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THE DISTRIBUTION AND ABUNDANCE OF THE CHINESE MUSSEL *ANODONTA WOODIANA* (LEA, 1834) IN THE HEATED KONIN LAKES

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ABSTRACT. The Chinese mussel *Anodonta woodiana* was accidentally introduced into the heated Konin lakes system in the mid 1980's. It inhabits the littoral of the five lakes of the complex, a preliminary cooling reservoir, and most of the discharge and inflow channels. It prefers habitats of an increased flow velocity and of rather high temperature. It has been found to be the dominant benthic species in most of the habitats. At times, its biomass exceeded 10 kg m^{-2}, and it numbered more than 40 individuals per m^2.

Key words: UNIONIDAE, DISTRIBUTION, ABUNDANCE, THERMAL POLLUTION

INTRODUCTION

The Chinese mussel *Anodonta woodiana* (Lea), which has been classified to the genus *Sinanodonta* by some Russian investigators (Zatravkin and Bogatov 1987, Bogatov and Zatravkin 1988), inhabits the watershed ecosystems of the rivers Amur and Yangtze. The mussel has spread in European waters together with herbivorous Chinese fishes that have been introduced, including grass carp *Ctenopharyngodon idella* (Val.), big-headed carp *Aristichthys nobilis* Rich., and silver carp *Hypophthalmichthys molitrix* (Val.). Presently, this mussel can be found in Hungary, Romania, France, Yugoslavia, and the Czech Republic (Kiss and Pekli 1988, Kiss 1992, 1995, Beran 1997). It appeared in Poland in the mid 1980's. Herbivorous fish fry stocking material that was brought from Hungary and kept in the Gosławice Fish Stocking Center may have contained *A. woodiana* glochidia, which, following its transformation, may have accidentally entered the heated Konin lakes system.

The mussel inhabiting the Konin lakes complex is characterized by a high degree of polymorphism. This is probably determined by the considerable variation in the hydrological-thermal and nutritional conditions of the habitats, as well as to the structure of the bottom sediments. A preliminary survey of mussel distribution was conducted in 1993, and more detailed studies were done in 1994-1996 (Protasov et al. 1993, 1994, 1997). The Konin reservoirs are inhabited by three different forms, two of which have been identified as *Sinanodonta gibba* (Bensen) and *Sinanodonta orbicularis* (Heude) (Starobogatov, unpublished data). Genetic analysis of the izoenzymes failed to confirm this hypothesis (Soroka 1998, 1999, Soroka and Zdanowski 2001). According to Piechocki and Riedel (1997), the lakes contain *A. woodiana* exclusively; this species has been well described by Kiss (1992, 1995).

The purpose of this study was to monitor the distribution of the Chinese mussel in the Konin lakes and channels complex, this included determining their biomass and numbers, and analyzing the morphological characteristics of this species.

STUDY AREA AND METHODS

Studies of the mussels were conducted a the peak of the vegetative season, in July 1999 and 2000. A total of 52 sampling points were chosen in the littoral of five lakes, in the preliminary cooling reservoir and in the discharge and inflow channels of the power plants (Fig. 1). The Konin lakes form a complex situated in the watershed area of Gopło Lake. It is connected with the Warta River by the Warta-Gopło Channel. The lakes have a surface area of 13.03 km^2 and are characterized by variable morphology, trophic conditions and mixing (Table 1). The ecological structure and functioning of

TABLE 1

Limnological characteristics of the Konin lakes and the Konin power plant preliminary cooling reservoir

Lake	Limnological type	Surface area (ha)	Maximal depth (m)	Average depth (m)	Water retention (h) *	Water temperature (°C) *
Gosławskie	eutrophy polymixis	454.5	5.3	3.0	5 (4-6)	14.8 (6.5-27.0)
Pątnowskie	eutrophy polymixis	307.4	5.4	2.6	4 (3-6)	14.6 (2.3-30.0)
Licheńskie	eutrophy monomixis	153.6	13.3	4.9	3 (2-5)	16.3 (5.0-31.5)
Wąsosko-Mikorzyńskie	ß-m/ eutrophy dymixis	245.3	38.0	11.9	9 (5-16)	14.3 (4.0-27.5)
Ślesińskie	eutrophy dymixis	148.1	25.7	7.5	14 (6-30)	13.0 (0.6-27.8)
Reservoir	artificial reservoir	~ 75	4.2	2.5	3 (3-4)	22.0 (6.0-33.0)

**Data from 1999-2000. Values of water retention in the Ślesińskie and Wąsosko-Mikorzyńskie lakes during the vegetative season*

