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Project:
Resources pilot centre for cross-border preservation of the aquatic biodiversity of Prut River MIS ETC 1150

THE SEVENTH REPORT, 08 JULY – 07 NOVEMBER 2014

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GA4: PRUT RIVER INVESTIGATION

HYDROCHEMICAL PARAMETERS

There were collected 72 samples of water between 8 July 2014 and 7 November 2014 in the frame of the project MIS ETC 1150 from Costesti-Stinca reservoir and the Prut River, stations: Costesti, Braniste, Sculeni, Leuseni, Leova, Cahul, Cislita-Prut and Giurgiulesti. At each point of sampling the following works were done in field conditions: the measurement of water transparency and temperature, filtration of some water samples through membrane filters with pore size of 0.45 μ and their preservation for further analysis, preservation of dissolved oxygen, and preservation of biological material.

pH, dissolved oxygen, biochemical oxygen demand

The values of **water pH** in monitored areas of the Prut River and Costesti-Stinca reservoir varied from 7.95 to 8.42 and not exceeded the limits (6.5 – 8.5) allowed by the *Regulation on environment quality requirements for the surface waters* (2013) (Fig. 1).

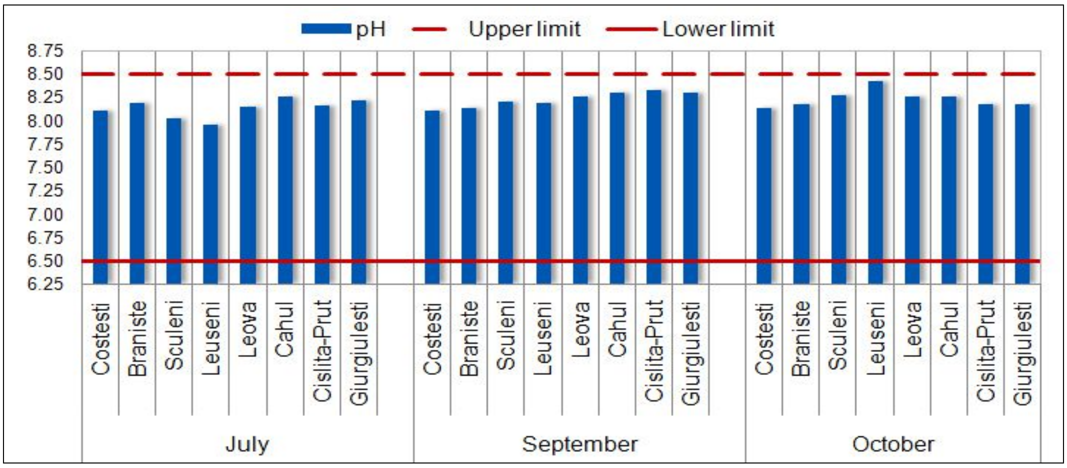

Fig. 1 Fluctuation of pH in the Prut River and Costesti-Stinca reservoir (2014)

The content of **dissolved oxygen** in surface waters is influenced by a range of factors, and among them are listed the water temperature, atmospheric pressure, flow speed, the presence of organic and inorganic pollutants, the substance exchange of hydrobionts. The monthly variations of the content of dissolved oxygen were analysed in correlation with the water temperature (Fig. 2). According to Fig. 2, the water temperature corresponded to the season, but the content of dissolved oxygen depended also on other factors. Its higher values in Costesti-Stinca reservoir were caused by the activity of phytoplankton. Its low content at Braniste station in September may have caused by anthropic factor.

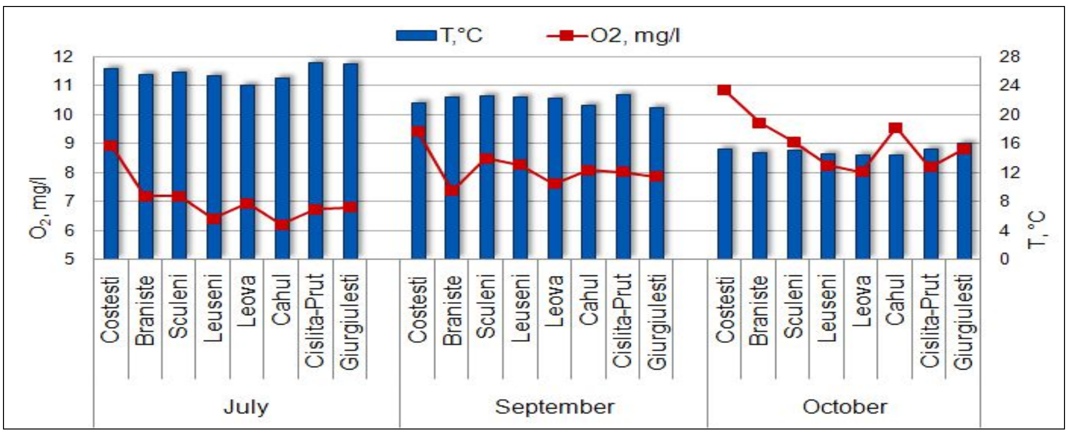

Fig. 2 Correlation between the content of dissolved oxygen and the water temperature in the Prut River and

Costesti-Stinca reservoir (2014)

The level of water pollution with easily degradable organic compounds, as well the presence of oxygen consumers in an aquatic ecosystem may be analyzed by using the biochemical oxygen demand (CBO_n). Significant oscillations of **CBO_5** were registered in October: 0.95 mg/l O_2 (Braniste) – 2.43 mg/l O_2 (Leuseni) at a water temperature of 14.8 – 14.2°C and a content of dissolved oxygen of 9.7 – 8.2 mg/l, correspondingly. The content of dissolved oxygen being satisfactory, it is necessary to analyse the content of biogenic elements in order to find the cause of increase of CBO_5 in the sector Sculeni – Leova.

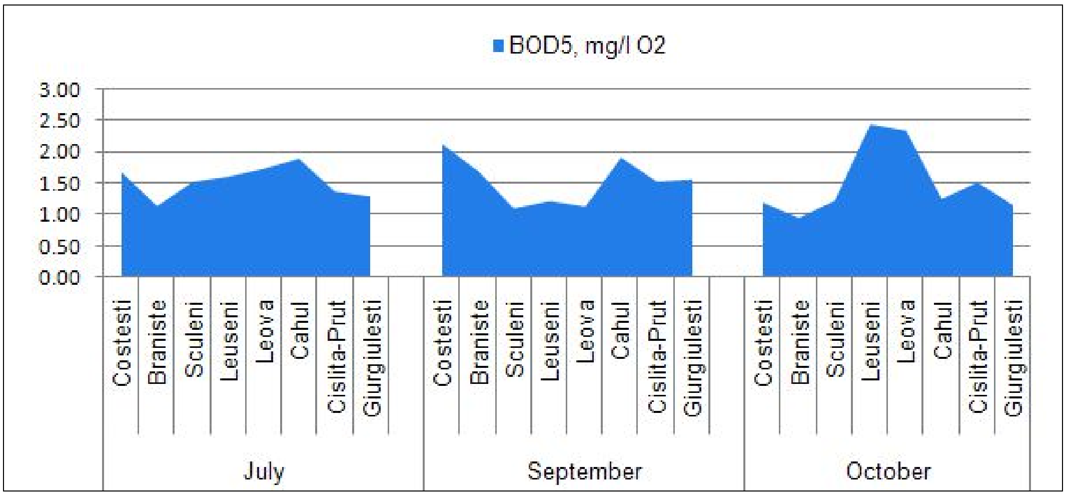

Fig. 3 Time fluctuations of the biochemical oxygen demand (CBO_5) in the Prut River and Costesti-Stinca reservoir (2014)

Suspended substances

In surface waters the content of **suspended substances (SS)** is influenced by the geological, climate, biological and anthropic factors. The high turbidity is characteristic for the Lower Prut, as well for its tributaries in this area. The values of the content of suspended substances registered a wide diapason. It was recorded the increase of the content of suspended substances along the river course starting from Leuseni station, this part of the river receiving the waters of a range of Prut tributaries. Thus, the lowest contents of SS in all three carried out samplings were recorded in Costesti-Stinca reservoir (lower sector) and Braniste station. Taking in account the significant differences between the values of SS in upper sector (Costesti-Stinca reservoir and Braniste station) and the part of the river Sculeni-Giurgiulesti, the dynamics of SS is showed in two different figures, which clearly demonstrates that at Costesti and Braniste station the content of SS not exceeded 3.5 mg/l, when downstream it can increase up to 100 times (Fig. 4).

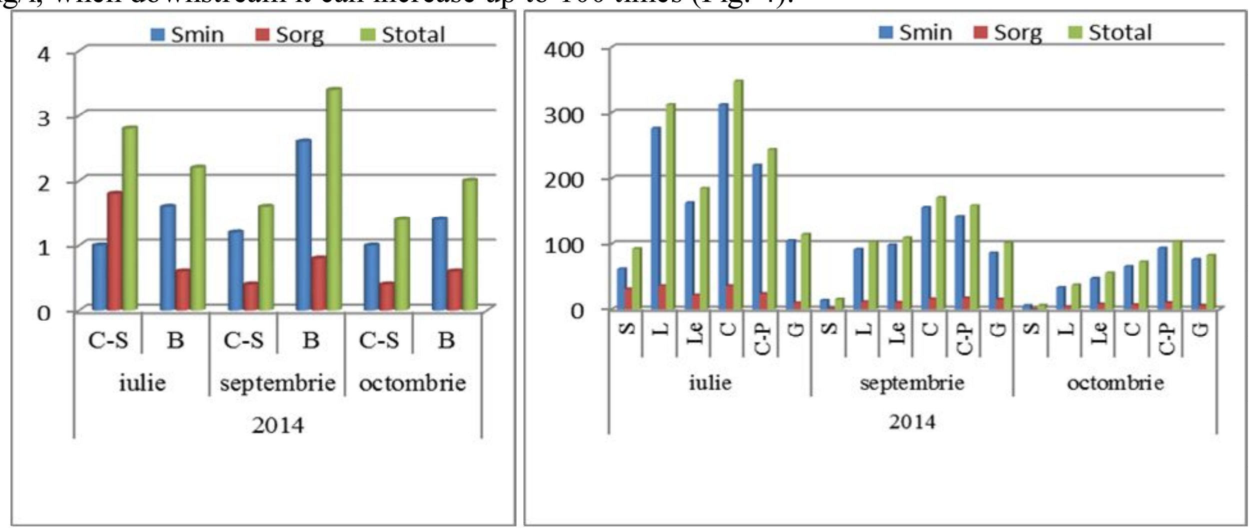

Fig. 4 Dynamics of mineral (Smin), organic (Sorg) and total (Stot) content of suspensions in the Prut River and Costesti-Stinca reservoir (C-S – Costesti-Stinca, B – Braniste, S – Sculeni, L- Leuseni, Le-Leova, C – Cahul, C-P – Cislita- Prut and G – Giurgiulesti)

In the river part Sculeni-Giurgiulesti the highest values of SS were recorded in summer (July) and the lowest – in autumn (October). More exactly, the highest value was registered at Cahul station (347.4 mg/l), what was twice more than in September and almost 4 times more than in October.

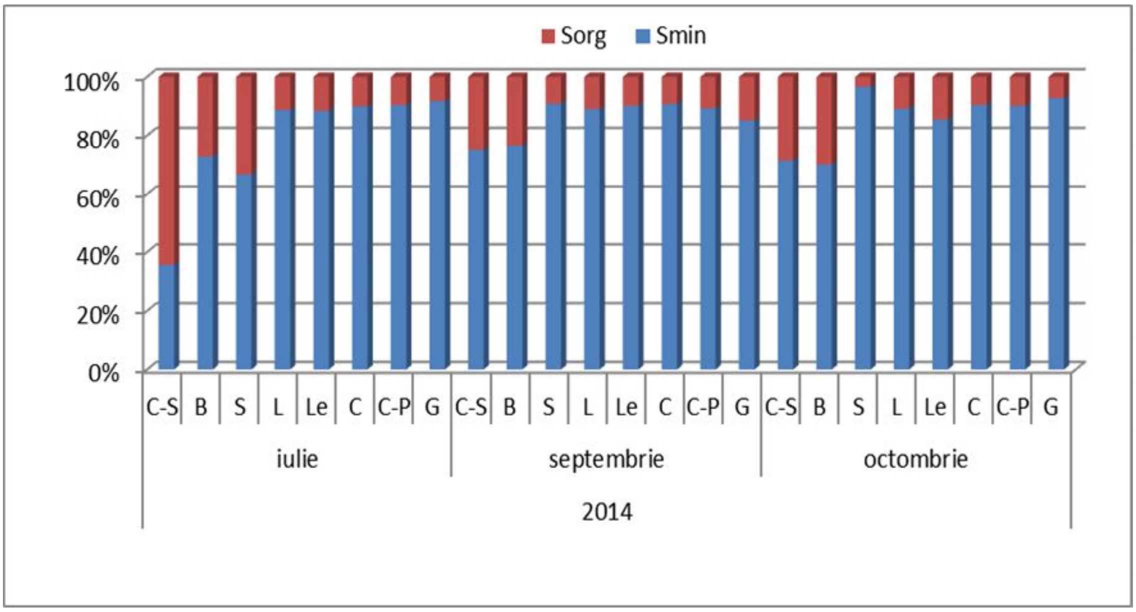

Fig. 5 Ratio between the content of mineral (Smin) and organic (Sorg) suspensions in its total content in the Prut River and Costesti-Stinca reservoir (C-S – Costesti-Stinca, B – Braniste, S – Sculeni, L- Leuseni, Le-Leova, C – Cahul, C-P – Cislita- Prut and G – Giurgiulesti)

Excepting one sample, the mineral forms of SS dominated in the formation of total SS: their share was equal to 70% and above. The exception was recorded at Costesti station in July, when the mineral part formed only 30% from the total content of suspended substances, the organic part prevailing (Fig. 5).

Main ions

In waters of the Prut River the content of hydrogen carbonate and carbonate ions varied from 161.7 mg/l in Costesti-Stinca reservoir, lower sector (September) to 231.9 mg/l at Leova station (October). It was revealed that in the given period of investigations the content of hydrogen carbonate and carbonate ions increased from Costesti-Stinca to Giurgiulesti along the river course (Fig.6).

