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INTENSIVE PRODUCTION OF COD FRY
SYSTEMS AND RESULTS SO FAR

by

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ABSTRACT

Experiments were started in 1979 with the aim of developing methods for intensive production of cod fry. Eggs were hatched in indoor incubators and transferred to large PVC-coated nylon fabric bags in the sea for start-feeding. Natural plankton for start-feeding was collected from the sea with propeller pumps and net cones, and was distributed directly and automatically to the larvae in the bags. Cultured rotifers Brachionus plicatilis were also used as start-feed.

Survival has varied between 0 and 5% in different years. The largest production so far was 5000 5 cm fry in 1982.

A spawning and egg collecting system for cod was developed. It consisted of a 175m^3 bag with a roof and a collecting net. The eggs were brought into the net by a rotation of the water column in the bag. This rotation was set up by introducing the incoming water horizontally through a nozzle at depth of about 2 m.

Research is being done to produce an inert diet for start-feeding larvae. The production potential and nutritional quality of local marine rotifers are also being tested.

INTRODUCTION

During the last decade fish mariculture has gone through a tremendous development. Large sea ranching programs have been launched both in Japan and in the U.S., and intensive fish farming in the sea has become an industry in Europe as well as in Asia.

The breakthrough for marine fish mariculture came with the development of methods for fry production of red sea bream in Japan and turbot in Great Brittain. These events led to a general increase of interest in this field in many countries and for many fish species.

In Norway an intensive fry mass rearing program was started at Austevoll Marine Aquaculture Station in 1979 (Jensen et. al 1979). Cod was chosen as a model animal as it is one of the most throroughly investigated marine fish species. It is also the most important species in the North Atlantic fisheries. The main objective of the program was to mass produce fry for restocking purposes, but today there is also great interest for cod farming in the Norwegian aquaculture industry.

SYSTEM DESCRIPTION, DEVELOPMENT, AND EVALUATION

A system for intensive mass production of fish fry normally includes components for the following purposes:

1. Egg procuration
2. Incubation
3. Larval rearing
4. Start feed collection/production

In the following the development of each component in the system used at Austevoll will be described and evaluated.

Egg procuration

The first season the parental fish was stripped. Stripping has its advantages if homogeneity in egg quality is a prerequisite. In production experiments, however, a steady supply of good eggs is very important, so for the 1980 season it was decided to let the fish spawn in a 175 m^3 plastic bag or pen (Huse & Jensen, 1980). Before the spawning season the brood stock is kept in ordinary net cages. At the onset of spawning, normally around 10th of February, the fish is transferred to the spawning pen. First the fish is weighed and measured. Then a number is tatooed on the ventral side of the fish, and the fish is dumped into the spawning pen. There it spawns and the eggs are collected. The collection is brought about by rotating the whole water column in the pen and catching the eggs with a surface net mounted in the pen. The rotation of the water column in the pen is set up by introducing the supply water through a nozzle which is mounted horizontally along the pen wall at about 2 m depth. Only small adjustments have been made to this system since 1980. This season a modified egg collector was attached to the end of the net, giving a better water flow over the eggs and also a better flow through the system resulting in more effective collection. With a few exceptions and accidents the system has functioned very well and the brood stock of abt. 100 fish have given a steady supply of good eggs of around 4 liters per day for the 2 months the spawning season lasts. A detailed description of the spawning/egg collection system is given in a paper presently being published in Aquacultural Engineering (Huse & Jensen 1983).

Incubation

Very little has changed in the hatchery during the project period. The eggs are placed in black 100 l polythylene cylinders with a diameter of 50 cm. Water is supplied at the top and drained through a bottom filter. The gravel filters used

in the first seasons are now exchanged with synthetic foam rubber filters. The supply water is filtrated and UV-treated. Each incubator takes about 500 000 eggs. The hatching percentage has varied greatly, but normal expectancies are between 50 and 80%. Fungal infections cause the greatest problems. The system was adopted from Flødevigen Biological Station and has given good service.

Larval rearing

The first season the whole larval rearing phase took place in a 175 m^3 plastic pen. The results were promising, but the rearing system was not easy to operate. For the 1980-season a system with several 15 m^3 pens floating inside bigger pens was designed. The idea was to start feed the larvae in the smaller pens and then emptying these into the bigger pens when the fry were able to sustain lower food densities. The big pens would act as a water bath as well as a wave breaker for the smaller ones and later provide extra space for the growing fry. The system functioned reasonably well, so with minor modifications we also run the 1981 season. To add further to our chinese box theory with smaller units inside bigger ones the 15 m^3 start feed pens were supplied with inner plankton gauze bags of 3 m^3 (Huse & Jensen, 1981). The idea was to concentrate larvae and start feed in a small volume to create better prey densities. The idea failed, and so did the whole 1981 season. Algal growth in the pens with subsequent clogging of filters and sinking of pens had caused many of the problems in 1981. For the 1982 season we therefore supplied the big pens with roofs (Huse et al., 1982a). We did manage to stop algal growth, but with the unwanted side effect that the larvae also almost stopped growing. Nevertheless, we had a fairly good result in terms of numbers with 5 000 produced fry.

