CHANGES IN PHYTOPLANKTON COMMUNITY OF LOWER DNIESTER IN 2018-2019

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Introduction

The recent studies of planktonic communities of the lower Dniester were carried out mostly in spring and summer period, as the periods of the highest development of planktonic organisms. However, autumn and winter periods may reflect the influence of climatic changes on plankton even more clearly than spring and summer, for example, alterations in quantitative and qualitative structure of communities as the result of changes in vegetation terms of plankton species, and winter blooms of phytoplankton in the mild winters.

The hydroecological history of Dniester River and Dniester estuary may be divided into three periods: 1. “natural” period, when the water regime depends on snow melting and frequent storm floods, with great runoff fluctuations and maximum of nutrient runoff in spring (about 60% of year runoff); 2. partially regulated period (starts in 1954 after Dubossary Reservoir and Dubossary Hydroelectric Power Plant were put in operation); 3. fully regulated period (from 1987 when Dniester Reservoir and Dniester Hydroelectric Power Plant were put in operation)[19]. Regulation smoothed seasonal fluctuations of the water runoff, and added the summer periods of high water, along which the runoff volume could be close to the spring values.

During the eutrophication period (70^{th}-80^{th}), the concentration of nitrogen and phosphorus compounds increased in several times. Then in 90^{th}, nutrient concentration began to decrease, and in the modern period, the concentrations of most nutrients exceed their level in 50^{th}. Only the concentration of nitrates is several times higher, and the concentration of silicon is in contrary lower [19]. Phytoplankton communities response to the above changes of hydrological and hydrochemical regimes as well as to the global climatic changes. Thus, we face the problem of updating the data and search for new patterns in the changes of the biocenoses.

Materials and methods

Phytoplankton samples were collected in 2018 and 2019 as the part of the project BSB165 HydroEcoNex, together with zooplankton and hydrochemical samples. The sampling took place every month, in the Dniester riverbed near the village Mayaki. Sampling and subsequent processing was carried out by standard methods.

Results and Discussion

Algological studies in the lower part of Dniester River were carried out for a long time. Some data on the algae of the lower Dniester is available in the work of N.K. Sredinsky [17]. The first lists of species belonged to B.N. Aksentiev [1] and D.O. Svirenko [16]. The detailed quantitative and qualitative studies of the phytoplankton in the lower part of the Dniester and the Dniester estuary were carried out by A.I. Ivanov and co-authors [10-15]. The recent period of phytoplankton development in the lower part of Dniester and Dniester estuary was described in the works of N. V. Derezyuk and co-authors [2-9], but their studies took part mainly in the Dniester estuary and in summer period. In general, these studies showed that in the lower part of the Dniester, phytoplankton spread very unevenly over the seasons and along the riverbed, as well as in the water column. Such a sharp uneven distribution of the composition and abundance of phytoplankton is explained by the extremely high dynamism of the hydrological regime of the Dniester and frequent floods, which not only dilute the waters of the river, but also significantly increase their turbidity. The change in phytoplankton biomass at the mouth of the river is not directly related to the change in the concentration of nutrients, but positively correlates with the transparency of the water. When high water transparency coincides with elevated concentration of nutrients, it leads to the massive development of microalgae. Inflows and floodplain water bodies also have a great influence on phytoplankton in the river.

During the period of the present study, we found 186 species and intraspecific taxa (Bacillariophyta – 77 species, Chlorophyta – 62, Euglenozoa – 13, Cyanobacteria – 23, Dinophyta – 9, Chrysophyta – 2). The biomass of microalgae was rather low, but higher than in pre-eutrophication period (fig.1). Comparing with the period of 1970-1972, the average biomass in winter was higher. More active development of phytoplankton in winter may be due to higher winter temperatures and absence of stable ice cover during the cold period, as the result of global climatic changes. For other periods, the average biomass was lower. The greatest difference was observed in the autumn period, when the average biomass decreased by about four times. According to Ivanov [13], high development of phytoplankton in autumn was due to simultaneous decreasing of turbidity and increasing concentration of nutrients, especially phosphorus. Therefore, drop of biomass in autumn comparing with 70^{th} may be the result of decreasing of DIP concentration to pre-eutrophication values [19]; but also due to the hydrological peculiarities of the certain years.