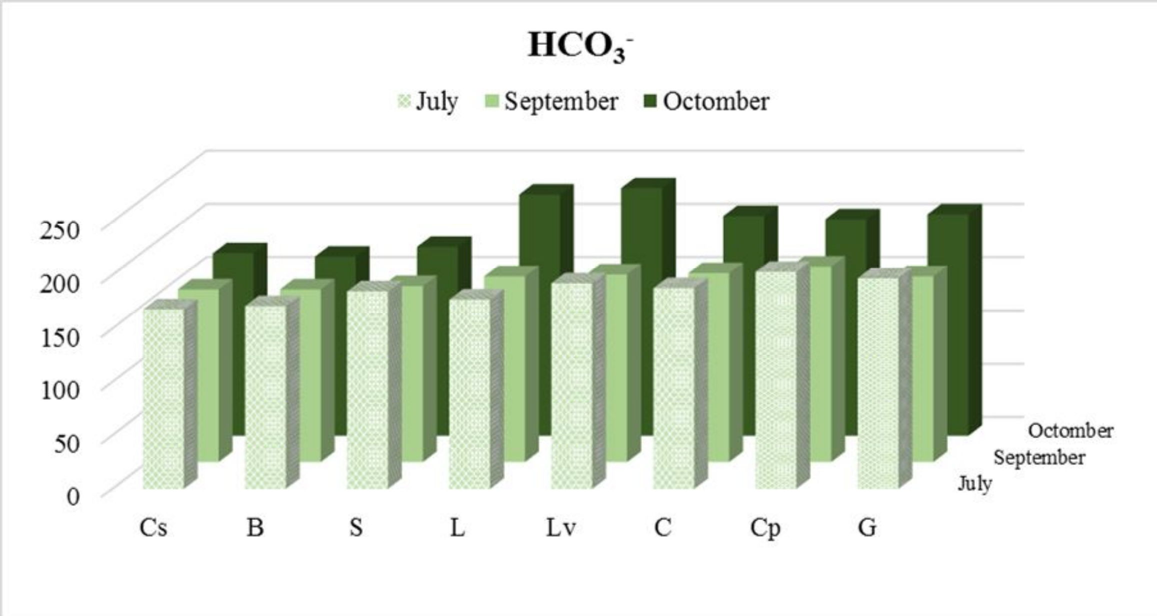

Fig.6 Hydrogen carbonate ions in the Prut River, 2014, mg/l (Cs - Costesti-Stinca, B - Braniste, S - Sculeni, L - Leuseni, Lv - Leova, C - Cahul, Cp - Cislita-Prut, G – Giurgiulesti)

The highest concentrations of the hydrogen carbonate and carbonate ions were recorded in October in the sector Leuseni-Leova.

Along the Prut River, from Costesti-Stinca to Giurgiulesti an evident increase of the concentration of **sulphate ions** was observed during the entire period of investigations. The concentrations of sulphate ions suddenly increased in October in the sector Leuseni-Leova and reached 142.8 mg/l (Fig.7). This part of the river is the most polluted of sulphates, which penetrate into the Lower Prut with household and agriculture enteprise waste waters.

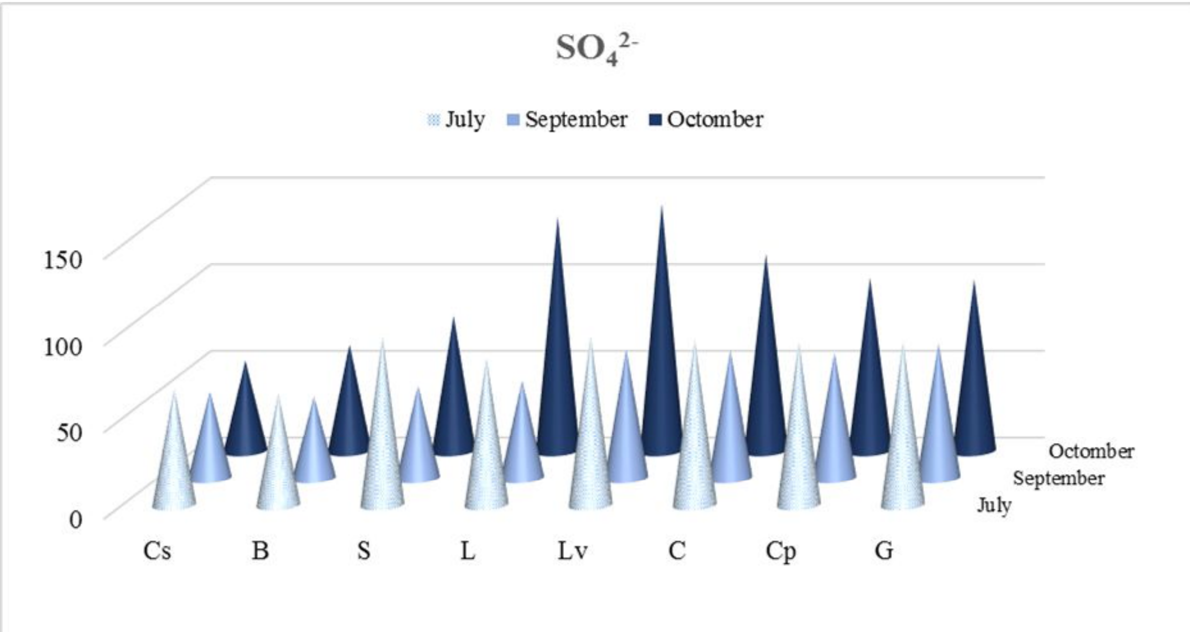

Fig. 7 Sulphate ions in the Prut River, 2014, mg/l (Cs - Costesti-Stinca, B - Braniste, S - Sculeni, L - Leuseni, Lv - Leova, C - Cahul, Cp - Cislita-Prut, G – Giurgiulesti)

According to the *Regulation on environment quality requirements for the surface waters* (2013), the water of the Prut Rivers in July-October 2014, in dependence of sulphate concentration, in 83.3% of cases belonged to the class of quality I and in 16.7% of cases – to class II.

The content of **chloride ions** along the Prut course has a low tendency to go up (Fig. 8). The highest concentration of chloride ions (29.9 mg/l) was found at Leuseni station in October, and the lowest (20.3 mg/l) – at Sculeni station in September. In accordance with the regulation, the content of chloride ions in the Prut River indicated the class of water quality I.

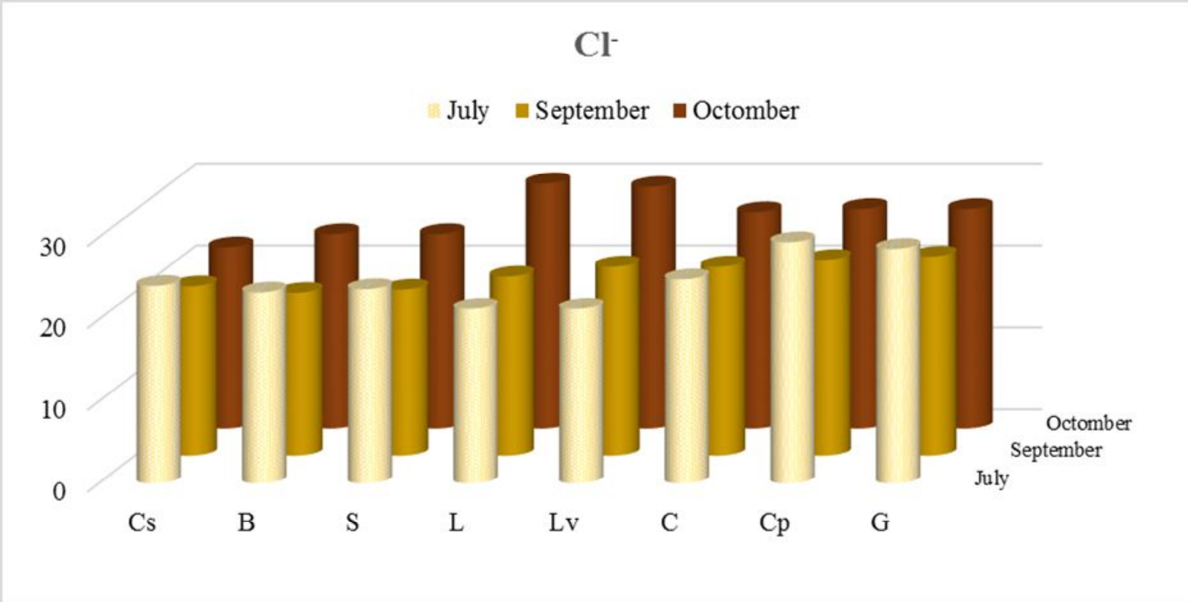

Fig. 8 Chloride ions in the Prut River, 2014, mg/l (Cs - Costesti-Stinca, B - Braniste, S - Sculeni, L - Leuseni, Lv - Leova, C - Cahul, Cp - Cislita-Prut, G – Giurgiulesti)

Calcium and magnesium penetrate into the surface waters mainly in the result of chemical disaggregation and dissolution of dolomites, shale and other minerals. The content of calcium in waters of the Prut Rivers varied slightly: from 49.1 (Leuseni, July and Sculeni, September) to 58.1 mg/l (Cislita-Prut, July and Leuseni, October). Magnesium ions ranged from 11.6 (Braniste, July) to 26.1 mg/l (Leova, October).

Downstream on the river course the share of magnesium in the formation of water hardness increased, but this was not enough for the change of dominant ion. In the sector Leova - Giurgiulesti important quantities of magnesium penetrate into the river with waste waters of enterprises.

According to regulation, the waters of the Prut River in July-October 2014, in conformity with the content of calcium and magnesium ions, belonged to the class of quality I.

The **water hardness** is a property of natural water, which depends mainly on the presence of dissolved salts of calcium and magnesium.

From July to October 2014 the water hardness of the Prut River varied from la 3.55 mg*echiv/l (Costesti-Stinca, September) to 4.85 mg*echiv/l (Leuseni, October). In September the values of water hardness were the lowest (Fig. 9).

According to the values of water hardness, the water can be used for drinking purposes.

In conformity with water hardness, in the given period the waters of the Prut River referred to the classes of quality I-II.

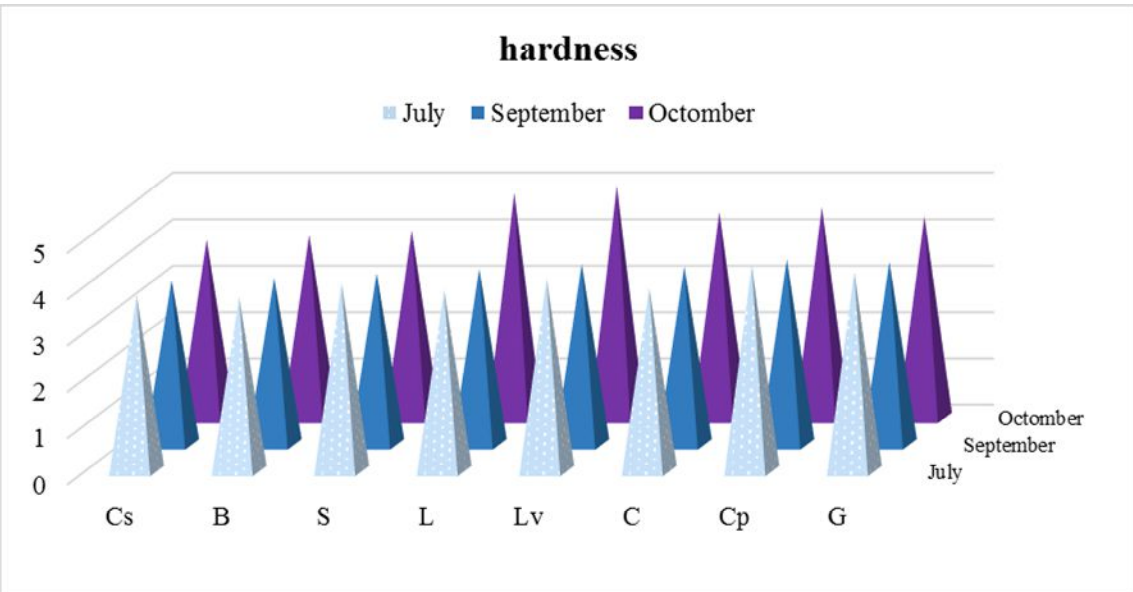

Fig. 9 Prut River water hardness, 2014, mg*echiv/l (Cs - Costesti-Stinca, B - Braniste, S - Sculeni, L - Leuseni, Lv - Leova, C - Cahul, Cp - Cislita-Prut, G – Giurgiulesti)

In July-October 2014 the content of **sodium and potassium ions** in the Prut River waters oscillated from 14.8 mg/l (Braniste, September) to 65.0 mgl (Leova, October). An obvious increase of sodium and potassium ions was observed in the Leuseni – Leova sector in October 2014. The contents of sodium and potassium ions in Leuseni-Giurgiulesti sector were higher that in Costesti-Stinca – Sculeni one, possible this fact being determined by the intense pollution of river with waste waters on the Leuseni – Leova sector.

In accordance with the *Regulation on environment quality requirements for the surface waters* (2013), the Prut waters, in conformity with the concentration of sodium and potassium ions in 58.3% of cases referred to the class of quality I, in 29.2% of cases – to class II and in all other cases – to class III.

Mineralization, as well the content of main ions, is a conservative parameter and depends mainly on natural factors. It is well known that the mineralization decreases during the period of spring floods and increases during the periods with low flows, but in the last years the Prut waters infringed this rule.

During given period of investigations the values of mineralization ranged 306.8 mg/l (Braniste, September) – 552.4 mg/l (Leova, October). In all three months it was observed the increase of the content of main ions, and consequently, of mineralization along the course of the Prut River, especially on the Leuseni – Giurgiulesti sector (Fig. 10).

In accordance with the *Regulation on environment quality requirements for the surface waters* (2013), in July-October 2014 the Prut waters, in conformity with the concentration of main ions referred to the class of quality I.

