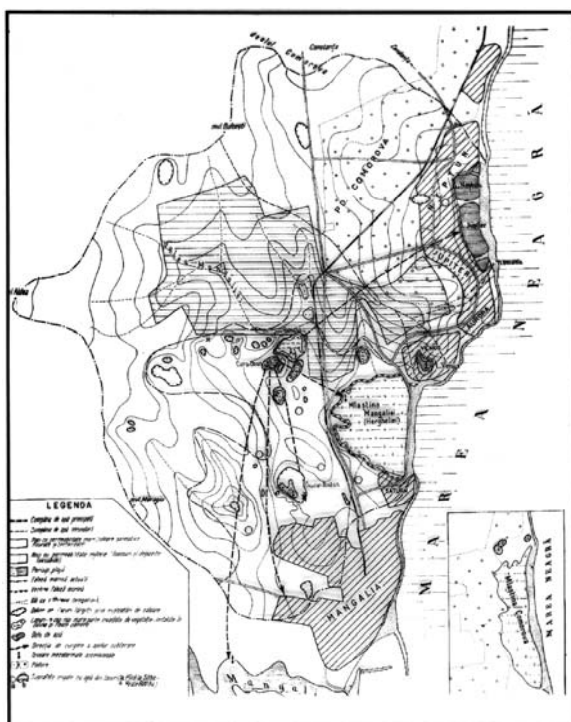


Fig. 1. Map of the North Mangalia Region

All the three lakes were made with concrete borders and, in order to prevent the swamp vegetation from growing again (especially reed and club rush), along these borders the bottom of the basins is covered with limestone rocks. The depth of the lakes is small, about 2.5 - 3.0 m. As a result, under the influence of the weather, especially of the winds, the mass of the water is uniform from the

thermic and chemical points of view. Their waters are well oxygenated and the sunlight reaches the bottom of the basins. The level of the lakes is at a +1.15 quota as against the sea level, thus preventing the infiltration of seawater; as a result the lakes have fresh water.

The lakes are separated one from the other by filling material on which, at present, there are asphalted alleys providing the access of the tourists from the resort to the beach situated on the sandy litoral belt (Fig. 1).

- Lakes Neptune is the northernmost lake. It is almost like a square with the sides of approx. 400 m and it has an area of 15.6 acres.
- The Jupiter lake is the middle one; it is rectangular in shape, it is 300 m wide and it covers an area of 15.6 acres.
- The Tismana lake is the southernmost lake, it has a triangular shape and it covers an area of 18.2 acres.

From the hidrological point of view, the three lakes are very different:

- The Neptune lake is supplied by a series of freshwater springs, without sulphur, coming from the Comorova forest, as well as by 8 pipes bringing „conventionally clean” rainwater from the Neptune tourist resort. The excess of waters in the lake can flow into the sea through a pipe. From its creation and up to the present, it was emptied several times in winter (e.g. the winter of 2003-2004).
- Lake Jupiter receives most of its waters from a series of sulphuric mesothermal springs (with temperatures of 22 – 24 °C) which come from the hills in the west of the resort (Feru a.o., 1991). As a result of the more elevated temperatures during winter, the water seldom freezes and the macrophytic vegetation in this lake can vegetate for a longer time, sometimes it can even survive the winter. The lake has low mineralization and has H₂S in concentrations up to 16mg/l near the mouth of the springs (but this gas is rapidly emitted from the water into the atmosphere and it does not hinder the normal progress of the biological processes in the lake). The water excess flows into the Neptune lake through a pipe.
- Lake Tismana is predominantly supplied with rain waters from the Jupiter resort and only to a

small extent with underwaters with a low sulphur content. Its water excess flows into the sea through a pipe.

MATERIAL AND METHOD

The three lakes were researched during the period 2003-2005 from the limnological point of view (i.e. based on physical and chemical tests as well as on biocenosis tests – phytoplankton, aquatic macrophytes, zooplankton, phytophylous fauna, benthos and ichthyofauna). Samples were collected every season, from three stations on the Neptune and Jupiter lakes and only from 2 stations on the Tismana lake. The chemical tests were made in a fresh state within under 24 hours from the sampling, in one of the chemistry laboratories of the „Ovidius” University of Constantza and the biological samples, on a material fixed in 4% formaldehyde, at the Institute of Applied Ecology in Bucharest. The mathematical processing of the data was performed using the common ecological indices (Gomoiu M., Solka M., 2001).

