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**MORPHOLOGICAL CHARACTERISTICS OF ARCTIC CHARR,
SALVELINUS ALPINUS (L., 1758) FROM THE HORNSUND AREA OF VEST
SPITSBERGEN**

**CHARAKTERYSTYKA MORFOLOGICZNA *SALVELINUS ALPINUS* (L., 1758)
SPITSBERGENU ZACHODNIEGO – REJON HORNSUNDU**

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Morphological characteristics of Arctic charr (*Salvelinus alpinus*) are presented. Meristic and plastic characters were treated statistically. Males and females were found to differ in 8 plastic characters, all related to head structure and fin length. Males had more massive and longer jaws and a longer snout as well as longer pectoral, ventral, and dorsal fins. The mean arch gill raker and pyloric caeca counts in the population studied are 26.42 and 37.76, respectively. The Spitsbergen Arctic charr is regarded as a typical form of *Salvelinus alpinus* (L.).

INTRODUCTION

The Arctic charr (*Salvelinus alpinus*) has the widest range among the *Salvelinus* species; it inhabits fresh waters, rivers and lakes of northern Europe, the Alps, Siberia, Alaska, Canada, and Greenland. It is the northernmost species in fresh waters and frequently the sole representative of ichthyofauna in those waters. An array of numerous forms of the species includes migratory forms ascending fresh waters from the sea to spawn, the population under study belonging to this group.

In spite of numerous studies, the intraspecific systematics of the Arctic charr is not clear (Behnke, 1972, 1980; Morrow, 1980; Svvaityova, 1980), due to a considerable anatomical and biological plasticity of the species. It should be expected that the intraspecific variability of *S. alpinus* will soon be worked out in more detail as a substantial amount of data has been collected from different areas and new analytical methods are being used (Mednikov et al., 1980; Glubokovskij and erenev, 1981; Partington and Mills, 1988).

The present paper is aimed at describing morphology of *S. alpinus* from Spitsbergen waters, one of the northernmost parts of the species' range.

MATERIALS AND METHODS

S. alpinus specimens caught in Lake Svartvatnet and in the mouth of River Revelva (Vest Spitsbergen) in July 1986 were examined. Measurements of plastic characters were made based on Smitt's scheme published in Pravdin (1966). A total of 22 characters were measured (Fig. 1) on 46 individuals.

Fig. 1. Measurement scheme for plastic characters in Arctic charr: ab = lateral head length (longitudo capitalis lateralis), ac = preorbital distance (distantia praeocularis), ae = maxilla length (longitudo ossis maxillae), af = mandible length (longitudo ossis dentale), ai = preoperculum distance (distantia praeoperculum), aj = predorsal distance (distantia praedorsalis), ak = preventral distance (distantia preventralis), al = preanal distance (distantia praeanal), cd = eye diameter (diameter oculi), gh = head height (altitudo capitis), jm = length of dorsal fin base (longitudo basis D), jn = maximum height of dorsal fin (summa altitudo D), kr = maximum length of ventral fin (summa longitudo V), lo = length of anal fin base (longitudo basis A), lp = maximum height of anal fin (summa altitudo A), o'u = length of caudal peduncle (longitudo pedunculi caudae), st = maximum length of pectoral fin (summa longitudo P), wz = minimum body height (minima altitudo corporis); arrow indicates site of interorbital distance (distantia interorbitalis) measurement

Meristic characters analyzed include ray counts in the dorsal, anal, ventral, and pectoral fins; gill raker counts; and pyloric caeca counts. Gill raker counts are given for lower and upper sections of the gill arch.

For each character measured, the mean value (M), standard error of the mean (m), standard deviation (S), and coefficient of variation (CV) were calculated. Sexual dimorphism was analysed by means of the formula:

$$M_{\text{diff}} = \frac{M_1 - M_2}{\sqrt{m_1^2 + m_2^2}}$$

where:

M_1, M_2 = arithmetic means;

m_1, m_2 = standard errors of the respective means.

