Deliverable Report

Deliverable No:	D11.2		**Delivery Month:**	36
Deliverable Title	Report on optimal characteristics of feed particles and feeding environment for early weaning of Atlantic halibut larvae.			
WP No:	11		**WP Lead beneficiary:**	P17. NIFES
WP Title:	Nutrition - Atlantic halibut			
Task No:	11.1		**Task Lead beneficiary:**	P7. IMR
Task Title:	Early weaning of Atlantic halibut			
Other beneficiaries:				
Status:	Delivered		**Expected month:**	36
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Other Scientists participating: Harboe, Torstein (IMR)

Objective: The objective of this Deliverable was to develop a protocol for early weaning of Atlantic halibut (*Hippoglossus hippoglossus*) larvae.

Introduction

Atlantic halibut larvae are approximately 12 mm in standard length (SL) at first-feeding, and because of their relatively large larval siz, they are first-fed on *Artemia* nauplii. The main constrains for Atlantic halibut hatcheries are (1) slow growth during the late larval stages and (2) high mortalities caused by opportunistic bacteria and 3) slow growth after weaning.

The slow growth in late larval stages may be overcome by early weaning. Most often, weaning of Atlantic halibut occurs only at 60 days post first-feeding (dpff), but attempts have been made to introduce formulated diets from 20 and 50 dpff, with varying results. The first problem arising is that the larvae refuse to eat formulated feed (Harboe, Hamre and Erstad, unpublished results). It has frequently been observed, however, that they ingest inert particles such as *Artemia* cysts and pollen from pinewood, the main similarity being that both particles have neutral buoyancy and a bright color. Previous experiments have also shown better feed ingestion with floating compared to sinking feed particles. Furthermore, the structure of the visual system of Atlantic halibut larvae indicates that they hunt prey in the horizontal plane (Helvik, pers. com.), favoring feed intake when particles stay in the same position in the water column for some time.

In 2015 we chose three candidate feeds (AgloNorse, Otohime and Gemma micro) based on chemical content and earlier experience, and tested them for weaning of Atlantic halibut larvae 28 dpff in a 5-d experiment. In 2016, the best feed was given to Atlantic halibut larva at 15, 22 and 28 dpff, again for 5 d, using the same experimental conditions as in 2015. The gut filling of the larvae was observed in the morning and in the evening.

Materials and methods
2015 experiment:
Approximately 5000 Atlantic halibut larvae were transferred from a yolk sac incubator (silo) to a standard 1.5-m diameter 0.8-m depth first feeding tank. The larvae were fed *Artemia* nauplii from 1 until day 28 dpff and then transferred to 50-l tanks (**Figure 1**). In the experiment, the larvae were fed either Gemma micro, AgloNorse or Otohime in triplicate tanks for 5 d. Larvae in one tank were fed *Artemia* to have a quality control. Each tank had continuous water supply of 10 l / hour, central aeration and a belt feeder. Clay was added to the tanks three times a day to create turbidity. Larvae were fed formulated feeds continuously, using belt feeders, and were also hand fed three times during a day. In the morning before handfeeding and clay addition and in the evening after handfeeding, 28 larvae were examined for gut content using a strong light. The categories used for gut fullness were full, partly full and empty.

2016 experiment:
We use the same setup as in the 2015 experiment above. The aim was to wean the larvae using the best feed from last year (Otohime) at 15, 22 and 28 dpff.

Results and Discussion
The gut fullness of larvae was lower in the morning than in the evening in both experiments, possibly because the gut fullness was measured before and after handfeeding and clay addition in the morning and evening, respectively (**Figures 2 and 3**). According to the evening measurements in the first experiment, larvae fed *Artemia* were almost full after one day and stayed full for the rest of the experiment. Larvae fed Otohime showed increasing fullness over the whole period and on day 5, almost 100% of the larvae were full in the evening. The fraction of larvae with food in their gut increased more slowly on Gemma and Aglonorse. On the evening of day 5, 12.0±0.6 and 14.7±1.2 larvae, respectively, out of 28 had filled guts, while 0-0.3 larvae had partly filled guts on these diets.

