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LONG-TERM CHANGES IN THE FAUNA OF FAMILY UNIONIDAE BIVALVES IN THE MIKOŁAJSKIE LAKE*

ABSTRACT: In 1987, in the eutrophic Mikołajskie Lake the occurrence, numbers, biomass, age structure, size structure and growth of family Unionidae bivalves were determined and compared with the results of identical studies performed 15 years earlier. There were adverse changes in the Unionidae populations, related to an increase in lake eutrophication and pollution.

KEY WORDS: lake, Unionidae bivalves, age structure, growth.

1. INTRODUCTION

The Mikołajskie Lake situated in the system of Great Masurian Lakes is strongly affected by the eutrophication-causing factors, among which the inflow of municipal sewage from the city of Mikołajki is most essential. Many years' hydrobiological studies of this lake testify to various environmental and biocenotic changes related to the rise of trophy. Many cumulative papers deal with the Mikołajskie Lake (e.g. (Pieczyńska 1976, Kajak 1978, Gliwicz et al. 1980). Long-term changes observed in the Mikołajskie Lake concern e.g. the phytoplankton (Spodniewska 1976), submerged macrophytes (Ozimek and Kowalczewski 1984), and bivalve *Dreissena polymorpha* (Pall.) (Stańczykowska 1975, 1978, Lewandowski 1982). Examples of these changes are recorded in Table 1.

The present studies were designed to evaluate the populations of several bivalve species of the family Unionidae, as compared with their state 15 years ago (Lewandowski and Stańczykowska 1975).

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Table 1. Examples of long-term changes in some elements of the Mikołajskie Lake ecosystem

Parameter	Earlier studies (yr)	Later studies (yr)	Authors
Secchi's disc visibility (m)	3.0 (1954)	1.1 (1977)	Szczepański 1968, Gliwicz et al. 1980
Maximal biomass of phytoplankton (mg/l)	18.7 (1963)	55.0 (1972)	Spodniewska 1976
Maximal biomass of filamentous algae in littoral (g/l)	0.7 (1966)	894.0 (1982)	Pieczynska et al. 1988
Biomass of emerged macrophytes (t/ha)	2.1 (1963)	0.2 (1980)	Ozimek and Kowalczewski 1984

2. MATERIAL AND METHODS

Unionidae were studied in the Mikołajskie Lake in September 1987. The distribution of sampling stations, depths of sample collection and methods for Unionidae collection were identical as in 1972 (Lewandowski and Stańczykowska 1975). The only difference consisted in the fact that the material was in 1987 collected once (in September), and in 1972 — four times (in May, June, August and September).

3. RESULTS

In 1987 three species of the family Unionidae: *Anodonta piscinalis* Nilsson, *Unio tumidus* Philipsson and *U. pictorum* L., have been found in the Mikołajskie Lake. As compared with the year 1972, when five species of this family have been found, this is a considerable decrease. At present the species *Anodonta cygnea* L. and *Anodonta (Pseudanodonta) complanata* Rossmässler failed to occur; only single empty shells of these species, usually greatly decomposed, were found. In 1987 *U. tumidus* was the most common species, whereas in 1972 *A. piscinalis* has been dominant (Table 2). In 1987 the zone of Unionidae occurrence was greatly limited. These bivalves were absent from both shallow and relatively deep sites; they were found only at 1.5–3.5 m depths. In 1972 Unionidae have occurred in the zone of 0.2–5.5 m depths.

In both these zones of Unionidae occurrence, differing in area, the mean numbers of these bivalves were similar in both years compared, amounting to ca. 0.4 indiv. · m⁻²; this is a very low value. Both in September 1987 and September 1972, Unionidae occurred most abundantly at 1.5–2.5 m depths (Fig. 1).

Table 2. Percentages of different Unionidae species in the Mikołajskie Lake in 1972 and 1987

Species	1972* (%)	1987 (%)
<i>Unio tumidus</i>	20.5	62.5
<i>Unio pictorum</i>	3.8	6.2
<i>Anodonta piscinalis</i>	71.5	31.3
<i>Anodonta cygnea</i>	4.0	no living indiv.
<i>Anodonta (Pseudanodonta) complanata</i>	0.2	no living indiv.