Studies carried out at the mouth of the Dniester in 1952 showed that the curve of changes in phytoplankton biomass was not directly dependent on the concentration of nutrients, but, as it were, repeated the course of the water transparency curve [13]. Our 2019 research (fig. 2) showed a weak positive correlation (r= 0,322) with the concentration of dissolved inorganic nitrogen (DIN), and a weak negative correlation (r= -0,378) with the concentration of phosphates (DIP). This fits well with the theory of a lack of phosphorus, which comes simultaneously with nitrogen, but is more actively absorbed by microalgae. The weak negative correlation (r= -0,374) with silicates reflects its use by diatoms, which form the basis of phytoplankton biomass. We did not find a clear-cut correlation with the concentration of total suspended solids, and, accordingly, with transparency (r=0,099). Thus, at present time it is impossible to identify the main factor determining the development of phytoplankton. To predict the development of microalgae, it is necessary to carry out a comprehensive assessment of the combined action of hydrological and hydrochemical factors.

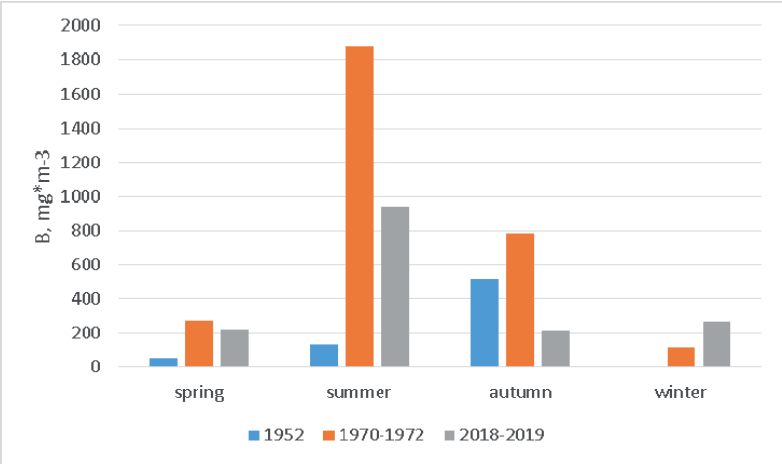


Fig. 1. Long-term changes in the average biomass of phytoplankton (1952 and 1970-1972 – according to Ivanov [13], 2018-2019 – our data)

The contribution of different phyla of microalgae in the total phytoplankton biomass is shown on Fig.3. For autumn period, it is quite the same as for the period of 1970-1973, with increased part of Chlorophyta and a little decrease of Cyanobacteria. The contribution of different microalgae in total biomass for winter period had changed greater. In 1972, Chlorophyta predominated, and the part of Cyanobacteria was quite high. In 2019, the main contribution belonged to Bacillariophyta, the part of Chlorophyta was also high, and the contribution of Cyanobacteria was less than 1%. A decrease in the proportion of cyanobacteria may indicate a decrease in water trophicity. For spring period, the share of Chlorophyta decreased greatly, and the share of Bacillariophyta raised up to 90%. In summer period, the situation is vice versa, with rather high development of cyanobacteria and dinoflagellates.

Therefore, our studies showed that the role of Cyanobacteria in phytoplankton of lower Dniester in the autumn and winter period had decreased (comparing with 1970-1973), and in summer period increased. During autumn-winter period in the studied area there was observed the diatom-green complex of species that reminded those of pre-eutrophication period, in spring diatoms totally dominated. However, it is necessary to note that this decrease may be due to hydrological peculiarities of the certain years.

The direct reaction of phytoplankton community on the water release from Dubossary Reservoir and the Dubossary Hydroelectric Power Plant was studied in April-May 2019. On fig. 4, we may see the correlation between relative water level (if we take the water level before the release as zero), phytoplankton biomass and concentration of total suspended solids. Before the release (26.04.2019), the concentration of phytoplankton was rather low. When the water became rising, the biomass of microalgae also sharply increased. The maximum of biomass was observed on 29.04.2019, and then (on 30.04.2019) began to decrease, maybe due to the deterioration of the conditions for the phytoplankton development by increasing the flow rate. The level of water began to go down on 02.05.2019, but the concentration of suspended solids, brought by the waters from water reserve, sharply rose up, the transparency of water decreased greatly, and the development of microalgae also greatly decreased, so the values of biomass became even lower than before the release.

