# RESEARCH CONCERNING THE ECOLOGICAL STATE OF AQUATIC ECOSYSTEM MALINA

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**Abstract**

*This study aimed at establishing the water quality of the fish farm Malina, Galati County through environmental and diversity indices of phytoplankton communities. The ecological indices and the estimation of diversity are important tools in the assessment of any ecosystem health. A healthy ecosystem is an ecosystem "stable and sustainable" meaning that it maintains its organization and autonomy over the years. In order to assess the structure of phytoplankton have been used different ecological indices (the abundance, the constancy, the dominance, the ecological significance), and the analysis of diversity was done by calculating indices such as Shannon - Wiener (**H'**), Shannon equitability index ($E = H_R$). Simpson diversity index (1-D), Simpson equitability index ($E_{1/D}$). Also, the algal pollution index (API) was calculated to determine if the ecosystem has a high organic load. The research on phytoplankton taxonomic structure led to the establishment of aquatic ecosystem studied, which is the identification of 28 species belonging to five taxonomic groups: Cyanophyceaea (0.07%), Euglenophyceae (29.789%), Bacillarophyceae (1.04), Chlorophyceae (68.63%), Zymnematophyceae (0.48%). The eudominante species belong to the Clorophyceae and Euglenophyceae genus. The Shannon - Wiener index (**H'**) value was calculated at 1.78 and Shannon equitability at 0.71. The Simpson's diversity index value is 0.77 and 0.79 for the Simpson equitability. The value obtained for algal pollution index was API = 11. The results indicate that the studied aquatic ecosystem presents good environmental status, optimal for increasing the carp and asian cyprinids.*

**Key words**: phytoplankton, ecological indices, diversity indices, eudominate species

## INTRODUCTION

The water quality is the most important factor in aquaculture. Depending this, can ensure efficient management so that the fish production to be maximal with minimum expenses. The qualitative assessment of surface water is determined by studying the dynamics of the physical, chemical and biological parameters.

The phytoplankton is an important component of any aquatic ecosystem that contributes substantially to its primary productivity.

The ecological indicators and the dynamics of phytoplankton diversity together with the physico -chemical parameters complete the overall picture of actual conditions existing in aquatic ecosystems because permanent changes occurring in the physical processes - chemical lead to changes in the aquatic biota.

The biodiversity based on the richness (number of species) of the species and the evenness (species distribution) can reflect phytoplankton community composition and also can describe the impacts of water pollution on the biotic communities [4].

Because phytoplankton determines and promote the evolution of an aquatic ecosystem trophic it has been calculated the index API (Algal Pollution Index).

This index was developed to determine the level of organic pollution of the water studying the presence algae in the water samples, being known the fact that some algal species are more tolerant to organic pollution and other species are more sensitive.

## MATERIAL AND METHOD

Description of aquatic ecosystem studied

Malina farm is located in Galati County on the European road E 87.

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The activity profile of the company is popular material production and fish consumption. The fish species, subjects of the production of this farm are grass carp, silver carp, bighead carp and carp.

The power supply is made from the Siret River (pumped). Water drainage from the basin juvenile growth is also done by pumping.

The farm has a total area of S = 127 ha. The pond which samples were collected is the growing pond of juveniles which has surface of S = 30 ha (figure 2).

For the results to be representative the samples were collected from seven stations arranged so as to capture the heterogeneity living conditions (5 stations located inside the pond, one supply channel and one evacuation channel).

The phytoplankton samples were collected from the water surfaces in bottles (500 ml) and immediately fixed with Lugol solution in a ratio of 1:100 (1 ml of solution for 100 ml of sample). Previous, to microscopically analyses, the samples were centrifuged for 5 min at 1200 rpm.

The vegetal plankton was evaluated from the qualitative and the quantitative.

The qualitative determination was made after [1], [3], [5], [7].

<u>Relations used for calculating ecological indices</u>

To quantify the phytoplankton community response to its environmental quality following indices have been used:

- The dominance is calculated with the relation:

$$Di = \frac{n_i}{N} * 100$$ Where:

$D_i$ – the species dominance i;

$n_i$ – the total number of individuals of species i, found in the samples examined

N – the total number individuals of all species present in the samples investigated.

