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THE ROLE OF *Anodonta* sp. IN ORGANIC MATTER DESTRUCTION, IN VARIOUS ZONES OF THE CHANNELS OF KONIŃSKIE LAKES SYSTEM[1]

Olga O. Sinicyna, Aleksander A. Protasov*, Siergiej A. Afanasjev*, Jacek Tunowski**, Bogusław Zdanowski***

* Institute of Hydrobiology, Ukrainian Academy of Sciences in Kiev
** The Stanisław Sakowicz Inland Fisheries Institute in Olsztyn

A B S T R A C T. Biotope conditions and abundance of benthic organisms in the channels were studied. Oxygen consumption was measured *in situ*, as well as organic matter assimilation, and water filtration rate. The role of large Chinese *Anodonta sp.* and *Dreissena polymorpha* in self-purification of the lakes was evaluated.

Key words: HEATED WATER, ZOOPERYPHITON, BENTHOS, *Dreissena polymorpha* (Pall.), *Anodonta* sp., DESTRUCTION

INTRODUCTION

Previous studies of the Konińskie channels revealed considerable heterogeneity of settlement of various zones by zooperiphyton and zoobenthos, related to thermal, substrate and hydrologic conditions (Protasov et al. 1994, 1997). In August 1995 oxygen consumption of benthos and periphyton were measured under natural conditions, in the most characteristic zones of warm Licheński - Piotrkowicki Channel, just below the siphon under Morzysławski Channel, 150 m from it, near the outlet to Licheńskie Lake, and in Piotrkowicki Channel zone, below the pumping station, behind Licheńskie Lake (fig. 1).

MATERIAL AND METHODS

Metabolism of benthos and periphyton was measured in respirometer chambers of original construction, made in the Institute of Hydrobiology of UAN (phot. 1). The

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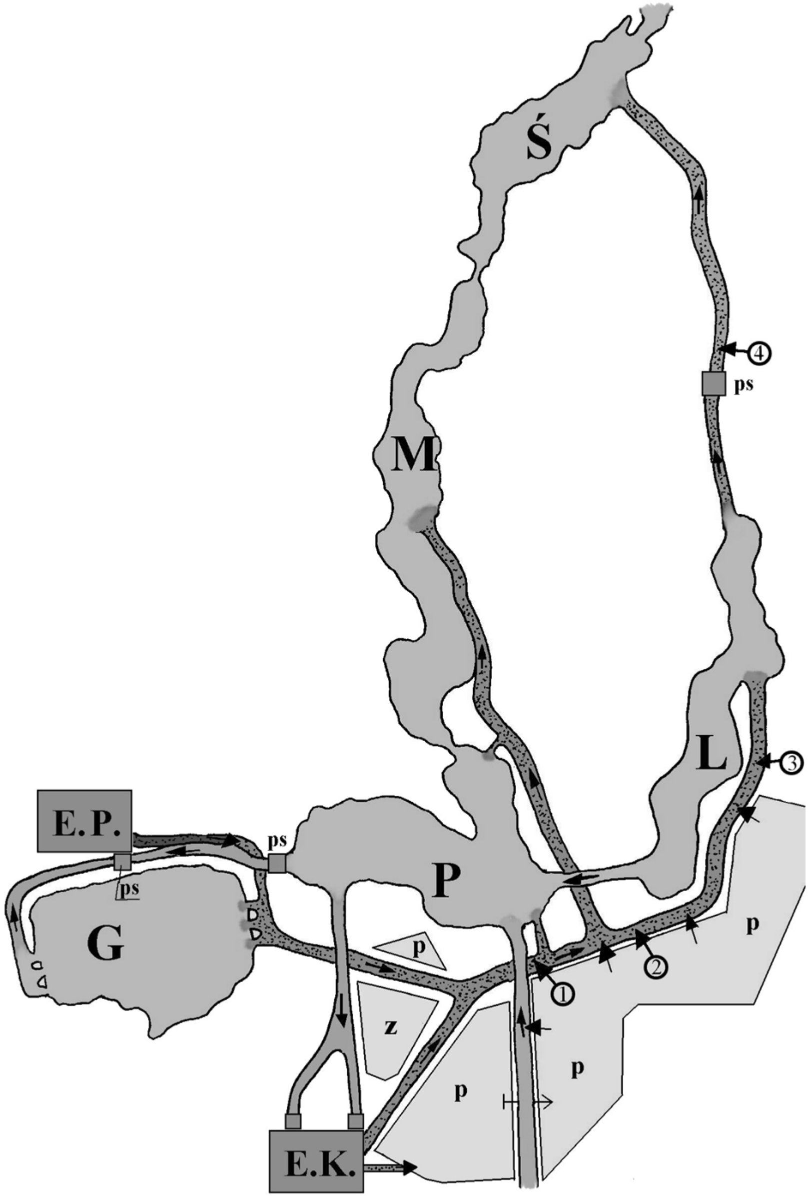
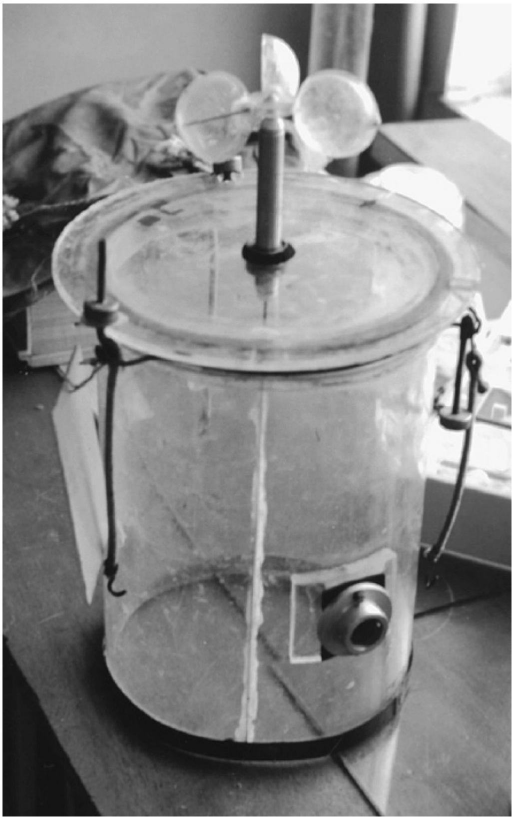


