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OBSERVATIONS ON THE ARCTIC CHARR, *SALVELINUS ALPINUS* (L. 1758)
FROM THE HORNSUND REGION (VEST SPITSBERGEN) IN 1985–1987

OBSERWACJE NAD GOLCEM ARKTYCZNYM *SALVELINUS ALPINUS* (L. 1758)
Z REJONU HORNSUNDU (ZACHODNI SPITSBERGEN) W OKRESIE 1985–1987

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Results of observations on biology, occurrence, capture methods, and preservation of the Arctic charr from the Hornsund region are presented.

Certain unfavourable changes in abundance and age composition of the population sampled justify the plea for protection of the species in the Svalbard area studied.

INTRODUCTION

The Arctic charr, *Salmo alpinus* L. = *Salvelinus alpinus* (L.) is the commonest salmonid fish in northern polar regions, including freshwater reservoirs and rivers of the Hornsund region (Balon, 1980; Dahl, 1926; Gullestad, 1973; Lydersen et al., 1985; Radziun and Stańkowska-Radziun, 1987; Radziun et al., 1980; Różycki, 1988; Sparholt, 1985; Winnicki et al., 1991).

The species, known also as the "Spitsbergen salmon", is very plastic biologically and has evolved a number of ecological forms: a migratory (anadromous) form and two stationary (non-migratory) ones residing in lakes and streams discharging to lakes and rivers. The forms differ in size, shape, colour, and age of sexual maturity. The taxonomy is further complicated by the possible crosses between the forms (Gullestad, 1973, 1975; Johnson, 1980).

The paper presents results of observations on the Arctic charr in the Hornsund region of Spitsbergen and describes methods of collection and preservation of biological materials used by the researchers from the Academy of Agriculture in Szczecin while working on a project dealing with functioning of Arctic ecosystems and coordinated by the Institute of Ecology, Polish Academy of Sciences (Stańkowska-Radziun and Radziun, 1987).

AREA OF STUDY

The fish were observed and captured in Lakes Revvatnet and Svartvatnet as well as in the River Revelva system in summer seasons of 1985–1987 (Fig. 1).

Lake Revvatnet is situated at the altitude of 30 m above the sea level in the northern part of Hornsund Fjord. Streams from the nearby glaciers and Revdalen tundra supply the lake with their water. The lake, about 2 km long and 0.5 km wide, is si-

Fig. 1. Area of study on Vest Spitsbergen. Circles mark capture sites

tuated meridionally; its bottom is covered with rubble and coarse gravel, the bottom in its shallower northern part being covered with sand and coarse gravel, particularly in stream discharge sites. River Revelva leaves the lake in the southern end of its basin (Figs 2 and 4).

River Revelva, about 2 km long, has a strong current; the river's width and depth vary along its length. The river bed is lined with boulders, stones, and solid rock, the bars and islets consisting of gravel and sand. The river tends to change its course periodically. Its left bank receives numerous small tributaries originating at the feet of the Skoddefjellet mountain range and in the Ariedalen Valley. In its mouth, the river forms a kind of a small cove, 1.5 m deep on the average; the cove is estuarine in its character: during the flow phase of the tide its level rises considerably, the tidal current reaching 100 m upstream. Approaching the mouth area, the river breaks through a high embankment and constantly changes its width and depth in the process. In certain extreme cases (strong storms), the mouth can be completely clogged with sediment, the water trickling to the fjord through the stones and gravel of the embankment (Figs. 3 and 5).

Lake Revvatnet and River Revelva are both ice-bound for a considerable part of the year; the ice in the river disappears almost completely in early July, at which time only the inshore part of the lake thaws.

Lake Svartvatnet is situated south of Hornsund, in the Lisbetdalen Valley and is connected with River Lisbetelva. Geomorphologically, the lake and the river are almost mirror images of the Revvatnet-Revelva system described above. Due, however, to its location and sheltering by mountain ranges to the south, the climatic conditions affecting Lake Svartvatnet are much harsher. For this reason, the ice stays longer in the lake, River Lisbetelva being frequently ice-bound until as late as July.

During our visits to Spitsbergen, the meteorological and physiographic conditions outlined above restricted access to certain sites, affected the collection methods used, and have – in consequence – exerted a considerable influence on the set of materials on the Arctic charr that could be collected.

METHODS OF STUDY

The materials were collected by the authors and participants of Polish Academy of Sciences' Polar Expeditions to Spitsbergen. The materials included larvae, juveniles, and adult individuals of the Arctic charr preserved as whole specimens or their fragments (stomachs, carcasses, backbones, etc.) (Cavander, 1980; Sobociński and Radziun, 1988; Radziun et al., 1988). As an auxiliary material for toxicological assays, samples of algae and crustaceans were collected from the sea.

