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# WEANING TRIALS WITH COD *(GADUS MORHUA L.)* FRY ON FORMULATED DIETS

by

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ABSTRACT

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In the course of three experiments, three size groups of cod fry, (13, 49 and 465 mg wet-weight) were offered 6 different diets: One wet feed, one moist feed, three commercial dry feeds and one of the dry feeds supplied with live plankton. Each experiment lasted for 28 days.

Growth was similar on all diets, probably because of prominent cannibalism. Significant differences in biomass and survival were found. Survival ranged from 0 to 39 % for the smallest group and from 72 to 90 % for the largest group. Moist feed gave the best survival rate, 39, 64 and 90 % in the small, medium and large size group, respectively. Cannibalism was a major cause of the mortality in all experiments, and averaged 28 % of the total mortality rate in the smallest size group. No clear relationship between cannibalism and diet was observed.

## INTRODUCTION

In recent years there has been a growing interest in intensive farming, and sea-ranching (Svåsand, 1990), of Atlantic cod *(Gadus morhua L.)* in Norway. The production of fry has been one of the major bottlenecks in the development of cod farming. First feeding cod larvae on formulated diets has not been established (Garatun-Tjeldstø *et al.*, 1989). Fry production has so far mainly been carried out in extensive systems (Øiestad *et al.*, 1985), relying on natural zooplankton as the only food source for larvae. These systems are very suitable for first feeding cod larvae, with relatively high survival beyond metamorphosis (Øiestad, 1985). After metamorphosis the quantity of food needed for the rapidly growing fry is difficult and costly to meet with zooplankton alone, resulting in severe mortality due to starvation and subsequent cannibalism (Øiestad *et al.*, 1985; Blom *et al.*, in press).

Therefore, to increase the production capacity and reduce the cost per fry, it is essential to wean the fry to a formulated diet before zooplankton biomass in the rearing unit is depleted. At present, cod fry are weaned to commercial dry diets at an age of 2 - 3 months, or when they weigh 0.15 — 2 gram (Bromley and Sykes, 1985; Øiestad *et al.*, 1985; Folkvord, 1989; Blom *et al.*, in press), which often is too late to prevent heavy mortality (Øiestad *et al.*, 1985; Blom *et al.*, in press). Results on weaning cod of smaller size has not been published, and scarce information is available on effects of the type of feed. Successful weaning of cod fry to a formulated diet depends basically on two factors: the feed intake, and the ability of the diet to meet the nutritional requirements of the fry. The stomach and pyloric caeca of cod fry starts to develop at about 15 mm length and reach the juvenile form at 40 mm (Pedersen and Falk-Pettersen, 1990), a factor that is clearly related to nutritional requirements. The acceptance of the diet is related to palatability, texture and other physical properties of the diet.

The purpose of this study was to investigate at what fish size weaning could be feasible on to commercial dry diets, and to compare these diets with new diets with higher water content and presumably a better palatability and texture.

## MATERIALS AND METHODS

During the summer of 1989 three experiments (Exps.I, II and III) were carried out on different size-groups of cod fry.

Six diets (Table 1), with three replicates were tested in each experiment. The wet feed (WF) was squid mantle, homogenized and supplied with sardine oil, vitamins and minerals as described by Hemre *et al.* (1989). The

*Table 1:* Chemica l composition (% of wet-weight) and gross energy (kJ/g dry-weight) of the diets used in the experiments.

| DIET | DRY MATTER | PROTEIN | FAT | GROSS ENERGY |
|---|---|---|---|---|
| Wet feed (WF) | 25 | 18 | 2 | - |
| Moist feed (MF) | 67 | 33 | 10 | 21.9 |
| Dry feed 1 (D1) | 92 | 39 | 12 | 20.8 |
| Dry feed 1 supplied with live plankton (D1P) | 92 | 39 | 12 | 20.8 |
| Dry feed 2 (D2) | 94 | 73 | 4 | 24.7 |
| Dry feed 3 (D3) | 91 | 51 | 12 | 21.5 |