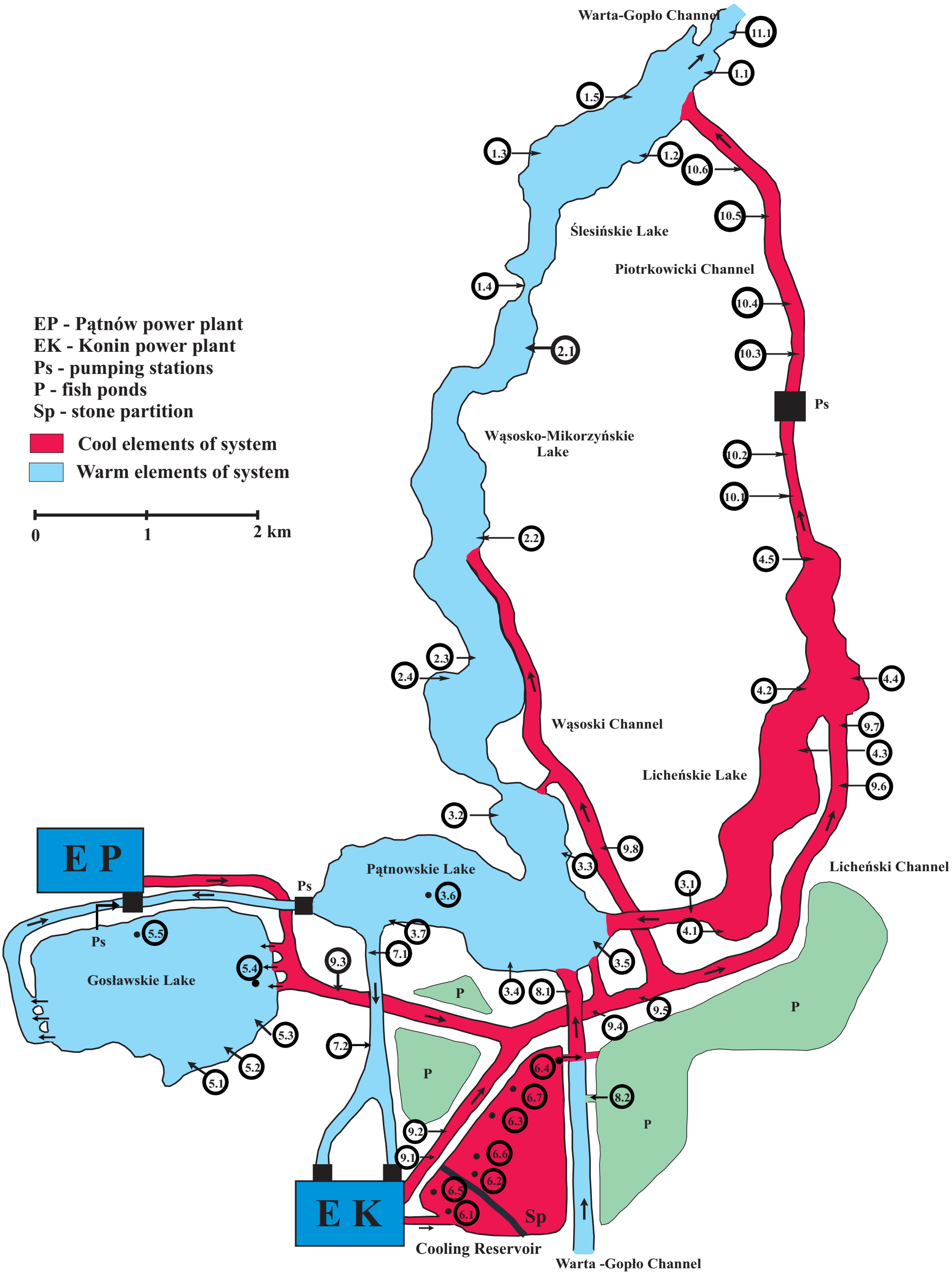

Fig. 1. The Konin lakes system. Sampling stations for *A. woodiana* in 1999-2000.

these reservoirs is determined mainly by ecological factors, such as water warming in individual lakes, water retention and flow, and the degree of water pollution (Hillbricht-Ilkowska and Zdanowski 1988, Zdanowski 1989, 1994, Zdanowski et al. 1992, Protasov et al. 1993, Socha 1997).

The Konin power plant cooling system network consists of 26 km of discharge channels and 6 km of water intake channels. The morphometry of the basic parts of the channels are similar - 15 to 50 m wide and 2 to 3.5 m deep (Table 2). Fragments of the channels located directly behind the power plant water outflow, and in the area of the pumping stations in Piotrkowice and Przesmyk (Fig. 1) have the highest water velocity and increased turbidity. The initial cooling reservoir for heated water from the Konin power plant has a surface area of about 75 hectares, a maximum depth of 4.2 m, and an average depth of 2.5 m. Directly beyond the discharge outlet, at a distance of more than ten meters, the reservoir is divided into two parts by an underwater stone barrier (Fig. 1). Water exchange in the reservoir occurs every three to four days (Table 1).