Fig. 1. System of Konińskie lakes and channels. Experimental sites (1-4). Lakes: (G)osławskie, (L)icheńskie, ()lesińskie, (M)ikorzyńskie, and (P)ątnowskie. EP - “Pątnów” power plant, EK - “Konin” power plant, Z - cooling reservoir, ps -pumping stations, p - carp ponds.



Phot. 1. Respirometer for benthos and periphyton respiration measurements "in situ".

respirometers consisted of cylinders of 1.2, 5.6, or 9.3 l volume, made of plexiglass in two versions: transparent for photosynthesis measurements, and darkened with poliethylen foil for destruction measurements. Upper part of the chamber was equipped with a rubber shock absorber placed between the cylinder and the substrate. On the cover there was a water mixer made of a vane with three semispheric paddles connected with an axle to the mixing paddle. Mobility of the axle was ensured by a tephlon bearing. Construction of the mixer allows to simulate water mixing under natural conditions, and thorough mixing before sampling, preventing oxygen microstratification. The cover can be easily fitted by a diver. Samples of water (5 ml) were taken using calibrated syringes through the rubber plug in the chamber wall.

Chambers of various volumes were applied for various samples, depending on the species composition and biomass. Exposure time (according to Alimov 1981) did not exceed the period of 20% oxygen consumption. Water was sampled at the beginning (control) and at the end of exposure. Oxygen concentration was measured with a modified Winkler method (Fox, Wingfield 1938), applicable to small volume samples (5 ml).

Metabolism of benthos and periphyton was calculated from:

[1] Oxygen budget of the organisms for a unit of substrate surface, in light and dark chambers, according to the formula:

$$B = \frac{Co - Ck}{T} \cdot \frac{Co - Ck\ plankt.}{T} \cdot \frac{V}{S}$$

where:

B - total oxygen consumption of all the organisms of the community ($mg\ O_2/m^2 \cdot h$),

Co - initial oxygen concentration in the chamber,

Ck - final oxygen concentration,

Ckplankt. - final oxygen concentration in the respirometer with plankton,

T - exposure time of the chamber with benthos or periphyton,

Tplankt. - exposure time of the respirometer with plankton,

V - chamber volume minus substrate volume,

S - substrate surface under the chamber.

[2] Average of a series of measurements, separately for light and dark chambers.

[3] Photosynthesis:

$$P = Bkl - Bkd,$$

where:

P - photosynthesis ($mg\ O_2/m^2 \cdot h$)

Bkl - average from light chambers

Bkd - average from dark chambers.

[4] Plant respiration:

$$Rb = P \cdot K,$$

where K - coefficient of the respiration / photosynthesis ratio.

[5] Animal respiration:

$$Ra = Bkd - Rb$$

Moreover, total primary production (photosynthesis) of algae and total destruction of organic matter by all autotrophic and heterotrophic organisms were estimated experimentally. Applied coefficients enable division of the general equation into particular components and to calculate net primary production of algae.

Benthos and periphyton were counted at four sites of Licheńsko - Piotrkowicki Channel (fig. 1) in 64 series of experiments, and 400 DO measurements. The rate of oxygen consumption by *Anodonta sp*. (Protasov et al. 1997) was measured for the individuals of 11.5 - 506.1 g (weighed with the shell) within a temperature range of 29.0 - 33.0°C. The values were corrected for temperature, according to Alimov (1981). For estimation of daily production of *Anodonta sp*. K2 coefficient equal to 0.3 was assumed (Alimov 1983).