moist feed (MF) was made from commercially available salmon feed (25 % silage, 25 % crude fish, 46 % Salmomix-35 and 4 % shrimp-shells) by adding 14 % krill-meal and 0.9 % vitamin C. It was graded through a 1 mm Endecott sieve for Exps. I and II, and a 2 mm sieve for Exp. III. Dry feeds 1 and 3 (D1 and D3) were commercially available diets, commonly used for weaning and ongrowing of marine fish fry in Norway. The main fat and protein source in D1 and D3 were capelin oil and fish-meal (Norse LT-94) respectively, and squid- and/or krillmeal were used as attractants. In Exps.I and II 0.6 mm granulates were used, and in Exp.III 1.0 mm granulates. Dry feed 2 (D2) was a commercial test diet of dried cod eggs. The last diet was D1 supplied with live zooplankton (D1P). The amount of plankton supplied was not recorded, but was of minor quantity compared to the dry feed. Live plankton for D1P were collected from a plankton filter and supplied 1 — 2 times per day. All feeds except WF were fed in excess with automatic disc feeders, which dispersed feed every 60 sec. Wet feed was hand fed in excess 2 — 4 times per day. Surplus feed was drained from the tanks once a day.

The experiments were carried out in facilities connected to the production pond Parisvatnet (Blom *et al.*, in press), located 60 km north west of Bergen, Norway. Eighteen circular tanks (v = 180 L) with conical bottoms, made of black fiberinforced polyester were used in each experiment. The seawater was taken from a depth of 30 m, filtered (20 $\mu$m) and treated with UV-light. Mean temperatures during the three experiments were 8.9, 9.2 and 10.9 ° C respectively (range: 7.1 — 11.0, 7.1 — 11.2 and 8.5 - 13.4 °C). Salinity varied from 30.9 to 33.6 g/L. The tanks were constantly illuminated (range 60-240 lux) with fluorescent tubes in the ceiling.

The cod fry used in the experiments were collected gently from the production pond, where they had been eating natural zooplankton. Day of hatching was March 15, 1989 ($\pm$ 2 days). They were kept in a tank for one day before the start of each experiment to eliminate injured individuals. The largest individuals were also removed. Standard-length and wet-weight were measured from a sample of the remaining fish (Table 2). The stocking density was 100 individuals per tank in Exps.I and II, and 50 individuals per tank in Exp.III. Dead fish were replaced with new fish on the following day.

Each experiment lasted for 28 days. Daily mortality was recorded and the fish were counted after 14 days. At the end of the experiment all the fish were counted and individually weighed (wet-weight). Missing fish were ascribed to cannibalism. In Exp.II one of the tanks (MF) was excluded from the results, because of total mortality caused by a stop in the water supply. In Exp.III one tank from the D1 and one tank from the D3 groups was excluded for the same reason.

From Exp.II a sample of fish were frozen for chemical analysis and

*Table 2:* Date of start, numbers of fish measured, wet-weight in mg (mean, SD, maximum size and minimum size) and standard-length in mm (mean and SD) at start of the three experiments.

| EXP. Ø | DATE | N | WET-WEIGHT | | | | LENGTH | |
|---|---|---|---|---|---|---|---|---|
| | | | Mean | SD | Max | Min | Mean | SD |
| I | 10 May | 50 | 12.8 | 4.35 | 26 | 7 | 12.2 | 1.31 |
| II | 19 May | 100 | 49.2 | 16.26 | 103 | 24 | 18.6 | 1.95 |
| III | 9 June | 100 | 464.5 | 141.16 | 1247 | 256 | 37.1 | 3.32 |

bomb-calorimetry. Diets and whole fish (Exp.II only) from all tanks were analyzed in pooled samples for water, protein and fat. Protein (N * 6.25) was determined according to Crooke and Simpson (1971) and fat was extracted with ethyl acetate. Gross energy content in feed and pooled samples of whole fish were measured with a Gallenkamp Autobomb according to Ulgenes (1982). Measurements were not corrected for acid production.

