Proceedings of the BSSR Academy of Sciences
1990, February, v.34, N 2

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FUNCTION OF SEDIMENTATORS AND MICROPHAGES IN THE CONVERSION OF BLUE-GREEN ALGAE IN WATER-COOLER

Long-term impact of high thermal load on water reservoirs reduces the number of species in biocenosis and results in mass development of blue-green algae which change water quality for worse. Planctonic crustaceous-filters as potential consumers of blue-green algae use them as a food (1). The latter are utilized mostly through detritus food chains. However, there are some literature data that blue-green algae and bacterial - vegetative layer are consumed by thermophilic ostracods of hot springs (2,3) and rice fields (4,5) and by thermophilic mollusks (6). Seston is actively settled by bryozoans (7). At present the growing number of water reservoirs with thermal press sets the task to reveal the role of all potential consumers capable of converting blue-green alga organic matter into detritus food chains. The aim of the present research was qualitative analysis of conversion of seston organic matter in the water-cooler in the chain: blue-green algae-sedimentators-microphages.

The research was fulfilled in 1984-1986 in the water-cooler of the Bereza Hydroelectric Power Plant (Brest reg., BSSR). Specific characteristics of this water system are thermal contamination, high rate of water turnover (5-6 days), constant supply with biogenes from fishery farm stews located in the discharge channels. This all results in high value of primary production which is the cause of water reservoir's "over-growing" in summer. Biocenosis of discharge channels system, where summer temperature rises up to 34-36° C, is widely represented by the populations: Bryozoa Plumatella fungosa (Pallas, 1768), thermophilic ostracods Stenocypris major (Baird, 1859) and mollusks Physella integra (Haldeman, 1841) which consume organic matter produced by blue-green algae (Table). Quantitative samples for estimation of populational density (N) and biomass (B) were taken using biocenometers. Rates of phytoplankton photosynthesis and desrtuction were determined in a glass in oxygen modification. To avoid mistakes caused by daily exposure of glasses under the conditions of the highly eutrophic water reservoir, they were exposed in water for 2-3 hours at the depth of "optimal" photosynthesis and water transparency of 0.1-0.4 m. The total primary product value was calculated on the basis of its rate per hour and day duration using equation which we obtained for the given water reservoir: $A_{m^2} = 0.43 \cdot A_{max} \cdot l$, where A_{m^2} and A_{max} - total photosynthesis rate (g $O_2 \cdot m^{-2} \cdot day^{-1}$) under one unit of surface and at the depth of optimal photosynthesis, respectively; l – depth of photosynthesis area (equals to morning water transparency). Seston dry mass was determined gravimetrically using "nucleus" filters (spore size 1.1-1.5 mcm).

Table. Structural and functional indices of the populations studied at 30° C

Species	N, spm· m^{-2}	B, g· m^{-2}	c, J·mg^{-1}, Dry matter	W/W, %	P/B, day^{-1}	A/B, day^{-1}
Plumatella fungosa	$3{,}25 \cdot 10^6$	$5{,}4 \cdot 10^3$	14,6*)	10	0,10	0,38
Stenocypris major	$7 \cdot 10^4$	5,8	11,3	28	0,06	0,27
Physella integra	$5 \cdot 10^3$	7,4	5,6	28	0,12	0,23

*) Specific energy capacity of live polyps which make up 15% of wet biomass in Bryozoa colony.

Gas metabolism rate was measured in animals using closed vessel technique and then oxygen content was determined according to Winkler. Energy waste for respiration (R) was calculated using oxygen consumption rate (1 ml O_2/20.34 J). Specific energy capacity (c) was found using method of bichromate oxidation according to A.P.Ostapenia's technique (8). Production (P_Σ) of mollusk and ostracod populations was presented as a total somatic and generative product. All required parameters were determined using conventional hydrobiological methods (8).

