

ANTONI PRZYBYŁ, JAN MAZURKIEWICZ, JANUSZ GOLSKI, WOJCIECH ANDRZEJEWSKI

Institute of Zoology  
Poznań University of Life Sciences

## **BIOLOGICAL CHARACTERISTICS OF THE FISHED POPULATION OF VENDACE (*COREGONUS ALBULA* L.) FROM THE WINNOGÓRA LAKE (MIĘDZYCHÓD DISTRICT)**

**Summary.** The objective of studies carried out in 2003 was the investigation of the most important biological and morphometrical features of the fished population of vendace from the Winnogóra lake lying in the Międzychód-Sieraków Lakeland. The following features were studied: sex structure, growth rate, fish condition, fertility, as well as biometric and meristic features of the studied vendace. At the same time, the most important physicochemical water indices were determined permitting to characterise the environmental conditions. The lake water (on the basis of seven physicochemical indices) can be classified to the 2nd purity class. However, it has been found that in the summer season, the hypolimnion is almost completely deoxygenated. Vendace from the studied lake belongs to a group with a medium growth reaching in the third year of life the mean total length of 0.90 cm. Fulton's index of fish condition oscillated from 0.69 to 1.27 with a mean value of 0.90. The mean absolute fertility was 9184.6 eggs, while the relative fertility was 7750.26 eggs per 100 g of body mass. Considering the measurable features, the fish population of the Winnogóra lake differs significantly regarding the highest and the lowest body height from the populations with a medium growth described by Bernatowicz. The countable features of the studied population do not significantly deviate from the values reported by other researchers, except for the filtration processes.

**Key words:** vendace (*Coregonus albula* L.), eutrophication, growth rate, condition, population features

### **Introduction**

During the passed 50 years, because of the quickly progressing environmental degradation, the water acreage where vendace can find adequate life conditions has been significantly limited. As reported by BERNATOWICZ et AL. (1975), in the 70-ies, vendace existed in about 500 lakes and actually it is found in 200 lakes making about 30% of the

total acreage. Among 54 lakes of the Międzychód-Sieraków Lakeland with a total area of 2880 ha, vendace lives only on an area of 1085 ha.

The objective of the presented work was the investigation of the most important biological and morphometric features of the fished population of vendace from the Winnogóra lake lying on the Międzychód-Sieraków Lakeland.

## Material and methods

The Winnogóra lake belongs to the agglomeration of the Gorzyńskie lakes extending in the catchment area of the Warta river, in the western part of the Międzychód-Sieraków Lakeland. The lake belongs to dimictic reservoirs with a comparatively not large area covering 64 ha and a significant depth reaching 31 m. The most important morphometric indices are shown in Table 1.

Table 1. Morphometric indices of the Winnogóra lake  
Tabela 1. Wskaźniki morfometryczne jeziora Winnogóra

Morphometric index	Value
Height (a.s.l.)	36.5
Area (ha)	64
Volume (thous. m <sup>3</sup> )	5 925.7
Maximal depth (m)	31
Medium depth (m)	9.1
Maximal length (m)	1 310
Maximal width (m)	730
Length of shore line (m)	4 850
Development of shore line	1.70
Exposure index	7

In order to realise the objective of studies, the following features were determined: sex structure, growth rate, fish condition, fecundity, as well as biometric and meristic (countable) features of the studied vendace. At the same time, the most important physicochemical indices of water were determined permitting to characterise the environmental conditions.

Fish for studies were caught at the beginning of December 2003 using gill nets with 22 mm mesh size. Water samples were taken in the period of summer stagnation in September and during winter stagnation at the beginning of February. In summer and in winter, thermal and oxygen profiles were made which permitted to determine the stratification and oxidization of waters. Furthermore, in the summer period, water samples were taken to determine the following physicochemical indices: visibility of Secchi's disc, biochemical demand for oxygen (BOD<sub>5</sub>), total phosphorus, total nitrogen, proper electrolytic conductivity, *a*-chlorophyll.