*According to Lewandowski and Stańczykowska (1975).

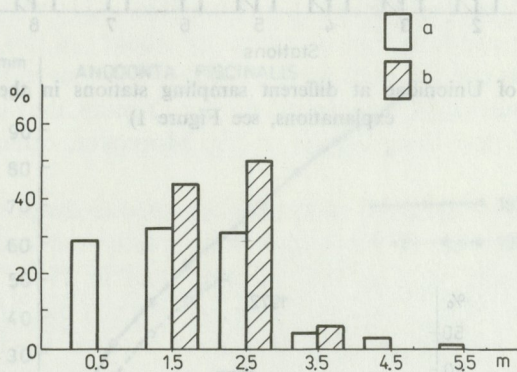


Fig. 1. Percentages of different Unionidae species at various depths of the Mikołajskie Lake a – data for September 1972 (Lewandowski and Stańczykowska 1975), b – data for September 1987

In both years of studies the distributions of various species at different depths was similar: *A. piscinalis* was dominant in the middle part of the occurrence zone, and *U. tumidus* and *U. pictorum* – in the more shallow layers.

There were fairly great differences in Unionidae densities between sampling stations. In 1987 Unionidae were absent from four sampling stations, as compared with the year 1972 when they have been found at all sampling stations (Fig. 2). Locally, the highest density in 1972 has amounted to $7 \text{ indiv.}\cdot\text{m}^{-2}$ (st. 3, 0.5-m depth), and in 1987 it was $4 \text{ indiv.}\cdot\text{m}^{-2}$ (st. 2, 1.5-m depth; st. 8, 2.5-m depth).

In contrast to the Unionidae numbers being similar in both compared years, their biomass greatly differed. The biomass was ca. 10 times smaller in 1987 than in 1972. Mean biomass (wet weight, with shells) in the zone of occurrence amounted in 1987 and 1972 to 1.0 and $9.9 \text{ g}\cdot\text{m}^{-2}$, respectively. Maximal biomass found locally in 1987 and 1972 was 10.5 and $154.1 \text{ g}\cdot\text{m}^{-2}$, respectively.

In 1987 the biomass values were so low because of the age structure and size structure of the collected Unionidae. Among the dominant species, i.e. *U. tumidus*,

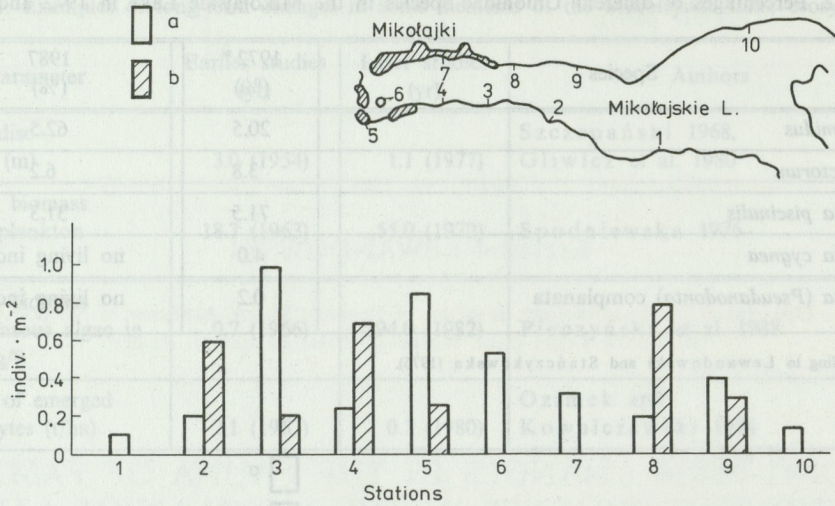


Fig. 2. Mean densities of Unionidae at different sampling stations in the Mikołajskie Lake (for explanations, see Figure 1)