TABLE 2

Hydrological characteristics of the Konin channels

	Length [km]	Width [m]	Nominal value of water flow [$m^3 s^{-1}$]	Water temperature [^oC] *
Konin power plant inlet channel	2.3	20-50	25	14.2 (1.5-27.8)
Discharge channel "Konin"	1.8	25-40	25	21.3 (10.6-34)
Pątnów power plant discharge channel	4.3	20-40	30	23.2 (12.5-34.8)
Licheński Channel	4.4	20-50	29	21.1 (9.4-33.8)
Piotrkowicki Channel; in front of the pumping station	1.5	25-45	23	16.0 (4.0-30.3)

**data from 1999-2000.*

Sampling stations for the studies were chosen based on a preliminary morphometric survey that was conducted by scuba divers (Protasov et al. 1982, 1994) in different sites in the channels and littoral zones of the lakes. It included identifying zones with greater turbulence, water flow velocity, types of bottom deposits, and the types of bottom habitats of plants and mussels. The mussels were collected at chosen stations from an area of at least 0.5 m^2 delineated by a 0.25 m^2 (0.5 $\times$ 0.5 m) frame. Native Unionidae species were also included in the study: *Unio tumidus* Philipsson, *Unio pictorum* (L.), *Anodonta anatina* (L.), *Anodonta complanata* (Rossmässler). The mussel shells were cleaned of periphyton and bottom sediments and were left to dry on a blotting filter for 5 to 10 minutes. After their body weight and shell size measurements were taken, the specimens were returned the environment from which they originated.

RESULTS AND DISCUSSION

A. woodiana occurred both in the lotic and lentic zones of the lakes, and it avoided areas where the current velocity was high, such as at the pumping station. One-year-old individuals measuring 4-6 cm were encountered sporadically in areas where the water current velocity was low, and in shallower water (Afanasjev et al. 2001). The largest aggregations of mussels were consistently found in belts 1.5 to 2.5 m wide, while somewhat smaller clusters were observed along the shores at depths of 0.8 to 1.5 m. In areas where occurrence was abundant, the mussels were generally buried in the sediment to one third of their height. They sit uniformly beside one another, with their siphons directed upwards opposing the flow of water; they utilized the habitat by nearly 100%.

The morphological variation of the mussels was manifested distinctly by the variability of shell shape. They were either oval or circular-oval with the top slanted forward. The shell's elongation towards the back, and the shortening of the front part enabled it to anchor itself in the muddy and soft bottom. The back edge is directed upwards behind the shell top. Shells of older individuals have thick, massive walls, while those of the younger ones are fragile with thin walls. The shell color varies from dark brown to brown, honey, and green-olive. The interior parts of shells have differently shaped incrustations and deposits which were reminiscent of pearls.

Throughout the entire lakes complex there was high variation in average shell lengths. Individuals measuring 80 to 120 mm were most commonly encountered in the lake littoral and in the power plant intake channels. In the moderately heated channels, the typical shell lengths were 100-140 mm, in the warmest channels and in the preliminary cooling reservoir, the most common lengths were 110-180 mm. The largest individuals measured 200-225 mm (Fig. 2). Still larger individuals, measuring 250-270 mm in length, have only been observed in western Europe (Kiss 1992).

The *A. woodiana* mussel inhabits the littoral belt of Ślesińskie Lake at depths from 1.5 to 3.5 m, and at station 1.5 it was even found at a depth of 4.5 m. The largest aggre-

