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SELECTED MORPHOMETRIC CHARACTERS, CONDITION, AND BODY CHEMICAL COMPOSITION OF PERCH (*Perca fluviatilis* L.) FROM LAKE MIEDWIE, POLAND

WYBRANE CECHY MORFOMETRYCZNE, KONDYCJA ORAZ SKŁAD CHEMICZNY CIAŁA OKONI (*Perca fluviatilis* L.) Z JEZIORA MIEDWIE, POLSKA

Abstract: The study material comprised perch obtained from commercial catches conducted in May and November 2009 in Lake Miedwie. Catches were made using gill nets with a mesh size ranging from 40 to 45 mm. Fifty perch (25 from each of the catches) were obtained for the study. The fish were weighed [g], and then total length [mm] and maximum body height [mm] were measured. The dependencies between total length and weight, total length and body height, and weight and body height were calculated. The condition of the perch was determined with *Fulton's condition coefficient* (KF).

Twelve fish were chosen at random from among the study material collected in spring and autumn to determine body chemical composition. The mean weight of these individuals was 220.51 ± 18.68 g and mean length was 264.33 ± 6.86 mm in spring and 91.08 ± 17.20 g and 189.17 ± 7.52 mm in autumn, respectively. The stomachs were excised from the fish and their contents were identified. Gutted and deheaded fish were homogenized, and the percentage share of the following were determined according to Polish norms: protein, lipids, dry matter, and ash. Qualitative analysis of the fatty acid content of the fish was performed with the PN-EN ISO 5509: 2001 chromotagraphic method.

The results of the analyses indicate that the perch caught in May 2009 have greater body weights, lengths, and heights and higher quantities of lipid in comparison with the perch caught in autumn of 2009. The values of these parameters for spring and autumn, respectively, are as follows: body weight – 156.86 ± 15.98 and 86.46 ± 8.98 g; total length – 233.68 ± 7.37 and 189.08 ± 4.49 mm; body height – 52.66 ± 1.97 and 44.39 ± 1.59 mm; body lipid content – 1.32 ± 0.03 and 0.24 ± 0.01 %. However, the fish caught in November 2009 had higher KF, and contained more EPA and DHA fatty acids in comparison with fish caught in spring 2009, as follows (for spring and autumn, respectively): KF – 1.128 ± 0.02 and 1.203 ± 0.02; EPA content – 7.025 ± 0.005 and 8.725 ± 0.015 %; DHA content – 16.890 ± 0.030 and 18.575 ± 0.005 %.

Keywords: perch, condition, protein, lipids, fatty acids, Miedwie lake

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Lake Miedwie is a deep, post-glacial trough basin with a surface area of 3527 ha, and it is the largest freshwater lake in West Pomerania. Since it is a water source for the city of Szczecin, Lake Medwie and its tributaries are monitored annually. Based on the prevailing hydrochemical conditions, this lake is classified as mesotrophic [1, 2].

Intense fisheries have been conducted in Lake Medwie for many years, and, currently, catches of perch, *Perca fluviatilis* L. (*Perciformes*), are significant source of fishermen income in this basin (Fig. 1). Although perch is a lean fish, consumer demand for its meat is high because of its excellent taste, its easily assimilable protein, and its high content of fatty acids from the n-3 and n-6 families [3-6].

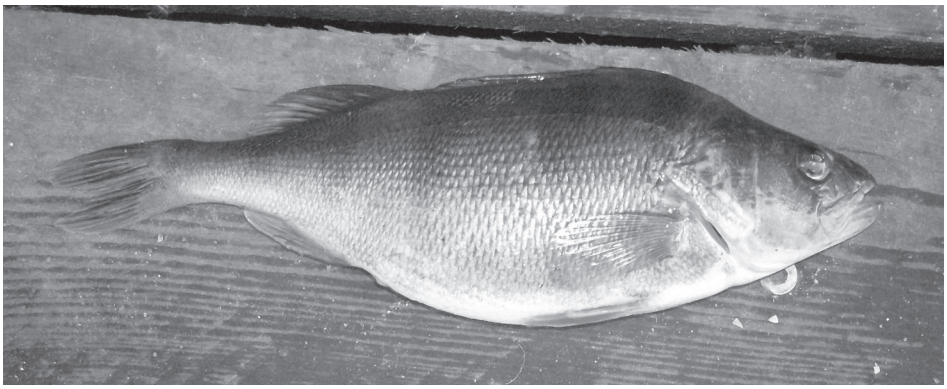

Fig. 1. Perch (*Perca fluviatilis* L.)