RESULTS AND DISCUSSIONS

The chemistry of the waters. Only two series of physical and chemical tests were performed, both from the Neptune and Jupiter lakes. You can see in table 1 that the pH of the water in both lakes is always basic. The waters have a low durity (even lower in autumn), mild mineralization (670 – 724 mg/l), the predominant salts are the chlorids (213 – 254 mg/l), these values placing these lakes in the category of freshwater ones. H₂S from the water of the underground springs transforms rapidly into sulphurs, their highest values being recorded in autumn in the Jupiter lake, as expected. O₂ has high values, both as a result of the large contact surface between air and water, and as a result of the process of photosynthesis achieved by the phytoplankton and the aquatic macrophytes. The low organic load of the waters of the lake places them in the 1st category of quality. It should be specified that these lakes are at present the cleanest lakes on the Romanian coast of the Black Sea. All the metals that were tested (iron, copper and chromium) have values below the maximum admissible limits (Chirila a.o., 2002) .

Table 1. The water chemistry in the Neptune and Jupiter lakes

Parameters	November 2003				May 2004			
	Lake Neptun		Lake Jupiter		Lake Neptun		Lake Jupiter	
	Surface water	Interface water/sediments	Surface water	Interface water/sediments	Surface water	Interface water/sediments	Surface water	Interface water/sediments
pH	8.3	8.3	7.8	8.0	8.3	8.7	8.8	7.4
D _T german ⁰	3.82	4.03	4.12	3.96	4.61	4.73	4.53	5.10
D _C german ⁰	1.86	1.60	1.59	1.29	1.99	1.79	1.71	2.12
Cl ⁻ (mg/l)	224	254	213	250	237	242	229	241
Salinity (mg/l)	0.43	0.48	0.41	0.47	0.45	0.27	0.44	0.46
S ²⁻ (mg/l)	0.97	0.20	1.21	0.094	0	0	0	0
O ₂ (mg/l)	9.93	10.82	9.91	11.79	9.45	11.12	10.85	7.09
CCO _{Mn} (mg/l)	3.78	10.92	2.57	19.31	2.58	2.43	7.30	4.71
Fe II (µg/l)	0.09	0.34	0.94	1.49	-	-	-	-
Fe III (µg/l)	0.77	1.00	0.99	0.87	-	-	-	-
Cu ((µg/l)	0.41	0.80	0.51	0.86	-	-	-	-
Cr (µg/l)	0.36	0.21	0.36	0.29	-	-	-	-

The primary producers are represented by aquatic macrophytes and phytoplankton.

Only 4 species of macrophytes have been found: *Chara* sp. in Jupiter lake, *Myriophyllum spicatum* and *Potamogeton pusillus* in all the three lakes and *Potamogeton crispus* in the Neptune and Jupiter lakes. It should be noted that the highest abundance of macrophytes is found in the Jupiter lake and the lowest one in the Tismana lake.

The phytoplankton is represented by 96 taxons belonging to 6 phylums. The most numerous are the representatives of the phylum *Chlorophyta* (46 taxons), followed by those of the phylum *Heterocontophyta* (27 taxons). The very low number of *Cyanobacteria* (6 taxons) should be noted. The qualitative tests have revealed that the microflora of algae is very different from one lake to the other. Both in point of quantity and in point of quality the highest number of phytoplankton organisms is found in the Neptune lake and the lowest number is found in the Jupiter lake (where we consider that their

development is prevented by the large presence, throughout the year, of aquatic macrophytes which represent the competition for the nutrients of algae). The Tismana lake exhibits the lowest number of taxons, but these are represented by a large number of individuals (the characteristic case of small water basins). Regarding the phytoplankton in these lakes, it should also be noted that there has not been a „blooming” of algae in the summer. As expected, in winter the phytoplankton is dominated by diatoms.

The consumers form the following zoocenoses: zooplankton, phitophilous fauna, benthos, ichthyofauna and birds.

