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# Long-term assessment of a vendace (*Coregonus albula* L.) stock in Lake Paravani, South Georgia

Bella Japoshvili

with 5 figures and 2 tables

**Abstract:** A total sample of 1854 vendace (Coregonus albula L.) specimens was collected on a seasonal basis from Lake Paravani during 1999–2005. Nets of different types (seines, trap nets and gillnets) with various mesh sizes and length were used for sampling. Samples were collected from 3 horizontal strata. In the samples collected, most vendace were age 1+ and 2+ although a few individuals lived to age 4. Vendace is the dominant species comprising 70 % of the annual catch. Catches from this study were compared with historical data. It was found that the annual abundance of vendace decreased dramatically from 1994 to present, from 50 tonnes to 17 tonnes or less annually. The average size of vendace in catches has also decreased in recent years. We believe intensive poaching, in addition to commercial fishing, climate changes and global warming, are the leading factors that have caused the decrease in overall number of individuals and the smaller sizes of adult vendace in the current population.

**Keywords:** vendace, age structure, abundance, Lake Paravani, Georgia.

## Introduction

Vendace (*Coregonus albula* L.) was introduced into Lake Paravani during the 1930s from Lake Ladoga (Russia, Volkhov hatchery). The species easily adapted to the new environment and soon became a primary target for commercial fishery in this lake (Demetrashvili 1960; Japoshvili 2002). The fish community of the Lake Paravani did not previously include any fish species that could utilize zooplankton as prey prior to the introduction of vendace. Vendace in Lake Paravani had very good growth—higher than that recorded in the populations inhabiting other lakes of Russia and Finland (Potopova 1978; Helminen & Sarvala 1997; Sarvala et al. 1999). This indicates the availability of abundant appropriate food resources for the vendace in Lake Paravani (Japoshvili 2004). Favourable biologic features of this species such as quickly attaining market size, fast growth rate, schooling behaviour facilitating

**Author's address:**
[1] Ilia State University, Institute of Zoology, 31 Chavchavadze ave. Head of the lab of Hydrobiology and Ichthyology. 0179, Tbilisi, Georgia.
* Corresponding author, e-mail: bela_japoshvili@iliauni.edu.ge

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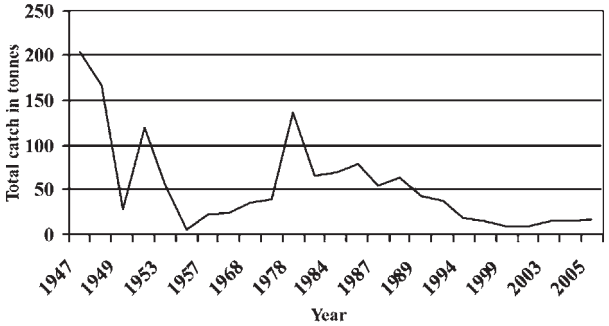


**Fig. 1.** Catches of vendace from 1947 to 2005.

commercial catches, and a high meat value made it a desirable species for human consumption.

Since 1940, vendace has been the dominant species in Lake Paravani commercial catches. From historical data and annual records of commercial fisheries, it is known that vendace catch was high in 1947, 1948, 1952 and 1978 years comprising 203.5 tonnes, 166.7 tonnes, 119.52 tonnes and 137 tonnes respectively. Annual catches of vendace fluctuated greatly year by year. Starting from 1989 to 2005, vendace catches decreased; during this time the sum of commercial catches of vendace was less than 300 tonnes (Fig. 1). This decline was caused by intensive fishing, unfavourable combinations of water conditions due to climate change and by other ecological factors (Japoshvili 2004). At the same time, the economic breakdown of the 1990s left negative impacts on fish production. It should be mentioned that before the collapse of the USSR, Lake Paravani was stocked by vendace fry from a coordinated network of hatcheries.

Studies of bio-ecological features of introduced vendace in Lake Paravani were last conducted in the 1950s (Demetrashvili 1960). Currently, there are no data on length-weight relationships, population structure or condition of vendace. Further, the effects of the cessation of coordinated stocking on the vendace population following the collapse of the USSR are unknown.

The aim of this study was to investigate basic biological characteristics of vendace in Lake Paravani, such as length, weight, age and sex frequencies, catch rates and potential factors influencing catch rates.