- The constancy is calculated with:

$$Ci = \frac{p_i}{N_p} * 100$$ Where:

$n_{pi}$ – the number of samples in which the species A is found;

$N_p$ – total number of samples examined.

- Ecological significance index (W)

$$Wi = \frac{C_{i*}D_i}{100},$$ where

Ci – constancy

Di - dominance

<u>Relationships used to calculate diversity indices</u>

*Shannon - Wiener index (H')* derived from information theory. For calculation the empirical data come from analysis of a sample taken at random from a particular ecosystem [13].

$$H' = -\sum P_i \ln P_i$$ Where

pi – proportion of the species abundance i;

ln – natural logarithm;

*Simpson diversity index (1-D)*

Simpson index is calculated by the equation:

$$D = \sum_i (pi)^2$$ [14] Where

pi – proportion of the species abundance i;

$$1 - D = 1 - \sum_i (pi)^2$$

*Evenness (*or equitability) *(E)* is a measure of the degree of equilibrium or imbalance of a community. Evenness refers to the distribution model of the individuals between species.

Evenness is the ratio between the observed diversity and maximum diversity (theoretical) that can be achieved by the ecosystem, while the biocenosis would achieve maximum species.

For this we need to define the term of maximum diversity. We have two cases:

a) If S=N, S>1, N>1

$$H' \max = \log N$$

$$D \max = 1$$

b) If 1<S<N

$$H' \max = \log S$$

$$D \max = 1 - \frac{N - S}{S(N-1)}$$

(**N**- total number of individuals, **S**- total number of species). [10].

Equitability (E) varies between 0 and 1. It tends to 0 when most of the individuals belong to a single species and to 1, where each species is represented by the same number of individuals.

Index API (Algal Pollution Index) [8] is calculated based on the frequency of algal species in the samples. Thus, the most tolerant species of algae to organic pollution receive a note from 1-5. The most tolerant given the highest grade 5 and the less tolerant receive lower grades.

## RESULTS AND DISCUSSIONS

The phytoplankton plays a central role in the structure and functioning of the freshwater ecosystems [9].

The phytoplankton taxonomic diversity of farm Malina is presented in Table 1. The 28 species identified in this study belong to five taxonomic groups: *Cyanophyceaea* (1 species), *Euglenophyceae* (4 species), *Bacillarophyceae* (4 species), *Chlorophyceae* (17 species), *Zymnematophyceae* (2 species).

The green algae of the genus *Chlorophyceae* (68, 63%) şi *Euglenophyceae* (29, 79%) were dominant (figure 1).