Fish were stored in frozen condition at  $-28^{\circ}\text{C}$  in special foil bags which prevented water sublimation from fish bodies. After defreezing, the mass of each fish was measured exact to 0.1 g, 25 body shape lengths were measured (Table 2) and the most important meristic features were counted. Furthermore, for female fish, the mass of gonads was determined and, on the basis of sampled gonad cut-outs, the absolute fecundity and the relative fecundity were defined. In order to determine the age of fish, scales were sampled along the lateral line of the body from the place between the adipose fin and

Table 2. Measurable and countable features and their symbols  
Tabela 2. Cechy mierzalne i policzalne oraz ich oznaczenia

Measurable features		Countable features	
symbol	feature	symbol	feature
X <sub>1</sub>	Lateral head length	PD	Dorsal fin
X <sub>2</sub>	Preorbital distance	PD III T	PD hard rays
X <sub>3</sub>	Eye diameter	PD 8 M	PD soft rays
X <sub>4</sub>	Postorbital distance	PA	Anal fin
X <sub>5</sub>	Head height	PA III T	PA hard rays
X <sub>6</sub>	Head width	PA 8 M	PA soft rays
X <sub>7</sub>	Total fish length	PC	Caudal fin
X <sub>8</sub>	Caudal length	PC 8 M	PC soft rays
X <sub>9</sub>	Body length	PP	Pectoral fins
X <sub>10</sub>	Predorsal length	PP III T	PP hard rays
X <sub>11</sub>	Postdorsal length	PP 8 M	PP soft rays
X <sub>12</sub>	The greatest body height	PV	Ventral fins
X <sub>13</sub>	Preanal length	PV III T	PV hard rays
X <sub>14</sub>	The smallest body height	PV 8 M	PV ventral rays
X <sub>15</sub>	Caudal peduncle length	LI	Scale number on lateral line
X <sub>16</sub>	Caudal fin length	LI s/i	Scale number over and under lateral line
X <sub>17</sub>	Pectoral fin length	Sp. branch	Number of filtration processes
X <sub>18</sub>	Ventral fin length	RB	Number of subbranchial rays
X <sub>19</sub>	Dorsal fin height		
X <sub>20</sub>	Anal fin height		
X <sub>21</sub>	Dorsal fin base length		
X <sub>22</sub>	Anal fin base length		
X <sub>23</sub>	Distance between pectoral fin and ventral fin		
X <sub>24</sub>	Distance between ventral fin and anal fin		
X <sub>25</sub>	Length of adipose fin		

the dorsal fin (BERNATOWICZ 1952). Growth rate of vendace was determined by the method of back calculations according to Lea.

On the basis of the measurements, Fulton's coefficient was calculated which defines the correlation between the length and the individual mass of fish (OPUSZYŃSKI 1983).

Results of the above measurements are shown in Tables for their further analysis which in effect will permit a biological characteristics of vendace population from the Winnogóra lake.

## Results and discussion

### Environmental conditions – physicochemical indices

At the beginning of September, water at the lake surface was already cool, nevertheless, one could observe a distinct thermal stratification (Table 3). The depth of epilimnion was 7 m, that of metalimnion was 3 m, while hypolimnion started from the 11th meter.

Table 3. Temperature and oxidization in the Winnogóra lake waters in the summer and winter periods

Tabela 3. Termika i natlenienie wód w jeziorze Winnogóra w okresach letnim i zimowym

Depth (m)	Summer stagnation			Winter stagnation		
	temperature (°C)	O <sub>2</sub>		temperature (°C)	O <sub>2</sub>	
		mg/l	%		mg/l	%
1	15.3	9.40	81.08	2.9	9.50	70.1
2	14.7	9.40	79.09	2.8	9.75	71.7
3	14.1	9.40	77.01	2.8	9.30	78.7
4	13.7	9.00	75.57	2.8	9.30	78.7
5	13.3	8.90	73.65	2.8	9.32	78.7
6	12.9	7.40	72.77	2.7	9.11	77.7
7	12.7	2.25	20.57	2.7	9.24	78.0
8	9.6	0.50	4.32	2.7	9.32	78.5
9	7.8	0.50	4.15	2.7	9.45	79.4
10	6.2	0.15	1.20	2.7	9.06	76.6
11	5.5	0.05	0.39	2.7	9.16	77.4
12	5.2	0.00	0.00	2.7	9.14	77
13	4.8	0.00	0.00	2.6	9.19	77.2
14	4.7	0.00	0.00	2.6	9.16	77.0
15	4.6	0.00	0.00	2.6	9.16	77.0
...						
31	4.6	0.00	0.00	3.3	8.95	69.3

Within the epilimnion down to the 6th meter, the oxidation was good, but between the 6th and the 7th meter, the oxygen content suddenly dropped and from the 11th meter till the bottom, there reigned anaerobic conditions. Such a situation is characteristic of eutrophic lakes (KAJAK 1998). In that difficult period for the fish, the area where they can abide and feed is drastically limited and this may have a negative effect on fish condition and their growth rate. MULLER and STADELMAN (2004) stated that the critical minimal oxygen content in a vendace reservoir should not drop below 4 mg/l. In the winter period, oxygen content from the surface to the bottom oscillated around 9 mg/l.