## Materials and methods

### Study lake

Lake Paravani (41°23'–41°29'N, 43°46'–43°50'E) is located in the southern part of Georgia on the Javakheti upland about 2080 m above sea level (Fig. 2). Lake Paravani is the biggest lake in Georgia by surface area (37.5 $km^2$) (Table 1). The volume of the lake is 90.8 million $m^3$. The lake usually freezes in the second half of December, while the ice layer reaches its maximal thickness in March, but can occur as early as late February. The lake is totally ice-free in early May of each year. There

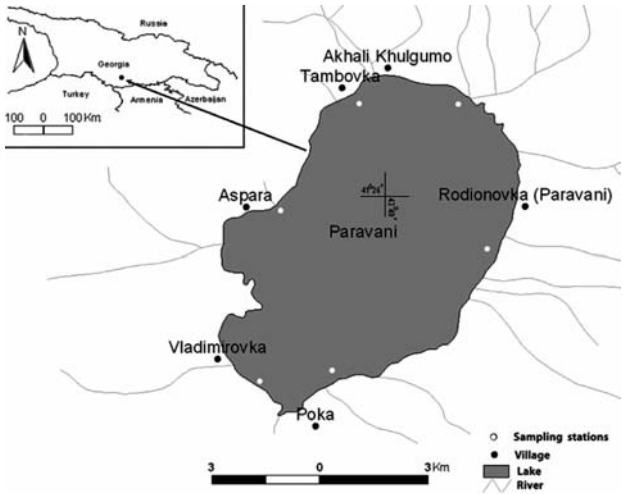


**Fig. 2.** Map of Lake Paravani.

**Table 1.** Hydrobiological characteristics of the Lake Paravani

| Characteristics | Measure | Citation |
|---|---|---|
| Altitude | 2080 m | Baratch 1964 |
| Surface area | 37.5 km$^2$ | Baratch 1964 |
| Maximum depth | 2.8 m | Baratch 1964 |
| Average depth | 1.87m | Baratch 1964 |
| Maximum length | 10 km | Baratch 1964 |
| Maximum width | 5.8 km | Baratch 1964 |
| Water transparency | 30–140 cm | This study |
| pH | 8.0 | This study |
| Dissolved oxygen | 7.32 mg/l | This study |
| Zooplankton biomass | 0.96 g/m$^3$ | Macharshvili & Lomadze 2002 |
| Macrozoobenthos biomass | 44.5 g/m$^2$ | Pataridze 2002 |

are a number of other fish species represented in Lake Paravani: Schneider (*Alburnoides bipunctatus*), roach (*Rutilus rutilus*), Transcaucasian barb (*Capoëta capoëta*), chub (*Squalius cephalus*), kura gudgeon (*Romanogobio persus*), murtsa (*Luciobarbus mursa*), Crucian carp (*Carassius carassius*) and in very small numbers brown trout (*Salmo trutta*) and the native carp (*Cyprinus carpio morpha hungaricus Heck*). An introduced vendace (*Coregonus albula*) comprises 70 % of total catches, Crucian carp (*Carassius carassius*), which is an introduced species as well and appeared in the Lake Paravani from 1980, comprises 20 % of total catches and the remaining eight inhabitants of the lake contribute 10 % of total catches. There are six villages located around the lake. The main business of the population of these villages is animal husbandry and fishing, but fishing regulations are frequently ignored and not enforced.

### Catch methods and sampling

Six stations were chosen for study (Fig. 2). Vendace catches were carried out in 1999–2005 on a seasonal basis. Nets of different types (seines in winter, trap nets in autumn, and gillnets in summer) with various mesh-size (bar mesh 10, 18, 20, 22, 24, 26, and 28 mm) were used for sampling. Samples were collected from 3 horizontal strata: zone 1 comprised shallow water from the shoreline to the depth of 1 m, zone 2 covered the depth to the 2 m, and zone 3 covered the central pelagic area deeper than 2 m. Fishing with winter seines was often difficult because of poor ice and weather conditions. Seines were operated below the ice through a series of holes, using ropes driven under the ice between holes with long, floating poles.