Ungureanu [18] notes that the creation of reservoirs leads to their excessive eutrophication, mass development, as a rule, of cyanobacteria and deterioration of water quality. When water is released, cyanobacteria from the Dubossary reservoir can enter the lower reaches of the Dniester, which cause an increase in the proportion of cyanobacteria in river phytocenoses. However, during our study, the qualitative composition of phytoplankton did not change greatly (fig. 5). Before the release, during the period of high water and a month later after the release, in phytoplankton community, diatoms dominated. The contribution of green algae in total biomass during the period of high water increased (from 3 to 9%), but in may be the seasonal peculiarities of phytoplankton development.

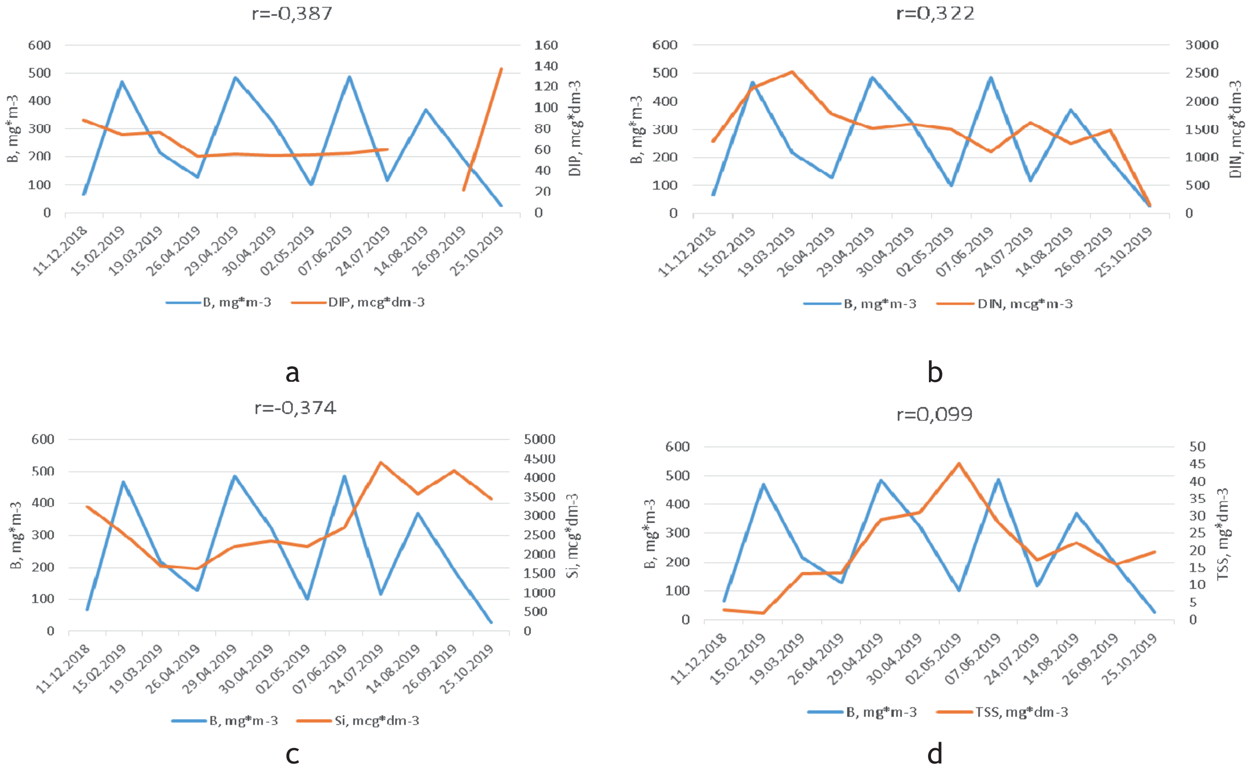
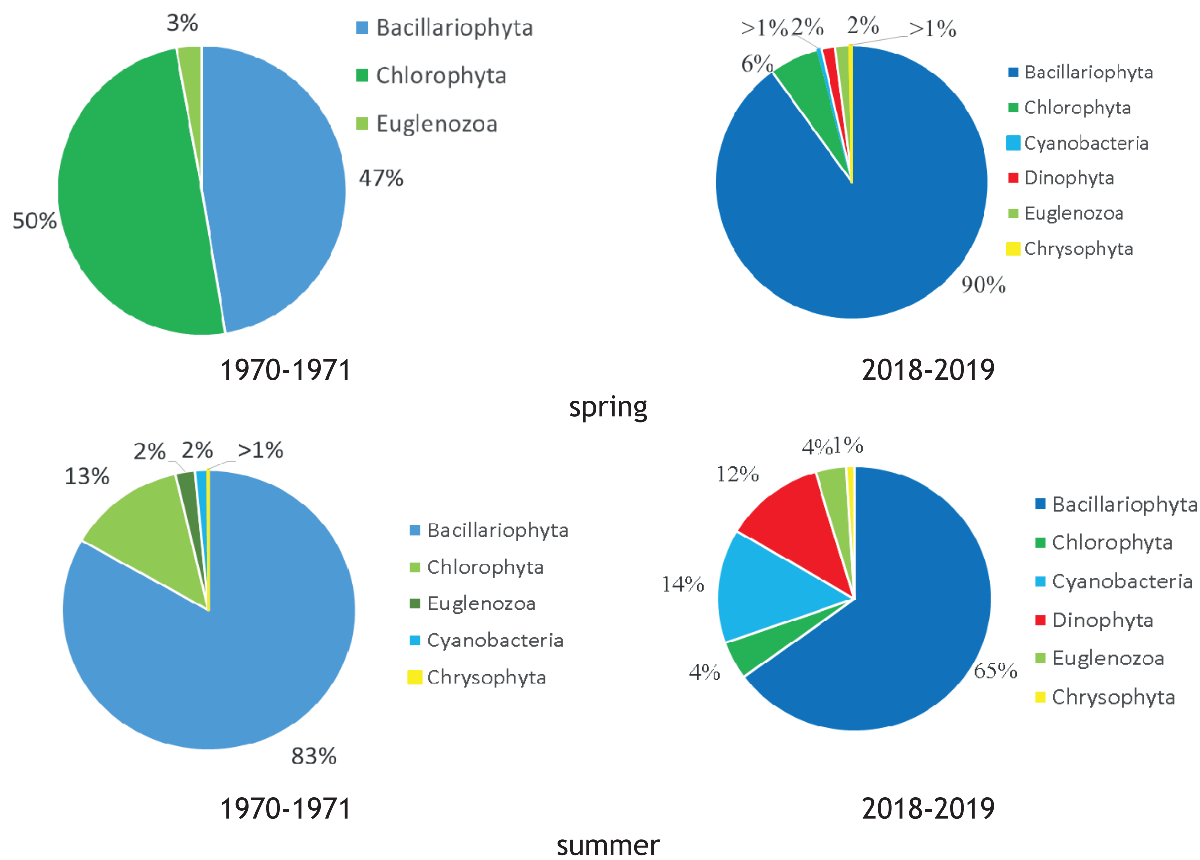


Fig. 2. Changes in phytoplankton biomass and DIP (a), DIN (b), silicon (c) and TSS (d) in Lower Dniester in 2019