On the basis of seven most important chemical indices, the lake waters can be counted to the 2nd purity class, but the final classification was definitely lowered by the parameters of the mean oxygen saturation of hypolimnion and by the proper electrolytic conductivity (Table 4). The remaining indices reflecting the lake riches in biogens ranged within I and II class. Carlson's index calculated on the basis of *a* chlorophyll and the visibility of Secchi's disk indicated that the mean lake trophy ranged between mezo-eutrophy and eutrophy.

Table 4. Values of the most important physicochemical indicators representing water quality in the Winnogóra lake

Tabela 4. Wartości najważniejszych wskaźników fizykochemicznych obrazujących jakość wody w jeziorze Winnogóra

Indicator	Value	Class
Mean saturation of hypolimnion with oxygen (%)	0.16	non
BZT <sub>5</sub> (mg O <sub>2</sub> per 1 l)	1.20	I
P <sub>tot</sub> (mg/l)	0.050	I
N <sub>tot</sub> (mg/l)	1.066	II
Visibility of Secchi's disc (m)	4.40	II
Conductivity (µS/cm)	475	non
Chlorophyll <i>a</i> content	2.70	I
Final estimation		II
TSI	46.7	

### Structure of the studied population

Studies on vendace population biology in the Winnogóra lake were based on 50 individuals caught in the autumn period.

Analysis indicated that in the catches carried out with gill nets with 22 mm mesh diameter, there dominated two-year-old individuals making 91% of the total caught number (Table 5). Only single caught individuals were at the age of 1+ and 3+, no four-year-old fish were found. CZERNIEJEWSKI et AL. (2006) who studied vendace population in three West-Pomeranian lakes (using gill nets with 24 mm mesh diameter) obtained only slightly smaller mean result at the level of 78%. Another work of CZERNIEJEWSKI and FILIPIAK (2002 b) referring to vendace from six West-Pomeranian lakes reported that in economic catches, there definitely dominated individuals at the age of 2+.

Table 5. Age, sex and length of vendaces from the Winnogóra population  
Tabela 5. Wiek, płeć oraz długość sielaw z populacji winnogórskiej

Age	Number of individuals	Sex structure		Length range, <i>l.c.</i> (cm)
		♂	♀	
1+	3	–	3	18.1-19.1
2+	45	–	45	18.4-22.9
3+	2	–	2	21.2-24.9
Total	50		50	

Interesting is the fact that among the caught 50 vendaces, there were no male individuals. However, it must be noted that the catches were carried out in the lake pelagic zone and therefore, it is very likely that in the time of our catches, the male fish abided near the shore in the spawning zones. CZERNIEJEWSKI et AL. (2006) obtained quite different results recording the domination of males in 8:1 proportion.

The length of the studied fish ranged from 18.1 to 24.9 cm and there definitely dominated individuals of 19.2-20.5 cm length. These lengths are similar to those reported by CIEPIELEWSKI (1974 b) who investigated the efficiency of vendace gill nets with mesh diameters of 18, 22 and 24 mm. The author reported that gill nets with 22 mm showed the highest selectivity (1) for fish with mean length of 19.5 cm within the range from 16.6 to 22.4 cm.

### Growth rate

According to RADZIEJ (1973), fish growth depends on environmental conditions. In case of fish, in contrast to homoeothermic animals, their body growth is continued even after their sexual maturity although at a significantly slower rate. Vendace in lakes of the Baltic Sea catchment area is characterised by a high differentiation of growth.

The mean increments of the vendaces studied in the particular years are shown in Figure 1. One-year-old fish from the Winnogóra lake reach 10.46 cm, while in the successive years, they reach 16.62 and 19.95 cm. According to the division elaborated by SZCZERBOWSKI (1978) vendaces from the Winnogóra lake are characterised by a mean growth rate reaching in their third year of life the length of almost 20 cm. Analysis of length increments of fish from 186 studied Polish lakes (MARCIAK 1970) has shown that the growth of vendace from the Winnogóra lake is slightly slower in comparison with the mean fish increments from all studied lakes. Vendace, in the majority of the studied reservoirs, in its first year of life, increases to 12 cm, while in the Winnogóra lake, it reaches 10.46. Also in the second year of life, the studied vendace grew slower than the fish from the majority of Polish populations which reach on the average 17.4 cm, while those of the Winnogóra lake show only 16.62 cm. At the age of 3+, the differences in the growth rate diminish; vendaces from the Winnogóra lake reach the length of 19.95 cm, while the mean length of fish from lakes analysed by MARCIAK (1970) showed 20.3 cm.

