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Embryonic Development and Fry of the Kyūriuo, *Osmerus eperlanus mordax* (Mitchill).

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Abstract

Smelt eggs were artificially fertilized and the embryonic development was observed in water temperature regulated at $11 \pm 0.5^\circ\text{C}$ during the incubation. The eggs were demersal and adhesive, and, after water absorption, measured from 1.28 to 1.51 mm in diameter. 453 hours (19 days) after fertilization, hatching occurred and the total length of the newly hatched fry ranged from 7.21 to 7.80 mm.

Introduction

Osmerus eperlanus mordax usually lives near coastal waters in Hokkaido and ascends rivers only in the spawning season. In southern Hokkaido, the spawning continues for about a month and the peak of spawning may be in early May.

The embryonic development is one of the important parts in the study of life history. Some observations have been worked on the osmerid fishes in Japan, i.e. *Spirinchus lanceolatus* by Hikita¹⁾, *Hypomesus olidus* and *H. sakhalinus* by Hamada²⁾, and *Hypomesus olidus* by Yamada³⁾. In the fishes of the genus *Osmerus*, Gottwald and Nagiec⁴⁾ described the development and course of the hatching of *Osmerus eperlanus eperlanus*. In regard to *Osmerus eperlanus mordax*, however, only gross studies of the embryonic development were done by Mihara and Shibata⁵⁾, Nakamura⁶⁾, and Shibata⁷⁾.

In this paper the embryonic development of *Osmerus eperlanus mordax* is for the first time described in detail based on the artificial fertilization.

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Material and Methods

On May 14, 1976 mature males and females were obtained from Shirarika River near Yakumo, southern Hokkaido. The eggs were fertilized by the dry method in the river and in the laboratory. The fertilized eggs were made to adhere to the glass plates, because the eggs have adherent membranes. The water temperature

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was regulated at $11 \pm 0.5^\circ\text{C}$ during the incubation. The egg diameters, the total body lengths and the lengths of body parts of the fry were measured by a toolmaker's microscope.

The egg photographs were taken by the microscope, and the fry by the Multiphot.

Results

Smelt eggs were mostly rounded with many oil globules, demersal and adhesive. The egg diameters after water absorption ranged from 1.28 to 1.51 mm. The embryonic development of smelt from fertilization to hatching in relation to the time of incubation is shown in Fig. 1.

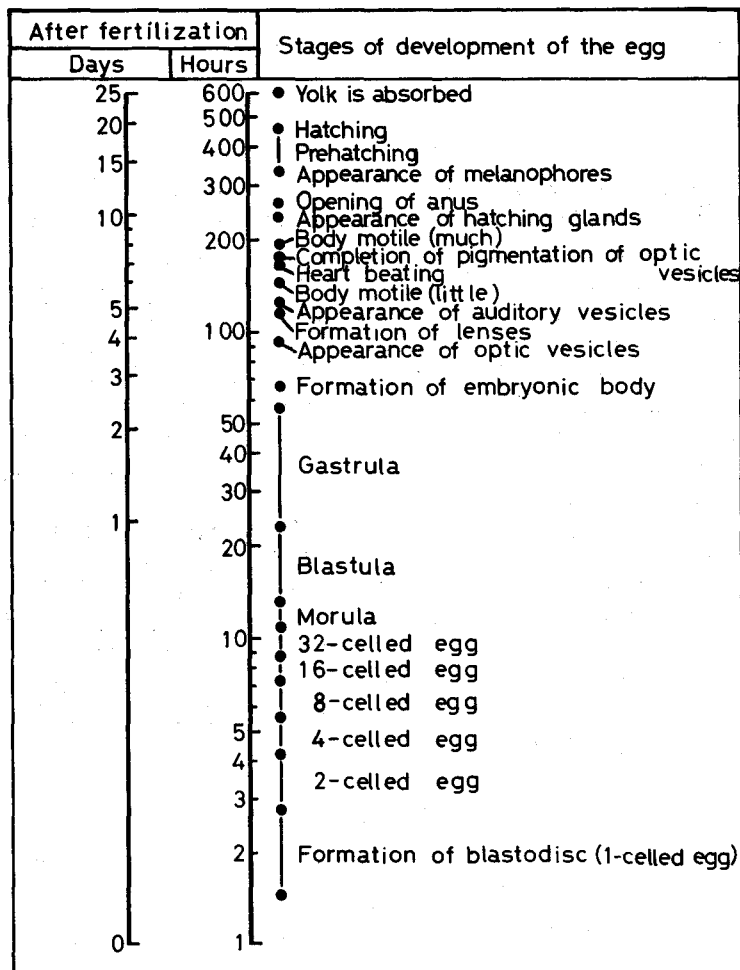


Fig. 1. Embryograph showing the development of smelt ova from the one-celled stage up to hatching in relation to the time of incubation.