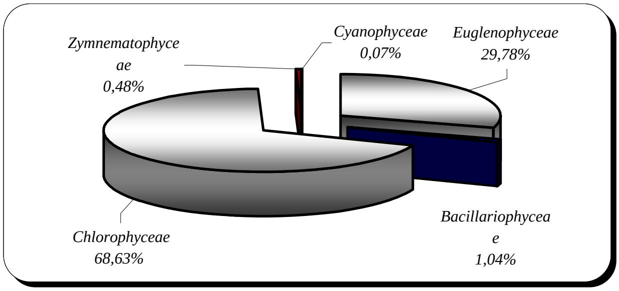


Figure 1 The taxonomic distribution of the phytoplankton

Table 1 The taxonomic structure of phytoplankton communities in the study area

| Nr. crt. | Genus | Species | Number of individuals | Algal pollution index (API) |
|---|---|---|---|---|
| 1. | **Cyanophyceae** | *Cryptomonas ovata* | 1 | |
| 2. | **Euglenophyceae** | *Euglena viridis* | 56 | 5 |
| 3. | | *Trachelomonas armata* | 3 | |
| 4. | | *Trachelomonas oblonga* | 271 | |
| 5. | | *Trachelomonas volvocina* | 100 | |
| 6. | **Bacillariophyceae** | *Asterionella formosa* | 2 | |
| 7. | | *Synedra acus* | 2 | |
| 8. | | *Gyrosigma acuminatum* | 9 | |
| 9. | | *Navicula cuspidata* | 2 | |
| 10. | **Chlorophyceae** | *Actinastrum hantzschii* | 269 | |
| 11. | | *Chlorella vulgaris* | 1 | 2 |
| 12. | | *Lagerheimia genevensis* | 20 | |
| 13. | | *Oocistys lacustris* | 3 | |
| 14. | | *Monoraphidium contortum* | 5 | |
| 15. | | *Crucigenia cruciata* | 9 | |
| 16. | | *Pediastrum boryanum* | 4 | |
| 17. | | *Pediastrum duplex* | 7 | |
| 18. | | *Pediastrum tetras* | 10 | |
| 19. | | *Scenedesmus acuminatus* | 145 | |
| 20. | | *Scenedesmus denticulatus* | 2 | |
| 21. | | *Scenedesmus opoliensis* | 9 | |
| 22. | | *Scenedesmus quadricauda* | 435 | 4 |
| 23. | | *Scenedesmus spinosus* | 57 | |
| 24. | | *Tetraedron caudatum* | 8 | |
| 25. | | *Tetraedron trigonum* | 7 | |
| 26. | | *Ulothrix sp.* | 1 | |
| 27. | **Zymnematophyceae** | Spirogyra sp. | 1 | |
| 28. | | *Staurastrum tetracerum* | 5 | |
| | *TOTAL* | | 1444 | 11 |

The ecological indices

The phytoplankton community composition is a critical component in monitoring the environment, the restoration and management of the ecosystem. [11]

The phytoplankton is the primary energy source of the aquatic ecosystem and has a major influence on the ecosystem of others components (zooplankton, macrophytes, macronevertebrtate). All components of lake function are influenced in major ways by the dynamics of the phytoplankton and zooplankton. Phytoplankters are the primary source of energy driving large lake ecosystems; and the zooplankton is the central trophic link between primary producers and fish. [12], [15]

Establishing the structure of planktonic communities shows the functioning way of an ecosystem.

To characterize and establish the structure of typical phytoplankton communities on the studied pond were calculated the analytical and synthetic ecological indices: like constancy - C (structural index) dominance - D (production index), and ecological significance index (W). Ecological significance index is a synthetic index which accurately determines the position of a species in a biocenosis. [16]

- From the constancy point of view
  - The best adapted to the offered conditions by studied biotope are the following species: *Trachelomonas oblonga, Scenedesmus quadricauda, Trachelomonas volvocina* being euconstante species.
  - From the constant species class are: *Euglena viridis, Actinastrum hantzschii, Lagerheimia genevensis, Crucigenia cruciata, Scenedesmus acuminatus, Scenedesmus spinosus*, *Pediastrum duplex* – these showing a high adaptability.

The rest are accessory and accidental species.

- As for the dominance: *Scenedesmus quadricauda*, *Trachelomonas oblonga, Actinastrum hantzschii, Scenedesmus acuminatus*, are eudominante species - these having the highest percentage in the natural productivity of the studied ecosystem.
- Among the dominant species *Scenedesmus acuminatus, Trachelomonas volvocina* are species with a significant contribution to the biomass production.

The other species have a smaller contribution to the natural productivity of the studied aquatic ecosystems.

Based on the two indices is calculated the synthetic ecological significance analytical index (W), index that provide an insight into the relationship between species. Based on this index it can be determined the phytoplankton community structure (Table no. 2).

Table 2 The phytoplankton community structure in the studied area

| Nr. crt. | The group | Species | Value of the ecological significance – W |
|---|---|---|---|
| 1. | Leading species ($W_5$=>10%) | *Scenedesmus quadricauda* | 30,12 |
| 2. | | *Trachelomonas oblonga* | 18,76 |
| 3. | | *Actinastrum hantzschii* | 13,31 |
| 4. | Characteristic species ($W_4$=5,1-10%) | *Scenedesmus acuminatus* | 7,1 |
| 5. | | *Trachelomonas volvocina* | 5,94 |
| 6. | Complementary species ($W_3$=1,1-5%) | *Scenedesmus spinosus* | 2,82 |
| 7. | | *Euglena viridis* | 2,77 |
| 8. | Associated species ($W_2$=0,1-1%) | *Lagerheimia genevensis* | 0,99 |
| 9. | | *Crucigenia cruciata* | 0,449 |
| 10. | | *Pediastrum duplex* | 0,28 |
| 11. | | *Gyrosigma acuminatum* | 0,27 |
| 12. | | *Scenedesmus opoliensis* | 0,27 |
| 13. | | *Tetraedron caudatum* | 0,24 |
| 14. | | *Tetraedron trigonum* | 0,21 |
| 15. | | *Pediastrum tetras* | 0,2 |
| 16. | | *Staurastrum tetracerum* | 0,15 |