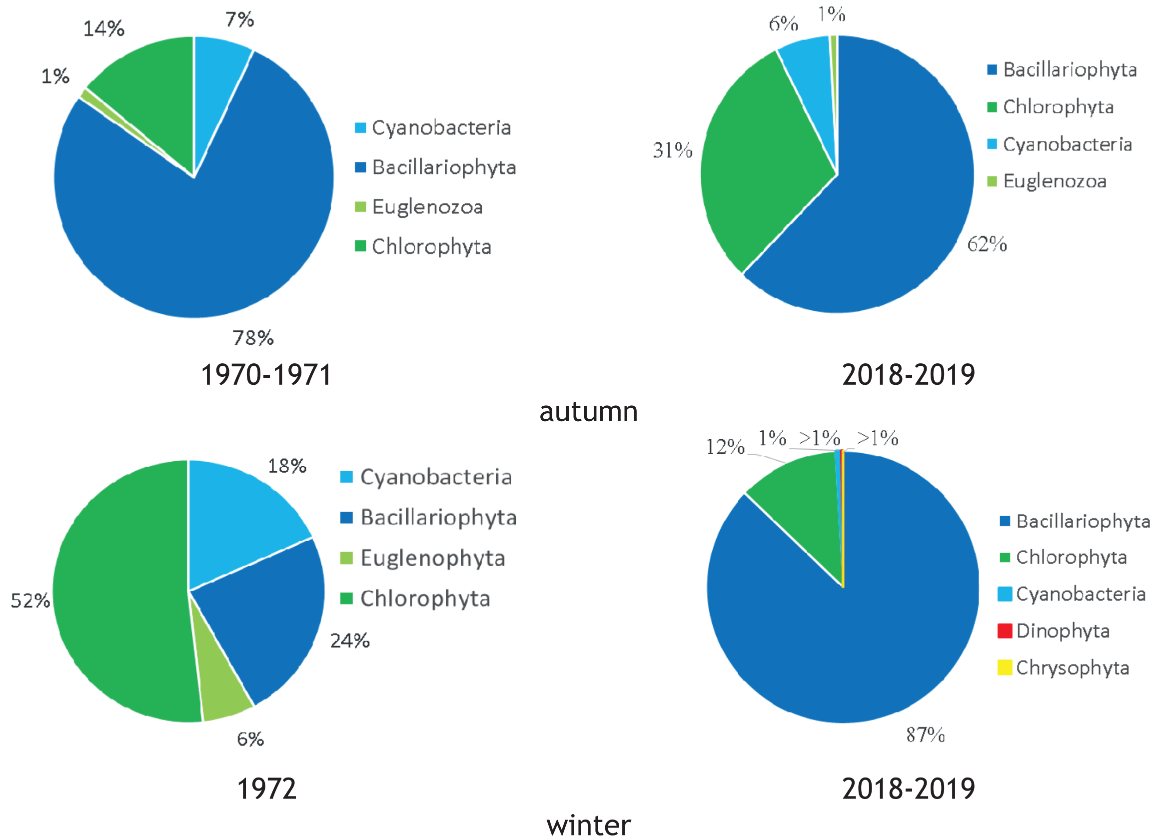


Fig. 3. The contribution of different phyla of microalgae in the total biomass for different seasons (2018-2019 – our data, 1970-1972 – according to Ivanov [13].

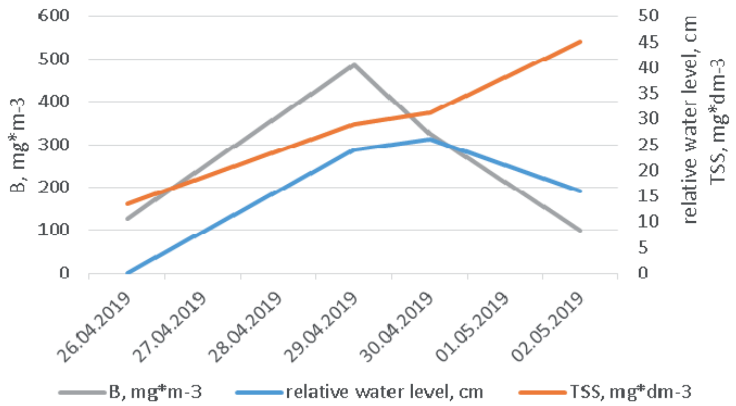


Fig. 4. The changes of relative water level (if take the level before release as zero), concentration of total suspended solids and biomass of microalgae during the release from Dubossary power plant reservoir (April-May 2019)