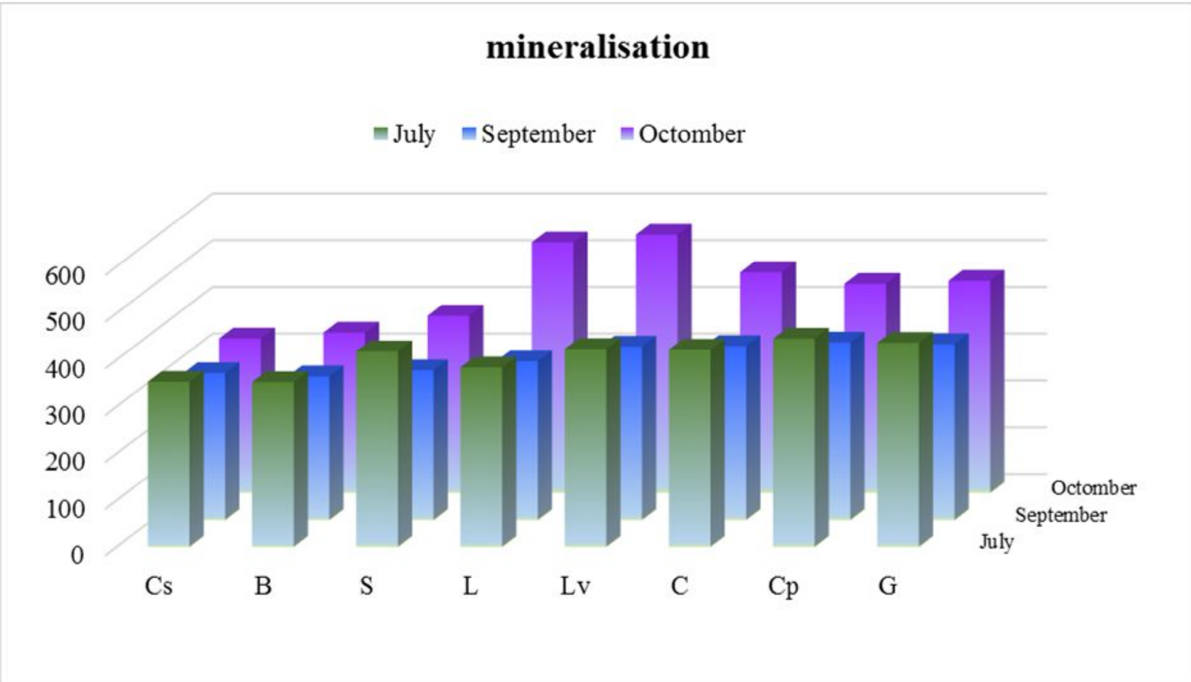

Fig. 10 Mineralization of the Prut River waters, 2014, mg/l (Cs - Costesti-Stinca, B - Braniste, S - Sculeni, L - Leuseni, Lv - Leova, C - Cahul, Cp - Cislita-Prut, G – Giurgiulesti)

It is well known that the correlation between the cations and anions is a basic indicator in the determination of surface water stability. In the given period of investigations no modification of water class or water metamorphosis was recorded, which could indicate the presence of a heavy pollution. According to the classification of Aleokin (1970), the Prut waters referred to the hydrogen carbonate class, group of calcium, type II (C^{Ca}_{II}).

Nutritive (biogenic) elements

Nitrogen compounds. In summer (July) the highest values of the content of ammonium ions ($N\text{-}NH_4^+$) were recorded in the lower part of Costesti-Stinca reservoir – Leuseni sector, they exceeding up to 4 times those from the lower part of the river in the same month and also those from September and October. Due to this fact, in July at Leuseni station the water was moderately polluted with ammonium ions and corresponded to the class of quality III, but in remaining cases the water quality was better (classes I-II). In September an increase of concentration of ammonium ions at Leova and Giurgiulesti stations was observed in comparison with upstream stations. These stations support a heavy influence of anthropic factor – the presence of station of discharge of waste waters at Leova and the functioning of Giurgiulesti port (Fig. 11).

In the dynamics of nitrite nitrogen ($N\text{-}NO_2^-$) the most often the highest values were registered in the lower part of Costesti-Stinca reservoir, followed by the Braniste (September and October) and Leuseni (September) stations. More exactly, in the given period the highest value – of 0,057 mgN/l – was registered at Costesti-Stinca station in September. According to the content of nitrite nitrogen, the water referred always to the class of quality II (Fig. 11).

The dynamics of nitrate nitrogen ($N\text{-}NO_3^-$) in July differed from those from September and October – the highest value was recorded at Leova station (1.29 mgN/l), followed by those at Leuseni and Cahul stations. Only at these three stations the water belonged to the class of quality II; in all other cases it belonged to class I. In the same time, the share of nitrate nitrogen in the total content of mineral nitrogen was equal to 60% and more, the second place being held by ammonium nitrogen (Fig.12).

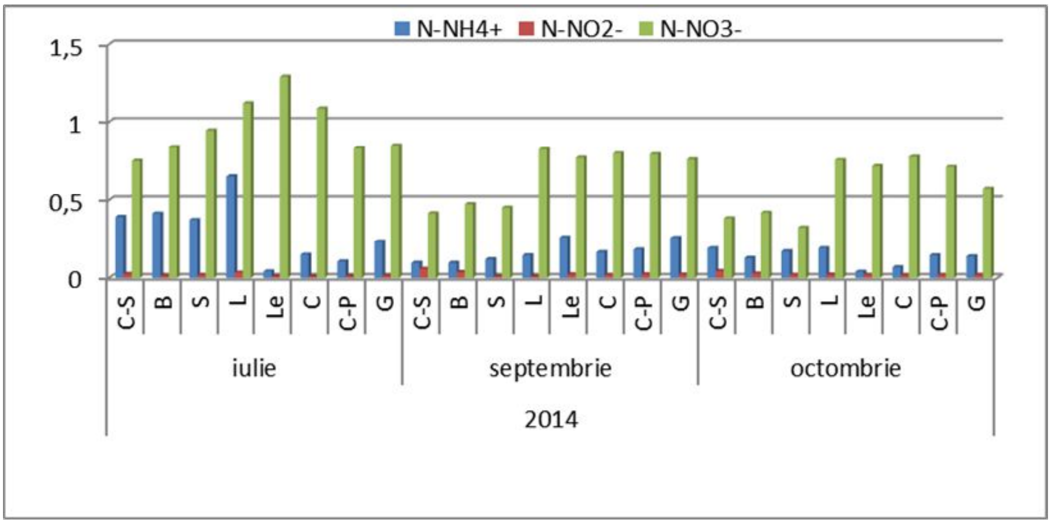

Fig. 11 Dynamics of mineral forms of nitrogen in the Prut River waters, 2014, mgN/l (C-S - Costesti-Stinca, B - Braniste, S - Sculeni, L - Leuseni, Le - Leova, C - Cahul, C-P - Cislita-Prut, G – Giurgiulesti)

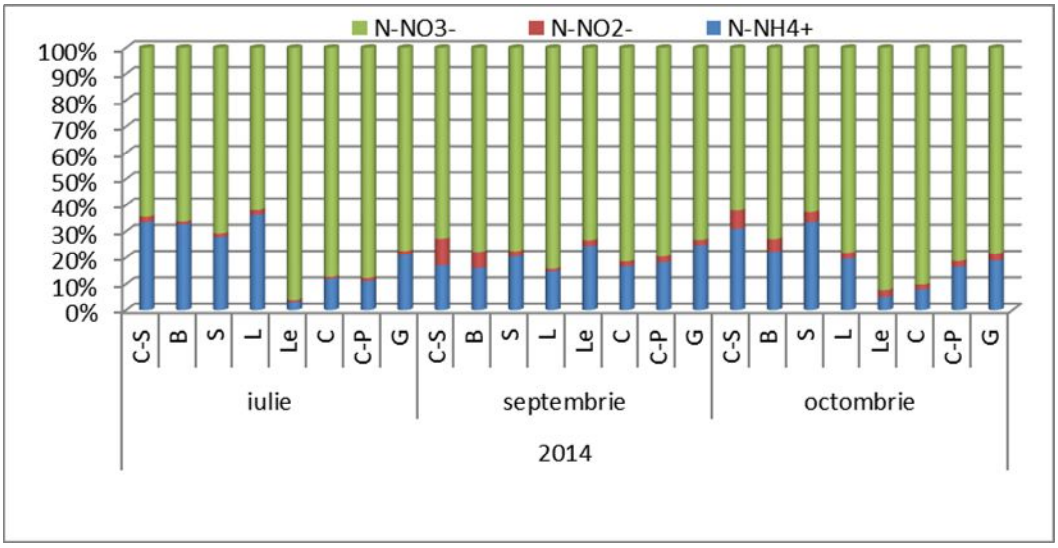

Fig. 12 Share of mineral forms of nitrogen, Prut River waters, 2014 (C-S - Costesti-Stinca, B - Braniste, S - Sculeni, L - Leuseni, Le - Leova, C - Cahul, C-P - Cislita-Prut, G – Giurgiulesti)

Analyses of the dynamics of mineral nitrogen (Nmin) revealed that the highest values were characteristic for July. The dynamics of mineral nitrogen in both autumn months was quite similar – a relatively low content at Costesti-Stinca (lower part of reservoir), Braniste and Sculeni stations and quite stable concentrations starting with Leuseni down to Giurgiulesti station, without exceeding 1 mg/l (Fig. 13).

In correlation with the values of mineral and organic nitrogen, those of total nitrogen were the highest in summer (July): 2.46 mgN/l at Sculeni station, followed by 2.4 mgN/l at Leuseni station. If in July and September the content of total nitrogen decreased along the river course, then in October the lowest values were recorded on Costesti-Stinca (lower part)- Braniste-Sculeni sector (Fig.13).

The ratio between the content of mineral, organic and total nitrogen (Nmin:Norg:Ntot) is an indicator of mineralization process of nitrogen compounds. In July the content of mineral nitrogen prevailed that of organic nitrogen. In September and October the correlation Nmin:Norg was opposite. Thus, in September on Costesti-Stinca (lower part) – Braniste - Sculeni sector the Nmin<Norg, but on Leuseni – Leova – Cahul – Cislita- Prut - Giurgiulesti sector - Nmin>Norg. In October on first sector prevailed mineral nitrogen (Nmin>Norg), and on the second – organic form (Nmin<Norg). One of explanations for September could be the mineralization along the river course of organic compounds, which penetrated into the river in its upper part. In October the organic load of nitrogen compounds could be caused by tributaries, which enter the river starting from Leuseni.

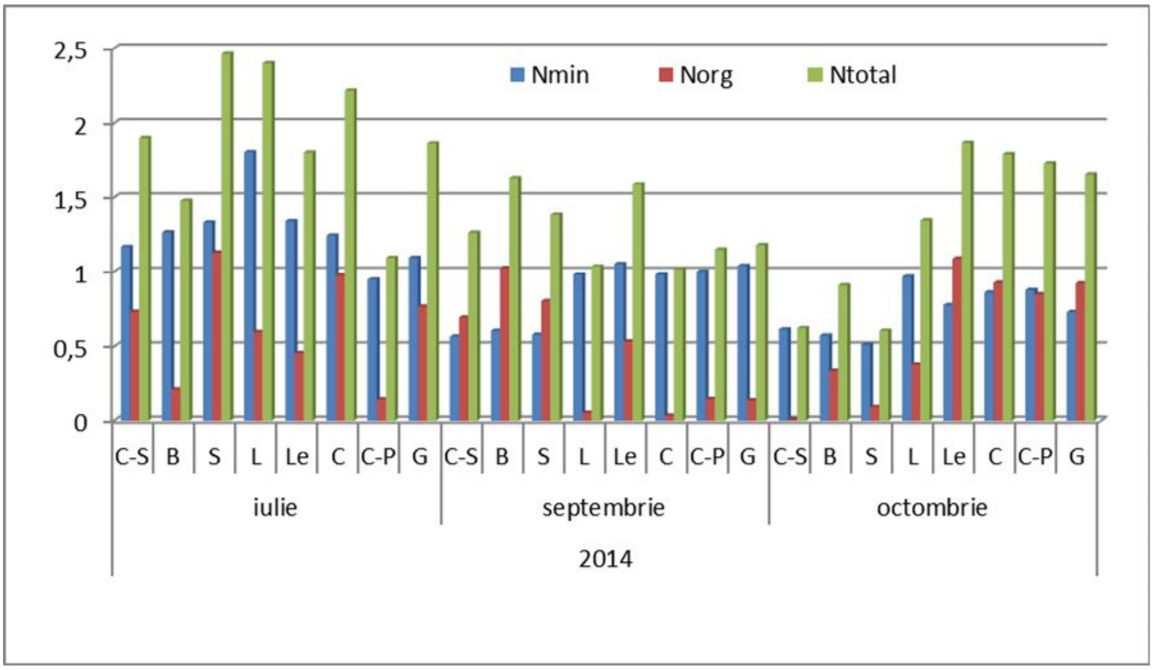

Fig. 13 Dynamics of mineral (Nmin), organic (Norg) and total (Ntot) nitrogen in waters of the Prut River, 2014 (C-S - Costesti-Stinca, B - Braniste, S - Sculeni, L - Leuseni, Le - Leova, C - Cahul, C-P - Cislita-Prut, G – Giurgiulesti)

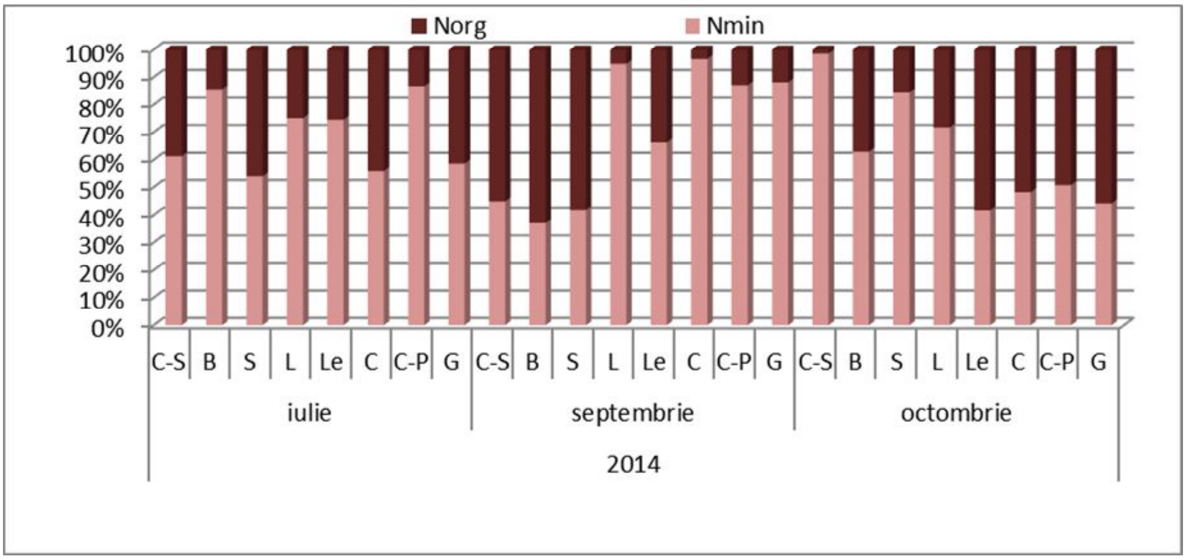

Fig. 14 Ratio between the mineral (Nmin) and organic (Norg) forms of nitrogen in the Prut River waters, 2014 (C-S - Costesti-Stinca, B - Braniste, S - Sculeni, L - Leuseni, Le - Leova, C - Cahul, C-P - Cislita-Prut, G – Giurgiulesti)

More exactly, in September and October in river sectors with low content of mineral nitrogen the share of mineral form in the total content of nitrogen was approximately 40% (Fig.14).

