BEHAVIOUR STUDIES OF COD LARVAE, *GADUS MORHUA* L.

ANNE BERIT SKIFTESVIK & INGVAR HUSE

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This note describes a study of the behaviour and feeding of cod larvae by means of computer aided observation and positioning system. The study was undertaken to establish estimates for search volume and activity under different feeding conditions in order to facilitate assessment of optimal prey and larval densities in intensive culture experiments. The results showed a clear activity peak around day 6 both in the starving and the feeding group. Volumes searched were around 10 mm^3/s at day 5, increasing steadily to 100 mm^3/s at day 25 for feeding larvae.

Anne Berit Skiftesvik and Ingvar Huse, Institute of Marine Research, Austevoll Marine Aquaculture Station, N–5392 Storebø, Norway.

The experiments were carried out from 3 May to 10 July 1985. Two larval groups, each containing 1500 larvae, were investigated. One group was fed while the other starved. The eggs were spawned naturally, in a plastic bag, and transferred to an observation chamber where they hatched. The observation period started when 50 % of the eggs were hatched (day 0). The observation ended either, when the larvae died in the starvation group (day 15) or well beyond metamorphosis (day 68) in the feeding group. For the latter group, 98 larvae were still alive when the experiments ended.

The observation chambers contained 70 litres. Temperature was kept at 3–5° C. The chambers were continuously illuminated with a fluorescent tube giving 300 lux at the water surface. The feeding group was offered rotifers (*Brachionus plicatilis* O.F. MÜLLER) and copepod nauplii (*Tisbe* sp.) from day 4 and plankton collected from the sea from day 36. The prey density was kept above 1 per ml.

A schematic overview of the computer aided observation and positioning system is shown in Fig.1. The operator follows the larva by moving the video camera with a joystick. The computer registers the position of the larva every second, and the operator logs behaviour patterns on the keyboard. The third dimensional coordinate is obtained through the focusing of the video camera. Experimentally, 10 randomly selected larvae were individually tracked for five minutes every day for 68 days. An activity period was defined as a period of constant activity consisting of one or several swim bursts.

The mean number of activity periods per observation period is given in Fig.2. An activity peak at day 6 was found both for the starving and the feeding group. This is in accordance with the findings of SOLBERG & TILSETH (1984) with regard to swimming activity and oxygen uptake. The activity level of the feeding group was higher than that of the starving group from day 4, when food was introduced. The difference seems attributed to the presence of prey. The activity difference was greatest on the day of feed introduction, even

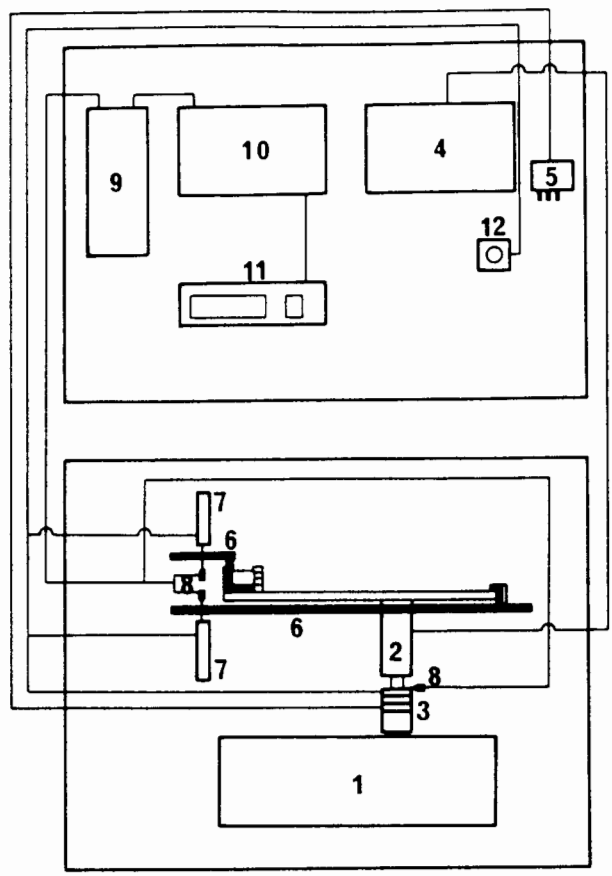

Fig.1. Schematic view of the behaviour observation system seen from above (Modified from HUSE & SKIFTESVIK 1985). 1. Observation chamber. 2. Video camera. 3. Lens with motor focus and monitor iris. 4. Video monitor. 5. Iris control. 6. Belt drives for camera movement. 7. Servo motors. 8. Potentiometers. 9. Analog/digital converter and diskette drives. 10. Microcomputer monitor. 11. Keyboard. 12. Joystick.