The zooplankton is present though 32 taxons, almost the same in all the lakes. The most numerous are the rotifers, followed by small cladocera and immature stages of copepods. This zooplankton is poor from the point of view of quantity (it has a relatively low plankton phytomass), but in the Jupiter lake it has strong competition for food from the

phytophilic fauna (especially in the vicinity of the bushes of aquatic macrophytes).

The phytophilous fauna is represented by 11 groups of organisms. The typical phytophilous ones are the young stages of *Ephemeroptera*, *Ostracoda*, the larvae of *Odonata*, various *Nematoda* and some

larvae of *Chironomidae*. The predominant forms are the ostracods, the oligochaetes and the larvae of *Chironomidae*, but their abundance and dominance differs from one lake to the other and from one support plant to the other (Table 2).

Table 2. The monthly abundance by taxonomic groups of the phytophilous fauna on the *Myriophyllum spicatum* and *Potamogeton pusillus* in the Neptune and Jupiter lakes

Myriophyllum spicatum

Month	March		June		July		August		September		October	
Lake	Neptun	Jupiter	Neptun	Jupiter	Neptun	Jupiter	Neptun	Jupiter	Neptun	Jupiter	Neptun	Jupiter
Hydrozoa	0	43.7	273	275.5	0	0	0	0	0	0	0	81.2
Oligochaeta	0	62.5	427.7	375.75	533.12	687.5	538	687.5	58.31	0	0	0
Cladocera	0	28075	546	609.55	0	0	0	0	716.38	525	0	231
Ostracoda	0	7125	523.25	450.9	499.8	437.5	500	450.5	216.58	500	0	0
Copepoda	0	15675	182	167	116.62	112.5	116	111.5	66.64	350	0	137.5
Ephemeroptera	0	0	9.1	0	16.66	12.5	10	0	16.66	0	0	0
Odonata	0	0	13.65	0	16.66	12.5	10	0	0	37.5	0	0
Protostigmata	0	0	4.55	0	0	0	10	0	0	25	0	6.25
Diptera	0	452.5	1328.6	1419.5	649.74	662.5	600	645.5	191.59	112.5	0	200
Total	0	52443.75	3307.85	3298.25	1832.6	1925	1784	1895	1266.16	1550	0	656

Potamogeton pusillus

Month	June		July		August		September	
Lake	Neptun	Jupiter	Neptun	Jupiter	Neptun	Jupiter	Neptun	Jupiter
Hydrozoa	617.5	623.6	133.32	111.1	120	111.1	16.66	0
Oligochaeta	406.25	390.12	33.33	44.44	40	33.3	41.65	62.5
Cladocera	508	515	77.77	55.55	70	44.44	158.27	162.5
Ostracoda	809.38	760.5	444.4	655.49	440	655.49	116.62	225
Copepoda	28.12	25.5	133.32	133.32	120	133.32	49.98	187.5
Ephemeroptera	0	0	0	0	0	0	0	0
Odonata	3.13	0	0	0	0	0	0	0
Protostigmata	0	0	0	0	0	0	0	12.5
Diptera	2950	3025	588.83	699.93	560	655.49	158.27	187.5
Total	5322.37	5339.72	1410.97	1699.83	1350	1633.14	541.45	837.5

The abundance (A), the dominance (D), the constant (C) and the index of ecological significance (Djuba index = W) vary from lake to lake and from one species of support plant to the other (Table 3). It should be noted that most groups of phytophilous organisms are found in the Jupiter lake. Odonate larvae have not been found on *Potamogeton pusillus* in the Jupiter lake. The ostracods are the most abundant on *Myriophyllum spicatum* in the Neptune lake, whereas in the Jupiter lake the chironomids larvae are dominant on the same plant. In the Neptune lake the oligochaetes, followed by the chironomids larvae are dominant on *Potamogeton pusillus*, and in the Jupiter lake only the chironomids larvae are dominant. The observation of the

abundance of the phytophilous fauna in the three lakes from June until September (when its cycle of vegetation ends and it begins to fall to the bottom of the lakes) reveals a clear tendency of decrease of the density of the phytophilous fauna.

