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INFLUENCE OF SUBMERGED VEGETATION ON THE DIET OF ROACH (*Rutilus rutilus* L.) IN SHALLOW POLESIE LAKES

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Summary. Diet composition of roach (*Rutilus rutilus* L.) was analysed in three shallow lakes of Polesie Lubelskie (Kleszczów, Głębokie and Syczyńskie), classified according to the alternative stable state theory based on submerged vegetation development. Obtained results showed significant influence of spatial distribution of vegetation on the composition of roach diet. Independently of the lake type, roach mostly fed on epiphytic fauna, while benthic taxa occurred randomly in a very little amount. In macrophyte dominated (MD) Lake Kleszczów the diet of roach constituted on planktonic *Cladocera* which amounted 66% of total food. In phytoplankton-macrophyte dominated (PMD) Lake Głębokie, the diet of the studied fish was dominated by *Trichoptera*, the share of which reached 52% of all food components. In phytoplankton dominated (PD) Lake Syczyńskie, roach fed on *Chironomidae* larvae (mostly epiphytic *Cricotopus* sp. gr. *sylvestris*). The larvae of midges constituted 40% of total food.

Key words: roach, diet composition, submerged vegetation, shallow lakes

INTRODUCTION

Submerged vegetation in shallow lakes provides a complex habitat for aquatic fauna. It may serve as breeding area, substrata for periphyton development, site for abundant food production and refuge against predators [Crowder and Cooper 1982, Glinsky 1984, Rennie and Jackson 2005]. Aquatic vegetation increases the structural complexity of habitat [Chambers and Kalff 1987, Sand-Jensen and Mebus 1996] and thus is an important determinant of habitat selection by fish [Killgore *et al.* 1989, Chick and McIvor 1994]. Macrophytes support the food availability and diminish the risk of predation [Rozas and Odum 1988].

Dense macrophyte stands support high densities of invertebrate taxa [Pieczyńska *et al.* 1999]. Littoral invertebrates constitute an important food component for omnivore fish which live among submerged vegetation where they can reduce the risk of predation by piscivorous fish [Mittelbach 1988].

Roach (*Rutilus rutilus* L.) is a widely distributed cyprinid fish in shallow lakes in Poland. It is classified as an omnivorous species that can feed on zooplankton, benthic invertebrates, planktonic algae and macrophytes tissue [Rask 1989, Giles *et al.* 1990, Horppila 1994, Specziar *et al.* 1997]. Due to the wide food spectrum, the composition of roach diet should change among lakes differing in submerged vegetation cover. Such a relationship was studied in three shallow lakes of Polesie Lubelskie, differing in spatial distribution of submerged macrophytes.

STUDY AREA, MATERIAL AND METHODS

The studies were conducted in three shallow lakes of Polesie Lubelskie differing in spatial distribution of submerged vegetation (Tab. 1). Fish were caught in autumn (October) 2001 using S-REV Norden multimesh gill nets. The nets consisted of 14 segments, each 3 m long, differing in mesh size: 10, 60, 30, 6.25, 43, 22, 50, 33, 12.5, 25, 8, 38, 75 and 16.5 mm. Nets were set in the evening and retrieved early in the morning (at 5 a.m.); the exposure lasted 12 hours. At least 25 individuals from each lake were taken for diet analysis (Tab. 2).

Analysis included relative abundances (in %) of particular components in the guts, frequency of occurrence of food components in the guts, and evaluation

Table 1. Morphometric, physical and chemical characteristic and structure of floating-leaved and submerged vegetation in studied lakes

Lake	Lake type	Surface area (ha)	Max. depth (m)	SD (m)	Chlorophyll-*a* (mg dm^{-3})	Total P (µg dm^{-3})	Mean coverage (%)	Dominating species
Kleszczów	macrophyte dominated	53.9	2.3	2.3	5.8	32.0	96	*Chara fragilis* *Chara vulgaris* *Myriophyllum spicatum*
Głębokie	phytoplankton-macrophyte dominated	20.5	7.1	0.9	58.6	204.0	5	*Nuphar lutea* *Nymphaea candida* *Potamogeton natans* *Elodea canadensis* *Ceratophyllum demersum*
Syczyńskie	phytoplankton dominated	5.6	2.9	0.2	330.8	369.5	–	–

Table 2. Selected morphometric features of studied roach

	Kleszczów	Głębokie	Syczyńskie
Total length, cm	range 10.5–17.2 mean 12.5	range 12.3–15.6 mean 13.8	range 10.8–19.4 mean 14.6
Weight, g	range 9.8–66.7 mean 19.8	range 14.8–32.9 średnia 20.8	range 13.2–102.5 mean 35.9
No. of individuals, n	29	26	25

of the importance of particular food items as roach food. The occurrence of the each diet component was expressed as the percentage of guts in which the item occurs. All of the components found were classified into the following groups: very constant component (occurring in 76–100% of the guts), constant component (occurring in 51–75%), accidental component (occurring in 26–50%) and accessory component (occurring in less than 25% of the guts). The importance of the dietary components was measured using the index of relative importance (Q) according to Kasprzak and Niedbała [1981], modified:

$$Q = \sqrt{\%F \cdot \%D}$$

where:

$\%D$ = relative abundances of a food type in the gut;

$\%F$ = percentage frequency of occurrence of a particular food type in the gut.