Slightly different results were obtained in the comparison of the increment in the body mass of vendace from the Winnogóra lake with data reported by MARCIAK (1970). In that analysis, vendaces from the Winnogóra lake gained higher increments in their third year of life.

Przybył A., Mazurkiewicz J., Golski J., Andrzejewski W., 2010. Biological characteristics of the fished population of vendace (*Coregonus albula* L.) from the Winnogóra lake (Międzychód district). *Nauka Przyr. Technol.* 4, 3, #32.

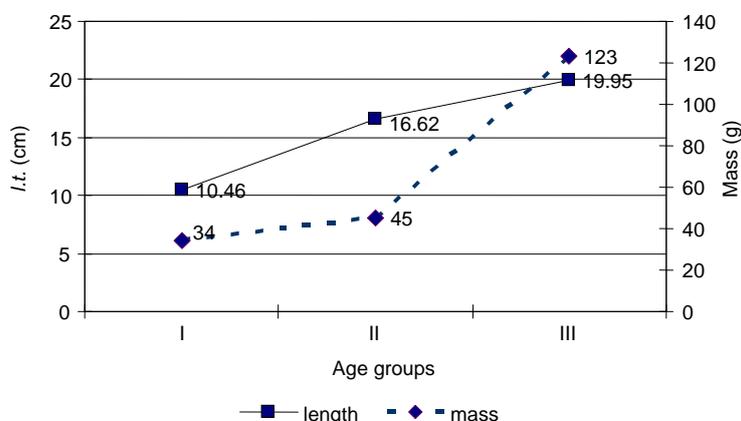


Fig. 1. Growth rate of vendace population from the Winnogóra lake  
Rys. 1. Tempo wzrostu populacji sielawy z jeziora Winnogóra

#### Fulton's coefficient of fish condition

Biological characteristics of vendace was also based on the fish condition coefficient shown in Table 6.

Table 6. Fish condition coefficient and fish mass  
Tabela 6. Współczynnik kondycji oraz masa ryb

Characteristics	Fulton's coefficient	Mass (g)
Number of individuals	50	50
Minimum	0.69	41
Maximum	1.27	231
Mean	0.90	111.65
Standard deviation	0.107	35.389

The determination of fish condition has a significant importance in ichthyology. When the relation of body mass to body length is adequate, then the condition is good testifying a good nutritional status of the fish. The condition coefficient is most useful in relation to fish in which the proportion between their body mass and body length changes insignificantly with their age.

OPUSZYŃSKI (1983) reported that in salmonid fish, Fulton's coefficient is close to the value of 1. The mean value for the Winnogóra population was 0.90; in case of significant oscillations, it ranged from 0.67 to 1.27. CZERNIEJEWSKI et AL. (2006) compared the condition of vendaces from the lakes in West Pomerania and received significantly lower values. In the Weltyń lake, where the authors found the best fish condition, the condition indicator showed on the average the value of 0.79 with oscillations between 0.59 and 1.09.

## Fecundity

Fecundity belongs to indicators which are indispensable for the rational fishing economy. From the number of 50 vendaces obtained from the Winnogóra lake, 25 female spawners were utilized for fecundity determination because the remaining ones were already after spawning.

The mean absolute fertility was 9184.6 eggs, while the relative fertility was 7750.26 pcs per 100 g body mass. The gonadosomatic index was defined on the level of 14.53%. It deserves attention that there are significant divergences between the minimal and the maximal values, particularly in reference to the GSI index (Table 7).

Table 7. Indicators describing fecundity of vendace population in the Winnogóra lake  
Tabela 7. Wskaźniki opisujące płodność populacji sielawy z jeziora Winnogóra

Characteristics	Absolute fertility (pcs of spawn eggs)	Relative fertility (pcs in 100 g)	GSI (%)
Number of individuals	25	25	25
Minimum	1 919	1 810	0.35
Maximum	13 656	14 574	26.27
Mean	9 184.6	7 750.26	14.53
Standard deviation	4 749.044	5 356.425	10.198

Vendace belongs to fish with a relatively low fecundity which is partially compensated by the comparatively early sexual maturity. According to BERNATOWICZ et AL. (1975), depending on environmental conditions, male individuals are able to reproduction most frequently in the second year of life, while females reach their reproduction maturity in the third year of life. Many authors believe that in Polish lakes, because of water temperature, both the males and females are able to reproduction already in the age of 1+ (CIEPIELEWSKI 1974 a, Budyh and IWASZKIEWICZ 1964, MASTYŃSKI 1978, DEMSKA-ZAKĘŚ and DŁUGOSZ 1995). Fish age most probably depends on the origin of fish either from the eastern or the western part of the country. The collected research material, because of its homogeneity, permitted to determine fish fecundity only at the age of 2+.