The benthic fauna is represented by 8 groups of macroorganisms. In all the lakes, the nematodes represent the largest group in point of number, as their abundance is over 30%, but in point of gravimetry, the oligochaetes are dominant. The nematodes, the oligochaetes and the ostracods are the most representative benthonic organisms in all the lakes. A low biodiversity associated with an unequal distribution of the benthonic fauna can be noticed in all the three lakes (Table 4, 5, 6)

Table 3. Ecological indices on main groups of organisms from phytophilous fauna
A- Neptun lake, on *Myriophyllum spicatum*

Taxonomic group	Abundance (ind/10 g plant biomass)	Constance C%	Dominance D%	Djuba Index W%	
				Value	Semnification
Hydrozoa	273.00	25	3.33	3.3	recedent
Oligochaeta	157.13	100	19.01	19.01	eudominant
Cladocera	1262.38	50	15.41	7.7	dominant
Ostracoda	1739.63	100	21.22	21.22	eudominant
Copepoda	481.26	100	5.87	5.87	dominant
Ephemeroptera	52.42	100	0.64	0.64	recedent
Odonata	40.31	75	0.49	0.36	recedent
Protostigmata	14.55	50	0.17	0.08	subrecedent
Chironomida	2769.93	100	33.81	33.81	eudominant

B- Jupiter lake, on Myriophyllum spicatum

Taxonomic group	Abundance (ind/10 g plant biomass)	Constance C%	Dominance D%	Djuba Index W%	
				Value	Semnification
Hydrozoa	400.55	50	0.65	0.32	recedent
Oligochaeta	1813.25	66	2.98	1.96	subdominant
Cladocera	29440.55	66	48.44	31.97	eudominant
Ostracoda	8963.90	83	14.75	12.24	eudominant
Copepoda	16553.50	100	27.24	27.24	eudominant
Ephemeroptera	12.50	16	0.02	0.003	subrecedent
Odonata	50.00	33	0.08	0.02	subrecedent
Protostigmata	31.25	33	0.05	0.01	subrecedent
Chironomida	3502.50	100	5.76	5.76	dominant

C- Neptun lake, on Potamogeton pusillus

Taxonomic group	Abundance (ind/10 g plant biomass)	Constance C%	Dominance D%	Djuba Index W%	
				Value	Semnification
Hydrozoa	887.48	100	10.28	10.28	eudominant
Oligochaeta	521.23	100	6.04	6.04	dominant
Cladocera	814.04	100	9.43	9.43	dominant
Ostracoda	1810.40	100	20.99	20.99	eudominant
Copepoda	331.42	100	3.84	3.84	subdominant
Ephemeroptera	0	0	0	0	-
Odonata	3.13	0.03	0.03	0.007	subrecedent
Protostigmata	0	0	0	0	-
Chironomida	4257.10	49.35	49.35	49.35	eudominant

D- Jupiter lake, on Potamogeton pusillus

Taxonomic group	Abundance (ind/10 g plant biomass)	Constance C%	Dominance D%	Djuba Index W%	
				Value	Semnification
Hydrozoa	845.80	75	8.89	6.66	dominant
Oligochaeta	530.37	100	5.57	5.57	dominant
Cladocera	777.49	100	8.17	8.17	dominant
Ostracoda	2296.48	100	24.14	24.14	eudominant
Copepoda	479.64	100	5.04	5.04	subdominant
Ephemeroptera	0	0	0	0	-
Odonata	0	0	0	0	-
Protostigmata	12.5	25	0.13	0.03	subrecedent
Chironomida	4562.92	100	48.02	48.02	eudominant

Table 4. Abundance of benthic fauna in Neptun lake in 2004

Group of organisms	Abundance monthly average			
	May	July	September	November
Nematoda	420	571	335	152
Oligochaeta	418	356	136	60
Gasteropoda	35	46	29	0
Cladocera	72	0	43	17
Ostracoda	126	197	239	101
Copepoda	37	19	54	16
Chironomidae	494	0	0	0
Total	1601	1188	837	345