The differences in the composition of roach diet in studied lakes were verified using one-way ANOVA [SAS 2001].

RESULTS

Diet composition of roach changed visibly among the studied lakes (Fig. 1), in particular the lakes differed significantly in amounts of phytophilous midges (ANOVA, F = 160.33, p = 0.015), larvae of Trichoptera (ANOVA, F = 231.14, p = 0.041) and detritus (ANOVA, F = 44.81, p = 0.028) noted in roach guts. In MD Lake Kleszczów the highest share in the diet was planktonic Cladocera (66%), the remaining food items did not exceed 10%. In PMD Lake Głebokie roach fed mostly on Trichoptera larvae; this amounted to 52% of total food. Instead of trichopterans, the second important food component was constituted by Chironomidae larvae – 26%. In the third PD Lake Syczyńskie the highest amount in the roach guts were Chironomidae larvae (mostly phytophilous *Cricotopus* sp. gr. *sylvestris*) – 40%. In all studied lakes in the diet of fish detritus was observed, its amount increasing significantly (ANOVA) with decrease of macrophytes biomass and ranging from 10% (MD Lake Kleszczów) to 27% (PD Lake Syczyńskie).

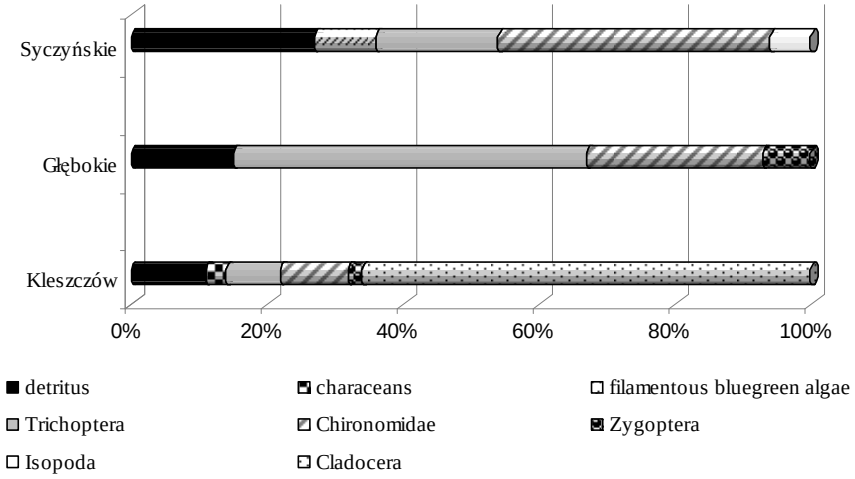

Fig. 1. Relative abundance of food components in roach diet in studied lakes

In the diet of roach two very constant components were distinguished – Cladocera (Lake Kleszczów) and detritus (lakes Głębokie and Syczyńskie), and three constant components – Trichoptera (Lake Głębokie), larvae of phytophilous midge *Cricotopus* sp. gr. *sylvestris* and filamentous blue-green algae (Lake Syczyńskie). The remaining food items were classified as accidental or accessory components (Tab. 3).

Table 3. Frequency of occurrence of particular components in roach diet

Dietary component – Lake	Kleszczów	Głębokie	Syczyńskie
Cladocera	++++		
Isopoda (*Asellus aquaticus*)			
Zygoptera larvae	+	++	
Chironomidae larvae			
Chironomus sp.			++
Cricotopus sp. (gr. *sylvestris*)	+	++	+++
Parachironomus varus Goetghebuer			
Einfeldia sp.			+
Endochironomus albipennis (Meigen)		++	
Glyptotendipes sp.	+		+
Psectrocladius sp.	+		
Trichoptera larvae			
Polycentropodidae	++	+++	
Orthotrichia sp.	++	+++	
detritus	+++	++++	++++
characeans	++		
filamentous blue-green algae			+++

++++ very constant component; +++ constant component; ++ accidental component; + accessory component

Table 4. Values (in %) of relative importance index (Q) of particular components of roach diet in studied lakes

Dietary components – Lake	Kleszczów	Głębokie	Syczyńskie
Cladocera	77		
Isopoda (*Asellus aquaticus*)			10
Zygoptera larvae	3	22	
Chironomidae larvae			
Chironomus sp.			9
Cricotpus sp. (gr. *sylvestris*)	12	27	34
Parachironomus varus Goetghebuer			
Einfeldia sp.			6
Endochironomus albipennis (Meigen)		32	
Glyptotendipes sp.	12		7
Psectrocladius sp.	12		
Trichoptera larvae			
Polycentropodidae	16	58	29
Orthotrichia sp.	11	58	
detritus	37	63	88
characeans	16		
filamentous blue-green algae			30

The highest values of Q index in MD Lake Kleszczów showed Cladocera – 77% and detritus – 37% (Tab. 4). In PMD Lake Głębokie the most important dietary components were detritus (Q = 63%), Trichoptera larvae (Q = 58%) and larvae of phytophilous midges *Endochironomus albipennis* (Q = 32%). In PD Lake Syczyńskie, similarly to lake Głębokie, the highest value of relative importance index was that of detritus (Q = 88%), and additionally two other items – larvae of *Cricotopus* sp. gr. *sylvestris* (Q = 34%) and filamentous blue-green algae (Q = 30%).

