J. FAC. SCI., SHINSHU UNIVERSITY, Vol. 29, No. 1, pp. 49-56 1994

Seasonal Distribution and Growth of *Sphaerium (Musculium) japonicum* (Bivalvia ; Sphaeriidae) in Lake Suwa, Japan

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Abstract

seasonal changes in the distribution and the growing characteristics of *Sphaerium (Musculium) japonicum* were investigated in Lake suwa from June 20 to November 11, 1993.

The main distribution area of *S. (Musculium) Japonicum* transfered from the littoral zone to the lake center with increasing water temperature, and began to retransfer to the littoral zone with decreasing dissolved oxygen content of bottom water. Thereafter, their distribution in the lake was at random. The organic contents of bottom mud in Lake Suwa were 13.5-15.6%, but they were no influence on the movement of *S. (Musculium) Japonicum.*

In vitro, their migration speed was 50 cm per hour at 16.9°C water temperature (D. O. 7.52 mg/1), and their movement distance per minute corresponded to their shell length.

All adults of *S. (Musculium) japonicum* were taken from June 21 to september 24 held juveniles inside them. The maximum size of the inside juveniles was 1.71 mm, and the minimum size of the outside adult was 1.59 mm. The young taken from the lake grew up to 1.92-2.12 mm in nature and to 2.25-2.55 mm in vitro after 100 days. The growth rate was 0.1 mm in one month in natural conditions, against 2 weeks in vitro. The living shells of juvenile decreased to 50% during 50 days in vitro, and after that remained stable for 50-100 days.

Introduction

The first report on *Sphaerium (Musclium) japonicum* was made by WESTERLUND (1883). MORI (1933, 1935, 1936, 1937) proposed the classification of Japanese *Sphaerium*, and HABE (1977) classified them into 4 species. OKADA (1935 a, b, c, 1936) reported the embryological characteristics of *S. (Musculium) japonicum*, indicating their reproductive cycle from spring to autumn.

In Lake Suwa there are many ecological studies on the population dynamics and the life cycles of benthos. However, they focused on Chironomidae and Oligochata, and

there are few studies on mollusca, particularly *Spherium* sp. The purpose of the present study is to make clear the seasonal changes in the distribution and the growing characteristics of *S. (Mushulium) japonicum* in Lake Suwa.

Material and Methods

Specimen of *Sphaerium (Musculium) japonicum* were collected twice a month using Eckman-Birge grabs (15×15 cm), ten times at each station at 6 m, 5 m and 4 m water depth from June 20 to November 11, 1993. The juveniles inside the adult shell were measured from every ten adults.

Water and mud temperature along with dissolved oxygen content were measured by electrothermometer (Toho Dentan ET-3) and Winkler method, respectively. Organic content of mud was measured as the ignition loss. Mud was dried in dry oven at 100°C for 24 hours, and after that burnt in dry oven at 500°C for 30 minutes.

The collected shells were preserved in 10% (v/v) formalin, and the shell lengths were measured using a ten-fold projector (Olympus, UP-350) with a caliper. The number of embryonic shells contained in adults was counted, and the shell lengths were measured for 50 juveniles reared in glass cages (ϕ 10× height 10 cm) for 100 days. Then the growth and death rates for the experimental period were calculated.

Results

In Lake Suwa, the main species of benthic fauna in individual members were *Limnodrilus claparedeianus* (51.0% of total individuals), *Branchiura sowerbyi* (18.0%) *Chironomus plumosus* (15.7%), and the sum of them were accounted for 80.0% and more. That of *Sphaerium (Musculium) japonicum* was 7.6%. The biomass of each species was largest in *Chironomus plumosus* (43.2%). Those of *Branchiura sowerbyi, Limnodrilus claparedeianus* and *S. (Musculium) japonicum* were 29.9%, 14.9% and 5.6%, respectively.

The individual numbers of *S. (Musculium) japonicum* adult taken from 6 m depth increased till July 3, and after that decreased up to September 6. However, the adults at 5 m depth began to increase from September 6, and reached maximum by October 8. On and after October 24, they could not taken at 6 m depth (Fig. 1). The juveniles obtained first were from July 20, and their total number increased till September 24. However, that taken from 6 m depth began to reduce from July 20. That of 5 m depth increased to September 24 and reduced after October 8 (Fig. 2). When changes in the densities of adults and juveniles occurred, water temperature and dissolved oxygen content changed as well. Bottom temperature rose until September 6, and afterward decreased in each depth (Fig. 3). As shown in Fig. 4, the dissolved oxygen content at bottom was always sufficient for living in each station.