Energy transformation by the communities was calculated as a sum of daily production and destruction of organic matter (Alimov 1989). Destruction rates at other sites which were not studied were calculated from the literature data (Alimov, Nikulina 1974). Water filtration by the molluscs was calculated from filtration coefficient Q = F/R (ml/mgO_2), equal to 910 for *Unionidae* and *Dreissenidae.*

Macroorganisms were localized and quantitative samples taken under water by divers, in the 1 m transects of the cross-sections of the channels. Large molluscs were collected inside a frame of 0.5 · 0.5 m, placed on the bottom. 110 individuals were measured and weighed. Individuals of *D. polymorpha* (Pall.) were removed from the stones using a scraper, and dense colonies were sampled with box sampler of 0.01 m^2 surface.

RESULTS

Channel part near the syphon was 45 - 46 m wide, and deep (maximum depth) about 3 m (site 1). The bottom near the right bank, at the depth of 2 m, was covered with silt, and in the strong current central zone near the left bank, with hard clay. Large *Bivalvia* were fairly abundant. At the left bank only single individuals were found. At 8 - 10 m from the bank, at 1.8 - 2.0 m, the density was 30 ind./m^2. At 15 - 16 m from the bank, at the depth of 2.0 - 2.1 m, 44 ind./m^2 were observed. At 20 m from the bank the density was 88 ind./m^2, and at 25 m - 36 ind./m^2. In the zone of strong current, on hard clay bottom, no molluscs were found.

At the sand and silt bottom, 150 m below the syphon (site 2), where the channel is wider and water less turbulent, *Anodonta sp*. density was much lower (1.6 - 2.7 ind./m^2). The density increased again below the bridge near the channel outlet to Licheńskie Lake (site 3), where 4 ind./m^2 were noted at 1 m depth, 12 ind./m^2 at 2 m, and 20 ind./m^2 at 3 m.

With increasing distance from the banks, *Anodonta sp*. biomass decreased from 217.4 to 156.7 g/m^2 near the syphon, and from 203.9 to 81.4 g/m^2 at the end of the channel. The highest biomass was observed near the siphon: 9560 - 17110 g/m^2, below the siphon - 343.5 - 505.3 g/m^2, and at the end of the channel - 815.9 - 1620.8 g/m^2.

Relationship between respiration rate and body mass of *Anodonta sp*. was calculated from the experimental data, according to the equation:

$$R = 0.089\ w^{\,0.85},$$

where:

R - oxygen consumption rate in mg $O_2/m^2/h$,

w - fresh mass of the molluscs with the shell in g (for 30°C).

In Piotrkowicki Channel (site 4), filled with water during vegetation season (May - September) and drained in winter, the bottom and stones were inhabited every year by new, year-old populations of *D. polymorpha*. Biomass of the colonies on the stones below the pumping station reached 1344.9 g/m^2 at 0.6 m depth, and 4685.6 g/m^2 at 2 m. On the sand bottom, at 3 m, a mosaic-type distribution of dense colonies produced 112.7 - 1091.9 g/m^2. Only in the marshes of the channel, filled with water in fall-winter season, single individuals were found.

Recognition of environmental conditions, the level of settlement of the channels by large *Anodonta sp*., measurements of oxygen consumption, and water filtration rate allowed to evaluate the role of these organisms in self-purification process in Konińskie lakes (Tab. 1). Settled Chinese *Anodonta sp*. better adapted to high temperatures, comparing to *D. polymorpha* (Afanasjev et al. 1997) played leading role in self-purification of the warmest channels. Average daily oxygen consumption by these organisms in Licheński Channel below the siphon was equal to 511.4 mg O_2/m^2 (almost 80% of total oxygen consumption of the benthic community). Values of daily oxygen consumption of other organisms were lower, and on silt substrate amounted to 116.4 mg O_2/m^2. On the sand substrate at the outlet of the channel to Licheńskie Lake it was equal to only 70.96 mg O_2/m^2.

D. polymorpha played most important role in water self-purification of cooler parts of the system - in the channels supplying power plants with cooling water, and in the lake littoral (Protasov et al. 1994, 1997). In Piotrkowicki Channel, assimilation of organic matter, destruction, and water filtration indices for *D. polymorpha* were two fold higher than the highest values for *Anodonta* sp. measured at the siphon of Licheński Channel. It should be stressed that 92% of total destruction of organic matter in the section of Piotrkowicki Channel under study was performed by *D. polymorpha* living on the stones of the channel. Taking that into consideration, promoting *D. polymorpha* population in other parts of the system could help to maintain good water quality of the lakes.