Table 5. Abundance of benthic fauna in Jupiter lake in 2004

Group of organisms	Abundance monthly average			
	May	July	September	November
Nematoda	688.33	1400.66	774.66	434.33
Oligochaeta	783.66	166.00	795.00	385.00
Gasteropoda	14.66	32.00	8.00	0
Cladocera	343.66	0	317.00	121.66
Ostracoda	312.00	410.33	321.66	159.00
Copepoda	143.66	119.66	609.00	242.00
Chironomidae	612.66	28.33	188.33	131.33
Protostigmata	0	0	18.33	0
Total	2898.66	2144.33	3032.00	1484.33

Table 6. Abundance of benthic fauna in Tismana lake in 2004

Group of organisms	Abundance monthly average			
	May	July	September	November
Nematoda	606.00	555.50	297.5	193.5
Oligochaeta	546.50	649.50	197.50	77.00
Gasteropoda	142.50	143.50	40.50	20.00

Cladocera	112.00	0	112.50	59.00
Ostracoda	80.00	103.00	45.00	84.00
Copepoda	60.00	48.50	240.00	71.00
Chironomidae	635.00	0	0	0
Total	2182.00	1500.00	942.00	504.50

The factors determining the variation of the abundance and the density of the benthic fauna are: the granulometry of the underlayer, the quantity of organic matter which accumulates in the sediments, the degree of development of the macrophytic vegetation, the water temperature, as well as the migration during the cold season of the phytophilous fauna on the benthonic sediments simultaneously with the plants which fall on the bottom and begin to decompose slowly. Similar to the phytophilous fauna, the benthonic one has undergone great fluctuations in area and time from a qualitative point of view. It should be noted that the larvae of chironomids appear in the Neptune and Tismana lakes only at the beginning of May, whereas they are present throughout the year in the Jupiter lake due to

the thermal springs at the bottom of the lake. The monthly average of the total abundance exhibits similar fluctuations in all the lakes, but in the Neptune and Tismana lakes decreases of abundance are recorded from May until September, whereas in the Jupiter lake a short-term increase of the abundance of the benthonic fauna occurs in September. The values of the benthonic fauna in the Jupiter lake are constantly superior to those recorded in the other lakes as a result of the mesothermal springs coming into the lake.

Abundance (A), dominance (D), constance (C) and index of ecological semnification (Djuba index = W) of the benthic fauna is different from one lake to another (Table 7).

Table 7. Ecological indices of the mains groups of organisms from benthic fauna in A- Neptun lake

Taxonomic group	Abundance (ind/m ²)	Constance C%	Dominance D%	Djuba Index W%	
				Value	Semnification
Nematoda	1108.00	100	37.19	37.19	eudominant
Oligochaeta	727.75	100	24.43	24.43	eudominant
Gasteropoda	81.75	100	2.74	1.37	subdominant
Cladocera	99.25	100	3.33	0.83	recedent
Ostracoda	497.70	100	16.70	15.31	eudominant
Copepoda	94.50	100	3.17	2.38	subdominant
Chironomidae	370.25	25	12.43	3.11	subdominant

B- Jupiter lake

Taxonomic group	Abundance (ind/m ²)	Constance C%	Dominance D%	Djuba Index W%	
				Value	Semnification
Nematoda	824.75	100	34.54	34.54	eudominant
Oligochaeta	533.17	100	22.30	22.30	eudominant
Gasteropoda	10.50	50	0.44	0.22	recedent
Cladocera	195.58	66.66	8.19	5.46	dominant
Ostracoda	300.75	100	12.60	12.60	eudominant
Copepoda	278.58	100	11.67	10.70	eudominant
Chironomidae	240.17	66.66	10.06	6.71	dominant
Protostigmata	4.58	16.66	0.19	0.03	subrecedent

C- Tismana lake

Taxonomic group	Abundance (ind/m ²)	Constance C%	Dominance D%	Djuba Index W%	
				Value	Semnification
Nematoda	415.50	100	32.40	32.40	eudominant
Oligochaeta	368.00	100	28.67	28.67	eudominant
Gasteropoda	86.50	88	6.76	5.91	dominant
Cladocera	71.00	50	5.53	2.76	subdominant
Ostracoda	78.00	88	6.08	5.32	dominant
Copepoda	105.00	100	8.18	8.18	dominant
Chironomidae	159.00	25	12.38	3.10	subdominant

The ichthyofauna of the three lakes is represented by 5 species of cyprinids: *Carassius carssius*, *Carssius auratus gibelio*, *Cyprinus carpio*, *Scardinius erythrophthalmus* and *Rhodeus sericeus amarus* and one percid, *Perca fluviatilis*. During the years 1988-1989 the Neptune lake was populated with cu *Ctenopharyngodon idella*, but this disappeared after it ate rapidly all the aquatic macroflora, and, later on, as a result of poaching, it became extinct. At present, the piscicultural fauna has decreased significantly.