The organic content of mud taken from Lake Suwa was 13.5-16.1%. It showed no

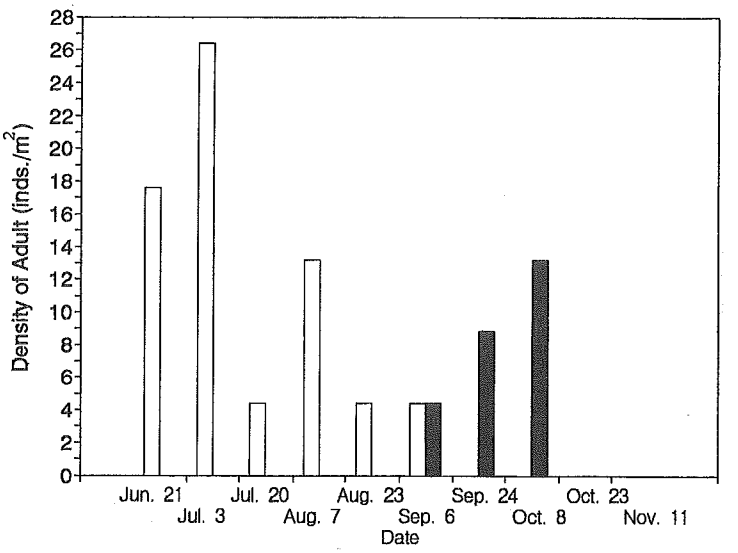

Fig. 1. Changes in the densities of *Sphaerium (Musculium) japonicum* (adult) at each station in Lake Suwa (1993).
□ 6 m; ■ 5 m water depth

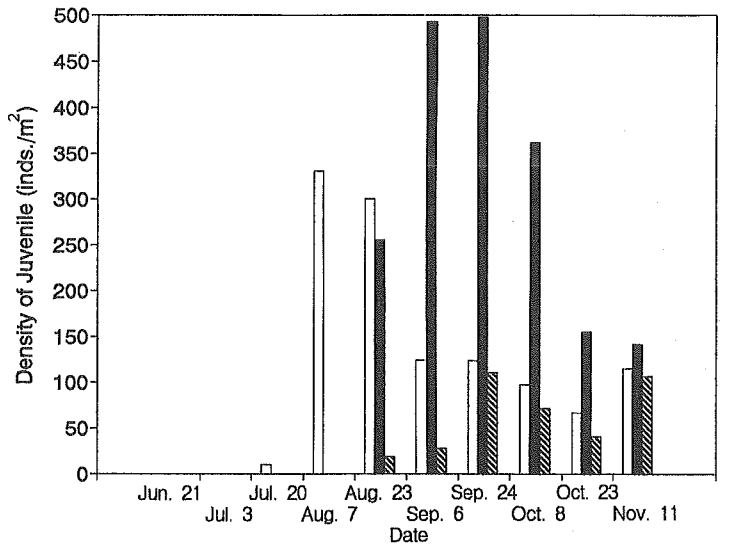

Fig. 2. Seasonal changes in the density of juveniles at each station in Lake Suwa (1993).
□ 6 m; ■ 5 m; ▨ 4 m water depth

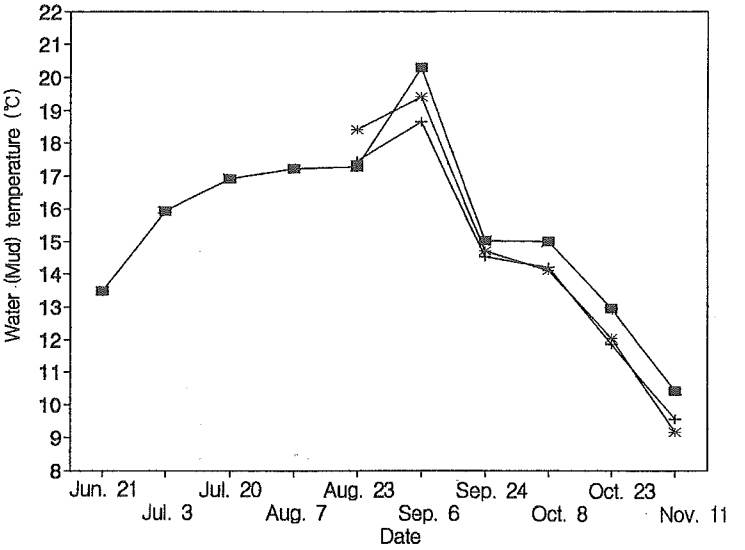

Fig. 3. Seasonal changes in water temperature of bottom water and mud at each station in Lake Suwa (1993).
■ 6 m; +5 m; * 4 m water depth