- 1 hr. 20 min. (Text-fig. 1) The egg membrane rises and the perivitelline space is formed. Protoplasm begins to accumulate and is formed in the blastodisc at the animal pole.
- 2 hrs. 20 min. (Text-fig. 2) The blastodisc reaches full development.
- 3 hrs. (Text-fig. 3) The blastodisc is divided into two almost equal blastmeres.
- 4 hrs. 30 min. (Text-fig. 4a, 4b) At the second cleavage, two cells are divided into four blastmeres.
- 6 hrs. (Text-fig. 5) Four cells are divided into eight blastmeres.
- 8 hrs. (Text-fig. 6) Eight cells are divided into almost equal irregular sixteen blastmeres.
- 9 hrs. (Text-fig. 7) Sixteen cells are divided into irregularly sized thirty-two blastmeres.
- 12 hrs. (Text-fig. 8) Many smaller divided cells reach the morula stage.
- 17 hrs. (Text-fig. 9) Blastmeres at the morula stage are divided into even smaller cells, reaching the blastula stage. Minute cells become more subdivided.
- 32 hrs. (Text-fig. 10a, 10b) The germinal ring is nearly equatorial in position or extends over the equatorial plane.
- 66 hrs. (Text-fig. 11) The germinal ring exceeds two-thirds of the yolk and the embryo is clearly established.
- 90 hrs. (Text-fig. 12) The embryo enlarges anteriorly, forming the head. Optic vesicles appear clearly in the head region. The blastopore is closed.
- 114 hrs. (Text-fig. 13) The lenses are forming in the optic vesicles.
- 122 hrs. (Text-fig. 14a, 14b) Auditory vesicles are forming and the brain begins to form. About 20 pairs of somites are apparent.
- 142 hrs. (Text-fig. 15) Optic vesicles begin to be pigmented and the body is little motile.
- 161 hrs. (Text-fig. 16) The tail is sometimes motile and the heart begins to beat. The body has encircled the yolk sphere. About 40 pairs of somites are observable.
- 173 hrs. (Text-fig. 17) The pigmentation of optic vesicles is complete.
- 232 hrs. (Text-fig. 18) The fin folds are surrounding dorsal and ventral margins of the body. Many hatching glands become visible along the lateral space.
- 256 hrs. (Text-fig. 19) The anus is opening.
- 334 hrs. (Text-fig. 20) Melanophores appear at the base of the ventral fin fold.
- 356 hrs. (Text-fig. 21) There are melanophores on the fin fold and the yolk.
- 453 hrs. (Text-fig. 22) Fry hatched out on the 19th day or so. Newly hatched fry were 7.52 mm in average total length with a range of 7.21 to 7.80 mm. The body is slender, its depth ranging from 0.40 to 0.45 mm, and 16.19 to 19.23 times in total length. The yolk sac is small, measuring 0.81-0.97 mm in its horizontal axis, and 7.44 to 9.27 times in total length. A large oil globule is at the anterior end of the yolk sac. The oil globule is 0.27-0.31 mm in diameter, and 2.67 to 3.55 times in the length of the yolk sac. The number of somites ranges from 62 to 65, being nearly equal to the number of vertebrae and the number of the midlateral scales in adult smelt. Melanophores are distributed from the front of the yolk sac, the yolk sphere and the fin fold along the ventral side to the base of the caudal fin. There are some melano-

phores along the peritoneal wall and relatively large melanophores are there just above the anus. The fin fold begins just behind the head and reaches the anus continuously surrounding the tail. In the ventral side, the fin fold extends from the posterior half of the yolk sac to the anus. Pectoral fins only are present at hatching time. The fry is able to swim mainly by body undulation, and using pectoral fins.

6 days after hatching (Text-fig. 23) The yolk is mostly absorbed, but a small oil globule remains at the anterior part of the body cavity. The fry is already eating diets. The mouth is relatively small, the intestine is straight and transparent. Blood is transparent and the heart is located back below the auditory vesicles.