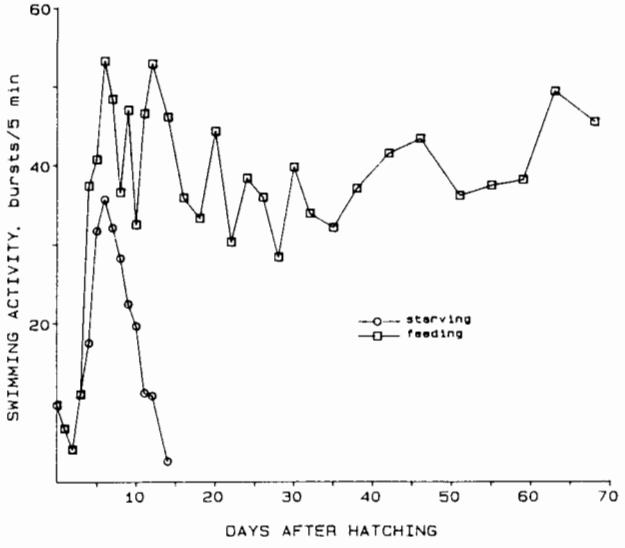

Fig.2. Swimming activity of feeding and starving cod *(Gadus morhua* L.) larvae. Each data point is the mean of 10 larvae.

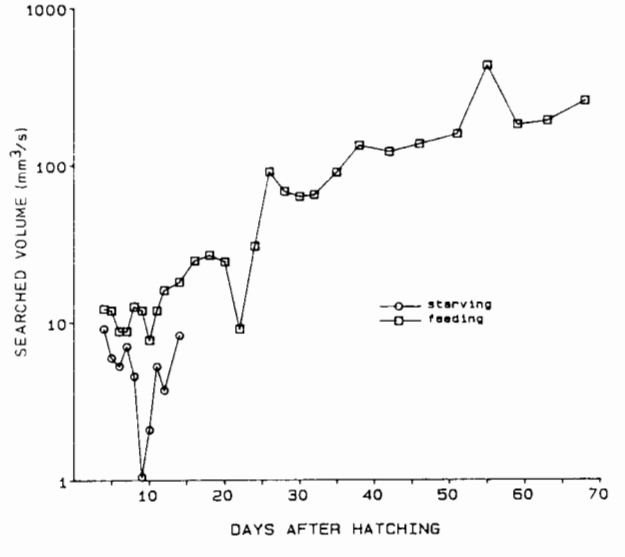

Fig.3. Searched volume, mm^3/s, of feeding and starving cod *(Gadus morhua* L.) larvae. Each data point is the mean of 10 larvae.

though the majority of the larvae at that day did not have a functional jaw. This suggests that the presence of prey stimulates activity in the cod larvae even at prefeeding stages. Consequently, food should not be presented before the feeding stage to avoid unnecessary energy expenditure.

Mean volume searched (mm^3/s) (BLAXTER & STAINES 1971) is shown in Fig.3. Perception distance was set to one standard length, and lengths were adjusted at day 4, 11, 24, and 32. Search volumes after day 40 thus, became less reliable. Compared to the results of SOLBERG & TILSETH (1984), swimming speeds, and therefore also volume searched, were substantially lower in the present study. This is most likely related to differences in experimental layout:

The observation chamber used by SOLBERG & TILSETH (1984) was 3.5 litres compared to 70 litres in the present study. The smaller volume may induce a higher activity level due to more frequent collisions with the walls.

The larvae in the present study were maintained in the observation chamber throughout the experiment, while SOLBERG & TILSETH (1984) transferred the larvae into the chamber prior to observation. We aimed at eliminating any stress which could artificially increase activity.

SOLBERG & TILSETH (1984) observed only free swimming larvae, while in the present study larvae staying at the surface were also included, as this study related to laboratory conditions contrary to the natural.

The volume searched at the beginning of feeding was found to be c. 36 ml/hour. SOLBERG & TILSETH (1984) calculated a demand for exogenous food of c. 0.1 calories per larva/day, and an energy content of a copepod nauplii of 1.7×10^{-3} calories. A rotifer *(Brachionus plicatilis)* has an energy content of c. 1.0×10^{-3} calories (THEILACKER & MCMASTER 1971). This means that a first feeding cod larva requires around 100 rotifers per day. With a feeding success of 11 % (SOLBERG & TILSETH 1984) the rotifer density should be c. 1 per ml which is well within what is considered normal in laboratory experiments.

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