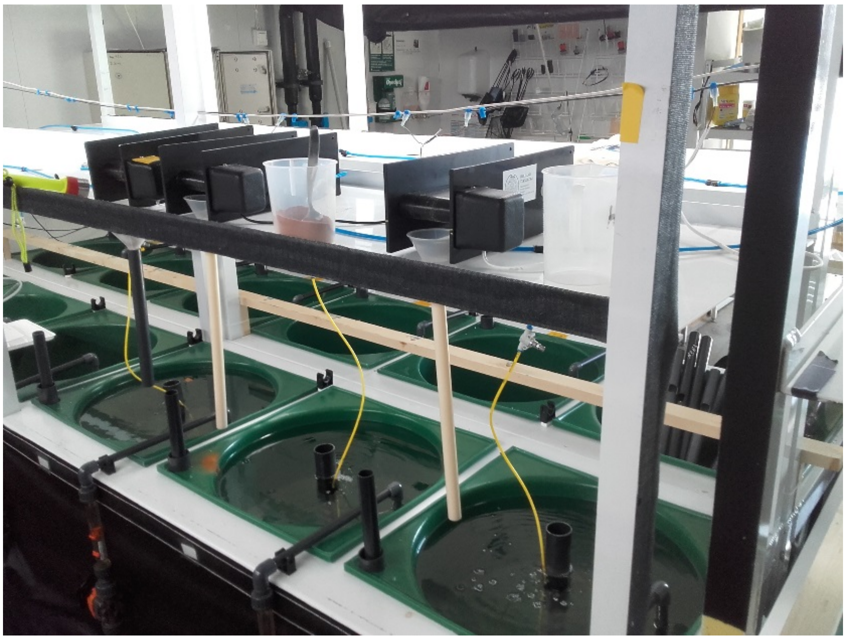

Figure 1. Tanks used for early weaning of Atlantic halibut larvae.

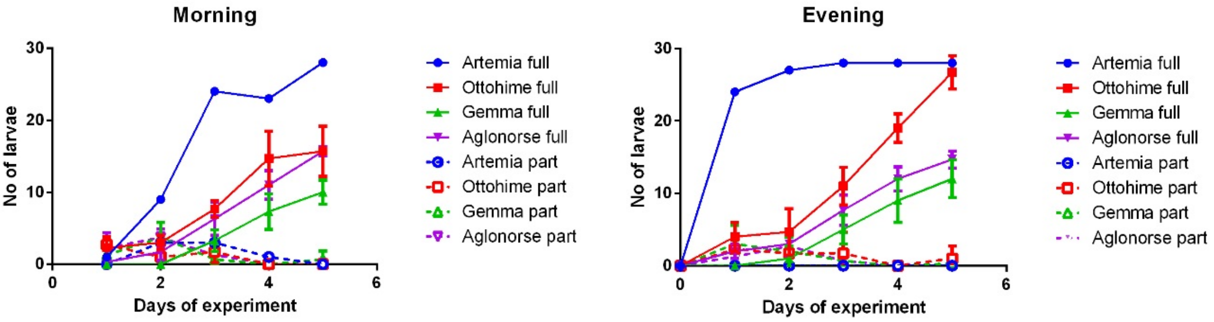

Figure 2. Gut filling in Atlantic halibut larvae fed different diets for 5 days from 28 dpff. The experiment was run in triplicate tanks and 28 larvae were examined for gut filling morning and evening each day. The categories for gut filling were full, partly full and empty.

In the second experiment (**Figure 3),** the number of larvae with filled guts was very low when weaning started on 15 dpff, concomitant with almost total mortality during the five days the experiment lasted. When weaning started on 22 dpff, both feed intake and survival were higher than on 15dpff. Weaning on 28 dpff resulted in a mortality of only 3±1 out of 17±2 larvae and all surviving larvae were full on day 3 of the experiment. The low success rate at the two early time points may be connected to the rearing system, which may have been suboptimal for pelagic larvae or to the quality of the feed.