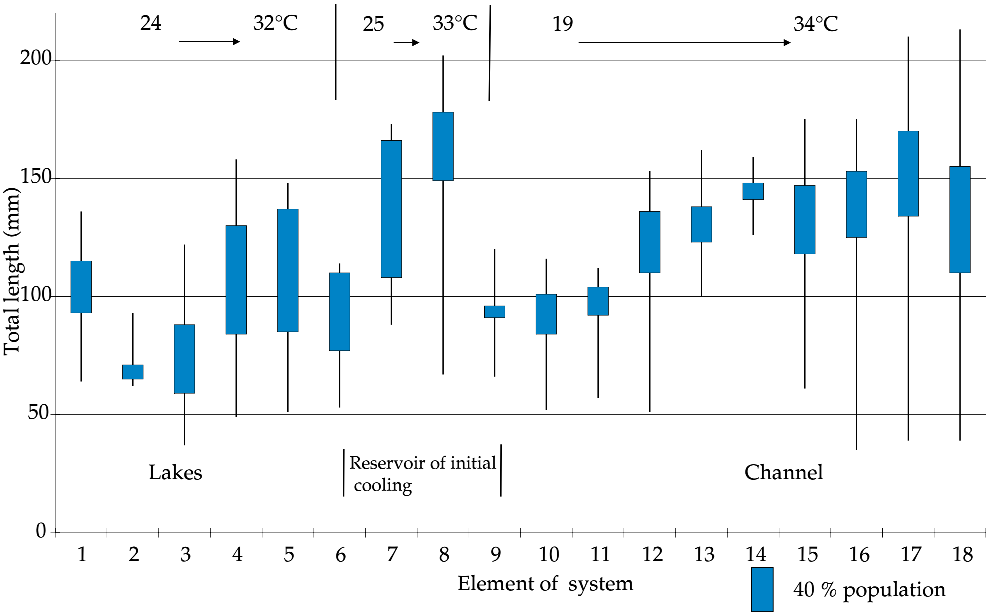

Fig. 2. Ranges of the total length variations of *A. woodiana* in the lakes and channels of the Konin lakes system, 1999-2000 (1. Ślesińskie Lake, 2. Wąsosko-Mikorzyńskie Lake, 3. Gosławskie Lake, 4. Pątnowskie Lake, 5. Licheńskie lake, 6. reservoir of initial cooling, 7. discharge zone, 8. beyond the stone barrier, 9. inlet to the Konin power plant, 10. between Ślesińskie and Pątnowskie lakes, 11. outlet from fish stocking ponds , 12. Piotrkowicki Channel, 13. between Licheńskie and Pątnowskie lakes, 14. Wąsoski Channel, 15. lower station of the Warta-Gopło Channel, 16. Licheński Channel, 17. Pątnów power plant discharge channel, 18. Konin power plant discharge channel).

gation of the mollusk occurs at this sampling station with 10 to 20 individuals m^{-2} and a biomass of 2,400 g m^{-2}. The average density of the species in this lake varied from 1 to 5 individuals m^{-2}, and with a biomass ranging from 90 to 380 g m^{-2}. The sandy bottom of the littoral was covered with filamentous algae. *A. woodiana* biomass in the channel between lakes Ślesińskie and Mikorzyńskie (station 1.4) was 1,000 g m^{-2}, and the numbers were 12 individuals m^{-2}. The mussels were not found in the inflow zone of the Piotrkowicki Channel (station 1.2).

Both the numbers and biomass of *A. woodiana* in Wąsosko-Mikorzyńskie Lake were relatively low, and varied from 1 to 4 individuals m^{-2}, and 60-110 g m^{-2}, respectively. The mussels inhabited the littoral at depths of 2-3.5 m. They were most frequent at station 2.4 where the species *Unio pictorum* was also well represented.

This Chinese mussel was also dominant in the shallow Pątnowskie Lake. It inhabited the shore zone at 1.2 to 2.8 m (station 3.3). It was also encountered in the central part of the lake at a depth of about 4 m (station 3.6). Its numbers (5 individuals m^{-2})

and biomass (470 g m^{-2}) were not high. The highest aggregations of mussels (14 individuals m^{-2}, and 2,050 g m^{-2}) were observed at station 3.5 in the area of water discharge from the Licheński Channel and the channel between the Licheńskie and Pątnowskie lakes. The densities were also high (26 individuals m^{-2}, 2,700 g m^{-2}) at station 3.7 in the vicinity of the water intake channel of the Konin power plant.

In Gosławskie Lake, *A. woodiana* occurred most frequently at the south-eastern stations (5.1, 5.2, 5.3) at depths of 1.2-2 m (7-20 individuals m^{-2}, 550-1,100 g m^{-2}). In the water discharge zone (station 5.4), the abundance of *A. woodiana* was still higher (16 individuals m^{-2}, 2,800 g m^{-2}). The native Unionidae (*U. pictorum* and *U. tumidus*) co-occurred with *A. woodiana* only at station 5.5.

In Licheńskie Lake, the warmest in the complex, the Chinese mussel occurred quite abundantly only in areas which were free of *Vallisneria spiralis* L., or it was found at depths of 2-3 m outside of the reach of this species. This plant is an expanding species in the lakes, forming thick underwater meadows down to depths of 3 m. Several years ago its maximal range of occurrence was 1.5 m (Afanasjev et al. 1996). The highest aggregations of the mussel (8-17 individuals m^{-2}, 1,000-2,500 g m^{-2}) were noted in the outlet zone of the Licheński Channel at stations 4.2 and 4.3, as well as at the outlet of the channel joining Licheńskie and Pątnowskie lakes (station 4.1). The mussel's biomass was lower (580 g m^{-2}) in the vicinity of station 4.5 where the water outlet from the lake to Piotrkowicki Channel is located.

In the preliminary cooling reservoir before the stone barrier, and directly beyond the heated water discharge from the Konin power plant, the abundance of *A. woodiana* was high on the muddy bottom beginning at depths of 1 m. Its density varied from 26 to 50 individuals m^{-2}, and the biomass reached 11,300-24,700 g m^{-2}. These values were lower beyond the stone barrier at 11-30 individuals m^{-2} and 2,600-4,900 g m^{-2}, respectively. The population contained very large individuals with shell lengths measuring from 150 to 180 mm. In the central part of the reservoir, the mussel biomass fell to 1,000 g m^{-2}, and at the outlet it was 700 g m^{-2}.