Fig. 2. Aerial view of Revdalen Valley; Lake Revvatnet in the background

Fig. 3. Aerial view of River Revelva mouth draining into Ariebukta Bay in Hornsund Fjord

Fig. 4. Fishing in Lake Revvatnet; July 1, 1986

Fig. 5. River Revelva mouth area during ebb tide

Table 1

Arctic charr [*Salvelinus alpinus* (L.)] collection
(number of individuals) obtained within 1985–1987
in the Hornsund region

Capture site	1985	1986	1987
Lake Revvatnet	3	2	—
River Revelva	24	3	5
Lake Svartvatnet	—	40	—

All the adult fishes were caught with a spinning rod, the only type of gear possible to use under the existing conditions; the the larvae and alevins were caught by hand (Table 1).

Immediately after capture the fish were killed, photographed and labelled, their appearance (colour, shape) being recorded in the log. Preliminary measurements of external plastic and meristic characters were made under field conditions of Hornsund, using abbreviated biometric measurement protocols of Gąsowska (1963) and Hubbs and Lagler (1958). Scales and otoliths were collected, while intestines, gonads, fragments of other organs and tissues were preserved for subsequent parasitological and biostructural studies following standard methods of histology and electron microscopy.

An individual caught in 1986 in Lake Revvatnet yielded fragments of gill lamellae with parasitic copepods anchored on them. Following the *in vitro* incubation of the copepod eggs, initial developmental stages of *Salmincola edwardsii* (Olsson, 1869) could be observed (Stańkowska-Radziun and Radziun, 1989, 1991).

The remaining biological material was frozen at -30°C at the Polish Polar Station in Hornsund and transported frozen to the home laboratory in Szczecin.

RESULTS AND DISCUSSION

A total of 77 individuals (72 adults, 2 juveniles, and 3 larvae) were obtained within 1985–1987 (Table 1).

Lake Revvatnet yielded two adult individuals only: a male, 45 cm in total length, caught on 21 July 1985 and a female, 55.5 cm long. Both individuals were silver in colour, rays of their caudal and anal fins showing weak pigmentation. The fishes

were spindle-shaped, elongated, the head being relatively small in both. No sexual dimorphism could be observed. Although the stomachs were filled with food, the appearance of both individuals indicated their permanent starvation. A few more individuals were observed on both occasions in the lake, but they were not interested in taking up the bait (a troll). The lake shores and the river were at both times free from ice, thus the fish had an opportunity to move downstream unhampered. For this reason, when our observations were compared with those reported by Gullestad (1973, 1975) and Johnson (1980), the two individuals caught could be classified as the so-called "large" charr residing in the lake (Figs. 6 and 7).

A shallow, sandy inshore zone of Lake Revvatnet yielded 2 larvae in 1985 and 1 in 1986.

The Arctic charr from Lake Svartvatnet behaved quite differently; on 20 July 1986, Messrs. Piotr Głowacki and Jerzy Jaciński, members of the Polish Academy of Sciences' expedition, caught, using a spinning rod and a troll, 40 individuals 42–60 cm long. All the fish were caught at the same site, in a small ice-free fragment of the lake in its northern part. At the same time, the entire River Lisbetelva, including its part leaving the lake, were still covered with ice. It seemed as if the fish had been trapped by ice in the lake, following the previous year's spawning.

The appearance of those individuals was typical of the anadromous form; they showed a bright pigmentation typical of the Arctic charr, their sexual dimorphism being very pronounced (Fig. 8). The fishes were emaciated, with ribs visible under the skin; instances of cannibalism were recorded. Most probably, the physiological condition of the fish prompted them to eagerly take up the bait.

After capture, the fish were measured and, after removing fillets, their complete skeletons and viscera were frozen for further examination. River Revelva, its mouth region in particular, was inhabited by the Arctic charr whose residence there was tuned to the tidal regime. The fish were observed to ascend the river during flow tide which was accompanied by a rise in the water level and a back-up of the water upstream into the river. The Arctic charr remained in the river for a short period of time only, the residence time being necessary for their physiology to set off osmoregulatory mechanisms indispensable during the spawning migration proper. The migration in Revelva takes place in September (Gullestad, 1973). These facts may provide a reason for a lack of fish response to a moving bait and explain the trouble with obtaining more fish with a spinning rod.

Within 21 July – 11 August 1985, 22 adult individuals of total length ranging within 40–62 cm and 2 juveniles were caught in the Revelva mouth. At about the same time next year, only 3 adults could be caught: 1 individual 59 cm long was caught on 14 July, while 2 specimens (53.6 and 52.8 cm in total length) were obtained on 20 July; in addition, a single juvenile could be caught as well. All the adults were silver in colour and in good condition; they showed white pigmentation of fins typical of the Arctic charr and a weak sexual dimorphism (Figs. 9–11).