Vendace's fecundity, as well as of other fish species, is subject to different fluctuations depending on environmental and populational factors (ZAWISZA and BACKIEL 1970). BERNATOWICZ et AL. (1975) believes that vendace in the lakes of West Poland is characterised by a higher fecundity than of the species occurring in the eastern part of the country. The value of gonadosomatic index depends primarily on the age of fish, on fish body length and body mass, as well as on the environmental conditions. In Polish lakes, this parameter shows a high variability. In the reservoirs of West Pomerania, the size of gonads amounted from 14.63 to 23.16% of body mass (WALCZAK 1963). A still wider range (9.5-33.2%) was reported by BERNATOWICZ (1963) for the Mazurian lakes.

CZERNIEJEWSKI and FILIPIAK (2002 b), who studied the reproductive potential of vendace from the West Pomerania lakes, found the highest absolute fecundity in the

Przybył A., Mazurkiewicz J., Golski J., Andrzejewski W., 2010. Biological characteristics of the fished population of vendace (*Coregonus albula* L.) from the Winnogóra lake (Międzychód district). Nauka Przyr. Technol. 4, 3, #32.

range of 6900-22 230 spawn eggs in individuals from the Drawsko lake, while the smallest number (within 2610-4120) were found in Pelcz lake. The highest value of gonadosomatic coefficient (on the average 20.3%) was found by the above mentioned authors in the Moryńskie lake, while the lowest value (14.9%) was recorded in the Drawsko lake.

### Population features

Meristic (countable) features are very significant in the identification of the particular species or forms within a given family (RYBY SŁODKOWODNE... 2000).

The mean number of hard rays in the dorsal fin is 3, while the mean number of soft rays is 8.4 (Table 8). These values are characteristic of vendace and they are contained within the variabilities given by THIENEMANN (1922), BERG (1948), CZERNIEJEWSKI and FILIPIAK (2002 a). Also regarding the ray number in the caudal, anal and ventral fins, the Winnogóra population does not differ from other Polish populations. In the caudal fin, on the average 22.7 soft rays were found and in the anal fin – 2.5 hard rays and 10.5 soft rays were present, while in the ventral fin – 1.95 and 9.11 rays, respectively.

Table 8. Meristic features characterizing vendace population from the Winnogóra lake  
Tabela 8. Cechy merystyczne charakteryzujące populację sielawy z jeziora Winnogóra

Feature	Number of individuals	Mean	Minimum	Maximum	Standard deviation
PD pr. T	50	3.00	2	4	0.452
PD pr. M	50	8.42	7	9	0.642
PC pr. M	50	22.70	19	26	1.657
PA pr. T	50	2.50	2	3	0.505
PA pr. M	50	10.46	8	13	1.110
PV pr. T	50	1.98	1	2	0.141
PV pr. M	50	9.04	8	11	0.755
PP pr. T	50	1.04	1	2	0.198
PP pr. M	50	13.34	10	16	1.099
RB	50	8.00	6	11	0.990
LI	50	81.32	55	90	6.153
LI 1 (s)	50	8.00	6	9	0.756
LI 2 (i)	50	7.10	6	9	0.863
Sp. branch	50	37.06	20	49	4.983

The number of hard rays in the pectoral fin of the studied population was 1, thus, it agrees with the value reported by many authors (BERNATOWICZ et AL. 1975, RYBY SŁODKOWODNE... 2000, CZERNIEJEWSKI and FILIPIAK 2002 a). In case of soft rays, the average number is 13.3, but THIENEMANN (1922) reported the mean number of 14-15. Our results are closer to those reported by WALCZAK (1953), who found in the pectoral fin 13 soft rays.

The number of subbranchial rays usually is 8, but it may range between 6 and 11, thus agreeing with the values quoted by other researchers (THIENEMANN 1922, WALCZAK 1953, CZERNIEJEWSKI and FILIPIAK 2002 a).

The successive meristic feature used for the studied population was the number of scales in the transverse and longitudinal rows. According to RADZIEJ (1973), the number of scales in the lateral line in vendace ranges between 70 and 91; for the Winnogóra population, the mean number of scales was 81.32. RADZIEJ (1973) reported that in vendace occurring on the area of Poland, the number of scales above the lateral line is 7-9, while below the lateral line, there are 6-8 scales. Fish from the Winnogóra lake do not differ regarding this feature and the mean values are 9.03 and 7.1, respectively.