Characters for which $M_{\text{diff}} \geq 3$ are considered different in males and females.

RESULTS AND DISCUSSION

Analysis of the meristic characters yielded the following formula applicable to the population studied: D(III) IV (V) 9–11; A(II) III (IV) 8–10; V I (8) 9 (10); P I 12–14; gill rakers (22) 24–29 (30); pyloric caeca 32–43 (47).

Of the above characters, the pyloric caeca count proved to be most plastic (Table 1), with coefficient of variation equal to 10%. The pyloric caeca count is a very important character in classification of the genus *Salvelinus*, particularly with respect to the intraspecific systematics of Arctic charr.

Table 2 summarizes the plastic characters studied. Among them, eight characters proved to be sex-dependent; those characters showed the highest coefficients of variation. Major differences between males and females were observed in the head structure and size of the dorsal and paired fins (Table 3). The male head is more massive and proportionally longer with respect to the caudal length (l. caud.). Larger males had the lower jaw clearly curving upwards, hook-like (Fig. 2).

Systematics of the genus *Salvelinus* Richardson, 1836 is still unclear; the number of species within the genus is debated, 6 or 7 species being mostly referred to. The question of taxonomic status of *S. alpinus* (L., 1758) and *S. malma* (Walbaum, 1792) is frequently discussed, the discussion focussing on whether those two are independent species or whether differences between them result from inherent variability. In their respective large studies, Savvaitova (1980) and Morrow (1980) une-

Table 1

Meristic characters of *Salvelinus alpinus*

Character			n	Range	M $\pm$ m	SD	CV
fin	D	hard rays	46	3— 5	4.02 $\pm$ 0.04	0.25	6.2
		soft rays	46	9—11	10.15 $\pm$ 0.09	0.62	6.1
	A	hard rays	37	2—4	2.97 $\pm$ 0.05	0.28	9.4
		soft rays	37	8—10	9.05 $\pm$ 0.11	0.65	7.2
	V	hard rays	32	1	1.00 $\pm$ 0.00	0.00	0.0
		soft rays	32	8—10	8.72 $\pm$ 0.10	0.57	6.5
	P	hard rays	46	1	1.00 $\pm$ 0.00	0.00	0.0
		soft rays	46	12—14	13.20 $\pm$ 0.09	0.58	4.4
Gill raker count			45	22—30	26.42 $\pm$ 0.24	1.58	6.0
Gill raker count on lower section of gill arch			45	12—18	15.33 $\pm$ 0.17	1.12	7.3
Gill raker count on upper section of gill arch			45	9—13	11.09 $\pm$ 0.14	0.94	8.5
Pyloric caeca count			45	32—47	37.76 $\pm$ 0.56	3.75	10.0

quivocally stress the validity of both species. On the other hand, Behnke (1972, 1980) supports the older view of *S. malma* being a subspecies.

Taxonomic problems stem mainly from the considerable variability of the genus *Salvelinus*, the Arctic charr being a particularly variable species. The species has numerous migratory and stationary forms. Migrations are anadromous or are confined to the lake and river (the so-called lacustrine-riverine forms). Frequently, too, stationary and migratory forms can be found coexisting (Nilsson and Filipsson, 1971; McCart and Craing, 1971).

Values of plastic characters obtained for *S. alpinus* from Alpine lakes (Balon and Penczak, 1980) or a Lena tributary in Siberia (Kalašnikov, 1978) differ considerably from those obtained in the present work. Most probably, this is the result of totally