Fish were processed by generally accepted methods; fish body length (total length), body mass (total weight), sex and age were determined. Ages were estimated from scales, using a MBC-10 microscope (Pravdin 1966, Reshetnikov 1980, Lakin 1990, Murphy & Willis 1996). The mean lengths and weights of vendace were measured from a subsample of 100 specimens from each sampling period. To examine relationships between stocking and yield, stocking data were collected from the Paravani Lake hatchery during the study.

One-way ANOVA (with Tukey's HSD post-hoc test) was conducted to test whether differences between age groups were significant between sampling periods. All analyses were carried out with SPSS version 16.0 for windows (SPSS Inc., Chicago, IL, USA).

## Results

A total sample of 1854 specimens of the vendace (*Coregonus albula* L.) was collected on a seasonal basis from Lake Paravani from 1999 to 2005 (Fig. 3). The major portion of the total catch (47 %) was taken with seine nets in autumn and winter. The catch-per-unit-effort (CPUE) varied from 20 to 70 kg per haul. The gillnet fishery in summer contributed 21 % of the total catch, and trap nets fished in autumn, where CPUE (kg per fishing day) averaged 8.7 kg, contributed the remainder of the total catch. Of the total number of fish sampled, 770 (41.5 %) were females, 786 (42.4 %) males and 298 (16.1 %) juveniles (Male:Female:Juvenile = 2:2:1). 5 age groups were found in the population during the investigation. In the samples collected, 16.1 % were of the 0+ age group, 39.6 % were the 1+ age group, 31.7 % were the 2+ age group, 9.4 % were the 3+ age group, and 3.2 % were from the 4+ age group.

ANOVA showed that between-age-group variation during the years of investigation was significantly greater than within groups ($F = 33.1$, $P < 0.001$; Fig. 3). A Post-hoc test (Tukey HSD) showed that mean numbers of captured vendace aged 0+, 3+ and 4+ were significantly lower than mean numbers of 1+ and 2+ age groups (Fig. 4). Thus, the investigation has shown that the 1 + and 2+ age groups of vendace dominated the commercial catch and the 1+ age group is the most abundant age group in the catch materials.

The body size of vendace varied from 11.2 to 31.4 cm, and the average size was 22.4 cm. Body mass varied from 52 g to 187 g, and the average was 135 g (Fig. 5). Mean length and weights observed were much less than those observed in the 1940s and 1950s, reported to be 25.2 cm and 312 g respectively (Demetrashvili 1960). Data obtained from a survey conducted by the Lake Paravani hatchery also indicated that average body mass before the 1990s was 300 ± 1.14 g (B. Chivchian, personal communication), suggesting that declines in body size have occurred since then.

There was a positive relation between the intensity of stocking and the level of vendace catches in recent years (Table 2). Since 2003, stocking was not possible because of the

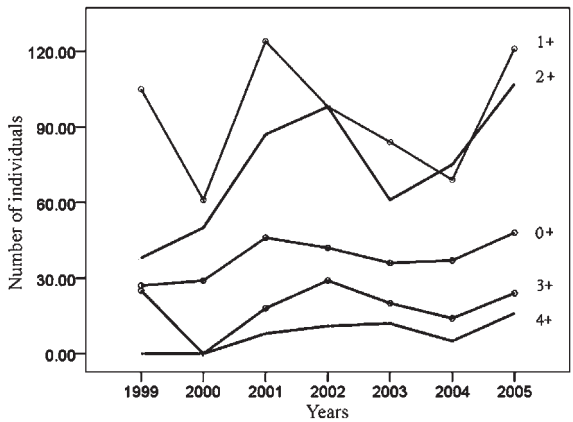


**Fig. 3.** Abundance of vendace in samples taken 1999–2005.

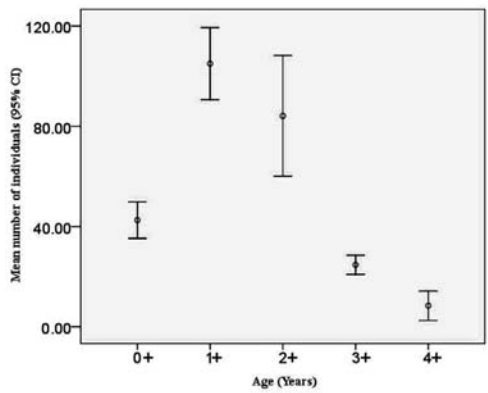


**Fig. 4.** Mean number of vendace captured over all years sampled. Means plus or minus 95 % confidence intervals are shown.