The final meristic feature identifying the studied population was the number of filtering processes on the first left branchial arch. This number permits to differentiate related subspecies and even geographic populations.

In case of the studied vendaces, a comparatively small number of filtration processes was found – 20 to 49, with 37 as a mean value.

The number of filtration processes on branchial arches is connected with the formation of filtration abilities of the branchial system (OPUSZYŃSKI 1983). BERG (1948) found in his studies 36-54 processes, while GAŚOWSKA (1973) reported for all Poland the range of 35-52, while for the Mazurian lakes the number was 33-49. The studied vendaces show a structure of the filtration apparatus which fits within the average variability of the species, but in a lower range.

In the presented work, the countable features were used for the characterisation and definition of the shape and proportion of the whole fish body and the fins in relation to the caudal length.

The values of meristic features closely depend on the environmental conditions which primarily include the availability and accessibility of food and the water temperature in the reservoir. There are known forms of hungry fish with a distinctly big head and a small dorsal arching of the body which significantly deviate from the characteristic body shape for the definite taxon.

The lateral length of head for vendace from the Winnogóra lake makes 11.12% of the caudal length of the fish body (Table 9). Analysis of this parameter permits to state that among the studied vendaces, there are no fish with the "hungry form". According to BERNATOWICZ et AL. (1975), vendace is characterized by a rather small head (constituting about 20% of fish length). The studied population has the lateral head length similar to the values reported by other authors (CZERNIEJEWSKI and FILIPIAK 2002 a).

Values of the successive features describing the shape of head such as the preorbital eye diameter, head width, head height do not deviate from the literature data referring to vendace population from other lakes.

Also the values of features describing the shape of the trunk range within the values quoted by researchers for Polish populations (GAŚOWSKA 1973, BERNATOWICZ et AL. 1975, RYBY SŁODKOWODNE... 2000, CZERNIEJEWSKI 2002, CZERNIEJEWSKI and FILIPIAK 2002 a) with the exception of the highest and the lowest body height. These features define the degree of the dorsal arching and their values are: 120.12 and 5.85%, respectively. CZERNIEJEWSKI and FILIPIAK (2002 a) reported the corresponding values of vendace from the Drawsko lake (21.8 and 6.8%, respectively), the discussed values for vendace reported by RADZIEJ (1973) from the Wierzbiczany lake in Wielkopolska were 24.7 and 8.1%, respectively. No differences have been noted in the shape, distribution and the length of fins.

Przybył A., Mazurkiewicz J., Golski J., Andrzejewski W., 2010. Biological characteristics of the fished population of vendace (*Coregonus albula* L.) from the Winnogóra lake (Międzychód district). Nauka Przyr. Technol. 4, 3, #32.

Table 9. Biometrical features characterising vendace population from the Winnogóra lake  
Tabela 9. Cechy biometryczne charakteryzujące populację sielawy z jeziora Winnogóra

Feature	Number of individuals	Mean (%)	Minimum (%)	Maximum (%)	Standard deviation
X <sub>1</sub>	50	19.12	16.38	23.15	1.08
X <sub>2</sub>	50	4.99	3.97	6.31	0.52
X <sub>3</sub>	50	4.70	3.81	5.73	0.48
X <sub>4</sub>	50	10.05	7.93	11.29	0.74
X <sub>5</sub>	50	12.76	11.63	14.13	0.61
X <sub>6</sub>	50	5.31	4.14	6.25	0.49
X <sub>7</sub>	50	109.15	102.28	113.70	2.57
X <sub>8</sub>	50	100.00	100.00	100.00	0.00
X <sub>9</sub>	50	94.03	89.00	97.51	1.83
X <sub>10</sub>	50	43.71	39.50	48.74	1.88
X <sub>11</sub>	50	35.60	31.49	38.89	1.70
X <sub>12</sub>	50	17.41	14.93	20.71	1.33
X <sub>13</sub>	50	68.18	57.46	76.12	3.02
X <sub>14</sub>	50	5.87	4.57	7.20	0.60
X <sub>15</sub>	50	8.98	6.54	11.72	1.15
X <sub>16</sub>	50	21.34	16.86	25.74	1.62
X <sub>17</sub>	50	13.67	11.45	16.86	1.10
X <sub>18</sub>	50	13.93	11.16	16.60	1.28
X <sub>19</sub>	50	16.86	12.14	19.76	1.72
X <sub>20</sub>	50	10.69	7.83	15.61	1.30
X <sub>21</sub>	50	9.87	8.14	12.47	0.85
X <sub>22</sub>	50	11.84	9.32	14.19	1.11
X <sub>23</sub>	50	27.74	22.26	31.66	1.75
X <sub>24</sub>	50	23.38	20.07	27.62	1.89
X <sub>25</sub>	50	3.76	2.37	5.80	0.73