Table 2

Plastic characters of *Salvelinus alpinus*

Character	n	Range	M $\pm$ m	SD	CV
longitudo totalis in cm	46	42.7–60.7	50.77 $\pm$ 0.74	5.01	9.9
longitudo caudalis in cm	46	40.9–58.4	48.84 $\pm$ 0.73	4.92	10.1
longitudo corporis in cm	46	37.8–53.0	44.82 $\pm$ 0.64	4.33	9.7
longitudo caudalis = 100					
longitudo capitis lateralis	46	19.1–23.5	21.30 $\pm$ 0.17	1.13	5.3
diameter oculi	43	3.2– 4.7	3.95 $\pm$ 0.05	0.34	8.6
longitudo ossis maxillae	46	9.1–14.5	11.61 $\pm$ 0.18	1.19	10.2
longitudo ossis dentale	46	11.1–17.7	13.86 $\pm$ 0.18	1.23	8.9
distantia praeocularis	43	3.7– 7.1	5.70 $\pm$ 0.11	0.74	13.0
distantia interorbitalis	46	6.2– 8.8	7.25 $\pm$ 0.08	0.57	7.9
altitudo capitis	46	12.7–15.6	14.22 $\pm$ 0.11	0.75	5.3
distantia praeoperculum	46	14.4–20.0	17.10 $\pm$ 0.17	1.18	6.9
distantia praedorsalis	46	39.8–48.1	44.73 $\pm$ 0.23	1.55	3.5
distantia praeventralis	30	47.9–53.9	51.68 $\pm$ 0.28	1.54	3.0
distantia praeanal	40	67.1–71.9	69.11 $\pm$ 0.18	1.16	1.7
longitudo basis D	46	9.5–13.2	11.34 $\pm$ 0.11	0.75	6.6
summa altitudo D	46	12.1–17.3	14.53 $\pm$ 0.18	1.23	8.5
longitudo basis A	38	7.2– 9.9	8.59 $\pm$ 0.11	0.65	7.6
summa altitudo A	38	10.6–15.2	12.87 $\pm$ 0.18	1.12	8.7
summa longitudo V	31	10.1–15.1	12.53 $\pm$ 0.23	1.26	10.1
summa longitudo P	46	12.8–17.7	15.34 $\pm$ 0.16	1.07	7.0
longitudo pedunculi caudae	39	14.9–17.8	16.17 $\pm$ 0.16	1.03	6.4
minima altitudo corporis	26	5.7– 7.6	6.78 $\pm$ 0.08	0.40	5.9

Table 3

Sexual dimorphism-related characters of *Salvelinus alpinus*

Character	Females		Males		M _{diff}
	n	M ± m	n	M ± m	
longitudo caudalis = 100					
longitudo capitis lateralis	25	20.70 ± 0.19	21	22.01 ± 0.21	4.6
longitudo ossis maxillae	25	11.03 ± 0.15	21	12.30 ± 0.28	4.0
longitudo ossis dentale	25	13.28 ± 0.15	21	14.56 ± 0.30	3.8
distantia praeocularis	24	5.34 ± 0.15	19	6.15 ± 0.12	4.2
distantia praeoperculum	25	16.56 ± 0.20	21	17.74 ± 0.24	3.8
summa altitudo D	25	13.97 ± 0.21	21	15.19 ± 0.26	3.7
summa longitudo V	15	11.62 ± 0.24	16	13.39 ± 0.25	5.1
summa longitudo P	25	14.93 ± 0.20	21	15.83 ± 0.23	3.0

Fig. 2. Differences in head structure between males and females of Arctic charr

different environmental conditions. Any comparison, given the high morphological and biological variability of the Arctic charr, is pointless from the taxonomic standpoint. Hammar et al. (1989) who studied Arctic charr in Tasialuk Lake (Northern Labrador) reported values similar to those observed in the present work.

The Arctic charr population under study should be regarded as a typical form of *S. alpinus*. The statement is based mainly on the gill raker and pyloric caeca counts.

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REFERENCES

- Balon E.K., T. Penczak, 1980: The dwarfed charr of Dörsener See, an alpine lake in Austria (In: Charrs, salmonid fishes of the genus *Salvelinus* Ed. E.K. Balon). — Dr W. Junk Publ., The Hague: 773–794.
- Behnke R.J., 1972: The systematics of salmonid fishes of recently glaciated lakes. — J. Fish. Res. Board Canada, 29, 6: 639–671.
- Behnke R.J., 1980: A systematics review of the genus *Salvelinus* (In: Charrs, salmonid fishes of the genus *Salvelinus* Ed. E.K. Balon). — Dr W. Junk Publ., The Hague: 441–480.
- Glubokovskij M.K.G., J.A. Čerčinev, 1981: Spornye voprosy filogenii golcov roda *Salvelinus* Golarktiki. — Vopr. Ichtiol., 21, 5: 771–786.