In coolest part of the Konin complex, the power plant inlet channel, single individuals of *A. woodiana* were noted and representatives of the species *A. complanata* also occurred infrequently. On the other hand, the warmest part of the lake system, the discharge channel of the same power plant, was inhabited only by *A. woodiana* in very abundant aggregations. The most numerous aggregations at this site were at the depths of 2-3 m. Although it did not settle in the shallower parts of the channel at depths to 1 m, it did appear (4 individuals m^{-2}) at a distance of several tens of meters from the discharge point (station 9.1) between stones on the sandy bottom and in the strong water flow zone. The numbers (10-50 individuals m^{-2}) and biomass (2,300-16,700 g m^{-2}) in the farther reaches of the channel were both rather high. In the discharge channel of the Pątnów power plant, the numbers and biomass (38 individuals m^{-2}, 10,920 g m^{-2}) were somewhat lower than at the previous site; however, in the area of fish fry stocking in this channel, very high biomass (50-70 kg m^{-2}) had been recorded previously (Protasov et al. 1994).

The uniform distribution of *A. woodiana* from a depth of 1 m was noted only at station 8.1 in the warmest part of the Warta-Gopło Channel (38-50 individuals m^{-2}, 9,000-10,000 g m^{-2}). On the other hand, different parts of the Licheński Channel were not inhabited uniformly. The mussel occurred abundantly (40-60 individuals m^{-2}, 15,000-17,000 g m^{-2}) at station 9.4 where the channel is wide and has a moderate water current velocity. On the sandy-stony bottom, 200 meters away (station 9.5), the numbers and biomass decreased (4 individuals m^{-2}, 940 g m^{-2}), only to increase again (34 individuals m^{-2}, 7,230 g m^{-2}) near a fish fry stocking pond (station 9.6). At station 9.7 the largest aggregation of mussels (926 individuals m^{-2}, 7,800 g m^{-2}) was observed at depths of 2-2.5 m along the sides of the channels, and not, as was typical in other locations, in its central part. A similar situation was noted in the channel joining Licheńskie and Pątnowskie lakes (station 3.1) where at a depth of 2-2.5 m the abundance and biomass were 40 individuals m^{-2} and 10,460 g m^{-2}, respectively.

In Piotrkowicki Channel near the pumping station, *A. woodiana* inhabited the muddy bottom at a shallow depth of 0.5 m. The maximal numbers (16 individuals m^{-2}) and biomass (4,460 g m^{-2}) were found in the central part of the channel. Beyond the pumping station, where the channel is filled with water only during periods of high water circulation (May, September), the mussel occurred in small quantities at station 10.5 (2 individuals m^{-2}, 523 g m^{-2}).

As stated by Kiss (1992), *A. woodiana* biomass may form as much as 75% of the total benthic fauna biomass in a given reservoir. For example, it reached a value of 20-25 tons ha^{-1} in Hungary's Körös River. Similarly, in the Konin lakes complex, the biomass of *A. woodiana* constituted more than 70% of the total population biomass of the family Unionidae. It occurred in most of the channels, as well as in the five lakes (Table 3). Periodically, at certain sampling stations, the biomass exceeded 50 kg m^{-2}, for example, in 1993 in the discharge channel of the Pątnów power plant (Protasov et al. 1994).

TABLE 3

Distribution of the Unionidae mussels in the Konin lakes system

Site		*Anodonta woodiana*	*Unio pictorum*	*Unio tumidus*	*Anodonta anatina*	*Anodonta complanata*
Ślesińskie Lake	1.1, 1.3, 1.5	x	x	x	x	
Channel between the Ślesińskim and Wąsoskim lakes	1.4	x	x			
Wąsosko-Mikorzyńskie Lake	2.1, 2.2, 2.3, 2.4,	x	x			
Channel between the Licheńskie and Pątnowskie lakes	3.1	x	x	x		
Pątnowskie Lake	3.2, 3.3, 3.4, 3.5, 3.6, 3.7	x	x	x		
Licheńskie Lake	4.1, 4.2, 4.3, 4.4, 4.5	x	x		x	
Gosławskie Lake	5.1, 5.2, 5.3, 5.4, 5.5	x	x	x		
Preliminary cooling reservoir	6.1, 6.5	x		x		
	6.2, 6.6	x		x		
	6.3, 6.7	x	x	x		
	6.4	x	x			
Inlet channel EK	7.1, 7.2	x				x
Discharge channel EK	9.1, 9.2	x				
Discharge channel EP	9.3	x				
Warta-Gopło Channel (lower station)	8.1	x	x	x		
Water withdrawal construction from ponds	8.2	x		x		
Licheński Channel	9.4, 9.5, 9.6, 9.7	x				
Wąsoski Channel	9.8	x				
Piotrkowicki Channel	10.1, 10.2	x	x	x		
	10.3, 10.4, 10.5, 10.6	x	x			

The lowest mussel numbers (1-5 individuals m^{-2}) were observed in Ślesińskie and Wąsosko-Mikorzyńskie lakes, and in the inlet canal of the Konin power plant, and also beyond the pumping station in the Piotrkowicki Channel. The highest numbers (30-60 individuals m^{-2}) were found in the preliminary cooling reservoir, in the Warta-Gopło Channel (station 8.1), in the Licheński Channel (in the vicinity of the siphon), in the discharge channel of the Konin power plant, and in the channel joining Licheńskie and Pątnowskie lakes (Fig. 3). The highest biomass (up to 25 kg m^{-2}) was recorded in the Konin power plant preliminary cooling reservoir. In the heated channels of the lakes complex, its values were lower and varied from 10 to 17 kg m^{-2} (Fig. 4).