Fig. 6. Arctic charr from Lake Revvatnet: 1. larva, 24 mm total length; 2. alevin, 45 mm total length; 3. juvenile, 59 mm total length; 4. male of non-migratory form, 450 mm total length; 5. female of non-migratory form, 555 mm total length

Fig. 7. Head of a non-migratory male (450 mm total body length) from Lake Revvatnet

Fig. 8. Head of a male (574 mm total body length) residing in Lake Svartvatnet

Fig. 9. Different forms of Arctic charr from River Revelva: 1. stream-dwelling non-migratory form, 145 mm total length; 2. juvenile form, 166 mm total length; 3. anadromous, estuary-dwelling form (male), 431 mm total length; 4. anadromous female, 465 mm total length; 5. anadromous female, 620 mm total length

Fig. 10. Head of anadromous female (375 mm total body length) caught in the estuarine, mouth region of River Revelva

Fig. 11. Head of anadromous male (431 mm total body length) from the mouth region of River Revelva

Fig. 12. Habitat of stream-dwelling Arctic charr in a Revelva tributary

Fig. 13. Stream-dwelling Arctic charr in their natural habitat

Photographers:

Marta Stańkowska-Radziun: Fig. 2, Fig. 3, Fig. 4, Fig. 5, Fig. 12.

Krzysztof Radziun: Fig. 6, Fig. 7, Fig. 8, Fig. 9, Fig. 10, Fig. 11, Fig. 13.

During a survey of left-bank tributaries of Revelva, a little school (consisting of about 15 individuals) of small charr was observed in a place where a stream flowing from Ariedalen Valley entered the river. The fish were elongated, their bodies showing a characteristic marble-like pigmentation (Figs 12 and 13). Spinning rod catches yielded 5 individuals whose total length ranged within 9–15.4 cm (Fig. 9.1). The fish belonged to the stream-dwelling, non-migratory form as evidenced by both their size, pigmentation, and a tendency to remain in the same place. These observations are in agreement with findings of Gullestad (1973, 1975) with respect to the occurrence of non-migratory "small" Arctic charr in streams entering Lake Svartvatnet and River Revelva. Piotr Głowacki (pers. comm.) observed identical charr individuals in River Lisbetelva.

SUMMING UP

Biological observations on and catches of the Arctic charr on Spitsbergen were facilitated to a large extent by the hospitality of the Polish Polar Station in Hornsund. For logistic reasons, the author's visits to Spitsbergen were coincident with cruises of ships transporting supplies and people to the Station, which usually happened in the early Arctic summer. At that time, ice conditions in the sites of planned catches were usually unfavourable. The lakes were still frozen completely or partially, while in rivers, after the spawning fish and smolts had descended, only the "small" stream forms could be found accompanied, in mouth areas, by solitary anadromous individuals performing an "osmotic survey" as the spawning migration proper begins in the region in September (Gullestad, 1973).

Thus this situation determined both the amount and the kind of the material collected, for which reason appropriate labelling and preservation of the material on the spot for transportation to Poland for further studies were of a paramount importance.

To sum up the observations made on the Arctic charr in the Hornsund region within 1985–1987, one may contend that, as a result of periodically occurring natural obstacles for spawning migrations of the anadromous form and a considerable antropogenic pressure which has increased over the recent years, all the Arctic charr forms in the region have succumbed to visible, adverse changes in abundance and age structure. The changes manifest themselves as a clearly reduced age of the fish caught. While 18-yr-old individuals were being caught within 1965–1971 (Gullestad, 1973), the oldest individual caught in 1986 in Lake Svartvatnet was aged 12+ and the oldest Revelva individual was still younger (9+) (Krzykowski and Radziun, 1988, 1991).

These findings only might serve as an indication that the Arctic charr in the Hornsund region should be completely protected for at least 10 years in order to fully reconstitute all the forms of the species. The image of these fascinating fish should not remain only in the memory of and photographs taken by polar explorers.

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OBSERWACJE NAD GOLCEM ARKTYCZNYM *SALVELINUS ALPINUS* (L., 1758)
Z REJONU HORNSUNDU (ZACHODNI SPITSBERGEN) W OKRESIE 1985–1987

STRESZCZENIE

W latach 1985–1987 na Zachodnim Spitsbergenie w rejonie Hornsundu prowadzono obserwacje behawioralne golca arktycznego *Salvelinus alpinus* (L., 1758). Pozyskano materiał w postaci narybku, osobników młodocianych oraz ryb dorosłych, form anadromicznych i nie wędrujących, rezydujących w jeziorach Revvatnet, Svartvatnet i w systemie wodnym rzeki Revelva (Tabela 1).

Opisano rejony występowania, metody połowu i zabezpieczania do dalszych, specjalistycznych analiz pozyskanego materiału biologicznego. Stwierdzone niekorzystne zmiany w składzie ilościowym i wiekowym poławianych ryb, spowodowane przyczynami naturalnymi oraz nadmierną i niekontrolowaną eksploatacją, mogą być sygnałem do objęcia całkowitą ochroną golca arktycznego, jedyne go słodkowodnego, dwuśrodowiskowego przedstawiciela ichtiofauny w rejonie Hornsundu, celem pełnej restytucji jego stada.

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