The birds fauna is represented by the most common aquatic birds, like ducks and seagulls. Their variety increases in spring and autumn, during the migration periods. Every year, there are swans in winter.

CONCLUSION

The lakes formed 35 years ago where the Comorova swamp used to be are at present the cleanest aquatic basins on the Romanian coast of the

Black Sea. Due to the fact that they are situated above the sea level they are fresh water lakes and, according to the various means of water supply, their chemical composition and the size of their area have evolved differently. The only lake that has been emptied completely several times is the Neptune lake. This fact has also led to the highest mineralization of its organic sediments. Lake Tismana has the lowest quantity of organic sediments as a result of the smaller quantities of non-mineralized organic sediments. Lake Jupiter, situated between the other two lakes, is supplied from mesothermal springs with H₂S. Due to the higher temperature of its waters, its surface does not freeze during milder winters so that the macrophytic flora has an extraordinary development and it sometimes remains alive during the whole year.

The phytoplankton and the zooplankton are very poor both in quality and in quantity and they are represented especially by small, common forms.

The macrophytic flora is represented only by 4 species, whose presence differs in the three lakes: in the Neptune lake there are small quantities, in the Jupiter lake there is a massive development and in the Tismana lakes there are only traces.

The phytophilous flora is present through 11 groups of organisms and it is dominated in point of quantity by ostracods, oligochaetes and chironomid larvae. Typical phytophilous forms are also present, such as hydrozoans, ephemeroptera and odonates. The presence and the abundance of the various groups of organisms differs from one species to the other. As expected, the maximum abundance is recorded in the Jupiter lake.

The benthonic fauna is represented by only 8 groups of organisms, the nematods, the oligochaetes and the ostracods being dominant. In winter, part of the phytophilous species survive on the macrophytes fallen to the bottom of the aquatic basins. The highest abundance of this fauna is maximum in the Jupiter lake, followed by that in the Tismana lake, and the lowest has been permanently recorded in the Neptune lake, possibly as a result of the presence of a large number of cyprinids in this lake.

The ichthyofauna is relatively poor: 5 species of cyprinids and one of percids, the latter being fished by the tourists and poachers.

The birds fauna is relatively poor, typical for the stagnant oligotrophic waters; it is only during the period of migration that its number and diversity increases, particularly with phytophagous species.

REZUMAT

Cele trei lacuri din stațiunile Neptun și Jupiter au evoluat în cei 30 ani de existență în mod diferit, deși provin din aceeași mlaștină eutrofă. Cauza o constituie volumul diferit de apă, sursele de alimentare și gradul diferit de dezvoltare a

macrofitelor acvatice, principala sursă de materie organică din sedimente. În cazul golirii lacului Neptun, sedimentele acestuia se mineralizează aerob, astfel încât în anii următori fitoplanctonul se dezvoltă mai abundent în defavoarea macrofitelor. Este de subliniat calitatea foarte bună a apei lacurilor din punct de vedere fizico-chimic și biologic; ca urmare lacul se încadrează în categoria apelor oligotrofe. În lucrare sunt trecute în revistă chimismul apelor, precum și structura și dinamica sezonieră a reprezentanților următoarelor biocenozes: fitoplancton, macrofite acvatice, zooplancton, fauna fitofilă și bentos. La fiecare este prezentată abundența, densitatea principalelor grupe de organisme, ca și faunele lor piscicolă și aviară. Sunt de asemenea menționați la fauna fitofilă și la cea bentonică o serie de indici ecologici: abundența, densitatea, constanța și indicele de semnificație ecologică. În prezent lacurile sunt stabile din punct de vedere limnologic și se află în stadiu de climax.

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