Since the occurrence of perch dominates the catches made in Lake Miedwie, it was decided to determine the dependencies in this species between length and weight, the condition coefficient, and the chemical composition of their bodies with a particular focus on the fatty acids.

Materials and methods

The study material comprised perch obtained from commercial catches conducted in spring (05.2009) and autumn (11.2009) in Lake Miedwie. Catches were made using gill nets with a mesh size ranging from 40 to 45 mm. Fifty perch (25 from each of the catches) were obtained for the study. The fish were weighed [g], and then total length [mm] and maximum body height [mm] were measured. The dependencies between total length and weight, total length and body height, and weight and body height were calculated. The condition of the perch was determined with *Fulton's coefficient* (KF) using the following formula:

$$KF = \frac{W \times 100000}{TL^3}$$

*W – total weigh*t of fish [g];
TL – total length of fish [mm].

Twelve fish of mean weight 220.51 ± 18.68 g and mean length 264.33 ± 6.86 mm in spring and another twelve fish of mean weight 91.08 ± 17.20 g and mean length 189.17 ± 7.52 mm in autumn were chosen at random from among the samples taken from the spring and autumn catches to determine the chemical composition of their bodies. The stomachs were excised and the contents identified. The gutted and deheaded fish were homogenized and the percentage shares of the following were determined according to the Polish norms:

– total protein – Kjeldahl method;
– raw lipids – Soxhlet method;
– dry matter – samples were dried at a temperature of 105 ^{o}C for 12 h;
– ash – samples were pyrolized at a temperature of 550 ^{o}C for 10 h.

The fatty acid contents of the fish were analyzed qualitatively with the PN-EN ISO 5509: 2001 chromatographic method.

The results were analyzed statistically with STATISTICA 7.1 operating in a Windows environment [7], and the graphs were generated with Microsoft Office Excel 2003.

Results

The perch caught in May 2009 weighed more, had longer total lengths, and higher maximum body heights in comparison with the fish caught in November 2009 (Table 1).

Table 1

Mean weight [g], total length [mm] and body height [mm] of perch caught in May and November 2009, x ± SEM, n = 50

	May 2009	November 2009
Weight [g]	156.86 ± 15.98	86.46 ± 8.98**
TL [mm]	233.68 ± 7.37	189.08 ± 4.49**
Height [mm]	52.66 ± 1.97	44.39 ± 1.59**

** Statistically different differences at $p \leq 0.01$.

The dependence of body length on weight in the fish caught in spring took the form of the exponential equation $y = 5.5016e^{0,0138x}$; in autumn, the exponential equation was $y = 3.3278e^{0.0168x}$ (Fig. 2). The dependence of body height and weight in fish caught in spring took the form of the exponential equation $y = 9.1778e^{0.0515x}$, while in autumn it was $y = 10.4770e^{0.0457x}$ (Fig. 3). The value for the dependence of length and body height of the fish caught in spring took the form of the linear equation $y = 0.2578x – 7,5869$, while in autumn it was $y = 0.3286x – 17.7480$ (Fig. 4).

The value of Fulton's condition coefficient was statistically ($p \leq 0.01$) higher in the perch caught in November in comparison to the fish caught in May 2009 (Table 2).

Significant changes were noted in the chemical composition of fish body from the catches made in May and those from the November 2009 catches (Table 3).