Phosphorus compounds. According to the content of mineral and total phosphorus, in the given period of investigations the Prut River water corresponded to the classes of quality I-II (very good-good) (Fig. 15). However, increased contents of mineral phosphorus were observed at Costesti-Stinca (lower part), Sculeni and Leuseni stations in different months. In July both in the dynamics of mineral phosphorus and total phosphorus it was remarked an increase along the river course from Costesti-Stinca (lower part) to Leuseni station and a decrease from Leova to Giurgiulesti.

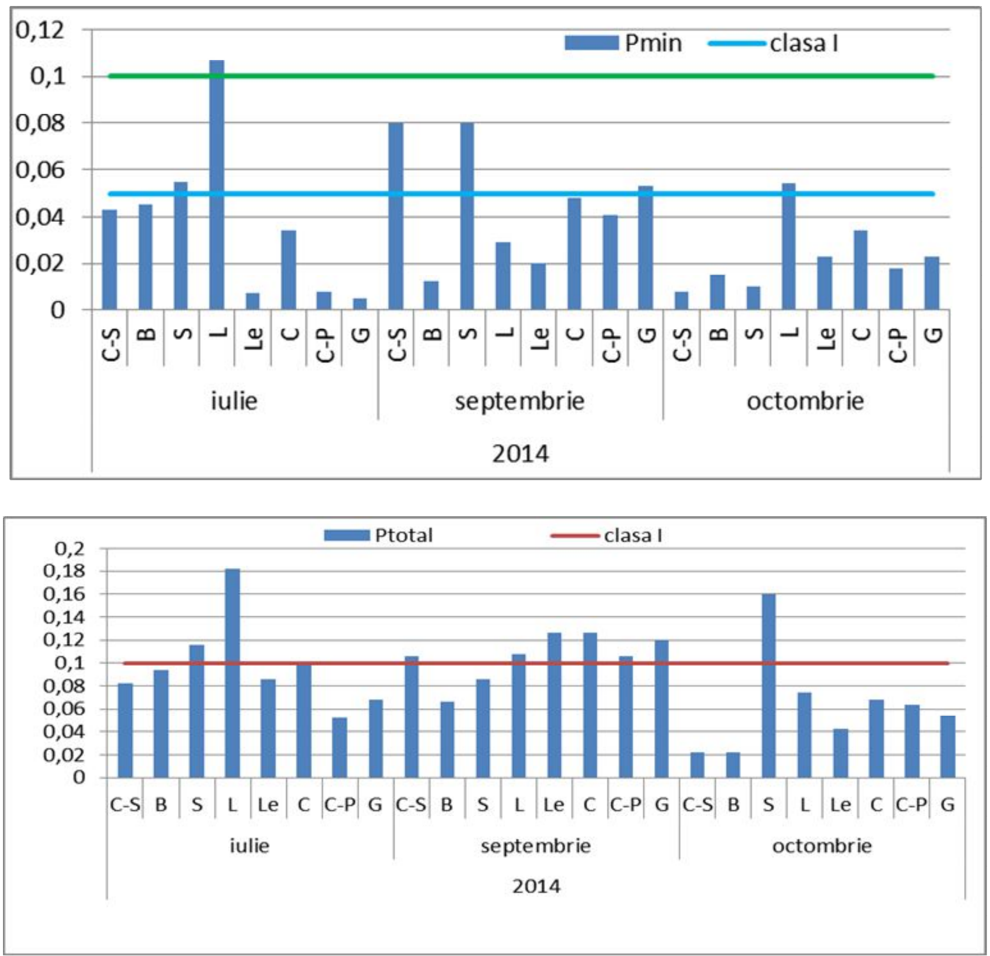

Fig. 15 Dynamics of mineral (Pmin) and total (Ptot) phosphorus in the Prut River waters, 2014 (C-S - Costesti-Stinca, B - Braniste, S - Sculeni, L - Leuseni, Le - Leova, C - Cahul, C-P - Cislita-Prut, G – Giurgiulesti)

Correlation between the mineral and organic forms of phosphorus differed from that of nitrogen. In July on the river sector Costesti-Stinca – Leuseni the ratio Pmin:Porg was approximately of 1:1, but downstream, from Leova to Giurgiulesti, the share of mineral phosphorus in its total content accounted only 10-15% (Fig. 16).

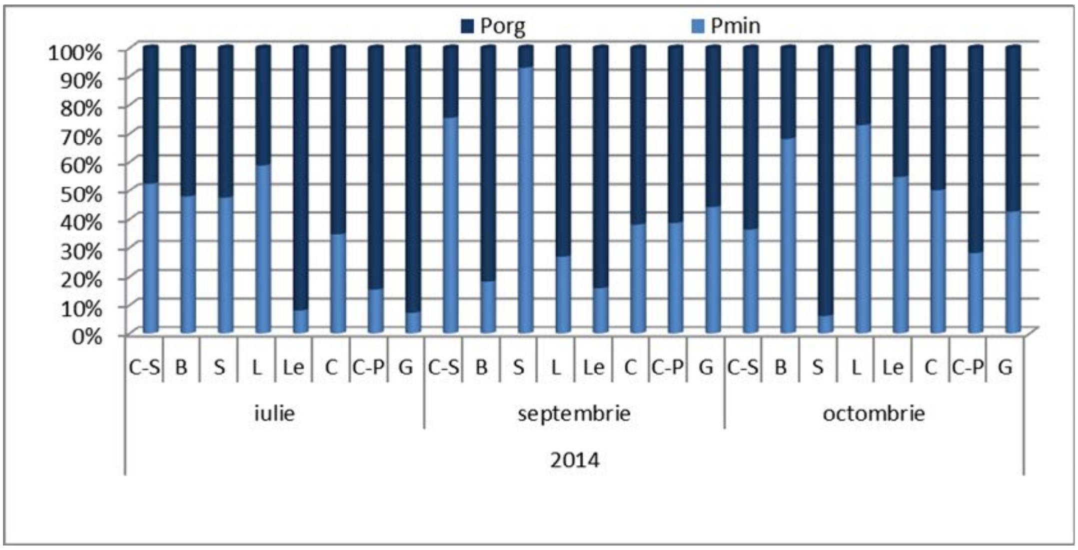

Fig. 16 Ratio between the mineral (Pmin) and organic (Porg) forms of phosphorus in the Prut River waters, 2014 (C-S - Costesti-Stinca, B - Braniste, S - Sculeni, L - Leuseni, Le - Leova, C - Cahul, C-P - Cislita-Prut, G – Giurgiulesti)

The same situation was registered at Braniste station in September. To note that this station is characterized as one of the most reach from plant and animal diversity point of view. The highest content of organic phosphorus was determined in October at Sculeni station (0.15 mgP/l), when it formed about 90% of total phosphorus.

Silicon compounds. Although the *Regulation on environment quality requirements for the surface waters* (2013) not includes any requirement regarding the content of silicon in water, it was a part of carried out water chemical analyses. During the given period of investigation its content in water has not exceeded 3 mg/l (Fig. 17).

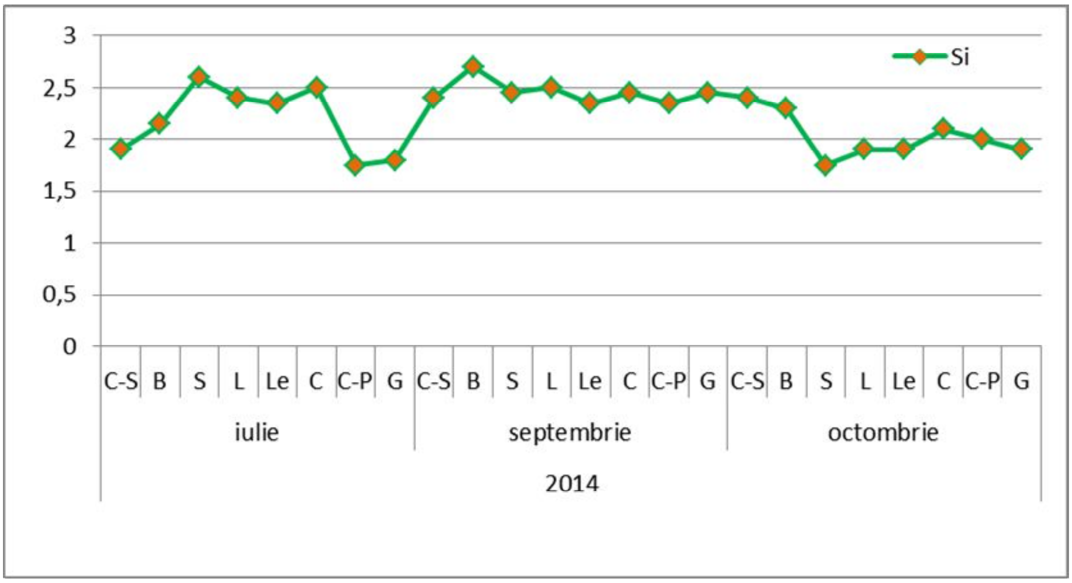

Fig. 17 Dynamics of silicon in the Prut River waters, 2014, mg/l (C-S - Costesti-Stinca, B - Braniste, S - Sculeni, L - Leuseni, Le - Leova, C - Cahul, C-P - Cislita-Prut, G – Giurgiulesti)

HYDROBIOLOGICAL PARAMETERS

Bacterioplankton

The total number of planktonic bacteria (Ntot) from July to October 2014 varied in a wide diapason – 0.4-11.0 million cells/ml and the dynamics in time of this parameter is quite specific (Fig.18).

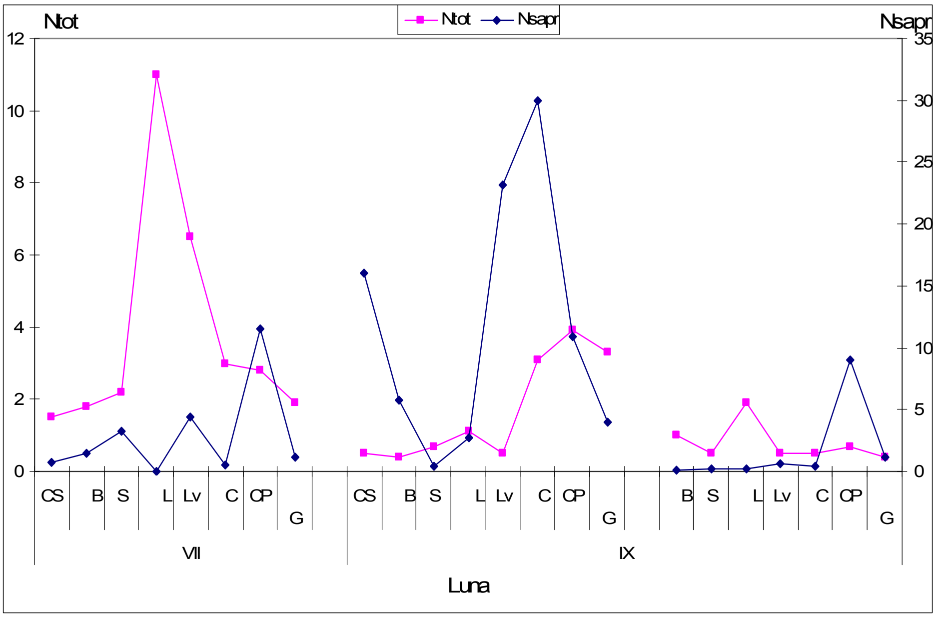

Fig. 18 Dynamics of total number of planktonic bacteria (Ntot, million cells/ml) and number of saprophytic bacteria (Nsapr, thousand cells/ml) in the Prut River, 2014 (CS - Costesti-Stinca, B - Braniste, S - Sculeni, L - Leuseni, Lv - Leova, C - Cahul, CP - Cislita-Prut, G – Giurgiulesti)

We can state that in the most of cases the total number of planktonic bacteria fits to the diapason 0.4 - 4.0 million cells/ml, which is also characteristic for the bacterioplankton of the Dniester River in the analogic period of time. The highest values were observed in July at Leova (6.5 million cells/ml) and Leuseni (11.0 million cells/ml) stations.

The dynamics of saprophytic bacteria demonstrated also a rather large variability: 0.4-38.4 thousand cells/ml. As in the case of the density of total bacterioplankton, the most favourable thermic and trophic conditions for the development of this group of bacteria occur in summer time, for example, in July at Leova station it accounted 38.4 thousand cells/ml.

The analysis of bacterial production and destruction activity (Fig. 19) for July-October 2014 put in evidence that in most of cases the values of bacterial production (P) were low and oscillated between 0.08 (Costesti-Stinca, October) and 3.39 (Leuseni, July) cal/l in 24 hours. The bacterial destruction (R) ranged 1.19 (Costesti-Stinca, July) – 30.13 (Leova, October) cal/l in 24 hours. No evident seasonal dynamics was registered for both of parameters.