Before the 1983 season we summed up all our good and bad experiences and designed a new system. The basic unit is a 10 m^3 pen made of transparent 3-ply wowen and welded polyethylene while the other pens were made of PVC-coated nylon fabric. The new material is cheaper, less likely to be fouled, and is

biologically inert while the PVC-coating is questionable in this respect. The floating collar is made with a very high fence to withstand sinking and wave action. The pens can be drained either through a bottom drainage hose or through a flexible drainage hose with a large filtering tube at the end of the hose. This filtering tube can be placed anywhere in the pen and can also be taken up for cleaning. The flexible hose attached to this filtering tube is led through the pen wall at surface level. Normally most of the supplied water is drained through this system. The bottom drainage is mainly used to get rid of sedimenting food. This is done very effectively as the bottom of the pen is conical. The big water bath pens are abandoned. Ligth level in the pen is controlled by placing dark nylon netting over it. In the 1983 season this system has functioned very well indeed, and we have no plans of changing it.

Start feed collection and production

The basis of the whole project was the theory that living plankton could be collected by filtrating large amounts of sea water. A system for doing so was constructed in 1979 (Jensen et al., 1979) and has only gone through minor adjustments since then. The system consists of a propeller pump and two filtrating cones made of plankton gauze, the one inside the other. The inner cone has a mesh size of 250 µ while the mesh size of the outer one is 120 µ. Both cones end up in hoses which are led to units of collection and further concentration. The plankton used for start feed goes through the inner cone and is stopped by the outer one. Thus it ends up in the hose which leads from the tip of the outer cone. In the 1979 season this hose ended up directly in the big production pen. The flow in the hose was aided by a small pump.

For the 1980 season two parallel systems were installed, and the start feed hoses were led into a concentration bag made of plankton gauze. From here plankton was distributed to the different start feed units by an automatic pump and a piping system. The whole system is basicly the same today apart from

minor adjustments and the installation of a new peristaltic distribution pump. The quantity and quality of the plankton is monitored by means of a particle counter and microscope. As a technical device the plankton collection system functions quite well. One is forced to use relatively coarse mesh size in the filtering cones to avoid clogging by algae. This means that valuable start feed like most rotifers is lost. Vulnerable organisms are also destroyed in the system. However, the system can, depending on abundance, collect substantial amounts of crustaceans, mainly different stages of copepods.

The time when copepod nauplea can be caught in large quantities in the spring is short. We therefore went looking for an alternative start feed source, and the answer was all too obvious, namely cultured rotifers. So far we have used it only supplementary and experimentally in the 1982 and 1983 season. The cultured species is Branchionus plicatilis, but domestication experiments with local species are also taking place. The rotifers have been grown both on dry compound feed and on algae. Our experience is that rotifer culturing is not complicated, but production at high densities require much attention and good husbandry.

Sampling

The first four seasons sampling was carried out by means of plexiglass tubes and small plankton nets. For the 1983 season a new device was designed. It consists of two PVC-tubes and a plankton gauze net with the same length as the depth of the start feed pens. Both tubes and net have approximately the same diameter, and the net is attached to the two tubes at the ends. When making the sampling device ready the net is threaded on to the bottom tube, and when this is done the top tube is attached to the bottom tube by friction. The bottom tube has a bottom plate with a corked hole for drainage and a side window with plankton gauze. The top tube has a conical top to diminish aperture. This top can be removed. In operation the device is first lowered to the bottom of the pen along the side by means of a fishing rod with nylon gut. Then the two tubes

are divided by a strong jerk with the fishing rod and the top tube with net attached is brought rapidly to the surface, pulled up, and the content of the lower tube is concentrated and preserved. Afterwards the larvae are examined and eventually weighed with microgram precision. The new sampling system has functioned well in the larval stages with increasing avoidance towards metamorphosis.

Lab experiments

A series of lab experiments has also been carried out (Huse , 1981; Huse et al. 1982b). The main part of the experiments have been aimed at trying to develop an artificial start feed for marine fish larvae. This work is a cooperation with the Institute of Biochemistry at the University of Bergen where a research team are studying the endocrine development of the digestive system of cod larvae with special emphasize on hormons. There is also cooperation with the University of Tromsø in this work. The results so far are interesting and promising, but not revolutionary. The facilities for doing lab studies at Austevoll are greatly improved by a new lab, and a good filtration and UV treatment system.

CONCLUSION

In 1979 we produced 600 cod fry and were optimistic. In 1982 we produced 5 000 fry and were pessimistic. This year we also produced 5 000 fry, but now we are optimistic again for two reasons:

1. All our systems have functioned very well technically speaking.

2. We have found an explanation to many of our earlier problems.

Through a series of experiments we have managed to show quite clearly that the collected zooplankton we use as start feed cause physical harm to the larvae resulting in heavy mortality.

Lillelund and Lasker (1971) and other authors have described predation on fish larvae by copepods. These investigations, however, are mainly carried out with adult copepods which have body lengths of around 3 000 µ while we screen our plankton through 250 µ mesh. Still our experiments this season clearly show that even these small plankters (nauplia, copepodites, and adult copepods of small species) cause deadly harm to yolk sac cod larvae. These findings explain many strange larval mortality patterns we have observed during these five years, and also more or less dictate the strategy for the future: The larvae will be start fed for a short time with cultured rotifers only and then gradually be offered collected plankton. In the laboratory we have had very good growth- and survival results for cod larvae fed rotifers enriched with dry nutriant mixture according to the methods described by Gatsoupe and Luquet (1981). So if our planned escalation of rotifer production goes well we also hope to be able to enhance our production experiments substantially.

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