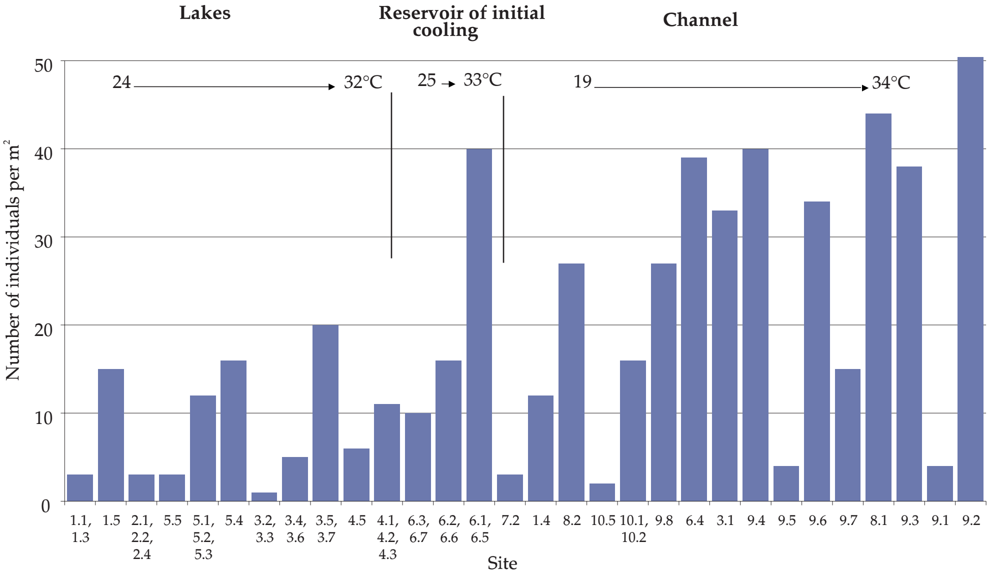

Fig. 3. Variation of the number of *A. woodiana* as water heating increased in the lakes, the preliminary cooling reservoir, in the channels of the Konin system, at different stations in 1999-2000.

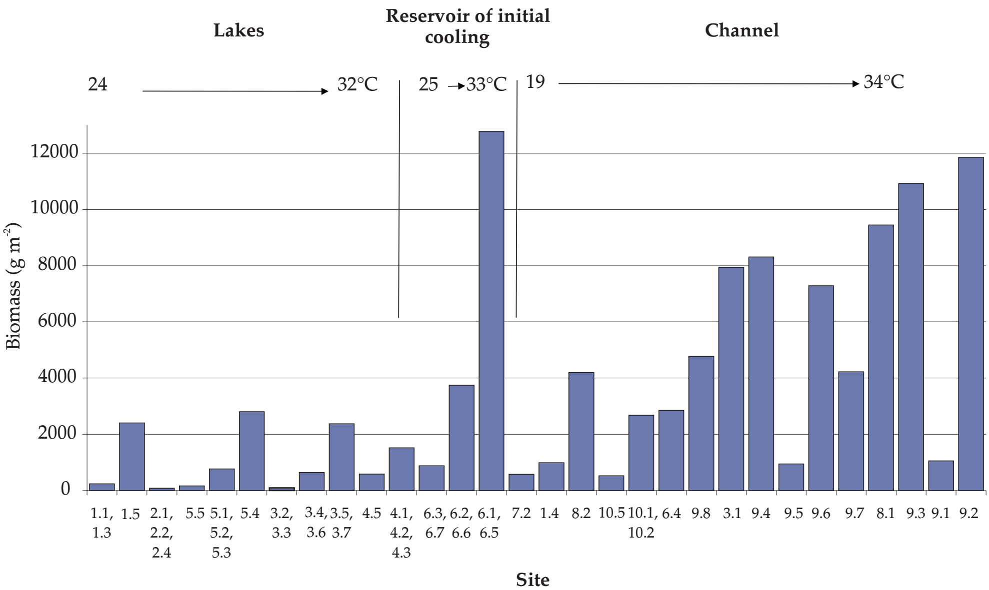

Fig. 4. Variation of the average biomass (g m^{-2}) of *A. woodiana* as water heating increased in the lakes, the preliminary cooling reservoir, in the channels of the Konin system, at different stations in 1999-2000.

CONCLUSIONS

The Chinese mussel *A. woodiana* has found favorable growth conditions in the Konin lakes system, and it has become the dominant species of the channel bottom communities. During the study period, both the biomass and numbers of the species were considerable, but variable, with regard to distribution and abundance in the various zones.