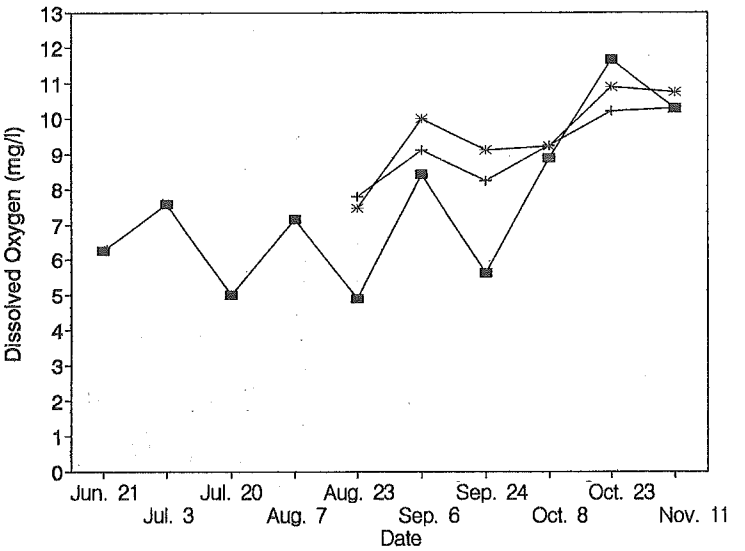

Fig. 4. Seasonal changes in dissolved oxygen concentration in bottom water at each station in Lake Suwa (1993).
■ 6 m; + 5 m; * 4 m water depth

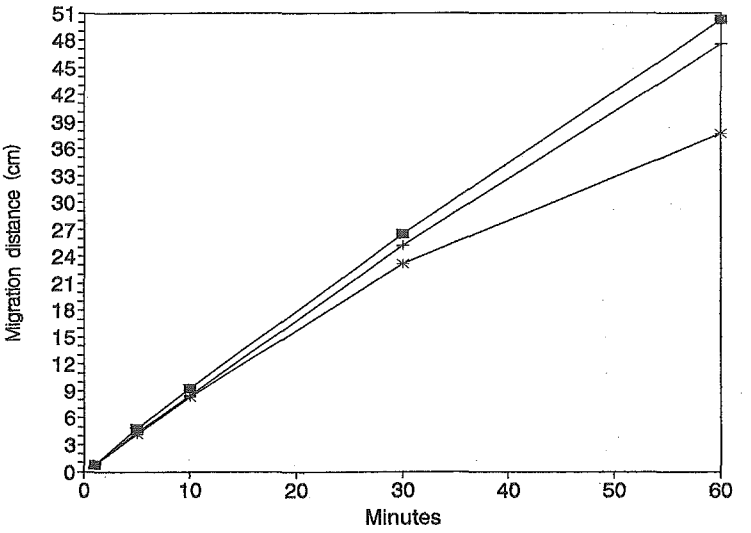

Fig. 5. Migration distance of *Sphaerium (Musculium) japonicum* adults in vitro in dark condition.
■ 8.17 mm; + 7.94 mm; ∗ 7.30 mm in shell length

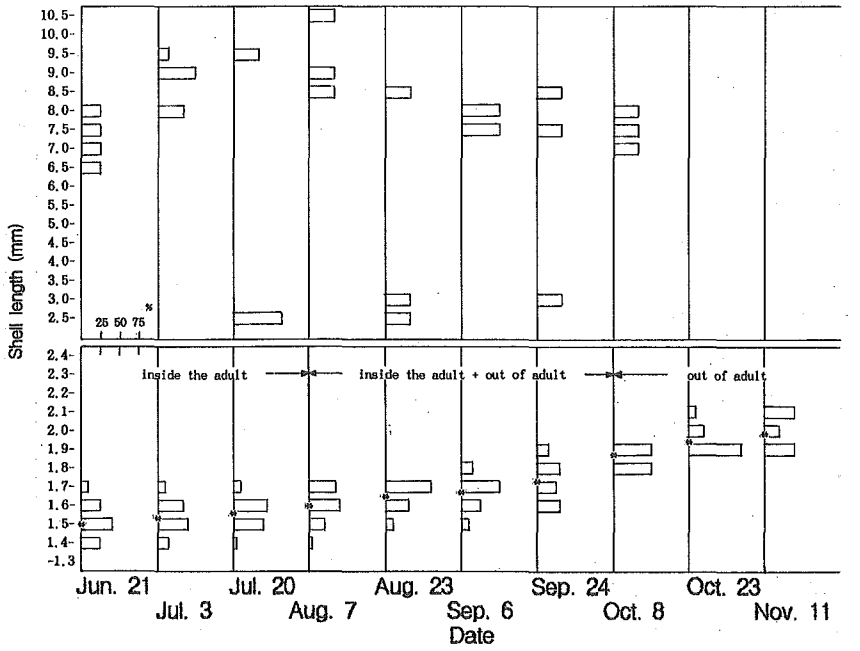

Fig. 6. Growing pattern by the emergence frequency in the shell lengths of *Sphaerium (Musculium) japonicum* in Lake Suwa.
∗ Length of more than 2.5 mm and less than 2.4 were calculated separately.
∗ The symbol marks in the figure show the mean value of shell length in each sampling