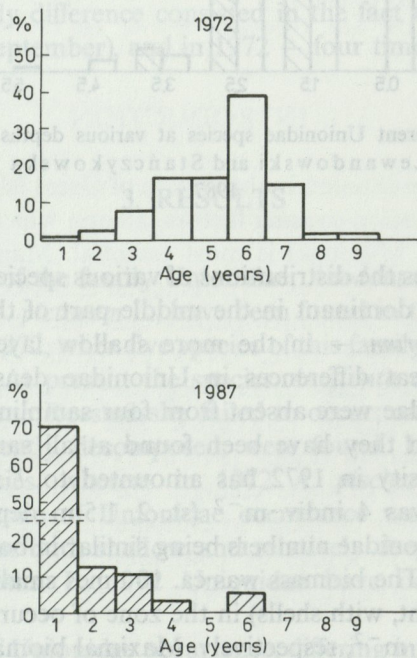


Fig. 3. Age structure of *Unio tumidus* in the Mikołajskie Lake in 1972 (Lewandowski and Stańczykowska 1975) and 1987

the youngest (1-year old) individuals accounted for 70% of the population; as many as 90% were less than 3 cm in length. The oldest individuals were 6 years of age; the length range of *U. tumidus* was 9–48 mm. In the case of *A. piscinalis*, in 1987 1-year old individuals accounted for 80% of the population. The smallest individuals were 8 mm in length, and the largest (whose age did not exceed 5 years) were 55 mm long.

For comparison, in 1972 the largest *A. piscinalis* caught has been found to be 99 mm in length; individuals of a length exceeding 85 mm were relatively common. The oldest *A. piscinalis* have been 10 years old. The age of the oldest *U. tumidus* has been estimated at 9 years; the length of the largest individuals attained 62 mm. In both species individuals aged 4–6 years have been dominant.

The fact that in 1987 bivalves being more than 1 year of age occurred in low numbers and individuals older than 6 years were completely absent (Fig. 3) indicates that these animals died out relatively rapidly. This is confirmed by the

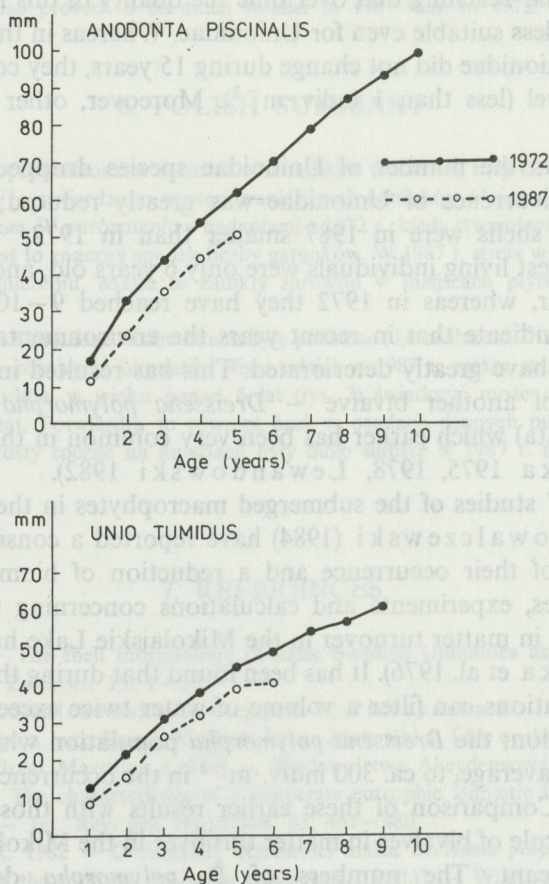


Fig. 4. Mean length of Unionidae in relation to age in the Mikołajskie Lake in 1972 (Lewandowski and Stańczykowska 1975) and 1987

lack of empty shells of older *U. tumidus* and *A. piscinalis* individuals in bottom sediments.

Also an analysis of the annuli on shells indicates that they were much smaller in 1987 than in 1972 (Fig. 4).

4. DISCUSSION

Bivalves of the family Unionidae are common and widespread in fresh waters. Usually they are more abundant in eutrophic than in lower-trophy lakes. According to Agrell (1949), the numbers of Unionidae are greatest in highly eutrophic lakes.