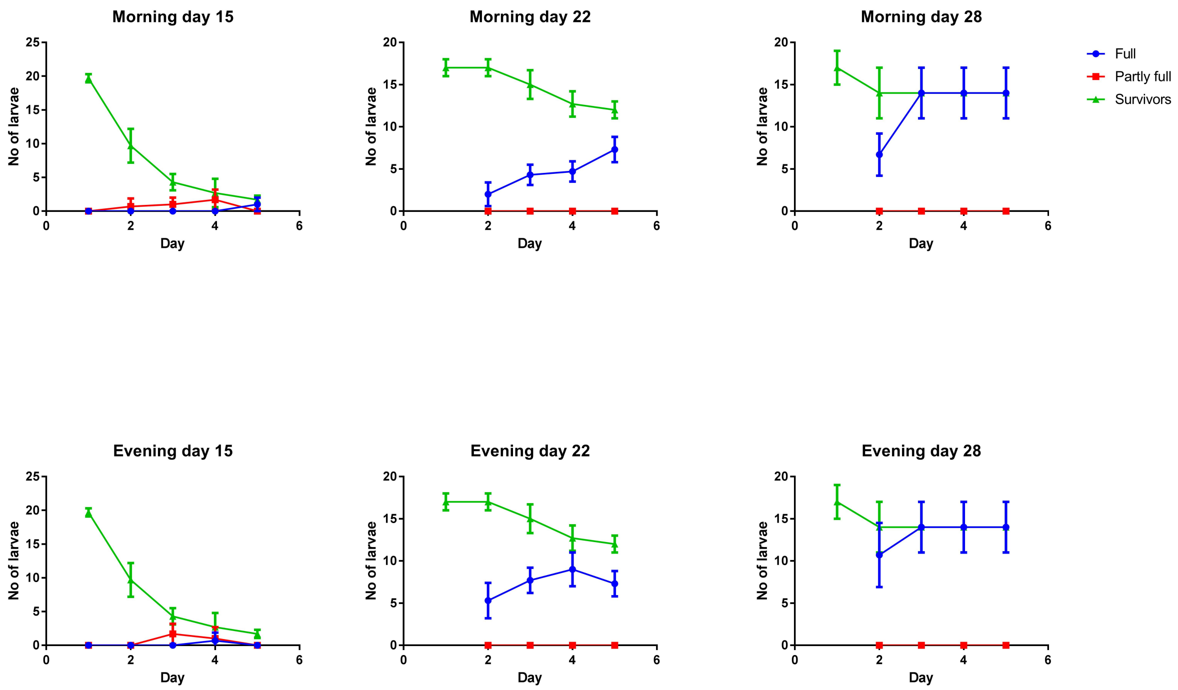

Figure 3. Gut filling and mortality of Atlantic halibut larvae fed the Otohime diet for 5 d, starting from 15, 22 and 28 dppf. The gut filling of the larvae was observed in the morning before handfeeding and in the evening after handfeeding. The data are mean±SD of full, partly full and surviving larvae in three tanks.

Conclusion
Otohime was the best of the three diets for weaning of Atlantic halibut larvae. The diet gives good feed intake during weaning of Atlantic halibut larvae from 28 dpff, while earlier weaning may give high mortalities. The ability of the larvae to digest and grow on the diet must be tested in further experiments. Early weaning should be further tested in rearing systems that are better adjusted to pelagic Atlantic halibut larvae. Due to their size and swimming abilities we have so far not been able to first feed them in tanks smaller than 100 cm in diameter. It seems that the larvae need time to adjust to the prey or feed particle before intake of the particle, and that this process needs time and space. Floating characteristics of the particle is also important since *Artemia* cysts are a preferred particle for first feeding Atlantic halibut larvae.

Deviations: There were no deviations from the approved DOW.

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