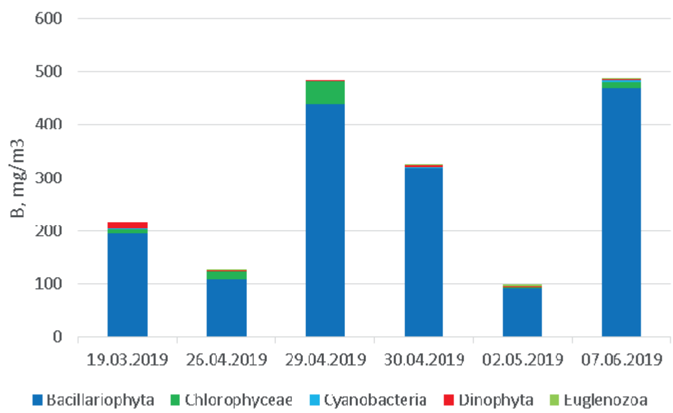


Fig. 5. The changes in biomass of different phytoplankton phyla before, during and after the release from Dubossary power plant (Mayaki, 2019)

I It is important to say that during the period of the release, the condy centration of nutrients did not change evidently (the fluctuation was about 6% for DIN, 2% for DIP and 5% for Si). Comparing with the pre-release sample, DIN concentration slightly drop down, DIP and silicon concentration slightly rose up, so we may suggest that the main reason for the fall in phytoplankton development after the release was the decrease of transparency due to the high amount of suspended solids brought from the water reservoir of Dubossary power plant.

Conclusions

1. Comparing with the eutrophication period (1970-1972), we noticed the evident decrease of average biomass of phytoplankton. Only in winter the average biomass was higher, may be due to higher winter temperatures and absence of stable ice cover during the cold period, as the result of global climatic changes. For autumn, the average biomass decreased by about four times comparing with 1972, and became even lower, than in pre-eutrophication period (1952). It may be the result of decreasing of phosphorus concentration to pre-eutrophication values. The study of species composition show that the role of Cyanobacteria in phytoplankton of lower Dniester in the autumn and winter period had decreased (comparing with 1970-1973), and in summer period increased. During autumn-winter period there was observed the diatom-green complex of species that reminded those of pre-eutrophication period, in spring diatoms totally dominated.
2. Correlation analysis shows that at present time it is impossible to identify the main factor determining the development of phytoplankton. We found weak positive correlation with the concentration of mineral nitrogen, a weak negative correlation with the concentration of phosphorus and silicon, and no clear-cut correlation with the concentration of total suspended solids, Thus, to predict the development of microalgae, it is necessary to carry out a comprehensive assessment of the combined action of hydrological and hydrochemical factors.
3. The study of direct reaction of phytoplankton community on the water release from Dubossary Reservoir and Dubossary Hydroelectric Power Plant shows the increase of phytoplankton biomass during the release and sharp drop after the release, presumably due to high increase of the turbidity.

References

1. Аксентьев Б.Н. Планктонные диатомеи низовий Днестра и некоторых прилегающих к нему водоемов // Журн. наук.-досл. кафедр м. Одеси» т. II. 1926.
2. Гаркуша О.В., Дерезюк Н.В. Літній фітопланктон Дністровського лиману // Біологічні дослідження-2014: зб. наук. праць V Всеукр. наук.-практ. конф., (4-5 березня 2014 р., Житомир). – Житомир: ЖДУ ім. І. Франка, 2014. – С. 404-407.
3. Гаркуша О.В., Дерезюк Н.В. Популяційні характеристики фітопланктону на акваторії Дністровського лиману влітку (2012- 2015 рр.) // Біологічні дослідження-2016: зб. наук. праць. - Житомир: ЖДУ ім. І. Франка, 2016. – С. 339-341.
4. Дерезюк Н.В., Ковалева Н.В., Label Мединец В.И., Конарева О.П. Микроводоросли как индикаторы качества воды рекреационных зон Одесской области // Одеса, 2009. – Екологія міст та рекреаційних зон: Матеріали Всеукр. наук.–практ. конф. Одеса: Інноваційно– інформаційний центр «ІНВАЦ», 2009. – С.77– 81.
5. Дерезюк Н.В., Конарева О.П., Молодит О.В. Мониторинговые исследования фитопланктона в Днестровском лимане (2003–2011 гг.) // Мат. Всеукр. Науково-практ. конф. «Лимани північно-західного Причорномор›я: актуальні гідроекологічні проблеми та шляхи їх вирішення» / Зб. статей за матер. доповідей / Одеськ. Держ. Екологічний університет – Одеса: ТЕС, 2012. С.102 – 105.
6. Дерезюк Н.В, Конарева О.П., Солтыс И.Е. Летние цветения фитопланктона в Днестровском лимане (2003- 2016 гг.) // Transboundary Dniester River Basin Management: Platform For Cooperation And Current Challenges. - Tiraspol: Eco-Tiras. 2017- С. 96–100.
7. Дерезюк Н.В. Видовое разнообразие и количество фитопланктона в дельте Днестра и