Differences in survival and biomass between groups fed different diets at the end of each experiment were tested with 1-way ANOVA (Model 1), and the group means were subsequently compared using Scheffe's procedure (Sokal and Rohlf, 1981). Differences in chemical composition and energy content among the fish fed different diets were tested in the same way. Homogeneous variances and normal distributions were tested with Cochran's test and Wilk-Shapiro tests respectively (Zar, 1974; Sokal and Rohlf, 1981).

## RESULTS AND DISCUSSION

Survival in Exp.I is presented in Table 3. All the fish fed wet feed died during the experiment. 82 % of the mortality could be accounted for by collected dead fish, the remaining 18 % was ascribed to cannibalism. It was very difficult to grade WF to feed particles of suitable size and texture. The total mortality on WF was thus probably a result of a low acceptance due to its unsuitable texture, as well as the infrequent feeding. The survival of the remaining five groups was significantly different ($P = 0.0022$). Moist feed gave the highest mean survival of 39 % which was significantly higher than that for D1, D3 ($P < 0.05$) and D2 ($P < 0.01$). Biomass per tank at end of the experiment (Table 3) was also significantly different between the diets (P =

*Table 3:* Mean percentage survival, percentage mortality ascribed to cannibalism, growth rate (pooled tanks) and biomass among the diets after termination of Exps. I, II and III. Standard deviations are given in parenthesis (n = 3).

| EXP. Ø | DIET | SURVIVAL (%) | | CANNIBAL. (%) | | GROWTH RATE (%) | | BIOMASS (mg) | |
|---|---|---|---|---|---|---|---|---|---|
| | WF | 0 | | 18 | (13.5) | - | | - | |
| | MF | 39 | (3.1) | 29 | (4.6) | 5.45 | (1.00) | 2686 | (393) |
| I | D1 | 17 | (8.2) | 40 | (11.1) | 4.87 | (2.10) | 1031 | (647) |
| | D2 | 8 | (2.5) | 20 | (6.5) | 5.91 | (2.18) | 620 | (307) |
| | D3 | 12 | (3.0) | 25 | (4.6) | 6.69 | (2.27) | 1221 | (505) |
| | D1P | 25 | (12.4) | 37 | (15.9) | 5.74 | (2.23) | 2010 | (160) |
| | WF | 9 | (5.9) | 76 | (11.2) | 8.37 | (2.31) | 4768 | (2010) |
| | MF[1] | 64 | (14.1) | 26 | (10.6) | 8.45 | (1.68) | 33509 | (18) |
| II | D1 | 36 | (23.6) | 59 | (24.5) | 9.07 | (2.09) | 23172 | (9608) |
| | D2 | 48 | (15.8) | 30 | (19.9) | 8.89 | (1.79) | 28363 | (5947) |
| | D3 | 65 | (9.6) | 24 | (11.7) | 8.72 | (1.46) | 35418 | (2909) |
| | D1P | 61 | (19.0) | 29 | (16.6) | 8.44 | (1.72) | 31976 | (11341) |
| | WF | 72 | (7.2) | 9 | (3.1) | 4.98 | (1.51) | 70304 | (12412) |
| | MF | 90 | (1.2) | 3 | (3.1) | 4.76 | (1.35) | 82373 | (2184) |
| III | D1[1] | 80 | (2.6) | 10 | (5.7) | 5.48 | (1.20) | 86916 | (5156) |
| | D2 | 76 | (4.0) | 10 | (3.5) | 5.66 | (1.59) | 89339 | (3945) |
| | D3[1] | 88 | (7.0) | 5 | (4.2) | 5.41 | (1.62) | 96630 | (9402) |
| | DIP | 84 | (8.2) | 7 | (3.1) | 5.46 | (1.40) | 91313 | (1534) |

[1] One tank excluded from the calculations due to technical accident.

0.0012), with MF giving significantly higher biomass than D1, D3 ($P < 0.05$) and D2 ($P < 0.01$).