## Recapitulation

1. The greatest threat for the studied population of vendace seems to be the summer period oxygen deficit.
2. Gill nets with mesh diameter of 22 or 24 mm are the best suited to be used in economic fish catches in the discussed reservoir.
3. Vendace in the Winnogóra lake are characterised by a medium growth rate in the scale of Poland.

4. Regarding fecundity, the studied population does not differ from other Polish populations.

5. Among the population features, worth of noticing are: a lower number of filtration processes and lower values of the minimal and the maximal body heights.

## References

- BERG L.S., 1948. Ryby presnykh vod SSSR i sopredel'nykh stran. Moskva.
- BERNATOWICZ S., 1952. Zagadnienie trafności oznaczania wieku i przyrostu sielawy na podstawie łusek z różnych okolic. *Rocz. Nauk Roln. Ser. B* 65: 311-335.
- BERNATOWICZ S., 1963. Obserwacje nad rozrodem sielawy w kompleksie jeziora Mamry. *Rocz. Nauk Roln. Ser. B* 82: 337-352.
- BERNATOWICZ S., DEMBIŃSKI W., RADZIEJ J., 1975. Sielawa. PWRiL, Warszawa.
- RYBY SŁODKOWODNE Polski. 2000. Ed. M. Brylińska. Wyd. Nauk. PWN, Warszawa.
- BUDYCH J., IWASZKIEWICZ M., 1964. Płodność sielawy z jezior Pojezierza Sierakowskiego. *Rocz. WSR Pozn.* 22: 13-20.
- CIEPIELEWSKI W., 1974 a. Obfitość składanych jaj i ocena przeżywalności narybku sielawy w jeziorze Maróz. *Rocz. Nauk Roln. Ser. H* 96, 2: 23-36.
- CIEPIELEWSKI W., 1974 b. Selektowność wontonów sielawowych. *Rocz. Nauk Roln. Ser. H* 96, 1: 17-29.
- CIEPIELEWSKI W., 1974 c. Względne liczebności roczników sielawy w jeziorze Maróz. *Rocz. Nauk Roln. Ser. H* 96, 1: 31-47.
- CZERNIEJEWSKI P., 2002. Biometric characteristics of vendace (*Coregonus albula* L.) from lake Leśne. *Acta Sci. Pol. Piscaria* 1, 1: 5-14.
- CZERNIEJEWSKI P., FILIPIAK J., 2002 a. Biological and morphological characteristics of vendace, *Coregonus albula* L. from lakes Drawsko and Pelcz. *Acta Ichthyol. Piscat.* 32, 1: 53-69.
- CZERNIEJEWSKI P., FILIPIAK J., 2002 b. Fecundity assessment of vendace, *Coregonus albula* L. from six lakes in Polish Western Pomerania. *Acta Ichthyol. Piscat.* 32, 1: 71-82.
- CZERNIEJEWSKI P., RACZYŃSKI M., WAWRZYŃSKI W., 2006. Age, growth rate, and condition of vendace, *Coregonus albula* (L.), from some Pomeranian lakes (NW Poland). *Acta Ichthyol. Piscat.* 31, 1: 65-72.
- DEMSKA-ZAKĘŚ K., DŁUGOSZ M., 1995. Fecundity of vendace from two lakes of Mazurian Lake district. *Arch. Ryb. Pol.* 3, 1: 37-50.
- GĄSOWSKA M., 1973. Porównawcze, biometryczne studia sielawy (*Coregonus albula* L.) z jezior Polski i niektórych krajów ościennych. *Rocz. Nauk Roln. Ser. H* 95, 1: 41-54.
- KAJ J., 1955. Sieja jezior międzychodzkich. Studia nad jej pogłowiem, biologią i autochtonizmem. *Pr. Kom. Nauk Roln. Kom. Nauk Leśn. PTPN* 2, 9.
- KAJAK Z., 1998. Hydrobiologia – limnologia. Ekosystemy wód śródlądowych. Wyd. Nauk. PWN, Warszawa.
- MARCIAK Z., 1970. Podstawa przyrodnicza gospodarki sielawowej. In: Zagospodarowanie jezior sielawą. Cz. II. Brosz. IRS Olszt. 39: 8-13.
- MULLER R., STADELMAN P., 2004. Fish habitat requirements as the basis for rehabilitation of eutrophic lakes by oxygenation. *Fish. Manage. Ecol.* 11: 251-260.
- MASTYŃSKI J., 1978. Sieja (*Coregonus lavaretus* L.) i sielawa (*Coregonus albula* L.) w jeziorach Polski Zachodniej. *Rocz. AR Pozn. Rozpr. Nauk.* 85.
- OPUSZYŃSKI K., 1983. Podstawy biologii ryb. PWRiL, Warszawa.
- RADZIEJ J., 1973: Wpływ środowiska na wolnorosnącą sielawę (*Coregonus albula* L.) wsiedloną z jeziora Narie do jeziora Wierzbiczano. *Rocz. Nauk Roln. Ser. H* 95, 1: 129-146.
- SZCZERBOWSKI J.A., 1978. Ocena tempa wzrostu sielawy, siei, leszcza, płoci i sandacza jako podstawy określania wymiaru gospodarczego. Brosz. IRS Olszt. 111.