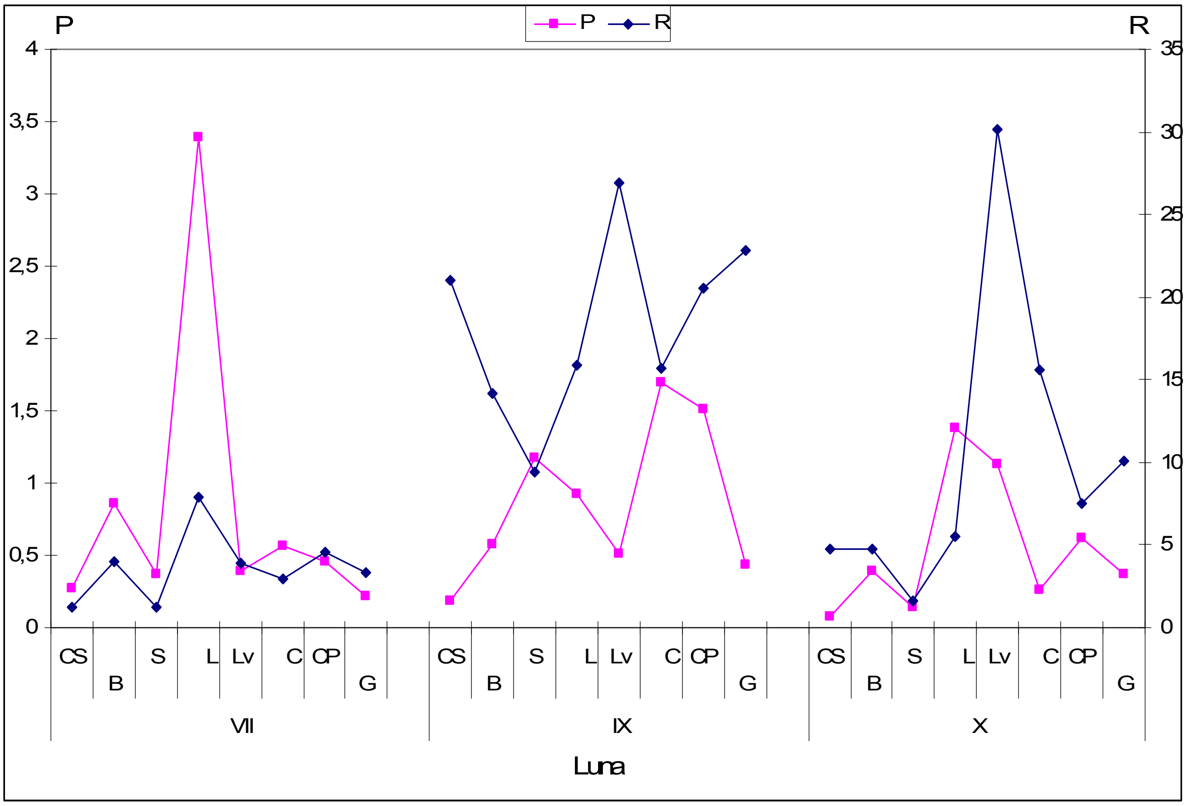

Fig. 19 Monthly dynamics of bacterioplankton production (P, cal/l in 24 hours) and destruction (R, cal/l in 24 hours) in the Prut River, 2014 (CS - Costesti-Stinca, B - Braniste, S - Sculeni, L - Leuseni, Lv - Leova, C - Cahul, CP - Cislita-Prut, G – Giurgiulesti)

A classic numerical analysis of ecophysiological groups of microorganisms, which are implied at different stages in the natural circles of the main biogenic elements (nitrogen, phosphorus, carbon) was done, and also of those which participate to the decomposition of phenols and petroleum products.

Phenolytic and petrolytic bacteria were found in all water samples (Fig. 20). The variation limits of phenolytic bacteria are very large (0.1 – 1.1 thousand cells/ml), in function of the presence of phenols in the water, which penetrate into the river with the waste waters, and of submerged water plants, which form toxic compounds, including phenols, in the process of their decomposition. The density of petrolytic bacteria was also high - 0.29 – 1.5 thousand cells/ml. Their limits of variation depend on the presence of petroleum products, which are brought into the river with run-offs from rural and urban areas and discharged waste waters.

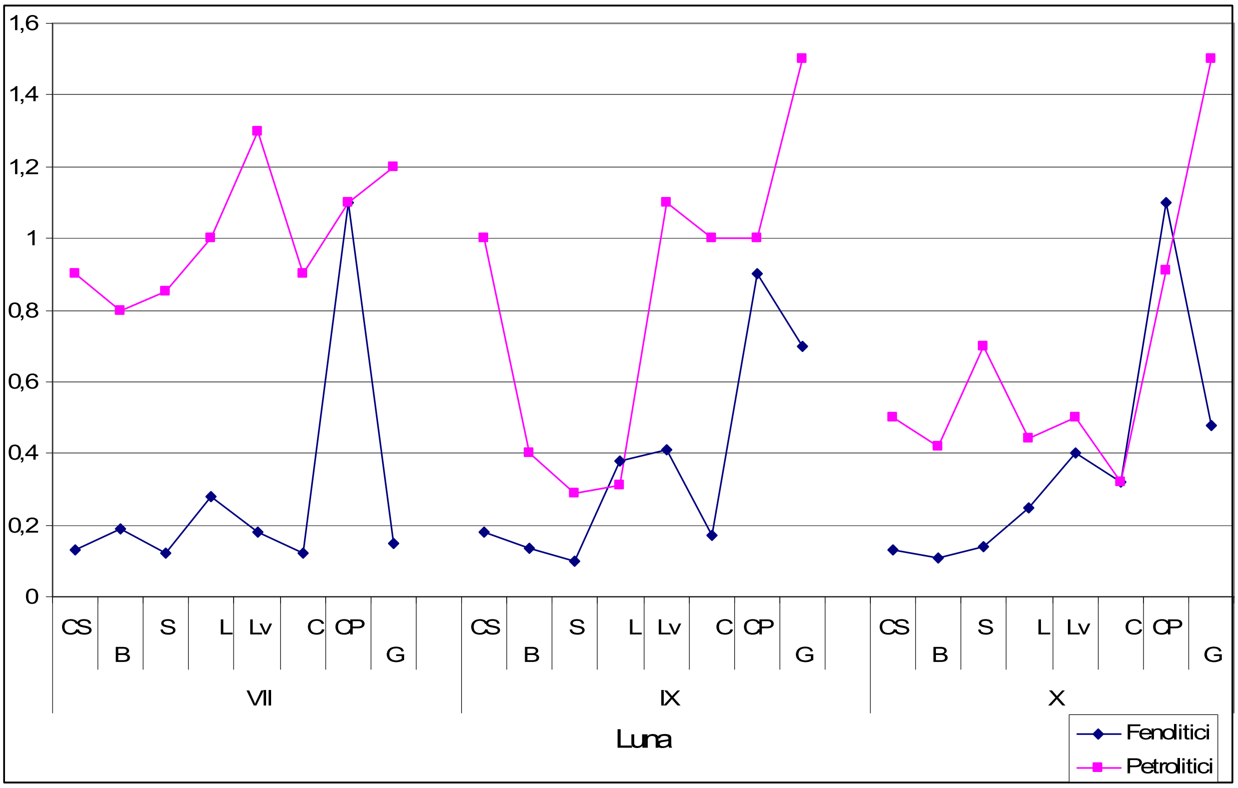

Fig. 20 Monthly dynamics of phenolytic and petrolytic bacteria (thousand cells/ml) in the Prut River, 2014 (CS - Costesti-Stinca, B - Braniste, S - Sculeni, L - Leuseni, Lv - Leova, C - Cahul, CP - Cislita-Prut, G – Giurgiulesti)

Phytoplankton

In the given period of investigation (08.07.2014 – 07.11.2014) there were collected 48 samples of phytoplankton from Costesti-Stinca reservoir and the Prut River, stations Costesti, Braniste, Sculeni, Leuseni, Leova, Cahul, Cislita-Prut and Giurgiuleşti. At each sampling point the water transparency and temperature were measured, experiments on assessment of phytoplankton primary production and destruction of organic substances were carried out (24 experiments).

It was stated that in July-October 2014 the phytoplankton of the Prut River was represented by 66 species and intraspecific taxa, of which *Cyanophyta* - 8, *Bacillariophyta* – 33, *Euglenophyta* - 6, and *Chlorophyta* - 19. Correspondingly, in the structure of phytoplankton was dominated by cianophytes, bacillariophytes and green algae.

The density of phytoplankton ranged 0.36-14.28 million cells/l in the Prut River and 4.51 – 9.05 million cells/l in Costesti-Stinca reservoir (Fig. 21).

The values on phytoplankton density in July were much lower in comparison with those recorded in September, especially in the Braniste-Leova sector. In October higher values of density were registered in the Lower Prut, decreasing continuously from Leuseni to Giurgiulesti.

The biomass of phytoplankton, composed mainly by bacillariophytes, oscillated in the diapason 0.53-5.77 g/m^3 in the Prut River and 0.94- 2.73 g/m^3 – in Costesti-Stinca reservoir (Fig. 22), being higher at Cislita-Prut and Giurgiulesti stations in July and at Leuseni station in September and October.

The values of primary production (A) in the Prut River ranged 0.07- 2.19 gO_2/m^{-2} 24h, the highest values being recorded in autumn at Braniste and Leuseni stations, and the lowest – at Leuseni and Cahul stations in July (Fig. 23).

The values of destruction of organic substances (R) were higher in July, especially in the Braniste-Leuseni sector of the Prut River (13.1-19.44 gO_2/m^{-2} 24h). In the lower sector of Costesti-Stinca reservoir the intensity of destruction processes (1.72-12.87 g O_2/m^{-2} 24h) exceeded considerably that of production processes (0.98-2.42 gO_2/m^{-2} 24h), thus, the ratio A/R was less than 1.

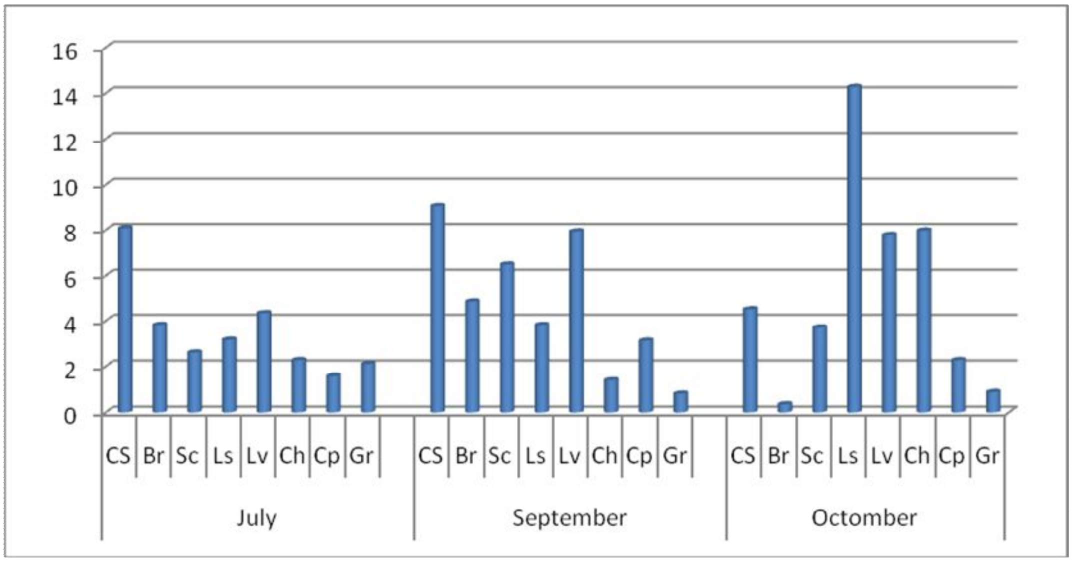

Fig. 21. Density (million cells/l) of phytoplankton in the lower part of Costesti-Stinca reservoir (CS) and the Prut River, 2014 (Br- Braniste, Sc-Sculeni, Ls-Leuseni, Lv- Leova, Ch-Cahul, Cp-Cislita-Prut, Gr-Giurgiulesti)

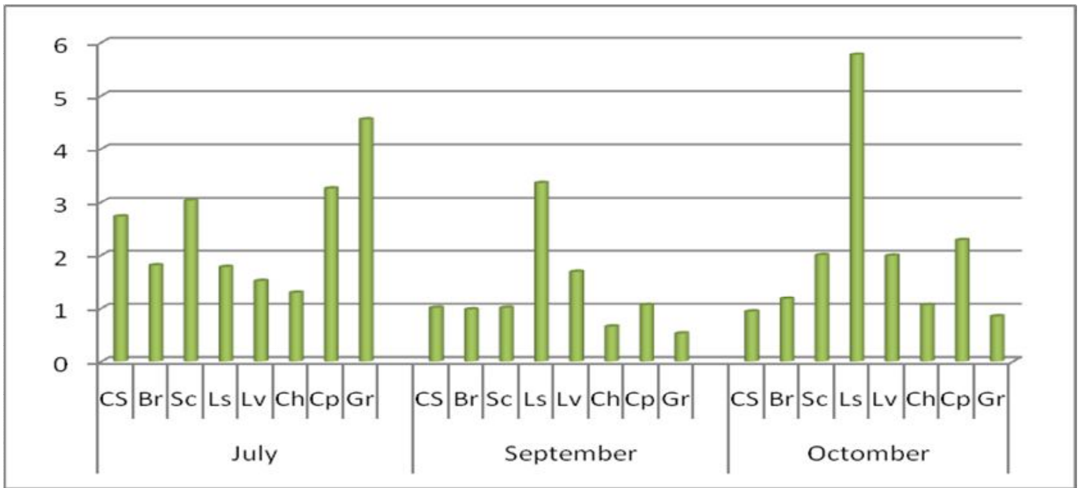

Fig. 22. Biomass (g/m^3) of phytoplankton in the lower part of Costesti-Stinca reservoir (CS) and the Prut River, 2014 (Br- Braniste, Sc-Sculeni, Ls-Leuseni, Lv- Leova, Ch-Cahul, Cp-Cislita-Prut, Gr-Giurgiulesti)

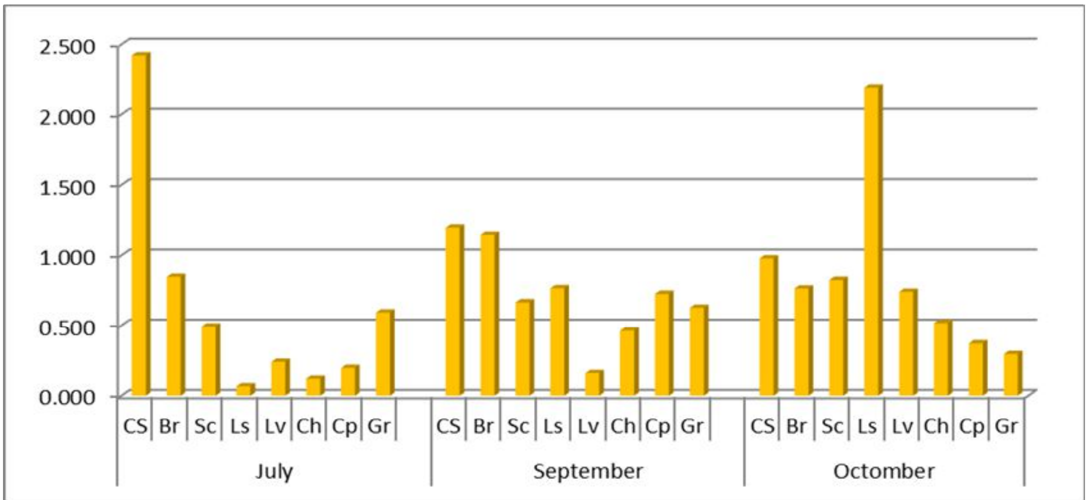

Fig. 23. Dynamics of primary production of phytoplankton (gO^2/m^{-2} 24h) in the lower part of Costesti-Stinca reservoir (CS) and the Prut River, 2014 (Br- Braniste, Sc-Sculeni, Ls-Leuseni, Lv- Leova, Ch-Cahul, Cp-Cislita-Prut, Gr-Giurgiulesti)

According to the values of saprobic index (1.89-2.6), calculated of the base of quantitative parameters of planktonic algae, in July-October 2014 the waters of the Prut River can be characterized as of good quality (class of quality II) and moderately polluted (class of quality III).