Днестровском лимане (июль 2010 г.): тез. докл. VII – междунар. научн.-практ конф. «Эколого-экономические проблемы Днестра», 07-08 окт. 2010- г. Одесса, ИНВАЦ. - С. 24-25.
8. Дерезюк Н.В. Разнообразие альгофлоры (фитопланктон) в Днестровском лимане (2012 – 2013 гг.) // Мат – ли Всеукраїнської наук. – практ. конф. «Лимани північно-західного Причорномор'я: сучасний гідроекологічний стан; проблеми водного та екологічного менеджменту, рекомендації щодо їх вирішення», (1–3 жовтня 2014, Одеса). – Одеса, ТЕС, 2014. – С. 87–89.
9. Дерезюк Н.В. Підсумки багаторічних досліджень структури та біорізноманітності фітопланктону Дністровськоо лиману в літній період (2003-2014 рр.) //Наук. зап. Терноп. нац. пед. ун-ту ім. В. Гнатюка. Сер. Біол., Спец. вип.:Гідроекологія. 2015. №3-4(64). – С.185-188.
10. Иванов А.И. Фитопланктон Днестровского лимана и низовий р. Днестра // Материалы по гидробиологии и рыболовству лиманов северо-западного Причерноморья, вып. 2, Одесса, 1953.- с.19-37
11. Иванов А.И. Фитопланктон Днестровского лимана и нижнего течения р. Днестра, Автореф. дисс, 1954. – 12 с.
12. Иванов А.И. Особенности фитопланктона Днестра и влияние его на формирование фитопланктона Днестровского лимана. Тр.зон. совещ. по тип. и биол. обосн. рыбохоз. исп. преснов. (внутр.) водоемов южн. зоны СССР. - Кишинев, 1962, с. 125-129.
13. Иванов А.И. Фитопланктон устьевых областей рек северозападного Причерноморья. Киев: Наук. думка. 1982. с.72-100
14. Костикова Л.Е., Иванов А.И. Фитопланктон нижнего Днестра и Днестровского лимана / Л.Е. Костикова, А.И. Иванов, Т.И. Митковская, Л.А. Сиренко и др. Гидробиологический режим Днестра и его водоемов. // Киев: Наук. думка, 1992. – С. 90 – 134.
15. Ролл Я.В., Іванов А.І. Матеріали про фитопланктон нижнього Дністра та деяких його приток. Наукові записки Одеської біологичної станції. - Київ: Вид. АН УРСР, 1960, вип. 2, с. 68-84.
16. Свиренко Д.О. О планктоне нижнего Днестра и некоторых водоемов его бассейна, «Журн. н.-досл. кафедр м. Одеси», т. II, № 4, 1926.
17. Срединский Н.К., Материалы для флоры Новороссийского края и Бессарабии, Зап. Новоросс. об-ва естествоисп., т. I и II, 1872—1873.
18. Унгуряну И.В. Особенности формирования фитопланктона Костешского и Днестровского водохранилищ : Автореф. дис. ... канд. биол. наук. - Кишинев, 1985. - 24 с.
19. Goncharov O., Denga Yu. Long-term change in nutrients concentrations of the lower Dniester // Hydropower impact on river ecosystem functioning. Proc. Int. Conf. Tiraspol: Eco-TIRAS, 2019. – p.55-59.