The mussel appears to play a significant role in the biological purification processes of water (Sinicyna et al. 1997). With its great filtration abilities, it hinders the development of algae, and by removing suspended particular matter it has a beneficial effect on water purification. It plays also a significant role in the phosphorus bio-accumulation process, which is the key element of water eutrophication. It also accumulates calcium and heavy metals (Królak and Zdanowski 2001).

The presence of mussels in an aquatic environment indicates the low degree of toxicity of the Konin lakes complex. Mussels have a relatively long life span in relation to other aquatic organisms, such as those in the plankton, or some invertebrates, or the fishes. Mussels are considered as bio-indicators of environmental pollution, and readily react to harmful substances in a continuous way (Kramer et al. 1989, Domek et al. 1994, 1995). Their mass disappearance is related to the occurrence of high concentrations of toxic substances in the environment. On the other hand, populations characterized by a long life duration, have the ability to quickly regenerate following the removal of unfavorable factors.

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REFERENCES

Afanasjev C.A., Protasov A., Zdanowski B., Tunowski J. 1996 - Osobennosti raspredeleniya dvustvorchatykh molluskov v sistemie podogretykh koninskikh ozer - Gidrob. Zh. 32 (3): 33-44.

Afanasjev C.A., Zdanowski B., Kraszewski A. 2001 - Growth and population structure of the mussel *Anodonta woodiana* (Lea, 1834) (*Bivalvia, Unionidae*) in the heated Konin lakes system - Arch. Pol. Fish. 9 (1): 123-131.

Beran L. 1997 - First record of *Sinanodonta woodiana* (Mollusca: Bivalvia) in the Czech Republic - Acta Soc. Zool. 61 (1): 1-2.

Bogatov B. B., Zatravkin M. H. 1988 - Novye vidy otryada s yuga Dalnego Vostoka CCCP. Sistematika i fauna bryukhonogikh, dvustvorchatykh i glovonogikh - Tr. Zool. In-ta AN CCCP: 155-168.

Domek P., Piotrowicz R., Klimaszyk P., Kraska M. 1994 - Mussels as indicators of incidental pollution of surface waters - XVI Seminary of Polish Hydrobilogists, Wrocław, 40 pp. (in Polish).

Domek P., Kraska M., Klimaszyk P., Piotrowicz R. 1995 - Mussels as indicators of incidental pollution of surface waters - XXVI Congress of International Association of Theoretical and Applied Limnology, 23 - 29. 07.1995 Sao Paulo (Brazil), 379 pp.

Hillbricht-Ilkowska A., Zdanowski B. 1988 - Changes in lake ecosystems connected with the power - generating industry (the outline of problem). The Konin lake (Poland) as the study sites - Ekol. Pol. 36 (1-2): 5-21.

Kiss A. 1992 - *Anodonta woodiana woodiana* (Lea 1834), (Bivalvia: Unionacea) in Hungary - Atti Congresso di Parma, 11 - 13 ottobre 1990, Lavori S. I. M., Parma, 24: 171-176.

Kiss A. 1995 - The propagation, growth and biomass of the chinese huge mussel (*Anodonta woodiana woodiana* 1834) in Hungary. University of Agricultural Sciences of Godollo. Hungary. Privat Edition, Second Ed., 33 pp.

Kiss A., Pekli J. 1988 - On the growth rate of *Anodonta woodiana woodiana* (Lea 1834), (Bivalvia: Unionacea) - Bull. Agric. Sci. 1: 119-124.

Kramer K., Jenner H., De Zwart D. 1989 - The valve movement response of mussels: A tool of biological monitoring - Hydrobiol. 188/189: 433-443.

Królak E., Zdanowski B. 2001 - Bioaccumulation of heavy metals by the mussels *Anodonta woodiana* (Lea 1834) and Dreissena polymorpha (Pall.) in the heated Konińskie lakes - Arch. Pol. Fish 9: 229-237.

Petro E. 1984 - The occurance and presence of *Anodonta woodiana woodiana* (Lea 1834) in Hungary - Allatani Kozelemenyek, LXXI, 84: 189-191.

Piechocki A., Riedel A. 1997 - *Mollusca.* Ed. J. Razowski. Checklist of Animals of Poland. Classification and Evolution Institute of Animals, Polish Academy of Science. Kraków 4: 104-121 (in Polish).

Protasov A. A., Afanasjev S. A., Sinicyna O. O., Zdanowski B. 1994 - Ecological disturbances in heated Konin lakes. Composition and functioning of benthnic communites - Arch. Pol. Fish. 2 (2): 257-284.

Protasov A. A., Afanasjev S. A., Zdanowski B. 1993 - Natural self-purification systems of Konin lakes - Komun. Ryb. 6: 6-9 (in Polish).

Protasov A.A., Starodub K.D., Afanasjev S.A. 1982 - Wodolaznyi metod issledovaniya presnovodnogo perifitona - Gidrob. Zh. 18 (4): 91-93.