Basing on the data obtained, flows of energy (A), going through the populations of the described block (see fig.), have been compared in terms of structural and functional parameters and density (Table) of midsummer (1st decade of July, t=30 C). As a result of heating and high content of biogenic substance in the system of water-cooler, the organic matter production rate is high. Chlorophyll content and seston concentration conform to those of highly eutrophic water reservoirs. In summer each of two discharge channels had water flow of $1.3 \cdot 10^6$ $m^3 \cdot day^{-1}$. The mean width and depth of the channel were 30 and 2 m, respectively, $2.16 \cdot 10^4$ $m^3 \cdot day^{-1}$ of water goes through its 1 m^2 section. Water flow contains 35 mg·l^{-1} of dry matter of suspension, that equals to 644.35 kJ·m^{-3}. Thus, total seston biomass (B_Σ), going through channel section unit, is $13.92 \cdot 10^6$ kJ·$m^{-2} \cdot day^{-1}$.

Phytoplankton amounts 46.3% of seston dry matter. Phytoplankton primary product is formed mostly by blue-green algae, Anabaenopsis raciborskii and Aphanisomenon flos-aquae accounting for more than 90% of them. The bryozoan colonies, developing on substrate, consume blue-green algae which move along discharge channels with water. Zooids are filtering suspension and form fecal pallets (F_n), throwing them out. Pallets are gradually settling down to the bottom where they are used in the rations of microphages: mollusks Ph. integra and ostracods S. major. The greater part of fecal pallets is decomposed by saprophages or consumed by detritophages (See Fig.).

Judging from the gross production and destruction values, it is obvious that net phytoplankton product, produced in the unit of water volume, going through $1 m^2$ of the channel section, makes up 92.65 $kJ \cdot m^3 \cdot day^{-1}$ (Fig). P/B of phytoplankton is equal 0.14 day^{-1}.

The rate of fecal pallet production in Bryozoa at definite biomass (Table), temperature of 30° C and above mentioned seston content made up 380.6 g of dry matter or 6863.4 $kJ \cdot m^{-2} \cdot day^{-1}$. This means that bryozoans, covering $1 m^2$ of substrate, settle down substance in a value equal to that of primary phytoplankton product, produced in the $80 m^3$ volume of the lake which supplies plant turbines with water.

Estimation of energy flow, going through bryozoan population, revealed high absolute (Fig.) and assimilation intensity (A/B) (Table) values. Assimilation value (U^{-1} =A/C = 6.2%) and coefficient of ecological efficiency (K_1 = 1.6%) appeared to be unexpectedly low. These non-typical for other hydrobionts values allow us to suppose that at high temperature suspension moves fast through digestive tract of bryozoans and they produce and throw the pallets out without proper food utilization. Thus, the principal role of bryozoans is to convert seston into sediment and to supply bottom biogeocenoses with organic matter.

Both microphage populations studied are characterised by high absolute indices of energy flow and production (see Fig.), which are several times higher than the similar ones in hydrobionts of the colder water reservoirs [9-12]. Thus, for example, energy flow through ostracod population is close in value or even higher than the total energy flow through the whole macrobenthic community at less trophic water reservoirs [12,13]. Assimilation intensity in microphage populations studied is close to that of lake filtrators [14]. Values of energy flow intensity together with P/B coefficients (see Table) are important populational characteristics and they evidence about high rate of organic matter conversion in the populations of hydrobionts inhabiting discharge channels of water-cooler. The energy flow going through microphage populations studied makes up 7.3% of the net phytoplankton product (see Fig.). This is a greater part of energy produced by autotrophs. It is evident that if the only food of microphages is 60%-assimilated settled pallets, they are capable of consuming only 0.1-0.2% of pallet organic matter energy produced by bryozoans. But taking into account the wider food ration of microphages, we can suppose that practically all energy-carrying matter of water flow suspension, transformed by bryozoans into sediment, gets into sapro-and detritophage ration. In the block under study Bryozoa population plays the most significant part as a supplier of bottom biocenoses with seston matter for its conversion into detritus food chains.

Summar

The prime function of Plumatella fungosa (Pallas, 1768) (Bryozoa) in the block-diagram studied is to convert organic matter of seston to detritus food chains. Energy flow through the microphage populations Stenocypris major Baird, 1859 (Crustacea, Ostracoda) and Physella integra (Haldeman, 1841) (Mollusca, Pulmonata) amounts to 7.3% of the net phytoplankton production and is several times higher than the same values for hydrobionts form unheated reservoirs.