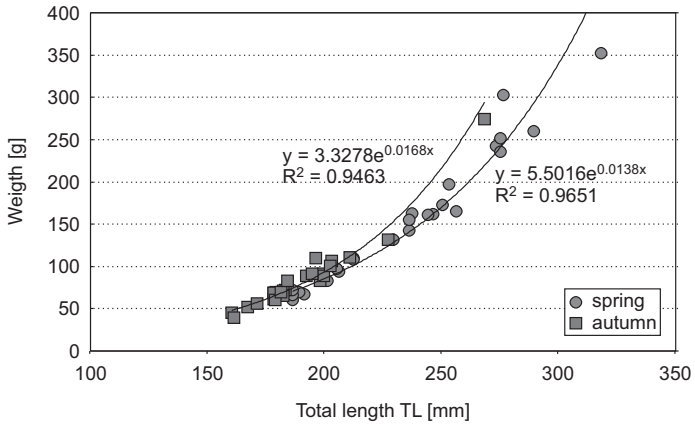

Fig. 2. Length-weight dependency

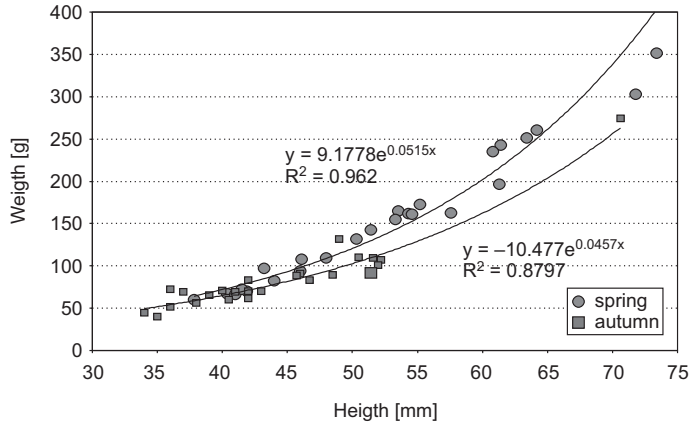

Fig. 3. Height-weight dependency

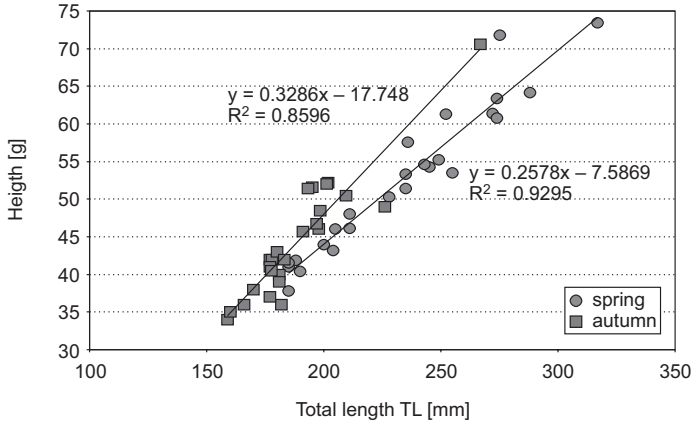

Fig. 4. Length-height dependency

Table 2

Fulton's condition coefficient (KF) of perch caught in May and November 2009, x ± SEM, n = 50

May 2009	November 2009
1.128 ± 0.02	1. 203 ± 0.02*

* Statistically significant differences at $p \leq 0.05$.

Table 3

Proximal composition of perch caught in May and November 2009 [%] x ± SEM

Chemical component	May 2009	November 2009
Dry matter	21.14 ± 0.07	19.42 ± 0.06**
Total protein	19.35 ± 0.07	19.39 ± 0.04
Lipids	1.32 ± 0.03	0.24 ± 0.01**
Ash	1.46 ± 0.01	1.25 ± 0.03*

** Statistically different differences at $p \leq 0.01$; * statistically significant differences at $p \leq 0.05$.

Qualitative analyses of the lipid composition indicated there were significant differences in the levels of selected fatty acids from the n-3 and n-6 families between the fish from catches made in May and November 2009 (Table 4).

Table 4

Composition of fatty acids [%] of perch caught in May and November, x ± SEM, n = 50

Acid		May 2009	November 2009
Miristic	C 14:0	2.970 ± 0.010	1.030 ± 0.030**
Miristicoleic	C 14:1	0.365 ± 0.015	0.050 ± 0.000**
Palmitic	C 16:0	13.155 ± 0.015	20.495 ± 0.095**
Palmitoleic	C 16:1	9.115 ± 0.015	4.405 ± 0.035**
Stearic	C 18:0	2.255 ± 0.015	4.440 ± 0.050**
Oleic	C 18:1	17.795 ± 0.135	11.965 ± 0.015**
Linoleic	C 18:2	3.880 ± 0.030	3.395 ± 0.015**
Gamma linolenic	C 18:3n6	0.030 ± 0.010	< 0.01
Alfa linolenic	C 18:3n3	4.955 ± 0.025	1.990 ± 0.030**
Arachidic	C 20:0	0.090 ± 0.000	< 0.01
Eicosenoic	C 20:1	0.340 ± 0.020	0.365 ± 0.005**
Eicosadienoic	C 20:2	0.240 ± 0.000	0.300 ± 0.000
Eicosatrienoic	C 20:3	0.335 ± 0.015	0.190 ± 0.000*
Arachidonic	C 20:4	3.790 ± 0.000	8.845 ± 0.005**
Eicosapentaenoic (EPA)	C 20:5	7.025 ± 0.005	8.725 ± 0.015**
Erucic	C 22:1	< 0.01	< 0.01
Docosapentaenoic	C 22:5	1.310 ± 0.000	< 0.01
Docosahexaenoic (DHA)	C 22:6	16.890 ± 0.030	18.575 ± 0.005**
Nervonic	C 24:1	0.130 ± 0.000	< 0.01