Protasov A. A., Zdanowski B, Sinicyna O. O., Afanasjev S. A. , Tunowski J. 1997 - Structure and functioning of zooperyfiton and benthos communites of the channels of heated lakes of Konińskie district - Arch. Pol. Fish. 5 (1): 77-98.

Sinicyna O., Protasov A., Afanasjev S.A., Tunowski J., Zdanowski B. 1997 - The role *of Anodonta sp.* in organic matter destruction in various zones of the channels of Konińskie lakes system. Arch. Pol. Fish. 5 (1): 109-116.

Socha D. 1997 - Changes in quality of waters and trophics heated Konin lakes - Monitoring Environment Library, Konin 1997, 72 pp. (in Polish).

Soroka M. 1998 - Conchiological and genetic variation of *Anodonta* (Bivalia: Unionidae) in the Konin Lakes - Folia. Malac. 6: 81.

Soroka M. 1999 - Genetic study of the different freshwater bivalves in Poland - Polish Zoological Symposium. Ed. High Pedagogical of Słupsk: 260-261 (in Polish).

Soroka M., Zdanowski B. 2001 - Morphological genetic variability of the population of *Anodonta woodiana* (Lea 1834) occuring in the heated Konin water reservoir - Arch. Pol. Fish 9: 239-252.

Zatravkin M. H, Bogatov B. B. 1987 - Krupnye dvustvorchatye molluski presnykh i solonovatykh vodoemov Dalnego Vostoka CCCP - Vladivostok: izd. Biologo-pochv. In-ta DVNTS ÀN, 146 pp.

Zdanowski B. 1989 - Itogi mnogoletnikh nablyudenii za izmenieniem ekosistem ozer pod vodeistviem sbrosnykh vod GRES - Sb. Nauk. Trudov. GOSNIORCH Leningrad, 299: 3-22.

Zdanowski B. 1994 - Ecological disturbances in heated Konin lakes. Characteristics of heated Konin lakes, pollution, sources, main results and conclusions - Arch. Pol. Fish 2 (2): 139-160.

Zdanowski B., Wilkońska H., Ciepielewski W., Socha D., Świątecki A., Tunowski J. 1992 - Konin lakes - thirty years of study - Conference: Pollution problems and the protection surfacewater - today and tomorrow - University of Warmia and Mazury, Series Biology 49: 361-380 (in Polish).

STRESZCZENIE

ROZMIESZCZENIE I LICZEBNOŚĆ MAŁŻA CHIŃSKIEGO *ANODONTA WOODIANA* (LEA, 1834) W SYSTEMIE PODGRZANYCH JEZIOR KONIŃSKICH

Małż *Anodonta woodiana* (Lea, 1834) pochodzi z Chin i zawleczony został do jezior konińskich z Węgier wraz z rybami roślinożernymi (Protasov i in. 1993, 1994, 1997). Znalazł tu korzystne dla siebie warunki bytowania i zasiedla obecnie litoral pięciu jezior kompleksu, zbiornik wstępnego chłodzenia wody, jak i większość kanałów zarówno zrzutowych, jak i dolotowych (rys. 1, tabela 3). Preferuje siedliska o znacznej turbulencji wody i stosunkowo wysokiej temperaturze (30-34^{o}C).

Na podstawie badań przeprowadzonych w szczytowym okresie wegetacji (lipiec) w latach 1999-2000, na 52 stanowiskach, określono rozmieszczenie małży w systemie (rys. 1) oraz określono ich cechy morfologiczne, liczebność i biomasę (rys. 2, 3, 4). Osobniki młodociane o wymiarach 4-6 cm spotykane były sporadycznie. W litoralu jezior oraz w kanałach dolotowych do elektrowni przeważały z reguły osobniki o długości 80-120 mm, w kanałach umiarkowanie podgrzanych o długości 100-140 mm, a w najcieplejszych kanałach i w zbiorniku wstępnego chłodzenia o długości 110-180 mm. Największe osobniki (200-225 mm), aczkolwiek nielicznie, spotykano w kanałach zrzutowych i w zbiorniku wstępnego chłodzenia.

Największe skupiska małży odnotowywano w pasie na głębokości 1,5-2,5 m, a nieco mniejsze wzdłuż brzegów na głębokości 0,8-1,5 m. Największą frekwencję małży (30-60 osob. m^{-2}), stwierdzono w zbiorniku wstępnego chłodzenia oraz w ciepłych kanałach, zaś najmniejszą (1-5 osob. m^{-2}) w jeziorach i chłodniejszych kanałach. Największą biomasę małży (do 25 kg m^{-2}) odnotowano w zbiorniku wstępnego chłodzenia elektrowni "Konin".

Małż *A. woodiana* zajmując pozycję dominanta w zespołach dennych odgrywa, jak się wydaje, istotną rolę w procesach biologicznego oczyszczania wody, bioakumulacji fosforu, wapnia i metali ciężkich, jak też jest doskonałym bioindykatorem stanu środowiska.

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