TABLE 1

Oxygen consumption, organic matter assimilation, and filtration rate of the molluscs from Koniskie channels (study sites - see fig. 1)

Mollusc	Area of transect (m^2)	Oxygen consumption (R - mg O_2/h)	Organic matter assimilation (A - g C/24h)	Water filtration (F - m^3/24h)
1. (near the siphon) *Anodonta*	26	3927.5	49.95	60.80
2. (below the siphon) *Anodonta*	30	666.0	7.79	10.36
3. (Outlet toLicheńskie Lake) *Anodonta*	15	983.5	12.83	15.16
4. (below the pumping station) *D. polymorpha*	21	9 020.1	105.56	139.54

CONCLUSION

Konińskie lakes represent a unique lotic system, in which self-purification of water is controlled by heterotrophic organisms. Intensity of production and destruction of organic matter by the bottom fauna and periphyton depends on the network of channels through which water is mixed within the system, as well as on the level of heating in particular zones, creating site diversity (Zdanowski 1994). Site diversity results in biodiversity of the system, expressed in the occurence of native and foreign species of the molluscs. The highest densities of these organisms were observed in the zones of the highest and moderate temperatures (Protasov et al. 1994, 1997). In other reservoirs used for cooling of heated water, filtrating molluscs play an important role usually only in zones of moderate temperatures (Protasov et al. 1991, Protasov 1994).

Applying an *in situ* method of oxygen consumption measurements for settled organisms confirmed observations of Protasov et al. (1991, 1994) and Protasov (1994) that contribution of dominating in the community *D. polymorpha* in organic matter destruction reached 90%. In matter transformation by the bottom fauna the most important role is played by *Anodonta sp.*, with considerable contribution of microbenthos.

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STRESZCZENIE

ROLA MAŁŻY *Anodonta sp.* W DESTRUKCJI MATERII ORGANICZNEJ W RÓŻNYCH STREFACH KANAŁÓW SYSTEMU JEZIOR KONIŃSKICH

Eksperymentalnie (*in situ*) zmierzono zużycie tlenu, asymilację materii organicznej i tempo filtracji wody przez zespoły organizmów dennych oraz określono znaczenie dużych małży chińskich *Anodonta sp.*, *D. polymorpha* i mikrobentosu w samooczyszczaniu wód systemu jezior konińskich. Badania wykonano w sierpniu 1995 roku w czterech charakterystycznych strefach ciepłego Kanału Licheńsko - Piotrkowickiego, tj. tuż za syfonem pod Kanałem Morzysławskim, w odległości 150 m od niego, w pobliżu ujścia kanału do Jeziora Licheńskiego i w strefie Kanału Piotrkowickiego poniżej stacji pomp za Jez. Licheńskim (rys. 1). Do zbadania metabolizmu bentosu i peryfitonu zastosowano komory respirometryczne oryginalnej konstrukcji, opracowane w Instytucie Hydrobiologii UAN (fot.).

Z eksperymentalnie otrzymanych wartości ogólnego zużycia tlenu wyznaczono zależność tempa oddychania małży *Anodonta sp.* od ich masy, które można ekstrapolować równaniem: $R = 0.089w^{0.85}$, gdzie: R - tempo zużycia tlenu w $mg/m^2/h$, w - masa mokra małży ze skorupą w gramach (dla 30^oC).

Osiadłe małże chińskie *Anodonta sp.*, ze względu na większe ich niż *D. polymorpha* możliwości adaptacyjne do wyższych temperatur, odgrywają istotną rolę w samooczyszczaniu wód najcieplejszych kanałów (tab. 1). Średniodobowe zużycie tlenu przez ten rodzaj małży, zasiedlających masowo Kanał Licheński za syfonem, wynosiło 511.4 mg O_2/m^2 i stanowiło prawie 80% sumarycznego zużyciu tlenu przez cały zespół bentosowy.

D. polymorpha odgrywa najbardziej znaczącą rolę w procesach samooczyszczenia wód chłodniejszych części systemu, tj. w kanałach doprowadzających wody do elektrowni oraz w litoralu jezior (Protasov i in. 1994, 199). W Kanale Piotrkowickim, zmierzone wskaźniki destrukcji, asymilacji materii organicznej i filtracji wody tego małża były dwa razy większe niż najwyższe wskaźniki dla *Anodonta sp.*, odnotowane przy syfonie Kanału Licheńskiego (tab. 1).

ADRES AUTORÓW:

Dr Olga O. Sinicyna
Prof. dr Aleksander A. Protasov
Dr Siergiej Afanasjev
Institute of Hydrobiology
Ukrainian Academy of Sciences
Geroev Stalingrada 12
252210 Kiev

Prof. dr hab. Bogusław Zdanowski
Instytut Rybactwa Śródlądowego
10-719 Olsztyn, ul. Oczapowskiego 10