** Statistically different differences at $p \leq 0.01$; * statistically significant differences at $p \leq 0.05$.

Discussion

Perch catches are an important source of income for the commercial fishers operating in Lake Miedwie. In the current study, the body measurements of the fish caught in spring were greater than those of fish caught in autumn. However, the fish caught in the autumn had a higher Fulton's condition coefficient in comparison with that of the perch caught in May 2009. The condition of the perch examined in this study was comparable to that of the same species from the Solina (1.23–1.55) and Roznow (1.27–1.62) dam reservoirs [8]. It was, however, lower than the values of the condition coefficient (2.13) noted by Szypula [9] for perch from Lake Miedwie in the 1997–2000 period. It must be emphasized that Szypula [9] determined the condition coefficient of the fish using *standard length* (SL) in the equation and not *total length* (TL) as was done in the present study. The occurrence of larger individuals in the spring catches than in those made in the autumn could be linked to the season of the year and perch spawning. The measurements taken for the current study provide the basis for concluding that the length, weight, and height of the perch examined during the current study in different seasons of the year were strongly mutually correlated.

The analysis of perch food indicated that they fed primarily on small fish (mainly bleak). Most of the stomachs examined were empty, which is likely a consequence of storms that occurred prior to the catches in both the spring and autumn.

Fish are divided into three groups according to the lipid content of their muscles: fatty fish contain more than 5 % fat; moderately fatty fish contain from 1–5 % fat; lean fish contain up to 1 % fat [10]. According to the table of nutritional norms by Kunachowicz [11], the fat content of perch is 0.8 %, which places this fish in the lean category. This might indicate that the main nutritional value of perch meat for the consumer is its easily assimilable protein, the content of which remains at high levels regardless of the season of the year. The analysis of the proximate composition of the perch examined indicated that the lipid content in perch from Lake Miedwie during the spring is relatively high which permits classifying these fish as moderately fatty during this period.

Stanek et al [5] observed a different phenomenon in their study of perch females from the Wloclawski Reservoir; the lipid content in these fish was 1.97 ± 0.58 % in June and 2.17 ± 0.54 % in December. In their study of the annual chemical composition of perch body from the River Mouse, Blanchard et al [3] observed lower lipid levels in perch tissues in June (0.564 %) than in October (0.633 %). Neja et al [12] also studied perch from Lake Miedwie in the autumn period and noted relatively high lipid levels (1.71 ± 0.04 %). Presumably, the low lipid levels noted in the perch in the autumn during the current study were the result of a long storm that disrupted normal feeding prior to the catches.

While the content of easily assimilable protein and lipids is important, the nutritional value of fish meat is determined largely by the content of polyunsaturated fatty acids from the *n*-6 and *n*-3 families. *Eicosapentaenoic* (EPA) and *docosahexaenoic* (DHA) acids, which are long-chain fatty acids of the *n*-3 family, play important roles in the human body. In addition to their significance in preventing and treating lifestyle

diseases, these acids are also key to a variety of physiological functions [13; 14]. EPA is an important stimulator of the cardiac and circulatory systems, while DHA is a component of nerve tissues, the brain stem, and the eyes, which means that it can have a significant impact on vision [15]. DHA is essential to the workings of the brain, has an impact on intelligence, and can also aid in relieving the symptoms of stress [16].

Many studies indicate that the type and content of fatty acids in fish depend on the species, their physiological state, the basin they inhabit, the season of the year, hydrochemical conditions, and feeding behavior [17–21].

The lipids of fish from cold northern seas have higher levels of eicosapentaenoic (EPA) fatty acids, while fish from southern seas contain more docosahexaenoic (DHA) fatty acids [13]. It has been demonstrated recently that in addition to marine fish, freshwater fish can be a good source of polyunsaturated fatty acids [16, 22–24]. Bieniarz and Koldras [25] reported that the European wels, pike, and rainbow trout all have lipids that are similar to those of marine fish species in both quantity and composition.