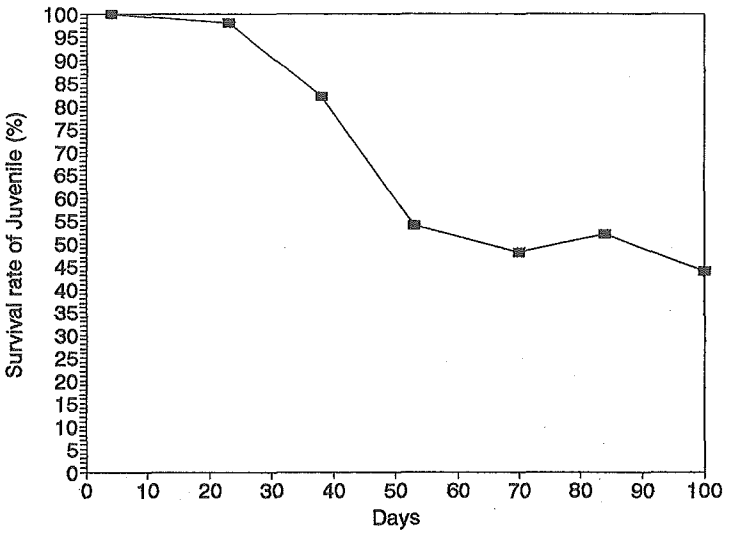

Fig. 7. Survival curve of *Sphaerium (Musculium) japonicum* juvenile.

influence on migration of *S. (Musculium) japonicum*. In vitro, the adults moved the same distances of their shell length per minute at 16.9°C water temperature (D. O. 7.52 mg/1), and their speed corresponded to 50 cm per hour (Fig. 5).

The adults of *S. (Musculium) japonicum* had juveniles inside from June 21 to September 24, and the maximum number of juvenile was obtained on August 7. The maximum number of juveniles inside gills was 38 (range: 3-38, mean number: 22). The maximum length of adults containing juveniles was 10.61 mm, and the minimum was 6.85 mm. The maximum length of juveniles inside adults was 1.71 mm. However, the minimum length of juveniles observed in and out of adults was 1.59 mm. In nature, the juveniles grew to a length of 1.92-2.12 mm till November 11. Their growth rate corresponded to 0.1 mm in one month (Fig. 6). However, in vitro, the juveniles grew to a length of 2.25-2.55 mm for the same period as in nature. This rate corresponded to 0.1 mm in 2 weeks. The mortality of juvenile in vitro reached 50% after 50 days, and it was stable till 100 days afterwards (Fig. 7). In the experimental period, the dissolved oxygen content remained stable at 7.08-7.24 mg/1.

Discussion

Embryologically, *S. (Musculium) japonicum* are ovoviviparous. The fertilized eggs are retained and incubated within the body of the parent, and the subsequent development of the embryos into post-disconch fry takes place in the marsupia formed in the gills. However, the young is not parasitic, but free living after leaving the parent. It was a distinctive anal and branchial siphon. The number of juveniles inside adult were not influenced by the size of the aduult.

S. (Musculium) japonicum moved from the littoral zone to the lake center with increasing water (mud) temperature by the July 27. However, it began to move despite the stable temperature at 16.9-17.3°C by the August 23, and they moved littorally toward 5 m depth until September 24. *S. (Musculium) japonicum* in bottom mud of lake may be sensitive to the change in water temperature and the increase and decrease of dissolved oxygen content in bottom water. When they experienced changes of water temperature or dissolved oxygen content, they had to migrate toward a place of more favorable conditions, Based on the present results, they can migrate 12 meters per day. However, their speed may not be sufficient in terms of the speed of the dissomved oxygen decrease in the bottom water of a eutrophic lake. As a result, in a suddenly eutrophicated lake their distribution zone was limitted, and their standing crops was decreased. Fortunately, in Lake Suwa, the distribution of *S. (Musculium) japonicum* was observed at a place of maximum depth, the lake center, and the recovery of the lake environmental conditions was confirmed from their distribution in summer season.

As shown in Fig. 6, their mamximum length was 10.5 mm, and their generation was estimated to be 3 or 4 from the frequency pattern of their shell lengths. However, the middle generations could not be obtained in the present study. The first generation grew from 1.5 to 2.0 mm in length in one year, and the maximum lifetimes was estimated as 4-6 years from their lengths growing speed and the growth lines on their shells.

Acknowledgements

We are very thankful to H. Shionogaki and other members of Suwa Hydrobiological Station, Shinshu University, for their kind assistance and advices in the course of this study. We also wish to thank Prof. H. Hayashi, Dr. Ho-Dong Park and T. Fujita of Shinshu University, for their useful advices in the preparation of the manuscript.

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