Przybył A., Mazurkiewicz J., Golski J., Andrzejewski W., 2010. Biological characteristics of the fished population of vendace (*Coregonus albula* L.) from the Winnogóra lake (Międzychód district). *Nauka Przyr. Technol.* 4, 3, #32.

THIENEMANN A., 1922. Weitere Untersuchungen an Coregonen. *Arch. Hydrobiol.* B 13: 414-468.

WALCZAK J., 1953. Sielawa (*Coregonus albula* L.) z kilku jezior Pomorza Zachodniego. *Rocz. Nauk Roln. Ser. B* 67, 1: 21-37.

ZAWISZA J., BACKIEL T., 1970. Gonad development, fecundity and egg survival in *Coregonus albula* L. In: *Biology of coregonid fishes*. Eds. C.C. Lindsey, C.S. Woods. University of Manitoba Press: 363-399.

## BIOLOGICZNA CHARAKTERYSTYKA ŁOWNEJ CZĘŚCI POPULACJI SIELAWY (*COREGONUS ALBULA* L.) Z JEZIORA WINNOGÓRA (POW. MIĘDZYCHODZKI)

**Streszczenie.** Celem przeprowadzonych w 2003 roku badań było poznanie najważniejszych cech biologicznych i morfometrycznych eksploatowanej rybacko części populacji sielawy z jeziora Winnogóra, leżącego na Pojezierzu Międzychodzko-Sierakowskim. Podczas realizacji pracy określono strukturę płci, tempo wzrostu, kondycję, płodność, a także cechy populacyjne (biometryczne i merystyczne) badanych sielaw. Równocześnie oznaczono najważniejsze wskaźniki fizyczno-chemiczne wody, pozwalające scharakteryzować warunki środowiskowe. Na podstawie siedmiu z nich wody zbiornika można zakwalifikować do II klasy czystości, jednak duży niepokój wzbudza niemal całkowite odtlenienie hypolimnionu w okresie letnim. Sielawa z badanego zbiornika należy do grupy o średnim wzroście, osiągając w trzecim roku życia średnio 19,95 cm długości całkowitej. Wartość wskaźnika kondycji Fultona wynosiła od 0,69 do 1,27, przy średniej 0,90. Średnia płodność absolutna wyniosła 9184,6 jaja, natomiast płodność względna 7750,26 jaja na 100 g masy ciała. Biorąc pod uwagę cechy mierzalne, populacja winnogórska nieznacznie różni się pod względem największej i najmniejszej wysokości ciała od innych populacji o średnim wzroście, opisanych przez Bernatowicza. Cechy policzalne badanej populacji nie odstają od wartości podanych przez innych badaczy, z wyjątkiem liczby wyrostków filtracyjnych.

**Słowa kluczowe:** sielawa (*Coregonus albula* L.), eutrofizacja, tempo wzrostu, kondycja, cechy populacyjne

*Corresponding address – Adres do korespondencji:*

Janusz Golski, Instytut Zoologii, Uniwersytet Przyrodniczy w Poznaniu, ul. Wojska Polskiego 71 C, 60-625 Poznań, Poland, e-mail: golski@up.poznan.pl

*Accepted for print – Zaakceptowano do druku:*

5.03.2010

*For citation – Do cytowania:*

Przybył A., Mazurkiewicz J., Golski J., Andrzejewski W., 2010. Biological characteristics of the fished population of vendace (*Coregonus albula* L.) from the Winnogóra lake (Międzychód district). *Nauka Przyr. Technol.* 4, 3, #32.