In Exp.II. D3, MF and D1P gave the highest survivals, 65, 64 and 61 % respectively (Table 3), similar to Folkvords (in press) experience for 0.2 gram cod fed dry feed for 4 weeks (73 %). Fish fed D1 and D2 had a considerable lower survival (36 and 48 %), and only 9 % survived on WF. Although differences in survival among fish fed different diets were significant ($P = 0.0097$), the relatively large differences between triplicates resulted in only WF and D3 means being significantly different according to Scheffe's procedure ($P < 0.05$). Mean biomasses per tank at the end of the experiment (Table 3) was also significantly affected by the treatments ($P = 0.0025$). Wet feed was significantly different from all other diets, except D1 ($P < 0.05$ for MF, D2 and D1P; $P < 0.01$ for D3).

Survivals ranged from 72 to 90 % in Exp.III (Table 3). As in Exp.II, MF and D3 apparently gave the highest survival. Although the differences between the diets were judged to be significant by ANOVA ($P = 0.0276$), Scheffe's procedure did not reveal any significant differences between pair of means. Mean biomasses per tank (Table 3) also were quite similar on all diets, although biomass of fish fed WF was significantly lower than that of fish fed D3 ($P < 0.05$).

The good overall results provided by MF may have been caused by a better acceptance due to its higher water content and thus softer texture, although drying on the disc feeders reduced the water content prior to feeding. Atlantic salmon parr preferred soft feed-particles to hard particles (Stradmeyer *et al.*, 1988). Bromley and Howell (1983) on the other hand did not find any significant correlation between the diet water content and survival in turbot weighing about 1 gram. In that study, dry feed resulted in better growth than moist feeds, possible due to a better stability in the water of the dry feed (Bromley and Howell, 1983). In the present study, the attractiveness of MF may have been improved because of the added krillmeal. Extracts from various crustacea are known as attractants for fish (Mackie and Mitchell, 1985) and specifically for cod (Lie *et al.*, 1989). The red colour of krillmeal could also have improved the visual characteristics of the feed (Knights, 1985; Jakobsen *et al.*, 1987).

*Table 4:* Chemical composition (% of wet-weight) and gross energy (kJ/g dry-weight) of fish from termination of Exp.II. Fish fed WF were not analyzed due to insufficient amount of material.

| | DRY MATTER | | PROTEIN | | FAT | | GROSS ENERGY | |
|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| MF | 17.3 | 0.14 | 9.9 | 0.28 | 2.3 | 0.14 | 21.1 | 0.15 |
| D1 | 18.1 | 0.36 | 9.6 | 0.26 | 2.7 | 0.35 | 21.1 | 0.27 |
| D2 | 18.5 | 0.38 | 10.1 | 0.55 | 2.9 | 0.26 | 22.1 | 0.06 |
| D3 | 18.4 | 0.68 | 9.6 | 0.56 | 2.6 | 0.10 | 21.2 | 0.33 |
| D1P | 17.4 | 0.56 | 9.6 | 0.12 | 2.5 | 0.06 | 21.3 | 0.31 |
| POOLED | 18.0 | 0.64 | 9.8 | 0.39 | 2.6 | 0.27 | 21.4 | 0.46 |

Addition of small quantities of live zooplankton may have had a positive effect. Particularly for the two smallest size groups, D1P apparently gave better survival and biomass than D1, although the differences were not significant.

Survival on D2 in Exp.I was poor compared to the other diets, but the difference became smaller in Exp.II and all diets gave comparable survival and biomass results in Exp.III. The hard texture of D2 may have been of importance for the low survival on D2 for the smallest fish, for reasons discussed earlier. In addition, the particles partly floating on the water surface and clinging to the wall of the tanks, may have been difficult for the fry to catch.

Gross energy content (Table 4) of fish fed different diets were significantly different ($P = 0.0040$), and fish fed D2 had significantly higher energy-content than fish fed the other diets ($P < 0.05$). This was probably caused by a higher, although not significantly higher fat and protein content of that fish (Table 4). Some of it could also be explained by remains of energy rich D2 feed in the stomach at the time of analysis. Still, these results indicate that the high energy-content of the D2 feed was reflected in the chemical composition of the fish.

In general D3 gave better results than D1, but the differences were small. The much higher protein content in D3 did not seem to be of major importance for growth or survival of the fish.