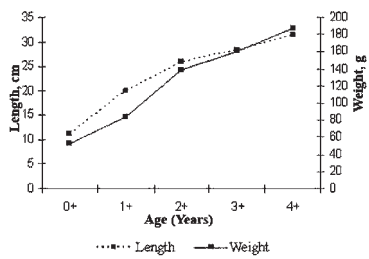


**Fig. 5.** Length and weight of different age groups of vendace in Lake Paravani.

**Table 2.** Fry stocking, catch effort and production of vendace in Lake Paravani.

| year | Number of stocked fry (mln) | Vendace Catches Kg/ha | Production (kg) |
|---|---|---|---|
| 1999 | 3.0 | 15.0 | 65000 |
| 2000 | 2.0 | 9.8 | 37000 |
| 2001 | 2.0 | 12.9 | 45000 |
| 2002 | 2.5 | 14.6 | 62000 |
| 2003 | – | 4.8 | 17800 |
| 2004 | – | 5.33 | 18365 |
| 2005 | – | 5.4 | 18580 |

closure of the Tambovka hatchery and the vendace population was maintained only by natural reproduction.

## Conclusions

The vendace population in Lake Paravani is an important resource. It is now at a low level from a combination of heavy exploitation, no supplemental stocking of larvae due to hatchery closures, and other potential factors such as climate change. Poaching is a continued problem for vendace. The low catches of adult vendace at the present time relative to historical catches is a major concern. Although vendace is the dominant species in catches of Lake Paravani, their catch-by-weight has declined during the last 20 years. In addition, the average weight of vendace decreased; prior to the 1990s, mean weight of vendace was 300 ± 1.14 g and is now less than half of this value (135 ± 1.09 g). Most of the current catch is composed of very young individuals and there are fewer adults to spawn each year.

The present uncontrolled fishery may prevent the fish from utilising their ecological productive potential to the benefit of the local population, and may threaten a balanced functioning of the fish community of the Lake Paravani ecosystem. This study suggests that stocking may be necessary to support this population given the current set of stressors it faces.

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## References


Baratch, G. (1964): Lakes of Georgia and their importance for fisheries. Sabchota sakartvelo, Tbilisi. 191. [In Russian].

Demetrashvili, M. (1960): Biology of lake Paravani vendace. – Bull. Georg. Natl. Acad. Sci.. **XXV, 1**: 65–79. [In Georgian].

Murphy, B. & Willis, D. (1996): Fisheries Techniques. – American Fisheries Society, Bethesda, Maryland, USA. XX+732.

Helminen, H. & Sarvala J. (1997): Responses of Lake Pyhäjärvi (south-western Finland) to variable recruitment of the major planktivorous fish, vendace (*Coregonus albula*). – Can. J. Fish. Aquat. Sci. **54:** 32–40.

Japoshvili, B. (2002): Results of visual observation on gonadogenesis of vendace (*Coregonus albula* L.) in conditions of Paravani Lake. – Bull. Georg. Natl. Acad. Sci. **166**: 591–594.

Japoshvili, B. (2004): Some biological and morphometric characteristics of a vendace (*Coregonus albula* L.) of the lake Paravani. – Proc. Georg. Acad. Sci., Biol. Ser. B Vol. 2, **1–2**: 97–100.

Lakin, G. (1990): Biometry. – Vischaya shkola, Moscow. 352. [in Russian].

Macharashvili, V. & Lomadze, N. (2002): Zooplankton of the Paravani Lake. – Proceedings of the Institute of Zoology. **XXI**: 372–378.

Pataridze, A. (2002): Paravani Lake Zoobenthos. – Proceedings of the Institute of Zoology. **XXI**: 379–387.

Potopova, O. (1978): Vendace *Coregonus albula* L. Nauka, Moscow. 135. [In Russia].

Pravdin, I. (1966): Manual on study of fishes. – Pischevaya propishlennost, Moscow, 376. [In Russian].

Reshetnikov, Y. (1980): Ecology and systematics of coregonid fishes. Nauka. Moscow, 300. [In Russian].

Sarvala, J., Helminen, H. & Auvinen, H. (1999): Portrait of a flourishing freshwater fishery: Pyhäjärvi, a lake in SW Finland. – Boreal Environ. Res. **3**: 329–245.