- Hammar J., J.B. Dempson, E. Sköld, 1989: Natural hybridization between Arctic Charr (*Salvelinus alpinus*) and Lake Charr (*S. namaycush*): Evidence from Northern Labrador. — *Nordic J. Freshw. Res.* 65: 54–70.
- Kalašnikov J.J., 1978: *Ryby bassejna reki Vitim*. — Nauka, Novosibirsk, 191 pp.
- Mednikov B.M., V.A. Maksimov, K.A. Savvaitova, 1980: Genetic divergence of Eurasian Charrs (In: Charrs, salmonid fishes of the genus *Salvelinus* Ed. E.K. Balon). — Dr W. Junk Publ., The Hague: 357–363.
- McCart P., P. Craig, 1971: Meristic differences between anadromous and freshwater resident arctic charr (*Salvelinus alpinus*) in the Sagavanirktok River Drainage, Alaska. — *J. Fish. Res. Board Canada*, 28, 1: 115–118.
- Morrow J.E., 1980: Analysis of the dolly varden charr, *Salvelinus malma* of northwestern North America and northeastern Siberia (In: Charrs, salmonid fishes of the genus *Salvelinus* Ed. E.K. Balon). — Dr W. Junk Publ., The Hague: 323–338.
- Nilsson N.A., O. Filipsson, 1971: Characteristics of two discrete populations of arctic charr (*Salvelinus alpinus*) in a North Swedish lake. — *Inst. Freshwater Res. Drottningholm Rep.*, 51: 90–108.
- Pravdin I.F., 1966: *Rukovodstvo po izučeniu ryb*. — Piščepromizdat, Moskva, 376 pp.
- Partington J.D., C.A. Mills, 1988: An electrophoretic and biometric study of Arctic charr, *Salvelinus alpinus* (L.), from ten British Lake. — *J. Fish. Biol.* 33: 791–814.
- Savvaitova K.A., 1980: Taxonomy and biogeography of charrs in the Palearctic (In: Charrs, salmonid fishes of the genus *Salvelinus* Ed. E.K. Balon). — Dr W. Junk Publ., The Hague: 281–294.

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CHARAKTERYSTYKA MORFOLOGICZNA *SALVELINUS ALPINUS* (L., 1758)
SPITSBERGENU ZACHODNIEGO – REJON HORNSUNDU

STRESZCZENIE

Ryby do badań pochodziły z jeziora Svartvatnet i rzeki Revelvy. Pomiaru 22 cech plastycznych wykonano według schematu zamieszczonego na rycinie 1. Opracowanie cech merystycznych dotyczy liczby promieni w płetwach, liczby wyrostków filtracyjnych i pylorycznych. W tabeli 1 i 2 przedstawiono statystyczne opracowanie badanych cech. Na podstawie analizy cech merystycznych utworzono dla badanych ryb następującą formułę: D (III) IV (V) 9–11, A (II) III (IV) 8–10, V I (8) 9 (10), P I 12–14, wyrostki filtracyjne (22) 24–29 (30), wyrostki pyloryczne 32–43 (47). Wśród cech plastycznych stwierdzono 8 cech związanych z płcią. Główne różnice pomiędzy samcami i samicami obserwuje się w budowie głowy i rozmiarach płetwy grzbietowej i płetw parzystych (Tabela 3).

Badaną populację z wód Spitsbergenu należy uznać za typową formę *Salvelinus alpinus*. Głównym wyznacznikiem tej przynależności jest liczba wyrostków filtracyjnych i pylorycznych. Cechy plastyczne, przy wysokiej zmienności tego gatunku, tracą praktycznie na znaczeniu dla celów taksonomicznych.

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