Zooplankton

In the given period of investigation (08.07.2014 – 07.11.2014) there have been collected 24 quantitative samples of zooplankton from the lower part of Costesti-Stinca reservoir and the Prut River (stations Braniste, Sculeni, Leuseni, Leova, Cahul, Cislita-Prut and Giurgiulesti).

There were identified 24 taxa of the main groups of zooplankton in the collected samples: 9 – *Rotifera* (37.5 %), 9 – *Copepoda* (37.5 %) and 6 – *Cladocera* (25.0 %). In order to analyse the zooplanktonic communities from structural and functional point of view, a range of quantitative parameters and biocenotic indices were calculated: density (N, ind./m^3), biomass(B, mg/m^3), productivity (P, mg/m^3/24 h), abundance (A, %), frequency (F, %), and saprobic index (I_S).

The most favourable conditions for zooplankton development occur in lentic ecosystems and this is proved by all analysed parameters (Fig. 24 – 26).

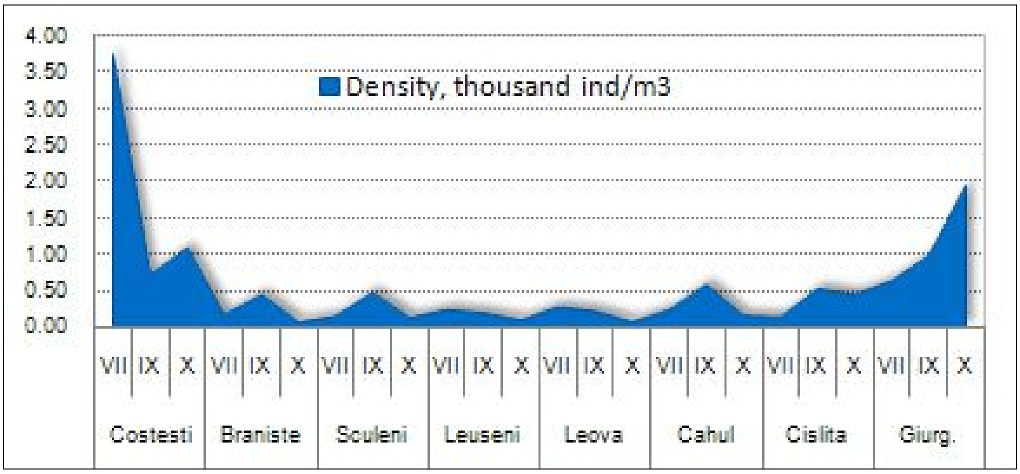

Fig. 24. Density of zooplankton in the Prut River and Costesti-Stinca reservoir, 2014

In monitored area of the Prut River the lentic system is represented by Costesti-Stinca reservoir: values of zooplankton density, biomass and productivity are the highest there. In running Prut waters the density of zooplankton ranged from 70 ind./m^3 (Braniste, October) to 1960 ind./m^3 (Giurgiulesti, October). The better conditions for the development of zooplankton in the Cislita-Prut – Giurgiulesti sector, comparatively with upstream sector, are caused by the lower water speed and the presence of submerged macrophytes in littoral area, where the biologic material was sampled.

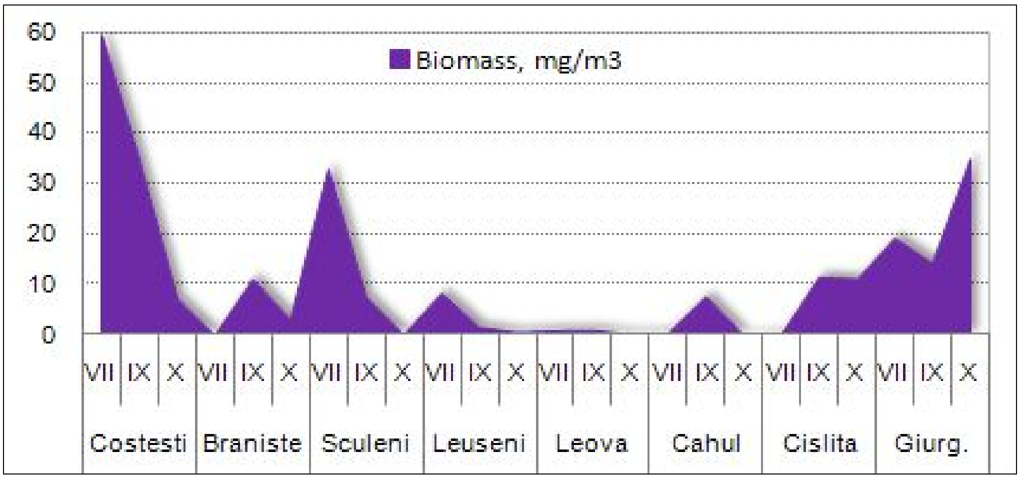

Fig. 25. Biomass of zooplankton in the Prut River and Costesti-Stinca reservoir, 2014

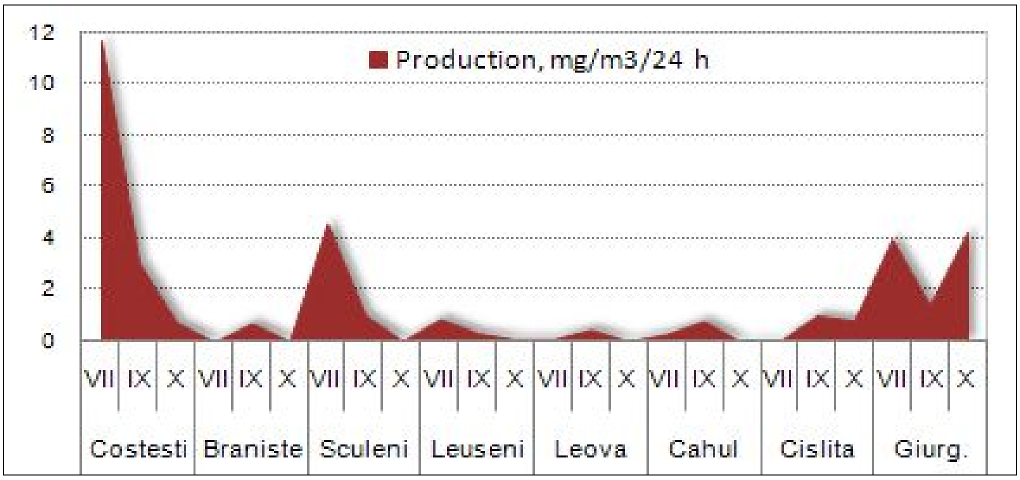

Fig. 26 Productivity of zooplankton in the Prut River and Costesti-Stinca reservoir, 2014

Species diversity (number of taxa) of zooplankton in the monitored area of the Prut River showed the same tendencies as the quantitative parameters. The highest diversity of zooplankton taxa was recorded at Costesti and Giurgiulesti stations (Fig. 27).

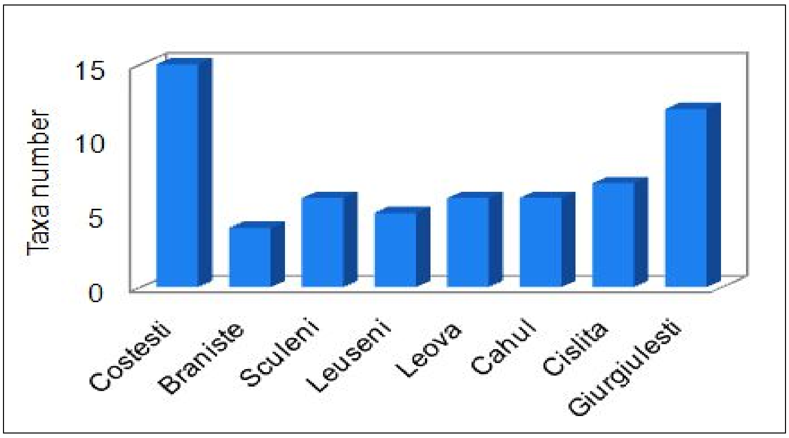

Fig. 27 The number of zooplankton taxa in the Prut River and Costesti-Stinca reservoir, July – October 2014

Taxonomic structure of zooplankton communities can be presented in the form of relative abundance. Numerical abundance of the main groups of zooplankton (%) is showed in the Fig. 28. The dominance of rotifers in zooplankton communities is an indicator of increasing ecosystem trophicity (Крючкова, 1987; Садчиков, 2007). Taking in account this fact, we can assume that in July the anthropic pollution of the river with biogenic compounds was more intensive at Braniste and Cahul stations, but in September and October it was considerable at the most of monitored stations.

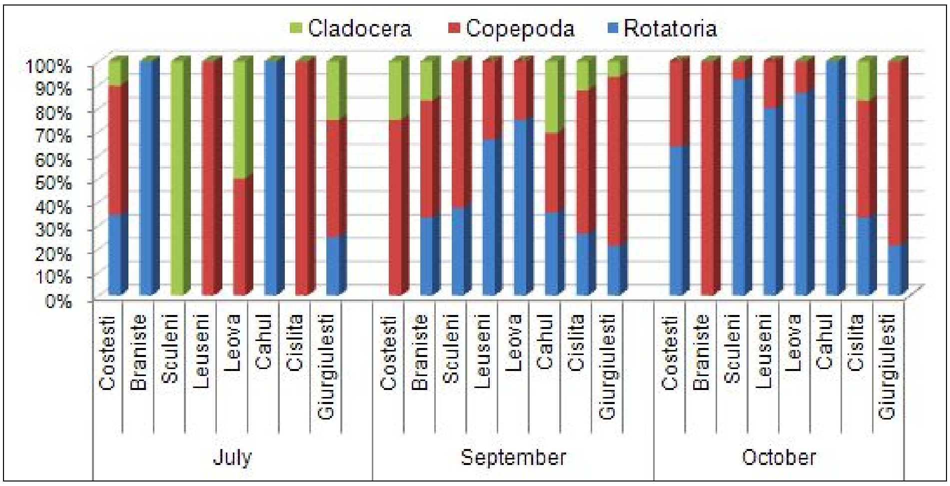

Fig. 28 Relative numerical abundance of zooplankton taxonomic groups in the Prut River and Costesti-Stinca reservoir, 2014

In studied ecosystems the group of rotifers from the structural complex of zooplankton included the representatives of genera *Brachionus*, *Euchlanis*, *Filinia*, *Keratella* and *Polyarthra.* In many samples the larval and juvenile stages of copepods *(Copepoda gen sp*., st. nauplius and st. *copepodit*) were constant components of zooplankton communities. Adult copepods were represented by the species *Acanthocyclops vernalis*, *Mesocyclops crassus*, *Mesocyclops leuckarti*, *Mesocyclops oithonoides*. The least represented were crustaceans from the suborder *Cladocera.* This group was represented by the species *Alona rectangula*, *Chydorus sphaericus*, *Daphnia cucullata*, *Eurycercus lamellatus*, *Moina micrura* and *Sida crystallina*.

In the given period among identified zooplankton taxa 18 species (78%) are saprobic indicators, of which 39% are representatives of oligo-saprobic zone, 17% - of oligo-β-mezosaprobic and 44 % – of β-mezosaprobic zone (Fig. 29).

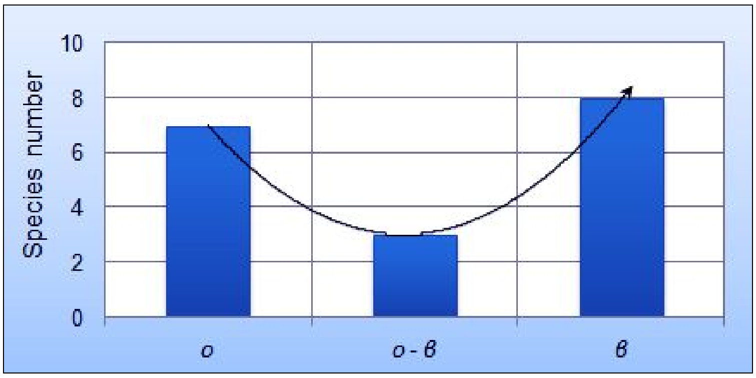

Fig. 29 Distribution of zooplankton species according to the grup of saprobic indicators, the Prut River and Costesti-Stinca reservoir, July – October 2014

In order to assess the level of saprobity of aquatic ecosystem in conformity to zooplankton indicator species, the saprobic index was calculated for each monitored station.