Discussion

The degreedays calculated from known data are 312 (Mihara and Shibata⁵), 208 to 273 (Nakamura⁶), and 330 to 432 (Shibata⁷). Since the degreedays estimated for this experiment are 209 to 253, this falls into the range of this species. But, the three former calculated degreedays were wide in range. It seems that the water temperature was irregular during the incubation. Gottwald and Nagiec⁴ incubated the eggs of *Osmerus eperlanus eperlanus* under a water temperature regulated at 6°C. It took 40 days till hatching, and the calculated degreedays were 240. This result agrees well with the present study.

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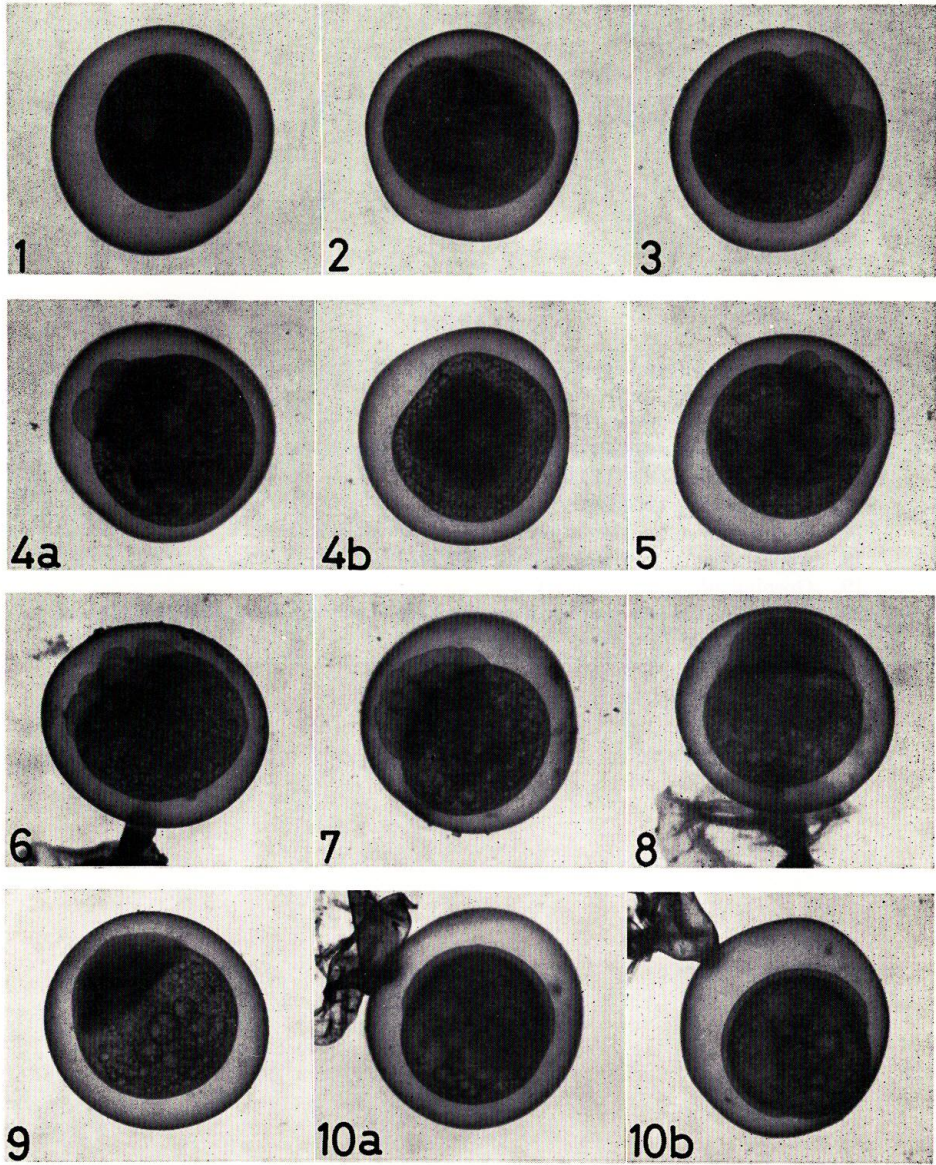
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EXPLANATION OF PLATES

The magnification rate of egg development is 50 times, and fry is 3 times.