In the Mikołajskie Lake the eutrophication processes, and particularly pollution with municipal sewage (e.g. Pieczyńska 1976, Gliwicz et al. 1980), are — however — so far-reaching that over time the quality of this lake's waters proves to be increasingly less suitable even for Unionidae. Whereas in the Mikołajskie Lake the numbers of Unionidae did not change during 15 years, they continually remained on a very low level (less than 1 indiv.·m⁻²). Moreover, other indices testified to adverse changes:

- during 15 years the number of Unionidae species dropped from 5 to 3;
- the zone of occurrence of Unionidae was greatly reduced;
- the annuli on shells were in 1987 smaller than in 1972;
- in 1987 the oldest living individuals were only 6 years old, and thus they failed to survive any longer, whereas in 1972 they have reached 9–10 years of age.

These results indicate that in recent years the environmental conditions in the Mikołajskie Lake have greatly deteriorated. This has resulted in a substantial drop in the numbers of another bivalve — *Dreissena polymorpha* (K. Lewandowski — unpublished data) which earlier has been very common in the Mikołajskie Lake (Stańczykowska 1975, 1978, Lewandowski 1982).

In many years' studies of the submerged macrophytes in the Mikołajskie Lake, Ozimek and Kowalczewski (1984) have reported a considerable decrease in the depth range of their occurrence and a reduction of biomass.

In the seventies, experiments and calculations concerning the role of various groups of bivalves in matter turnover in the Mikołajskie Lake have been performed (Stańczykowska et al. 1976). It has been found that during the vegetation season the bivalve populations can filter a volume of water twice exceeding the volume of this lake's epilimnion; the *Dreissena polymorpha* population which at this time has amounted, on the average, to ca. 300 indiv.·m⁻² in the occurrence zone proved to be most important. Comparison of these earlier results with those obtained in 1987 indicates that the role of bivalves in matter turnover in the Mikołajskie Lake became virtually insignificant. The numbers of *D. polymorpha* decreased 30 times (K. Lewandowski — unpublished data). The area of the occurrence zone of Unionidae was reduced more than twice, and the youngest individuals with the slightest filtration possibilities became dominant.

Thus, the Mikołajskie Lake is now virtually deprived of a significant element of the biocenosis, contributing to water purification from suspensions.

5. SUMMARY

Studies performed in 1987 in the Mikołajskie Lake were identical with those carried out in 1972. In 1987 three species of Unionidae: *Anodonta piscinalis*, *Unio tumidus* and *U. pictorum*, were found. As compared with 1972 when five Unionidae species have been recorded, this is a substantial drop in the number of species. In 1987 the zone of Unionidae occurrence proved to be greatly limited. These bivalves disappeared from both shallow and relatively deep sites (Fig. 1).

In contrast to the numbers of Unionidae ($0.4 \text{ indiv.} \cdot \text{m}^{-2}$ in the occurrence zone) being closely similar in both years under study, there were considerable differences in their biomass between years. The fact that in 1987 the proportion of individuals older than 1 year was low and bivalves more than 6 years of age were completely absent (Fig. 3) may testify to relatively rapid dying out of these animals. This is also confirmed by a lack of empty shells of older *U. tumidus* and *A. piscinalis* individuals in bottom sediments. The annuli on shells also proved to be much smaller in 1987 than in 1972.

6. POLISH SUMMARY

Badania, które przeprowadzono w Jeziorze Mikołajskim w 1987 r., były dokładnym powtórzeniem badań z 1972 r. W 1987 r. stwierdzono występowanie trzech gatunków Unionidae: *Anodonta piscinalis*, *Unio tumidus* i *U. pictorum*. W porównaniu z badaniami z 1972 r., kiedy stwierdzono występowanie pięciu gatunków Unionidae, jest to znaczny spadek liczby gatunków. W 1987 r. strefa występowania Unionidae uległa znacznemu ograniczeniu. Małże te zanikły zarówno w miejscach płytkich jak i stosunkowo głębokich (rys. 1).

Mimo iż liczebności Unionidae w obu latach były podobne ($0,4 \text{ osobn.} \cdot \text{m}^{-2}$ w strefie występowania), to zanotowano znaczne różnice w biomase. Niski udział w 1987 r. małży starszych niż jednoroczne i całkowity brak osobników w wieku ponad 6 lat (rys. 3) świadczyć może o stosunkowo szybkim wymieraniu tych zwierząt. Potwierdza to również brak w osadach dennych pustych muszli starszych skójek i szczeżuj. Przyrosty roczne na muszlach były dużo słabsze w 1987 r. niż u małży zbieranych w 1972 r.

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