The montly averages of saprobic index for July-October 2014 are showed in Fig. 30. According to received results, the sector Costesti-Sculeni can be assessed as a oligo-saprobic zone, at Leuseni, Cislita-Prut and Giurgiulesti stations the ecosystem is oligo-β-mezosaprobic, at Leova and Cahul stations - β-mezosaprobic. Considering the fact that the instantaneous planktonic samples are not always representative, the assessment of the water body according to the indicator species of zooplankton may be taken into consideration only in conformity with other hydrobiological and hydrochemical parameters.

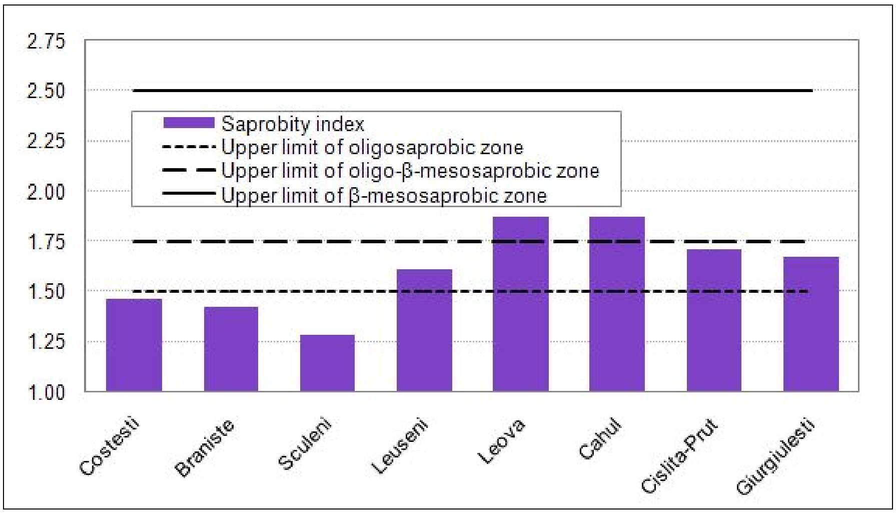

Fig. 30 Montly averages of saprobic index in Costesti-Stinca reservoir and the Prut River according to indicator species of zooplankton, July-October 2014

Macrozoobenthos

More than 40 samples of benthic macroinvertebrates have been collected from the Prut River during 08.07.2014 – 07.11.2014. Benthic invertebrates have been sampled in shallow zones of the Prut River, including Costesti-Stinca reservoir, at depths up to 1.2 m. Species composition and structural characteristics of macrozoobenthos were studied at the following stations: Costesti-Stinca, Braniste, Sculeni, Leuseni, Leova, Cahul, Cislita-Prut, and Giurgiulesti.

Thus, it was determined that downstream on the Prut River a decrease of the density of total zoobenthos, density of zoobenthos without molluscs and of the biomass of zoobenthos without molluscs occurred (Fig. 31-33).

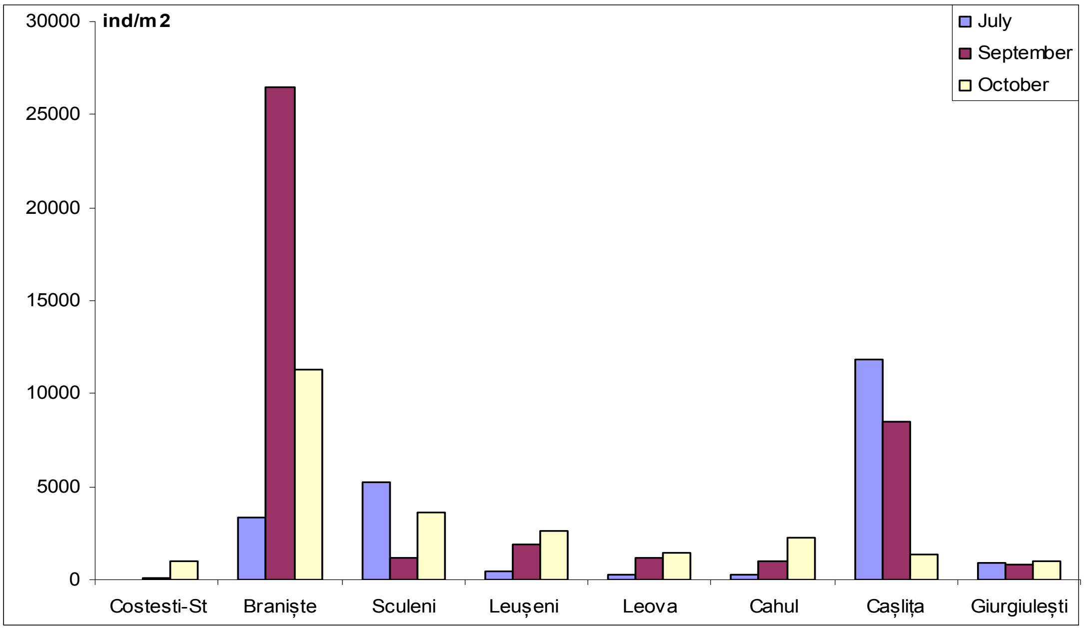

Fig. 31 Density (ind./m^2) of total zoobenthos in the Prut River, July – October 2014

The highest density was registered at Braniste station in September: zoobenthos without mollusks - 25384 ind./m^2 and total zoobenthos - 26504 ind./m^2 (Fig. 31- 32), the significant part of which consisted of representative of Gammaridae - *Pontogammarus robustoides* (G.O. Sars, 1894) with a density of 20800 ind./m^2.

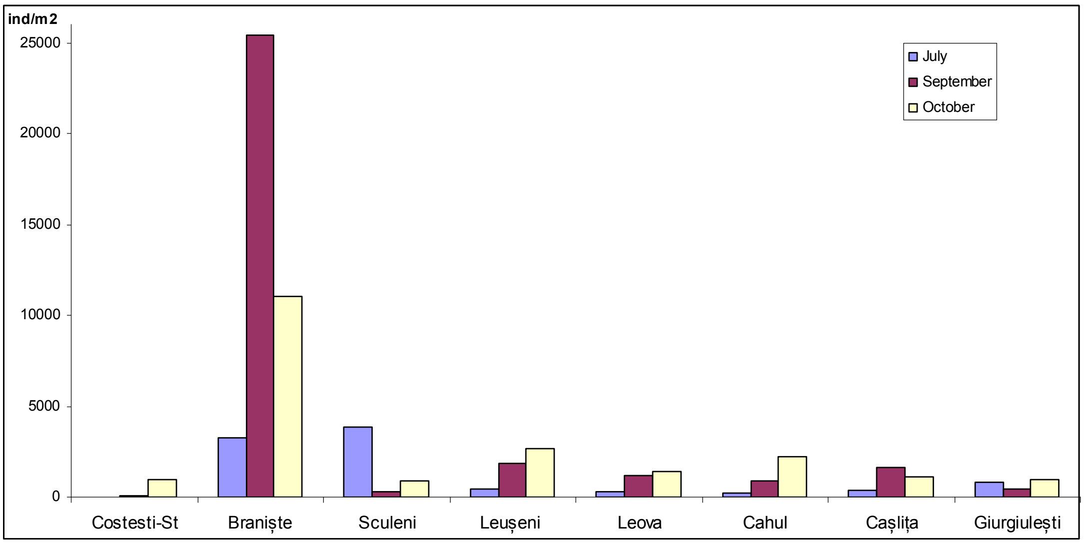

Fig. 32. Density (ind./m^2) of zoobenthos without molluscs in the Prut River, July – October 2014

The lowest density of total zoobenthos was recorded at Costesti-Stinca station with 30 ind./m^2 (Fig.31), where only dredge has been used for quantitative sampling. In the case of usual quantitative sampling (with Petersen grab) the lowest value was recorded at Cahul station - 241 ind./m^2.

The highest values of biomass of zoobenthos without molluscs were registered at Braniste stations - 34.24 g/m^2 (Gammaridae) in September and Leuseni station - 53.6 g/m^2 (*Aphelocheirus* *aestivalis* (Fabricius, 1794)) in September and 57.28 g/m^2 (*Palingenia longicauda* (Olivier, 1791)) in October.

The highest value of biomass of total zoobenthos was registered at Cahul station in September -1393.926 g/m^2, of which 1393.2 g/m^2 consisted of *Unio tumidus* (Retzius, 1788) (Fig. 34).

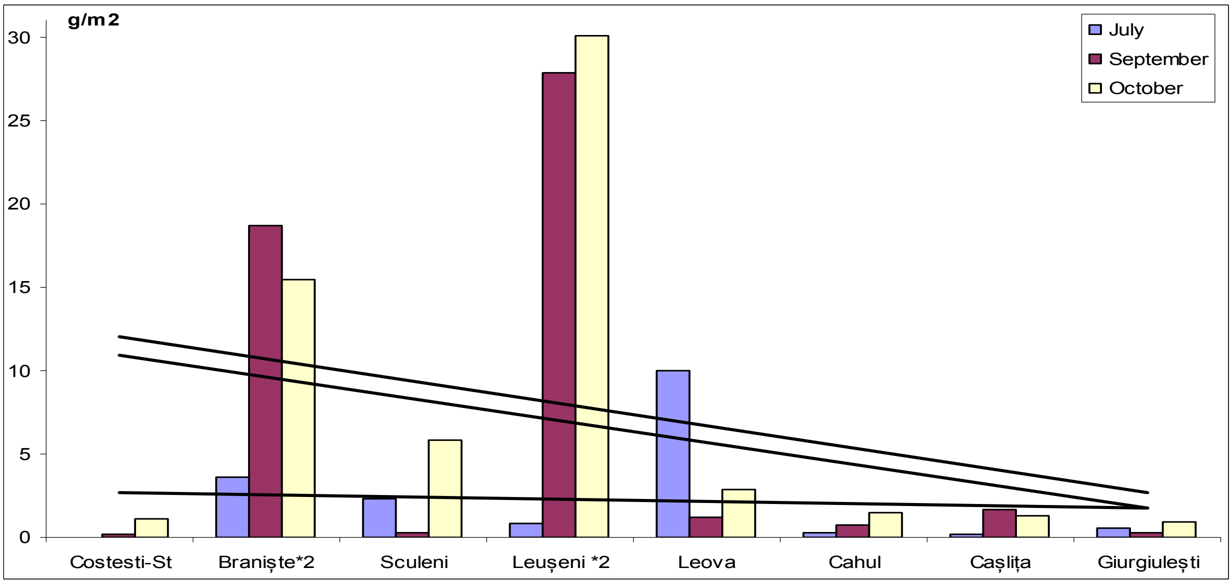

Fig. 33. Biomass (g/m^2) of zoobenthos without molluscs in the Prut River, July – October 2014

In general, the biomass of total zoobenthos depends on the presence in samples of large bivalve mollusks. For example, in October at Leova station the biomass of total zoobenthos was of 1361.56 g/m^2, 99.7% of which was formed by *Crassiana crassa.* Another example: in July at Giurgiulesti station the biomass of total zoobenthos was of 1360 g/m^2, but 99.9% of which consisted of *Unio tumidus* (Retzius, 1788) (Fig. 34).

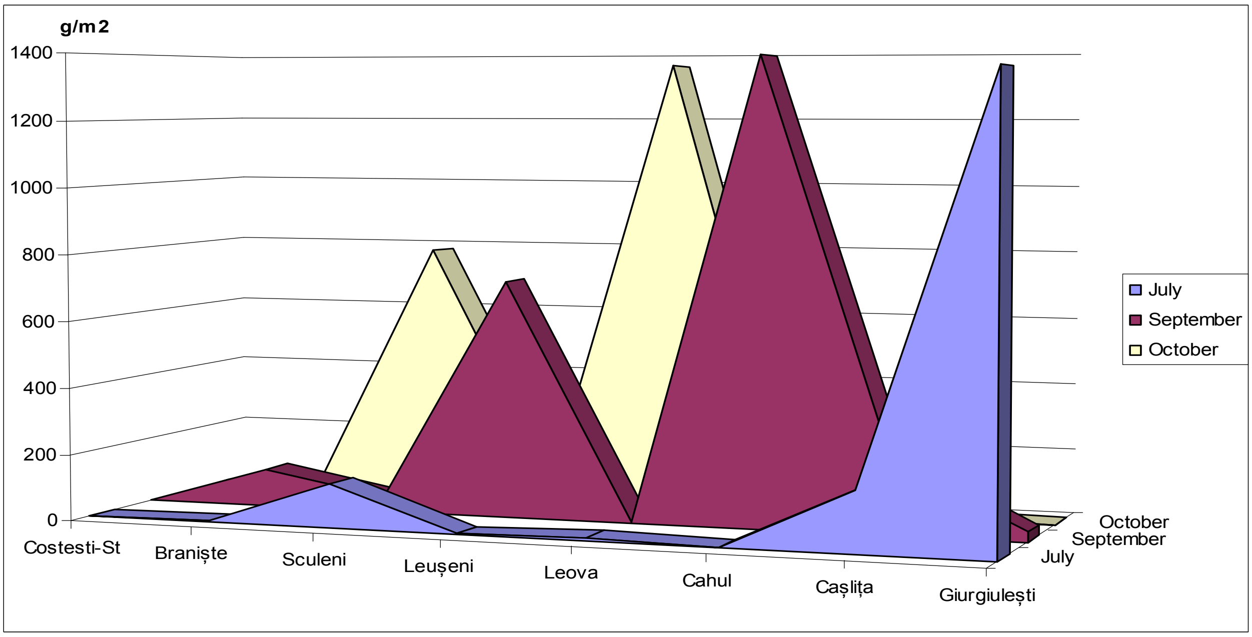

Fig. 34. Biomass (g/m^2) of total zoobenthos in the Prut River, July – October 2014

The highest biodiversity was registered at Braniste station. Regardless of month or season of sampling, the number of taxa from July to October 2014 varied between 24 and 28, including 10 species of *Ephemeroptera* and *Trichoptera*, which are sensitive to pollution. The lowest biodiversity was registered at Giurgiulesti station, with only 3-6 species, without any species of *Ephemeroptera* and *Trichoptera* (Fig. 35).