When evaluating the experiments we have emphasized survival and biomass per tank at the end of the experiments. In most cases these parameters gave coinciding results. There was usually no clear relationship between growth and diet. In experiments with high rates of cannibalism, the growth properties of the diets will be masked, thus making growth alone a poor estimate of the quality of the diet (Folkvord, in press). Mean growth rates ($100 \times [e^g-1]$; where $g = [\ln W_2 - \ln W_1]/[t_2 - t_1]$) ranged from 4.87 — 6.69 % and 8.37 — 9.07 % per day among the diets in Exp.I. and II respectively. This is well below the figures of Blom *et al.* (in press) for cod fry of the same size (14—17 %), which were reared in a pond. On the other hand comparable or even lower growth rates were reported in cod fry of 0.15 and 0.2 gram fed zooplankton or dry feed, 4.51 to 7.20 and 2.56 to 5.44 % respectively (Folkvord, 1989; Folkvord, in press). Part of this difference may be explained by a higher temperature in our experiment. For the largest size group (Exp.III) the growth in the tanks (4.76 — 5.66 %) was comparable to the growth in pond-experiments (Øiestad *et al.*, 1985).

Total mortality rates during the first and second experimental period were quite similar in Exps. II and III. In Exp.I mortality rates, particulary rates of collected dead fish, were usually much higher during the first experimental period. This demonstrates the inappropriateness of the formulated feeds in meeting the nutritional and behavioral requirements for fish of that size, resulting in a rapid mortality of the smallest and weakest individuals. The size of the fish used in Exp.I corresponds to about 1 week after metamorphosis, when copepods are the main natural feed (Wiborg, 1948). At this stage the morphological structures of the gut are not fully developed (Pedersen and Falk-Pettersen, 1990) and possibly not able to digest fully the diets that were offered.

Cannibalism was a major cause of the mortality in all three experiments (Table 3), and may even be underestimated due to indirect deaths caused by injurious aggressions as suggested by Folkvord (in press). In Exp.I the overall average mortality rate due to cannibalism was 28 %. No clear relationship between cannibalism and total mortality, or diet could be demonstrated. The rates of cannibalism in Exp.II were similar to those in Exp.I, except for fish fed WF and D1, where cannibalism rates were much higher (76 and 59 %). These two diets also gave the lowest survival rate and the highest growth, the latter probably as a consequence of the high cannibalistic rate. Density dependent growth could also explain this difference, although stocking density of 60 or 300 individuals (ca. 1 g wet weight) per tank gave similar growth in an earlier experiment (Otterå, unpublished results). In Exp.III the cannibalism rates were low (mean = 7.3 %).

*Concluding remarks*

Weaning of cod of about 0.5 gram gave acceptable results on all commercial diets, but for smaller fish growth and survival must be improved. This study does not give any clear indication of what type of diet is needed to obtain this, but a moist diet seems to be most promising. In developing a better weaning diet for cod fry, effort should be made to improve the nutritive value of the diet to match the digestion capacity of the fry. Acceptance of the diet also seems to be very important, taste and physical properties of the diet, like texture and sinking rate are important. Cannibalism and feed quality are obviously closely connected, but factors like size distribution of the fish and feeding regime should also be considered to optimize the weaning to a formulated diet.

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## REFERENCES

BLOM, G., OTTERÅ, H., SVÅSAND, T., KRISTIANSEN, T.S. and SERIGSTAD, B. in press. The relationship between feeding conditions and production of cod fry *(Gadus morhua L.)* in a marine semi- enclosed ecosystem in western Norway: illustrated by use of a consumption model. Rapp. P.-v. Réun. Cons. int. Explor. Mer, in press.

Bromley, P.J. and Howell, B.R., 1983. Factors influencing the survival and growth of turbot larvae, Scophthalmus maximus L., during the change from live to compound feeds. Aquaculture, *31*: 31-40.

BROMLEY, P.J. and SYKES, P.A., 1985. Weaning diets for turbot *(Scophthalmus maximus* L.), sole *(Solea solea* L.) and cod *(Gadus morhua* L.). In: C.B. Cowey, A.M. Mackie, and J.G. Bell (Editors), Nutrition and feeding in fish. Academic Press, London. pp. 191—211.