DISCUSSION

The presence of phytophilous invertebrates, low amounts of macrophytes tissue and planktonic algae noted in studied roach guts, as well very little amount of bottom fauna, confirm that spatial distribution of submerged vegetation should be considered as a factor influencing the composition of roach diet.

The most wide food spectrum, totally 6 food items (midges and trichopterans larvae, planktonic cladocerans, detritus and macrophytes) were noted in roach guts in macrophyte dominated lake covered by dense characeans meadows. Apart from many items, the diet was dominated by zooplankton, which can be surprising because usually uptake of cladocerans by roach is lower inside macrophytes beds than in the open water [Okun and Mehner 2005]. Effective foraging of roach on zooplankton is usually observed in non-structured open water as a result of roach feeding behaviour which is characterized by fast swimming and snapping while searching for prey [Winfield 1986, Diehl 1988, Person and Elköv 1995].

In the phytoplankton-macrophyte dominated lake, roach feed mostly on animal food (all invertebrates collected from the guts were phytophilous) and detritus, while no plant material was found in the guts. It is worth pointing that the lake is characterised by high development of floating-leaved plants (*Potamogeton natans*, *Nuphar lutea*, *Nymphaea candida*) and roach is known to pluck leaves of *P. pectinatus* during its search for attached invertebrates [Körner and Dugdale 2003].

Bottom invertebrates, larvae of midges *Chironomus* sp. and *Einfeldia* sp. were observed in the diet only in the phytoplankton dominated lake. In that lake, due to the absence of dense submerged vegetation, fish can easily penetrate the bottom during foraging activity, opposite to the other lake types where vegetation covers large parts of bottom sediments, and at the time foraging fish have to seek an alternative food source which constitutes epiphytic fauna [Diehl 1992, Kornijów and Moss 1998].

The presence of blue-green algae and larvae of epiphytic and benthic midges in the guts suggests that in the phytoplankton dominated lake roach fed in both the open water zone and among dense *Phragmites* stands. In highly eutrophic lakes, cyanobacteria are available as alternative food source to zooplankton [Kamjunke *et al*. 2002], and the use of the habitat by fish can vary according to resource availability [Grenouillet and Pont 2001].

Together with decreasing submerged vegetation cover, in the fish guts larger amounts of detritus appeared. Probably unavailability of preferred food induced roach to increase consumption of less nutrition detritus/plant food [Persson and Greenberg 1990].

CONCLUSION

Spatial distribution of submerged vegetation strongly affected the diet of roach (*Rutilus rutilus* L.). Like typical omnivorous species, in studied lakes roach showed a wide food spectrum, fed on zooplankton, phytophilous fauna, detritus, macrophytes and filamentous blue-green algae. The highest number of food items was noted in the guts of fish collected in the macrophyte-dominated lake, and the lowest in the phytoplankton-macrophyte dominated lake.

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WPŁYW STOPNIA ROZWOJU ROŚLINNOŚCI ZANURZONEJ NA SKŁAD POKARMU PŁOCI (*Rutilus rutilus* L.) W PŁYTKICH JEZIORACH POLESIA

Streszczenie. Skład pokarmu płoci (*Rutilus rutilus* L.) badano w trzech jeziorach Polesia Lubelskiego (Kleszczów, Głębokie i Syczyńskie), sklasyfikowanych wg teorii stanów alternatywnych na podstawie stopnia rozwoju roślinności zanurzonej. Uzyskane wyniki potwierdzają wpływ stopnia porośnięcia dna przez roślinność na skład diety płoci. Niezależnie od typu jeziora, płoć żerowała głównie na faunie naroślinnej, fauna denna spotykana była sporadycznie w niewielkich ilościach. W makrofitowym jeziorze Kleszczów płoć odżywiała się głównie planktonowymi wioślarkami (*Cladocera*), ich udział stanowił 66% ogólnej ilości zjedzonego pokarmu. W fitoplanktonowo-makrofitowym jeziorze Głębokie w diecie płoci dominowały larwy chruścików (*Trichoptera*), osiągając 52% ogólnej ilości zjedzonego pokarmu. W fitoplanktonowym jeziorze Syczyńskie płoć żerowała przede wszystkim na larwach ochotkowatych (Chironomidae), zwłaszcza naroślinnym taksonie *Cricotopus* sp. gr. s*ylvestris.* Udział ochotkowatych w diecie wynosił 40%.

Słowa kluczowe: płoć, skład pokarmu, roślinność zanurzona, płytkie jeziora