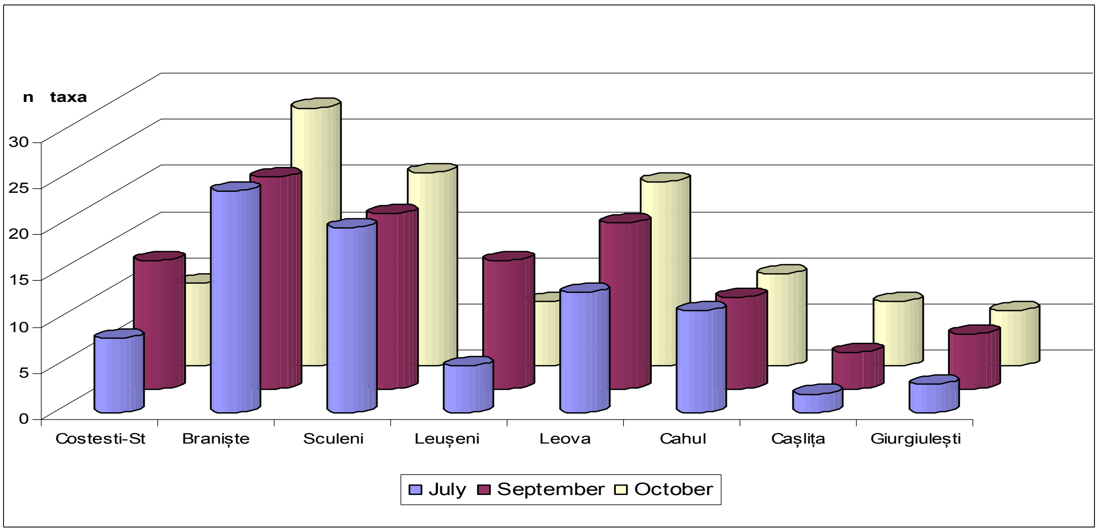

Fig. 35 Number of zoobenthos taxa in the Prut River, July – October 2014

Ichthyofauna

In the given period of time control scientific fishing was performed in different ecosystems of the Danube basin: ecosystem of the Middle Prut – Costesti-Stinca reservoir and the Lopatnic River, tributary of the Prut River, ecosystem of the Lower Prut – Braniste station, Slobozia Mare station (at the confluence of Garla Navodului (Beleu lake) with the Prut riverbed), macroecosystem of the Lower Danube (Isaccea and Chilia Veche stations) (Fig. 36).

Fig. 36 Points of sampling of ichthyologic material for molecular genetic analysis

All sampled ichthyologic material was classified according to the taxa affiliation and morphologic parameters (Tab.1-2).

Table 1 Fish species collected in the Danube basin, including the Prut River for molecular genetic analysis

Species	L, cm	l, cm	P, g	Female♀/Male♂, Stage of gonad development	Age, years
Ord. Esociformes Fam. Esocidae					
Esox lucius Linnaeus, 1758 - Northern pike	43.5	38.5	536	♂, III	2+
Esox lucius Linnaeus, 1758 - Northern pike	41.5	37	375	♀, III	2+
Esox lucius Linnaeus, 1758 - Northern pike	46	40.5	637	♀, III	2+
Ord. Cypriniformes Fam. Cyprinidae					
Vimba vimba(Linaeus, 1758)- Vimba bream	24.5	21.5	126	♂, II-III	2+
Vimba vimba(Linaeus, 1758)- Vimba bream	29	24.5	225	♂, II-III	3+
Vimba vimba(Linaeus, 1758)- Vimba bream	25	20.5	135	♂, II-III	2+
Vimba vimba(Linaeus, 1758)- Vimba bream	27	22	152	♀, III	2+
Vimba vimba(Linaeus, 1758)- Vimba bream	22.5	19	103	Juvenile	1+
Vimba vimba(Linaeus, 1758)- Vimba bream	22.5	18.8	105	Juvenile	1+
Aspius aspius (Linaeus, 1758) - Asp	14.9	12.2	21.7	Juvenile	0+
Aspius aspius (Linaeus, 1758) - Asp	13.2	10.9	15.3	Juvenile	0+
Aspius aspius (Linaeus, 1758) - Asp	12	9.6	11.63	Juvenile	0+
Aspius aspius (Linaeus, 1758) - Asp	22.5	18.5	81.34	Juvenile	1+
Aspius aspius (Linaeus, 1758) - Asp t	31.5	26.5	261	Juvenile	1+
Aspius aspius (Linaeus, 1758) - Asp	28.2	22.7	159	Juvenile	1+
Aspius aspius (Linaeus, 1758) - Asp	29.5	24.2	190	Juvenile	1+
Aspius aspius (Linaeus, 1758) - Asp	28.5	23.5	180	Juvenile	1+
Pelecus cultratus (Linnaeus, 1758) - Sichel	36.5	31.5	312	♀, III	3+
Ord. Siluriformes Fam. Siluridae					
Silurus glanis Linnaeus, 1758 - Wels catfish	154	146	26000	♂, IV	15+
Silurus glanis Linnaeus, 1758 - Wels catfish	84	79	4270	♀, IV	6+
Silurus glanis Linnaeus, 1758 - Wels catfish	69	65	1590	Juvenile	3+
Silurus glanis Linnaeus, 1758 - Wels catfish	24.5	22	90.2	Juvenile	0+
Silurus glanis Linnaeus, 1758 - Wels catfish	23.5	21.7	81.2	Juvenile	0+
Silurus glanis Linnaeus, 1758 - Wels catfish	34	32	272	Juvenile	0+
Ord. Perciformes Fam. Percidae					
Perca fluviatilis (Linnaeus, 1758) – European perch	14.5	12.7	43.63	♂, III	1+
Perca fluviatilis (Linnaeus, 1758) – European perch	15	13	39.95	♂, III	1+
Perca fluviatilis (Linnaeus, 1758) – European perch	22	19.5	132	♂, III	2+
Perca fluviatilis (Linnaeus, 1758) – European perch	27.5	23.5	253	♀, IV	4+
Perca fluviatilis (Linnaeus, 1758) – European perch	21	17.8	92	♀, IV	2+
Sander lucioperca (Linnaeus, 1758) – Pike-perch	39	33	378	Juvenile	1+
Sander lucioperca (Linnaeus, 1758) – Pike-perch	11.5	9.3	8.85	Juvenile	0+
Sander lucioperca (Linnaeus, 1758) – Pike-perch	29.5	25.5	225	Juvenile	1+
Sander lucioperca (Linnaeus, 1758) – Pike-perch	28	23.5	152	Juvenile	1+
Sander lucioperca (Linnaeus, 1758) – Pike-perch	25	21.5	129	Juvenile	1+

Table 2 Alogene fish species sampled in the Danube basin, including the Prut River for molecular genetic analysis

Species	L, cm	l, cm	P, g	Female♀/Male♂, Stage of gonad development	Age, years
Ord. Cypriniformes Fam. Cyprinidae					
Carassius gibelio (Bloch, 1782) – Prussian carp	24	19.2	210	♀, III	2+
Carassius gibelio (Bloch, 1782) Prussian carp	19.5	16.2	117	♂, III	1+
Ord. Perciformes Fam. Centrarchidae					
Lepomis gibbosus (Linnaeus,1758) - Pumpkinseed	8.2	6.8	7.59	Juvenil	1+
Lepomis gibbosus (Linnaeus,1758) - Pumpkinseed	8	6.5	6.74	Juvenil	1+
Lepomis gibbosus (Linnaeus,1758) - Pumpkinseed	7.9	6.5	6.09	Juvenil	1+
Ord. Perciformes Fam. Odontobutidae					
Perccottus glenii Dybowski, 1877 - Chinese sleeper	15.5	13	47.2	♂, II-III	5+

Perccottus glenii Dybowski, 1877 - Chinese sleeper	11.7	9.6	22.43	♀, II-III	4+
Perccottus glenii Dybowski, 1877 - Chinese sleeper	8.1	6.7	6.91	♂, II-III	2+
Perccottus glenii Dybowski, 1877 - Chinese sleeper	10	8.2	12.93	♀, II-III	3+
Perccottus glenii Dybowski, 1877 - Chinese sleeper	14	12.2	44.85	♂, III	5+

The ichthyologic material was sampled in accordance with the technology of genetic barcoding of the Food Safety and Inspection Service (www.fsis.usda.gov/), which aims adjusting and confirming the results of classical scientific researches on the taxonomic status and phylogenetic origin of biological material. The obtained results are given in Fig. 37.

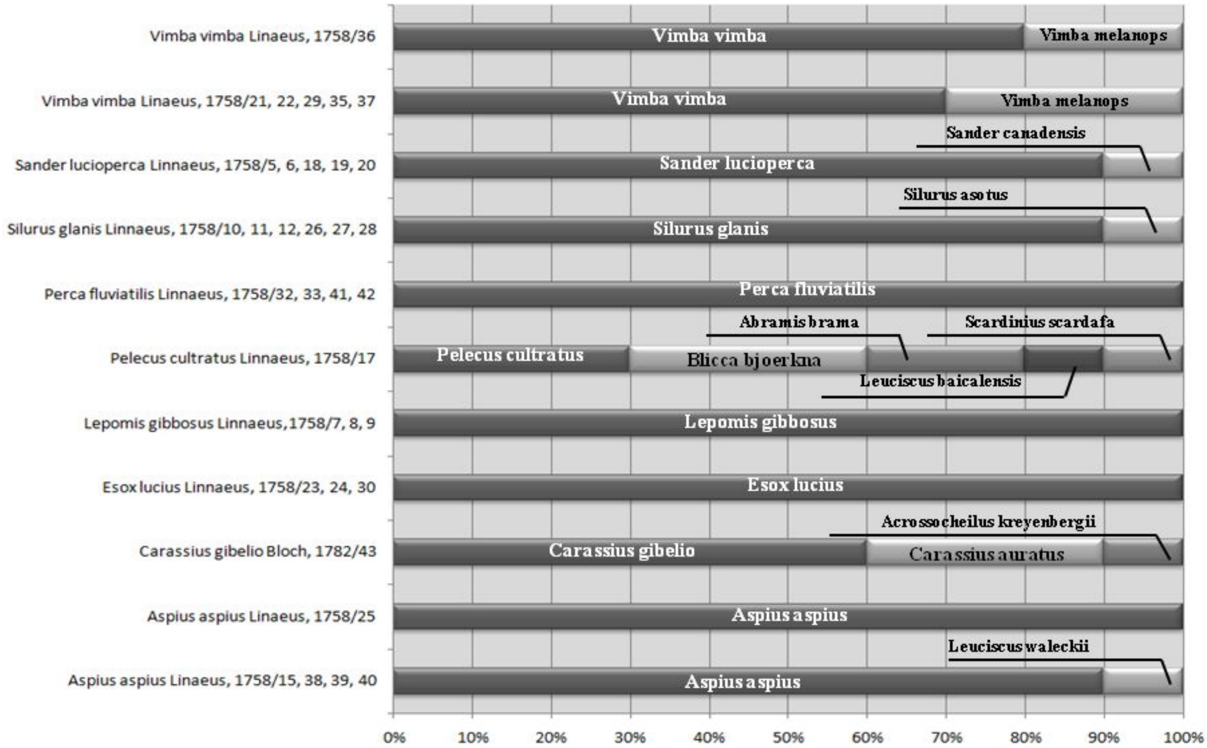

Fig. 37 The results of fish molecular genetic analysis

For all collected fish species the taxonomical status, identified through classical methods of analysis of morphometric and meristic peculiarities, was confirmed. However, in the case of some species there are some reservations regarding the certainty of results (score). The data of molecular genetic analysis, which showed score less than 100% and indicate the ambiguity of identification of other related taxa, are as following:

1. *Vimba vimba* and *Vimba melanops* – with a score of 70 %. The native areal of species *Vimba melanops* is the north part of the Aegean Sea basin: Turkey, Greece, Bulgaria and Macedonia. The penetration into the Prut River is excluded, because the species has not been documented yet in the Danube River.
2. *Sander lucioperca* and *Sander canadensis* - with a score of 90 %. Canadian pike (*Sander canadensis* is a species with a wide native areal, which covers the northern part of the USA and a part of Canada. It was introduced in the Mississippi basin. Penetration into the natural waters of Europe can have only an anthropochore character, but this information has not documented yet. Its existence in the Prut River is excluded.
3. *Silurus glanis* and *Silurus asotus* - with a score of 90 %. The native areal of Amur catfish (*Silurus asotus)* is the basin of Amur River. It is easy to distinguish it phenotypically from Wels catfish, so it cannot be confused with it. Its existence in the Prut River is excluded.

4. *Aspius aspius* and *Leuciscus waleckii* – with a score of 90 %. The native areal of *Leuciscus waleckii* is the basin of Amur River. Its presence in Europe, including the Prut River is excluded.
5. Among all studied species (Fig. 2), only *Carassius gibelio* and *Carassius auratus* can be confused phenotypically easily, but the molecular genetic analysis showed a score of 60%. A range of researchers consider that Prussian carp *(Carassius gibelio* Bloch, 1782) went into the aquatic ecosystems of Europe as far back as in the 19th century. Until 1960' it was the unique identified form. But later, as result of major acclimatization works, the second species - *Carassius auratus* (Linnaeus, 1758) in a short period of time invaded the whole Ponto-Caspian basin (Абраменко, 2011; Вехов, 2013; Межжерин, Кокодий, 2007). To note that in the population of *Carassius auratus* (Linnaeus, 1758) the females and males are represented almost equally.

Comparative morphological analysis of bisexual and unisexual populations of Prussian carp *(Carassius gibelio* Bloch, 1782) revealed that for most of characters no evident differentiations exist, what does not allow their certain validation by using classical methods. Nor the morpho-metric distinctive characters, proposed by Kottelat M. (2007), are not determinant, they relying more on body colour (*Carassius auratus* Linnaeus, 1758 has more golden shades) and the number of scale in *linia laterale* (*Carassius auratus* – 26-31 and *Carassius gibelio – 29-33).* Also Mejjerin and Kokodii (2009) consider that the separation of these taxa can be made only by using the genetic markers, due to rapid transgression of most of distinctive morpho-metric characters, although certain trends of spatial separation of these biotypes is observed.

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