| | | | |
|---|---|---|---|
| 17. | Accidental species ($W_1$=>0,1%) | *Trachelomonas armata* | 0,06 |
| 18. | | *Oocistys lacustris* | 0,06 |
| 19. | | *Monoraphidium contortum* | 0,05 |
| 20. | | *Asterionella formosa* | 0,04 |
| 21. | | *Pediastrum boryanum* | 0,04 |
| 22. | | *Scenedesmus denticulatus* | 0,04 |
| 23. | | *Cryptomonas ovata* | 0,02 |
| 24. | | *Synedra acus* | 0,02 |
| 25. | | *Navicula cuspidata* | 0,02 |
| 26. | | *Chlorella vulgaris* | 0,001 |
| 27. | | Ulothrix sp | 0,001 |
| 28. | | Spirogyra sp. | 0,001 |

Diversity indices

A diversity index is a synthetic measurement of the biological community structure that incorporates two aspects, the number of taxa (richness) and the distribution in the number of individuals among taxa (evenness) [6].

Diversity indices are the best indices which reflected changes in the composition of the biota in a water [11]. The loss of biodiversity leads to disturbance in the ecosystem functions, which makes them more vulnerable and therefore less resistant ultimately decrease supply necessary services.

In table no. 3 are shown the values of diversity indices used in this study:

| Shannon Index | | Simpson Index | |
|---|---|---|---|
| **$H'_S$** | 1,78 | **(1-D)** | 0,77 |
| **$H'_{max}$** | 2,5 | **$D_{max}$** | 0,97 |
| **$E_H$ ($H_R$)** | 0,71 | **$E_{1/D}$** | 0,79 |

***$H_{(S)}$** – real diversity; **$H_{(S)MAX}$** – maximum diversity;*
***$H_R$=E** – relative diversity (evenness);*
***1-D** –Simpson diversity index;*
***(1-D)$_{max}$** - maximum Simpson diversity index;*
***$E_{1/D}$** –Simpson evenness*

For a correct appreciation of the diversity was calculated the maximum value too that can be touched by the ecosystem under ideal conditions, if all species samples are represented by the same values of absolute abundances.

The diversity index values indicate a good diversity of the anthropogenic studied ecosystem considering the fact that phytoplankton development achieve the first maximum in June-July.

The index that gives a more accurate picture is equitability. This indicator shows how far the observed diversity deviates from the hypothetical (maximum).

Thus, the diversity is calculated using Shannon equation that is $H'_S$=1,78 and the Shannon equitability is $E_H$=0,71, meaning that the real the diversity is 71% of the hypothetical one.

The Simpson diversity index 1-D = 0.77 has a good value; the Simpson equitability shows that diversity is 79% of the maximum one.

## CONCLUSIONS

The fish productivity depends largely on the primary productivity. The quantity of the food available to fish depends by the primary producers and by the biomass transfer in a food chain.

The aquatic studied ecosystem represents the growth pond of the asian cyprinid and carp. So, phytoplankton quantity and its quality plays a special role because the nutritional spectrum of this species is represented by phytoplankton or other trophic links whose food source is phytoplankton.

The best adapted species to the living conditions of this ecosystem that bring an important contribution to productivity belong to the *Euglenophyceae* and *Chlorophyceae*.

The biodiversity is a key factor in ecology, directly linked with the regulation and functioning of the ecosystems. [2]

The diversity indices calculated for aquatic ecosystems studied have good values, so that the equitability calculated for the two indices shows that diversity between 70-80% of maximum.

This can be explained by the fact that the maximum peak development of phytoplankton is reached later, in June-July and can also be explained by the fact that there are species herbivores.

Through organic pollution index (API = 11) we conclude that the study has a slightly polluted pond.

Corroborating the results with those aimed at ecological diversity indices we can conclude that the ecological status of the water pond in the study period is good with the mention that monitoring will be continued.

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