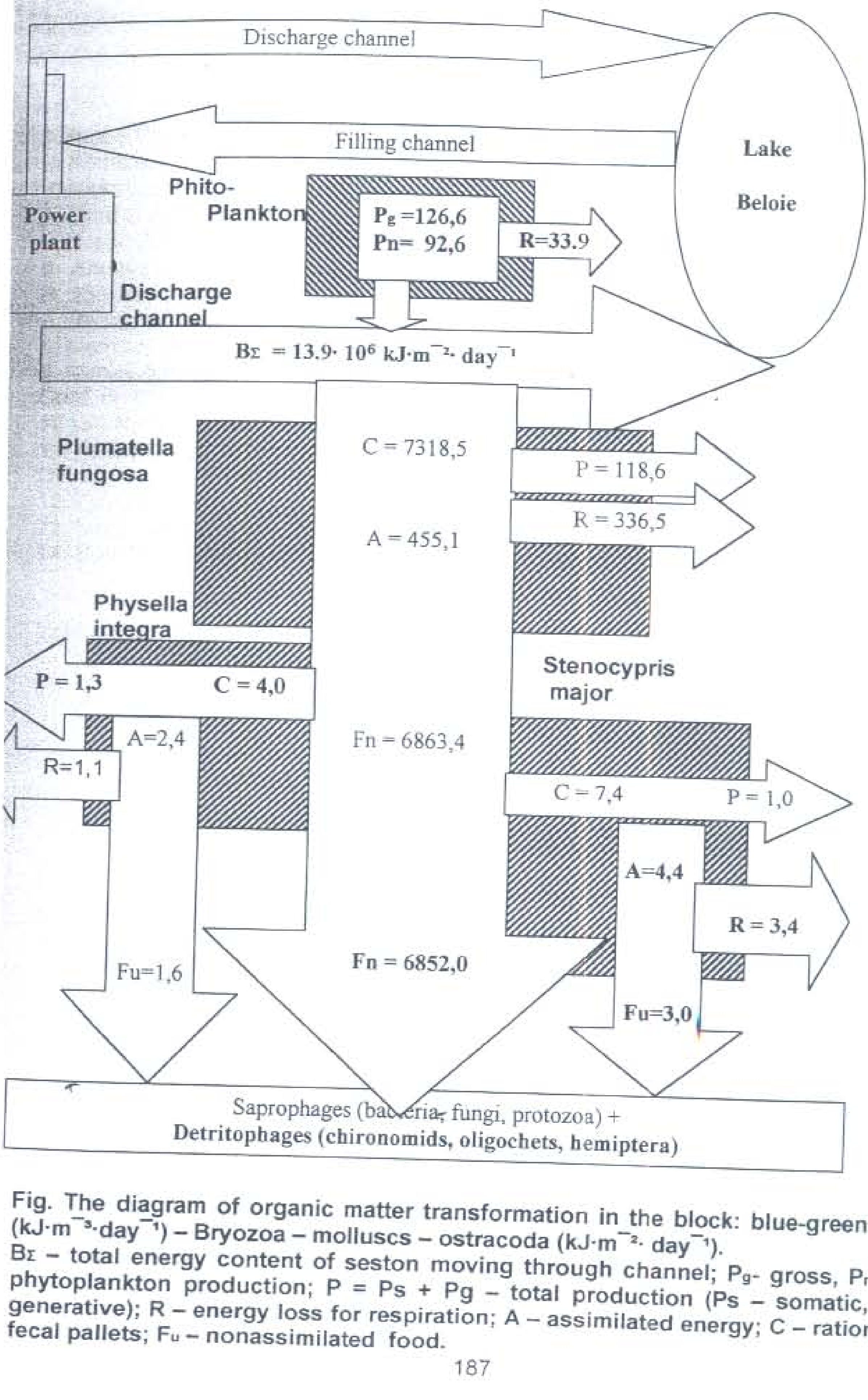

Fig. The diagram of organic matter transformation in the block: blue-green algae (kJ·m^{-3}·day^{-1}) – Bryozoa – molluscs – ostracoda (kJ·m^{-2}· day^{-1}). B_Σ – total energy content of seston moving through channel; P_g- gross, P_n- net phytoplankton production; P = Ps + Pg – total production (Ps – somatic, Pg – generative); R – energy loss for respiration; A – assimilated energy; C – ration; F_n – fecal pallets; F_u – nonassimilated food.

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Institute of Zoology, BSSR Ac. Sci. Submitted 07.11.89