PLATE I

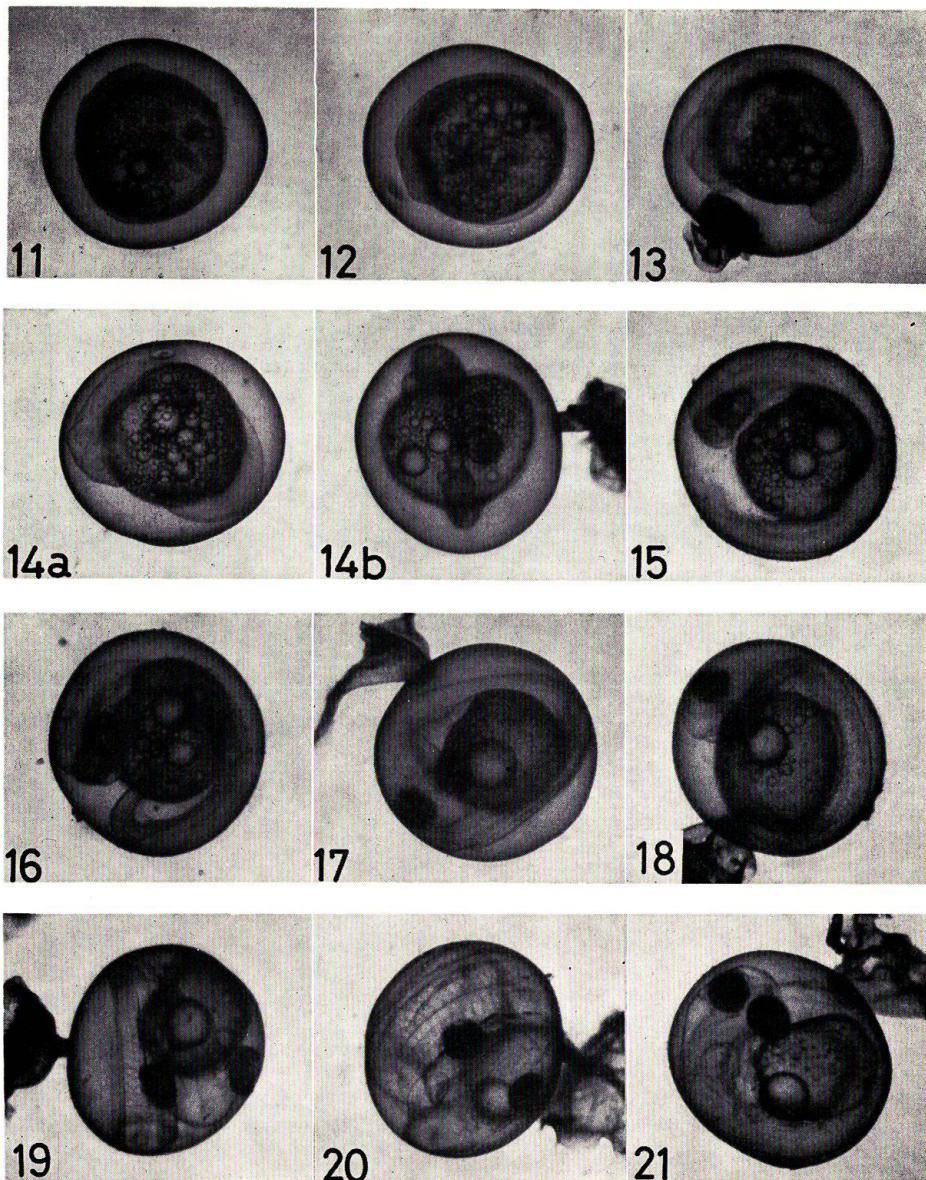
- Text-fig. 1. Formation of blastodisc (1 hr. 20 min.)
2. One-celled stage (2 hrs. 20 min.)
3. Two-celled stage (3 hrs.)
4a, 4b. Four-celled stage (4 hrs. 30 min.)
5. Eight-celled stage (6 hrs.)
6. Sixteen-celled stage (8 hrs.)
7. Thirty-two-celled stage (9 hrs.)
8. Morula stage (12 hrs.)
9. Blastula stage (17 hrs.)
10a, 10b. Gastrula stage (32 hrs.)



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PLATE II

11. Formation of embryonic body (66 hrs.)
12. Appearance of optic vesicles (90 hrs.)
13. Formation of lenses (114 hrs.)
- 14a, 14b. Appearance of auditory vesicles (122 hrs.)
15. Body motile little (142 hrs.)
16. Heart beating (161 hrs.)
17. Completion of pigmentation of optic vesicles (173 hrs.)
18. Appearance of hatching glands (232 hrs.)
19. Opening of anus (256 hrs.)
20. Appearance of melanophores on the base of ventral fin fold (334 hrs.)
21. Pre-hatching (356 hrs.)



YANAGAWA: Embryonic Development and Fry of *O. e. mordax*

PLATE III

22. Newly hatched fry, 7.799 mm in total body length (453 hrs.)
23. Six days old fry, 8.848 mm