In the current study, significantly higher percentage shares of EPA and DHA were noted in perch in autumn in comparison with spring, which could have resulted from the impact of water temperature, feeding behavior, and the spring spawning period. Similar tendencies were observed in female perch from the Wloclawski Reservoir, and it is notable that the percentage content of EPA was similar while that of DHA was significantly lower than the levels recorded in perch from Lake Miedwie [5]. Similar levels of the fatty acids EPA and DHA were noted in perch from the River Mouse. However, despite a significant increase in the content DHA fatty acid in the fish from this river from June to October, there was a decrease in the content of fatty acid EPA [3].

To summarize, it was concluded that perch from spring and autumn catches differ in body size, condition, and body chemical composition. The fish caught in May 2009 were characterized by greater weight, length, and body height as well as a higher body fat content. Perch caught in November, however, had higher values of the condition coefficient (KF) and higher contents of EPA and DHA fatty acids. These difference were undoubtedly linked to the season of the year, feeding behavior, and the physiological state of the perch examined.

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WYBRANE CECHY MORFOMETRYCZNE, KONDYCJA ORAZ SKŁAD CHEMICZNY CIAŁA OKONI (*Perca fluviatilis* L.) Z JEZIORA MIEDWIE, POLSKA

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Zachodniopomorski Uniwersytet Technologiczny w Szczecinie

Abstrakt: Materiał do badań stanowiły okonie pochodzące z połowów gospodarczych prowadzonych wiosną (05.2009) oraz jesienią (11.2009) w jeziorze Miedwie. Połowy ryb prowadzone były wontonami o rozmiarach

oczka od 40 do 45 mm. Do badań pozyskano 50 okoni, po 25 sztuk z każdego połowu. Ryby ważono [g], a następnie mierzono ich długość całkowitą l.t. [mm] oraz maksymalną wysokość ciała [mm]. Ponadto obliczono relację długości całkowitej do masy badanych ryb. Obliczono także relację długości całkowitej do wysokości badanych ryb oraz masy badanych ryb do ich wysokości. Kondycję okoni określano za pomocą *współczynnika kondycji Fultona* (KF).

Ponadto spośród złowionych ryb, zarówno wiosną jak i jesienią, wybrano losowo po 12 sztuk o średniej masie 218 ± 74 g i długość l.t. 218 ± 74 mm w celu oznaczenia składu chemicznego ich ciała. Od ryb pobrano żołądki i oznaczono ich zawartość. Wypatroszone i odgłowione ryby zhomogenizowano i w tak uzyskanej próbie oznaczono wg Polskiej Normy procentową zawartość białka, tłuszczu, suchej masy i popiołu. Przeprowadzona została także analiza jakościowa tłuszczu zawartego w ciele ryb metodą chromatografii PN-EN ISO 5509: 2001.

Na podstawie przeprowadzonych badań można stwierdzić, że okonie odłowione w maju charakteryzowały się większą masą, długością oraz wysokością ciała, a także większą zawartością tłuszczu w ciele w porównaniu do ryb odłowionych jesienią 2009 r.; odpowiednio wiosną i jesienią: masa ciała – 156,86 ± 15,98 i 86,46 ± 8,98 g; długość całkowita – 233,68 ± 7,37 i 189,08 ± 4,49 mm; wysokość ciała – 52,66 ± 1,97 i 44,39 ± 1,59 mm; ilość tłuszczu w ciele – 1,32 ± 0,03 i 0,24 ± 0,01%. Natomiast okonie odłowione w listopadzie charakteryzowały się większą wartością *współczynnika kondycji* (KF) oraz większą zawartością kwasów tłuszczowych EPA i DHA w ciele w porównaniu do ryb odłowionych wiosną 2009 r.; odpowiednio wiosną i jesienią: współczynnik kondycji (KF) – 1,128 ± 0,02 i 1,203 ± 0,02; zawartość EPA – 7,025 ± 0,005 i 8,725 ± 0,015 %; zawartość DHA – 16,890 ± 0,030 i 18,575 ± 0,005 %.

Słowa kluczowe: okoń, kondycja, białka, tłuszcz, kwasy tłuszczowe, jezioro Miedwie