CROOKE, W.M. and SIMPSON, W.E., 1971. Determination of ammonium in Kjeldahl digest of crops by automated procedure. J. Sci. Food Agric., *22*: 9 - 10.

FOLKVORD, A. 1989. Growth and cannibalism of cod fry (*Gadus Morhua* L.) in intensive systems. In: N. De Pauw, E. Jaspers, H. Ackefors and N. Wilkins (Editors), Aquaculture - A bio-technology in progress. European Aquaculture Society, Bredene, Belgium, pp. 133 - 138.

FOLKVORD, A. Growth, survival and cannibalism of cod juveniles *(Gadus Morhua)*: Effects of feed type, starvation and fish size. Aquaculture, in press.

GARATUN-TJELDSTØ, O. OPSTAD, I., HANSEN, T. and HUSE, I., 1989. Fish roe as a major component in start-feed for marine fish larvae. Aquaculture, *79*: 353-362.

HEMRE, G.I., LIE, Ø., LIED, E. and LAMBERTSEN, G., 1989. Starch as an energy source in feed for cod *(Gadus morhua)*: Digestibility and retention. Aquaculture, *80*: 261 — 270.

JAKOBSEN, P.J., JOHNSEN, G.H. and HOLM, J.C., 1987. Increased growth rate in Atlantic salmon parr *(Salmo salar)* by using a two-coloured diet. Can. J. Fish. Aquat. Sci., *44*: 1079 — 1082.

KNIGHTS, B., 1985. Feeding behaviour and fish culture. In: C.B. Cowey, A.M. Mackie, and J.G. Bell (Editors), Nutrition and feeding in fish. Academic Press, London. pp. 223 —241.

LIE, Ø., LIED, E. and LAMBERTSEN, G., 1989. Feed attractants for cod *(Gadus morhua)*. Fisk.Dir. Skr., Ser. Ernæring, *2*: 227 — 233.

MACKIE, A.M. and MITCHELL, A.I., 1985. Identification of gustatory feeding stimulants for fish- applications in aquaculture. In: C.B. Cowey, A.M. Mackie, and J.G. Bell (Editors), Nutrition and feeding in fish. Academic Press, London. pp. 177 — 189.

PEDERSEN, T. and FALK-PETTERSEN, I.B., 1990. Morphological changes during transformation from larvae to juvenile in cod *(Gadus morhua* L.) with particular reference to the development of stomach and pyloric caeca. Development and Aquaculture of Marine Larvae. Symposium 12 — 15 August, 1990, Bergen, Norway; poster no. 9.

SOKAL, R.R. and ROHLF, F.J., 1981. Biometry. W.H. Freeman and Company, San Francisco. 776 pp.

Stradmeyer, L., Metcalfe, N.B and Thorpe, J.E., 1988. Effect of food pellet shape and texture on the feeding response of juvenile Atlantic salmon. Aquaculture, *73*: 217 — 228.

SVÅSAND, T., 1990. Cod enhancement experiments in Norway. In: R.L. Saunders (Editor), Proceedings of Canada-Norway finfish aquaculture workshop, Sept. 11-14, 1989. Can. Tech. Rep. Fish. Aquat. Sci. 1761.

ULGENES, Y., 1982. Energi og ernæring hos fisk. Thesis, University of Bergen- In Norwegian.

Wiborg, K.F., 1948. Investigations on cod larvae in the coastal waters of northern Norway. Fisk.Dir. Skr., Ser. HavUnders., Vol IX. No *3*: 27 pp.

ØIESTAD, V., 1985. Predation on fish larvae as a regulatory force, illustrated in mesocosm studies with large groups of larvae. NAFO Sci. Counc. Stud. *8*: 25 — 32.

ØIESTAD, V., KVENSETH, P.G. and FOLKVORD, A., 1985. Mass production of Atlantic cod juveniles *Gadus morhua* in a Norwegian saltwater pond. Trans. Am. Fish. Soc., *114*: 590 — 595.

ZAR, J.H., 1974. Biostatistical analysis. Prentice- Hall, Inc., Englewood Cliffs, N.Y. 620 pp.